

respect ranged over the whole field of modern engineering, the experience accumulated in his long career, coupled with his extensive and profound reading, conducing to render his participation in the debates of much value and interest.

BENJAMIN PIERCY was born at Trefeglwys, Montgomeryshire, on the 16th of March, 1827. He was the third son of Mr. Robert Piercy, who was well known in the counties of Montgomery, Denbigh and Flint as commissioner, valuer and surveyor in the inclosure of commons and waste lands, and who was also extensively engaged in the construction of public roads and other works, and in surveys and valuations under the Poor Law and Tithe-Commutation Acts. Mr. Benjamin Piercy, who was educated privately, at an early age entered his father's office, and soon became actively engaged upon important surveys and other work of varied description. About 1847, he became chief assistant to the late Mr. Charles Mickleburgh of Montgomery, who had a large practice as surveyor, land-agent and inclosure-commissioner, with whom he remained four or five years. During this period, as well as during the time passed in his father's office, Mr. Piercy devoted the whole of his leisure to the study of civil engineering and general railway practice. He had had the opportunity of travelling through every part of Wales, and had noted the necessity which existed for the establishment there of railway communication. He had not long to wait for an opportunity of participating in active work. The late Mr. Henry Robertson,¹ sometime M.P. for Shrewsbury, and subsequently for the county of Merioneth, engaged Mr. Piercy to assist him in making the parliamentary surveys for the Shrewsbury and Chester Railway. So much energy and attention did Mr. Piercy devote to the work, that he was the means of preventing the loss of a year in obtaining the Act for that line. He was afterwards employed under Mr. Robertson upon the plans and sections for the first Bill for a railway from Oswestry to Newtown; that Bill was not passed. Application was made to Parliament in a subsequent session, and Mr. Piercy was again engaged in the engineering, but upon that occasion, too, the Bill was not passed. It was in 1852, when he became the Engineer for the Red Valley Railway Bill for constructing a line from Shrewsbury to Minsterley

¹ Minutes of Proceedings Inst. C.E., vol. xciii. p. 488.

and Newtown, that Mr. Piercy's independent practice commenced. With characteristic energy and skill, he had within a very limited time prepared the parliamentary plans for deposit, but they were surreptitiously removed from the room which he occupied at a hotel in London, so that it was impossible to proceed with the Bill in the then ensuing session. In the following year, however, he duly deposited the plans for a railway from Shrewsbury to Welshpool, with a branch to Minsterley. Although strongly opposed at every stage, including Standing Orders, Mr. Piercy succeeded in carrying the Bill through both Houses, and it received the Royal assent. It was in the Select Committees on this Bill that he first made his reputation as a witness in Parliamentary Committees.

After this, he was engaged upon nearly all the projects for introducing independent railways into Wales, all of them meeting with fierce opposition; for several days consecutively he was as a witness under cross-examination by the genial Mr. Serjeant Merewether and other eminent counsel, but so little headway were they able to make against Mr. Piercy, that upon one occasion, when a Committee passed a Bill of Mr. Piercy's, Mr. Merewether held up his brief-bag and asked the Committee whether they would not give that too to Mr. Piercy?

Amongst the numerous railways in this country of which he was engineer are the following:—The Oswestry, Ellesmere and Whitchurch, the Oswestry and Newtown, the Llanidloes and Newtown, the Newtown and Machynlleth, the Welsh Coast Railways extending to Aberystwith, the Aberdovey, Barmouth and Pwllheli, the Vale of Clwyd, the Carnarvonshire, the Denbigh, Ruthin and Corwen, the Bishops Castle, the Mid-Wales, the Hereford, Hay and Brecon, the Kington and Eardisley, the Hoylelake, and the Wrexham, Mold and Connahs Quay, with its extensions and branches.

The principal engineering works upon the railways above enumerated were as follow:—Upon the Oswestry and Newtown Railway, several important river bridges, comprising the crossing of the River Vyrnwy, and three crossings of the Severn; in these cases, the railway was carried over upon iron-plate girders of large span resting upon iron cylinders sunk to a great depth and filled in with concrete. There were also two fine stations, one at Oswestry, the other at Welshpool. The construction of the Newtown and Machynlleth Railway, owing to the mountainous nature of the country, involved some heavy work, *e.g.*, an open cutting about 120 feet deep at Talerddig, and several long skew

bridges over mountainous torrents, constructed with unusually massive masonry firmly bedded in solid rock foundations at great depth. Upon the Welsh Coast Railway was the crossing of two great estuaries, exposed to the sea, with tides of 16 feet range. One of these at Barmouth, about 2 miles wide, was crossed with iron girders resting upon screw piles, with an opening bridge to admit of the passage of sea-going vessels.¹ The other estuary crossing was near Portmadoc.

In 1862 Mr. Piercy was consulted by the Concessionaires of Railways in the Island of Sardinia, with reference to the construction of the railways for which they had obtained the concession, comprising about 250 miles of lines. The plans and sections, which had been prepared by Italian engineers, involved the construction of about 20 miles of tunnels and many heavy works of art, so that it was found impossible to get contractors who would be willing to build the railways within the limit of time allowed by the concession, and at a cost within the amount of funds available. Mr. Piercy re-surveyed the whole of the projected railways, and changed their proposed course, reducing very considerably the tunnelling and other heavy work, and he succeeded in designing a system of lines capable of construction at a practicable cost within the prescribed time. The Royal Sardinian Railway Company was thereupon successfully formed, having first obtained the adoption and acceptance of Mr. Piercy's plans by the Italian Government, and a contract was entered into with Messrs. Smith, Knight and Co. for the construction and completion of the railways accordingly. The works progressed, and some of the easier sections of railway were nearly completed, when the war broke out between Italy and Austria and stopped all further operations. Everything remained suspended until 1869. During the interval, the works sustained considerable damage from floods and otherwise. Mr. Piercy was again called in by the railway company to re-survey the lines and prepare new estimates for their completion. When these were finished, he negotiated on behalf of the company a new convention with the Italian Government; by this convention, which came into force in August, 1870, an increased annual kilometrical guarantee was obtained for the company, and it was agreed that the railways should be divided into two series, one called the "lines of the first period," the other, the "lines of the second period."

The "lines of the first period" comprised only the lines of the

¹ Minutes of Proceedings Inst. C.E., vol. xxxii. pp. 163, 169.

plains left unfinished in 1865, of a total length of 197 kilometres; the "lines of the second period" were the more difficult lines over and along the mountains, 194 kilometres. The time allowed for completing the "lines of the first period" was extended to the 31st of December, 1874, after which, the company was to decide whether it would construct the "lines of the second period," or whether it would sell the undertaking to the Government. Mr. Piercy lost no time in taking energetic action on this new convention; for some months, he carried on the construction of the railways on behalf of the company, but subsequently the works were again let to a contractor, Mr. Piercy acting as engineer-in-chief, and early in 1872, the "lines of the first period," excepting one section of about 45 kilometres, were opened for public traffic, leaving only the construction of that section to fulfil the company's obligations under the convention of 1870.

The construction of the "lines of the second period" was subsequently proceeded with, and after almost endless difficulties from various causes, the junction of the "lines of the first period" with the "lines of the second period" was effected in June, 1880, and the whole were formally accepted, approved by the Government, and opened throughout early in 1881. As an acknowledgment of the great national service rendered by Mr. Piercy, he was created a Commendatore of the Crown of Italy, and the freedom of various cities in Sardinia was conferred upon him. Subsequently, it was decided to construct an extension of the system from the extreme north-eastern terminus of the line at Terranova to the Golfo di Aranci, a splendid natural harbour directly facing Civita-Vecchia, the port of Rome; the construction of this extension, about 27 kilometres, was also entrusted to Mr. Piercy; the works involved a heavy cutting of more than $\frac{1}{2}$ mile in length, and over 40 feet deep through difficult strata. The cutting was completed within ninety days, and the whole line within seven months. Mr. Piercy also designed a mole and other harbour works at the Golfo di Aranci, which are now being constructed to his plans.

Supplementary to the main lines of railway in Sardinia, which are all of the standard 4 feet 8 $\frac{1}{2}$ -inch gauge, Mr. Piercy took advantage of his long residence in the island to study several series of subsidiary lines of the metre gauge to be feeders to the main system; his studies extended to nearly 2,000 kilometres of narrow-gauge railways, passing through difficult mountainous districts at an altitude, in several instances, of from 3,000 to 4,000 feet; for several of these lines, his plans were accepted by the company

and approved by the Government, and they are now in course of construction.

It was not in railways only that Mr. Piercy interested himself in Sardinia; he gave great attention to effecting agricultural improvements in the island; deserts and swamps were converted by him into perfect gardens by extensive drainage works, and the planting of many thousands of eucalyptus and other trees, so that places, formerly noted as hot-beds of fever, were rendered perfectly healthy; he also planted vineyards and orchards on a large scale. He acquired large estates, which he stocked with cattle, horses and sheep, of all of which he so improved the breeds that his stock attained the reputation of being far superior to any other in the island, and he gained many medals awarded by Government as well for cattle, horses and sheep, as for agriculture. He, moreover, did a good deal towards instructing the natives in good husbandry, which was before in a very primitive state. In short, Mr. Piercy's hand was pre-eminently visible in all improvements, and he was universally looked upon as a public benefactor, throughout the period of his connection with Sardinia, which extended over twenty-five years.

During Mr. Piercy's residence in Italy, he was an intimate friend of Garibaldi, who paid him frequent visits in Sardinia; and one of Garibaldi's sons was for some time one of his pupils.

In addition to the Sardinian railways, Mr. Piercy was employed upon other public works in Italy, notably a project for the canalization of the Tiber; he also prepared the plans for the *Acqua Marcia*, the great company by which Rome is now supplied with water. In France, he was the Engineer-in-chief of the *Napoléon-Vendée* Railway, a line which has been constructed and in operation many years, about 160 miles in length, from Tours, *viâ* Bressuire, to Sables d'Olonne, a well-known port and seaside resort on the Bay of Biscay. In India, he was the Engineer for the lines, about 90 miles in length, of the Assam Railways and Trading Company, Limited, passing through the tea-plantations in Assam, and connecting Dibrugarh, on the River Brahmaputra, with the coalfields at Makum, in the Naga Hills near the frontier of Burmah, where the company is working extensive collieries. These collieries were opened up under Mr. Piercy's direction, and he was engaged at the time of his death in taking measures for the working of the valuable petroleum deposits also belonging to the Assam Railways and Trading Company. He also took an active part in projecting an extension of the Assam Railway across the Burmah frontier, through the Naga Hills, south-eastward, to meet the railway now being con-

structed in Burmah northward from Mandalay; holding a strong opinion that the right way to obtain access to the interior of Burmah, and to pacify that country, was to connect the railway systems of India with the railways in Burmah, utilizing the Assam railways as the middle link.

To revert to the year 1881, when the Sardinian "lines of the second period" were completed; Mr. Piercy then again took up his residence in Great Britain, and purchased an estate, Marchwiell Hall, near Wrexham, with the intention of devoting himself to the resuscitation of the railways in North Wales, of which he had been the engineer before he went to Italy. He took them in hand financially as well as in the capacity of engineer; consolidating and re-arranging their capital accounts, and planning extensions, branches and improvements, so as to develop the valuable mineral resources of the districts through which they passed, and to bring to the lines their fair share of traffic. He found a ready ally in Mr. Henry Robertson, who had, before Mr. Piercy's departure for Italy, occupied a position antagonistic to the latter's Welsh railway projects, and the two became cordially associated in the common object of improving the industries of North Wales. Parliamentary powers were obtained by the Manchester, Sheffield and Lincolnshire Railway Company, for connecting the Wrexham, Mold and Connah's Quay Railway with Birkenhead, Liverpool and Chester on the north, by a bridge across the Dee at Connah's Quay, and powers were obtained for connecting the Wrexham line with the Cambrian Railways on the south, by an extension to Ellesmere, thus completing the North Wales railway system, and providing a new through continuous route, uniting Liverpool, Manchester and the North with all parts of Wales, South as well as North.

Mr. Piercy received many invitations to become a candidate for Parliament, but he determined to bide his time; had he lived he would doubtless have entered the House of Commons. He was a chess player of no mean ability, and a great advocate and patron of all manly games and intellectual pursuits. He laid out at Marchwiell Hall one of the finest cricket grounds in the kingdom; he was ardently fond of the game, and excelled in it. He was a Justice of the Peace for the County of Denbigh, his assistance in matters of County Government being highly appreciated for its eminently practical and original character. In private life, Mr. Piercy's tastes were simple, healthy and intellectual; he was a most agreeable companion, and he was much esteemed by his intimates for his generous and amiable disposition;

but his great characteristics were thoroughness, a habit of bestowing regard upon things which those around him would consider trifles, infinite capacity for taking pains, an extraordinary power of premeditation and forethought, thinking things out to the end, and mentally working out the result of even the smallest matter to which he put his hand, coupled with indomitable and unceasing perseverance and persistence in all which he undertook, but, at the same time, modest and unassuming to an unusual degree. Mr. Piercy was elected a Member of the Institution on the 8th of January, 1860. He died on the 24th of March, 1888.

ARTHUR POTTS, the second son of Mr. Henry Potts, of Glan-yr-Afon, Denbighshire, was born on the 23rd of June, 1814. He was apprenticed to Messrs. Mather, Dixon & Co., of Liverpool, where he was a contemporary of Mr. W. B. Buddicom, and other engineers afterwards destined to rise to note in connection with the establishment of the railway system. He was known to George Stephenson, who was constructing the Liverpool and Manchester Railway when young Potts was serving his time. Messrs. Mather, Dixon and Co. did a good deal of work for the early lines, and in this way Mr. Potts was thrown much in contact with Mr. Robert Stephenson, Mr. Locke, and Mr. Errington, and became a personal friend of each. Some time after completing his apprenticeship, Mr. Potts joined Mr. John Jones at the Viaduct Foundry, near Newton le Willows, which had a very prosperous career. Messrs. Jones and Potts employed about eight hundred men, and for several years were fully employed in making locomotive-engines for various railways, notably the Caledonian Railway. This latter line owed much to the Newton firm, for being about the year 1848 in great pecuniary straits, owing to the financial crisis caused by the unsettled state of the Continent, it was very much owing to the forbearance of Messrs. Jones and Potts that the great bulk of the company's creditors were prevented from taking hostile action. Had that been done the completion of the Caledonian line would have been deferred for years, and many a prosperous manufactory would have ceased to exist. The firm also executed stationary and marine-engine work. Mr. Potts did not take a large share in the practical management of the works; he did nearly all the travelling, but when at the works used to make frequent rounds of all the shops. He used to amuse the good fitters when he examined the work of their indifferent mates by trying to insert the edge of his pen-knife into