farming pursuits. There he died, after a long illness, on the 22nd of June, 1893, at the ripe age of seventy-five. As to his ability as an engineer, no better testimony is needed than the opinion of his Chief, who, on Mr. Cooper's retirement from the Board of Works, spoke in the highest terms of the valuable services he had rendered on all occasions, and of the sound, substantial and enduring character of that portion of the works which had fallen to his share. One who acted under him for nearly thirty years writes as follows:—"Mr. Cooper was very kind-hearted towards all who had the good fortune to serve under him; very liberal and willing at all times to assist any person in need. I am able to say honestly that I never met a more noble-minded friend."

Mr. Cooper was elected a Member of the Institution on the 3rd of December, 1867.

EDWARD ALFRED COWPER, born on the 10th of December, 1819, was a son of the late Mr. Edward Cowper, professor in the engineering department of King's College, London, one of the early improvers of the printing-machine, and the Author of a Paper[1] on that subject read before the Institution in 1850. When only fourteen the subject of this notice was apprenticed for seven years to the late Mr. John Braithwaite.[2] While still an apprentice, he invented, about 1841 the detonating fog-signal, which was recommended as worthy of adoption by General Pasley, then Inspector-General of Railways, in a report dated the 14th of April, 1844.[3] It was first tried on the Croydon railway, and has long since been in general use.

In 1841 Mr. Cowper entered the service of Messrs. Fox (afterwards Sir Charles Fox)[4] and Henderson of Birmingham. While with that firm he invented an ingenious method of casting railway-chairs,[5] and designed the wrought-iron roof of the New Street Station at Birmingham,[6] which had a span of 211 feet—at that time the largest iron roof in existence. It was originally intended to have two spans, or more, supported by columns; but

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[1] *Minutes of Proceedings* Inst. C.E., vol. ix. p. 409.
[2] *Ibid*, vol. xxxi. p. 207.
[3] *Ibid*, vol. xxxviii. p. 204.
[4] *Ibid*, vol. xxxix. p. 264.
[5] Proceedings Inst. Mech. Engs., 1851.
[6] Minutes of Proceedings Inst. C.E., vol. xiv. p. 251, and Proceedings Inst. Mech. Engs., 1854, p. 79.

at Mr. Cowper's suggestion, that method of construction was not adopted. The site was extremely awkward, as it was formed of a parallel and two taper portions, on which were four platforms and ten lines of rails. The ground, however, was so surrounded by buildings that it was possible to adopt a sloping ridge over the taper portions and thus simplify the task of designing the principals, all of which were made similar, the dimensions of each part being reduced as the span narrowed. He also superintended the preparation of the contract drawings for the building of the Great Exhibition of 1851, which was subsequently re-erected at Sydenham for the Crystal Palace Company.

At the end of 1851 Mr. Cowper resigned his post as chief draughtsman and designer to Messrs. Fox and Henderson and commenced to practise on his own account in London as a consulting engineer. Six years later he invented the regenerative hot-blast stove, in which fire-bricks are used instead of the cast-iron pipes through which the air to be heated previously passed. He subsequently effected various improvements in this design, an account[1] of which he presented to the Institution in 1870; for that Paper he was awarded a Watt medal and a Telford premium. In its latest form, the stove consists of a vertical combustion-chamber, and a "regenerator" composed of a number of honeycomb passages or flues. Gas from the top of the blast-furnace is admitted to the combustion-chamber, together with air, and burns in it, the products of combustion, on arriving at the summit of the chamber, being drawn down through the honeycomb flues. The upper end of the regenerator rapidly becomes red-hot, and the heat travels gradually downwards until a considerable length of the flues becomes incandescent. The gas is then shut off, and blast is passed through the regenerator from the bottom to the top, gradually cooling it, the process taking some hours before the gas must be again admitted.

Mr. Cowper gave great attention to the subject of the economy of steam and was an ardent advocate of the compound-engine and of steam-jacketing. About the year 1858 he introduced the steam-jacketed receiver, which was subsequently known in the navy as "Cowper's Hot-Pot." In its early form, this was a vessel into which the steam entered at one end, leaving it at the other; but it was afterwards modified by the addition of an inner lining which forced every particle of steam in progress to the outlet to pass close to the heated walls.

[1] Minutes of Proceedings Inst. C.E., vol. xxx. p. 309.

At his suggestion, the engine-cranks were placed at right-angles, obviating the necessity of having six cylinders, two to each engine. In 1870 H.M.Ss. "Briton" and "Thetis" were fitted by Messrs. Rennie on this plan, with the result that the "Briton," when steaming at a speed of ten knots, burned only 1·3 lb. of coal per HP. per hour.[1]

In 1879 Mr. Cowper invented a beautiful and ingenious instrument, the writing-telegraph,[2] by means of which the operator at a distant station was enabled to write as though he were present, without the use of any special signals, code or signs, and without the assistance of any person to translate the signals as received. The exact position of the pencil of the operator at the sending-station was communicated to the writing-pen at the receiving-station through two line wires, one giving the vertical and the other the horizontal position of the pencil. It may also be interesting to record that as far back as 1868 he designed what was practically the modern bicycle wheel—a wire-spoke suspension wheel with a rubber tyre. Other matters prevented him, however, from taking out a patent and the idea eventually became common property. In conjunction with Dr. Anderson, he carried out in 1887 a series of experiments on the mechanical equivalent of heat, the results of which were contained in a Paper[3] read at the meeting of the British Association at Manchester in that year.

Another point which stands out clearly in Mr. Cowper's career is the part he took in founding the Institution of Mechanical Engineers. He was one of the few original members of that body at its inception in 1847 and in the following year was elected a Member of Council. In 1880–81 he served the office of President. Among the Papers he contributed to the Proceedings of that Institution may be mentioned, in addition to those already referred to:—"An Inverted Arch Suspension Bridge" (1847); "Cugnot's Locomotive for Use on Common Roads" (1853); "Blast Engines for the East Indian Iron Company" (1855); "Two Pairs of Horizontal Pumping Engines" (1858); "Regenerative Hot-Blast Stoves working at a temperature of 1,300° Fahrenheit" (1860); and "The Inventions of James Watt, and his Models preserved at Handsworth and South Kensington" (1883).

Mr. Cowper was a member of the Committee of Advice with reference to the collection of models in the Machinery and Inven-

[1] Minutes of Proceedings Inst. C.E., vol. li. p. 62.

[2] Journal of the Society of Telegraph Engineers, vol. viii. p. 141.

[3] Report of the British Association, 1887, p. 562.

tions Division of the South Kensington Museum, an exhaustive catalogue[1] of which, prepared by him, was published by the Science and Art Department in 1890. He was a member of the Jury at the International Inventions Exhibition and acted as a judge for the Royal Agricultural Society in 1868 and 1870. Among his many miscellaneous inventions may be mentioned improvements in candle-making machinery adopted by Price's Candle Company; an apparatus for the recovery of lead fumes which effected great economy by securing fine particles of lead previously lost through the chimney; a sugar-cutting machine in which knives arranged in squares were employed to cut the slabs into small cube-shaped lumps; and an improved gin for removing the fibre of cotton from the seed. He frequently acted as a witness in patent and arbitration cases.

Mr. Cowper was elected an Associate of the Institution on the 13th of January, 1852, and was transferred to the class of Member on the 28th of February, 1860. In 1878 he was elected a Member of the Council, on which he continued to serve until his death. In addition to the Paper on the "Regenerative Hot-blast Stove," above referred to, he delivered before the Institution on the 17th of January, 1884, a lecture on the "Steam-Engine," which formed one of the special series of lectures on "Heat in its Mechanical Applications." He was a constant attendant at the meetings and frequently took part in discussions; shortly before his death he interested himself greatly in a Paper on the "Break-down of the R.M.S. 'Umbria,'" by Mr. Thomas Sopwith, and it was under his direction that the model of the broken shaft of that vessel, then exhibited, was prepared.

Mr. Cowper died from pneumonia, after a very brief illness, on the 9th of May, 1893, at the age of seventy-three. He may be said to have died in harness, for it was only a few weeks previously that he had taken into partnership his son, Mr. Charles E. Cowper, with a view of relieving himself from much of the strain of work which he had begun to feel.

FRANCIS FOWLER, fifth son of the late Mr. J. K. Fowler of Aylesbury, was born on the 28th of June, 1829, and in March, 1846, was articled for three years to the late Mr. Richard Madigan, then an engineer on the London and Birmingham Railway. On

[1] Library Inst. C.E.