simply from his determination to succeed. For several years Stephenson plodded steadily on until he reached the turning-point in his career, the doctoring of the Newcomen engine at Killingworth High Pit, which spread his fame far and wide amongst collieries, and led to his being appointed to a position in which he found scope for his talents. A short time before that event Stephenson had been drawn for the militia, and it was probably a "lucky draw" for this country and the world. To find a substitute George not only parted with all his little savings, but borrowed money of a friend, and was thus prevented from emigrating to Australia with his sister and her husband. When he was about thirty-four years of age Stephenson was appointed engine-wright at Killingworth, a position of much trust and responsibility, with corresponding advantages from a pecuniary point of view. Mindful of his short-comings in the matter of education he sent his son Robert to a good school, and derived benefit himself by going over the lessons with the boy on his return home. Robert also spent his spare time in the Literary and Philosophical Institute of Newcastle, and he recounted what he had read to his father. The latter had by this time become intimately acquainted with such steam-engines as were to be found in mines, and had a fair book knowledge of other kinds; when, therefore, Mr. Blackett, encouraged by the success of Mr. Blenkinsop, renewed his experiments, with locomotives, Stephenson studied the question with ever increasing interest, and had abundant opportunities of witnessing the failures of others. Trevithick some ten years previously had invented a locomotive, and Blenkinsop and Blackett, the latter with the assistance of Foster and Hedley, had made engines which served to show that the thing was to be done when the man and the hour arrived. The earlier attempts were practical failures, and the colliery owners gave up experimenting; but meanwhile Stephenson had been thinking, and in 1813 he broached the subject to the lessees of the Killingworth colliery. He had by this time made his mark as a clever engineer and an ingenious man, and Lord Ravensworth, who had a high opinion of him, gave the desired permission to make a locomotive. This engine, like its predecessors, was not altogether a success; it did the work, but it cost as much as horses. However, it did something more, for it gave the engineer experience, and in 1815 Stephenson took out a patent for a locomotive which combined the essential features of success. That date marks the real birth of the locomotive; it became a practical machine, and might be trusted to grow with the experience of its makers. Differences of opinion still continue as to who invented this or that detail of the locomotive, but the great fact remains that Stephenson made it a paying machine, and just as Watt is regarded as the father of the steam-engine so is Stephenson the parent of the railway system. He had seen the failures of Blackett, and had talked with Foster and Hedley, and when they had practically given up the task, his belief in himself and his determined perseverance led Stephenson on until he grasped success. Another quality of the man was his unflinching courage. Years before the locomotive troubled his active brain he had made experiments on coal gas, and had frightened the pitmen by the apparently reckless way in which he held lighted candles near the "blowers." To all remonstrances his answer was that he "hoped to make something useful in preserving mens' lives." The famous experiment with the lamp, the outcome of much thought, was made in the same year as the patent for the locomotive was completed, and before the year had closed, the lamp, too, was a practical success. Helmholtz, in his recent lecture on Faraday, spoke of his wonderful intuitive perception, which enabled him to understand the causes of the effects he witnessed, although he had none of the training which is supposed to assist in the work of research. The same gift was a notable characteristic of Stephenson. Quite ignorant of laws and principles, and possibly unable to give a clear reason for doing anything one way instead of another, it is certain that his practical experience enabled him to comprehend the why and the wherefore and to foretell the results of the experiments. Although Trevithick had, some years before shown that the friction between the wheel and the road was sufficient without cogs and rack, Blenkinsop adopted the latter; but Stephenson thinking for himself, made an experiment which satisfied him how far the rail was an advantage, and to what extent smooth wheels could be used. The rack was the weak part of Blenkinsop's engine, as the geared wheels were of Hedley's, and though ,in his first locomotive, he adopted spur wheels and an endless chain. Stephenson discarded them in his next. The manner in which he laid out the colliery tramways under his charge shows that he had fully grasped the secret of success, for, where inclines were absolutely necessary, he put down stationary engines to haul the waggons, and used his locomotives only on the practically level parts. His ingenuity was extraordinary, and enabled him to surmount the difficulties which the undeveloped state of the mechanical arts placed in his way. The road-bed of the early railways was unequal to the heavy weights of locomotives; and the spring-makers had not then succeeded in making the compound springs which now so easily carry the heavier loads of our modern engines. Stephenson was equal to the occasion, and made the boiler itself act as springs by connecting it with pistons and cylinders to the frames or axles. Although colliery railways had been developed to a considerable extent, it was not until Mr. Pease started the idea of the Stockton and Darlington railroad that Stephenson found another opportunity; but his earnestness, and the proof of what he had done at Killingworth and Hetton, won him the favour of the far-seeing Quaker, and by his influence the locomotive was adopted. As a reward for his safety-lamp, a subscription of £1,000 had been given to Stephenson, which he, seeing the need of getting a number of the best mechanics together for the making of engines, put down as half the capital in a workshop which has since become famous, and he persuaded Mr. Pease to advance the other half. Whether he foresaw what was coming may be doubted; but the wisdom of the step is apparent, for the workshop at Newcastle certainly helped George Stephenson to win the day at Liverpool. The success of the "Rocket" established the reputation of the engineer, and opened the path for the great social revolution of which Stephenson was the pioneer. It may well be doubted whether all his inventions put together required so much perseverance as did the famous battle over the Liverpool and Manchester railway. The ridicule heaped upon the scheme and upon the manner in which it was proposed to carry it out was enough to make the most courageous man turn back; but Stephenson had thought it out, and Chat Moss was a difficulty he had determined to conquer. At this time it is amusing to read the speeches of the legal gentlemen engaged in the great case; they are curiosities of forensic eloquence, and of the license of the Bar. As Stephenson pursued his course, gradually overcoming the difficulties he met, the unreasoning scepticism gave way, and those who had been most madly opposed to the introduction of the iron-horse developed a mania in the contrary direction. Through all, the great engineer passed determinedly, though his feeling must often have been aroused by the abuse of those who dogmatised on subjects they had never studied. When the turn of the tide came, just as he had felt confident of the success of the locomotive, so Stephenson was not led astray by the delusion which seized his countrymen, and his sterling honesty prevented him from lending his name to schemes which other engineers less scrupulous puffed for professional purposes. We, nowadays, cannot realize the difficulties which the early pioneers of railways had to encounter, but we can appreciate the courage of the man who, when satisfied in his own mind as to the possibilities of the locomotive, found that he had almost to force his great revolution upon an unwilling world. At the age of 40, Stephenson, when he presented himself to Mr. Pease, was practically an uneducated man; but he had had experience in laying down railways, and had learnt the art of surveying; he had, as we have shown, an intuitive skill and the faculty of observation, which compensated to a large extent for the absence of school training; and he had invincible courage and a determination to succeed where success seemed at all possible. It might be urged that if such a man could do so much, education could help him to do little more; but Stephenson's opinion on that point is left without any doubt, in the care that he took, and the self-denial he practised, in order that his son Robert might have the best training he could afford to give him. The best memorial of the great engineer, then, apart from the gigantic memorial we see around us, is the Stephenson College in what may be termed his native town, and we are happy to think that the establishment of such an institution will not be the least important outcome of the Stephenson Centenary.

A patent has been taken out on behalf of Herr B. Roeber, of Dresden, for transmitting heat to the contents of steam-boilers. The method consists mainly in the creation of currents of heat in vessels or pipes situated partly within the material to be heated and filled with fluids of special qualities in a fluid or gaseous condition, or in a condition of chemical dissociation and reunion. By means of these pipes the heat of the fire is transmitted to the interior of the boiler or other vessel without direct contact of the fire with the walls of the vessel. The number of the specification is 4516, 1880, and there are 87 figures and 35 claims.