MEMOIRS OF DECEASED MEMBERS.

MR. JOHN HENRY ABBEY was born in the year 1831, and began his professional career as a pupil of Mr. Thomas Brook, surveyor, Huddersfield, after which he entered the office of Mr. Martin, a civil engineer of Leeds. In the year 1853 he was appointed surveyor to the Huddersfield Improvement Commissioners but resigned in 1857 to commence practice on his own account, and to take up appointments rendered vacant by the death of his uncle Mr. Mallinson Abbey, as surveyor to several important turnpike trusts and landed estates. On the incorporation of the borough of Huddersfield in 1868 he was elected borough surveyor, and in that capacity rendered valuable assistance to the corporation in the promotion of and carrying into effect several improvement bills; but owing to numerous engagements he resigned that appointment in August 1879.

He attained considerable eminence as a valuer, and his general knowledge and experience led to his being extensively employed in arbitration cases. He was architect of the new borough offices in Ramsden Street, and also of the public hall now in course of completion in Princess Street. Mr. Abbey was elected an Associate of the Institution on the 11th of May, 1869, and was transferred to the class of Members on the 27th of November, 1877. He died, after a short illness, of cancer in the stomach, in the fiftieth year of his age, on the 27th of November, 1880.

SIR THOMAS BOUCH, the third son of William Bouch, a retired captain in the mercantile marine, was born in the village of Thursby, Cumberland, on the 22nd of February, 1822. The village school of Thursby was for a time conducted by Mr. Joseph Hannah, and the elementary part of Thomas Bouch's education was acquired under that teacher, who still survives, and who has given interesting information regarding the early career of his subsequently distinguished pupil. For a time, the boy showed no greater inclination for study than is usual with an average village lad, and the beginnings of his interest in learning are attributed to a curious cause. Fond of out-door exercise, hunting, &c., he was

more prominent in the rougher traits of school life than in attention to his teacher, and in the annual carnival of "barring out"—when the scholars occupy the schoolhouse, and defy the master till some concession as to holidays, &c., has been gained—Thomas Bouch took an active part. It appeared to Mr. Hannah that this rather barbarous and demoralising practice might give way to a more rational procedure, and he persuaded his boys to come to the schoolhouse to a lecture on Natural Philosophy. Bouch was the last to give in, but, deserted by his comrades, he too attended. Many years afterwards he confessed to his teacher that the lecture (which treated of ways of raising water in ancient and modern times) had not proceeded far before he found his whole attention engrossed, and he began to wish the master would talk till night! He at once took to reading books on the subject of Mechanics, "Ferguson's Lectures on Select Subjects" being a favourite volume. This stimulus appears to have eventually led him into that career wherein he won distinction. Mr. Hannah removed from Thursby to take charge of an old-established school in Carlisle, and there Thomas Bouch followed him, completing his education about the year 1840.

His first entrance to business was in a mechanical engineering establishment in Liverpool, but he did not find this congenial or suitable for his tastes, and after a short interval he returned to Carlisle. At the age of seventeen, he was engaged by Mr. Larmer, civil engineer, who was then employed on the construction of the Lancaster and Carlisle railway, under Messrs. Locke and Errington. Here Mr. Bouch remained about four years, giving such satisfaction that Mr. Larmer asked Mr. Hannah, "if he could send another youth as well qualified to act as assistant." In November 1844, Mr. Bouch proceeded to Leeds, where he was occupied for a short time under Mr. George Leather, M. Inst. C.E. Subsequently he was for four years one of the Resident Engineers on the Stockton and Darlington railway, under the late Mr. John Dixon, Engineer-in-chief, and in that position took part in many important engineering operations for the Company.

In January 1849, Mr. Bouch left Darlington to assume the position of manager and engineer of the Edinburgh and Northern railway, subsequently known as the Edinburgh, Perth and Dundee, and now absorbed in the North British system. This engagement first brought to his notice the inconvenient breaks in railway communication caused by the wide estuaries of the Forth and the Tay, the efforts to remedy which afterwards occupied so much of his attention.

His first proposal was to cross the estuaries by convenient steam ferries; and he soon prepared and carried into effect plans for a "floating railway," a system for shipping goods trains which has now been in operation for thirty years.[1] From the discussion at the Institution in 1861, ten years after the system had come into operation, it would appear that several plans and suggestions, more or less nearly approaching that carried out by Mr. Bouch, had previously been in existence. But the dictum of the late Mr. Bidder, who was President at the time, may be accepted, that "there was little merit in a simple conception of this kind, as compared with a work practically carried out in all its details, and brought to perfection." With the exception of such slight accidents as are perhaps inevitable in working such a system, it has been used daily, in all weathers, and with unqualified success, during the whole period since it was erected under Mr. Bouch's direction. It may be mentioned that the "Leviathan," the vessel first employed on this service on the Forth, was built by the late Mr. Robert Napier, M. Inst. C.E., of Glasgow, and was brought round from the Clyde, by the north of Scotland, in weather which fully tested its sea-going qualities. Mr. W. Hall, M. Inst. C.E., from whose Paper some of the above particulars are taken, urged the success of the scheme as a plea for its more general adoption.

Shortly after completing this work, Mr. Bouch left the service of the Northern railway, and engaged in general engineering business. The railways actually carried out on designs by Mr. Bouch embraced the Darlington and Barnard Castle, 20 miles; the South Durham and Lancashire Union, 50 miles; the Eden Valley, 22 miles; the Cockermouth, Keswick and Penrith, 31 miles; the Sevenoaks and Maidstone, 20 miles; the Peebles (long the pattern for cheap construction), 21 miles; the Kinross-shire, 10½ miles; the Leven (Fife), 6 miles; the Leslie, 5 miles; the St. Andrews, 5 miles; the Crieff Junction, 9 miles; the Coatbridge undertaking, 8 miles; the Edinburgh, Loanhead and Roslin, 6 miles; the Leadburn, Linton and Dolphinton, 10 miles; the Penicuick, 6¼ miles; the North British Arbroath and Montrose (on the eve of completion at his death), 16 miles; the Newport (Fife), 6 miles; the Tay bridge, tunnel, station, and connecting lines, 8 miles; and the Edinburgh Suburban Railway, 8 miles, for which powers were obtained last session. In addition to the lines actually constructed, Mr. Bouch's name is associated with a number of plans of railways which from various causes were not

[1] *Vide* Minutes of Proceedings Inst. C.E., vol. xx., pp. 376–390.

carried out. In 1861, he was engineer of a scheme to connect Edinburgh with Perth by a new line, carrying the trains across the Forth at Queensferry by an adaptation of the "floating railway," which had then been proved by ten years' experience at the wider crossing at Burntisland. Some years later he projected the Glasgow and North British railway, with a bridge over the Forth above Queensferry, which will be noticed further on. In 1864 he was the author of an important scheme for completing the "inner" and "outer" circles of the London system, and his proposals were in part adopted by the Joint Committee of Lords and Commons which sat on this question, and from whose labours sprang the "District" railway. On the introduction of the tramway system, Mr. Bouch was extensively engaged in laying out lines, including some of the London tramways, the Edinburgh, Glasgow, and Dundee tramways, and others.

In the course of his professional work, Mr. Bouch constructed a number of remarkable bridges, chiefly in connection with railways. At Newcastle-on-Tyne, he designed the Redheugh viaduct, described by him as a compound, or stiffened-suspension bridge. It consists of four spans, two of 260 feet, and two of 240 feet each. Its piers, formed of four grouped pillars of 3 feet in diameter, with horizontal cast-iron girders and diagonal wrought-iron bars, are 80 feet above high water, being the same height as the high-level railway bridge. His principal railway bridges, independent of the Tay bridge, were the Deepdale and Beelah viaducts on the South Durham and Lancashire Union railway, the Bilston Burn bridge on the Edinburgh, Loanhead and Roslin line, and a bridge over the Esk at the Montrose end of the North British, Arbroath and Montrose line. The Beelah viaduct presents a design of sixteen spans of 60 feet, the greatest height being 196 feet. The piers consist of a group of six columns, two centres and two rakers on each side, with a diameter of 12 inches. The Deepdale viaduct has eleven spans of 60 feet, with a maximum height of 160 feet. At Bilston the bridge is constructed with stone piers, and has six spans of 70 feet, with a maximum height of 150 feet. In a bridge crossing the Tees, the spans, five in number, are 120 feet each, with a maximum height of 130 feet, the piers being, as in the Bilston bridge, constructed of stone. In all these bridges Mr. Bouch made use of the lattice girder, because of its simplicity and its slight resistance to the wind encountered at such high elevations.

After the "floating railway," already described, had come into operation, Mr. Bouch's attention was drawn to the desirability

of having a more direct connection between the north and south of Scotland, by carrying uninterrupted railway communication across the two estuaries of the Forth and the Tay. Taking the Forth first, besides laying out the scheme for a railway ferry at Queensferry, he projected the Glasgow and North British railway, plans for which were lodged in 1864, and in which it was proposed to cross the estuary by a fixed bridge. This was proposed to be 3 miles long, and was to extend from the south side to a point called the Stacks, about a mile above Charleston on the Fife shore, the piers consisting of wrought-iron cylinders supported on a wide base on the silt bottom of the river. An experimental pier for this bridge was prepared and partly sunk to its place, attracting much attention amongst professional men at the time. The bridge was to have been 125 feet above high-water level, and five of its spans were to have been 500 feet each, to cross the fairway of the river. After considerable progress had been made with the experimental pier, the project was abandoned, on the failure of Mr. Hodgson's policy as chairman of the North British railway. The question of bridging the Forth was, however, not lost sight of by Mr. Bouch, who in 1873, after the Tay bridge had been begun, projected a design of a much bolder character. He removed the point of crossing to Queensferry, where the width was much reduced, but the depth much increased. Taking advantage of the island of Inchgarvie, in the middle of the estuary, as a foundation for a central pier, he proposed to cross the deep-water channels on each side by two spans of 1,600 feet each, elevated 150 feet above high-water line. Each span was to be supported by suspension chains, having a deflection of 375 feet, the stiffening necessary for railway traffic being provided by tie-rods and stron lattice girders. The piers were formed of cast-iron columns, strongly braced, and their total height from the foundation was upwards of 600 feet. The advantages promised by this scheme were so great that the several railway companies, both English and Scotch, who were interested in the traffic on the eastern side of the kingdom, eagerly professed their willingness to support it, if it were practicable: but on account of the unexampled boldness of the design, they stipulated that it should be submitted to the opinion of some of the highest engineering authorities in the kingdom. Accordingly a committee of four eminent engineers, Sir John Hawkshaw, Messrs. W. H. Barlow, G. P. Bidder, and T. E. Harrison, were appointed for the purpose, and at their suggestion an elaborate investigation of the proposed design, in full theoretical

and practical detail, was undertaken by Mr. W. H. Barlow and Dr. Wm. Pole, assisted on some points by the Astronomer Royal, Sir G. B. Airy. Their report was given on the 30th June 1873, and it was so favourable that the four referees pronounced an unqualified approval of the plan. They said: "It affords us great satisfaction to be able to give our sanction to a work of so imposing a character, and to express our high approval of the skill, scientific research, and practical knowledge which have been brought to bear upon the elaboration of this interesting work." It is right to add that in the designs of this, as of many other important structures, Mr. Bouch was assisted by Mr. A. D. Stewart, of Edinburgh, whose high mathematical attainments and great practical experience in iron construction, were of much advantage to him.

Some years elapsed, in consequence of financial difficulties, before the scheme took a practical shape, but in 1878 a company was formed, the contracts for the Forth Bridge were let, and on the 30th September in that year the works were formally begun.

Although Mr. Bouch had, as early as 1849, expressed his determination to bridge both estuaries, it was not till 1863 that the first proposal for a Tay bridge was made public, and not till July 1870 that the Bill for this purpose received the royal assent. As originally designed, the Tay bridge differed in some of its details from the scheme ultimately carried out. As eventually built, the bridge was within a few yards of 2 miles long: it consisted of eighty-five spans, namely, seventy-two in the shallow water on the north and south sides varying from 29 to 145 feet; and thirteen larger spans over the fairway channel, two of these being 227 feet, and eleven 245 feet, wide. The rails rested on the upper members of the girders generally, but on the lower members of the thirteen large spans. The system of wrought-iron lattice girders was adopted throughout, Mr. Bouch adhering to the form of construction which had been successfully employed in other works designed by him. The piers were originally intended to be of brickwork, but after the fourteen nearest the south shore had been thus erected, the fifteenth showed a failure of the anticipated foundation, which led to the abandonment of brick and the introduction of iron. In the lesser piers the group of pillars consisted of four of 12 inches diameter, and for the larger spans six pillars were used, disposed in two triangular groups of three each, and stiffened with cross bracing. After many vicissitudes and delays caused by unexpected difficulties in carrying out the work, the line was completed continuously from shore

to shore on the 22nd of September, 1877, after which date there was a heavy ballast traffic across the river, testing the carrying power of the bridge in a satisfactory way. The inspection of the work by Major-General Hutchinson, R.E., on behalf of the Board of Trade occupied three days, and on the 31st of May, 1878, the bridge was opened with much ceremony and rejoicing, the engineer being presented with the freedom of the town of Dundee. Traffic on the bridge was at once begun, and a direct service of trains from Edinburgh and Glasgow to Aberdeen was organised, saving much time and inconvenience by the abandonment of the ferry crossing and the double change of conveyance it involved. The improvement was fully appreciated by the public, and in June 1879 the Queen crossed the bridge on her journey southwards from Balmoral. As a mark of royal approval of the striking achievement of the engineer, the Queen commanded the attendance of Mr. Bouch at Windsor, and on the 26th of June, 1879, he received the honour of knighthood.

The traffic was continued uninterruptedly till the evening of Sunday the 28th of December, 1879, when a violent hurricane arose, and during the passage of a train from Edinburgh across the bridge, the central portion fell into the river, carrying with it the entire train and its load of about seventy passengers, all of whom lost their lives. An inquiry was instituted by the Board of Trade into the circumstances of the accident, the evidence showing much conflict of opinion as to its cause. There could be no doubt, however, of the almost unprecedented violence of the gale, and Sir Thomas Bouch strongly held the opinion that under this force some part of the train had left the rails, which he considered would amply account for the disaster. He had for some time not been well, and under the shock and distress of mind caused by the casualty his health more rapidly gave way, and he died at Moffat on the 30th of October, 1880. In his death the profession has to lament one who, though perhaps carrying his works nearer to the margin of safety than many others would have done, displayed boldness, originality and resource in a high degree, and bore a distinguished part in the later development of the railway system.

One unfortunate effect of the disaster was to paralyse the operations that had been favourably going on towards the larger project of crossing the estuary of the Forth. The public had, for the moment, lost faith in large iron bridges; the Board of Trade made larger demands of security, and the Forth Bridge Company, rather than persevere in so bold a scheme in the face of

a temporarily unfavourable phase of public opinion, resolved to abandon the undertaking, or at least to wait till a more convenient season for its further prosecution. There must, however, be a feeling of universal regret at the loss to the public, without any sufficient cause, of the enormous advantages offered by a scheme so favourably launched, and which would have been so great a credit to the engineering talent and commercial enterprise of Great Britain.

Sir Thomas Bouch married in July 1853 Miss Margaret Ada Nelson, who survives him with one son and two daughters. He became an Associate of the Institution on the 3rd of December, 1850, and was advanced to the class of Member on the 11th of May, 1858. His brother, the late Mr. William Bouch, was long connected with the locomotive department of the Stockton and Darlington and North Eastern lines.

MR. WILLIAM CLARK was born at Colchester, on the 17th of March, 1821. His education was obtained principally at King's College, London, which he entered in 1842, and where he was so distinguished for industry and diligence, that, on the termination of his three years' course, he was made an Associate of the College. Soon afterwards he became a pupil of, and subsequently an assistant to, Mr. Birkinshaw, M. Inst. C.E., under whom, first as assistant and afterwards as resident engineer, he was employed for a period of three or four years on the works of the York and North Midland railway system. In 1850 he was connected with the late Sir Goldsworthy Gurney, who at that time had charge of the warming and ventilating of the Houses of Parliament. In 1851 he entered into partnership with Mr. A. W. Makinson, M. Inst. C.E., the firm devoting special attention to the warming and ventilating of public buildings. He was shortly afterwards offered and accepted the appointment of surveyor to the Local Board of Health of Kingston-upon-Hull, and devised a complete system of drainage for that town, the works of which were commenced by him. In 1854 he entered the service of the East Indian Railway Company as a second-class engineer. After acting for upwards of a year as resident engineer on a portion of the East Indian railway, forming part of the district under Mr. Sibley, M. Inst. C.E., he became the secretary, and subsequently the engineer, to the Municipality of Calcutta, who were considering what could be done to im-