

other places, and in all carried out in their entirety, or partially, some sixty works or systems for gas, water, or sewerage.

Mr. Stevenson was elected an Associate of the Institution on the 1st of April, 1851, and was transferred to the class of Members on the 27th of May, 1879. He was President of the Gas Institute in 1882.

Mr. Stevenson died on the 23rd of October, 1889.

WILLIAM STROUDLEY was born on the 6th of March, 1833, at Sandford, in Oxfordshire; in 1847 he was apprenticed to Mr. John Inshaw, of Birmingham, but as his parents were not able to pay a premium he got no indentures. He worked in the shop, learning to fit and turn, and to work the engines in a twin-screw passenger boat started in 1840 by Mr. Inshaw, to run on the canal between Birmingham and Wolverhampton. In 1848 he went for a few months to work an engine of 15 HP. for Mr. Middleton of the Vulcan Foundry, Birmingham, and then performed similar duties for Mr. W. Dean, an engineer and millwright, in Birmingham, under whom he acquired practice as a hand-turner and at general work. He was also sent out to assist in the erection of a set of pumps and a steam-engine to drain a deep well at the Hatton Asylum, near Warwick. In 1849 Mr. Inshaw received an order for the engines of eight steam-boats, on his plan of twin-screws, for the Grand Canal Company, Dublin, and Mr. Stroudley was again engaged with him, being employed fitting up the engines and boilers, after which he was sent to Dublin to assist in erecting them; this and other work kept him employed until 1851, when he went to work for Mr. Edwards, of the Islington Foundry, Birmingham; there he was engaged in erecting a large condensing engine for a corn-mill, and afterwards on a pair of compound engines for a paper-mill, and another pair of compound engines for Messrs. Nettlefold and Chamberlain, Birmingham. By this time he was near twenty years of age, and Mr. Inshaw failing in business, young Stroudley left him, and in May 1853 was engaged at the Swindon Locomotive Works, where he was employed, under the superintendent, the late Sir Daniel Gooch, in fitting up valve- and slide-motions for new goods-engines. He was principally engaged on piece-work, at which he occasionally earned as much as 7s. per day. He was soon advanced to day-work at 31s. 6d. per week. He received an offer from his old

employer, Mr. Inshaw, in the early part of 1854, to go out to Australia to erect a pair of engines and a corn-mill; and Stroudley left Swindon for that purpose, having been offered £15 per month; on reaching home, however, his parents used every means, and successfully, to persuade him not to leave England. In consequence he went to the Peterborough shops of the Great Northern Railway, and started to work as a running-shed fitter under Mr. Owen, the District Superintendent. In September 1854 Mr. C. Sacré succeeded Mr. Owen, and on his becoming acquainted with Stroudley he made him working foreman, and he had charge of the passenger-engines at Peterborough, doing all ordinary repairs, at a salary of £104 per annum. In 1857 he was sent by Mr. Sacré to take charge of a small line of railway for Lord Willoughby D'Eresby, which had failed from bad management. He worked this line, 5 miles long, having gradients of 1 in 40, 1 in 30, and, in one part a long incline of 1 in 27, and got the permanent way put in good order, improving the switches and crossings, so that the line was passed for passenger-traffic by Colonel Yolland, and gradually settled down to an ordinary branch line. In 1858 Mr. Stroudley was induced by his brother, who was Manager of the Helpstone Paper-mills, to take charge of the steam-engines and machinery at that place, as they were in very bad order; and on the Managing Director offering him £2 10s. per week, with house, &c., he agreed to do so, and soon made great alterations in the machinery and the consumption of coal. He got everything into excellent order, and in 1859 went back to his old post at Peterborough, where he had charge, as before, of the passenger-engines, but under Mr. Francis Cortazzi, Mr. Sacré having been appointed to the Manchester, Sheffield and Lincolnshire Railway. In less than a year Mr. Cortazzi was appointed Locomotive Superintendent of the Great Indian Peninsula Railway, and Mr. W. Brown succeeded him at Peterborough and New England. Mr. Stroudley continued to give the most unremitting attention to his duties, and was able to keep the passenger-engines at Peterborough in excellent order, and their consumption of coke and coal at the bottom of the list. The Peterborough district included Grantham, and the passenger-engines collectively ran about 20,000 miles per week.

In September 1861 Mr. Brown was appointed Locomotive and Carriage Superintendent of the Edinburgh and Glasgow Railway; and in October of the same year Mr. Stroudley was made Manager of the Cowlairst Works of that railway at Glasgow. He had entire charge of repairing and building locomotive-engines, carriages and

wagons, and of the large stationary engine and rope for working the Glasgow Junction. He had also charge of designing the engines, carriages, and wagons, the Drawing Office likewise being under his superintendence. During this time there were built about fifteen new engines, eight new boilers for the stationary engines, sixty carriages, and four hundred wagons; besides many heavy repairs of all kinds were effected. He turned up the large pulleys, 20 feet in diameter, of the incline engine; put in the new boilers (which he had both designed and made in the shops), and also inserted heavy girders under the main shaft plummer-block; the whole of this work was done without causing the least stoppage or delay to the engines, although they only stood still for twelve hours on Sunday. For this work Mr. Stroudley was congratulated by the Members of the Institution of Mechanical Engineers, on their visiting the works on the occasion of their meeting at Glasgow.

Mr. Stroudley also designed and built a small engine for a steam-yacht, and was successful in producing the fastest and lightest boat on the Clyde. The boat was built by Mr. William Denny, of Dumbarton, and he paid Mr. Stroudley the compliment of saying it was the best small engine and boiler he had ever seen. The boat was 35 feet by 5 feet, and would run 11 miles an hour. His salary as Manager of the Cowlares Works was £200 per annum, with free house, coals, &c., and Mr. Brown having bad health, he had more than his share of the charge of the work.

In 1865 Mr. Stroudley was appointed Locomotive and Carriage Superintendent at Inverness of the Highland Railway, at a salary of £500 per annum. During his stay at Inverness he designed snow-ploughs, which have been successful in keeping that line clear and open for traffic ever since. He also designed new workshops, which were accounted at the time among the simplest and most convenient in this country. He invented and patented a locking-apparatus for facing points, as also a "ramp" for re-railing carriages, wagons, or engines, which is in use on almost all the railways in Great Britain, on the Continent, and in India.

In January 1870 he was appointed to the position of Locomotive and Carriage Superintendent of the London, Brighton and South Coast Railway, where he had the entire charge of the locomotive and carriage department and of the engines, machinery, &c., of the Company's sea-going steamers. On the 24th of May in the same year he was elected an Associate of this Institution; and on the 6th of February, 1877, he was made a full Member.

During the twenty years that Mr. Stroudley held the position of

Locomotive Superintendent to the Brighton Railway, he succeeded in raising himself to the very front rank of English mechanical engineers. His early career was such that he had no opportunity of obtaining what is termed technical education. Professors of engineering never taught him anything; in a letter accompanying his application for admission into the Institution, he said, with proud humility: "I am the son of a working-man, and have been a working-man myself." His mathematical attainments were of the most moderate description; and yet it may be doubted if that which Mr. Stroudley did not know was, for the engineer, worth knowing. Above and beyond most men, he possessed a special power of not only doing the right thing in mechanical engineering, but of doing it in the right way. He wanted to know the reason for everything, and was always ready to give a reason for what he did. He continually and persistently went to the roots of things, and from these he worked upwards. For instance, he found that on the Brighton Railway, as on others, carriage- and wagon-axles broke constantly. They always broke at the same place—the junction of the journal with the wheel. He cast about till he found the reason. Then he eliminated the cause, and as a result, to all intents and purposes, broken axles disappeared. His early experience with locomotives showed him that the paramount defect of such engines is being short of steam. Given steam enough, and almost every other defect becomes endurable. Consequently, he adopted what may be termed lavish proportions for his boilers, and the result was one which he never regretted. A lesson once taught him by experience, he never forgot; it was stowed away in a stupendous memory, and acted upon when the occasion arose. Thus, for example, a fireman was killed while standing on the tender by his head coming in contact with an overhead bridge. Mr. Stroudley resolved that this class of accident should become impossible in the future. A man may now stand where he pleases on the tank, his head will clear a bridge by a foot. He found that the wheels of the tenders were different in diameter from those of the engines, and he asked himself if there was a good reason for this; finding that there was not, he designed all his engines with carrying-wheels of the same diameter as those of the tenders. The axles and journals are the same, and thus they are all interchangeable. He inquired why coupled engines should have the outside cranks radially opposite to the inside cranks. The answer was that they then balanced each other; but he also saw that the stresses in the driving axle-boxes were very much augmented; so he put the coupling cranks at the same side of the centre as the inside cranks,

and forged suitable balance-weights inside the wheels. The results were all that he expected.

Now and then he adopted experimentally things about whose success he had doubts, but he always so managed that the evil consequences of failure should be minimised. Showing to a friend certain long bogie passenger-coaches, he explained that they had been built in deference to the wishes of others in authority. "I am not quite sure whether they will suit our lines," he said, "but they are just twice as long as our ordinary stock, and if they don't answer I'll put a hand-saw through them, and so make two bodies out of one."

Mr. Stroudley had an intense and truly refined sense of mechanical fitness. On him a faulty, ill-designed, or unmeaning detail had the same effect as a discord on a musician, and he valued good workmanship next to good design. He carried his views on this point almost to an extreme. He would never tolerate the least leak about a locomotive; and it is scarcely too much to say that no one can tell by looking at one of his engines, standing, whether it is in steam or not, unless the safety-valves happen to be blowing off. He invented many things, but his skill and talent were more fully manifest in what is known as "scheming" than in inventing. He would take sheet after sheet of drawings, and give a definite reason why each separate detail was made as he had made it, and not in some other way or of some other shape. It was quite possible that the listener did not agree with him; that might be a matter of opinion, but there could be no doubt of the honest sincerity of purpose which prevented him from ever adopting any shape or form, or proportion, or thing, because it "would do well enough." Nothing did "well enough" for Mr. Stroudley. He manifested wonderful powers of selecting the best of several solutions of a difficulty—not only the best mechanically, but the best and most suitable all round. He was always ready to adopt and acknowledge what was good. Thus, for example, being satisfied that the Westinghouse brake was the best for his purpose, he introduced it on the Brighton line, modifying it where necessary. In steamships he accepted the compound system as the best possible, but he would not use it for locomotives. He did not reject it blindly or without reason. He maintained persistently that there were circumstances and conditions under which it would do good service, but that these did not exist on the lines under his control. He believed that a big boiler would always give as good results with a non-compound engine, as could be got with a smaller

boiler out of a compound engine; and he pointed to his coal-bills, asking if any locomotive superintendent could beat them.

In his management of men, Mr. Stroudley was a rigid disciplinarian, but extremely fair-minded and just. He delighted in giving men an interest in their work, and adopted many devices for the purpose. He held that there was no reason why a locomotive or its driver should be dirty, and the foot-plates of the Brighton Railway engines have been fastidiously kept under his rule.

Mr. Stroudley was among the earliest to recognize the value of the system of interchangeability of parts, and to carry out that system to its full extent in his own practice. Not only did he make engines of the same class identical in all respects, but he also made many of the parts of engines of different classes interchangeable. As he had but few types of locomotives, he thus built up a workshop system of great simplicity; he was rigorous in the application of the principle, preferring to sacrifice a part which accidentally differed from the standard, rather than admit any deviation from his rules. In the management of his men it was his aim to cultivate in them the same pride in their work which he felt himself; each driver had his own engine, and his name was painted inside the cab, with the number of miles run between successive overhauls. In this way a spirit of emulation was set up, and the extra care which the machinery received far more than compensated, in Mr. Stroudley's opinion, for the reduced amount of work which any one engine was able to perform, in consequence of its being in charge of one set of men only.

One of the most striking points in Mr. Stroudley's practice was the use of large leading-wheels. He ran express engines with 6 feet 6-inch coupled leading-wheels, a plan which greatly simplified the design, since it enabled him to utilize the weights of the cylinders and motion for adhesion, and to avoid the use of cast-iron foot-plates. The small trailing-wheels also allowed of the construction of a specially large firebox. The centre of gravity of the engine was kept high, and the outside rods were placed on the same side of the crank-shaft as the corresponding inside rods. Engines of this type have done splendid service on the Brighton line, and all who have ridden on them will willingly testify to their exceptionally steady running. Mr. Stroudley was strongly opposed to complication, and hence he kept to the six-wheel engine without bogie or radial axle, believing that for such a line as he had to work, the truest economy lay in the use of simple engines of moderate weight and ample heating-surface. His practice, which

embodied a great number of original and interesting features, has been fully recorded in the Paper on Locomotives, which he presented to the Institution in 1885, and for which he was awarded a Telford medal and premium.¹

Mr. Stroudley had the knack of making friends among every class with which he came in contact, and even those against whom he was obliged, by business requirements, to act in opposition were impressed by his intelligence and individuality. He approached every question from an original standpoint, and was never content to follow an established usage unless it could be demonstrated to him that it was right. The most striking example of this feature of his character is found in the fine boats of the Brighton Railway Company which run between Newhaven and Dieppe. Mr. Stroudley was neither a naval architect nor a marine engineer, yet it is probable that all the best points both in the vessels and their engines were due to him. Many men in his position would have thrown the entire responsibility upon the builders, and would have accepted their designs without criticism. But so far from doing this, he not only got out the drawings for the engines, but also constructed models of various forms of hulls, making up for his lack of technical knowledge by ingeniously devised experiments, which enabled him to determine displacement, metacentric heights, and the like, without recourse to mathematics, or to the accumulated data possessed by shipbuilders. The results have more than justified his action, for the boats have not only been exceedingly successful, and economical in working, but they have been accepted as embodying the correct type for channel service.

Again, the peculiar circumstances of the Brighton Railway, which embraces a network of nearly 100 miles of suburban lines in the London district, with many steep inclines and frequent stations, and which lines have to be worked by frequent trains of moderate weight, induced Mr. Stroudley to depart entirely from the beaten track in designing an engine to suit this traffic. As a result he introduced little three-coupled tank locomotives which, probably from their small proportion and general all-round usefulness, came to be known as "Terrier" engines. Here, as in a goods engine, every particle of the weight is utilized for adhesion; and, as the "omnibus" service which the terriers work does not call for high speed, these machines are very economical, while their wheel-base being not much greater than that of the ordinary two-coupled engines, they are able to go round sharp curves with ease. Mr.

¹ Minutes of Proceedings Inst. C.E., vol. lxxxi. p. 86.

Stroudley got a gold medal for one of these engines, the "Brighton" at the Paris Exhibition of 1878; and it was in connection with another engine exhibited at Paris, in 1889, the "Edward Blount," for which again he got a gold medal, that he met with his death. This locomotive, named after the Chairman of the Western Railway of France, with which the Brighton Company has very intimate relations, embodied all Mr. Stroudley's most recent practice, and had attracted much notice at the Exhibition, both from its design and its splendid workmanship. In December 1889, Mr. Stroudley was summoned to Paris to conduct some trials with it on the Paris, Lyons and Mediterranean Railway, in competition with several other locomotives that had been in the Exhibition. While thus engaged he got a chill, which being neglected, rapidly induced inflammation of the lungs. He died in Paris on the 20th of December, 1889. The body was brought to Brighton, and four days later was interred in the extra-mural cemetery of that town, a funeral procession extending for more than $\frac{1}{2}$ mile testifying to the opinion of William Stroudley entertained by the engineering world and by his fellow-townsmen.

ROBERT VAWSER, third son of the late Mr. Charles Vawser of Waldersea, March, Cambridgeshire, was born on the 13th of September, 1841, educated at Peterborough, and afterwards articled to the late Mr. M. O. Tarbotton, of Nottingham, with whom he subsequently remained for a short period, being entrusted by Mr. Tarbotton with the carrying out of various important works.

In 1863 Mr. Vawser entered the office of the late Mr. C. E. Cawley (sometime M.P. for Salford), of London and Manchester, under whom he designed and superintended various engineering works. In 1866, he left Mr. Cawley, having obtained the appointment of principal assistant to the Borough Engineer of Belfast, under whom he carried out public works of considerable magnitude, including the sewerage and paving, in one year alone, of one hundred and thirty streets.

In 1867 Mr. Vawser was appointed Borough Surveyor of Warrington, where he designed and carried out many important works, including main-sewerage works, several miles of impervious pavements, an infectious disease hospital, art gallery, &c. In his letter of resignation, dated October 22, 1877, he stated that nearly ten years had elapsed since his pleasing association with the council commenced, and that he should always remember with