V.—HENRY WILDE.

BY
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HENRY WILDE, the eldest child of a working mechanic, was born in Manchester in 1833. When Henry was sixteen he was left without parents, and had the charge of a younger brother, Joseph, and a sister. The brothers were apprenticed to an engineering firm. Henry soon showed considerable skill, and before he was of age he obtained a position of some responsibility in the works. His leisure hours were devoted to study, especially of electricity; and he constructed electrical machines and made experiments with electrical kites and the electro-deposition of metals. He soon realised the great possibilities of the industrial applications of electricity, and decided in 1856, when he was twenty-three, to set up in business as a telegraph and lightning-conductor engineer. He first had an office in Cross Street, Manchester; but in 1861 he removed to 2, Winter's Buildings, St. Ann's Church Yard.

An important fact in the life of Henry Wilde was the friendship of his brother-in-law, Mr. George Cliff Lowe, silversmith, of 26, St. Ann's Street, Manchester. They became partners, and the firm of Wilde and Co. was established, with a works in Mill Street, Ancoats.

Lightning Conductor Expert.

In 1861 his attention was directed to the danger of having lightning conductors near water and gas pipes, especially when the pipes were made of lead, a metal that may be easily fused by side flashes. He advised that in all cases lightning conductors should be metallically connected with the pipes, which is now the general practice. Wilde established a local reputation as a lightning conductor expert, and in a Lancashire factory town was known as "t' thunder an' leetnin' mon."

Telegraphy.

At the time that Wilde commenced business, commercial telegraphy was fast developing, and he saw that an alphabetic system was likely to be adopted by works and business houses. He devoted five years to the design and manufacture of suitable transmitters and receivers worked by magnetos, and succeeded in producing an ingenious system, which was a rival to that of Sir Charles Wheatstone. The Universal Private Telegraph Company, which used the Wheatstone system, brought an action against Wilde for infringement of its patents; but the action was dismissed with costs.

June 30th, 1920.
The use of Wilde's ABC system was so encouraging that it was decided to extend the sale of the apparatus by the formation of a limited liability company. A prospectus was issued with the object of forming the Globe Telegraph Company, Limited, with a capital of £100,000. The chief object of the company was to establish "a system of private telegraphic communication between Public Offices, Police, Fire and Railway Stations, Banks, Docks, Mines, 'Manufactories, Merchants' Offices, etc." Only about two hundred shareholders were obtained, and £5 per share was called up. To carry out the intentions of the company it was necessary, in accordance with the Telegraph Act of 1863, to have an Act of Parliament. This was obtained in 1864, but the legal expenses were so heavy that the bulk of the called-up capital was required to settle them. About forty firms, including Messrs. Platt Brothers of Oldham, Messrs. Strutt of Belper, Messrs. George Crossland & Son of Huddersfield, Messrs. William Jessop & Sons of Sheffield, and Messrs. Rylands of Manchester, used Wilde's instruments and found them easy to work and of considerable utility. The Telegraph Act of 1868 enabled the Government to acquire, work and maintain electric telegraphs, and the Act as amended in the following year practically gave the Government a monopoly in telegraphic business. Against this Wilde petitioned, and in his evidence before a Select Committee, he claimed that his patent rights would be greatly depreciated, if not entirely destroyed, by the Act. He further urged that his new system of laying and working subterranean wires would have no chance of adoption. Much to his disappointment, the Committee decided against his claims, and the Globe Telegraph Company ceased its business.

_Electric Generators._

An important consequence of Wilde's work in telegraphy was his patent of 1863, which related to an improved machine for producing electric currents. To understand the position of the inventor, it will be necessary to review very briefly the previous history of the subject. In 1831 Faraday rotated a copper plate between the poles of a permanent magnet and so produced induced electric currents. The effect was increased by replacing the permanent magnet by an electro-magnet. Faraday may therefore be regarded as the real first inventor of a machine for obtaining electric currents by the rotation of a copper armature in a magnetic field produced either by a permanent magnet or an electro-magnet. The immediately succeeding inventors, Pixii (1832), Sexton (1833), and Clarke (1834) used armatures with bobbins wound with wire and permanent magnets. All such machines are called magneto-electric, or simply magnetos. The first great step in their improvement did not come until 1856, when Siemens introduced the shuttle-wound armature.
Fig. 1.

Simens Armature used by Wilde.

Fig. 2.

Wilde's Magneto and Dynamo.
This type of armature (See Pl. I., Fig. 1) Wilde adopted, and he described the details of his machine in a paper with the title, "Experimental Researches in Magnetism and Electricity," which was communicated to the Royal Society by Faraday in 1866. The magneto is shown in the upper part of Fig. 2. Two blocks of cast iron D and D, and two pieces of brass of the same length were fixed together with brass bolts, so that a hollow cylinder—which he termed the "magnet cylinder"—was formed, having a hole of $1\frac{5}{8}$ in. in diameter. The armature core was of cast iron, on which was wound 163 feet of copper wire 0.03 in. diameter. The U-shaped steel magnets A were 8 in. long, 1 in. wide, and $\frac{1}{4}$ in. thick. Each magnet was about 1 lb. in weight, and able to support 10 lbs. The armature was rotated at 3,000 revolutions per minute by the belt M. Experiments were made with a varying number of magnets, and what Wilde called "the quantity of electricity produced" was measured by a tangent galvanometer (see Appendix A). This magneto was used to excite electro-magnets, the largest having limbs 2 ft. long and $3\frac{1}{2}$ in. diameter. With four steel magnets in position on the magneto, 1,088 lbs. was required to detach the keeper of the electro-magnet, this being 27 times the weight that the combined four magnets were able to support. This he regarded as a paradoxical phenomenon, which appeared to him to be a new principle in electro-magnetism.

The second part of the 1866 Royal Society paper is especially interesting and important in connection with the history of electrical generators. It relates to "A new and powerful generator of dynamic electricity," and describes the construction of a new magneto and of three machines with electro-magnets. The magneto was fixed to the top of the electro-magnetic machine, and its electro-magnet B (see Fig. 2) was excited by the current from the magneto. The armature of the electro-magnetic machine was driven by the belt M*. Further details of the four machines are given in Appendix B. They are classified according to the size of the bore of the magnet cylinder, which in the three electro-magnetic machines was $2\frac{1}{2}$, 5 and 10 ins. respectively. The 10-in. machine was provided with two armatures, one for "intensity" and the other for "quantity." With this large machine, using the intensity armature, Wilde was enabled to produce a strong arc light. He used a Foucault arc lamp provided with a parabolic reflector 20 ins. in diameter. This was placed on the top of his works, and cast shadows of the flames of the street lamps a quarter-of-a-mile away on the neighbouring walls. He says: "When viewed from that distance, the light was a very magnificent object to behold, the rays proceeding from the reflector having all the rich effulgence of sunshine." A piece of photo paper exposed to the light for 20 seconds at a distance of 2 feet from the light was darkened as
much as a piece of the same kind of paper when exposed for
one minute to the direct rays of the sun at noon on a very clear
day in March.

These electro-magnetic generators had a very serious defect.
The eddy and other currents in the armature, being converted into
heat, produced a rise of temperature of 300°F. and upwards.
Wilde found that the smaller generators ran cooler than those
of larger size; but even the former, during long runs, got so hot
as to endanger the insulation. At a works where it was desir-
able to run the machines for days and nights without a stop,
water was passed round hollow brass segments forming part of
the armature cylinder, and the hot water produced was used to
feed the steam boilers. In order to obtain sufficiently large
currents it was necessary to run a number of the small genera-
tors in parallel. This led to a number of difficulties. Although
the armatures of the machines were driven with equal-sized
pulleys from the same countershaft by belts, the want of perfect
synchronism prevented efficient parallel running. Wilde tried
gearing a pair of machines together, and he then made his most
important discovery. He ran the machines as alternators. When
the armatures were so clutched that the currents were in the
same phase, the sum of the currents was obtained in the main
circuit; but when they were clutched together so that the currents
were in opposite phase, no current resulted. He found now that
when the clutch was unfastened and the machines were run dis-
connected from one another, the armatures were pulled into phase
and they ran perfectly in parallel, so that no mechanical gearing
was necessary. Wilde had thus discovered that alternators can
run in parallel when synchronous. The full importance of this
was not realised until electrical engineering was more developed.
Subsequently, John Hopkinson showed that it was mathematically
possible; and now the parallel running of alternators is in every-
day use at supply stations.

With the threefold object of obtaining a generator that would
heat less, that could be driven at a lower speed, and in which the
pulsations of the rectified current would not be so marked,
Wilde designed and constructed electro-magnetic machines of
a type entirely different from those previously described. The
details are given in a paper read before this Society in 1873. The
shuttle-wound type of armature was abandoned, and he used one
with 16 cylindrical bar magnets. The originator of this type of
armature is claimed for King in 1846. Fig. 3 shows the details
of the machine. To each of the circular frames of cast iron
are fixed 16 electro-magnets. They are wound with insulated
copper wire and are joined up so that in the two circles the
adjacent poles and those opposite are of different polarity. The
armature bobbins are fixed on a heavy disc of cast iron. Four
of the bobbins are connected to a commutator; the alternating
Fig. 3.

Wilde's second type of Dynamo.
current is there rectified and furnishes an exciting or minor current for the electro-magnets. The remainder of the armature bobbins supply an alternating current that is collected by the brushes on the slip-rings. This major current may, if desired, be rectified by replacing the rings by a second commutator. When driven at 500 revolutions per minute the machine melted 8 feet of iron wire 0.065 in. in diameter or ran two arc lamps in series. At 1,000 revolutions per minute 12 feet of iron wire 0.075 in. diameter could be fused. A comparison between the power of the new machine and that of the 10 in. old type showed that it was capable of giving a double amount of power with less than one-fourth of the weight of materials necessary to construct the 10 in. machine.

Henry Wilde had thus produced two commercial types of generator, which could be used to replace the primary batteries used in electro-chemistry, and for arc lighting.

Between 1866 and 1877 he sold machines for the following purposes:—

<table>
<thead>
<tr>
<th>Purpose</th>
<th>No. of Machines</th>
</tr>
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<tbody>
<tr>
<td>Electric light for lighthouses and searchlights</td>
<td>8</td>
</tr>
<tr>
<td>Electric light for photographic purposes</td>
<td>1</td>
</tr>
<tr>
<td>Electro-deposition of metals</td>
<td>94</td>
</tr>
<tr>
<td>Electrical bleaching of sugar and of linen</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>105</td>
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**Electro-Chemical Work.**

The great demand for machines for electro-chemical purposes revived Wilde's interest in these applications of electricity, and he commenced experiments in his works. In 1871 he secured a patent for the coppering of iron tubes so that they were protected against corrosion; and the firm did a considerable business in supplying coppered tubes. In six years (1871-1877), 25,726 iron tubes and 1,521 steel "doctors" were coppered.

In 1875 Wilde secured a patent of very considerable importance, which became very remunerative. It was for the purpose of making the rollers used in calico printing. An iron roller is first coated with a thin layer of copper in a hot cyanide bath, and afterwards is mounted so as to be capable of being revolved vertically in a solution of copper sulphate. This enabled a much higher current density to be used and the rate of deposition to be greatly increased; and yet a very good quality of copper could be obtained, which was of even thickness. The specification also included a screw propeller for keeping the electrolyte at a uniform density. The patent was applied in a number of works, and was ultimately sold to the Broughton Copper Company Limited in 1880, who extended its use for the coating of hydraulic rams, etc. Two years previously, Henry Wilde had entered into an agreement with Sir Joseph C. Lee of Manchester for the use of the patent process of coppering.
After the Broughton Copper Company had taken over the patents, it was alleged that Sir Joseph Lee had infringed these patents. This led to a costly legal action, in which the defendant was defeated.

Dr. Wilde's association with the Elkingtons led to an important use of his machines. Richard Elkington may be regarded as the founder of the electro-plating industry in England. He and his cousin Henry opened a large electro-plating works in Birmingham in 1841. They soon realised that dynamos must be substituted for primary cells, and they tried the primitive machines then available. In 1865 G. R. Elkington, junior, patented a process for the electrolytic refining of copper, which is identical in principle with that used at the present day. He adopted the use of Wilde's machines, and his firm paid a royalty of £300 per annum for a number of years to Messrs. Wilde & Co. Messrs. Elliott of Pembrey, near Swansea, who took over the refining process from the Elkingtons, also used Wilde's machines. One of these was capable of giving 900 lbs. of copper in 24 hours. As the electrolytic refining process extended, Wilde obtained other users of his machines abroad. These included the Mansfield Mining Company of Eisleben and Messrs. Stern of Oker.

**Extension of Patents. Litigation.**

In 1877 Henry Wilde petitioned the Privy Council to extend his dynamo patents of 1863 and 1865. He had the advantage of the evidence of the eminent engineer, F. J. Bramwell, who made the claims of the patentee very clear. The result of the petition was that the patents were extended until 1884.

When the Gramme dynamo was introduced into this country, Wilde brought an action against the British agents for infringement of his patent. The agents obtained the opinions of F. H. Holmes, who for twenty-five years had been engaged in designing and constructing dynamos, S. A. Varley, one of the first to use residual magnetism for the excitation of electro-magnets, and Fontaine and Werdemann, well-known inventors. Their evidence was so strong, and threw so much doubt on the priority of Wilde's inventions, that Wilde found it advisable to withdraw his action.

Henry Wilde's fondness for litigation grew with his years, and in 1902 he brought a regrettable action against the late Professor S. P. Thompson and the printers and publishers of Thompson's standard treatise on "Dynamo-electric Machinery." The plaintiff claimed an injunction to restrain the defendants from asserting that Henry Wilde "is not the inventor of the generator of dynamic electricity known as the Dynamo or attributing such invention to any person or persons other than the Plaintiff," and claimed damages and costs. The report of
the action will be found in The Electrician, vol. 50, 1902-3. It was brought before Mr. Justice Buckley in the Chancery Division of the High Court of Justice, who ordered that the statement of claim be struck out on the ground that it disclosed no reasonable basis of action. The action was dismissed with costs against the plaintiff. Against this decision Henry Wilde appealed, but without success.

Electric Searchlights.

One of the applications of Wilde's machines already mentioned was for the purpose of providing electrical energy for arc lamps. The first idea was to use arc lamps in lighthouses; but when the buildings were isolated there was difficulty in providing motive power for the dynamos. Wilde supplied a machine to the Commissioners of Northern Lighthouses for the purpose in 1866, and in the following year one to the United States Lighthouse Board. In 1873 Wilde directed the attention of the Admiralty to the advantages of electric searchlights for naval purposes. Experiments were made at Spithead, extending over a year. They were especially arranged so as to ascertain whether the searchlight would be a useful protection against torpedo boats. The experiments were so successful that three warships, the Minotaur, the Alexandra and the Temeraire were fitted with Wilde's apparatus. The report of Admiral Sir Beauchamp Seymour stated that the searchlights were of very great value for navigation, signalling, and general naval manoeuvres. Wilde also introduced his inventions to the Mercantile Marine service, but the Admiralty claimed the exclusive use of the lights. After the loss of the Titanic, Dr. Wilde communicated two papers to the Society: "On Searchlights for the Mercantile Marine," and "On Searchlights and the Titanic disaster," in which he strongly urged the compulsory international use of searchlights at sea.

Aerodynamics and Aviation.

The tenth volume of the third series of the Memoirs of the Manchester Literary and Philosophical Society is of special interest in connection with the activities of Wilde in 1887. It contains five papers by him, two of which relate to the efflux of air through orifices. The first paper attracted the attention of Osborne Reynolds, who in the same volume has an article "On the Flow of Gases," in which he gives a theoretical explanation of the experiments of Wilde.

The experiments mentioned above were really the sequel of a number that he had begun as early as 1860, with the view of finding some means of solving the problem of aerial flight. Numerous trials were made on the discharge of steam and of air at pressures from 10 lbs. to 120 lbs. per square inch directly into the atmosphere from orifices of various forms. He also experimented on the reactive force produced by the explosion of a mixture of coal gas and air contained in a cylinder of steel.
The result of his many tests made with a view to the possibilities of aviation showed that the solution of the problem was not to be found in the discharge of gases through orifices. He then turned his attention to screw propellers, and used vanes from 1 to 4 feet in diameter, driven at velocities up to 2,000 revolutions per minute; but the results were not sufficiently encouraging to him. He remarked: "Although my experimental investigations on the possibility of aerial locomotion have so far been of a negative character, the confidence I have in the ultimate solution of the problem still remains unshaken."

Magnetic Researches.

On the expiration of the patents relating to the dynamo in 1884, Dr. Wilde retired from business. He was then fifty-one years of age, and vigorous; and he decided to devote his time to scientific research. During twelve years (1885-1897) his experimental work chiefly related to magnetism.

He was a great student of the works of the early investigators in the subject of terrestrial magnetism, and was especially attracted to the theory of Halley, the astronomer and contemporary of Newton, that the variation of the magnetic compass could be explained by the rotation within the earth of magnetic matter. This led him to design an apparatus that he called a "Magnetarium." It consisted of two concentric spheres, as shown in Fig. 4 (one half of the outer sphere being removed to show the inner). The inner sphere, which is 16 ins. in diameter, is wound over its whole surface with insulated copper wire. The outer sphere, two inches greater in diameter than the inner one, has its inner surface covered with iron wire gauze, over which is wound a magnetising coil. The spheres were mounted on axles as shown, and they could be revolved at different rates of speed by turning the handle, which operated gearing. The axles are supported on a semi-circular brass meridian mounted between rollers fixed to a vertical support. All observations of dip and variation were made by bringing the station under test beneath an upper small circular table on which a dip needle or declination compass can be placed. The magnetising coils were connected in parallel to a small magneto, and by variable resistances the currents in the two circuits could be adjusted. In order to represent more accurately the distribution of the earth's magnetism, it was found necessary to cover the spaces representing the oceans with thin sheets of iron and to fix the inner globe at an inclination of 23½ degrees to the axis of the terrestrial sphere. The train of wheels was so arranged that the internal sphere lost 12° for each revolution of the terrestrial globe, and this was taken as equivalent to 32 years. It was found possible by this magnetarium to represent fairly well the distribution of magnetism in time and place.
Fig. 4.
The Magnetarium.
The influence of temperature upon the magnetic properties of iron, nickel, and cobalt was studied with the help of a specially designed magnetometer, which is in the possession of the Society. Wilde was interested in finding the limit of magnetisation as tested by the method of traction, and obtained the value of 29.67 kilos per square centimetre.

**Wilde's Use of Bode's Law.**

The German astronomer, J. E. Bode (1747-1826) directed attention about 1776 to a remarkable empirical rule, now generally known as Bode's Law. The rule states that the relative values of the series of numbers:

0 + 4 = 4  
3 + 4 = 7  
6 - 4 = 10  
12 + 4 = 16  
24 - 4 = 28 etc.

are the same as the relative distances of the planets from the sun. Henry Wilde contended, in a paper before the Society about forty years ago, that a law of a similar kind should apply to the atomic weights. This early paper was followed at various times by twelve others; in that of 1913 he gave a revised table including all the more recently discovered elements, for which he found places in his table.

Tenacity of purpose was one of the most marked traits in Wilde's character. It is exhibited in an extraordinary degree in his obsession over Bode's Law. He regarded it as a great fundamental law of the universe, and devoted several of his astronomical papers to its advocacy. The last of all his papers, published by the Society when he was eighty-three, relates to the atomic weight of tellurium; in it he maintains that the atomic weight of this element must be exactly 128, as required by his tables.

**Henry Wilde and The Literary & Philosophical Society.**

Wilde was elected a member in 1859 when twenty-six years of age; and in the following year he gave a short communication relating to the ABC telegraph of Sir Charles Wheatstone. It was not until his retirement from business in 1884 that he became actively associated with the Society. His means had become ample, chiefly owing to the success of his electro-chemical patents. When Sir Henry Roscoe and other members of the Society wished to raise a sum of money for the extension and improvement of the house, Wilde contributed £100 and in the following year £400 for this purpose. He then undertook the cost of putting the old portion of the building into sound repair, and added a new portico and a storeroom. All the work was done under his direction, at a cost of £1,500. In 1893 he wrote a letter to the Council in which he said: "As the Society is so
closely identified with the history of the method of generating electricity... I shall be pleased to defray the cost of wiring up and supplying the necessary fittings in the parts of the house where gas can be replaced with advantage by the electric light." This was followed by other gifts. For two years (1894-1896) he was President of the Society. During this period "with the object of maintaining the high character which the Society has so long held in the estimation of the scientific world and to increase still further its means of usefulness," he had decided to endow the Society with £8,000 to be devoted to the following and other purposes:—(1) to provide the salary of an assistant secretary and librarian; (2) to award a gold medal, a premium, and to provide an honorarium for a yearly lecture; (3) to compensate for the loss of income due to the abolition of an entrance fee; and (4) to remit half or the whole amount of the subscriptions of fifteen members.*

In 1902 he gave the Wilde lecture "On the Evolution of the Mental Faculties in relation to some Fundamental Principles of Motion."

Benefactions and Gifts.

In addition to Dr. Wilde's liberality to the Society, and in accordance with his resolve to dispose of the greater part of his capital during his life-time, he made important benefactions to other institutions. To the Paris Académie des Sciences in 1897 he gave £5,500, the annual interest of which was to be applied as a prize for the author of a discovery or work in Astronomy, Physics, Chemistry, Mineralogy, Geology or Mechanics. The prize was to be international and retrospective. In 1900 he contributed £1,500 to the Benevolent Fund of the Institution of Electrical Engineers. The University of Oxford has most of all been favoured. In 1898 Wilde gave £10,000 to the University to institute a Readership in Mental Philosophy, and a further sum of £3,000 to establish a scholarship to be called the John Locke Scholarship for Mental Philosophy. In 1908 Wilde founded a Lectureship in Natural and Comparative Religion, the endowment being £4,000. In the following year he provided £600 for the purpose of founding an annual lecture on Astronomy and Terrestrial Magnetism, in honour and memory of Edmund Halley, sometime Professor of Geometry and Astronomer Royal. By his will Henry Wilde bequeathed the residue of his estate, after some bequests, to the University of Oxford: the sum amounted to about £10,000.

The full extent of his benefactions and gifts cannot be completely recorded. He presented to the Science Museum, South Kensington, a magnetarium, a separately-excited and a multipolar dynamo, and a set of ABC instruments. To Oxford University were given a Crossley gas engine, a Wilde's early type dynamo, and two multipolar machines and other electrical

* Some of these conditions are not now in operation.
apparatus. Owens College received the gift of a set of Wilde's machines; and the Manchester Grammar School was also provided with two dynamos.

**Personnel of the Works.**

Henry Wilde's association with Mr. G. C. Lowe, Silversmith, Jeweller, Chronometer and Watch Maker, and Electroplater, of St. Ann's Square, Manchester, has already been mentioned. It was the capital furnished by Mr. Lowe that enabled the firm of Henry Wilde & Co. to be founded, with works at 37, Mill Street, Ancoats. Here the ABC instruments were made. They needed careful and accurate construction with small tools; the manufacture of the dynamos required much larger plant. After the death of Mr. Lowe, Wilde continued the business without a partner. He was faithfully assisted by his younger brother, Joseph. An agreement was made between the brothers whereby Joseph received a salary and a commission. Joseph, unlike his brother, was not robust, and he died at a relatively early age. He was well known in Sale, where he lived, as a reserved and intelligent man. An adopted nephew of Joseph's, W. F. Hobday, acted as bookkeeper to the firm. Another assistant was Robert Marsh. He served the firm for a long term of years, and became well-known in connection with the installation of the dynamos and with general experimental work. On Henry's retirement, Joseph went into partnership with John Hill, who was the works manager, and the Electric Engineering Company was formed; but this partnership was dissolved in 1884.

**Honours.**

In 1886 Henry Wilde was elected to a Fellowship of the Royal Society of London; and in 1900 the degree of D.Sc. of the Victoria University was conferred upon him. Three years later he received from Oxford University the D.C.L. In 1885 he was awarded by the Council of the International Exhibition held in London a gold medal for his inventions. The medal of the Royal Society of Arts and the Dalton medal of this Society he refused to accept, because he did not agree with the reasons given for these honours.

**Photograph.**

Wilde had a strong objection to being photographed; but his personal friend Mr. Alfred Brothers, one of the best-known of the early photographers, overcame this objection. From the negative some prints were known to exist; one was the property of Joseph Wilde, and it passed into the possession of Mr. J. W. Winstanley of Sale, who has kindly allowed this to be reproduced. Another one was given by Henry Wilde to Professor H. B. Dixon, who has presented it to the Society. The photograph is of Wilde when he was about fifty-six.
Conclusion.

Henry Wilde's many inventions establish his position as a pioneer in Electrical Engineering; but it is not easy to give a just estimation of his scientific work. It must be remembered that he was a self-educated man. He was a great student of the earlier writers on science and philosophy, and his papers are full of quotations from them. He never realised the great advances that were being made in electrical science and the application of the laws of energy. Had his mental disposition been such as to tolerate guidance, his later work would have been of greater value, and he would have been saved from regarding as paradoxes experimental facts that could easily be explained. Although he cannot rank with Dalton and Joule, yet in the history of the affairs of the Society he held a unique position, and his benevolence at a critical time must ever be remembered.

Henry Wilde married Miss Lowe, the sister of his partner. She died about eighteen years ago, and there were no children. Henry died on March 28th, 1919, at the age of eighty-six, at The Hurst, Alderley Edge. He and his wife are buried at Bunbury in Cheshire.

Appendix A.

Galvanometer used by Wilde.

The tangent and sine galvanometer used by Wilde in his experiments with his magnetos, which is in the possession of the Society, is a fine instrument of brass as designed by Pouillet. It was made by Ruhmkorff of Paris. It has a compass box of 6½ ins. diameter and a brass hoop 12½ ins. in diameter. As a sine galvanometer, its readings can be taken to 2 minutes by a vernier; as a tangent galvanometer, tenths of a degree can be estimated. There are two coils, each of 0.15 ohm. When in series, the constant as a tangent instruments in the field of the earth has been determined for me by Dr. A. Ferguson to be about 0.13. Assuming that Wilde used the two coils in series, the maximum current obtained from his magneto when the four magnets were in place was only about one-fifth of an ampere.

Appendix B.

Details of Wilde's Early Machines.

(A) Magneto-Electric Machine (No. 2). Bore of cylinder, 2½ ins.; length, 12 ins. Armature wound with 67 feet of insulated wire 0.15 in. diameter. This gives an armature resistance of about 0.027 ohm. The field consisted of 16 magnets 12 ins. long, each 3 lbs. in weight and capable of supporting 20 lbs.

(B) Electro-Magnetic Machine (No. 1). Bore and length of magnet cylinder as in (A). Magnet, limbs of boiler plate 12½ X 9 X ¾ in. Wound with 700 feet of insulated copper wire 0.15 in. diameter: \( R = 0.28 \) ohm).

(C) Electro-Magnetic Machine (No. 2). Bore and length of magnet cylinder double that of (B), namely 5 ins. and 25 ins. respectively. Magnet wound with 1,170 feet of wire weighing 390 lbs. Armature with 84 feet of wire weighing 28 lbs.

(D) Electro-Magnetic Machine (No. 3). Dimensions of bore and length of magnet cylinder double those of (C). Each limb of the electro-magnet was of rolled iron 48 X 39 X 1½ ins. Weight of electro-magnet exclusive
of magnet cylinder, 1.5 tons. The magnet was wound with 13 wires of
1/2 in. diameter in parallel. Total length of multiple cable 4,800 feet.
Total weight of coils 1.3 tons. Weight of magnet cylinder 1.1 tons.
Two armatures were provided, which were interchangeable:—

(1.) “Intensity” Armature, wound with 376 feet of 13 wires of 1/4 in. diameter
in parallel. Total weight of wire, 232 lbs. Armature weight, 0.3 ton.

(2.) “Quantity” armature, wound with 67 feet of copper plate, each 6 ins. wide, 4 plates in parallel. Weight of copper, 344 lbs. Total weight of armature,
0.35 ton.

The total weight of the dynamo was 45 tons. It was 80 ins. long, 2 feet wide, and 5 feet high.

Wilde tested his machines by the length of iron wire of stated thickness that could be heated to redness or the thickness that could be melted. The following values of voltages, current, and output have been deduced by Mr. A. Adamson for me from Wilde’s experiments:—

(A) 3 ins. of iron 0.04 in. diameter heated to redness. Machine at 2,500 revolutions per minute. 15 amperes, 17 volts, 25.5 watts.

(B) 24 ins. of iron 0.04 in. diameter heated to redness. Excited by (A), both 2,500 r.p.m. 15 amperes, 13.6 volts, 204 watts. Excited by
(A), both at 2,000 r.p.m. 8 ins. of wire of 0.04 in. melted. 30 amperes, total e.m.f. 20.5 volts.

(C) 15 ins. of iron of 0.075 in. melted by estimated current of 64.7 amperes.

(D) Armature at 1,500 r.p.m. No. 1 magneto with six magnets used to excite (C), and the current from (C) excited (D).

Quantity armature:—

15 ins. iron 1/4 in. melted; 390 amperes.
15 ins. copper 1/8 in. melted; 450 amperes.

Intensity armature:—

21 ft. wire 0.065 in. heated to redness.
29 amperes, 105 volts, 3,045 watts, 4.1 horse-power.
7 feet iron 0.065 in. melted; 52 amperes, 143 volts.

**APPENDIX C.**

**List of the Chief Publications of Henry Wilde.**


“On a Property of the Magneto-electric Current to Control and render Synchronous the Rotations of the Armatures of a number of Electro-


“On some Improvements in Electro-magnetic (Dynamo) Machines.” *Phil. Mag.*, vol. 45, June, 1873.


"On the Causes of the Phenomena of Terrestrial Magnetism, and on some Electro-mechanism for exhibiting the Secular Changes in his horizontal and vertical Components." Roy. Soc. Proc., 19 June, 1890. (Complete paper was privately printed.)


"On the Evolution of the Mental Faculties in relation to some fundamental Principles of Motion (the Wilde Lecture)." Memoirs, vol. 46, 1902.

"On the Atomic Weight of Radium and other Elementary Substances." Phil. Mag., November, 1895.


* The word "Memoirs" refers to those of the Manchester Literary and Philosophical Society.

APPENDIX D.

Henry Wilde's Chief Patents.

1858.
293 Connecting the ends of lightning conductors and submarine telegraph cables.

1861.
858 Electro-magnetic telegraphs, etc.
1994 Electro-magnetic telegraphs, etc.

1862.
2997 Magneto-electric telegraphs.
   The momentary currents may be used for telegraphing through uninsulated cables.

1863.
3246 Electro-magnetic telegraphs, etc.
   Overhead wires are made by twisting several fine copper wires round a core of steel. To prevent the singing of the wires, they are connected to their supports by thongs of leather, etc., in such a way that the thong is maintained at the same tension as the line.

516 Electro-magnetic telegraphs.
   Describes a magneto with shuttle-wound armature. The poles of the U-shaped permanent magnets are uppermost. The alternating currents are produced with too great rapidity for use in telegraph lines, so they are turned in one direction by a commutator and then reversed by a more slowly revolving commutator before they are sent to the step-by-step telegraph instruments.

3006 Electric telegraphs.
   Iron wires are varnished and placed within iron pipes. The wire are supported and separated by perforated earthenware cylinders. Special insulated joints are provided. To prevent the pipes from being flooded, they are laid on an incline and drained by syphons. Junction boxes are provided where necessary.
   The generator of No. 516 (1863) is used for signalling through uninsulated submarine conductors. Electro-magnets may be used in place of the permanent magnets and excited by a voltaic battery or a small magneto. The generators may be used for producing the electric light, etc.

1865.
1200 & 2764 Electric telegraphs.

1412 Producing and applying electricity, etc.
   The current may be used to produce the heat necessary for the working of metals, by connecting the terminals to the insulated rolls between which the bar or plate to be heated passes.
   The machines may be used to prevent the fouling of ships' bottoms, a current being passed down the copper, etc., bottom of the ship through water to insulated metal in the water

2762 Electric telegraphs.
   Generator armature of cast iron with a slot extending through it for three-quarters of its length for the prevention of eddy-currents. Wound with ribbon sheet copper and sheet gutta-percha, and surrounded with strong bands.
1866. Electro-magnetic and magneto-electric machines. Relates to the new generator with a multipolar armature. A special type of commutator is described.

1867. Arc Lamps.

1871. Coating of iron with copper.

1873. Producing and regulating electric light. Improvements on No. 842 (1867).

Arc Lamp. The carbons are made to approach or recede from each other by means of a right- and left-handed screw. Each screw can be actuated independently, so as to keep a fixed focus.

Holophote. A lens or parabolic reflector is mounted on a platform which carries the lamp. The platform may be revolved about a vertical spindle by the use of a worm gear. The platform may be tilted as desired by a hinge and screw.

1874. Excavating coal, etc. Transmission of electric power. A reciprocating electric motor is described, which may be used for cutting coal.

1875. Making printing rollers.

1878. Producing and regulating electric light.

Arc Lamp. Two vertical carbons near each other. One carbon holder is pivoted at its lower end, and by an electromagnet the carbons are separated at the top and the arc is struck. When current is off an opposing spring brings the tops into contact.


1882. Induction coils. Improvements in dynamos.

(I am indebted to Mr. E. L. Sandbach of Messrs. Slater, Heelis & Co. for placing at my disposal a number of documents chiefly relating to Dr. Wilde's legal actions; to Mr. J. W. Winstanley for information about the brothers Wilde; to Mrs. Marsh, of Longsight, for details relating to the association of her husband with Messrs. Wilde & Co.; and to Miss Crabtree for assistance in the compilation of a list of Wilde's papers and apparatus.)