ment of his brother, Mr. J. S. Hulse, from business in 1881, he took over the Ordsal Works, Manchester, and under the style of Hulse and Co., re-designed and brought up to date the machine tools for which he became so well known. He also introduced many improvements, some of which were referred to in his Paper [1] read before the Institution in May, 1886, for which he was awarded a Watt medal and a Telford premium. On the occasion of the reading and discussion of that communication, Sir Frederick Bramwell, who was then President, said that so thoroughly had the Author kept himself in the background that, had it not been for Mr. Hulse's great reputation, no one who had listened to his Paper could have gathered that he was a tool-maker and was commercially interested.[2]

Mr. Hulse died at his residence, The Grove, Withington, near Manchester, on the 20th March, 1897, in the seventy-sixth year of his age. In addition to his immediate work he acted as one of the British judges at the Philadelphia Exhibition of 1876 and at other exhibitions. He was elected a Member on the 21st May, 1867.

HENRY GEORGE CLOPPER KETCHUM, whose name will remain associated with the important engineering undertaking of the Chignecto Ship Railway, was born at Fredericton, New Brunswick, on the 26th February, 1839, and was educated at the Collegiate Grammar School in that town. Early in 1854 he entered King's College University, New Brunswick, where he studied engineering under Mr. Thomas McMahon Cregan, and obtained the first diploma for civil engineering granted by that University. He then passed the Government examination for deputy land surveyors, but failing to find employment in that branch of the service, he acted for a time as a telegraph operator. In August, 1856, he became an assistant to Mr. Alexander Luders Light, who was then engaged in carrying out, for the Government of New Brunswick, a line of railway from St. John on the Bay of Fundy to Shediac on the Gulf of St. Lawrence. He served under Mr. Light four years, at first as a draughtsman, and then as an assistant engineer on this line, which was at that time called the European and North American Railway but is now known as the Intercolonial Railway of Canada. Mr. Ketchum was thus, at the outset of his career, associated with an engineering enterprise in

[1] Minutes of Proceedings Inst. C.E., vol. lxxxvi. p. 120.
[2] *Ibid*, vol. lxxxvi. p. 148.

the neighbourhood of the Isthmus of Chignecto, which was destined to be the scene of the most important work of his life.

In August, 1860, Mr. Ketchum proceeded to Brazil on the engineering staff of the contractors for the São Paulo Railway. He was in charge of some of the heaviest works on that line, including the Mogy viaduct of twelve spans, 180 feet high, which was constructed of iron columns on granite piers and was erected in the short space of seven months. On returning to New Brunswick in 1865 he was appointed resident engineer on the construction of the line from Moneton to Amherst, now part of the Intercolonial system, which work again brought him to the Isthmus of Chignecto. Not long after, the International Contract Company, which was responsible for the line, failed, and the Company's interest in the contract was taken over by Messrs. Clark, Punchard and Co., for whom Mr. Ketchum undertook at his own responsibility, and successfully carried out, the completion of the works as far as Dorchester. This undertaking accomplished, he began to practise on his own account in April, 1868. In the following year he was appointed chief engineer on the construction of the New Brunswick Railway from Fredericton to Edmundston, 170 miles, on which he was engaged for some years. He also acted as engineer on a section of the Quebec and New Brunswick Railway.

It was about this time that Mr. Ketchum first practically turned his attention to the great enterprise with which the last twenty years of his life were connected. In April and May, 1875, letters from him appeared in the *Daily Telegraph* of St. John, proposing a ship railway across the Isthmus of Chignecto between the Bay of Fundy and the Gulf of St. Lawrence, with railway and steam communication to Prince Edward Island and graving docks at Baie Verte, in connection therewith. This bold suggestion arrested all further idea of a canal, which had long been under discussion, but for six years no attempt was made to solve the problem of transit across the Isthmus. At length, in 1881, Mr. Ketchum carried out, at his own expense, a survey and location for a ship railway, and submitted a proposal to the Hon. Sir Charles Tupper, then Minister of Railways and Canals, offering to form a company to carry out the work, provided the Government would subsidize the undertaking, for about one-third the cost of a canal.[1] This proposal was accepted by the Government, approved

[1] See "The Cost, Feasibility and Advantage of a Ship Railway across the Isthmus of Chignecto," by H. G. C. Ketchum, Inst. C.E. Tracts 8vo., vol. 340; and "The Chignecto Ship Railway—the Substitute for the Baie Verte Canal," by H. G. C. Ketchum, Trans. Canadian Soc. Civil Engineers, vol. v. p. 329.

by Parliament, and a company, of which Mr. Ketchum was a director, was incorporated to carry out the project.

After various unsuccessful attempts had been made to induce contractors to undertake this novel and difficult work, and to find the money, Mr. John G. Meiggs, on the report of Sir Benjamin Baker, Past President, undertook the contract and a company was formed in London to carry it out. Plans were prepared and submitted—by Sir Benjamin Baker and Mr. Ketchum personally in Ottawa—to the Chief Engineer of the Department of Railways and Canals, and, after much detailed consideration, formal approval was given by the Governor-General in Council in May, 1888.[1] The works were commenced in the following October, under the superintendence of Mr. Ketchum and Sir Benjamin Baker, and were prosecuted vigorously until July, 1891, when, owing to financial reasons, they were unfortunately stopped. At that time three-fourths of the work was done—including the hydraulic lifts for raising ships of 2,000 tons gross weight a height of 40 feet, and the cradles for carrying and locomotives for hauling the ships—and it was said that but one summer season was required to finish the ship-railway and docks fit for opening to the public.[2] A complete description of the works by Sir Benjamin Baker has appeared in the *Nineteenth Century*,[3] from which the following brief particulars are taken. The ship-railway is 17 miles long in a straight line from Fort Lawrence on the Bay of Fundy to Tidnish on the Gulf of St. Lawrence, with a dock at each end. The method of transport intended to be adopted is as follows:—A vessel coming up the Bay of Fundy on the flood tide would pass into the dock and wait its turn to be lifted. Keel and bilge blocks having been arranged on a cradle, the cradle and gridiron would be lowered by hydraulic rams into the water and the vessel hauled over it by capstans and winches in the usual way. The gridiron would then be slowly raised until the vessel rested on the keel-blocks throughout the whole length, after which the sliding bilge-blocks would be pulled tight against the ship's bilge by chains attached to the blocks and carried up to the quay on either side. Lifting, by hydraulic rams and presses, would then proceed until the rails on the gridiron attained the same level as those on the main line; the ship and cradle would then be hauled on to the railway by powerful hydraulic winches and transported by locomotives across the isthmus to the hydraulic lift

[1] Trans. Canadian Soc. Civil Engineers, vol. v. p. 332.
[2] *Ibid*, p. 334.
[3] *Ibid*, p. 335, and the *Nineteenth Century*, March, 1891.

at the Tidnish end, where the converse operations would be effected to enable the vessel to resume her ocean voyage. Messrs. Easton and Anderson constructed the lifts and Messrs. Handyside and Co. the cradles.

While still fighting against adverse circumstances and—the financial difficulties having been overcome—seeking an extension of time from the Canadian Government to complete the work which had occupied so many years of his life, Mr. Ketchum, who had been in indifferent health for some months, died suddenly at Amherst, Nova Scotia, on the 8th September, 1896. His enthusiasm and confidence in the ultimate completion and success of this great undertaking never wavered. With persistent, earnest effort he devoted himself for fifteen years to the promotion of the enterprise with which his name is identified, and, although baffled when the work was within sight of completion, he never lost hope and was ready to stake all in support of his opinions. Some months before his death he had selected the spot, on the site of the great work of his life, where he now rests.

Mr. Ketchum was elected an Associate on the 1st May, 1866, and was transferred to the class of Members on the 30th April, 1878.

DAVID KIRKALDY was born at Mayfield, near Dundee, on the 4th April, 1820. As a boy his health was very precarious, and the nervous and highly sensitive disposition which this engendered remained a characteristic throughout life. He was educated under Dr. Low of Dundee, and at Merchiston Castle, Edinburgh, where he studied for some years, attending lectures also at the University. An interesting recollection was his discovery that his bedroom in the Castle had been the study of Napier, the celebrated mathematician and author of the system of logarithms. Kirkaldy had already developed a taste for experimenting (in those days it took the shape of chemistry) and was devoting a Saturday afternoon to laboratory work. Happening to burst a retort, or some vessel, and splashing the wall, he attempted to dry it, but in doing so removed the distemper, when he found traces of geometric figures and diagrams on the wall. The principal, Dr. Chalmers, had the walls carefully cleaned down, bringing to light many interesting souvenirs of the mathematician's work.

On leaving Merchiston, Kirkaldy returned to Dundee and worked in the office of his father, a merchant and shipper. But mercantile work was sorely against his inclinations, although, to please his