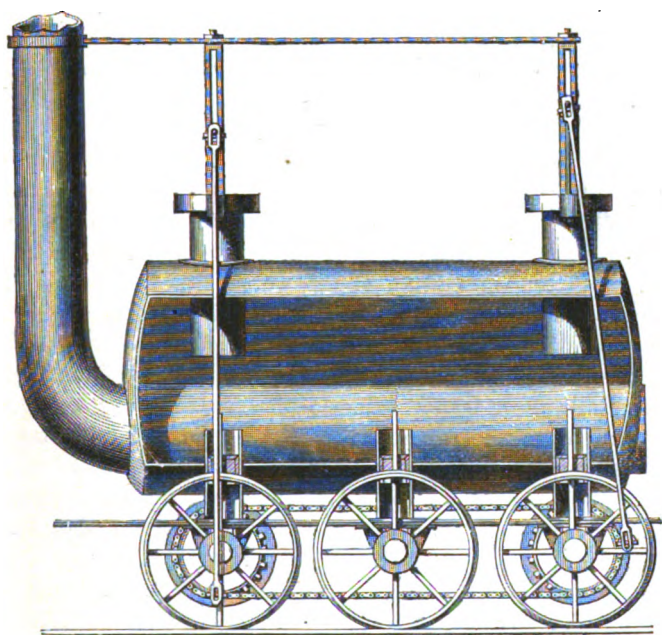


these engines continued in profitable use upon the Killingworth Colliery Railway for some years. Eventually the chain was laid aside, and the front and hind wheels were united by rods on the *outside*, instead of by rods and crank-ankles *inside* as specified in the original patent; and this expedient completely answered the purpose required, without involving any expensive or difficult workmanship.



SECTION OF KILLINGWORTH LOCOMOTIVE, 1815.

“Another important improvement was introduced in this engine. The eduction steam had hitherto been allowed to escape direct into the open atmosphere; but my father, having observed the great velocity with which the waste-steam escaped, compared with the velocity with which the smoke issued from the chimney of the same engine, thought that by conveying the eduction steam into the chimney and there allowing it to escape in a vertical direction, its velocity would be imparted to the smoke from the engine, or to the ascending current of air in the chimney. The experiment was no sooner made than the power of the engine became more than doubled; combustion was stimulated, as it were, by a blast; consequently the power of

the boiler for generating steam was increased, and, in the same proportion, the useful duty of the engine was augmented.

"Thus in 1815 my father had succeeded in manufacturing an engine which included the following important improvements on all previous attempts in the same direction: simple and direct communication between the cylinder and the wheels rolling upon the rails; joint adhesion of all the wheels, attained by the use of horizontal connecting-rods; and, finally, a beautiful method of exciting the combustion of fuel by employing the waste steam which had formerly been allowed uselessly to escape. It is, perhaps, not too much to say that this engine, as a mechanical contrivance, contained the germ of all that has since been effected. It may be regarded, in fact, as a type of the present locomotive engine.

"In describing my father's application of the waste steam for the purpose of increasing the intensity of combustion in the boiler, and thus increasing the power of the engine without adding to its weight, and while claiming for this engine the merit of being a type of all those which have been successfully devised since the commencement of the Liverpool and Manchester Railway, it is necessary to observe that the next great improvement in the same direction, the "multitubular boiler," which took place some years later, could never have been used without the help of that simple expedient *the steam-blast*, by which power only the burning of coke was rendered possible.

"I cannot pass over this last-named invention of my father's without remarking how slightly, as an original idea, it has been appreciated; and yet how small would be the comparative value of the locomotive engine of the present day without the application of that important invention!

"Engines constructed by my father in the year 1818 upon the principles just described are in use on the Killingworth Colliery Railway to this very day (1856), conveying, at the speed of perhaps five or six miles an hour, heavy coal trains, probably as economically as any of the more perfect engines now in use.

"There was another remarkable piece of ingenuity in this machine, which was completed so many years before the possibility of steam-locomotion became an object of general commercial interest and parliamentary inquiry. I have before observed that up to and after the year 1818 there was no such class of skilled mechanics, nor were there such machinery and tools for working in metals, as are now at the disposal of inventors and

manufacturers. Among other difficulties of a similar character, it was not possible at that time to construct springs of sufficient strength to support the improved engines. The rails then used being extremely light, the roads became worn down by the traffic, and occasionally the whole weight of the engine, instead of being uniformly distributed over four wheels, was thrown almost diagonally upon two. In order to avoid the danger arising from such irregularities in the road, my father arranged the boiler so that it was supported upon the frame of the engine by four cylinders which opened into the interior of the boiler. These cylinders were occupied by pistons with rods which passed downwards and pressed upon the upper side of the axles. The cylinders opening into the interior of the boiler allowed the pressure of steam to be applied to the upper side of the piston, and that pressure being nearly equal to the support of one-fourth of the weight of the engine, each axle, whatever might be its position, had the same amount of weight to bear, and consequently the entire weight was at all times nearly equally distributed amongst the wheels. This expedient was more necessary in this case, as the weight of the new locomotive engines far exceeded that of the carriages which had hitherto been used upon colliery railways, and therefore subjected the rails to much greater risk from breakage. And this mode of supporting the engine remained in use until the progress of spring-making had considerably advanced, when steel springs of sufficient strength superseded this highly ingenious mode of distributing the weight of the engine uniformly among the wheels."

The invention of the Steam-Blast by George Stephenson, in 1815, was fraught with most important consequences to railway locomotion; and it is not saying too much to aver that the success of the locomotive has been in a great measure the result of its adoption. Without the steam-blast, by means of which the intensity of combustion is maintained at its highest point, producing a correspondingly rapid evolution of steam, high rates of speed could not have been kept up; the advantages of the multitubular boiler (afterwards invented) could never have been fully tested; and locomotives might still have been dragging themselves unwieldily along at little more than five or six miles an hour.

As this invention has been the subject of considerable

controversy, it becomes necessary to add a few words respecting it in this place. It has been claimed as the invention of Trevithick in 1804, of Hedley in 1814, of Goldsworthy Gurney in 1820, and of Timothy Hackworth in 1829. With respect to Trevithick, it appears that he discharged the waste steam into the chimney of his engine, but without any intention of thereby producing a blast;<sup>1</sup> and that he attached no value to the expedient is sufficiently obvious from the fact that in 1815 he took out a patent for urging the fire by means of fanners, similar to a winnowing machine. The claim put forward on behalf of William Hedley, that he invented the blast-pipe for the Wylam engine, is sufficiently contradicted by the fact that the Wylam engine had *no* blast-pipe. "I remember the Wylam engine," Robert Stephenson wrote to the author in 1857, "and I am positive there was no blast-pipe." On the contrary, the Wylam engine embodied a contrivance for the express purpose of *preventing* a blast. This is clearly shown by the drawing and description of it contained in the first edition of Nicholas Wood's 'Practical Treatise on Railroads,' published in 1825. This evidence is all the more valuable for our purpose as it was published long before any controversy had arisen as to the authorship of the invention, and indeed before it was believed that any merit whatever belonged to it. And it is the more remarkable, as Nicholas Wood himself, who published the first practical work on railways, did not at that time approve of the steam-blast, and referred to the Wylam engine in illustration of how it might be prevented.

<sup>1</sup> It must, however, be mentioned, that Mr. Zerah Colburn, in his excellent work on 'Locomotive Engineering and the Mechanism of Railways,' points out that Mr. Davies Gilbert noted the effect of the discharge of the waste steam up the chimney of Trevithick's engine in increasing the draught, and wrote a

letter to 'Nicholson's Journal' (Sept. 1805) on the subject; and Mr. Nicholson himself proceeded to investigate the subject, and in 1806 he took out a patent for "steam-blasting apparatus," applicable to fixed engines, which, however, does not seem to have come into use. (See *ante*, p. 45).

The following passage from Mr. Wood's book clearly describes the express object and purpose for which George Stephenson invented and applied the steam-blast in the Killingworth engines. Describing their action, Mr. Wood says :—

“The steam is admitted to the top and bottom of the piston by means of a sliding valve, which, being moved up and down alternately, opens a communication between the top and bottom of the cylinder and the pipe that is *open into the chimney and turns up within it*. The steam, after performing its office within the cylinder, is thus thrown into the chimney, and the power with which it issues will be proportionate to the degree of elasticity; and *the exit being directed upwards, accelerates the velocity of the current of heated air accordingly.*”<sup>1</sup>

And again, at another part of the book, he says :—

“There is another great objection urged against locomotives, which is, the noise that the steam makes in escaping into the chimney; this objection is very singular, as it is not the result of any inherent form in the organisation of such engines, but an accidental circumstance. When the engines *were first made*, the steam escaped into the atmosphere, and made comparatively little noise; *it was found difficult then to produce steam in sufficient quantity to keep the engine constantly working, or rather to obtain an adequate rapidity of current in the chimney to give sufficient intensity to the fire. To effect a greater rapidity, or to increase the draught of the chimney, Mr. Stephenson thought that by causing the steam to escape into the chimney through a pipe with its end turned upwards, the velocity of the current would be accelerated, and such was the effect*; but, in remedying one evil another has been produced, which, though objectionable in some places, was not considered as objectionable on a private railroad. The tube through the boiler having been increased, there is now no longer any occasion for the action of the steam to assist the motion of the heated air in the chimney. The steam thrown in this manner into the chimney acts as a trumpet, and certainly makes a very disagreeable noise. Nothing, however, is more easy to remedy, and the very act of remedying this defect will also be the means of economising the fuel.”<sup>2</sup>

<sup>1</sup> Nicholas Wood, ‘Practical Treatise on Railways,’ ed. 1825, p. 147.

<sup>2</sup> Ibid. pp. 292-3.

Mr. Wood then proceeds to show how the noise caused by the blast, how in fact the blast itself, might be effectually prevented by adopting the expedient employed in the Wylam engine; which was, to send the exhaust steam, not into the chimney (where alone the blast could act with effect by stimulating the draught), but into a steam-reservoir provided for the purpose. His words are these:—

“Nothing more is wanted to destroy the noise than *to cause the steam to expand itself into a reservoir, and then allow it to escape gradually to the atmosphere through the chimney.* Upon the Wylam railroad the noise was made the subject of complaint by a neighbouring gentleman, and they adopted this mode, which had the effect above mentioned.”<sup>1</sup>

It is curious to find that Mr. Nicholas Wood continued to object to the use of the steam-blast down even to the time when the Liverpool and Manchester Railway Bill was before Parliament. In his evidence before the Committee on that Bill in 1825, he said: “Those engines [at Killingworth] *puff very much, and the object is to get an increased draught in the chimney.* Now (by enlarging the flue-tube and giving it a double turn through the boiler) we have got a sufficiency of steam without it, and I have no doubt by allowing the steam to exhaust itself in a reservoir, it would pass quietly into the chimney without that noise.” In fact, Mr. Wood was still in favour of the arrangement adopted in the Wylam engine, by which the steam-blast had been got rid of altogether.

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<sup>1</sup> Nicholas Wood, ‘Practical Treatise on Railways,’ ed. 1826, p. 294. These passages will be found in the first edition of Mr. Wood’s work, published in 1825. The subsequent editions do not contain them. A few years’ experience wrought great changes of opinion on many points connected with the practical working of railways, and Mr. Wood altered his

text accordingly. But it is most important for our present purpose to note that, in the year 1825, long before the Liverpool and Manchester line was opened, Mr. Wood should have so clearly described the steam-blast which had been in regular use for more than ten years in all Stephenson’s locomotives employed in the working of the Killingworth railway.

If these statements, made in Mr. Wood's book, be correct — and they have never been disputed — they render it perfectly clear that George Stephenson invented and applied the steam-blast for the express purpose of quickening combustion in the furnace by increasing the draught in the chimney. Although urged by Wood to abandon the blast, Stephenson continued to hold by it as one of the vital powers of the locomotive engine. It is quite true that in the early engines, with only a double flue passing through the boiler, run as they were at low speeds, the blast was of comparatively less importance. It was only when the improved passenger engine, fitted with the multitubular boiler, was required to be run at high speeds that the full merits of the blast were brought out; and in detecting its essential uses in this respect, and sharpening it for the purpose of increasing its action, the sagacity of Timothy Hackworth, of Darlington, is entitled to due recognition.



## CHAPTER VI.

## INVENTION OF THE "GEORDY" SAFETY-LAMP.

EXPLOSIONS of fire-damp were unusually frequent in the coal mines of Northumberland and Durham about the time when George Stephenson was engaged in the construction of his first locomotives. These explosions were often attended with fearful loss of life and dreadful suffering to the work people. Killingworth Colliery was not free from such deplorable calamities; and during the time that Stephenson was employed as brakesman at the West Moor, several "blasts" took place in the pit, by which many workmen were scorched and killed, and the owners of the colliery sustained heavy losses. One of the most serious of these accidents occurred in 1806, not long after he had been appointed brakesman, by which ten persons were killed. Stephenson was near the pit mouth at the time, and the circumstances connected with the explosion made a deep impression on his mind, as appears from the graphic account which he gave of it to the Committee of the House of Commons on accidents in mines, some thirty years after the event.

"The pit," said he, "had just ceased drawing coals, and nearly all the men had got out. It was some time in the afternoon, a little after mid-day. There were five men that went down the pit; four of them for the purpose of preparing a place for the furnace. The fifth was a person who went down to set them to work. I sent this man down myself, and he had just got to the bottom of the shaft about two or three minutes, when the explosion took place. I had left the mouth of the pit, and had gone about fifty or sixty yards away, when I heard a tremendous noise,

looked round, and saw the discharge come out of the pit like the discharge of a cannon. It continued to blow, I think, for a quarter of an hour, discharging everything that had come into the current. Wood came up, stones came up, and trusses of hay that went up into the air like balloons. Those trusses had been sent down during the day, and I think they had in some measure injured the ventilation of the mine. The ground all round the top of the pit was in a trembling state. I went as near as I durst go; everything appeared cracking and rending about me. Part of the brattice, which was very strong, was blown away at the bottom of the pits. Very large pumps were lifted from their places, so that the engine could not work. The pit was divided into four by partitions; it was a large pit, fourteen feet in diameter, and partitions were put down at right angles, which made four compartments. The explosion took place in one of those four quarters, but it broke through into all the others at the bottom, and the brattice or partitions were set on fire at the first explosion.

“Nobody durst go near the shafts for some time, for fear of another explosion taking place. At last we considered it necessary to run the rope backwards and forwards, and give the miners, if there were any at the bottom of the shaft, an opportunity of catching the rope as it came to the bottom. Several men were safely got up in this way; one man, who had got hold of the rope, was being drawn up, when a further explosion took place while he was still in the shaft, and the increased current which came about him projected him as it were up the shaft; yet he was landed without injury: it was a singular case. . . . The pit continued to blast every two or three hours for about two days. It appears that the coal had taken fire, and as soon as the carburetted hydrogen gas collected in sufficient quantity to reach the part where it was burning, it ignited again; but none of the explosions were equal to the first, on account of many parts of the mine having become filled with azotic gas, or the *after-damp* of the mine. All the ditches in the country-side were stopped to get water to pour into the pit. We had fire-engines brought from Newcastle, and the water was poured in till it came above the fire, and then it was extinguished. The loss to the owners of the colliery by this accident must have been about 20,000*l*.”<sup>1</sup>

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<sup>1</sup> Evidence given by George Stephenson before the Select Committee on Accidents in Mines, 26th June, 1835.

Another explosion took place in the same pit in 1809, by which twelve persons lost their lives. The blast did not reach the shaft as in the former case; the unfortunate persons in the pit having been suffocated by the after-damp. More calamitous still were the explosions which took place in the neighbouring collieries; one of the worst being that of 1812, in the Felling Pit, near Gateshead, a mine belonging to Mr. Brandling, by which no fewer than ninety men and boys were suffocated or burnt to death. And a similar accident occurred in the same pit in the year following, by which twenty-two men and boys perished.

It was natural that Stephenson should devote his attention to the causes of these deplorable accidents, and to the means by which they might if possible be prevented. His daily occupation led him to think much and deeply on the subject. As engine-wright of a colliery so extensive as that of Killingworth, where there were nearly 160 miles of gallery excavation, in which he personally superintended the working of inclined planes, along which the coals were sent to the pit entrance, he was necessarily very often underground, and brought face to face with the dangers of fire-damp. From fissures in the roofs of the galleries, carburetted hydrogen gas was constantly flowing; and in some of the more dangerous places it might be heard escaping from the crevices of the coal with a hissing noise. Ventilation, firing, and all conceivable modes of drawing out the foul air had been tried, while the more dangerous parts of the galleries were built up. Still the danger could not be wholly prevented. The miners must necessarily guide their steps through the extensive underground ways with lighted lamps or candles, the naked flame of which, coming in contact with the inflammable air, daily exposed them and their fellow-workers in the pit to the risk of death in one of its most dreadful forms.

One day, in the year 1814, a workman hurried into

Stephenson's cottage with the startling information that the deepest main of the colliery was on fire! He immediately hastened to the pit-head, about a hundred yards off, whither the women and children of the colliery were running, with wildness and terror depicted in every face. In a commanding voice, Stephenson ordered the engine-man to lower him down the shaft in the corve. There was danger, it might be death, before him, but he must go.



THE PIT HEAD, WEST MOOR. [By R. P. Leitch.]

He was soon at the bottom, and in the midst of the men, who were paralysed at the danger which threatened the lives of all in the pit. Leaping from the corve on its touching the ground, he called out: "Are there six men among you who have the courage to follow me? If so, come, and we will put the fire out." The Killingworth pitmen had the most perfect confidence in their engine-wright, and they readily volunteered to follow him. Silence succeeded the frantic tumult of the previous minute, and the men set to work with a will. In every mine, bricks, mortar, and tools enough are at hand, and by Stephenson's direction the materials were forthwith carried to the required spot, where, in a very short time, a wall was raised at the entrance to the main, he

himself taking the most active part in the work. The atmospheric air was by this means excluded, the fire was extinguished, most of the people in the pit were saved from death, and the mine was preserved.

This anecdote of George Stephenson was related to the writer, near the pit-mouth, by one of the men, Kit Heppel, who had been present, and helped to build up the brick wall by which the fire was stayed, though several of the workmen were suffocated. Heppel relates that, when down the pit some days after, seeking out the dead bodies, the cause of the accident was the subject of some conversation between himself and Stephenson, and Heppel then asked him, "Can nothing be done to prevent such awful occurrences?" Stephenson replied that he thought something might be done. "Then," said Heppel, "the sooner you begin the better; for the price of coal-mining now is *pitmen's lives*."

Fifty years since, many of the best pits were so full of the inflammable gas given forth by the coal, that they could not be worked without the greatest danger; and for this reason some were altogether abandoned. The rudest possible means were adopted of producing light sufficient to enable the pitmen to work by. The phosphorescence of decayed fish-skins was tried; but this, though safe, was very inefficient. The most common method employed was what was called a steel mill, the notched wheel of which, being made to revolve against a flint, struck a succession of sparks, which scarcely served to do more than make the darkness visible. A boy carried the apparatus, working the wheel; and by the imperfect light thus given forth the miner plied his dangerous trade. Candles were only used in those parts of the pit where gas was not abundant. Under this rude system not more than one-third of the coal could be worked, while two-thirds were left.

What the workmen, not less than the coal-owners, eagerly desired was a lamp that should give forth suffi-

cient light, without communicating flame to the inflammable gas which accumulated in certain parts of the pit. Something had already been done towards the invention of such a lamp by Dr. Clanny, of Sunderland, who, in 1813, contrived an apparatus to which he gave air from the mine through water, by means of bellows. This lamp went out of itself in inflammable gas. It was found, however, too unwieldy to be used by the miners for the purposes of their work, and did not come into general use. A committee of gentlemen interested in coal-mining was formed to investigate the causes of the explosions, and to devise, if possible, some means of preventing them. At the invitation of that committee, Sir Humphry Davy, then in the full zenith of his reputation, was requested to turn his attention to the subject. He accordingly visited the collieries near Newcastle on the 24th of August, 1815; and at the close of that year, on the 9th of November, 1815, he read before the Royal Society of London his celebrated paper "On the Fire-Damp of Coal Mines, and on Methods of Lighting the Mine so as to prevent its Explosion."

But a humbler though not less diligent and original thinker had been at work before him, and had already practically solved the problem of the Safety-Lamp. Stephenson was of course well aware of the desire which prevailed in the colliery districts for the invention of a lamp which should give light enough for the miners to work by without exploding the fire-damp; and the painful incidents above described only served to quicken his eagerness to master the difficulty.

For several years he had been engaged, in his own rude way, in making experiments with the fire-damp in the Killingworth mine. The pitmen used to expostulate with him on these occasions, believing the experiments to be fraught with danger. One of the sinkers, called M'Crie, observing him holding up lighted candles to the windward of the "blower" or fissure from which the

inflammable gas escaped, entreated him to desist; but Stephenson's answer was, that "he was busy with a plan by which he hoped to make his experiments useful for preserving men's lives." On these occasions the miners usually got out of the way before he lit the gas.

In 1815, although he was very much occupied with the business of the collieries and the improvement of his locomotive engine, he was also busily engaged in making experiments upon the inflammable gas in the Killingworth Pit. As he himself afterwards related to the Committee of the House of Commons which sat on the subject of Accidents in Mines in 1835, he imagined that if he could construct a lamp with a chimney so arranged as to cause a strong current, it would not fire at the top of the chimney; as the burnt air would ascend with such a velocity as to prevent the inflammable air of the pit from descending towards the flame; and such a lamp, he thought, might be taken into a dangerous atmosphere without risk of exploding.

Such was Stephenson's theory, when he proceeded to embody his idea of a miner's safety-lamp in a practical form. In the month of August, 1815, he requested his friend Nicholas Wood, the head viewer, to prepare a drawing of a lamp according to the description which he gave him. After several evenings' careful deliberations, the drawing was prepared, and it was shown to several of the head men about the works. "My first lamp," said Stephenson, describing it to the Committee above referred to, "had a chimney at the top of the lamp, and a tube at the bottom to admit the atmospheric air, or fire-damp and air, to feed the burner or combustion of the lamp. I was not aware of the precise quantity required to feed the combustion; but to know what quantity was necessary, I had a slide at the bottom of the tube in my first lamp, to admit such a quantity of air as might eventually be found necessary to keep up the combustion."

Accompanied by his friend Wood, Stephenson went into Newcastle, and ordered a lamp to be made according to his plan, by the Messrs. Hogg, tinmen, at the head of the Side—a well-known street in Newcastle. At the same time he ordered a glass to be made for the lamp at the Northumberland Glass House in the same town. This lamp was received from the makers on the 21st of October, and was taken to Killingworth for the purpose of immediate experiment.

“I remember that evening as distinctly as if it had been but yesterday,” said Robert Stephenson, describing the circumstances to the author in 1857. “Moodie came to our cottage about dusk, and asked, ‘if father had got back yet with the lamp?’ ‘No.’ ‘Then I’ll wait till he comes,’ said Moodie, ‘he can’t be long now.’ In about half-an-hour, in came my father, his face all radiant. He had the lamp with him! It was at once uncovered and shown to Moodie. Then it was filled with oil, trimmed, and lighted. All was ready, only the head viewer hadn’t arrived. ‘Run over to Benton for Nichol, Robert,’ said my father to me, ‘and ask him to come directly; say we’re going down the pit to try the lamp.’ By this time it was quite dark; and off I ran to bring Nicholas Wood. His house was at Benton, about a mile off. There was a short cut through Benton Church-yard, but just as I was about to pass the wicket, I saw what I thought was a white figure moving about among the grave-stones. I took it for a ghost! My heart fluttered, and I was in a great fright, but to Nichol’s house I must get, so I made the circuit of the church-yard; and when I got round to the other side I looked, and lo! the figure was still there. But what do you think it was? Only the grave-digger, plying his work at that late hour by the light of his lanthorn set upon one of the grave-stones! I found Wood at home, and in a few minutes he was mounted and off to my father’s. When I got home, I was told they had just

left—it was then about eleven—and gone down the shaft to try the lamp in one of the most dangerous parts of the mine.”

Arrived at the bottom of the shaft with the lamp, the party directed their steps towards one of the foulest galleries in the pit, where the explosive gas was issuing through a blower in the roof of the mine with a loud hissing noise. By erecting some deal boarding round that part of the gallery into which the gas was escaping, the air was thus made more foul for the purpose of the experiment. After waiting about an hour, Moodie, whose practical experience of fire-damp in pits was greater than that of either Stephenson or Wood, was requested to go into the place which had thus been made foul; and, having done so, he returned, and told them that the smell of the air was such, that if a lighted candle were now introduced, an explosion must inevitably take place. He cautioned Stephenson as to the danger both to themselves and to the pit, if the gas took fire. But Stephenson declared his confidence in the safety of his lamp, and, having lit the wick, he boldly proceeded with it towards the explosive air. The others, more timid and doubtful, hung back when they came within hearing of the blower; and apprehensive of the danger, they retired into a safe place, out of sight of the lamp, which gradually disappeared with its bearer in the recesses of the mine. It was a critical moment; and the danger was such as would have tried the stoutest heart. Stephenson advancing alone, with his yet untried lamp, in the depths of those underground workings,—calmly venturing his life in the determination to discover a mode by which the lives of many might be saved, and death disarmed in these fatal caverns,—presented an example of intrepid nerve and manly courage, more noble even than that which, in the excitement of battle and the collective impetuosity of a charge, carries a man up to the cannon’s mouth.

Advancing to the place of danger, and entering within the fouled air, his lighted lamp in hand, Stephenson held it firmly out, in the full current of the blower, and within a few inches of its mouth. Thus exposed, the flame of the lamp at first increased, then flickered, and then went out; but there was no explosion of the gas. Returning to his companions, who were still at a distance, he told them what had occurred. Having now acquired somewhat more confidence, they advanced with him to a point from which they could observe the experiment repeated, but still at a safe distance. They saw that when the lighted lamp was held within the explosive mixture, there was a great flame; the lamp was almost full of fire; and then it seemed to be smothered out. Again returning to his companions, he relighted the lamp, and repeated the experiment. This was done several times, with the same result. At length Wood and Moodie ventured to advance close to the fouled part of the pit; and, in making some of the later trials, Mr. Wood himself held up the lighted lamp to the blower.<sup>1</sup> Such was the result of the first experi-

<sup>1</sup> The accuracy of the above statement having been called in question, it is proper to state that the facts as set forth were verbally communicated to the author in the first place by Robert Stephenson, to whom the chapter was afterwards read in MS. in the presence of Mr. Sopwith, F.R.S., and received his entire approval. But at the time at which Mr. Stephenson communicated the verbal information, he also handed a little book with his name written in it, still in the author's possession, saying, "Read that, you will find it all there." This little book contains, amongst other things, a pamphlet, entitled 'Report on the Claims of Mr. George Stephenson relative to the Invention of his Safety-Lamp. By the Committee appointed at a Meeting holden in Newcastle, on the 1st of November, 1817. With an Appendix containing

the Evidence.' Among the witnesses examined were George Stephenson, Nicholas Wood, and John Moodie, and their evidence is given in the pamphlet. Stephenson said, that he tried the first lamp "in a part of the mine where the air was highly explosive. Nicholas Wood and John Moodie were his companions when the trial was made. They became frightened when they came within hearing of the blower, and would not go any further. Mr. Stephenson went alone with the lamp to the mouth of the blower." &c. This evidence was confirmed by John Moodie, who said the air of the place where the experiment was about to be tried was such, that, if a lighted candle had been introduced, an explosion would have taken place that would have been "extremely dangerous." "Told Stephenson it was foul, and hinted at the danger; never-

ments with the *first practical Miner's Safety-Lamp*; and such was the daring resolution of its inventor in testing its qualities.

Before leaving the pit, Stephenson expressed his opinion that, by an alteration of the lamp which he contemplated, he could make it burn better. This was by a change in the slide through which the air was admitted into the lower part of the lamp, under the flame. After making some experiments on the air collected at the blower, by means of bladders which were mounted with tubes of various diameters, he satisfied himself that, when the tube was reduced to a certain diameter, the explosion would not pass through; and he fashioned his slide accordingly, reducing the diameter of the tube until he conceived it was quite safe. In about a fortnight the experiments were repeated in the pit, in a place purposely made foul as before. On this occasion a larger number of persons ventured to witness the experiments, which again proved successful. The lamp was not yet, however, so efficient as the inventor desired. It required, he observed, to be kept very steady when burning in the inflammable gas, otherwise it was liable to go out, in consequence, as he imagined, of the contact of the burnt air (as he then called it), or azotic gas, which lodged round the exterior of the flame. If the lamp was moved backwards and forwards, the azote came in contract with the flame and extinguished it. "It struck me," said he, "that if I put more tubes in, I should discharge the poisonous matter that hung round the flame, by admitting the air to its exterior part."

Although he had then no access to scientific works,

theless, Stephenson *would* try the lamp, confiding in its safety. Stephenson took the lamp and went with it into the place in which Moodie had been, and Moodie and Wood, apprehensive of the danger, retired to a

greater distance," &c. The accuracy of the other statements made in the text relative to the invention of the safety-lamp is confirmed by the same publication.

nor intercourse with scientific men, nor anything that could assist him in his inquiries on the subject, besides his own indefatigable spirit of inquiry, Stephenson contrived a rude apparatus, by means of which he proceeded to test the explosive properties of the gas and the velocity of current (for this was the direction of his inquiries) required to permit the explosion to pass through tubes of different diameters. In making these experiments in his cottage at the West Moor, Nicholas Wood and George's son Robert usually acted as his assistants, and sometimes the gentlemen of the neighbourhood—among others William Brandling and Matthew Bell, who were interested in coal-mining—attended as spectators. One who was present on such an occasion remembers that, when an experiment was about to be performed, and all was ready, George called to Mr. Wood, who worked the stop-cocks of the gasometer, "Wise on [turn on] the hydrögen, Nichol!"

These experiments were not performed without risk, for on one occasion the experimenting party had nearly blown off the roof of the cottage. One of these "blows up" was described by Stephenson himself before the Committee on Accidents in Coal Mines in 1835:—

"I made several experiments," said he, "as to the velocity required in tubes of different diameters, to prevent explosion from fire-damp. We made the mixtures in all proportions of light carburetted hydrogen with atmospheric air in the receiver, and we found by the experiments that when a current of the most explosive mixture that we could make was forced up a tube four-tenths of an inch in diameter, the necessary current was nine inches in a second to prevent its coming down that tube. These experiments were repeated several times. We had two or three blows up in making the experiments, by the flame getting down into the receiver, though we had a piece of very fine wire-gauze put at the bottom of the pipe, between the receiver and the pipe through which we were forcing the current. In one of these experiments I was watching the flame in the tube, my son was taking the vibrations of the pendulum of the clock, and Mr

Wood was attending to give me the column of water as I called for it, to keep the current up to a certain point. As I saw the flame descending in the tube I called for more water, and Wood unfortunately turned the cock the wrong way; the current ceased, the flame went down the tube, and all our implements were blown to pieces, which at the time we were not very well able to replace."

The explosion of this glass receiver, which had been borrowed from the stores of the Philosophical Society at Newcastle for the purpose of making the experiments, caused the greatest possible dismay among the party, and they dreaded to inform Mr. Turner, the Secretary,<sup>1</sup> of the calamity which had occurred. Fortunately none of the experimenters were injured by the accident.

Stephenson followed up these experiments by others of a similar kind, with the view of ascertaining whether ordinary flame would pass through tubes of a small diameter, and with this object he filed off the barrels of several small keys. Placing these together, he held them perpendicularly over a strong flame, and ascertained that it did not pass upward. This was a further proof to him of the soundness of the principle on which he had been proceeding.

In order to correct the defect of his first lamp, he accordingly proceeded to alter it so as to admit the air to the flame by several tubes of reduced diameter, instead of by a single tube. He inferred that a

<sup>1</sup> The early connexion of Robert with the Philosophical and Literary Society of Newcastle had brought him into communication with the Rev. William Turner, one of the secretaries of the institution. That gentleman was always ready to assist the inquirer after knowledge, and took an early interest in the studious youth from Killingworth, with whose father he also became acquainted. Mr. Turner cheerfully helped them in their joint inquiries, and excited while

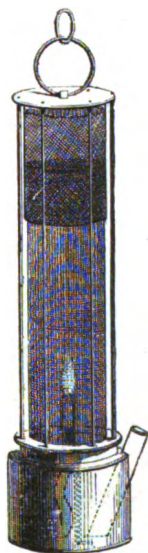
he endeavoured to satisfy their thirst for scientific information. Towards the close of his life, Mr. Stephenson often spoke of the gratitude and esteem he felt towards his revered instructor. "Mr. Turner," he said, "was always ready to assist me with books, with instruments, and with counsel, gratuitously and cheerfully. He gave me the most valuable assistance and instruction, and to my dying day I can never forget the obligations which I owe to my venerable friend."

sufficient quantity of air would thus be introduced into the lamp for the purposes of combustion, while the smallness of the apertures would still prevent the explosion passing downwards, at the same time that the "burnt air" (the cause, in his opinion, of the lamp going out) would be more effectually dislodged. The requisite alterations were made in the lamp by Mr. Matthews, a tinman in Newcastle, and it was so altered that the air was admitted by three small tubes inserted in the bottom, the openings of which were placed on the outside of the burner, instead of having (as in the original lamp) the one tube opening directly under the flame.

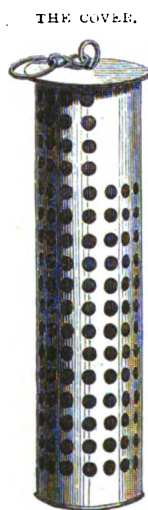
This second or altered lamp was tried in the Killingworth Pit on the 4th of November, and was found to burn better than the first lamp, and to be perfectly safe. But as it did not yet come up entirely to the inventor's expectations, he proceeded to contrive a third lamp, in which he proposed to surround the oil vessel with a number of capillary tubes. Then it struck him, that if he cut off the middle of the tubes, or made holes in metal plates, placed at a distance from each other, equal to the length of the tubes, the air would get in better, and the effect in preventing the communication of explosion would be the same.

He was encouraged to persevere in the completion of his safety-lamp by the occurrence of several fatal accidents about this time in the Killingworth Pit. On the 9th of November a boy was killed by a blast in the A pit, at the very place where Stephenson had made the experiments with his first lamp; and, when told of the accident, he observed that if the boy had been provided with his lamp, his life would have been saved. On the 20th of November he went over to Newcastle to order his third lamp from Mr. Watson, a plumber in that town. Mr. Watson referred him to his clerk, Henry Smith, whom Stephenson invited to join him at

a neighbouring public-house, where they might quietly talk over the matter, and finally settle the plan of the new lamp. They adjourned to the "Newcastle Arms," near the present High Level Bridge, where they had some ale, and a design of the lamp was drawn in pencil upon a half-sheet of foolscap, with a rough specification subjoined. The sketch, when shown to us by Robert Stephenson some years since, still bore the marks of the ale. It was a very rude design, but sufficient to work



DAVY'S SAFETY-LAMP.



STEPHENSON'S SAFETY-LAMP.



from. It was immediately placed in the hands of the workmen, finished in the course of a few days, and experimentally tested in the Killingworth Pit like the previous lamps on the 30th of November, by which date neither Stephenson nor Wood had heard of Sir Humphry Davy's experiments, nor of the lamp which that gentleman proposed to construct.

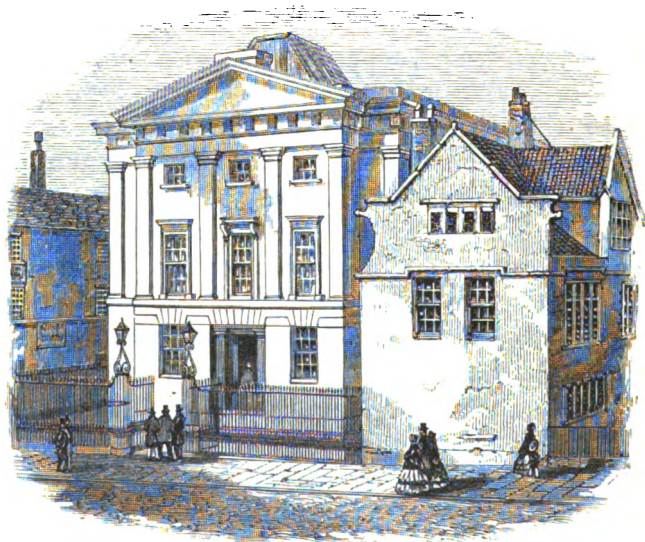
An angry controversy afterwards took place as to the respective merits of George Stephenson and Sir Humphry Davy in respect of the invention of the

Safety-lamp. A committee was formed on both sides, and the facts were stated in various ways. It is perfectly clear, however, that Stephenson had ascertained the fact that flame will not pass through tubes of a certain diameter—the principle on which the safety-lamp is constructed—before Sir Humphry Davy had formed any definite idea on the subject, or invented the model lamp afterwards exhibited by him before the Royal Society. Stephenson had actually constructed a lamp on such a principle, and proved its safety, before Sir Humphry had communicated his views on the subject to any person; and by the time that the first public intimation had been given of his discovery, Stephenson's second lamp had been constructed and tested in like manner in the Killingworth Pit. The *first* was tried on the 21st of October, 1815; the *second* was tried on the 4th of November; but it was not until the 9th of November that Sir Humphry Davy presented his first lamp to the public. And by the 30th of the same month, as we have seen, Stephenson had constructed and tested his *third* safety-lamp.

Stephenson's theory of the "burnt air" and the "draught" was no doubt wrong; but his lamp was right, and that was the great fact which mainly concerned him. Torricelli did not know the rationale of his tube, nor Otto Gürike that of his air-pump; yet no one thinks of denying them the merit of their inventions on that account. The discoveries of Volta and Galvani were in like manner independent of theory; the greatest discoveries consisting in bringing to light certain grand facts, on which theories are afterwards framed. Our inventor had been pursuing the Baconian method, though he did not think of that; his sole object being to invent a safe lamp, which he knew could only be done through the process of repeated experiment. Hence his numerous experiments on the fire-damp at the blowers in the mine, as well as on

carburetted hydrogen gas in his cottage by means of the apparatus above described. By experiment he distinctly ascertained that the explosion of fire-damp could not pass through small tubes; and he also did what had not before been done by any inventor—he constructed a lamp on this principle, and repeatedly proved its safety at the risk of his life. At the same time, there is no doubt that it was to Sir Humphry Davy that the merit belonged of elucidating the true law on which the safety-lamp is constructed. ●

The subject of this important invention excited so much interest in the northern mining districts, and Stephenson's numerous friends considered his lamp so completely successful—having stood the test of repeated



LITERARY AND PHILOSOPHICAL INSTITUTE, NEWCASTLE.

experiments—that they urged him to bring his invention before the Philosophical and Literary Society of Newcastle, of whose apparatus he had availed himself in the course of his experiments on fire-damp. After much persuasion he consented to do so, and a meeting

was appointed for the purpose of receiving his explanations, on the evening of the 5th of December, 1815. Stephenson was at that time so diffident in manner and unpractised in speech, that he took with him his friend Nicholas Wood, to act as his interpreter and expositor on the occasion. From eighty to a hundred of the most intelligent members of the Society were present at the meeting, when Mr. Wood stood forward to expound the principles on which the lamp had been formed, and to describe the details of its construction. Several questions were put, to which Mr. Wood proceeded to give replies to the best of his knowledge. But Stephenson, who up to that time had stood behind Wood, screened from notice, observing that the explanations given were not quite correct, could no longer control himself, and, standing forward, he proceeded in his strong Northumbrian dialect, to describe the lamp, down to its minutest details. He then produced several bladders full of carburetted hydrogen, which he had collected from the blowers in the Killingworth mine, and proved the safety of his lamp by numerous experiments with the gas, repeated in various ways; his earnest and impressive manner exciting in the minds of his auditors the liveliest interest both in the inventor and his invention.

Shortly after, Sir H. Davy's model lamp was received and exhibited to the coal-miners at Newcastle, on which occasion the observation was made by several gentlemen, "Why, it is the same as Stephenson's!"

Notwithstanding Stephenson's claim to be regarded as the first inventor of the Tube Safety-lamp, his merits do not seem to have been generally recognised. Sir Humphry Davy carried off the larger share of the *éclat* which attached to the discovery. What chance had the unknown workman of Killingworth with so distinguished a competitor? The one was as yet but a colliery engine-wright, scarce raised above the manual-

labour class, without chemical knowledge or literary culture, pursuing his experiments in obscurity, with a view only to usefulness; the other was the scientific prodigy of his day, the pet of the Royal Society, the favourite of princes, the most brilliant of lecturers, and the most popular of philosophers.

No small indignation was expressed by the friends of Sir Humphry Davy at Stephenson's "presumption" in laying claim to the invention of the Safety-lamp. The scientific class united to ignore him entirely in the matter. In 1831, Dr. Paris, in his 'Life of Sir Humphry Davy,' thus wrote:—"It will hereafter be scarcely believed that an invention so eminently scientific, and which could never have been derived but from the sterling treasury of science, should have been claimed on behalf of an engine-wright of Killingworth, of the name of Stephenson—a person not even possessing a knowledge of the elements of chemistry."

But Stephenson was really far above claiming for himself an invention not his own. He had already accomplished a far greater thing even than the making of a safety-lamp: he had constructed a successful locomotive, which was to be seen in daily work on the Killingworth Railway. By the improvements he had made in the engine, he might almost be said to have *invented* it; yet no one—not even the philosophers—detected as yet the significance of that wonderful machine. It excited no scientific interest, called forth no leading articles in the newspapers or the reviews, and formed the subject of no eloquent lectures at the Royal Society; for railways were, as yet, comparatively unknown, and the might which slumbered in the locomotive was scarcely, as yet, even dreamt of. What railways were to become, rested in a great measure with that "engine-wright of Killingworth, of the name of Stephenson," though he was scarcely known as yet beyond the bounds of his own district.

As to the value of the invention of the safety-lamp, there could be no doubt; and the colliery owners of Durham and Northumberland, to testify their sense of its importance, determined to present a testimonial to its inventor. The friends of Sir H. Davy met in August, 1816, to take steps to raise a subscription for the purpose. The advertised object of the meeting was to present him with a reward for "the invention of *his* safety-lamp." To this no objection could be taken; for though the principle on which the safety-lamps of Stephenson and Davy were constructed was the same; and although Stephenson's lamp was, unquestionably, the first successful lamp that had been constructed on such principle, and proved to be efficient,—yet Sir H. Davy did invent a safety-lamp, no doubt quite independently of all that Stephenson had done; and having directed his careful attention to the subject, and elucidated the true theory of explosion of carburetted hydrogen, he was entitled to all praise and reward for his labour. But when the meeting of coal-owners proposed to raise a subscription for the purpose of presenting Sir H. Davy with a reward for "his invention of *the* safety-lamp," the case was entirely altered; and Stephenson's friends then proceeded to assert his claims to be regarded as its first inventor.

Many meetings took place on the subject, and much discussion ensued, the result of which was that a sum of 2000*l.* was presented to Sir Humphry Davy as "the inventor of the safety-lamp;" but, at the same time, a purse of 100 guineas was voted to George Stephenson, in consideration of what he had done in the same direction. This result was, however, very unsatisfactory to Stephenson, as well as to his friends; and Mr. Brandling, of Gosforth, suggested to him that, the subject being now fairly before the public, he should publish a statement of the facts on which his claim was founded.

But this was not at all in George Stephenson's line.

He had never appeared in print before; and it seemed to him a far more formidable thing to write a letter for publication in "the papers" than even to invent a safety-lamp or design a locomotive. Having called his son Robert to his assistance, he set him down before a sheet of foolscap, and when all was ready, he said, "Now, put down there just what I tell you." The composition of this letter, as we were informed by the writer of it, occupied more evenings than one; and when it was at length finished after many corrections, and fairly copied out, the father and son set out—the latter dressed in his Sunday's round jacket—to lay the joint production before Mr. Brandling, at Gosforth House. Glancing over the letter, Mr. Brandling said, "George, this will never do." "It is all true, sir," was the reply. "That may be; but it is badly written." Robert blushed, for he thought it was the penmanship that was called in question, and he had written his very best. Mr. Brandling then requested his visitors to sit down while he put the letter in a more polished form, which he did, and it was shortly after published in the local papers.

As the controversy continued for some time longer to be carried on in the Newcastle papers, Mr. Stephenson, in the year 1817, consented to publish the detailed plans, with descriptions, of the several safety-lamps which he had contrived for use in the Killingworth Colliery. The whole forms a pamphlet of only sixteen pages of letterpress.<sup>1</sup>

His friends, being fully satisfied of his claims to priority as the inventor of the safety-lamp used in the Killingworth and other collieries, proceeded to hold a public meeting for the purpose of presenting him with a reward "for the valuable service he had thus rendered

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<sup>1</sup> 'A Description of the Safety-Lamp, invented by George Stephenson and now in use in the Killingworth Colliery.' London, 1817.

to mankind." Charles J. Brandling, Esq., occupied the chair; and several resolutions were passed, of which the first and most important was as follows:—"That it is the opinion of this meeting that Mr. George Stephenson, having *discovered the fact* that explosion of hydrogen gas will not pass through tubes and apertures of small dimensions, and having been *the first to apply that principle in the construction of a safety-lamp*, is entitled to a public reward."

A subscription was immediately commenced with this object, and a committee was formed, consisting of the Earl of Strathmore, C. J. Brandling, and others. The subscription list was headed by Lord Ravensworth, one of the partners in the Killingworth Colliery, who showed his appreciation of the merits of Stephenson by giving 100 guineas. C. J. Brandling and partners gave a like sum, and Matthew Bell and partners, and John Brandling and partners, gave 50 guineas each.

When the resolutions appeared in the newspapers, the scientific friends of Sir Humphry Davy in London met, and passed a series of counter-resolutions, which they published, declaring their opinion that Mr. Stephenson was *not* the author of the discovery of the fact that explosion of hydrogen will not pass through tubes and apertures of small dimensions, and that he was *not* the first to apply that principle to the construction of a safety-lamp. To these counter-resolutions were attached the well-known names of Sir Joseph Banks, P.R.S., William Thomas Brande, Charles Hatchett, W. H. Wollaston, and Thomas Young.

Mr. Stephenson's friends then, to make assurance doubly sure, and with a view to set the question at rest, determined to take evidence in detail as to the date of discovery by George Stephenson of the fact in question, and its practical application by him in the formation and actual trial of his safety-lamp. The witnesses ex-

amined were, George Stephenson himself, Mr. Nicholas Wood, and John Moodie, who had been present at the first trial of the lamp; the several tinmen who made the lamps; the secretary and other members of the Literary and Philosophical Society of Newcastle, who were present at the exhibition of the third lamp; and some of the workmen at Killingworth Colliery, who had been witnesses of Stephenson's experiments on fire-damp made with the lamps at different times before Sir Humphry Davy's investigations had been heard of. This evidence was quite conclusive to the minds of the gentlemen who investigated the subject, and they published it in 1817, together with their Report, in which they declared that, "after a careful inquiry into the merits of the case, conducted, as they trust, in a spirit of fairness and moderation, they can perceive no satisfactory reason for changing their opinion."<sup>1</sup>

The Stephenson subscription, when collected, amounted to 1000*l*. Part of the money was devoted to the purchase of a silver tankard, which was presented to the inventor, together with the balance of the subscription, at a public dinner given in the Assembly Rooms at

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<sup>1</sup> The committee, in their report, after setting forth in a tabular form the dates at which Stephenson and Davy verified their theories by experiments, and brought out their respective safety-lamps, proceeded to say: "The friends of Mr. Stephenson, with this table before them, conceive their resolution to be fully borne out by the testimony of dates and facts, so far as they are known; and without the slightest idea or wish of detracting from the scientific fame, honour, or veracity of Sir Humphry Davy, they would repeat, and confine themselves to the simple assertion of their belief, that Mr. Stephenson was the first to construct a lamp upon the

principle in question. And when the friends of Mr. Stephenson remember the humble and laborious station of life which he has occupied; when they consider the scanty means and opportunities which he has had for pursuing researches in practical science; and look to the improvements and discoveries which, notwithstanding so many disadvantages, he has been enabled to make by the judicious and unremitting exercise of the energy and acuteness of his natural understanding, they cannot persuade themselves that they have said anything more than any liberal and feeling mind would most readily admit."

Newcastle.<sup>1</sup> But what gave Stephenson even greater pleasure than the silver tankard and purse of sovereigns was the gift of a silver watch, purchased by small subscriptions collected among the colliers themselves, and presented to him by them as a token of their esteem and regard for him as a man, as well as of their gratitude for the perseverance and skill with which he had prosecuted his valuable and life-saving invention to a successful issue. To the last day of his life he spoke with pride of this watch as the most highly-prized gift he had ever received.

However great may be the merits of Stephenson in connexion with the invention of the tube safety-lamp, they cannot be regarded as detracting in any degree from the reputation of Sir Humphry Davy. His inquiries into the explosive properties of carburetted hydrogen gas were quite original; and his discovery of the fact that explosion will not pass through tubes of a certain diameter was made independently of all that Stephenson had done in verification of the same fact. It would even appear that Mr. Smithson Tennant and Dr. Wollaston had observed the same fact several years before, though neither Stephenson nor Davy knew of it while they were prosecuting their experiments. Sir Humphry Davy's subsequent modification of the tube-lamp, by which, while diminishing the diameter, he in the same ratio shortened the tubes without danger, and in the form of wire-gauze enveloped the safety-lamp by a multiplicity of tubes, was a beautiful application of the true theory which he had formed upon the subject.

<sup>1</sup> The tankard bore the following inscription:—"This piece of plate, purchased with a part of the sum of 1000*l.*, a subscription raised for the remuneration of Mr. GEORGE STEPHENSON for having discovered the fact that inflamed fire-damp will not pass through tubes and apertures of small dimensions, and having been the

*first* to apply that principle in the construction of a safety-lamp calculated for the preservation of human life in situations formerly of the greatest danger, was presented to him at a general meeting of the subscribers, Charles John Brandling, Esq., in the Chair. January 12th, 1818."

The increased number of accidents which have occurred from explosions in coal-mines since the general introduction of the Davy lamp, led to considerable doubts being entertained as to its safety, and inquiries were consequently made as to the means by which it might be further improved; for experience has shown that, under certain circumstances, the Davy lamp is *not* safe. Stephenson was himself of opinion that the modification of his own and Sir Humphry Davy's lamp, by combining the glass cylinder with the wire-gauze, would give the best lamp. At the same time it must be admitted that the Davy and the Geordy lamps alike failed to stand the severe tests to which they were submitted by Dr. Pereira, before the Committee on Accidents in Mines. Indeed, Dr. Pereira did not hesitate to say, that when exposed to a current of explosive gas the Davy lamp is "decidedly unsafe," and that the experiments by which its safety had been "demonstrated" in the lecture-room had proved entirely "fallacious."

It is worthy of remark, that under circumstances in which the wire-gauze of the Davy lamp becomes red-hot from the high explosiveness of the gas, the Geordy lamp is extinguished; and we cannot but think that this fact testifies to the decidedly superior safety of the Geordy. An accident occurred in the Oaks Colliery Pit at Barnsley, on the 20th of August, 1857, which strikingly exemplified the respective qualities of the lamps. A sudden outburst of gas took place from the floor of the mine, along a distance of fifty yards. Fortunately the men working in the pit at the time were all supplied with safety-lamps—the hewers with Stephenson's, and the hurriers with Davy's. On this occasion, the whole of the Stephenson lamps, over a space of five hundred yards, were extinguished almost instantaneously; whereas the Davy lamps were filled with fire and became red-hot, so that several of the men

using them had their hands burnt by the gauze. Had a strong current of air been blowing through the gallery at the time, an explosion would most probably have taken place—an accident which, it will be observed, could not, under such circumstances, occur from the use of the Geordy, which is immediately extinguished as soon as the air becomes explosive.<sup>1</sup>

Nicholas Wood, a good judge, has said of the two inventions, "Priority has been claimed for each of them—I believe the inventions to be parallel. By different roads they both arrived at the same result. Stephenson's

<sup>1</sup> The accident above referred to was described in the 'Barnsley Times,' a copy of which, containing the account, Robert Stephenson forwarded to the author, with the observation that "it is evidently written by a practical miner, and is, I think, worthy of record in my father's Life." Mr. John Browne, C.E., Barnsley, in a communication which appeared in the 'Times,' of December 24th, 1860, observed:—

"At the period of this occurrence we had two kinds of safety-lamps in use in this pit—viz., 'Davy' and 'Stephenson,' and the gas in going off to the upcast shaft had to pass great numbers of men, who were at work with both kinds of lamps. The whole of the 'Davy's' became red-hot almost instantaneously from the rapid ignition of the gas within the gauze; the 'Stephenson's' were as instantly self-extinguished from the same cause, it being the prominent qualification of these lamps that, in addition to affording a somewhat better light than the 'Davy' lamp, they are suddenly extinguished when placed within a highly explosive atmosphere, so that no person can remain working and run the risk of his lamp becoming red-hot—which, under such circumstances, would be the result with the 'Davy' lamp.

"The red-hot lamps, were, most fortunately, all safely put out, although the men in many cases had their hands severely burned by the

gauze; but from that time I fully resolved to adopt the exclusive use of the 'Stephenson' lamps, and not expose men to the fearful risk they must run from working with 'Davy' lamps during the probable recurrence of a similar event.

"I may remark that the 'Stephenson' lamp, originally invented by the great George Stephenson, in its present shape combines the merits of his discovery with that of Sir Humphry Davy—constituting, to my mind, the safest lamp at present known, and I speak from the long use of many hundreds daily in various collieries."

In an account given in the 'Times' of the 10th of August, 1867, of a number of experiments made upon different safety-lamps, at the Barnsley Gas-works, occasioned by the terrible explosion at the Lund Hill Colliery, it is stated that "the different lamps were tested with the following results:—"The 'Davy' lamp with no shield on the outside exploded the gas in six seconds, and with the shield inside the gauze in nine seconds. The 'Belgian' lamp exploded in ten seconds; the 'Mozard' in ten seconds; the small 'Clanny' in seven seconds, the large one in ten seconds; and the 'Stephenson' in seventy-five seconds. Although the 'Stephenson' is undoubtedly the best, it will be seen that none of the so-called safety-lamps can be depended upon when coming in contact with a *strong explosive current* of fire-damp and air."

is the superior lamp. Davy's is safe—Stephenson's is safer."

When the question of priority was under discussion at Mr. Lough's studio, in 1857, Sir Matthew White Ridley asked Robert Stephenson, who was present, for his opinion on the subject. His answer was, "I am not exactly the person to give an unbiassed opinion; but, as you ask me frankly, I will as frankly say, that if George Stephenson had never lived, Sir Humphry Davy could and most probably would have invented the safety-lamp; but again, if Sir Humphry Davy had never lived, George Stephenson certainly would have invented the safety-lamp, as I believe he did independently of all that Sir Humphry Davy had done in the matter."

To this day, the Geordy lamp continues in regular use in the Killingworth Collieries; and the Killingworth pitmen have expressed to the writer their decided preference for it compared with the Davy. It is certainly a strong testimony in its favour, that no accident is known to have arisen from its use, since it was generally introduced into the Killingworth pits.



THE STEPHENSON TANKARD.

## CHAPTER VII.

GEORGE STEPHENSON'S FURTHER IMPROVEMENTS IN THE LOCOMOTIVE — THE HETTON RAILWAY — ROBERT STEPHENSON AS VIEWER'S APPRENTICE AND STUDENT.

STEPHENSON'S experiments on fire-damp, and his labours in connexion with the invention of the safety-lamp, occupied but a small portion of his time, which was necessarily devoted for the most part to the ordinary business of the colliery. From the day of his appointment as engine-wright, one of the subjects which particularly occupied his attention was the best practical method of winning and raising the coal. Nicholas Wood has said of him that he was one of the first to introduce steam machinery underground with that object. Indeed, the Killingworth mines came to be regarded as the models of the district; and when Mr. Robert Bald, the celebrated Scotch mining engineer, was requested by Dr. (afterwards Sir David) Brewster, to prepare the article 'Mine' for the 'Edinburgh Encyclopædia,' he proceeded to Killingworth principally for the purpose of examining Stephenson's underground machinery. Mr. Bald has favoured us with an account of his visit made with that object in 1818, and he states that he was much struck with the novelty, as well as the remarkable efficiency of Stephenson's arrangements, especially in regard to what is called the underdip working.

"I found," he says, "that a mine had been commenced near the main pit bottom, and carried forward down the dip or slope of the coal, the rate of dip being about one in twelve; and the coals were drawn from the dip to the pit-bottom by the steam machinery in a very rapid manner. The water which oozed

from the upper winning was disposed of at the pit-bottom in a barrel or trunk, and was drawn up by the power of the engine which worked the other machinery. The dip at the time of my visit was nearly a mile in length, but has since been greatly extended. As I was considerably tired by my wanderings in the galleries, when I arrived at the forehead of the dip, Mr. Stephenson said to me, 'You may very speedily be carried up to the rise, by laying yourself flat upon the coal-baskets,' which were laden and ready to be taken up the incline. This I at once did, and was straightway wafted on the wings of fire to the bottom of the pit, from whence I was borne swiftly up to the light by the steam machinery on the pit-head."

The whole of the working arrangements seemed to Mr. Bald to be conducted in the most skilful and efficient manner, reflecting the highest credit on the colliery engineer.

Besides attending to the underground arrangements, the improved transit of the coals above ground from the pit-head to the shipping-place demanded an increasing share of Stephenson's attention. Every day's experience convinced him that the locomotive constructed by him after his patent of the year 1815, was far from perfect; though he continued to entertain confident hopes of its complete eventual success. He even went so far as to say that the locomotive would yet supersede every other traction-power for drawing heavy loads. It is true, many persons continued to regard his travelling engine as little better than a dangerous curiosity; and some, shaking their heads, predicted for it "a terrible blow-up some day." Nevertheless, it was daily performing its work with regularity, dragging the coal-waggons between the colliery and the staiths, and saving the labour of many men and horses.

There was not, however, so marked a saving in the expense of haulage as to induce the colliery masters to adopt locomotive power generally as a substitute for horses. How it could be improved and rendered more efficient as well as economical, was constantly present

to Stephenson's mind. He was fully conscious of the imperfections both in the road and the engine; and gave himself no rest until he had brought the efficiency of both up to a higher point. Thus he worked his way inch by inch, slowly but surely; and every step gained was made good as a basis for further improvements.

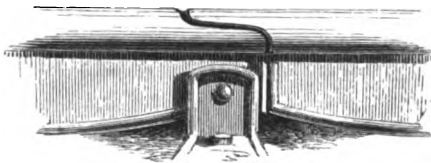
At an early period of his labours, or about the time when he had completed his second locomotive, he began to direct his particular attention to the state of the Road; perceiving that the extended use of the locomotive must necessarily depend in a great measure upon the perfection, solidity, continuity, and smoothness of the way along which the engine travelled. Even at that early period, he was in the habit of regarding the road and the locomotive as one machine, speaking of the Rail and the Wheel as "Man and Wife."

All railways were at that time laid in a careless and loose manner, and great inequalities of level were allowed to occur without much attention being paid to repairs. The consequence was a great loss of power, as well as much wear and tear of the machinery, by the frequent jolts and blows of the wheels against the rails. Stephenson's first object therefore was, to remove the inequalities produced by the imperfect junction between rail and rail.

At that time (1816) the rails were made of cast iron, each rail being about three feet long; and sufficient care was not taken to maintain the points of junction on the same level. The chairs, or cast-iron pedestals into which the rails were inserted, were flat at the bottom; so that whenever any disturbance took place in the stone blocks or sleepers supporting them, the flat base of the chair upon which the rails rested being tilted by unequal subsidence, the end of one rail became depressed, whilst that of the other was elevated. Hence constant jolts and shocks, the reaction of which very

often caused the fracture of the rails, and occasionally threw the engine off the road.

To remedy this imperfection, Mr. Stephenson devised a new chair, with an entirely new mode of fixing the rails therein. Instead of adopting the *butt-joint* which had hitherto been used in all cast-iron rails, he adopted the *half-lap joint*, by which means the rails extended a certain distance over each other at the ends like a scarf-joint. These ends, instead of resting on the



HALF-LAP JOINT

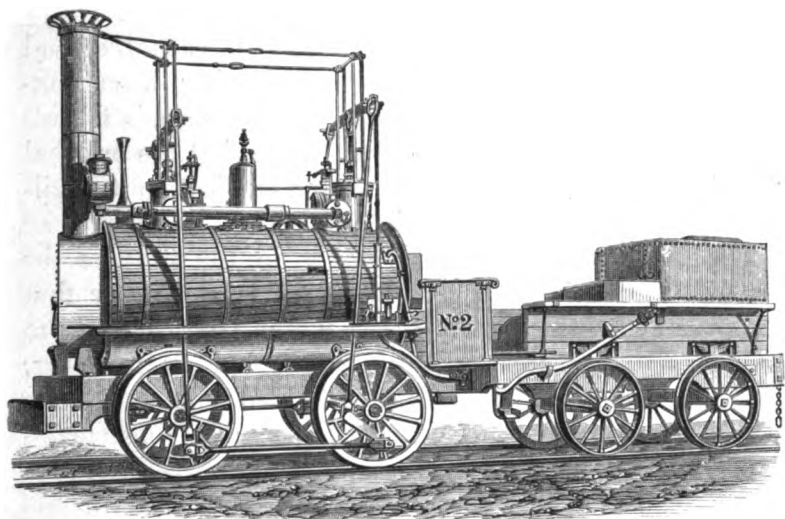
flat chair, were made to rest upon the apex of a curve forming the bottom of the chair. The supports were also extended from three feet to

three feet nine inches or four feet apart. These rails were accordingly substituted for the old cast-iron plates on the Killingworth Colliery Railway, and they were found to be a very great improvement on the previous system, adding both to the efficiency of the horse-power (still used on the railway) and to the smooth action of the locomotive engine, but more particularly increasing the efficiency of the latter.

This improved form of the rail and chair was embodied in a patent taken out in the joint names of Mr. Losh, of Newcastle, iron-founder, and of Mr. Stephenson, bearing date the 30th of September, 1816. Mr. Losh being a wealthy, enterprising iron-manufacturer, and having confidence in George Stephenson and his improvements, found the money for the purpose of taking out the patent, which, in those days, was a very costly as well as troublesome affair. At the same time, Mr. Losh guaranteed Stephenson a salary of 100*l.* per annum, with a share in the profits arising from his inventions, conditional on his attending at the Walker iron-works

two days a week,—an arrangement to which the owners of the Killingworth Colliery cheerfully gave their sanction.

The specification of 1816 included various important improvements in the locomotive itself. The wheels of the engine were improved, being altered from cast to malleable iron, in whole or in part, by which they were made lighter as well as more durable and safe. The patent also included the ingenious and original



OLD KILLINGWORTH LOCOMOTIVE STILL IN USE.

contrivance by which the steam generated in the boiler was made to serve as a substitute for springs,—an expedient already explained in a preceding chapter.

The result of the actual working of the new locomotive on the improved road amply justified the promises held forth in the specification. The traffic was conducted with greater regularity and economy, and the superiority of the engine, as compared with horse traction, became still more marked. And it is a fact worthy of notice, that the identical engines constructed by

Stephenson in 1816 are to this day in regular useful work upon the Killingworth Railway, conveying heavy coal trains at the speed of between five and six miles an hour, probably as economically as any of the more perfect locomotives now in use.

George Stephenson's endeavours having been attended with such marked success in the adaptation of locomotive power to railways, his attention was called by many of his friends, about the year 1818, to the application of steam to travelling on common roads. It was from this point, indeed, that the locomotive had started, Trevithick's first engine having been constructed with this special object. Stephenson's friends having observed how far behind he had left the original projector of the locomotive in its application to railroads, perhaps naturally inferred that he would be equally successful in applying it to the purpose for which Trevithick and Vivian had intended their first engine. But the accuracy with which he estimated the resistance to which loads were exposed on railways, arising from friction and gravity, led him at a very early stage to reject the idea of ever applying steam-power economically to common road travelling. In October, 1818, he made a series of careful experiments in conjunction with Mr. Nicholas Wood, on the resistance to which carriages were exposed on railways, testing the results by means of a dynamometer of his own contrivance. The series of practical observations made by means of this instrument were interesting, as the first systematic attempt to determine the precise amount of resistance to carriages moving along railways. It was then for the first time ascertained by experiment that the friction was a constant quantity at all velocities. Although this theory had long before been developed by Vince and Coulomb, and was well known to scientific men as an established truth, yet at the time when

Stephenson made his experiments, the deductions of philosophers on the subject were neither believed in nor acted upon by practical engineers. To quote again from the MS. account supplied to the author by Robert Stephenson for the purposes of his father's 'Life':—

“It was maintained by many that the results of the experiments led to the greatest possible mechanical absurdities. For instance, it was maintained, that if friction were constant at all velocities upon a level railway, when once a power was applied to a carriage which exceeded the friction of that carriage by the smallest possible amount, that same small excess of power would be able to convey the carriage along a level railway at all conceivable velocities. When this position was put by those who opposed the conclusions at which my father had arrived, he felt great hesitation in maintaining his own views; for it appeared to him at first sight really to be—as it was put by his opponents—an absurdity. Frequent repetition, however, of the experiments to which I have alluded, left no doubt upon his mind that his conclusion that friction was uniform at all velocities was a fact which must be received as positively established; and he soon afterwards boldly maintained that that which was an apparent absurdity was, instead, a necessary consequence. I well remember the ridicule that was thrown upon this view by many of those persons with whom he was associated at the time. Nevertheless, it is undoubted, that could you practically be always applying a power in excess of the resistance, a constant increase of velocity would of necessity follow without any limit. This is so obvious to most professional men of the present day, and is now so axiomatic, that I only allude to the discussion which took place when these experiments of my father were announced, for the purpose of showing how small was the amount of science at that time blended with engineering practice. A few years afterwards, an excellent pamphlet was published by Mr. Silvester on this question; he took up the whole subject, and demonstrated in a very simple and beautiful manner the correctness of all the views at which my father had arrived by his course of experiments.

“The other resistances to which carriages were exposed were also investigated experimentally by my father. He perceived that these resistances were mainly three; the first being upon the

axles of the carriage ; the second, which may be called the rolling resistance, being between the circumference of the wheel and the surface of the rail ; and the third being the resistance of gravity.

"The amount of friction and gravity he accurately ascertained ; but the rolling resistance was a matter of greater difficulty, for it was subject to great variation. He, however, satisfied himself that it was so great, when the surface presented to the wheel was of a rough character, that the idea of working steam-carriages economically on common roads was out of the question. Even so early as the period alluded to he brought his theoretical calculations to a practical test ; he scattered sand upon the rails when an engine was running, and found that a small quantity was quite sufficient to retard and even stop the most powerful locomotive engine that he had at that time made. And he never failed to urge this conclusive experiment upon the attention of those who were wasting their money and time upon the vain attempt to apply steam to common roads.

"The following were the principal arguments which influenced his mind to work out the use of the locomotive in a directly opposite course to that pursued by a number of ingenious inventors, who, between 1820 and 1836, were engaged in attempting to apply steam-power to turnpike roads. Having ascertained that resistance might be taken as represented by 10 lbs. to a ton weight on a level railway, it became obvious to him that so small a rise as 1 in 100 would diminish the useful effort of a locomotive by upwards of fifty per cent. This fact called my father's attention to the question of gradients in future locomotive lines. He then became convinced of the vital importance, in an economical point of view, of reducing the country through which a railway was intended to pass to as near a level as possible. This originated in his mind the distinctive character of railway works as contradistinguished from all other roads,—for in railroads he early contended that large sums would be wisely expended in perforating barriers of hills with long tunnels, and in raising low ground with the excess cut down from the adjacent high ground. In proportion as these views fixed themselves upon his mind, and were corroborated by his daily experience, he became more and more convinced of the hopelessness of applying steam locomotion to common roads,—for every argument in favour of a level railway was an argument against the rough and hilly course of a common road. He never ceased to urge upon the patrons of road steam-carriages that if, by any

amount of ingenuity, an engine could be made which could by possibility traverse a turnpike road at a speed at least equal to that obtainable by horse-power, and at a less cost, such an engine, if applied to the more perfect surface of a railway, would have its efficiency enormously enhanced. For instance, he calculated that if an engine had been constructed, and had been found to travel uniformly between London and Birmingham at an average speed of 10 miles an hour,—conveying, say, 20 or 30 passengers at a cost of 1*s.* per mile, it was clear that the same engine, if applied to a railway, instead of conveying 20 or 30 people, would have conveyed 200 or 300 people, and instead of a speed of 10 or 12 miles an hour, a speed of at least 30 to 40 miles an hour would have been obtained.”

At this day it is difficult to understand how the sagacious and strong common-sense views of Stephenson on this subject failed to force themselves sooner upon the minds of those who were persisting in their vain though ingenious attempts to apply locomotive power to ordinary roads. For a long time they continued to hold with obstinate perseverance to the belief that for such purposes a soft road was better than a hard one—a road easily crushed better than one incapable of being crushed; and they held to this after it had been demonstrated in all parts of the mining districts, that iron tramways were better than paved roads. But the fallacy that iron was incapable of adhesion upon iron continued to prevail, and the projectors of steam-travelling on common roads only shared in the common belief. They still considered that roughness of surface was essential to produce “bite,” especially in surmounting acclivities; the truth being, that they confounded roughness of surface with tenacity of surface and contact of parts; not perceiving that a yielding surface which would adapt itself to the tread of the wheel, could never become an unyielding surface to form a fulcrum for its progression.

Although Stephenson’s locomotive engines were in daily use for many years on the Killingworth Railway,

they excited comparatively little interest. They were no longer experimental, but had become an established tractive power. The experience of years had proved that they worked more steadily, drew heavier loads, and were, on the whole, considerably more economical than horses. Nevertheless eight years passed before another locomotive railway was constructed and opened for the purposes of coal or other traffic.

It is difficult to account for this early indifference on the part of the public to the merits of the greatest mechanical invention of the age. Steam-carriages were exciting much interest, and numerous and repeated experiments were made with them. The improvements effected by M'Adam in the mode of constructing turn-pike-roads were the subject of frequent discussions in the legislature, on the grants of public money being proposed, which were from time to time made to him. Yet here at Killingworth, without the aid of a farthing of government money, a system of road locomotion had been in existence since 1814, which was destined, before many years, to revolutionise the internal communications of England and of the world, but of which the English public and the English Government as yet knew nothing.

But Stephenson had no means of bringing his important invention prominently under the notice of the public. He himself knew well its importance, and he already anticipated its eventual general adoption; but being an unlettered man, he could not give utterance to the thoughts which brooded within him on the subject. Killingworth Colliery lay far from London, the centre of scientific life in England. It was visited by no savans nor literary men, who might have succeeded in introducing to notice the wonderful machine of Stephenson. Even the local chroniclers seem to have taken no notice of the Killingworth Railway. The "Puffing Billy" was doing its daily quota of hard work, and had long

ceased to be a curiosity in the neighbourhood. Blenkinsop's clumsier and less successful engine—which has long since been disused, while Stephenson's Killingworth engines continue working to this day—excited far more interest; partly, perhaps, because it was close to the large town of Leeds, and used to be visited by strangers as one of the few objects of interest in that place. Blenkinsop was also an educated man, and was in communication with some of the most distinguished personages of his day on the subject of his locomotive, which thus obtained considerable celebrity.

The first engine constructed by Stephenson to order, after the Killingworth model, was made for the Duke of Portland in 1817, for use upon his tramroad, about ten miles long, extending from Kilmarnock to Troon, in Ayrshire. It was employed to haul the coals from the Duke's collieries along the line to Troon harbour. Its use was, however, discontinued in consequence of the frequent breakages of the cast-iron rails, by which the working of the line was interrupted, and accordingly horses were again employed as before.<sup>1</sup>

There seemed, indeed, to be so small a prospect of introducing the locomotive into general use, that Stephenson,—perhaps conscious of the capabilities within him,—again recurred to his old idea of emigrating to the United States. Before entering as sleeping partner in a small foundry at Forth Banks, Newcastle, managed by Mr. John Burrell, he had thrown out the suggestion to the latter that it would be a good speculation for them to emigrate to North America, and introduce steamboats on the great inland lakes there. The first steamers were then plying upon the Tyne before his eyes; and he saw in them the germ of a great revolution in navi-

<sup>1</sup> The iron wheels of this engine were afterwards removed, and replaced with wooden wheels, when it was again put upon the road, and continued

working until quite recently. Its original cost was 750*l*. It was sold in 1848 for 13*l*., and broken up as old materials.

gation. It occurred to him that the great lakes of North America presented the finest field for trying their wonderful powers. He was an engineer, and Mr. Burrell was an ironfounder; and between them, he thought they might strike out a path to fortune in the mighty West. Fortunately, this idea remained a mere speculation so far as Stephenson was concerned; and it was left to others to do what he had dreamt of achieving. After all his patient waiting, his skill, industry, and perseverance were at length about to bear fruit.

In 1819, the owners of the Hetton Colliery, in the county of Durham, determined to have their waggon-way altered to a locomotive railroad. The result of the working of the Killingworth Railway had been so satisfactory, that they resolved to adopt the same system. One reason why an experiment so long continued and so successful as that at Killingworth should have been so slow in producing results, perhaps was, that to lay down a railway and furnish it with locomotives, or fixed engines where necessary, required a very large capital, beyond the means of ordinary coal-owners; while the small amount of interest felt in railways by the general public, and the supposed impracticability of working them to a profit, as yet prevented the ordinary capitalists from venturing their money in the promotion of such undertakings. The Hetton Coal Company were, however, possessed of adequate means; and the local reputation of the Killingworth engine-wright pointed him out as the man best calculated to lay out their line and superintend their works. They accordingly invited him to act as the engineer of the proposed railway. Being in the service of the Killingworth Company, Stephenson felt it necessary to obtain their permission to enter upon this new work. This was at once granted. The best feeling existed between him and his employers; and they regarded it as a compliment that their colliery engineer should be selected for a work so important as

the laying down of the Hetton Railway, which was to be the longest locomotive line that had, up to that time, been constructed in the neighbourhood. Stephenson accepted the appointment, his brother Robert acting as resident engineer and personally superintending the execution of the works.

The Hetton Railway extended from the Hetton Colliery, situated about two miles south of Houghton-le-Spring, to the shipping-places on the banks of the Wear, near Sunderland. Its length was about eight miles; and in its course it crossed Warden Law, one of the highest hills in the district. The character of the country forbade the construction of a flat line, or one of comparatively easy gradients, except by the expenditure of a much larger capital than was placed at Stephenson's command. Heavy works could not be executed; it was, therefore, necessary to form the line with but little deviation from the natural conformation of the district which it traversed, and also to adapt the mechanical methods employed for its working to the character of the gradients, which in some places were necessarily heavy.

Although George Stephenson had, with every step made towards its increased utility, become more and more identified with the success of the locomotive engine, he did not allow his enthusiasm to carry him away into costly mistakes. He carefully drew the line between the cases in which the locomotive could be usefully employed, and those in which stationary engines were calculated to be more economical. This led him, as in the instance of the Hetton Railway, to execute lines through and over rough countries, where gradients within the powers of the locomotive engine of that day could not be secured, employing in their stead stationary engines where locomotives were not practicable. In the present case, this course was adopted by him most successfully. On the original Hetton line, there were five

self-acting inclines,—the full waggons drawing the empty ones up,—and two inclines worked by fixed reciprocating engines of sixty-horse power each. The locomotive travelling engine, or “the iron horse” as the people of the neighbourhood then styled it, worked the rest of the line. On the day of the opening of the Hetton Railway, the 18th of November, 1822, crowds of spectators assembled from all parts to witness the first operations of this ingenious and powerful machinery, which was entirely successful. On that day five of Stephenson’s locomotives were at work upon the railway, under the direction of his brother Robert; and the first shipment of coal was then made by the Hetton Company at their new staiths on the Wear. The speed at which the locomotives travelled was about four miles an hour, and each engine dragged after it a train of seventeen waggons weighing about sixty-four tons.

While thus advancing step by step,—attending to the business of the Killingworth Colliery, and laying out railways in the neighbourhood,—he was carefully watching over the education of his son. We have already seen that Robert was sent to school at Newcastle, where he remained about four years. While Robert was at school, his father, as usual, made his son’s education instrumental to his own. He entered him a member of the Newcastle Literary and Philosophical Institute, the subscription to which was three guineas a year. Robert spent much of his leisure hours there, reading and studying; and when he went home in the afternoons, he was accustomed to carry home with him a volume of the ‘Repertory of Arts and Sciences,’ or of some work on practical science, which furnished the subject of interesting reading and discussion in the evening hours. Both father and son were always ready to acknowledge the great advantages they had derived from the use of so excellent a library of books; and, towards the close of his life, the latter, in recognition of his debt of grati-

tude to the Institution, contributed a large sum for the purpose of clearing off the debt, but conditional on the annual subscription being reduced to a guinea, in order that the usefulness of the Institute might be extended.

Robert left school in the summer of 1819, and was put apprentice to Mr. Nicholas Wood, the head viewer at Killingworth, to learn the business of the colliery. He served in that capacity for about three years, during which time he became familiar with most departments of underground work. His occupation was not unattended with peril, as the following incident will show. Though the use of the Geordy lamp had become general in the Killingworth pits, and the workmen were bound, under a penalty of half-a-crown, not to use a naked candle, it was difficult to enforce the rule, and even the masters themselves occasionally broke it. One day Nicholas Wood, the head viewer, Moodie, the under viewer, and Robert Stephenson, were proceeding along one of the galleries, Wood with a naked candle in his hand, and Robert following him with a lamp. They came to a place where a fall of stones from the roof had taken place, on which Wood, who was first, proceeded to clamber over the stones, holding high the naked candle. He had nearly reached the summit of the heap, when the fire-damp, which had accumulated in the hollow of the roof, exploded, and instantly the whole party were blown down, and the lights extinguished. They were a mile from the shaft, and quite in the dark. There was a rush of the workpeople from all quarters towards the shaft, for it was feared that the fire might extend to more dangerous parts of the pit, where, if the gas had exploded, every soul in the mine must inevitably have perished. Robert Stephenson and Moodie, on the first impulse, ran back at full speed along the dark gallery leading to the shaft, coming into collision, on their way, with the hind

quarters of a horse stunned by the explosion. When they had gone halfway, Moodie halted, and bethought him of Nicholas Wood. "Stop, laddie!" said he to Robert, "stop; we maun gang back, and seek the maister." So they retraced their steps. Happily, no further explosion took place. They found the master lying on the heap of stones, stunned and bruised, with his hands severely burnt. They led him to the bottom of the shaft; and he afterwards took care not to venture into the dangerous parts of the mine without the protection of a Geordy lamp.

The time that Robert spent at Killingworth as viewer's apprentice was of advantage both to his father and himself. The evenings were generally devoted to reading and study, the two from this time working together as friends and co-labourers. One who used to drop in at the cottage of an evening, well remembers the animated and eager discussions which on some occasions took place, more especially with reference to the growing powers of the locomotive engine. The son was even more enthusiastic than his father on the subject. Robert would suggest numerous alterations and improvements in detail. His father, on the contrary, would offer every possible objection, defending the existing arrangements,—proud, nevertheless, of his son's suggestions, and often warmed and excited by his brilliant anticipations of the ultimate triumph of the locomotive.

These discussions probably had considerable influence in inducing Stephenson to take the next important step in the education of his son. Although Robert, who was only nineteen years of age, was doing well, and was certain at the expiration of his apprenticeship to rise to a higher position, his father was not satisfied with the amount of instruction which he had as yet given him. Remembering the disadvantages under which he had himself laboured through his ignorance of practical

chemistry, during his investigations connected with the safety-lamp, more especially with reference to the properties of gas, as well as in the course of his experiments with the object of improving the locomotive engine, he determined to furnish his son with a better scientific culture than he had yet attained. He also believed that a proper training in technical science was indispensable to success in the higher walks of the engineer's profession; and he determined to give Robert the education, in a certain degree, which he so much desired for himself. He would thus, he knew, secure an able co-worker in the elaboration of the great ideas now looming before him, and with their united practical and scientific knowledge he probably felt that they would be equal to any enterprise.

He accordingly took Robert from his labours as under-viewer in the West Moor Pit, and in October, 1822, sent him for a short course of instruction to the Edinburgh University. Robert was furnished with letters of introduction to several men of literary eminence in Edinburgh; his father's reputation in connexion with the safety-lamp being of service to him in this respect. He lodged in Drummond Street, in the immediate vicinity of the college, and attended the Chemical Lectures of Dr. Hope, the Natural Philosophy Lectures of Sir John Leslie, and the Natural History Class of Professor Jameson. He also devoted several evenings in each week to the study of practical Chemistry under Dr. John Murray, himself one of the numerous designers of a safety-lamp. He took careful notes of the lectures, which he copied out at night before he went to bed; so that, when he returned to Killingworth, he might read them over to his father. He afterwards had the notes bound up, and placed in his library.

Long years after, when conversing with Thomas Harrison, C.E., at his house in Gloucester Square, he

rose from his seat and took down a volume from the shelves. Mr. Harrison observed that the book was in MS., neatly written out. "What have we here?" he asked. The answer was—"When I went to college, I knew the difficulty my father had in collecting the funds to send me there. Before going I studied shorthand; while at Edinburgh, I took down verbatim every lecture; and in the evenings, before I went to bed, I transcribed those lectures word for word. You see the result in that range of books." From this it will be observed that the maxim of "Like father, like son," was one that strictly applied to the Stephensons.

Robert was not without the pleasure of social intercourse either, during his stay at Edinburgh. Among the letters of introduction which he took with him was one to Robert Bald, the mining engineer, which proved of much service to him. "I remember Mr. Bald very well," he said on one occasion, when recounting his reminiscences of his Edinburgh college life. "He introduced me to Dr. Hope, Dr. Murray, and several of the distinguished men of the north. Bald was the Buddle of Scotland. He knew my father from having visited the pits at Killingworth, with the object of describing the system of working them, in his article intended for the 'Edinburgh Encyclopædia.' A strange adventure befel that article before it appeared in print. Bald was living at Alloa when he wrote it; and when finished he sent it to Edinburgh by the hands of young Maxton, his nephew, whom he enjoined to take special care of it, and deliver it safely into the hands of the editor. The young man took passage for Newhaven by one of the little steamers which then plied on the Forth; but on the voyage down the Frith, she struck upon a rock nearly opposite Queensferry, and soon sank. When the accident happened, Maxton's whole concern was about his uncle's article. He durst not return to Alloa if he lost it, and he must not go on to Edinburgh without it.

So he desperately clung to the chimney chains, with the paper parcel under his arm, while most of the other passengers were washed away and drowned. And there he continued to cling, until rescued by some boatmen, parcel and all; after which he made his way to Edinburgh, and the article duly appeared."

Returning to the subject of his life in Edinburgh, Robert continued: "Besides taking me with him to the meetings of the Royal and other Societies, Mr. Bald introduced me to a very agreeable family, relatives of his own, at whose house I spent many pleasant evenings. It was there I met Jeannie M——. She was a bonnie lass, and I, being young and susceptible, fairly fell in love with her. But, like most very early attachments, mine proved evanescent. Years passed, and I had all but forgotten Jeannie, when one day I received a letter from her, from which it appeared that she was in great distress through the ruin of her relatives. I sent her a sum of money, and continued to do so for several years; but the last remittance not being acknowledged, I directed my friend Sanderson to make inquiries. I afterwards found that the money had reached her at Portobello just as she was dying, and so, poor thing, she had been unable to acknowledge it."

One of the practical sciences in the study of which Robert Stephenson took special interest while at Edinburgh, was that of geology. The situation of the city, in the midst of a district of highly interesting geological formation, easily accessible to pedestrians, is indeed most favourable to the pursuit of such a study; and it was the practice of Professor Jameson frequently to head a band of his pupils, armed with hammers, chisels, and clinometers, and take them with him on a long ramble into the country, for the purpose of teaching them habits of observation and reading to them from the open book of Nature itself. The professor was habitually grave and taciturn, but on such occasions he would relax and

even become genial. For his own special science he had an almost engrossing enthusiasm, which on such occasions he did not fail to inspire into his pupils; who thus not only got their knowledge in the pleasantest possible way, but also fresh air and exercise in the midst of glorious scenery and in joyous company.

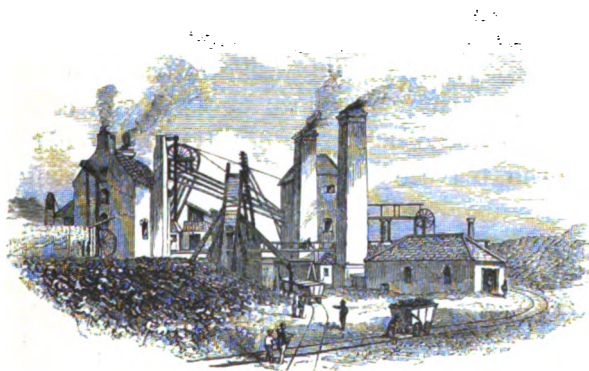
At the close of this session, the professor took with him a select body of his pupils on an excursion along the Great Glen of the Highlands, in the line of the Caledonian Canal, and Robert formed one of the party. They passed under the shadow of Ben Nevis, examined the famous old sea-margins known as the "parallel roads of Glen Roy," and extended their journey as far as Inverness; the professor teaching the young men, as they travelled, how to observe in a mountain country. Not long before his death, Robert Stephenson spoke in glowing terms of the great pleasure and benefit which he had derived from that interesting excursion. "I have travelled far, and enjoyed much," he said; "but that delightful botanical and geological tour I shall never forget; and I am just about to start in the *Titanica* for a trip round the east coast of Scotland, returning south through the Caledonian Canal, to refresh myself with the recollection of that first and brightest tour of my life."

Towards the end of the summer the young student returned to Killingworth to re-enter upon the active business of life. The six months' study had cost his father 80*l.*,—a considerable sum to him in those days; but he was amply repaid by the additional scientific culture which his son had acquired, and the evidence of ability and industry which he was enabled to exhibit in a prize for mathematics which he had won at the University.

We may here add that by this time George Stephenson, after remaining a widower fourteen years, had married, in 1820, his second wife, Elizabeth Hindmarsh,

the daughter of a respectable farmer at Black Callerton. She was a woman of excellent character, sensible, and intelligent, and of a kindly and affectionate nature. George's son Robert, whom she loved as if he had been her own, to the last day of his life spoke of her in the highest terms; and it is unquestionable that she contributed in no small degree to the happiness of her husband's home.

The story was for some time current that, while living at Black Callerton, in the capacity of engineman, twenty years before, George had made love to Miss Hindmarsh, and failing to obtain her hand, in despair he had married Paterson's servant. But the author has been assured by Mr. Thomas Hindmarsh of Newcastle, the lady's brother, that the story was mere idle gossip, and altogether without foundation.



WEST MOOR PIT, KILLINGWORTH.

## CHAPTER VIII.

GEORGE STEPHENSON ENGINEER OF THE STOCKTON AND  
DARLINGTON RAILWAY.

It is not improbable that the slow progress made by railways in public estimation was, in a considerable measure, due to the comparative want of success which had attended the first projects. We do not refer to the tramroads and railroads which connected the collieries and ironworks with the shipping-places. These were found convenient and economical, and their use became general in Durham and Northumberland, in South Wales, in Scotland, and throughout the colliery districts. But none of these were public railways. Though the Merthyr Tydvil Tramroad, the Sirhoway Railroad, and others in South Wales, were constructed under the powers of special Acts,<sup>1</sup> they were exclusively used for the private purposes of the coal-owners and ironmasters at whose expense they were made.

The first *public* Railway Act was that passed in 1801, authorising the construction of a line from Wandsworth to Croydon, under the name of "The Surrey Iron Railway." By a subsequent Act, powers were obtained to extend the line to Reigate, with a branch to Godstone. The object of this railway was to furnish a more ready means for the transport of coal and merchandise from the Thames to the districts of south London, and at the same time to enable the limeburners and proprietors of

<sup>1</sup> The Act for constructing the Merthyr Tydvil Tram-road was obtained from Parliament as early as 1794; that for the Sirhoway Rail-

road in 1801; the Carmarthenshire Railroad was sanctioned in the same year; and the Oystermouth Railway in 1803.

stone-quarries to send their lime and stone to London. With this object, the railroad was connected with a dock or basin in Wandsworth Creek capable of containing thirty barges, with an entrance lock into the Thames.

The works had scarcely been commenced ere the Company got into difficulties, but eventually 26 miles of iron-way were constructed and opened for traffic. Any person was then at liberty to put waggons on the line, and to carry goods within the prescribed rates; the waggons being worked by horses, mules, and donkeys. Notwithstanding the very sanguine expectations which were early formed as to the paying qualities of this railway, it never realised any adequate profit to the owners. But it continued to be worked, principally by donkeys for the sake of cheapness, down to the passing of the Act for constructing the London and Brighton line in 1837, when the proprietors disposed of their undertaking to the new Company. The line was accordingly dismantled; the stone blocks and rails were taken up and sold; and all that remains of the Wandsworth, Croydon, and Merstham Railway is the track still observable to the south of Croydon, along Smitham Bottom, nearly parallel with the line of the present Brighton Railway, and an occasional cutting and embankment, which still mark the route of this first public railway.

The want of success of this undertaking doubtless had the effect of deterring projectors from embarking in any similar enterprise. If a line of the sort could not succeed near London, it was thought improbable that it should succeed anywhere else. The Croydon and Merstham line was a beacon to warn capitalists against embarking in railways; and many years passed before another was ventured upon.

Sir Richard Phillips was one of the few who early recognised the important uses of the locomotive and its employment on a large scale for the haulage of goods

and passengers by railway. In his 'Morning Walk to Kew' he crossed the line of the Wandsworth and Croydon Railway, when the idea seems to have occurred to him, as it afterwards did to Thomas Gray, that in the locomotive and the railway were to be found the germs of a great and peaceful social revolution :—

"I found delight," said Sir Richard, in his book published in 1813, "in witnessing at Wandsworth the economy of horse labour on the iron railway. Yet a heavy sigh escaped me as I thought of the inconceivable millions of money which have been spent about Malta—four or five of which might have been the means of extending double lines of iron railway from London to Edinburgh, Glasgow, Holyhead, Milford, Falmouth, Yarmouth, Dover, and Portsmouth. A reward of a single thousand would have supplied coaches and other vehicles, of various degrees of speed, with the best tackle for readily turning out; and we might, ere this, have witnessed our mail-coaches running at the rate of ten miles an hour drawn by a single horse, or impelled fifteen miles an hour by Blenkinsop's steam-engine. Such would have been a legitimate motive for overstepping the income of a nation, and the completion of so great and useful a work would have afforded rational ground for public triumph in general jubilee."

There was, however, as yet no general recognition of the advantages either of railways or locomotives. The Government of this country never leads in any work of public enterprise, and is usually rather a drag upon industrial operations than otherwise. As for the general public, it was enough for them that the Wandsworth and Croydon Railway did not pay.

Mr. Tredgold, in his 'Practical Treatise on Railroads and Carriages,' published in 1825, observes :—

"Up to this period railways have been employed with success only in the conveyance of heavy mineral products, and for short distances where immense quantities were to be conveyed. In the few instances where they have been intended for the general purposes of trade, they have never answered the expectations of their projectors. But this seems to have arisen altogether from following too closely the models adopted for the conveyance of

minerals, such modes of forming and using railways not being at all adapted for the general purposes of trade."

The ill-success of railways was generally recognised. Joint-stock companies for all sorts of purposes were formed during the joint-stock mania of 1821, but few projectors were found daring enough to propose schemes so unpromising as railways. Hence nearly twenty years passed between the construction of the first and the second public railway in England. And this brings us to the projection of the Stockton and Darlington, which may be regarded as the parent public locomotive railway in the kingdom.

The district lying to the west of Darlington, in the county of Durham, is one of the richest mineral fields of the North. Vast stores of coal underlie the Bishop Auckland Valley; and from an early period it was felt to be an exceedingly desirable object to open up new communications to enable the article to be sent to market. But the district lay a long way from the sea, and, the Tees being unnavigable, there was next to no vend for the Bishop Auckland coal.

It is easy to understand, therefore, how the desire to obtain an outlet for this coal for land sale, as well as for its transport to London by sea, should have early occupied the attention of the coal-owners in the Bishop Auckland district. The first idea that found favour was the construction of a canal. About a century ago, in 1766, shortly after the Duke of Bridgewater's Canal had been opened between Worsley and Manchester, a movement was set on foot at Darlington with the view of having the country surveyed between that place and Stockton-on-Tees.

Brindley was requested to lay out the proposed line of canal; but he was engrossed at the time by the prosecution of the works on the Duke's Canal to Liverpool, and Whitworth, his pupil and assistant, was employed in his stead; George Dixon, grandfather of John Dixon,

engineer of the future Stockton and Darlington Railway, taking an active part in the survey. In October, 1768, Whitworth presented his plan of the proposed canal from Stockton by Darlington to Winston; and in the following year, to give weight to the scheme, Brindley concurred with him in a joint report as to the plan and estimate.

Nothing was, however, done in the matter. Enterprise was slow to move. Stockton waited for Darlington, and Darlington waited for Stockton; but neither stirred, until twenty years later, when Stockton began to consider the propriety of straightening the Tees below that town, and thereby shortening and improving the navigation. When it became known that some engineering scheme was a-foot at Stockton, that indefatigable writer of prospectuses and drawer of plans, Ralph Dodd, the first projector of a tunnel under the Thames, the first projector of the Waterloo Bridge, and the first to bring a steamboat from Glasgow into the Thames, addressed the Mayor and Corporation of Stockton, in 1796, on the propriety of forming a line of internal navigation by Darlington and Staindrop to Winston. Still nothing was done. Four years later, another engineer, George Atkinson, reported in favour of a water-way to connect the then projected Great Trunk Canal, from about Boroughbridge to Piersebridge, with the Tees above Yarm.

At length, in 1808, the Tees Navigation Company, slow in their movements, obtained an Act enabling them to make the short cut projected seventeen years before, and two years later the cut was opened, and celebrated by the inevitable dinner. The Stockton people, who adopted as the motto of their company "*Meliora speramus*," held a public meeting after the dinner to meditate upon and discuss the better things to come. They appointed a committee to inquire into the practicability and advantages of forming *a railway* or

canal from Stockton by Darlington to Winston. Here, then, in 1810, we have the first glimpse of the railway; but it was long before the idea germinated and bore fruit. The collieries must be got at to make the new cut a success, but *how* for a long time remained the question.

Sixteen months passed, and the committee at Stockton went to sleep. But it came up again, and this time at Darlington, with Edward Pease as one of the members. The Darlington committee met and made their report; but they could not decide between the respective merits of a railroad and a canal. It was felt that either would be of great advantage. To settle the question, they determined to call the celebrated engineer, John Rennie, to their aid, and he was ready with his report in 1813. His report was not published, but it is understood that he was in favour of a canal on Brindley and Whitworth's line, though he afterwards inclined to a tramroad. Still nothing was done. War was on foot in Europe, and enterprise was everywhere dormant. The scheme must therefore wait the advent of peace. At length peace came, and with it a revival of former projects.

At Newcastle, a plan was set on foot for connecting the Tyne with the Solway Frith by a canal. A county meeting was held on the subject in August, 1817, under the presidency of the High Sheriff. Previous to this time, Sir John Swinburne had stood up for a railway in preference to a canal; but when the meeting took place, the opinion of those present was in favour of a canal—Mr. William Armstrong (father of the present Sir William) being one of the most zealous advocates of the water-road. Yet there were even then railroads in the immediate neighbourhood of Newcastle, at Wylam and Killingworth, which had been successfully and economically worked by the locomotive for years past, but which the Northumbrians seem completely to have

ignored. The public head is usually very thick, and it is difficult to hammer a new idea into it. Canals were established methods of conveyance, and were everywhere recognised; whereas railways were new things, and were struggling hard to gain a footing. Besides, the only public railway in England, the Wandsworth, Croydon, and Merstham, had proved a commercial failure, and was held up as a warning to all speculators in tramways. But though the Newcastle meeting approved of a canal in preference to a railway from the Tyne to the Solway, nothing was really done to promote the formation of either.

The movement in favour of a canal was again revived at Stockton. A requisition, very numerously signed by persons of influence in South Durham, was presented to the Mayor of Stockton in May, 1818, requesting him to convene a public meeting "to consider the expediency of forming a canal for the conveyance of coal, lime, &c., from Evenwood-bridge, near West Auckland, to the River Tees, upon a plan recently made by Mr. George Leatham, engineer." Among the names attached to the petition we find those of Edward, John, and Thomas Pease, and John Dixon, Darlington. They were doubtless willing to pull with any party that would open up a way, whether by rail or by water, between the Bishop Auckland coal-field and Stockton, whether the line passed through Darlington or not.

An enthusiastic meeting was held at Stockton, and a committee was appointed, by whom it was resolved to apply to Parliament for an Act to make the intended canal "if funds are forthcoming." Never was there greater virtue in an *if*. Funds were *not* forthcoming; the project fell through; and a great blunder was prevented. When the Stockton men had discussed and resolved without any practical result, the leading men of Darlington took up the subject by themselves, determined, if possible, to bring it to some practical issue.

In September, 1818, they met under the presidency of Thomas Meynell, Esq. Mr. Overton, who had laid down several coal railways in Wales, was consulted, and, after surveying the district between the Bishop Auckland coal-field and the Tees, sent in his report. Mr. Rennie also was again consulted. Both engineers gave their opinion in favour of a railway by Darlington, in preference to a canal by Auckland, "whether taken as a line for the exportation of coal or as one for a local trade." The committee accordingly reported in favour of the railway.

It is curious now to look back at the modest estimate of traffic formed by the committee. They considered that the export trade in coal "might be taken, perhaps, at 10,000 tons a year, which is about one cargo a week!" It was intended to haul the coal by horse-power; a subsequent report stating "on undoubted authority," that one horse of moderate power could easily draw downwards on the railway, between Darlington and Stockton, about ten tons, and upwards about four tons of loading, exclusively of the empty waggons. No allusion was made to passengers in any of the reports; nor did the committee at first contemplate the accommodation of traffic of this description.

A survey of the line was then ordered, and steps were taken to apply to Parliament for the necessary powers to construct the railway. But the controversy was not yet at an end. Stockton stood by its favourite project of a canal, and would not subscribe a farthing towards the projected railway; but neither did it subscribe towards the canal. The landlords, the road trustees, the carriers, the proprietors of donkeys (by whom coals were principally carried for inland sale) were strenuously opposed to the new project; while the general public, stupid and sceptical, for the most part stood aloof, quoting old saws and keeping their money in their pockets.

Several energetic men, however, were now at the head of the Stockton and Darlington Railway project, and determined to persevere with it. Among these, the Peases were the most zealous. Edward Pease might be regarded as the back-bone of the concern. Opposition did not daunt him, nor failure discourage him. When apparently overthrown and prostrate, he



EDWARD PEASE.

would rise again like Antæus, stronger than before, and renew his efforts with increased vigour. He had in him the energy and perseverance of many men. One who knew him in 1818 said, "He was a man who could see a hundred years a-head." When the author last saw him, in 1854, a few years before his death, Mr. Pease was in his eighty-eighth year; yet he still possessed the hopefulness and mental vigour of a man in his prime. Still sound in health, his eye had not lost its brilliancy,

nor his cheek its colour, and there was an elasticity in his step which younger men might have envied.

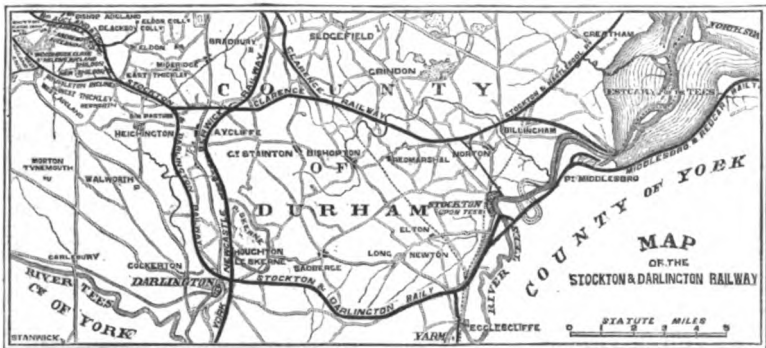
In getting up a company for surveying and forming a railway, Mr. Pease had great difficulties to encounter. The people of the neighbourhood spoke of it as a ridiculous undertaking, and predicted that it would be ruinous to all concerned in it. Even those most interested in the opening up of new markets for the sale of their coal, were indifferent if not hostile. Mr. Pease nevertheless persevered in the formation of a company; and he induced many of his friends and relations to follow his example. The Richardsons and Backhouses, members, like himself, of the Society of Friends, influenced by his persuasion, united themselves with him; and so many of the same denomination (having confidence in these influential Darlington names) followed their example and subscribed for shares, that the railway obtained the designation, which it long retained, of "The Quakers' Line."

The Stockton and Darlington scheme had to run the gauntlet of a fierce opposition in three successive sessions of Parliament. The application of 1818 was defeated by the Duke of Cleveland, who afterwards profited so largely by the railway. The ground of his opposition was, that the line would interfere with one of his fox-covers, and it was mainly through his influence that the Bill was thrown out,—but only by a majority of thirteen, upwards of one hundred members having voted for the Bill. A nobleman said, when he heard of the division, "Well, if the Quakers in these times, when nobody knows anything about railways, can raise such a phalanx in their support, I should recommend the country gentlemen to be very wary how they oppose them in future."

The next year, in 1819, an amended survey of the line was made; and, the Duke's fox-cover being avoided, his opposition was thus averted. But, on Parliament

becoming dissolved on the death of George III., the Bill was necessarily suspended until another session.

In the mean time, the local opposition to the measure revived, and now it was led by the road trustees, who spread it abroad that the mortgagees of the tolls arising from the turnpike-road leading from Darlington to West Auckland would be seriously injured by the formation of the proposed railway. On this, Edward Pease issued a printed notice, requesting any alarmed mortgagee to apply to the Company's solicitors at Darlington, who were authorised to purchase their securities at the prices originally given for them. This notice had the effect of allaying the alarm spread abroad; and the Bill, though still strongly opposed, passed both Houses of Parliament in 1821.



MAP OF STOCKTON AND DARLINGTON RAILWAY

The preamble of the Act sets forth the public utility of the proposed line for the conveyance of coal and other commodities from the interior of the county of Durham to Stockton and the northern parts of Yorkshire. Nothing was said about passengers, for passenger-traffic was not yet contemplated; and nothing was said about locomotives, as it was at first intended to work the line entirely by horse-power. The road was to be free to all persons who chose to place their waggon and horses upon it for the haulage of coal and

merchandise, provided they paid the tolls fixed by the Act.

The Company were empowered to charge fourpence a ton per mile for all coal intended for land sale ; but only a halfpenny a ton per mile for coal intended for shipment at Stockton. This latter proviso was inserted at the instance of Mr. Lambton, afterwards Earl of Durham, for the express purpose of preventing the line being used in competition against his coal loaded at Sunderland ; for it was not believed possible that coal could be carried at that low rate, except at a heavy loss. As it was, however, the rate thus fixed by the Act eventually proved the vital element of success in the working of the undertaking.

While the Stockton and Darlington Railway scheme was still before Parliament, we find Edward Pease writing letters to a York paper, urging the propriety of extending it southwards into Yorkshire by a branch from Croft. It is curious now to look back upon the arguments by which Mr. Pease sought to influence public opinion in favour of railways, and to observe the very modest anticipations which even its most zealous advocate entertained as to their supposed utility and capabilities :—

“The late improvements in the construction of railways,” Mr. Pease wrote, “have rendered them much more perfect than when constructed after the old plan. To such a degree of utility have they now been brought that they may be regarded as *very little inferior to canals*.

“If we compare the railway with the best lines of common road, it may be fairly stated that in the case of a level railway the work will be increased in at least an eightfold degree. The best horse is sufficiently loaded with three-quarters of a ton on a common road, from the undulating line of its draught, while on a railway it is calculated that a horse will easily draw a load of ten tons. At Lord Elgin’s works, Mr. Stevenson, the celebrated engineer, states that he has actually seen a horse draw twenty-three tons thirteen cwt. upon a railway, which was in

some parts level, and at other parts presented a gentle declivity!

“The formation of a railway, if it creates no improvement in a country, certainly bars none, as all the former modes of communication remain unimpaired; and the public obtain, at the risk of the subscribers, another and better mode of carriage, which it will always be to the interest of the proprietors to make cheap and serviceable to the community.

“On undertakings of this kind, when compared with canals, the advantages of which (where an extensive traffic on the ascending or descending line can be obtained) are nearly equal, it may be remarked, that public opinion is not easily changed on any subject. It requires the experience of many years, sometimes ages, to accomplish this, even in cases which by some may be deemed obvious. Such is the effect of habit, and such the aversion of mankind to anything like innovation or change. Although this is often regretted, yet, if the principle be investigated in all its ramifications, it will perhaps be found to be one of the most fortunate dispositions of the human mind.

“The system of cast-iron railways is as yet to be considered but in its infancy. It will be found to be an immense improvement on the common road and also on the wooden railway. It neither presents the friction of the tramway, nor partakes of the perishable nature of the wooden railway, and, as regards utility, it may be considered as the medium between the navigable canal and the common road. We may, therefore, hope that as this system develops itself, our roads will be laid out as much as possible on *one level*, and in connection with the great lines of communication throughout the country.”

Such were the modest anticipations of Edward Pease respecting railways in the year 1821. Ten years later, an age of progress, by comparison, had been effected.

Some time elapsed before any active steps were taken to proceed with the construction of the railway. Doubts had been raised whether the line was the best that could be adopted for the district; and the subscribers generally were not so sanguine about the undertaking as to induce them to press it forward.

One day, about the end of the year 1821, two

strangers knocked at the door of Mr. Pease's house in Darlington; and a message was brought to him that some persons from Killingworth wanted to speak with him. They were invited in, on which one of the visitors introduced himself as Nicholas Wood, viewer at Killingworth, and then turning to his companion, he introduced him as George Stephenson, engine-wright, of the same place.

Mr. Pease entered into conversation with his visitors, and was soon told their object. Stephenson had heard of the passing of the Stockton and Darlington Act, and desiring to increase his railway experience, and also to employ in some larger field the practical knowledge he had already acquired, he determined to visit the known projector of the undertaking, with the view of being employed to carry it out. He had brought with him his friend Wood, for the purpose at the same time of relieving his diffidence and supporting his application.

Mr. Pease liked the appearance of his visitor: "there was," as he afterwards remarked when speaking of Stephenson, "such an honest, sensible look about him, and he seemed so modest and unpretending. He spoke in the strong Northumbrian dialect of his district, and described himself as 'only the engine-wright at Killingworth; that's what he was.'"

Mr. Pease soon saw that our engineer was the very man for his purpose. The whole plans of the railway were still in an undetermined state, and Mr. Pease was therefore glad to have the opportunity of profiting by Stephenson's experience. In the course of their conversation, the latter strongly recommended a *railway* in preference to a tramroad. They also discussed the kind of tractive power to be employed: Mr. Pease stating that the company had based their whole calculations on the employment of *horse-power*. "I was so satisfied," said he afterwards, "that a horse upon an iron road would draw ten tons for one ton on a common road,

that I felt sure that before long the railway would become the King's highway."

But Mr. Pease was scarcely prepared for the bold assertion made by his visitor, that the locomotive engine with which he had been working the Killingworth Railway for many years past, was worth fifty horses, and that engines made after a similar plan would yet entirely supersede all horse-power upon railroads. Stephenson was daily becoming more positive as to the superiority of his locomotive; and hence he strongly urged Mr. Pease to adopt it. "Come over to Killingworth," said he, "and see what my engines can do; seeing is believing, sir." Mr. Pease accordingly promised that on some early day he would go over to Killingworth, and take a look at the wonderful machine that was to supersede horses.

The result of the interview was, that Mr. Pease promised to bring Stephenson's application for the appointment of engineer before the Directors, and to support it with his influence; whereon the two visitors prepared to take their leave, informing Mr. Pease that they intended to return to Newcastle "by nip;" that is, they expected to get a smuggled lift on the stage-coach by tipping Jehu,—for in those days the stage coachmen regarded all casual roadside passengers as their proper perquisites. They had, however, been so much engrossed by their conversation, that the lapse of time was forgotten, and when Stephenson and his friend made inquiries about the return coach, they found the last had left; and they had to walk eighteen miles to Durham on their way back to Newcastle.

Mr. Pease having made further inquiries respecting Stephenson's character and qualifications, and having received a very strong recommendation of him as the right man for the intended work, he brought the subject of his application before the Directors of the Stockton and Darlington Company. They resolved to adopt his

recommendation that a railway be formed instead of a tramroad; and they further requested Mr. Pease to write to Stephenson, desiring him to undertake a re-survey of the line at the earliest practicable period.

A man was despatched on a horse with the letter, and when he reached Killingworth he made diligent inquiry after the person named on the address, "George Stephenson, Esquire, Engineer." No such person was known in the village. It is said that the man was on the point of giving up all further search, when the happy thought struck some of the colliers' wives who had gathered about him, that it must be "Geordie the engine-wright" the man was in search of; and to Geordie's cottage he accordingly went, found him at home, and delivered the letter.

About the end of September, Stephenson went carefully over the line of the proposed railway, for the purpose of suggesting such improvements and deviations as he might consider desirable. He was accompanied by an assistant and a chainman,—his son Robert entering the figures while his father took the sights. After being engaged in the work at intervals for about six weeks, Stephenson reported the result of his survey to the Board of Directors, and showed that, by certain deviations, a line shorter by about three miles might be constructed at a considerable saving in expense, while at the same time more favourable gradients—an important consideration—would be secured.

It was, however, determined in the first place to proceed with the works at those parts of the line where no deviation was proposed; and the first rail of the Stockton and Darlington Railway was laid with considerable ceremony, near Stockton, on the 23rd May, 1822.

It is worthy of note that Stephenson, in making his first estimate of the cost of forming the railway according to the instructions of the Directors, set down, as part

of the cost, 6200*l.* for stationary engines, not mentioning locomotives at all. It was the intention of the Directors in the first place to employ only horses for the haulage of the coals, and fixed engines and ropes where horse-power was not applicable. The whole question of steam-locomotive power was, in the estimation of the public, as well as of practical and scientific men, as yet in doubt. The confident anticipations of George Stephenson as to the eventual success of locomotive engines, were regarded as mere speculations; and when he gave utterance to his views, as he frequently took the opportunity of doing, it even had the effect of shaking the confidence of some of his friends in the solidity of his judgment and his practical qualities as an engineer.

When Mr. Pease discussed the question with Stephenson, his remark was, "Come over and see my engines at Killingworth, and satisfy yourself as to the efficiency of the locomotive. I will show you the colliery books, that you may ascertain for yourself the actual cost of working. And I must tell you that the economy of the locomotive engine is no longer a matter of theory, but a matter of fact." So confident was the tone in which Stephenson spoke of the success of his engines, and so important were the consequences involved in arriving at a correct conclusion on the subject, that Mr. Pease at length resolved on paying a visit to Killingworth in the summer of 1822, in company with his friend Thomas Richardson, a considerable subscriber to the Stockton and Darlington undertaking,<sup>1</sup> to inspect the wonderful new power so much vaunted by their engineer.

When Mr. Pease arrived at Killingworth village, he inquired for George Stephenson, and was told that he must go over to the West Moor, and seek for a

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<sup>1</sup> Mr. Richardson was founder of the afterwards well-known discount-house of Richardson, Overend, and Gurney, Lombard Street, London.

cottage by the roadside, with a dial over the door—"that was where George Stephenson lived." They soon found the house with the dial; and, on knocking, the door was opened by Mrs. Stephenson. In answer to Mr. Pease's inquiry for her husband, she said he was not in the house at present, but that she would send for him to the colliery. And in a short time Stephenson appeared before them in his working dress, just as he had come out of the pit.

He very soon had his locomotive brought up to the crossing close by the end of the cottage,—made the gentlemen mount it, and showed them its paces. Harnessing it to a train of loaded waggons, he ran it along the railroad, and so thoroughly satisfied his visitors of its power and capabilities, that from that day Edward Pease was a declared supporter of the locomotive engine. In preparing the Amended Stockton and Darlington Act, at Stephenson's urgent request Mr. Pease had a clause inserted, taking power to work the railway by means of locomotive engines, and to employ them for the haulage of passengers as well as of merchandise.<sup>1</sup> The Act was obtained in 1823, on which Stephenson was appointed the Company's engineer, at a salary of 300*l.* per annum; and it was determined that the line should be constructed and opened for traffic as soon as practicable.

He at once proceeded, accompanied by his assistants, with the working survey of the line, laying out every foot of the ground himself. Railway surveying was as yet in its infancy, and was slow and difficult work. It afterwards became a separate branch of railway business, and was entrusted to a special staff. Indeed on no subsequent line did George Stephenson take the sights through the spirit-level with his own hands and eyes as

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<sup>1</sup> The first clause in any railway Act, empowering the employment of locomotive engines for the working of passenger traffic.

he did on this railway. He started very early—dressed in a blue tailed coat, breeches, and top-boots—and surveyed until dusk. He was not at any time particular as to his living; and, during the survey, he took his chance of getting a little milk and bread at some cottager's house along the line, or occasionally joined in a homely dinner at some neighbouring farmhouse. The country people were accustomed to give him a hearty welcome when he appeared at their door; for he was always full of cheery and homely talk, and, when there were children about the house he had plenty of humorous chat for them as well as for their seniors.

After the day's work was over, George would drop in at Mr. Pease's, to talk over the progress of the survey, and discuss various matters connected with the railway. Mr. Pease's daughters were usually present; and one occasion, finding the young ladies learning the art of embroidery, he volunteered to instruct them.<sup>1</sup> "I know all about it," said he; "and you will wonder how I learnt it. I will tell you. When I was a brakesman at Killingworth, I learnt the art of embroidery while working the pitmen's buttonholes by the engine fire at nights." He was never ashamed, but on the contrary rather proud, of reminding his friends of these humble pursuits of his early life. Mr. Pease's family were greatly pleased with his conversation, which was always amusing and instructive; full of all sorts of experience, gathered in the oddest and most out-of-the-way places. Even at that early period, before he mixed in the society of educated persons, there was a dash of speculativeness in his remarks, which gave a high degree of originality to his conversation; and he would sometimes, in a casual remark, throw a flash of light upon a subject, which called up a train of pregnant suggestions.

<sup>1</sup> This incident, communicated to the author by the late Edward Pease, has since been made the subject of a

fine picture by Mr. A. Rankley, A.R.A. exhibited at the Royal Academy Exhibition of 1861.

One of the most important subjects of discussion at these meetings with Mr. Pease, was the establishment of a manufactory at Newcastle for the building of locomotive engines. Up to this time all the locomotives constructed after Stephenson's designs had been made by ordinary mechanics working at the collieries in the North of England. But he had long felt that the accuracy and style of their workmanship admitted of great improvement, and that upon this the more perfect action of the locomotive engine, and its general adoption, in a great measure depended. One principal object that he had in view in establishing the proposed factory was, to concentrate a number of good workmen for the purpose of carrying out the improvements in detail which he was from time to time making in his engine. For he felt hampered by the want of efficient help from skilled mechanics, who could work out in a practical form the ideas of which his busy mind was always so prolific. Doubtless, too, he believed that the manufactory would prove a remunerative investment, and that, on the general adoption of the railway system which he anticipated, he would derive solid advantages from the fact of his establishment being the only one of the kind for the special construction of locomotive engines.

Mr. Pease approved of his design, and strongly recommended him to carry it into effect. But there was the question of means; and Stephenson did not think he had capital enough for the purpose. He told Mr. Pease that he could advance 1000*l.*—the amount of the testimonial presented by the coal-owners for his safety-lamp invention, which he had still left untouched; but he did not think this sufficient for the purpose, and he thought that he should require at least another 1000*l.* Mr. Pease had been very much struck with the successful performances of the Killingworth engine; and being an accurate judge of character, he believed that he could not go far wrong in linking a

portion of his fortune with the energy and industry of George Stephenson. He consulted his friend Thomas Richardson in the matter; and the two consented to advance 500*l.* each for the purpose of establishing the engine factory at Newcastle. A piece of land was accordingly purchased in Forth Street, in August, 1823, on which a small building was erected—the nucleus of the gigantic establishment which was afterwards formed around it; and active operations were begun early in 1824.

While the Stockton and Darlington Railway works were in progress, our engineer had many interesting discussions with Mr. Pease, on points connected with its construction and working, the determination of which in a great measure affected the formation and working of future railways. The most important points were these:—1. The comparative merits of cast and wrought iron rails. 2. The gauge of the railway. 3. The employment of horse or engine power in working it when ready for traffic.

The kind of rails to be laid down to form the permanent road was a matter of considerable importance. A wooden tramroad had been contemplated when the first Act was applied for; but Stephenson having advised that an iron road should be laid down, he was instructed to draw up a specification of the rails. He went before the Directors to discuss with them the kind of material to be specified. He was himself interested in the patent for cast-iron rails, which he had taken out in conjunction with Mr. Losh in 1816; and, of course, it was to his interest that his articles should be used. But when requested to give his opinion on the subject, he frankly said to the Directors, “Well, gentlemen, to tell you the truth, although it would put 500*l.* in my pocket to specify my own patent rails, I cannot do so after the experience I have had. If you take my advice, you will not lay down a single cast-iron rail.” “Why?”

asked the Directors. "Because they will not stand the weight, and you will be at no end of expense for repairs and relays." What kind of road, then," he was asked, "would you recommend?" "Malleable rails, certainly," said he; "and I can recommend them with the more confidence from the fact that at Killingworth we have had some Swedish bars laid down—nailed to wooden sleepers—for a period of fourteen years, the waggons passing over them daily; and there they are, in use yet, whereas the cast rails are constantly giving way."<sup>1</sup>

The price of malleable rails was, however, so high—being then worth about 12*l.* per ton as compared with cast-iron rails at about 5*l.* 10*s.*—and the saving of expense was so important a consideration with the subscribers, that Stephenson was directed to provide, in the specification, that only one-half of the rails required—or about 800 tons—should be of malleable iron, and the remainder of cast iron. The malleable rails were of the kind called "fish-bellied," and weighed 28 lbs. to the yard, being 2½ inches broad at the top, with the upper flange ¾ inch thick. They were only 2 inches in depth at the points at which they rested on the chairs, and 3½ inches in the middle or bellied part.

When forming the road, the proper gauge had also to be determined. What width was this to be? The gauge of the first tramroad laid down had virtually settled the point. The gauge of wheels of the common vehicles of the country—of the carts and waggons employed on common roads, which were first used on the tramroads—was about 4 feet 8½ inches. And so the first tramroads were laid down of this gauge. The tools

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<sup>1</sup> Stephenson's recommendation of wrought-iron instead of cast-iron rails, was the cause of a rupture between Mr. Losh and himself. Stephenson thought his duty was to give his employers the best advice; Losh thought

his business was to push the patent cast-iron rails wherever he could. Stephenson regarded this view as sordid; and the two finally separated after a quarrel, in high dudgeon with each other.

and machinery for constructing coal-waggon and locomotives were formed with this gauge in view. The Wylam waggon-way, afterwards the Wylam plate-way, the Killingworth railroad, and the Hetton railroad, were as nearly as possible on the same gauge. Some of the earth-waggon used to form the Stockton and Darlington road were brought from the Hetton Railway; and others which were specially constructed were formed of the same dimensions, these being intended to be afterwards employed in the working of the traffic.

As the period drew near for the opening of the line, the question of the tractive power to be employed was anxiously discussed. At the Brusselton incline, fixed engines must necessarily be made use of; but with respect to the mode of working the railway generally, it was decided that horses were to be largely employed, and arrangements were made for their purchase.

Although locomotives had been regularly employed in hauling coal-waggon on the Middleton Colliery Railway, near Leeds, for more than twelve years, and on the Wylam and Killingworth Railways near Newcastle for more than ten years, great scepticism still prevailed as to the economy of employing them for the purpose in lieu of horses. In this case, it would appear that seeing was *not* believing. The popular scepticism was as great at Newcastle, where the opportunities for accurate observation were the greatest, as anywhere else. In 1824 the scheme of a canal between that town and Carlisle again came up, and, though a few timid voices were raised on behalf of a railway, the general opinion was still in favour of a canal. The example of the Hetton Railway, which had been successfully worked by Stephenson's locomotives for two years past, was pointed to in proof of the practicability of a locomotive line between the two places; but the voice of the press as well as of the public was decidedly against the "new-fangled roads."

“There has been some talk,” wrote the ‘Whitehaven Gazette,’ “from a puff criticism in the ‘Monthly Review,’ of an improvement on the principle of railways; but we suspect that this improvement will turn out like the steam-carriages, of which we have been told so much, that were to supersede the use of horses entirely, and travel *at a rate almost equal to the speed of the fleetest horse!*” The idea was too chimerical to be entertained, and the suggested railway was accordingly rejected as impracticable.

The ‘Tyne Mercury’ was equally decided against railways. “What person,” asked the editor (November 16th, 1824), “would ever think of *paying anything* to be conveyed from Hexham to Newcastle in something like a coal-waggon, upon a dreary waggon-way, and to be dragged for the greater part of the distance by a ROARING STEAM-ENGINE!” The very notion of such a thing was preposterous, ridiculous, and utterly absurd.

When such was the state of public opinion as to railway locomotion, some idea may be formed of the clearsightedness and moral courage of the Stockton and Darlington directors in ordering three of Stephenson’s locomotive engines, at a cost of several thousand pounds, against the opening of the Railway.

These were constructed after Stephenson’s most matured designs, and embodied all the improvements which he had contrived up to that time. No. I. engine, the “Locomotion,” which was first delivered, weighed about eight tons. It had one large flue or tube through the boiler, by which the heated air passed direct from the furnace at one end, lined with fire-bricks, to the chimney at the other. The combustion in the furnace was quickened by the adoption of the steam-blast in the chimney. The heat raised was sometimes so great, and it was so imperfectly abstracted by the surrounding water, that the chimney became almost red-hot. Such

engines, when put to their speed, were found capable of running at the rate of from twelve to sixteen miles an hour; but they were better adapted for the heavy work of hauling coal-trains at low speeds—for which, indeed, they were specially constructed—than for running at the higher speeds afterwards adopted. Nor was it contemplated by the Directors as possible, at the time when they were ordered, that locomotives could be made available for the purposes of passenger travelling. Besides, the Stockton and Darlington Railway did not run through a district in which passengers were supposed to be likely to constitute any considerable portion of the traffic.

We may easily imagine the anxiety felt by George Stephenson during the progress of the works towards completion, and his mingled hopes and doubts (though his doubts were but few) as to the issue of this great experiment. When the formation of the line near Stockton was well advanced, the engineer one day, accompanied by his son Robert and John Dixon, made a journey of inspection of the works. The party reached Stockton, and proceeded to dine at one of the inns there. After dinner, Stephenson ventured on the very unusual measure of ordering in a bottle of wine, to drink success to the railway. John Dixon relates with pride the utterance of the master on the occasion. "Now lads," said he to the two young men, "I venture to tell you that I think you will live to see the day when railways will supersede almost all other methods of conveyance in this country—when mail-coaches will go by railway, and railroads will become the great highways for the king and all his subjects. The time is coming when it will be cheaper for a working man to travel on a railway than to walk on foot. I know there are great and almost insurmountable difficulties to be encountered; but what I have said will come to pass as sure as you now hear me. I only wish I may live to see the day, though

that I can scarcely hope for, as I know how slow all human progress is, and with what difficulty I have been able to get the locomotive introduced thus far, notwithstanding my more than ten years' successful experiment at Killingworth." The result, however, outstripped even George Stephenson's most sanguine anticipations; and his son Robert, shortly after his return from America, in 1827, saw his father's locomotive adopted as the tractive power on railways generally.

Tuesday, the 27th of September, 1825, was a great day for Darlington. The railway, after having been under construction for more than three years, was at length about to be opened. The project had been the talk of the neighbourhood for so long that there were few people within a range of twenty miles who did not feel more or less interested about it. Was it to be a failure or a success? Opinions were pretty equally divided as to the railway, but as regarded the locomotive the general belief was that it would "never answer." However, there the locomotive was—"No. I."—delivered on to the line, and ready to draw the first train of waggons on the opening day.

A great concourse of people assembled on the occasion. Some came from Newcastle and Durham, many from the Aucklands, while Darlington held a general holiday and turned out all its population. To give *éclat* to the opening, the Directors of the Company issued a programme of the proceedings, intimating the times at which the procession of waggons would pass certain points along the line. The proprietors assembled as early as six in the morning at the Brusselton fixed engine, where the working of the inclined planes was successfully rehearsed. A train of waggons laden with coals and merchandise was drawn up the western incline by the fixed engine, a length of 1960 yards, in seven-and-a-half minutes, and then lowered down the incline on the eastern side of the hill, 880 yards, in five minutes.

At the foot of the incline the procession of vehicles was formed, consisting of the locomotive engine, No. I., driven by George Stephenson himself; after it six waggons loaded with coals and flour, then a covered coach containing directors and proprietors, next twenty-one coal-waggons fitted up for passengers (with which they were crammed), and lastly six more waggons loaded with coals.

Strange to say, a man on a horse, carrying a flag, with the motto of the Company inscribed on it, *Periculum privatum utilitas publica*, headed the procession! A lithographic view of the great event, published shortly after, duly exhibits the horseman and his flag. It was not thought so dangerous a place after all. The locomotive was only supposed to be able to go at the rate of from four to six miles an hour; and an ordinary horse could easily keep ahead of that.



PROCESSION AT THE OPENING OF THE STOCKTON AND DARLINGTON RAILWAY

[Fac-simile of a local lithograph.]

Off started the procession, with the horseman at its head. A great concourse of people stood along the line. Many of them tried to accompany it by running,

and some gentlemen on horseback galloped across the fields to keep up with the train. The railway descending with a gentle incline towards Darlington, the rate of speed was consequently variable. At a favourable part of the road, Stephenson determined to try the speed of the engine, and he called upon the horseman with the flag to get out of the way! Most probably, deeming it unnecessary to carry his *Periculum privatum* further, the horseman turned aside, and Stephenson "put on the steam." The speed was at once raised to twelve miles an hour, and, at a favourable part of the road, to fifteen. The runners on foot, the gentlemen on horseback, and the horseman with the flag, were consequently soon left far behind. When the train reached Darlington, it was found that four hundred and fifty passengers occupied the waggons, and that the load of men, coals, and merchandise amounted to about ninety tons.

At Darlington the procession was re-arranged. The six loaded coal-waggons were left behind, and other waggons were taken on with a hundred and fifty more passengers, together with a band of music. The train then started for Stockton—a distance of only twelve miles—which was reached in about three hours. The day was kept throughout the district as a holiday; and horses, gigs, carts, and other vehicles, filled with people, stood along the railway, as well as crowds of persons on foot, waiting to see the train pass. The whole population of Stockton turned out to receive the procession, and after a walk through the streets, the inevitable dinner in the Town Hall wound up the day's proceedings.

All this, however, was but gala work. The serious business of the Company began on the following day. Upon the result of the experiment now fairly initiated by the Stockton and Darlington Company the future of railways, in a great measure, depended. If it failed,

like the Wandsworth, Croydon, and Merstham undertaking, then a great check would unquestionably be given to speculation in railways. If it succeeded, the Stockton and Darlington enterprise would mark the beginning of a new era, and issue in neither more nor less than a complete revolution of the means of communication in all civilised countries.

The circumstances were on the whole favourable, and boded success rather than failure. Prudent, careful, thoughtful men were at the head of the concern, interested in seeing it managed economically and efficiently; and they had the advantage of the assistance of an engineer possessed of large resources of mother-wit, mechanical genius, and strong common sense. There was an almost unlimited quantity of coal to be carried, the principal difficulty being in accommodating it satisfactorily. Yet it was only after the line had been at work for some time that the extensive character of the coal traffic began to be appreciated. At first it was supposed that the chief trade would be in coal for land sale. But the clause inserted in the original Act, at the instance of Mr. Lambton, by which the Company were limited to  $\frac{1}{2}d.$  per ton per mile for coal led to Stockton for shipment, led to the most unexpected consequences. It was estimated that only about 10,000 tons a year would be shipped, and that principally by way of ballast. Instead of which, in the course of a very few years, the coal carried on the line for export constituted the main bulk of the traffic, whilst that carried for land sale was merely subsidiary.<sup>1</sup>

<sup>1</sup> The rapid progress of the coal and merchandise traffic of the Stockton and Darlington line, of which Middlesbro' is the principal seaport, may be inferred from the following brief statement of facts:—The original estimate assumed that 165,488 tons of coal would be carried annually, and produce an income of 11,904*l.* The

revenue from other sources was taken at 4104*l.* In 1827, the first year in which the coal and merchandise traffic was fully worked, the revenue from coal was 14,455*l.*; from lime, merchandise, and sundries, 3285*l.*; and from passengers (which had not been taken into account), 563*l.* In 1860, when the original line of 25 miles had

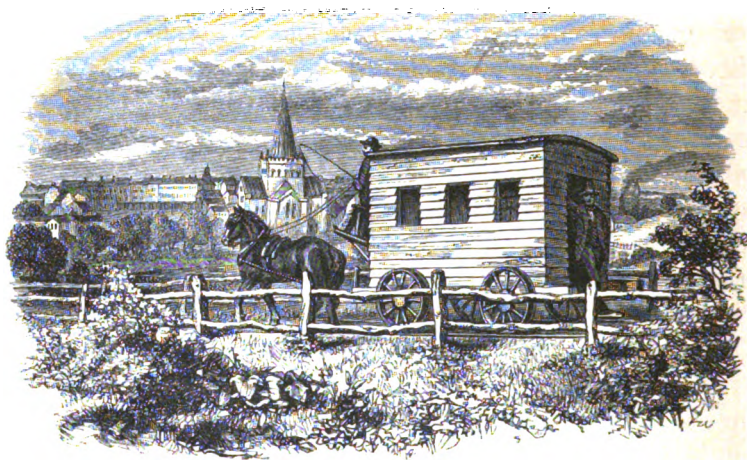
The anticipations of the Company as to passenger-traffic were in like manner more than realised. At first, passengers were not thought of; and it was only while the works were in progress that the starting of a passenger-coach was seriously contemplated. Some eighty years since, there was only one post-chaise in Darlington, which ran on three wheels. There are people still living who remember when a coach ran from Stockton three days in the week, passing through Darlington and Barnard Castle; but it was starved off the road for want of support. There was then very little intercourse between the towns, though they were so near to each other, and comparatively so populous; and it was not known whether people would trust themselves to the iron road. Nevertheless it was determined to make trial of a railway-coach; and George Stephenson was authorised to have one built at Newcastle at the cost of the Company. This was done accordingly; and the first railway passenger-carriage was built after our engineer's design. It was, however, a very modest, and indeed a somewhat uncouth machine, more resembling a showman's caravan than a passenger-coach of any extant form. A row of seats ran along each side of the interior, and a long deal table was fixed in the centre; the access being by means of a door at the back end, in the manner of an omnibus. This coach arrived from Newcastle on the day before the opening, and formed part of the procession above described. Stephenson was consulted as to the name of the coach, and he at once suggested the "Experiment;" and by this name it was called. Such was the sole passenger-carrying stock of the Stockton and Darlington Company

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become extended to 125 miles, and the original capital of 150,000*l.* had swelled to 3,800,000*l.*, the quantity of coal carried had increased to 3,045,596 tons in the year, besides 1,484,409 tons of ironstone and other

minerals, producing a revenue of 280,375*l.*; while 1,484,409 tons of merchandise had been carried in the same year, producing 63,478*l.*; and 687,728 passengers, producing 45,398*l.*

in the year 1825. But "The Experiment" proved the forerunner of a mighty traffic: and long time did not elapse before it was displaced, not only by improved coaches (still drawn by horses), but afterwards by long trains of passenger-carriages drawn by locomotive engines.



THE FIRST RAILWAY COACH

The "Experiment" was fairly started as a passenger-coach on the 10th of October, 1825, a fortnight after the opening of the line. It was drawn by one horse, and performed a journey daily each way between the two towns, accomplishing the distance of twelve miles in about two hours. The fare charged was a shilling, without distinction of class; and each passenger was allowed fourteen pounds of luggage free. The "Experiment" was not, however, worked by the Company, but was let to contractors who worked it under an arrangement whereby toll was paid for the use of the line, rent of booking-cabins, &c.<sup>1</sup>

<sup>1</sup> The coaches were not allowed to be run upon the line without considerable opposition. We find Edward Pease writing to Joseph Sandars, of

Liverpool, on the 18th January, 1827:—"Our railway coach proprietors have individually received notices of a process in the Exchequer

The speculation answered so well, that several private coaching companies were shortly after got up by inn-keepers at Darlington and Stockton, for the purpose of running other coaches upon the railroad; and an active competition for passenger-traffic sprang up. The "Experiment" being found too heavy for one horse to draw, besides being found an uncomfortable machine, was banished to the coal district. Its place was then supplied by other and better vehicles,—though they were no other than old stage-coach bodies purchased by the Company, each mounted on an underframe with flange-wheels. These were let on hire to the coaching companies, who horsed and managed them under an arrangement as to tolls, in like manner as the "Experiment" had been worked. Now began the distinction of inside and outside passengers, equivalent to first and second class, paying different fares. The competition with each other upon the railway, and with the ordinary stage-coaches upon the road, soon brought up the speed, which was increased to ten miles an hour—the mail-coach rate of travelling in those days, and considered very fast.

Mr. Clephan, a native of the district, has communicated to the author the following account of the competition between the rival coach companies :—

"There were two separate coach companies in Stockton, and amusing collisions sometimes occurred between the drivers—who found on the rail a novel element for contention. Coaches cannot pass each other on the rail as on the road; and, as the line was single, with four sidings in the mile, when two coaches

for various fines, to the amount of 150*l.*, in penalties of 20*l.* each, for neglecting to have the plates, with the numbers of their licenses, on the coach doors, agreeably to the provision of the Act 95 George IV. In looking into the nature of this proceeding and its consequences, it is clear, if the Court shall confirm it by conviction, that we are undone as to the

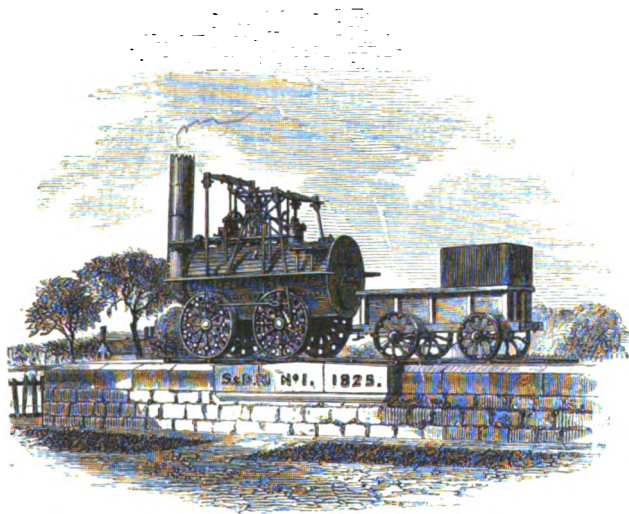
conveyance of passengers." Mr. Pease incidentally mentions the names of the several coach proprietors at the time—"Pickersgill and Co., Richard Scott, and Martha Hewson." The proceeding was eventually defeated, it being decided that the penalties only applied to coaches travelling on common or turnpike-roads.

met, or two trains, or coach and train, the question arose which of the drivers must go back? This was not always settled in silence. As to trains, it came to be a sort of understanding that empty should give way to loaded waggons; and as to trains and coaches, that passengers should have preference over coals; while coaches, when they met, must quarrel it out. At length, midway between sidings, a post was erected, and the rule was laid down that he who had passed the pillar must go on, and the 'coming man' go back. At the Goose Pool and Early Nook it was common for the coaches to stop; and there, as Jonathan would say, passengers and coachmen 'liquored.' One coach, introduced by an innkeeper, was a compound of two mourning-coaches,—an approximation to the real railway-coach, which still adheres, with multiplying exceptions, to the stage-coach type. One Dixon, who drove the 'Experiment' between Darlington and Shildon, is the inventor of carriage-lighting on the rail. On a dark winter night, having compassion on his passengers, he would buy a penny candle, and place it lighted amongst them on the table of the 'Experiment'—the first railway-coach (which, by the way, ended its days at Shildon as a railway cabin), being also the first coach on the rail (first, second, and third class jammed all into one) that indulged its customers with light in darkness."

The traffic of all sorts increased so steadily and so rapidly that considerable difficulty was experienced in working it satisfactorily. It had been provided by the first Stockton and Darlington Act that the line should be free to all parties who chose to use it at certain prescribed rates, and that any person might put horses and waggons on the railway, and carry for himself. But this arrangement led to increasing confusion and difficulty, and could not continue in the face of a large and rapidly-increasing traffic. The goods trains got so long that the carriers found it necessary to call in the aid of the locomotive engine to help them on their way. Then mixed trains of passengers and merchandise began to run; and the result was that the Railway Company found it necessary to take the entire charge and working of the traffic. In course of time new

coaches were specially built for the better accommodation of the public, until at length regular passenger-trains were run, drawn by the locomotive engine,—though this was not until after the Liverpool and Manchester Company had established this as a distinct branch of their traffic.

The three Stephenson locomotives were from the first regularly employed to work the coal-trains; and their proved efficiency for this purpose led to the gradual increase of the locomotive power. The speed of the engine—slow though it seems now—was in those days regarded as something marvellous. A race actually came off between No. 1. engine, the "Locomotion," and



THE NO. 1. ENGINE AT DARLINGTON

one of the stage coaches travelling from Darlington to Stockton by the ordinary road; and it was regarded as a great triumph of mechanical skill that the locomotive reached Stockton first, beating the stage coach by about a hundred yards! The same engine continued in good working order in the year 1846, when it headed the railway procession on the opening of the Middlesborough

and Redcar Railway, travelling at the rate of about fourteen miles an hour. This engine, the first that travelled on the first public locomotive railway, has recently been placed upon a pedestal in front of the railway station at Darlington.

For some years, however, the principal haulage of the line was performed by horses. The inclination of the gradients being towards the sea, this was perhaps the cheapest mode of traction, so long as the traffic was not very large. The horse drew the train along the level road, until, on reaching a descending gradient, down which the train ran by its own gravity, the animal was unharnessed, when, wheeling round to the other end of the waggons, to which a "dandy-cart" was attached, its bottom being only a few inches from the rail, and bringing his step into unison with the speed of the train, he leapt nimbly into his place in the hind car, which was usually fitted with a well-filled hay-rack.

The details of the working were gradually perfected by experience, the projectors of the line being scarcely conscious at first of the importance and significance of the work which they had taken in hand, and little thinking that they were laying the foundations of a system which was yet to revolutionise the internal communications of the world, and confer the greatest blessings on mankind. It is important to note that the commercial results of the enterprise were considered satisfactory from the opening of the railway. Besides conferring a great public benefit upon the inhabitants of the district and throwing open entirely new markets for the almost boundless stores of coal found in the Bishop Auckland district, the profits derived from the traffic created by the railway enabled increasing dividends to be paid to those who had risked their capital in the undertaking, and thus held forth an encouragement to the projectors of railways generally, which

was not without an important effect in stimulating the projection of similar enterprises in other districts. These results, as displayed in the annual dividends, must have been eminently encouraging to the astute commercial men of Liverpool and Manchester, who were then engaged in the prosecution of their railway. Indeed, the commercial success of the Stockton and Darlington Company may be justly characterised as the turning-point of the railway system. With that practical illustration daily in sight of the public, it was no longer possible for Parliament to have prevented its eventual extension.

Before leaving the subject of the Stockton and Darlington Railway, we cannot avoid alluding to one of its most remarkable and direct results—the creation of the town of Middlesborough-on-Tees. When the railway was opened in 1825, the site of this future metropolis of Cleveland was occupied by one solitary farm-house and its outbuildings. All round was pasture land or mud-banks; scarcely another house was within sight. The corporation of the town of Stockton being unwilling or unable to provide accommodation for the rapidly increasing coal traffic, Mr. Edward Pease, in 1829, joined by a few of his Quaker friends, bought about 500 or 600 acres of land, five miles lower down the river—the site of the modern Middlesborough—for the purpose of there forming a new seaport for the shipment of coals brought to the Tees by the railway. The line was accordingly extended thither; docks were excavated; a town sprang up; churches, chapels, and schools were built, with a custom-house, mechanics' institute, banks, shipbuilding yards, and iron-factories; and in a few years the port of Middlesborough became one of the most thriving on the north-east coast of England. In ten years a busy population of some 6000 persons (since swelled to about 25,000) occupied the site of the original farmhouse. More recently, the discovery of vast stores

of ironstone in the Cleveland Hills, close adjoining Middlesborough, has tended still more rapidly to augment the population and increase the commercial importance of the place.

It is pleasing to relate, in connexion with this great work—the Stockton and Darlington Railway, projected by Edward Pease and executed by George Stephenson—that when Mr. Stephenson became a prosperous and a celebrated man, he did not forget the friend who had taken him by the hand, and helped him on in his early days. He continued to remember Mr. Pease with gratitude and affection, and that gentleman, to the close of his life, was proud to exhibit a handsome gold watch, received as a gift from his celebrated *protégé*, bearing these words:—"Esteem and gratitude: from George Stephenson to Edward Pease."



MIDDLESBOROUGH-ON-TEES

## CHAPTER IX.

## THE LIVERPOOL AND MANCHESTER RAILWAY PROJECTED.

WHILE the coal proprietors of the Bishop Auckland district were taking steps to connect their collieries with the sea by means of an iron railroad, the merchants of Liverpool and Manchester were considering whether some better means could not be devised for bringing these important centres of commerce and manufacture into more direct connection.

There were canals as well as roads between the two places, but all routes were alike tedious and costly, especially as regarded the transit of heavy goods. The route by turnpike-road was thirty-six miles, by the Duke of Bridgewater's Canal fifty miles, by the Mersey and Irwell navigation the same, and by the Leeds and Liverpool Canal fifty-six miles.

These were all over-burthened with traffic. The roads were bad, the tolls heavy, and the haulage expensive. The journey by coach occupied from five to six hours; and by waggon nearly a day. But very few heavy goods went by road. The canals nearly monopolised this traffic, and, having contrived to keep up the rates, the canal companies charged what they liked. They conducted their business in a drowsy, sleepy, stupid manner. If the merchant complained of delay, he was told to do better if he could. If he objected to the rates, he was warned that if he did not pay them promptly his goods might not be carried at all.

The canal companies were in a position to dictate their own terms, and they did this in such a way as to disgust alike the senders and the receivers of goods;

so that both Liverpool and Manchester were up in arms against them. Worse even than the heavy charges for goods, was the occasional entire stoppage of the canals. Sometimes they were frozen up; sometimes they were closed by droughts; sometimes they were blocked by the press of traffic, so that goods lay on the wharves unmoved for weeks together; and at some seasons it occupied a longer time to bring cotton from Liverpool to Manchester by canal-boat than it had done to bring it from New York to Liverpool by sailing-ship.

Was there no way of remedying these great and admitted evils? Were the commercial public to continue to be bound hand and foot, and left at the mercy of the canal proprietors? Immense interests at Liverpool and Manchester were at stake. The Liverpool merchants wanted new facilities for sending raw material inland, and the Manchester manufacturers for sending the manufactured products back to Liverpool for shipment. Vast populations had become settled in the towns of South Lancashire, to whom it was of vital importance that the communication with the sea should be regular, constant, and economical.

These considerations early led to the discussion of some improved mode of transit from Liverpool into the interior for heavy goods; and one of the most favoured plans was that of a tramroad. It was first suggested by the corn-merchants of Liverpool, who had experienced the great inconveniences resulting from the canal monopoly. One of the most zealous advocates of the tramroad was Mr. Joseph Sandars, who took considerable pains to ascertain the results of the working of the coal lines in the north, both by horse and engine power; and he satisfied himself that either method would, if adopted between Liverpool and Manchester, afford the desired relief to the commercial and manufacturing interests. The subject was ventilated by him in the local papers, and in the course of the year 1821,

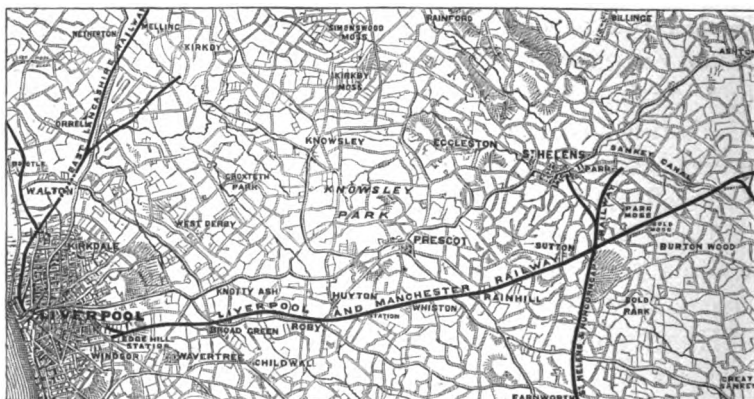
Mr. Sandars succeeded in getting together a committee of Liverpool gentlemen for the purpose of further considering the subject, and, if found practicable, of starting a company with the object of forming a tram-road between the two towns.

While the project was still in embryo, the rumour of it reached the ears of Mr. William James, then of West Bromwich, an enthusiastic advocate of tramroads and railways. As a land-surveyor and land-agent, as well as coal-owner, he had already laid down many private railroads. He had also laid out and superintended the execution and the working of canals, projected extensive schemes of drainage and enclosure, and on the whole was one of the most useful and active men of his time. But a series of unfortunate speculations in mines having seriously impaired his fortunes, he again reverted to his original profession of land-surveyor, and was so occupied in the neighbourhood of Liverpool when he heard of the scheme set on foot for the construction of the proposed tramway to Manchester.

He at once called upon Mr. Sandars and offered his services as its surveyor. We believe he at first offered to survey the line at his own expense, to which Mr. Sandars could not object; but his means were too limited to enable him to do this successfully, and Mr. Sandars and several of his friends agreed to pay him 300*l.* for the survey, or at the rate of about 10*l.* a mile. Mr. James's first interview with Mr. Sandars was in the beginning of July, 1821, when it was arranged that he should go over the ground and form a general opinion as to the practicability of a tramway.

A trial survey was then begun, but it was conducted with great difficulty, the inhabitants of the district entertaining much prejudice against the scheme. In some places Mr. James and his surveying party had even to encounter personal violence. At St. Helen's, one of the chainmen was laid hold of by a mob of

colliers, and threatened to be hurled down a coal-pit. A number of men, women, and children assembled, and ran after the surveyors wherever they made their appearance, bawling nicknames and throwing stones at them. As one of the chainmen was climbing over a gate one day, a labourer made at him with a pitchfork, and ran it through his clothes into his back; other watchers running up, the chainman, who was more stunned than hurt, took to his heels and fled. But that mysterious-looking instrument—the theodolite—most

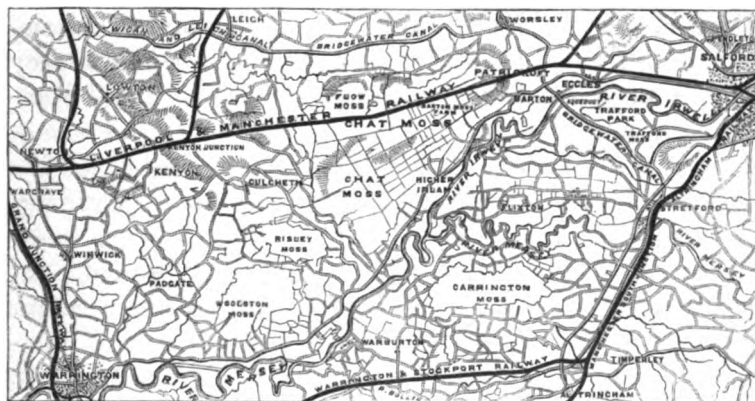


MAP OF LIVERPOOL AND MANCHESTER RAILWAY. [Western Part.]

excited the fury of the natives, who concentrated on the man who carried it their fiercest execrations and most offensive nicknames.

A powerful fellow, a noted bruiser, was hired by the surveyors to carry the instrument, with a view to its protection against all assailants; but one day an equally powerful fellow, a St. Helen's collier, cock of the walk in his neighbourhood, made up to the theodolite bearer to wrest it from him by sheer force. A battle took place, the collier was soundly pummelled, but the natives poured in volleys of stones upon the surveyors and their instruments, and the theodolite was smashed in pieces.

Met by these and other obstructions, it turned out that the survey could not be completed in time for depositing the proper plans, and the intended application to Parliament in the next session could not be made. In the mean time Mr. James proceeded to Killingworth to see Stephenson's locomotives at work. Stephenson was not at home at the time, but James saw his engines, and was very much struck by their power and efficiency. He saw at a glance the magnificent uses to which the locomotive might be applied.



MAP OF LIVERPOOL AND MANCHESTER RAILWAY [Eastern Part]

"Here," said he, "is an engine that will, before long, effect a complete revolution in society." Returning to Moreton-in-the-Marsh, he wrote to Mr. Losh (Stephenson's partner in the patent) expressing his admiration of the Killingworth engine. "It is," said he, "the greatest wonder of the age, and the forerunner, as I firmly believe, of the most important changes in the internal communications of the kingdom." Shortly after, Mr. James, accompanied by his two sons, made a second journey to Killingworth, where he met both Losh and Stephenson. The visitors were at once taken to where one of the locomotives was working, and invited to "jump up." The uncouth and extraordinary appear-

rance of the machine, as it came snorting along, was somewhat alarming to the youths, who expressed their fears lest it should burst; and they were with some difficulty induced to mount.

The engine went through its usual performances, dragging a heavy load of coal-waggon at about six miles an hour with apparent ease, at which Mr. James expressed his extreme satisfaction, and declared to Mr. Losh his opinion that Stephenson "was the greatest practical genius of the age," and that, "if he developed the full powers of that engine (the locomotive), his fame in the world would rank equal with that of Watt." Mr. James informed Stephenson and Losh of his survey of the proposed tramroad between Liverpool and Manchester, and did not hesitate to state that he would thenceforward advocate the construction of a locomotive railroad instead of the tramroad which had originally been proposed.

Stephenson and Losh were naturally desirous of enlisting James's good services on behalf of their patent locomotive, for as yet it had proved comparatively unproductive. They believed that he might be able so to advocate it in influential quarters as to ensure its more extensive adoption, and with that object they proposed to give him an interest in the patent. Accordingly, they entered into an agreement by which they assigned to him one-fourth of any profits which might be derived from the use of the patent locomotive on any railways constructed south of a line drawn across England from Liverpool to Hull. The arrangement, however, led to no beneficial results. Mr. James endeavoured to introduce the engine on the Moreton-on-Marsh Railway; but it was opposed by the engineer of the line, and the attempt failed. He next urged that a locomotive should be sent for trial upon the Merstham tramroad; but, anxious though Stephenson was as to its extended employment, he was too cautious to risk an experiment

which might bring discredit upon the engine; and the Merstham road being only laid with cast-iron plates which would not bear its weight, the invitation was declined.

The first survey made of the Liverpool and Manchester line having been found very imperfect, it was determined to have a second and more complete one made in the following year. Robert Stephenson, though then a lad of only nineteen, had already obtained some practical knowledge of surveying, having been engaged on the preliminary survey of the Stockton and Darlington Railway in the previous year; and he was sent over to Liverpool by his father to give Mr. James such assistance as he could. Robert Stephenson was present with Mr. James on the occasion on which he tried to lay out the line across Chat Moss,—a proceeding which was not only difficult but dangerous. The Moss was very wet at the time, and only its edges could be ventured on. Mr. James was a heavy, thick-set man; and one day, when endeavouring to obtain a stand for his theodolite, he felt himself suddenly sinking. He immediately threw himself down, and rolled over and over until he reached firm ground again, in a sad mess. Other attempts which he subsequently made to advance into the Moss for the same purpose were abandoned for the same reason—the want of a solid stand for the theodolite.

As Mr. James proceeded with his survey, he found a host of opponents springing up in all directions, some of whom he conciliated by deviations, but others refused to be conciliated on any terms. Among these last were Lords Derby and Wilton, Mr. Bradshaw, and the Strafford family. The proposed line passed through their lands, and, regarding it as a nuisance, without the slightest compensating advantage to them, they determined to oppose it at every stage. Their agents drove the surveyors off their land; the farmers set men

at the gates armed with pitchforks to resist their progress; and the survey proceeded with great difficulty. Mr. James endeavoured to avoid Lord Derby's Knowsley estate, but as he had received instructions from Messrs. Ewart and Gladstone to lay out the line so as to enable it to be extended to the docks, he found it difficult to accomplish this object and at the same time avert the hostility of the noble lord. The only large landowners who gave the scheme their support were Mr. Legh and Mr. Wyrley Birch, who not only subscribed for shares but attended several public meetings, and spoke in favour of the proposed railroad. Public opinion was, however, beginning to be roused, and the canal companies began at length to feel alarmed.

"At Manchester," Mr. James wrote to Mr. Sandars, "the subject engages all men's thoughts, and it is curious as well as amusing to hear their conjectures. The canal companies (southward) are alive to their danger. I have been the object of their persecution and hate; they would immolate me if they could; but if I can die the death of Samson, by pulling away the pillars, I am content to die with these Philistines. Be assured, my dear sir, that not a moment shall be lost, nor shall my attention for a day be diverted from this concern, which increases in importance every hour, as well as in the certainty of ultimate success."

Mr. James was one of the most enthusiastic of men—especially about railways and locomotives. He believed, with Thomas Gray, who brought out his book about this time, that railways were yet to become the great highroads of civilisation. The speculative character of the man may be inferred from the following passage in one of his letters to Mr. Sandars, written from London :—

"Every Parliamentary friend I have seen—and I have many of both Houses—eulogises our plan, and they are particularly anxious that engines should be introduced in the south. I am now negotiating about the Wandsworth Railroad. A fortune is

to be made by buying the shares, and introducing the engine system upon it. I am confident capital will treble itself in two years. I do not choose to publish my views *here*, and I wish to God some of our Liverpool friends would take this advantage. I have bought some shares, but my capital is locked up in unproductive lands and mines."

As the survey of the Liverpool and Manchester line proceeded, Mr. James's funds fell short, and he was under the necessity of applying to Mr. Sandars and his friends from time to time for further contributions. It was also necessary for him to attend to his business as a surveyor in other parts of the country, and he was at such times under the necessity of leaving the work to be done by his assistants. Thus the survey was necessarily imperfect, and when the time arrived for lodging the plans, it was found that they were practically worthless. Mr. James's pecuniary difficulties had also reached their climax. "The surveys and plans," he wrote to Mr. Sandars, "can't be completed, I see, till the end of the week. With illness, anguish of mind, and inexpressible distress, I perceive I must sink if I wait any longer; and, in short, I have so long neglected the suit in Chancery I named to you, that if I do not put in an answer I shall be outlawed."

Mr. James's embarrassments increased, and he was unable to shake himself free from them. He was confined for many months in the Queen's Bench prison; during which time this indefatigable railway propagandist wrote an essay illustrative of the advantages of direct inland communication by a line of engine railroad, between London, Brighton, and Portsmouth. Meanwhile the Liverpool and Manchester scheme seemed to have fallen to the ground. But it only slept. When its promoters found that they could no longer rely on Mr. James's services, they determined to employ another engineer.

Mr. Sandars had by this time visited George Stephen-

son at Killingworth, and, like all who came within reach of his personal influence, was charmed with him at first sight. The energy which he had displayed in carrying on the works of the Stockton and Darlington Railway, now approaching completion; his readiness to face difficulties, and his practical ability in overcoming them; the enthusiasm which he displayed on the subject of railways and railway locomotion,—concurred in satisfying Mr. Sandars that he was, of all men, the best calculated to help forward the undertaking at this juncture; and having, on his return to Liverpool, reported this opinion to the Committee, they approved his recommendation, and George Stephenson was unanimously appointed engineer of the projected railway. On the 25th of May, 1824, Mr. Sandars wrote to Mr. James as follows :—

“I think it right to inform you that the Committee have engaged your friend George Stephenson. We expect him here in a few days. The subscription-list for 300,000*l.* is filled, and the Manchester gentlemen have conceded to us the entire management. I very much regret that, by delays and promises, you have forfeited the confidence of the subscribers. I cannot help it. I fear now that you will only have the fame of being connected with the commencement of this undertaking.”

It will be observed that Mr. Sandars had held to his original purpose with great determination and perseverance, and he gradually succeeded in enlisting on his side an increasing number of influential merchants and manufacturers both at Liverpool and Manchester. Early in 1824 he published a pamphlet, in which he strongly urged the great losses and interruptions to the trade of the district by the delays in the forwarding of merchandise; and in the same year he had a Public Declaration drawn up, and signed by upwards of 150 of the principal merchants of Liverpool, setting forth that they considered “the present establishments for the transport of goods quite inadequate, and that a new

line of conveyance has become absolutely necessary to conduct the increasing trade of the country with speed, certainty, and economy."

A public meeting was then held to consider the best plan to be adopted, and resolutions were passed in favour of a railroad. A committee was appointed to take the necessary measures; but, as if reluctant to enter upon their arduous struggle with the "vested interests," they first waited on Mr. Bradshaw, the Duke of Bridgewater's canal agent, in the hope of persuading him to increase the means of conveyance, as well as to reduce the charges; but they were met by an unqualified refusal. He would not improve the existing means of conveyance; he would have nothing to do with the proposed railway; and if persevered in he would oppose it with all his power. The canal proprietors, confident in their imagined security, ridiculed the proposed railway as a chimera. It had been spoken about years before, and nothing had come of it then: it would be the same now.

In order to form a better opinion as to the practicability of the railroad, a deputation of gentlemen interested in the project proceeded to Killingworth to inspect the engines which had been so long in use there. They first went to Darlington, where they found the works of the Stockton line in progress, though still unfinished. Proceeding next to Killingworth with George Stephenson, they there witnessed the performances of his locomotive engines. The result of their visit was, on the whole, so satisfactory, that on their return to Liverpool it was determined to form a company of proprietors for the construction of a double line of railway between Liverpool and Manchester.

The original promoters of the undertaking included men of the highest standing and local influence in Liverpool and Manchester, with Charles Lawrence as chairman, Lister Ellis, Robert Gladstone, John Moss,

and Joseph Sandars as deputy-chairmen ; while amongst the ordinary members of the committee were Robert Benson, James Cropper, John Ewart, Wellwood Maxwell, and William Rathbone of Liverpool ; and the brothers Birley, Peter Ewart, William Garnett, John Kennedy, and William Potter, of Manchester.

The Committee also included another important name—that of Henry Booth, then a corn merchant of Liverpool, and afterwards the secretary and manager of the Liverpool and Manchester Railway. Mr. Booth was a man of admirable business qualities, sagacious and far-seeing, shrewd and practical, of considerable literary ability, and he also possessed a knowledge of mechanics, which afterwards proved of the greatest value to the railway interest ; for to him we owe the suggestion of the multi-tubular boiler in the form in which it has since been employed upon all railways, and the coupling-screw, as well as other important mechanical appliances which have come into general use.

The first prospectus, issued in October, 1824, set forth in clear and vigorous language the objects of the Company, the urgent need of additional means of communication between Liverpool and Manchester, and the advantages offered by the railway over all other proposed expedients. It was shown that the water-carriers not only exacted the most arbitrary terms from the public, but were positively unable to carry the traffic requiring accommodation. Against the indefinite continuance or recurrence of those evils, said the prospectus, the public have but one security :—"It is competition that is wanted ; and the proof of this assertion may be adduced from the fact, that shares in the Old Quay Navigation, of which the original cost was 70*l.*, have been sold as high as 1250*l.* each !" The advantages of the railway over the canals for the carriage of coals was also urged, and it was stated that the charge for transit would be very materially reduced.

“In the present state of trade and of commercial enterprise (the prospectus proceeded), despatch is no less essential than economy. Merchandise is frequently brought across the Atlantic from New York to Liverpool in twenty-one days; while, owing to the various causes of delay above enumerated, goods have in some instances been longer on their passage from Liverpool to Manchester. But this reproach must not be perpetual. The advancement in mechanical science renders it unnecessary—the good sense of the community makes it impossible. Let it not, however, be imagined that, were England to be tardy, other countries would pause in the march of improvement. Application has been made, on behalf of the Emperor of Russia, for models of the locomotive engine; and other of the continental Governments have been duly apprised of the important schemes for the facilitating of inland traffic, now under discussion by the British public. In the United States of America, also, they are fully alive to the important results to be anticipated from the introduction of railroads; a gentleman from the United States having recently arrived in Liverpool, with whom it is a principal object to collect the necessary information in order to the establishment of a railway to connect the great rivers Potomac and Ohio.”

It will be observed that the principal, indeed almost the sole, object contemplated by the projectors of the undertaking, was the improved carriage of merchandise and coal; and that the conveyance of passengers was scarcely calculated on, the only paragraph in the prospectus relating to the subject being the following:—“Moreover, as a cheap and expeditious means of conveyance for travellers, the railway holds out the fair prospect of a public accommodation, the magnitude and importance of which cannot be immediately ascertained.” The estimated expense of forming the line was set down at 400,000*l.*—a sum which was eventually found quite inadequate. The subscription list when opened, was filled up without difficulty.

While the project was still under discussion, its promoters, desirous of removing the doubts which existed

as to the employment of steam-power on the proposed railway, sent a second deputation to Killingworth for the purpose of again observing the action of Stephenson's engines. The cautious projectors of the railway were not yet quite satisfied; and a third journey was made to Killingworth, in January, 1825, by several gentlemen of the Committee, accompanied by practical engineers, for the purpose of being personal eye-witnesses of what steam-carriages were able to perform upon a railway. There they saw a train, consisting of a locomotive and loaded waggons, weighing in all 54 tons, travelling at the average rate of about 7 miles an hour, the greatest speed being about  $9\frac{1}{2}$  miles an hour. But when the engine was run with only one waggon attached containing twenty gentlemen, five of whom were engineers, the speed attained was from 10 to 12 miles an hour.

In the mean time the survey was proceeded with, in the face of great opposition on the part of the proprietors of the lands through which the railway was intended to pass. The prejudices of the farming and labouring classes were strongly excited against the persons employed upon the ground, and it was with the greatest difficulty that the levels could be taken. This opposition was especially manifested when the attempt was made to survey the line through the properties of Lords Derby and Sefton, and also where it crossed the Duke of Bridgewater's canal. At Knowsley, Stephenson and his surveyors were driven off the ground by the keepers, and threatened with rough handling if found there again. Lord Derby's farmers also turned out their men to watch the surveying party, and prevent them entering on any lands where they had the power of driving them off. Afterwards, Stephenson suddenly and unexpectedly went upon the ground with a body of surveyors and their assistants, who out-numbered

Lord Derby's keepers and farmers, hastily collected to resist them; and this time they were only threatened with the legal consequences of their trespass.

The same sort of resistance was offered by Lord Sefton's keepers and farmers, with whom the following ruse was adopted. A minute was concocted, purporting to be a resolution of the Old Quay Canal Company to oppose the projected railroad by every possible means, and calling upon landowners and others to afford every facility for making such a survey of the intended line as should enable the opponents to detect errors in the scheme of the promoters, and thereby ensure its defeat. A copy of this minute, without any signature, was exhibited by the surveyors who went upon the ground, and the farmers, believing them to have the sanction of the landlords, permitted them to proceed with the hasty completion of their survey.

The principal opposition, however, was experienced from Mr. Bradshaw, the manager of the Duke of Bridgewater's canal property, who offered a vigorous and protracted resistance to the survey in all its stages. The Duke's farmers obstinately refused permission to enter upon their fields, although Stephenson offered to pay for any damage that might be done. Mr. Bradshaw positively refused his sanction in any case; and being a strict preserver of game, with a large staff of keepers in his pay, he declared that he would order them to shoot or apprehend any persons attempting a survey over his property. But one moonlight night a survey was effected by the following ruse. Some men, under the orders of the surveying party, were set to fire off guns in a particular quarter; on which all the gamekeepers on the watch made off in that direction, and they were drawn away to such a distance in pursuit of the supposed poachers, as to enable a rapid survey to be made during their absence. Describing before Parliament the difficulties which he encountered

in making the survey, Stephenson said :—"I was threatened to be ducked in the pond if I proceeded, and, of course, we had a great deal of the survey to take by stealth, at the time when the people were at dinner. We could not get it done by night; indeed, we were watched day and night, and guns were discharged over the grounds belonging to Captain Bradshaw to prevent us. I can state further that I was myself twice turned off Mr. Bradshaw's grounds by his men, and they said if I did not go instantly, they would take me up and carry me off to Worsley."

The same kind of opposition had to be encountered all along the line of the intended railway. Mr. Clay, one of the Company's solicitors, wrote to Mr. Sandars from the Bridgewater Arms, Prescott, on the 31st December, that the landlords, occupiers, trustees of turnpike-roads, proprietors of bleachworks, carriers and carters, and even the coal-owners, were dead against the railroad. "In a word," said he, "the country is up in arms against us." There were only three considerable landowners who remained doubtful; and "if these be against us," said Mr. Clay, "then *the whole* of the great proprietors along the whole line are dissentient, excepting only Mr. Trafford."

The cottagers and small proprietors were equally hostile. "The trouble we have with them," wrote Mr. Clay, "is beyond belief; and those patches of gardens at the end of Manchester bordering on the Irwell, and the tenants of Hulme Hall, who, though insignificant, must be seen, give us infinite trouble; all of which, as I have reason to believe, is by no means accidental." There was also the opposition of the great Bradshaw, the Duke's agent. "I wrote you this morning," said Mr. Clay in a wrathful letter of the same date; "since which we have been into Bradshaw's warehouse, now called the Knot Mill, and, after traversing two of the rooms, we got very *civilly* turned out, which, under all

the circumstances, I thought very lucky and more than we deserved. However we have seen more than half of his d—d cottagers.”

There were also the canal companies, who made common cause, formed a common purse, and determined to wage war to the knife against all railways. The following circular, issued by the Liverpool Railroad Company, with the name of Mr. Lawrence, the chairman, attached, will serve to show the resolute spirit in which the canal proprietors were preparing to resist the Bill :—

“Sir,—the Leeds and Liverpool, the Birmingham, the Grand Trunk, and other canal companies having issued circulars, calling upon ‘every canal and navigation company in the kingdom’ to oppose *in limine* and by a united effort the establishment of railroads wherever contemplated, I have most earnestly to solicit your active exertions on behalf of the Liverpool and Manchester Railroad Company, to counteract the avowed purpose of the canal proprietors, by exposing the misrepresentations of interested parties, by conciliating good will, and especially by making known, as far as you have opportunity, not only the general superiority of railroads over other modes of conveyance, but in our peculiar case the absolute necessity of a new and additional line of communication, in order to effect with economy and despatch the transport of merchandise between this port and Manchester.—(Signed) CHARLES LAWRENCE, Chairman.”

Such was the state of affairs and such the threatenings of war on both sides immediately previous to the Parliamentary session of 1825.

When it became known that the promoters of the undertaking were determined,—imperfect though the plans were believed to be, from the obstructions thrown in the way of the surveying parties,—to proceed with the Bill in the next session of Parliament, the canal companies appealed to the public through the press. Pamphlets were published and newspapers hired to revile the railway. It was declared that its formation would prevent the cows grazing and hens laying, while the horses passing along the road would be driven dis-

tracted. The poisoned air from the locomotives would kill the birds that flew over them, and render the preservation of pheasants and foxes no longer possible. Householders adjoining the projected line were told that their houses would be burnt up by the fire thrown from the engine-chimneys: while the air around would be polluted by clouds of smoke. There would no longer be any use for horses; and if railways extended, the species would become extinguished, and oats and hay be rendered unsaleable commodities. Travelling by rail would be highly dangerous, and country inns would be ruined. Boilers would burst and blow passengers to atoms. But there was always this consolation to wind up with—that the weight of the locomotive would completely prevent its moving, and that railways, even if made, could *never* be worked by steam-power.

Although the press generally spoke of the Liverpool and Manchester project as a mere speculation—as only one of the many bubble schemes of the period<sup>1</sup>—there were other writers who entertained different views, and boldly and ably announced them. Among the most sagacious newspaper articles of the day, calling attention to the application of the locomotive engine to the purposes of rapid steam-travelling on railroads, was a series which appeared in 1824, in the ‘Scotsman’ newspaper, then edited by Mr. Charles Maclaren. In those publications the wonderful powers of the locomotive were logically demonstrated, and the writer, arguing from the experiments on friction made more than half a century before by Vince and Coulomb, which scientific men seemed to have altogether lost sight of, clearly showed that, by the

<sup>1</sup> “Many years ago I met in a public library with a bulky volume, consisting of the prospectuses of various projects bound up together, and labelled, ‘Some of the bubbles of 1825.’ Among the projects thus described, was one that has since been productive of the greatest and most

rapid advance in the social condition of mankind effected since the first dawn of civilisation: it was the plan of the Company for constructing a railway between Liverpool and Manchester.” —W. B. Hodge, in ‘Journal of the Institute of Actuaries,’ No. 40, July, 1860.

use of steam-power on railroads, the cheaper as well as more rapid transit of persons and merchandise might be confidently anticipated.

Not many years passed before the anticipations of the writer, sanguine and speculative though they were at that time regarded, were amply realised. Even Mr. Nicholas Wood, in 1825, speaking of the powers of the locomotive, and referring doubtless to the speculations of the 'Scotsman' as well as of his equally sanguine friend Stephenson, observed :—"It is far from my wish to promulgate to the world that the ridiculous expectations, or rather professions, of the enthusiastic speculist will be realised, and that we shall see engines travelling at the rate of twelve, sixteen, eighteen, or twenty miles an hour. Nothing could do more harm towards their general adoption and improvement than the promulgation of such nonsense."<sup>1</sup>

Among the papers left by Mr. Sandars we find a letter addressed to him by Sir John Barrow of the Admiralty, as to the proper mode of conducting the case in Parliament, which pretty accurately represents the state of public opinion as to the practicability of locomotive travelling on railroads, at the time at which it was written, the 10th of January, 1825. Sir John strongly urged Mr. Sandars to keep the locomotive altogether in the background,—to rely upon the proved inability of the canals and common roads to accommodate the existing traffic,—and to be satisfied with proving the absolute necessity of a new line of conveyance; above all, he recommended him not even to hint at the intention of carrying passengers.

"You will at once," said he, "raise a host of enemies in the proprietors of coaches, post-chaises, innkeepers, &c., whose interests will be attacked, and who, I have no doubt, will be strongly supported, and for what? Some thousands of passengers, *you* say—but a few hundreds *I* should say—in the year."

He accordingly urged that *passengers* as well as *speed*

<sup>1</sup> 'Wood on Railroads.' Ed. 1825, p. 290.

should be kept entirely out of the Act; but if the latter were insisted on, then he recommended that it should be kept as low as possible—say at five miles an hour!

Indeed, when George Stephenson, at the interviews with counsel held previous to the Liverpool and Manchester Bill going into Committee of the House of Commons, confidently stated his expectation of being able to run his locomotive at the rate of twenty miles an hour, Mr. William Brougham, who was retained by the promoters to conduct their case, frankly told him that if he did not moderate his views, and bring his engine within a *reasonable* speed, he would “inevitably damn the whole thing, and be himself regarded as a maniac fit only for Bedlam.”

The idea thrown out by Stephenson, of travelling at a rate of speed double that of the fastest mail-coach, appeared at the time so preposterous that he was unable to find any engineer who would risk his reputation in supporting such “absurd views.” Speaking of his isolation at the time, he subsequently observed, at a public meeting of railway men in Manchester: “He remembered the time when he had very few supporters in bringing out the railway system—when he sought England over for an engineer to support him in his evidence before Parliament, and could find only one man, James Walker, but was afraid to call that gentleman, because he knew nothing about railways. He had then no one to tell his tale to but Mr. Sandars, of Liverpool, who did listen to him, and kept his spirits up; and his schemes had at length been carried out only by dint of sheer perseverance.”

George Stephenson's idea was at that time regarded as but the dream of a chimerical projector. It stood before the public friendless, struggling hard to gain a footing, scarcely daring to lift itself into notice for fear of ridicule. The civil engineers generally rejected the notion of a Locomotive Railway; and when no leading man of the day could be found to stand forward in sup-

port of the Killingworth mechanic, its chances of success must indeed have been pronounced but small.

When such was the hostility of the civil engineers, no wonder the reviewers were puzzled. The 'Quarterly,' in an able article in support of the projected Liverpool and Manchester Railway,—while admitting its *absolute necessity*, and insisting that there was no choice left but a railroad, on which the journey between Liverpool and Manchester, whether performed by horses or engines, would always be accomplished "within the day,"—nevertheless scouted the idea of travelling at a greater speed than eight or nine miles an hour. Adverting to a project for forming a railway to Woolwich, by which passengers were to be drawn by locomotive engines moving with twice the velocity of ordinary coaches, the reviewer observed:—"What can be more palpably absurd and ridiculous than the prospect held out of locomotives travelling *twice as fast* as stage coaches! We would as soon expect the people of Woolwich to suffer themselves to be fired off upon one of Congreve's ricochet rockets, as trust themselves to the mercy of such a machine going at such a rate. We will back old Father Thames against the Woolwich Railway for any sum. We trust that Parliament will, in all railways it may sanction, limit the speed to *eight or nine miles an hour*, which we entirely agree with Mr. Sylvester is as great as can be ventured on with safety."



SURVEYING ON CHAT MOSS

## CHAPTER X.

PARLIAMENTARY CONTEST ON THE LIVERPOOL AND  
MANCHESTER BILL.

THE Liverpool and Manchester Bill went into Committee of the House of Commons on the 21st of March, 1825. There was an extraordinary array of legal talent on the occasion, but especially on the side of the opponents to the measure. Their wealth and influence enabled them to retain the ablest counsel at the bar; Mr. (afterwards Baron) Alderson, Mr. Stephenson, Mr. (afterwards Baron) Parke, Mr. Rose, Mr. Macdonnell, Mr. Harrison, Mr. Erle, and Mr. Cullen, appeared for various clients, who made common cause with each other in opposing the Bill; the case for which was conducted by Mr. Adam, Mr. Serjeant Spankie, Mr. William Brougham, and Mr. Joy.

Evidence was taken at great length as to the difficulties and delays in forwarding raw goods of all kinds from Liverpool to Manchester, as also in the conveyance of manufactured articles from Manchester to Liverpool. The evidence adduced in support of the bill on these grounds was overwhelming. The utter inadequacy of the existing modes of conveyance to carry on satisfactorily the large and rapidly-growing trade between the two towns was fully proved. But then came the main difficulty of the promoters' case,—that of proving the practicability of constructing a railroad to be worked by locomotive power. Mr. Adam, in his opening speech, referred to the cases of the Hetton and the Killingworth railroads, where heavy goods were safely and economically transported by means of locomotive engines.

“None of the tremendous consequences,” he observed, “have ensued from the use of steam in land carriage that have been stated. The horses have not started, nor the cows ceased to give their milk, nor have ladies miscarried at the sight of these things going forward at the rate of four miles and a half an hour.” Notwithstanding the petition of two ladies alleging the great danger to be apprehended from the bursting of the locomotive boilers, he urged the safety of the high-pressure engine when the boilers were constructed of wrought iron; and as to the rate at which they could travel, he expressed his full conviction that such engines “could supply force to drive a carriage at the rate of five or six miles an hour.”

The taking of the evidence as to the impediments thrown in the way of trade and commerce by the existing system extended over a month, and it was the 21st of April before the Committee went into the engineering evidence, which was the vital part of the question.

On the 25th, George Stephenson was called into the witness-box. It was his first appearance before a Committee of the House of Commons, and he well knew what he had to expect. He was aware that the whole force of the opposition was to be directed against him; and if they could break down his evidence, the canal monopoly might yet be upheld for a time. Many years afterwards, when looking back at his position on this trying occasion, he said:—“When I went to Liverpool to plan a line from thence to Manchester, I pledged myself to the directors to attain a speed of ten miles an hour. I said I had no doubt the locomotive might be made to go much faster, but that we had better be moderate at the beginning. The directors said I was quite right; for that if, when they went to Parliament, I talked of going at a greater rate than ten miles an hour, I should put a cross upon the concern. It was not an easy task for me to keep the engine down to ten miles

an hour, but it must be done, and I did my best. I had to place myself in that most unpleasant of all positions—the witness-box of a Parliamentary Committee. I was not long in it, before I began to wish for a hole to creep out at! I could not find words to satisfy either the Committee or myself. I was subjected to the cross-examination of eight or ten barristers, purposely, as far as possible, to bewilder me. Some member of the Committee asked *if I was a foreigner*,<sup>1</sup> and another hinted that *I was mad*. But I put up with every rebuff, and went on with my plans, determined not to be put down.”

George Stephenson stood before the Committee to prove what the public opinion of that day held to be impossible. The self-taught mechanic had to demonstrate the practicability of accomplishing that which the most distinguished engineers of the time regarded as impracticable. Clear though the subject was to himself, and familiar as he was with the powers of the locomotive, it was no easy task for him to bring home his convictions, or even to convey his meaning, to the less informed minds of his hearers. In his strong Northumbrian dialect, he struggled for utterance, in the face of the sneers, interruptions, and ridicule of the opponents of the measure, and even of the Committee, some of whom shook their heads and whispered doubts as to his sanity, when he energetically avowed that he could make the locomotive go at the rate of twelve miles an hour! It was so grossly in the teeth of all the experience of

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<sup>1</sup> George's Northumberland “burr” was so strong that it rendered him almost unintelligible to persons who were unfamiliar with it; and he had even thoughts of going to school again, for the purpose, if possible, of getting rid of it. In the year 1823, when Stephenson was forty-two years of age, we find his friend Thomas Richardson, of Lombard Street, writing to Samuel Thoroughgood, a schoolmaster at Peckham, as follows:—“Dear Friend,

My friend George Stephenson, a man of first-rate abilities as an engineer, but of little or no education, wants to consult thee or some other person to see if he cannot improve himself,—he has so much Northumberland dialect, &c. He will be at my house on sixth day next, about five o'clock, if thou could make it convenient to see him. Thy assured friend, THOS. RICHARDSON.”

honourable members, that the man "must certainly be labouring under a delusion!"

And yet his large experience of railways and locomotives, as described by himself to the Committee, entitled this "untaught, inarticulate genius," as he has been described, to speak with confidence on the subject. Beginning with his experience as a brakesman at Killingworth in 1803, he went on to state that he was appointed to take the entire charge of the steam-engines in 1813, and had superintended the railroads connected with the numerous collieries of the Grand Allies from that time downwards. He had laid down or superintended the railways at Burradon, Mount Moor, Springwell, Bedlington, Hetton, and Darlington, besides improving those at Killingworth, South Moor, and Derwent Crook. He had constructed fifty-five steam-engines, of which sixteen were locomotives. Some of these had been sent to France. The engines constructed by him for the working of the Killingworth Railroad, eleven years before, had continued steadily at work ever since, and fulfilled his most sanguine expectations. He was prepared to prove the safety of working high-pressure locomotives on a railroad, and the superiority of this mode of transporting goods over all others. As to speed, he said he had recommended eight miles an hour with twenty tons, and four miles an hour with forty tons; but he was quite confident that much more might be done. Indeed, he had no doubt they might go at the rate of twelve miles. As to the charge that locomotives on a railroad would so terrify the horses in the neighbourhood, that to travel on horseback or to plough the adjoining fields would be rendered highly dangerous, the witness said that horses learnt to take no notice of them, though there *were* horses that would shy at a wheelbarrow. A mail coach was likely to be more shied at by horses than a locomotive. In the neighbourhood of Killingworth, the cattle in the fields went on grazing while

the engines passed them, and the farmers made no complaints.

Mr. Alderson, who had carefully studied the subject, and was well skilled in practical science, subjected the witness to a protracted and severe cross-examination as to the speed and power of the locomotive, the stroke of the piston, the slipping of the wheels upon the rails, and various other points of detail. Stephenson insisted that no slipping took place, as attempted to be extorted from him by the counsel. He said: "It is impossible for slipping to take place so long as the adhesive weight of the wheel upon the rail is greater than the weight to be dragged after it." There was a good deal of interruption to the witness's answers by Mr. Alderson, to which Mr. Joy more than once objected. As to accidents, Stephenson knew of none that had occurred with his engines. There had been one, he was told, at the Middleton Colliery, near Leeds, with a Blenkinsop engine. The driver had been in liquor, and put a considerable load on the safety-valve, so that upon going forward the engine blew up and the man was killed. But he added, if proper precautions had been used with that boiler, the accident could not have happened. The following cross-examination occurred in reference to the question of speed:—

"Of course," he was asked, "when a body is moving upon a road, the greater the velocity the greater the momentum that is generated?" "Certainly."—"What would be the momentum of forty tons moving at the rate of twelve miles an hour?" "It would be very great."—"Have you seen a railroad that would stand that?" "Yes."—"Where?" "Any railroad that would bear going four miles an hour: I mean to say, that if it would bear the weight at four miles an hour, it would bear it at twelve."—"Taking it at four miles an hour, do you mean to say that it would not require a stronger railway to carry the same weight twelve miles

an hour?" "I will give an answer to that. I dare say every person has been over ice when skating, or seen persons go over, and they know that it would bear them better at a greater velocity than it would if they went slower; when they go quick, the weight in a measure ceases."—"Is not that upon the hypothesis that the railroad is perfect?" "It is; and I mean to make it perfect."

It is not necessary to state that to have passed through his severe ordeal scathless, needed no small amount of courage, intelligence, and ready shrewdness on the part of the witness. Nicholas Wood, who was present on the occasion, has since stated that the point on which Stephenson was hardest pressed was that of speed. "I believe," he says, "that it would have lost the Company their bill if he had gone beyond eight or nine miles an hour. If he had stated his intention of going twelve or fifteen miles an hour, not a single person would have believed it to be practicable." Mr. Alderson, had, indeed, so pressed the point of "twelve miles an hour," and the promoters were so alarmed lest it should appear in evidence that they contemplated any such extravagant rate of speed, that immediately on Mr. Alderson sitting down, Mr. Joy proceeded to re-examine Stephenson, with the view of removing from the minds of the Committee an impression so unfavourable, and, as they supposed, so damaging to their case. "With regard," asked Mr. Joy, "to all those hypothetical questions of my learned friend, they have been all put on the supposition of going twelve miles an hour: now that is not the rate at which, I believe, any of the engines of which you have spoken have travelled?" "No," replied Stephenson, "except as an experiment for a short distance."—"But what they have gone has been three, five, or six miles an hour?" "Yes."—"So that those hypothetical cases of twelve miles an hour do not fall within your general experience?" "They do not."

The Committee also seem to have entertained some alarm as to the high rate of speed which had been spoken of, and proceeded to examine the witness further on the subject. They supposed the case of the engine being upset when going at nine miles an hour, and asked what, in such a case, would become of the cargo astern. To which the witness replied that it would not be upset. One of the members of the Committee pressed the witness a little further. He put the following case:—"Suppose, now, one of these engines to be going along a railroad at the rate of nine or ten miles an hour, and that a cow were to stray upon the line and get in the way of the engine; would not that, think you, be a very awkward circumstance?" "Yes," replied the witness, with a twinkle in his eye, "very awkward—for the coo!" The honourable member did not proceed further with his cross-examination; to use a railway phrase, he was "shunted." Another asked if animals would not be very much frightened by the engine passing at night, especially by the glare of the red-hot chimney? "But how would they know that it wasn't painted?" said the witness.

On the following day (the 26th April), the engineer was subjected to a most severe examination. On that part of the scheme with which he was most practically conversant, his evidence was clear and conclusive. Now, he had to give evidence on the plans made by his surveyors, and the estimates which had been founded on those plans. So long as he was confined to locomotive engines and iron railroads, with the minutest details of which he was more familiar than any man living, he felt at home, and in his element. But when the designs of bridges and the cost of constructing them had to be gone into, the subject being comparatively new to him, his evidence was much less satisfactory.

He was cross-examined as to the practicability of forming a road on so unstable a foundation as Chat Moss.

"Now, with respect to your evidence upon Chat Moss," asked Mr. Alderson, "did you ever walk on Chat Moss on the proposed line of the railway?—The greater part of it, I have.

"Was it not extremely boggy?—In parts it was.

"How deep did you sink in?—I could have gone with shoes; I do not know whether I had boots on.

"If the depth of the Moss should prove to be 40 feet instead of 20, would not this plan of the railway over this Moss be impracticable?—No, it would not. If the gentlemen will allow me, I will refer to a railroad belonging to the Duke of Portland, made over a moss; there are no levels to drain it properly, such as we have at Chat Moss, and it is made by an embankment over the moss, which is worse than making a cutting, for there is the weight of the embankment to press upon the moss.

"Still, you must go to the bottom of the moss?—It is not necessary; the deeper you get, the more consolidated it is.

"Would you put some hard materials on it before you commenced?—Yes, perhaps I should.

"What?—Brushwood, perhaps.

"And you, then, are of opinion that it would be a solid embankment?—It would have a tremulous motion for a time, but would not give way, like clay."

Mr. Alderson also cross-examined him at great length on the plans of the bridges, the tunnels, the crossings of the roads and streets, and the details of the survey, which, it soon appeared, were in some respects seriously at fault. It seems that, after the plans had been deposited, Stephenson found that a much more favourable line might be laid out; and he made his estimates accordingly, supposing that Parliament would not confine the Company to the precise plan which had been deposited. This was felt to be a serious blot in the parliamentary case, and one very difficult to get over.

For three entire days was our engineer subjected to cross-examination by Mr. Alderson, Mr. Cullen, and the other leading counsel for the opposition. He held his ground bravely, and defended the plans and estimates with remarkable ability and skill; but it was clear they were imperfect, and the result was on the

whole damaging to the bill. Mr. (afterwards Sir William) Cubitt was called by the promoters,—Mr. Adam stating that he proposed by this witness to correct some of the levels as given by Stephenson. It seems a singular course to have been taken by the promoters of the measure; for Mr. Cubitt's evidence went to upset the statements made by Stephenson as to the survey. This adverse evidence was, of course, made the most of by the opponents of the scheme.

Mr. Serjeant Spankie then summed up for the Bill, on the 2nd of May, in a speech of great length; and the case of the opponents was next gone into, Mr. Harrison opening with a long and eloquent speech on behalf of his clients, Mrs. Atherton and others. He indulged in strong vituperation against the witnesses for the Bill, and especially dwelt upon the manner in which Mr. Cubitt, for the promoters, had proved that Stephenson's levels were wrong.

"They got a person," said he, "whose character and skill I do not dispute, though I do not exactly know that I should have gone to the inventor of the treadmill as the fittest man to take the levels of Knowsley Moss and Chat Moss, which shook almost as much as a treadmill, as you recollect, for he (Mr. Cubitt) said Chat Moss trembled so much under his feet that he could not take his observations accurately. . . . In fact, Mr. Cubitt did not go on to Chat Moss, because he knew that it was an immense mass of pulp, and nothing else. It actually rises in height, from the rain swelling it like a sponge, and sinks again in dry weather; and if a boring instrument is put into it, it sinks immediately by its own weight. The making of an embankment out of this pulpy, wet moss, is no very easy task. Who but Mr. Stephenson would have thought of entering into Chat Moss, carrying it out almost like wet dung? It is ignorance almost inconceivable. It is perfect madness, in a person called upon to speak on a scientific subject, to propose such a plan. . . . Every part of the scheme shows that this man has applied himself to a subject of which he has no knowledge, and to which he has no science to apply."

Then adverting to the proposal to work the intended line by means of locomotives, the learned gentleman proceeded :

“When we set out with the original prospectus, we were to gallop, I know not at what rate ;—I believe it was at the rate of twelve miles an hour. My learned friend, Mr. Adam, contemplated—possibly alluding to Ireland—that some of the Irish members would arrive in the waggons to a division. My learned friend says that they would go at the rate of twelve miles an hour with the aid of the devil in the form of a locomotive, sitting as postilion on the fore horse, and an honourable member sitting behind him to stir up the fire, and keep it at full speed. But the speed at which these locomotive engines are to go has slackened : Mr. Adam does not go faster now than five miles an hour. The learned serjeant (Spankie) says he should like to have seven, but he would be content to go six. I will show he cannot go six ; and probably, for any practical purposes, I may be able to show that I can keep up with him *by the canal*. . . . Locomotive engines are liable to be operated upon by the weather. You are told they are affected by rain, and an attempt has been made to cover them ; but the wind will affect them ; and any gale of wind which would affect the traffic on the Mersey would render it *impossible* to set off a locomotive engine, either by poking of the fire, or keeping up the pressure of the steam till the boiler was ready to burst.”

How amusing it now is to read these extraordinary views as to the formation of a railway over Chat Moss, and the impossibility of starting a locomotive engine in the face of a gale of wind !

Evidence was called to show that the house property passed by the proposed railway would be greatly deteriorated—in some places almost destroyed ; that the locomotive engines would be terrible nuisances, in consequence of the fire and smoke vomited forth by them ; and that the value of land in the neighbourhood of Manchester alone would be deteriorated by no less than 20,000*l.* ! Evidence was also given at great length showing the utter impossibility of forming a road of any kind upon Chat Moss. A Manchester builder, who

was examined, could not imagine the feat possible, unless by arching it across in the manner of a viaduct from one side to the other. It was the old story of 'nothing like leather.' But the opposition mainly relied upon the evidence of the leading engineers—not, like Stephenson, self-taught men, but regular professionals. Mr. Francis Giles, C.E., was their great card. He had been twenty-two years an engineer, and could speak with some authority. His testimony was mainly directed to the utter impossibility of forming a railway over Chat Moss. "*No engineer in his senses,*" said he, "*would go through Chat Moss if he wanted to make a railroad from Liverpool to Manchester. In my judgment a railroad certainly cannot be safely made over Chat Moss without going to the bottom of the Moss.*"

The following may be taken as a specimen of Mr. Giles's evidence:—

"Tell us whether, in your judgment, a railroad can be safely made over Chat Moss, without going to the bottom of the bog?—I say, *certainly not.*

"Will it be necessary, therefore, in making a permanent railroad, to take out the whole of the moss to the bottom, along the whole line of road?—Undoubtedly.

"Will that make it necessary to cut down the thirty-three or thirty-four feet of which you have been speaking?—Yes.

"And afterwards to fill it up with other soil?—To such height as the railway is to be carried; other soil mixed with a portion of the moss.

"But suppose they were to work upon this stuff, could they get their carriages to this place?—*No carriage can stand on the moss short of the bottom.*

"What could they do to make it stand,—laying planks, or something of that sort?—Nothing would support it.

"So that if you would carry a railroad over this fluid stuff,—if you could do it, it would still take a great number of men, and a great sum of money. Could it be done, in your opinion, for 6000*l.*?—I should say 200,000*l.* would not get through it.

"My learned friend wishes to know what it would cost to lay it with diamonds?"

Mr. H. R. Palmer, C.E., gave evidence to prove that resistance to a moving body going under four and a quarter miles an hour was *less* upon a canal than upon a railroad; and that, when going against a strong wind, the progress of a locomotive was retarded "very much." Mr. George Leather, C.E., the engineer of the Croydon and Wandsworth Railway, on which he said the waggons went at from two and a half to three miles an hour, also testified against the practicability of Stephenson's plan. He considered his estimate a "very wild" one. He had no confidence in locomotive power. The Wear-dale Railway, of which he was engineer, had given up the use of locomotive engines. He supposed that, when used, they travelled at three and a half to four miles an hour, because they were considered to be then more effective than at a higher speed.

When these distinguished engineers had given their evidence, Mr. Alderson summed up in a speech which extended over two days. He declared Stephenson's plan to be "the most absurd scheme that ever entered into the head of man to conceive:"—

"My learned friends," said he, "almost endeavoured to stop my examination; they wished me to put in the plan, but I had rather have the exhibition of Mr. Stephenson in that box. I say he never had a plan—I believe he never had one—I do not believe he is capable of making one. His is a mind perpetually fluctuating between opposite difficulties: he neither knows whether he is to make bridges over roads or rivers, of one size or of another; or to make embankments, or cuttings, or inclined planes, or in what way the thing is to be carried into effect. Whenever a difficulty is pressed, as in the case of a tunnel, he gets out of it at one end, and when you try to catch him at that, he gets out at the other."

Mr. Alderson proceeded to declaim against the gross ignorance of this so-called engineer, who proposed to make "impossible ditches by the side of an impossible railway" over Chat Moss; and he contrasted with

his evidence that given "by that most respectable gentleman we have called before you, I mean Mr. Giles, who has executed a vast number of works," &c. Then Mr. Giles's evidence as to the impossibility of making any railway over the Moss that would stand short of the bottom, was emphatically dwelt upon; and Mr. Alderson proceeded :

"Having now, sir, gone through Chat Moss, and having shown that Mr. Giles is right in his principle when he adopts a solid railway,—and I care not whether Mr. Giles is right or wrong in his estimate, for whether it be effected by means of piers raised up all the way for four miles through Chat Moss, whether they are to support it on beams of wood or by erecting masonry, or whether Mr. Giles shall put a solid bank of earth through it,—in all these schemes there is not one found like that of Mr. Stephenson's, namely, to cut impossible drains on the side of this road; and it is sufficient for me to suggest, and to show, that this scheme of Mr. Stephenson's is impossible or impracticable, and that no other scheme, if they proceed upon this line, can be suggested which will not produce enormous expense. I think that has been irrefragably made out. Every one knows Chat Moss—every one knows that Mr. Giles speaks correctly when he says the iron sinks immediately on its being put upon the surface. I have heard of culverts, which have been put upon the Moss, which, after having been surveyed the day before, have the next morning disappeared; and that a house (a poet's house, who may be supposed in the habit of building castles even in the air), story after story, as fast as one is added, the lower one sinks! There is nothing, it appears, except long sedgy grass, and a little soil, to prevent its sinking into the shades of eternal night. I have now done, sir, with Chat Moss, and there I leave this railroad."

Mr. Alderson, of course, called upon the Committee to reject the Bill; and he protested "against the despotism of the Exchange at Liverpool striding across the land of this country. I do protest," he concluded, "against a measure like this, supported as it is by such evidence, and founded upon such calculations."

The case of the other numerous petitioners against

the Bill still remained to be gone into. Witnesses were called to prove the residential injury which would be caused by the "intolerable nuisance" of the smoke and fire from the locomotives; and others to prove that the price of coals and iron would "infallibly" be greatly raised throughout the country. This was part of the case of the Duke of Bridgewater's trustees, whose witnesses "proved" many very extraordinary things. The Leeds and Liverpool Canal Company were so fortunate as to pick up a witness from Hetton, who was ready to furnish some damaging evidence as to the use of Stephenson's locomotives on that railway. This was Mr. Thomas Wood, one of the Hetton Company's clerks, whose evidence was to the effect that the locomotives, having been found ineffective, were about to be discontinued in favour of fixed engines. The evidence of this witness, incompetent though he was to give an opinion on the subject, and exaggerated as his statements were afterwards proved to be, was made the most of by Mr. Harrison, when summing up the case of the canal companies.

"At length," he said, "we have come to this,—having first set out at twelve miles an hour, the speed of these locomotives is reduced to six, and now comes down to two or two and a half. They must be content to be pulled along by horses and donkeys; and all those fine promises of galloping along at the rate of twelve miles an hour are melted down to a total failure—the foundation on which their case stood is cut from under them completely; for the Act of Parliament, the Committee will recollect, prohibits any person using any animal power, of any sort, kind, or description, except the projectors of the railway themselves; therefore, I say, that the whole foundation on which this project exists is gone."

After further personal abuse of Mr. Stephenson, whose evidence he spoke of as "trash and confusion," Mr. Harrison closed the case of the canal companies on the 30th of May. Mr. Adam replied for the promoters,

recapitulating the principal points of their case, and vindicating Mr. Stephenson and the evidence which he had given before the Committee.

The Committee then divided on the preamble, which was carried by a majority of only *one*—thirty-seven voting for it, and thirty-six against it. The clauses were next considered, and on a division the first clause, empowering the Company to make the railway, was lost by a majority of nineteen to thirteen. In like manner, the next clause, empowering the Company to take land, was lost; on which Mr. Adam, on the part of the promoters, withdrew the Bill.

Thus ended this memorable contest, which had extended over two months—carried on throughout with great pertinacity and skill, especially on the part of the opposition, who left no stone unturned to defeat the measure. The want of a new line of communication between Liverpool and Manchester had been clearly proved; but the engineering evidence in support of the proposed railway having been thrown almost entirely upon George Stephenson, who fought this, the most important part of the battle, single-handed, was not brought out so clearly as it would have been had he secured more efficient engineering assistance—which he was not able to do, as all the engineers of eminence of that day were against the locomotive railway. The obstacles thrown in the way of the survey by the land-owners and canal companies, by which the plans were rendered exceedingly imperfect, also tended in a great measure to defeat the Bill.

Mr. Gooch says the rejection of the scheme was probably the most severe trial George Stephenson underwent in the whole course of his life. The circumstances connected with the defeat of the Bill, the errors in the levels, his severe cross-examination, followed by the fact of his being superseded by another engineer, all told fearfully upon him, and for some time he was as terribly

weighed down as if a personal calamity of the most serious kind had befallen him. It is also right to add that he was badly served by his surveyors, who were unpractised and incompetent. On the 27th of September, 1824, we find him writing to Mr. Sandars: "I am quite shocked with Auty's conduct; we must throw him aside as soon as possible. Indeed, I have begun to fear that he has been fee'd by some of the canal proprietors to make a botch of the job. I have a letter from Steele,<sup>1</sup> whose views of Auty's conduct quite agree with yours."

The result of this first application to Parliament was so far discouraging. Stephenson had been so terribly abused by the leading counsel for the opposition in the course of the proceedings before the Committee—stigmatised by them as an ignoramus, a fool, and a maniac—that even his friends seem for a time to have lost faith in him and in the locomotive system, whose efficiency he continued to uphold. Things never looked blacker for the success of the railway system than at the close of this great parliamentary struggle. And yet it was on the very eve of its triumph.

The Committee of Directors appointed to watch the measure in Parliament were so determined to press on the project of a railway, even though it should have to be worked merely by horse-power, that the Bill had scarcely been defeated ere they met in London to consider their next step. They called their parliamentary friends together to consult as to future proceedings. Among those who attended the meeting of gentlemen with this object, in the Royal Hotel, St. James's Street,

<sup>1</sup> Hugh Steele and Elijah Galloway afterwards proceeded with the survey at one part of the line, and Messrs. Oliver and Blackett at another. The former couple seem to have made some grievous blunder in the levels on Chat Moss, and the circumstance weighed so heavily on Steele's mind that, shortly after hearing of the re-

jection of the Bill, he committed suicide in Stephenson's office at Newcastle. Mr. Gooch informs us that this unhappy affair served to impress upon the minds of Stephenson's other pupils the necessity of ensuring greater accuracy and attention in future, and that the lesson, though sad, was not lost upon them.

on the 4th of June, were Mr. Huskisson, Mr. Spring Rice, and General Gascoyne. Mr. Huskisson urged the promoters to renew their application to Parliament. They had secured the first step by the passing of their preamble; the measure was of great public importance; and whatever temporary opposition it might meet with, he conceived that Parliament must ultimately give its sanction to the undertaking. Similar views were expressed by other speakers; and the deputation went back to Liverpool determined to renew their application to Parliament in the ensuing session.

It was not considered desirable to employ George Stephenson in making the new survey. He had not as yet established his reputation as an engineer beyond the boundaries of his own district; and the promoters of the Bill had doubtless felt the disadvantages of this in the course of their parliamentary struggle. They therefore resolved now to employ engineers of the highest established reputation, as well as the best surveyors that could be obtained. In accordance with these views they engaged Messrs. George and John Rennie to be the engineers of the railway; and Mr. Charles Vignolles, on their behalf, was appointed to prepare the plans and sections. The line which was eventually adopted differed somewhat from that surveyed by Stephenson — entirely avoiding Lord Sefton's property, and passing through only a few detached fields of Lord Derby's at a considerable distance from the Knowsley domain. The principal parks and game preserves of the district were also carefully avoided. The promoters thus hoped to get rid of the opposition of the most influential of the resident landowners. The crossing of certain of the streets of Liverpool was also avoided, and the entrance contrived by means of a tunnel and an inclined plane. The new line stopped short of the river Irwell at the Manchester end, and thus in some measure removed the objections

grounded on an anticipated interruption to the canal or river traffic. And, with reference to the use of the locomotive engine, the promoters, remembering with what effect the objections to it had been urged by the opponents of the measure, intimated, in their second prospectus, that "as a guarantee of their good faith towards the public they will not require any clause empowering them to use it; or they will submit to such restrictions in the employment of it as Parliament may impose, for the satisfaction and ample protection both of proprietors on the line of road and of the public at large."

It was found that the capital required to form the line of railway, as laid out by the Messrs. Rennie, was considerably beyond the amount of Stephenson's estimate, and it became a question with the Committee in what way the new capital should be raised. A proposal was made to the Marquis of Stafford, who was principally interested in the Duke of Bridgewater's Canal, to become a shareholder in the undertaking. A similar proposal had at an earlier period been made to Mr. Bradshaw, the trustee for the property; but his answer was "all or none," and the negotiation was broken off. The Marquis of Stafford, however, now met the projectors of the railway in a more conciliatory spirit; and it was ultimately agreed that he should become a subscriber to the extent of a thousand shares.

The survey of the new line having been completed, the plans were deposited, the standing orders duly complied with, and the Bill went before Parliament. The same counsel appeared for the promoters, but the examination of witnesses was not nearly so protracted as on the former occasion. Mr. Erle and Mr. Harrison led the case of the opposition. The Bill went into Committee on the 6th of March, and on the 16th the preamble was declared proved by a majority of forty-three to eighteen. On the third reading in the House of Commons, an animated, and what now appears a

very amusing discussion, took place. The Hon. Edward Stanley (since Earl of Derby, and Prime Minister) moved that the Bill be read that day six months. In the course of his speech he undertook to prove that the railway trains would take *ten hours* on the journey, and that they could only be worked by horses; and he called upon the House to stop the Bill, "and prevent this mad and extravagant speculation from being carried into effect." Sir Isaac Coffin seconded the motion, and in doing so denounced the project as a most flagrant imposition. He would not consent to see widows' premises and their strawberry-beds invaded; and "what, he would like know, was to be done with all those who had advanced money in making and repairing turnpike-roads? What with those who may still wish to travel in their own or hired carriages, after the fashion of their forefathers? What was to become of coach-makers and harness-makers, coach-masters and coachmen, inn-keepers, horse-breeders, and horse-dealers? Was the House aware of the smoke and the noise, the hiss and the whirl, which locomotive engines, passing at the rate of ten or twelve miles an hour, would occasion? Neither the cattle ploughing in the fields or grazing in the meadows could behold them without dismay. Iron would be raised in price 100 per cent., or more probably exhausted altogether! It would be the greatest nuisance, the most complete disturbance of quiet and comfort in all parts of the kingdom, that the ingenuity of man could invent!"

Mr. Huskisson and other speakers, though unable to reply to such arguments as these, strongly supported the Bill; and it was carried on the third reading by a majority of eighty-eight to forty-one. The Bill passed the House of Lords almost unanimously, its only opponents being the Earl of Derby and his relative the Earl of Wilton. The cost of obtaining the Act amounted to the enormous sum of 27,000*l*.

## CHAPTER XI.

## CHAT MOSS — CONSTRUCTION OF THE RAILWAY.

THE appointment of principal engineer of the railway was taken into consideration at the first meeting of the directors held at Liverpool subsequent to the passing of the Act of incorporation. The magnitude of the proposed works, and the vast consequences involved in the experiment, were deeply impressed on their minds; and they resolved to secure the services of a resident engineer of proved experience and ability. Their attention was naturally directed to George Stephenson; at the same time they desired to have the benefit of the Messrs. Rennie's professional assistance in superintending the works. Mr. George Rennie had an interview with the board on the subject, at which he proposed to undertake the chief superintendence, making six visits in each year, and stipulating that he should have the appointment of the resident engineer. But the responsibility attaching to the direction in the matter of the efficient carrying on of the works would not admit of their being influenced by ordinary punctilios on the occasion; and they accordingly declined Mr. Rennie's proposal, and proceeded to appoint George Stephenson principal engineer at a salary of 1000*l.* per annum.

He at once removed his residence to Liverpool, and made arrangements to commence the works. He began with the "impossible thing"—to do that which some of the principal engineers of the day had declared that "no man in his senses would undertake to do"—namely, to make the road over Chat Moss! It was

indeed a most formidable undertaking ; and the project of carrying a railway along, under, or over such a material as that of which it consisted, would certainly never have occurred to an ordinary mind. Michael Drayton supposed the Moss to have had its origin at the Deluge. Nothing more impassible could have been imagined than that dreary waste ; and Mr. Giles only spoke the popular feeling of the day when he declared that no carriage could stand on it "short of the bottom." In this bog, singular to say, Mr. Roscoe, the accomplished historian of the Medicis, buried his fortune in the hopeless attempt to cultivate a portion of it which he had bought.

Chat Moss is an immense peat-bog of about twelve square miles in extent. Unlike the bogs or swamps of Cambridge and Lincolnshire, which consist principally of soft mud or silt, this bog is a vast mass of spongy vegetable pulp, the result of the growth and decay of ages. Spagni, or bog-mosses, cover the entire area ; one year's growth rising over another,—the older growths not entirely decaying, but remaining partially preserved by the antiseptic properties peculiar to peat. Hence the remarkable fact that, though a semifluid mass, the surface of Chat Moss rises above the level of the surrounding country. Like a turtle's back, it declines from the summit in every direction, having from thirty to forty feet gradual slope to the solid land on all sides. From the remains of trees, chiefly alder and birch, which have been dug out of it, and which must have previously flourished on the surface of the soil now deeply submerged, it is probable that the sand and clay base on which the bog rests is saucer-shaped, and so retains the entire mass in position. In rainy weather, such is its capacity for water that it sensibly swells, and rises in those parts where the moss is the deepest. This occurs through the capillary attraction of the fibres of the submerged moss, which is from twenty to thirty feet in

depth, while the growing plants effectually check evaporation from the surface. This peculiar character of the Moss has presented an insuperable difficulty in the way of draining on any extensive system—such as by sinking shafts in its substance, and pumping up the water by steam-power, as has been proposed by some engineers. For, supposing a shaft of thirty feet deep to be sunk, it has been calculated that this would only be effectual for draining a circle of about one hundred yards, the water running down an incline of about 5 to 1; indeed, it was found in the course of draining the bog, that a ditch three feet deep only served to drain a space of less than five yards on either side, and two ditches of this depth, ten feet apart, left a portion of the Moss between them scarcely affected by the drains.

The three resident engineers selected by Mr. Stephenson to superintend the construction of the line, were Mr. Joseph Locke, Mr. Allcard, and Mr. John Dixon. The last was appointed to that portion which included the proposed road across the Moss, the other two being anything but desirous of exchanging posts with him. On Mr. Dixon's arrival, about the month of July, 1826, Mr. Locke proceeded to show him over the length he was to take charge of, and to instal him in office. When they reached Chat Moss, Mr. Dixon found that the line had already been staked out and the levels taken in detail by the aid of planks laid upon the bog. The cutting of the drains along each side of the proposed road had also been commenced; but the soft pulpy stuff had up to this time flowed into the drains and filled them up as fast as they were cut. Proceeding across the Moss, on his first day's inspection, the new resident, when about half-way over, slipped off the plank on which he walked, and sank to his knees in the bog. Struggling only sent him the deeper, and he might have disappeared altogether, but for the workmen, who hastened to his assistance upon planks, and rescued him

from his perilous position. Much disheartened, he desired to return, and even for the moment thought of giving up the job; but Mr. Locke assured him that the worst part was now past; so the new resident plucked up heart again, and both floundered on until they reached the further edge of the Moss, wet and plastered over with bog sludge. Mr. Dixon's assistants endeavoured to comfort him by the assurance that he might in future avoid similar perils, by walking upon "pattens," or boards fastened to the soles of his feet, as they had done when taking the levels, and as the workmen did when engaged in making drains in the softest parts of the Moss. Still the resident engineer could not help being puzzled by the problem of how to construct a road for a heavy locomotive, with a train of passengers or goods, upon a bog which he had found to be incapable of supporting his own individual weight!

Stephenson's idea was, that such a road might be made to *float* upon the bog, simply by means of a sufficient extension of the bearing surface. As a ship, or a raft capable of sustaining heavy loads, floated in water, so, in his opinion, might a light road be floated upon a bog which was of considerably greater consistency than water. Long before the railway was thought of, Mr. Roscoe had adopted the remarkable expedient of fitting his plough-horses with flat wooden soles or pattens, to enable them to walk upon the Moss land which he had brought into cultivation. These pattens were fitted on by means of a screw apparatus, which met in front of the foot and was easily fastened. The mode by which these pattens served to sustain the horse is capable of easy explanation, and it will be observed that the *rationale* alike explains the floating of a railway. The foot of an ordinary farm-horse presents a base of about five inches diameter, but if this base be enlarged to seven inches—the circles being to each other as the squares of the diameters—it will be

found that, by this slight enlargement of the base, a circle of nearly double the area has been secured ; and consequently the pressure of the foot upon every unit of ground on which the horse stands has been reduced one half. In fact, this contrivance has an effect tantamount to setting the horse upon eight feet instead of four.

Apply the same reasoning to the ponderous locomotive, and it will be found, that even such a machine may be made to stand upon a bog, by means of a similar extension of the bearing surface. Suppose the engine to be twenty feet long and five feet wide, thus covering a surface of a hundred square feet, and, provided the bearing has been extended by means of cross sleepers supported upon a matting of heath and branches of trees covered with a few inches of gravel, the pressure of an engine of twenty tons will be only equal to about three pounds per inch over the whole surface on which it stands. Such was George Stephenson's idea in contriving his floating road—something like an elongated raft—across the Moss ; and we shall see that he steadily kept it in view in carrying the work into execution.

The first thing done was to form a footpath of ling or heather along the proposed road, on which a man might walk without risk of sinking. A single line of temporary railway was then laid down, formed of ordinary cross-bars about three feet long and an inch square, with holes punched through them at the end and nailed down to temporary sleepers. Along this way ran the waggons in which were conveyed the materials requisite to form the permanent road. These waggons carried about a ton each, and they were propelled by boys running behind them along the narrow bar of iron. The boys became so expert that they would run the four miles across at the rate of seven or eight miles an hour without missing a step ; if they had done so, they would

have sunk in many places up to their middle.<sup>1</sup> The slight extension of the bearing surface was sufficient to enable the bog to bear this temporary line, and the circumstance was a source of increased confidence and hope to our engineer in proceeding with the formation of the permanent road alongside.

The digging of drains had been proceeding for some time along each side of the intended railway; but they filled up almost as soon as dug, the sides flowing in and the bottom rising up; and it was only in some of the drier parts of the bog that a depth of three or four feet could be reached. The surface-ground between the drains, containing the intertwined roots of heather and long grass, was left untouched, and upon this were spread branches of trees and hedge-cuttings; in the softest places rude gates or hurdles, some eight or nine feet long by four feet wide, interwoven with heather, were laid in double thicknesses, their ends overlapping each other; and upon this floating bed was spread a thin layer of gravel, on which the sleepers, chairs, and rails were laid in the usual manner. Such was the mode in which the road was formed upon the Moss.

It was found, however, after the permanent road had been thus laid, that there was a tendency to sinking at those parts where the bog was the softest. In ordinary cases, where a bank subsides, the sleepers are packed up with ballast or gravel; but in this case the ballast was dug away and removed in order to lighten the road, and the sleepers were packed instead with cakes of dry turf or bundles of heath. By these expedients the subsided parts were again floated up to the level, and

<sup>1</sup> When the Liverpool directors went to inspect the works in progress on the Moss, they were run along the temporary rails in the little three-feet gauge waggons used for forming the road. They were being thus impelled one day at considerable speed, when the waggon suddenly ran off the road,

and Mr. Moss, one of the directors, was thrown out in a soft place, from which, however, he was speedily extricated, not without leaving a deep mark. George used afterwards laughingly to refer to the circumstance as "the meeting of the Mosses."

an approach was made towards a satisfactory road. But the most formidable difficulties were encountered at the centre and towards the edges of the Moss; and it required no small degree of ingenuity and perseverance on the part of the engineer successfully to overcome them.

The Moss, as has been already observed, was highest in the centre, and it there presented a sort of hunchback with a rising and falling gradient. At that point it was found necessary to cut deeper drains in order to consolidate the ground between them on which the road was to be formed. But, as at other parts of the Moss, the deeper the cutting the more rapid was the flow of fluid bog into the drain, the bottom rising up almost as fast as it was removed. To meet this emergency, a quantity of empty tar-barrels was brought from Liverpool; and as soon as a few yards of drain were dug, the barrels were laid down end to end, firmly fixed to each other by strong slabs laid over the joints, and nailed; they were then covered over with clay, and thus formed an underground sewer of wood instead of bricks. This expedient was found to answer the purpose intended, and the road across the centre of the Moss having thus been prepared, it was then laid with the permanent materials.

The greatest difficulty was, however, experienced in forming an embankment on the edge of the bog at the Manchester end. Moss, as dry as it could be cut, was brought up in small waggons, by men and boys, and emptied so as to form an embankment; but the bank had scarcely been raised three or four feet in height, when the stuff broke through the heathery surface of the bog and sunk overhead. More moss was brought up and emptied in with no better result; and for many weeks the filling was continued without any visible embankment having been made. It was the duty of the resident engineer to proceed to Liverpool every fort-

night to obtain the wages for the workmen employed under him ; and on these occasions he was required to colour up, on a section drawn to a working scale suspended against the wall of the directors' room, the amount of excavation, embankment, &c., executed from time to time. But on many of these occasions, Mr. Dixon had no progress whatever to show for the money expended on the Chat Moss embankment. Sometimes, indeed, the visible work done was *less* than it had appeared a fortnight or a month before !

The directors now became seriously alarmed, and feared that the evil prognostications of the eminent engineers were about to be fulfilled. The resident himself was greatly disheartened, and he was even called upon to supply the directors with an estimate of the cost of filling up the Moss with solid stuff from the bottom, as also the cost of piling the roadway, and, in effect, constructing a four-mile viaduct of timber across the Moss, from twenty to thirty feet high. But the expense appalled the directors, and the question then arose, whether the work was to be proceeded with, or *abandoned* !

Stephenson himself afterwards described the alarming position of affairs at a public dinner given at Birmingham, on the 23rd of December, 1837, on the occasion of a piece of plate being presented to his son, after the completion of the London and Birmingham Railway. He related the anecdote, he said, for the purpose of impressing upon the minds of those who heard him the necessity of perseverance.

"After working for weeks and weeks," said he, "in filling in materials to form the road, there did not yet appear to be the least sign of our being able to raise the solid embankment one single inch ; in short, we went on filling in without the slightest apparent effect. Even my assistants began to feel uneasy, and to doubt of the success of the scheme. The directors, too, spoke of it as a hopeless task : and at length they became seriously

alarmed, so much so, indeed, that a board meeting was held on Chat Moss to decide whether I should proceed any further. They had previously taken the opinion of other engineers, who reported unfavourably. There was no help for it, however, but to go on. An immense outlay had been incurred; and great loss would have been occasioned had the scheme been then abandoned, and the line taken by another route. So the directors were *compelled* to allow me to go on with my plans, of the ultimate success of which I myself never for one moment doubted."

During the progress of this part of the works, the Worsley and Trafford men, who lived near the Moss, and plumed themselves upon their practical knowledge of bog-work, declared the completion of the road to be utterly impracticable. "If you knew as much about Chat Moss as we do," they said, "you would never have entered on so rash an undertaking; and depend upon it, all you have done and are doing will prove abortive. You must give up altogether the idea of a floating railway, and either fill the Moss up with hard material from the bottom, or else deviate the line so as to avoid it altogether." Such were the conclusions of science and experience.

In the midst of all these alarms and prophecies of failure, Stephenson never lost heart, but held to his purpose. His motto was "Persevere!" "You must go on filling in," he said; "there is no other help for it. The stuff emptied in is doing its work out of sight, and if you will but have patience, it will soon begin to show." And so the filling in went on; several hundreds of men and boys were employed to skin the Moss all round for many thousand yards, by means of sharp spades, called by the turf-cutters "tommy-spades;" and the dried cakes of turf were afterwards used to form the embankment, until at length as the stuff sank and rested upon the bottom, the bank gradually rose above the surface, and slowly advanced onwards, declining in height and consequently in weight, until it became

joined to the floating road already laid upon the Moss. In the course of forming the embankment, the pressure of the bog turf tipped out of the waggons caused a copious stream of bog-water to flow from the end of it, in colour resembling Barclay's double stout; and when completed, the bank looked like a long ridge of tightly-pressed tobacco-leaf. The compression of the turf may be understood from the fact that 670,000 cubic yards of raw moss formed only 277,000 cubic yards of embankment at the completion of the work.

At the western, or Liverpool end of the Chat Moss, there was a like embankment; but, as the ground there was solid, little difficulty was experienced in forming it, beyond the loss of substance caused by the oozing out of the water held by the moss-earth.

At another part of the Liverpool and Manchester line, Parr Moss was crossed by an embankment about a mile and a half in extent. In the immediate neighbourhood was found a large excess of cutting, which it would have been necessary to "put out in spoil banks" (according to the technical phrase), but for the convenience of Parr Moss, into which the surplus clay, stone, and shale, were tipped, waggon after waggon, until a solid but concealed embankment, from fifteen to twenty-five feet high, was formed; although to the eye it appears to be laid upon the level of the adjoining surface, as at Chat Moss.

The road across Chat Moss was finished by the 1st of January, 1830, when the first experimental train of passengers passed over it, drawn by the "Rocket;" and it turned out that, instead of being the most expensive part of the line, it was about the cheapest. The total cost of forming the line over the Moss was 28,000*l.*, whereas Mr. Giles's estimate was 270,000*l.*! It also proved to be one of the best portions of the railway. Being a floating road, it was as smooth and easy to run upon as Dr. Arnott's water-bed is soft and easy to lie

upon—the pressure being equal at all points. There was, and still is, a sort of springiness in the road over the Moss, such as is felt when passing along a suspended bridge; and those who looked along the Moss as a train passed over it, said they could observe a waviness, such as precedes and follows a skater upon ice.

During the progress of the works the most ridiculous rumours were set afloat. The drivers of the stage-coaches, who feared for their calling, brought the alarming intelligence into Manchester from time to time, that “Chat Moss was blown up!” “Hundreds of men and horses had sunk in the bog; and the works were completely abandoned!” The engineer himself was declared to have been swallowed up in the Serbonian bog; and “railways were at an end for ever!”

In the construction of the railway, George Stephenson’s capacity for organising and directing the labours of a large number of workmen of all kinds, eminently displayed itself. A vast quantity of ballast-waggons had to be constructed for the purposes of the work, and implements and materials had to be collected, before the mass of labour to be employed could be efficiently set in motion at the various points of the line. There were not at that time, as there are now, large contractors, possessed of railway plant, capable of executing earth-works on a large scale. Our engineer had, therefore, not only to contrive the plant, but to organise the labour, and direct it in person. The very labourers themselves had to be trained to their work by him; and it was on the Liverpool and Manchester line that Mr. Stephenson organised the staff of that formidable band of railway navvies, whose handiworks will be the wonder and admiration of succeeding generations. Looking at their gigantic traces, the men of some future age may be found to declare, of the engineer and of his workmen, that “there were giants in those days.”

Although the works of the Liverpool and Manchester

Railway are of a much less formidable character than those of many lines that have since been constructed, they were then regarded as of a stupendous kind. Indeed, few works of such magnitude had before been executed in England. It had been the engineer's original intention to carry the railway from the north end of Liverpool, round the red-sandstone ridge on which the upper part of the town is built, and also round the higher rise of the coal formation at Rainhill, by following the natural levels to the north of Knowsley. But the opposition of the landowners having forced the line more to the south, it was rendered necessary to cut through the hills, and go over the high grounds instead of round them. The first consequence of this alteration in the plans, was the necessity for constructing a tunnel under the town of Liverpool a mile and a half in length, from the docks at Wapping to the top of Edgehill; the second was the necessity for forming a long and deep cutting through the red-sandstone rock at Olive Mount; and the third and worst of all, was the necessity for ascending and descending the Whiston and Sutton hills by means of inclined planes of 1 in 96. The line was also, by the same forced deviation, prevented passing through the Lancashire coal-field, and the engineer was compelled to carry the works across the Sankey valley, at a point where the waters of the brook had dug out an excessively deep channel through the marl-beds of the district.

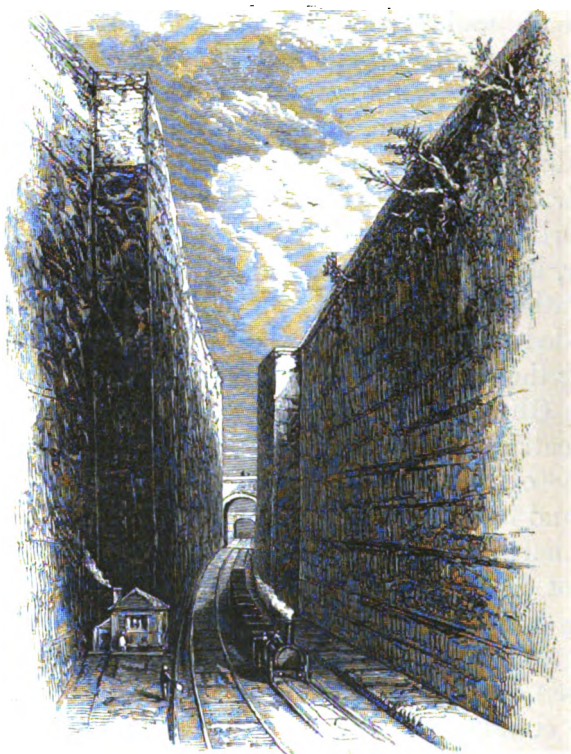
The principal difficulty was experienced in pushing on the works connected with the formation of the tunnel under Liverpool, 2200 yards in length. The blasting and hewing of the rock were vigorously carried on night and day; and the engineer's practical experience in the collieries here proved of great use to him. Many obstacles had to be encountered and overcome in the formation of the tunnel, the rock varying in hardness and texture at different parts. In some places the

miners were deluged by water, which surged from the soft blue shale found at the lowest level of the tunnel. In other places, beds of wet sand were cut through ; and there careful propping and pinning were necessary to prevent the roof from tumbling in until the masonry to support it could be erected. On one occasion, while Stephenson was absent from Liverpool, a mass of loose moss-earth and sand fell from the roof, which had been insufficiently propped. The miners withdrew from the work ; and on the engineer's return he found them in a refractory state, refusing to re-enter the tunnel. He induced them, however, by his example, to return to their labours ; and when the roof had been secured the work went on again as before. When there was danger, he was always ready to share it with the men ; and gathering confidence from his fearlessness, they proceeded vigorously with the undertaking, boring and mining their way towards the light.

The Olive Mount cutting was the first extensive stone cutting executed on any railway, and to this day it is one of the most formidable. It is about two miles long, and in some parts more than a hundred feet deep. It is a narrow ravine or defile cut out of the solid rock ; and not less than four hundred and eighty thousand cubic yards of stone were removed from it. Mr. Vignolles, afterwards describing it, said it looked as if it had been dug out by giants.

The crossing of so many roads and streams involved the necessity for constructing an unusual number of bridges. There were not fewer than sixty-three, under or over the railway, on the thirty miles between Liverpool and Manchester. Up to this time, bridges had been applied generally to high roads, where inclined approaches were of comparatively small importance, and in determining the rise of his arch the engineer selected any headway he thought proper. Every consideration was indeed made subsidiary to constructing the bridge

itself, and the completion of one large structure of this sort was regarded as an epoch in engineering history. Yet here, in the course of a few years, no fewer than sixty-three bridges were constructed on one line of railway! Mr. Stephenson early found that the ordinary arch was inapplicable in certain cases, where the head-



OLIVE MOUNT CUTTING [By Percival Skelton]

way was limited, and yet the level of the railway must be preserved. In such cases he employed simple cast-iron beams, by which he safely bridged gaps of moderate width, economising headway, and introducing the use of a new material of the greatest possible value to the engineer. The bridges of masonry upon the line were of many kinds; several of them were skew bridges,

while others, such as those at Newton and over the Irwell at Manchester, were straight and of considerable dimensions. But the principal piece of masonry on the line was the Sankey viaduct.



SANKEY VIADUCT [By Percival Skelton]

This fine work is principally of brick with stone facings. It consists of nine arches of fifty feet span each. The massive piers are supported on two hundred piles driven deep into the soil; and they rise to a great height,—the coping of the parapet being seventy feet above the level of the valley, in which flow the Sankey brook and Canal. Its total cost was about 45,000*l*.

By the end of 1828, the directors found they had expended 460,000*l*. on the works, and that they were still far from completion. They looked at the loss of interest on this large investment, and began to grumble at the

delay. They desired to see their capital becoming productive; and in the spring of 1829 they urged the engineer to push on the works with increased vigour. Mr. Cropper, one of the directors, who took an active interest in their progress, said to Stephenson one day, "Now, George, thou must get on with the railway, and have it finished without further delay: thou must really have it ready for opening by the first day of January next." "Consider the heavy character of the works, sir, and how much we have been delayed by the want of money, not to speak of the wetness of the weather: it is impossible." "Impossible!" rejoined Cropper; "I wish I could get Napoleon to thee—he would tell thee there is no such word as 'impossible' in the vocabulary." "Tush!" exclaimed Stephenson, with warmth; "don't speak to me about Napoleon! Give me men, money, and materials, and I will do what Napoleon couldn't do—drive a railroad from Liverpool to Manchester over Chat Moss!" And truly the formation of a high road over that bottomless bog was, apparently, a more difficult task than the making even of Napoleon's far-famed road across the Simplon.

The directors had more than once been embarrassed by want of funds to meet the heavy expenditure. The country had scarcely yet recovered from the general panic and crash of 1825: and it was with difficulty that the calls could be raised from the shareholders. A loan of 100,000*l.* was obtained from the Exchequer Loan Commissioners in 1826; and in 1829 an Act was passed enabling the Company to raise further capital, to provide working plant for the railway. Two Acts were also obtained during the progress of the undertaking, enabling deviations and alterations to be made; one to improve the curves and shorten the line near Rainhill, and the other to carry the line across the Irwell into the town of Manchester. Thanks to the energy of the engineer, the industry of his labourers,

and the improved supply of money by the directors, the railway made rapid progress in the course of the year 1829. Double sets of labourers were employed on Chat Moss and at other places, in carrying on the works by night and day, the night shifts working by torch and fire light; and at length, the work advancing at all points, the directors saw their way to the satisfactory completion of the undertaking.

It may well be supposed that Stephenson's time was fully occupied in superintending the extensive and for the most part novel works connected with the railway, and that even his extraordinary powers of labour and endurance were taxed to the utmost during the four years that they were in progress. Almost every detail in the plans was directed and arranged by himself. Every bridge, from the simplest to the most complicated, including the then novel structure of the "skew bridge," iron girders, siphons, fixed engines, and the machinery for working the tunnel at the Liverpool end, had all to be thought out by his own head, and reduced to definite plans under his own eyes. Besides all this, he had to design the working plant in anticipation of the opening of the railway. He must be prepared with waggons, trucks, and carriages, himself superintending their manufacture. The permanent road, turntables, switches, and crossings,—in short, the entire structure and machinery of the line, from the turning of the first sod to the running of the first train of carriages on the railway,—went on under his immediate supervision. And it was in the midst of this vast accumulation of work and responsibility that the battle of the locomotive engine had to be fought,—a battle, not merely against material difficulties, but against the still more trying obstructions of deeply-rooted mistrust and prejudice on the part of a considerable minority of the directors.

He had no staff of experienced assistants,—not even

a staff of draughtsmen in his office,—but only a few pupils learning their business; and he was frequently without even their help. The time of his engineering inspectors was fully occupied in the actual superintendence of the works at different parts of the line; and he took care to direct all their more important operations in person. The principal draughtsman was Mr. Thomas Gooch, a pupil he had brought with him from Newcastle. “I may say,” writes Mr. Gooch, “that nearly the whole of the working and other drawings, as well as the various land-plans for the railway, were drawn by my own hand. They were done at the Company’s office in Clayton Square during the day, from instructions supplied in the evenings by Mr. Stephenson, either by word of mouth, or by little rough hand sketches on letter-paper. The evenings were also generally devoted to my duties as secretary, in writing (mostly from his own dictation) his letters and reports, or in making calculations and estimates. The mornings before breakfast were not unfrequently spent by me in visiting and lending a helping hand in the tunnel and other works near Liverpool,—the untiring zeal and perseverance of George Stephenson never for an instant flagging, and inspiring with a like enthusiasm all who were engaged under him in carrying forward the works.”<sup>1</sup>

The usual routine of his life at this time—if routine it could be called—was, to rise early, by sunrise in summer and before it in winter, and “break the back

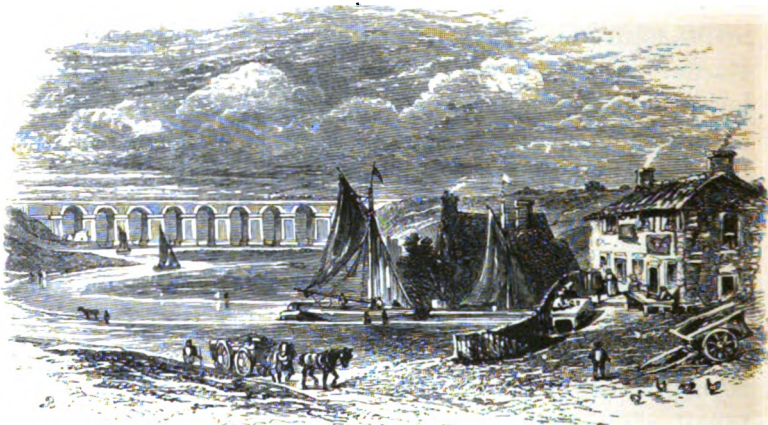
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<sup>1</sup> Mr. Gooch’s letter to the author, December 13th, 1861. Referring to the preparation of the plans and drawings, Mr. Gooch adds, “When we consider the extensive sets of drawings which most engineers have since found it right to adopt in carrying out similar works, it is not the least surprising feature in George Stephenson’s early professional career, that he should

have been able to confine himself to so limited a number as that which could be supplied by the hands of one person in carrying out the construction of the Liverpool and Manchester Railway; and this may still be said, after full allowance is made for the alteration of system involved by the adoption of the large contract system.”

of the day's work" by mid-day. While the tunnel under Liverpool was in progress, one of his first duties in the morning before breakfast was to go over the various shafts, clothed in a suitable dress, and inspect the progress of the work at different points; on other days he would visit the extensive workshops at Edgehill, where most of the "plant" for the line was manufactured. Then, returning to his house in Upper Parliament Street, Windsor, after a hurried breakfast, he would ride along the works to inspect their progress, and push them on with greater energy where needful. On other days he would prepare for the much less congenial engagement of meeting the Board, which was often a cause of great anxiety and pain to him; for it was difficult to satisfy men of all tempers, some of which were not of the most generous kind. On such occasions he might be seen with his right-hand thumb thrust through the topmost button-hole of his coat-breast, vehemently hitching his right shoulder, as was his habit when labouring under any considerable excitement. Occasionally he would take an early ride before breakfast, to inspect the progress of the Sankey viaduct. He had a favourite horse, brought by him from Newcastle, called "Bobby,"—so tractable that, with his rider on his back, he would walk up to a locomotive with the steam blowing off, and put his nose against it without shying. "Bobby," saddled and bridled, was brought to Stephenson's door betimes in the morning; and mounting him, he would ride the fifteen miles to Sankey, putting up at a little public house which then stood upon the banks of the canal. There he had his breakfast of "crowdie," which he made with his own hands. It consisted of oatmeal stirred into a basin of hot water,—a sort of porridge,—which was supped with cold sweet milk. After this frugal breakfast, he would go upon the works, and remain there, riding from point to point for the greater

part of the day. If he returned home before mid-day, it would be to examine the pay-sheets in the different departments, sent in by the assistant engineers, or by the foremen of the workshops; all this he did himself, with the greatest care, requiring a full explanation of every item.



STEPHENSON'S BAITING-PLACE AT SANKEY.

After a late dinner, which occupied very short time and was always of a plain and frugal description,<sup>1</sup> he would proceed to dispose of his correspondence, or prepare sketches of drawings, and give instructions as to their completion. He would occasionally refresh himself for this evening work by a short doze, which, however, he would never admit had exceeded the

<sup>1</sup> While at Liverpool, Stephenson had very little time for "company;" but on one particular occasion he invited his friend Mr. Sandars to dinner; and as that gentleman was a connoisseur in port wine, his host determined to give him a special treat of that drink. Stephenson accordingly went to the small merchant with whom he usually dealt, and ordered "half a dozen of his very best port wine," which was promised of first-rate quality. After dinner the wine was pro-

duced; and when Mr. Sandars had sipped a glass, George, after waiting a little for the expected eulogium, at length asked, "Well, Sandars, how d'ye like the port?" "Poor stuff!" said the guest, "Poor stuff!" George was very much shocked, and with difficulty recovered his good humour. But he lived to be able to treat Mr. Sandars to a better article at Tipton House, when he used to laugh over his first futile attempt at Liverpool to gain a reputation for his port.

limits of "winking," to use his own term. Mr. Frederick Swanwick, who officiated as his secretary after the appointment of Mr. Gooch as Resident Engineer to the Bolton and Leigh Railway, has informed us that he then remarked—what in after years he could better appreciate—the clear, terse and vigorous style of Stephenson's dictation; there was nothing superfluous in it; but it was close, direct, and to the point,—in short, thoroughly business-like. And if, in passing through the pen of the amanuensis, his meaning happened in any way to be distorted or modified, it did not fail to escape his detection, though he was always tolerant of any liberties taken with his own form of expression, so long as the words written down conveyed his real meaning. His strong natural acumen showed itself even in such matters as grammar and composition,—a department of knowledge in which, it might be supposed, he could scarcely have had either time or opportunity to acquire much information. But here, as in all other things, his shrewd common sense came to his help; and his simple, vigorous English might almost be cited as a model of composition.

His letters and reports written, and his sketches of drawings made and explained, the remainder of the evening was usually devoted to conversation with his wife and those of his pupils who lived under his roof, and constituted, as it were, part of the family. He then delighted to test the knowledge of his young companions, and to question them upon the principles of mechanics. If they were not quite "up to the mark" on any point, there was no escaping detection by evasive or specious explanations on their part. These always met with the verdict of, "Ah! you know nought about it now; but think it over again, and tell me the answer when you understand it." If there was even partial success in the reply, it would at once be acknowledged, and a full explanation was given, to which the

master would add illustrative examples for the purpose of impressing the principle more deeply upon the pupil's mind.

It was not so much his object and purpose to "cram" the minds of the young men committed to his charge with the *results* of knowledge, as to stimulate them to educate themselves—to induce them to develop their mental and moral powers by the exercise of their own free energies, and thus acquire that habit of self-thinking and self-reliance which is the spring of all true manly action. In a word, he sought to bring out and invigorate the *character* of his pupils. He felt that he himself had been made stronger and better through his encounters with difficulty; and he would not have the road of knowledge made too smooth and easy for them. "Learn for yourselves,—think for yourselves," he would say:—"make yourselves masters of principles,—persevere,—be industrious,—and there is then no fear of you." And not the least emphatic proof of the soundness of this system of education, as conducted by George Stephenson, was afforded by the after history of the pupils themselves. There was not one of those trained under his eye who did not rise to eminent usefulness and distinction as an engineer. He sent them forth into the world braced with the spirit of self-help—inspired by his own noble example; and they repeated in their after career the lessons of earnest effort and persistent industry which his daily life had taught them.

Mr. Stephenson's evenings at home were not, however, exclusively devoted either to business or to the graver exercises above referred to. He would often indulge in cheerful conversation and anecdote, falling back from time to time upon the struggles and difficulties of his early life. The not unfrequent winding up of his story, addressed to those about him, was—"Ah! ye young fellows don't know what *wark* is in these days!" Mr. Swanwick delights recalling to mind

how seldom, if ever, a cross or captious word, or an angry look, marred the enjoyment of those evenings. The presence of Mrs. Stephenson gave them an additional charm : amiable, kind-hearted, and intelligent, she shared quietly in the pleasure of the party ; and the atmosphere of comfort which always pervaded her home contributed in no small degree to render it a centre of cheerful, hopeful intercourse, and of earnest, honest industry.

When Stephenson retired for the night, it was not always that he permitted himself to sink into slumber. Like Brindley, he worked out many a difficult problem in bed ; and for hours he would turn over in his mind and study how to overcome some obstacle, or to mature some project, on which his thoughts were bent. Some remark inadvertently dropped by him at the breakfast-table in the morning, served to show that he had been stealing some hours from the night in reflection and study. Yet he would rise at his accustomed early hour, and there was no abatement of his usual energy in carrying on the business of the day.



CHAT MOSE—WORKS IN PROGRESS

## CHAPTER XII.

ROBERT STEPHENSON'S RESIDENCE IN COLOMBIA, AND RETURN —  
THE BATTLE OF THE LOCOMOTIVE — 'THE ROCKET.'

WE return to the career of Robert Stephenson, who was absent from England during the construction of the Liverpool Railway, but was now about to re-join his father and take part in "the battle of the locomotive" which was impending.

We have seen that on his return from Edinburgh College at the end of 1821, he had assisted in superintending the works of the Hetton Railway until its opening in 1822, after which he proceeded to Liverpool to take part with Mr. James in surveying the proposed railway there. In the following year we found him assisting his father in the working survey of the Stockton and Darlington Railway; and when the Locomotive Engine Works were started in Forth Street, Newcastle, he took an active part in that concern. "The factory," he says, "was in active operation early in 1824; I left England for Colombia in June of that year, having finished drawing the designs of the Brusselton stationary engines for the Stockton and Darlington Railway before I left."<sup>1</sup>

Speculation was very rife at the time; and amongst the most promising adventures were the companies organized for the purpose of working the gold and silver mines of South America. Great difficulty was experienced in finding mining engineers capable of carrying out those projects, and young men of even the

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<sup>1</sup> Letter to the author.

most moderate experience were eagerly sought after. The Colombian Mining Association of London offered an engagement to young Stephenson, to go out to Mariquita and take charge of the engineering operations of that Company. Robert was himself desirous of accepting it, but his father said it would first be necessary to ascertain whether the proposed change would be for his good. His health had been very delicate for some time, partly occasioned by his rapid growth, but principally because of his close application to work and study. Father and son proceeded together to call upon Dr. Headlam, the eminent physician of Newcastle, to consult him on the subject. During the examination which ensued, Robert afterwards used to say that he felt as if he were upon trial for life or death. To his great relief, the doctor pronounced that a temporary residence in a warm climate was the very thing likely to be most beneficial to him. The appointment was accordingly accepted, and, before many weeks had passed, Robert Stephenson had set sail for South America.

After a tolerably prosperous voyage he landed at La Guayra, on the north coast of Venezuela, on the 23rd of July, from thence proceeding to Caraccas, the capital of the district, about fifteen miles inland. There he remained for two months, unable to proceed in consequence of the wretched state of the roads in the interior. He contrived, however, to make occasional excursions in the neighbourhood, with an eye to the mining business on which he had come. About the beginning of October he set out for Bogota, the capital of Colombia or New Granada. The distance was about twelve hundred miles, through a very difficult region, and it was performed entirely upon mule-back after the fashion of the country.

In the course of the journey Robert visited many of the districts reported to be rich in minerals, but he met

with few traces except of copper, iron, and coal, with occasional indications of gold and silver. He found the people ready to furnish information, which, however, when tested, usually proved worthless. A guide, whom he employed for weeks, kept him buoyed up with the hope of finding richer mining places than he had yet seen; but when he professed to be able to show him mines of "brass, steel, alcohol, and pinchbeck," Stephenson discovered him to be an incorrigible rogue, and immediately dismissed him. At length our traveller reached Bogota, and after an interview with Mr. Illingworth, the commercial manager of the Mining Company, he proceeded to Honda, crossed the Magdalena, and shortly after reached the site of his intended operations on the eastern slope of the Andes.

Mr. Stephenson used afterwards to speak in glowing terms of this his first mule-journey in South America. Everything was entirely new to him. The variety and beauty of the indigenous plants, the luxurious tropical vegetation, the appearance, manners, and dress of the people, and the mode of travelling, were altogether different from everything he had before seen. His own travelling garb also must have been strange even to himself. "My hat," he says, "was of plaited grass, with a crown nine inches in height, surrounded by a brim of six inches; a white cotton suit; and a *ruana* of blue and crimson plaid, with a hole in the centre for the head to pass through. This cloak is admirably adapted for the purpose, amply covering the rider and mule, and at night answering the purpose of a blanket in the net-hammock, which is made from the fibres of the aloe, and which every traveller carries before him on his mule, and suspends to the trees or in houses, as occasion may require."

The part of the journey which seems to have made the most lasting impression on his mind was that between Bogota and the mining district in the neighbour-

hood of Mariquita. As he ascended the slopes of the mountain-range, and reached the first step of the table-land, he was struck beyond expression with the noble view of the valley of the Magdalena behind him, so vast that he failed in attempting to define the point at which the course of the river blended with the horizon. Like all travellers in the district, he noted the remarkable changes of climate and vegetation, as he rose from the burning plains towards the fresh breath of the mountains. From an atmosphere as hot as that of an oven he passed into delicious cool air; until, in his onward and upward journey, a still more temperate region was reached, the very perfection of climate. Before him rose the majestic Cordilleras, forming a rampart against the western sky, and at certain times of the day looking black, sharp, and even at their summit almost like a wall.

Our engineer took up his abode for a time at Mariquita, a fine old city, though then greatly fallen into decay. During the period of the Spanish dominion, it was an important place, most of the gold and silver convoys passing through it on their way to Cartagena, there to be shipped in galleons for Europe. The mountainous country to the west was rich in silver, gold, and other metals, and it was Mr. Stephenson's object to select the best site for commencing operations for the Company. With this object he "prospected" about in all directions, visiting long-abandoned mines, and analyzing specimens obtained from many quarters. The mines eventually fixed upon as the scene of his operations were those of La Manta and Santa Anna, long before worked by the Spaniards, though, in consequence of the luxuriance and rapidity of the vegetation, all traces of the old workings had become completely overgrown and lost. Everything had to be begun anew. Roads had to be cut to open a way to the mines, machinery had to be erected, and the ground opened up, when some of

the old adits were eventually hit upon. The native peons or labourers were not accustomed to work, and they usually contrived to desert when they were not watched, so that very little progress could be made until the arrival of the expected band of miners from England. The authorities were by no means helpful, and the engineer was driven to an old expedient with the object of overcoming this difficulty. "We endeavour all we can," he says, in one of his letters, "to make ourselves popular, and this we find most effectually accomplished by 'regaling the venal beasts.'" He also gave a ball at Mariquita, which passed off with *éclat*, the governor from Honda, with a host of friends, honouring it with their presence. It was, indeed, necessary to "make a party" in this way, as other schemers were already trying to undermine the Colombian Company in influential directions. The engineer did not exaggerate when he said, "The uncertainty of transacting business in this country is perplexing beyond description." In the mean time labourers had been attracted to Santa Anna, which became, the engineer wrote, "like an English fair on Sundays: people flock to it from all quarters, to buy beef and chat with their friends. Sometimes three or four torros are slaughtered in a day. The people now eat more beef in a week than they did in two months before, and they are consequently getting fat."<sup>1</sup>

At last, Stephenson's party of miners arrived from England, but they gave him even more trouble than the peons had done. They were rough, drunken, and sometimes ungovernable. He set them to work at the Santa Anna mine without delay, and at the same time took up his abode amongst them, "to keep them," he

<sup>1</sup> Letter to Mr. Illingworth, September 25th, 1825. The reports made to the directors and officers of the Company, which we have seen, contain the details of the operations

carried on at the mines; but they are as dry and uninteresting as such reports usually are, and furnish no materials calculated to illustrate the subject of the text.

said, "if possible, from indulging in the detestable vice of drunkenness, which, if not put a stop to, will eventually destroy themselves, and involve the mining association in ruin." To add to his troubles, the captain of the miners displayed a very hostile and insubordinate spirit, quarrelled and fought with the men, and was insolent to the engineer himself. The captain and his gang, being Cornishmen, told Robert to his face that because he was a North-country man, and not brought up in Cornwall, it was impossible that he should know anything of mining. Disease also fell upon him,—first fever, and then visceral derangement, followed by a return of his "old complaint, a feeling of oppression in the breast." No wonder that in the midst of these troubles he should longingly speak of returning to his native land. But he stuck to his post and his duty, kept up his courage, and by a mixture of mildness and firmness, and the display of great coolness of judgment, he contrived to keep the men to their work, and gradually to carry forward the enterprise which he had undertaken. By the beginning of July, 1826, quietness and order had been restored, and the works were proceeding more satisfactorily, though the yield of silver was not as yet very promising,—the engineer being of opinion that at least three years' diligent and costly operations would be necessary to render the mines productive.

In the mean time he removed to the dwelling which had been erected for his accommodation at Santa Anna. It was a structure speedily raised after the fashion of the country. The walls were of split and flattened bamboo, tied together with the long fibres of a dried climbing plant; the roof was of palm-leaves, and the ceiling of reeds. When an earthquake shook the district—for earthquakes were frequent—the inmates of such a fabric merely felt as if shaken in a basket, without sustaining any harm. In front of the cottage lay a woody ravine, extending almost to the base of the

Andes, gorgeously clothed in primeval vegetation—magnolias, palms, bamboos, tree-ferns, acacias, cedars; and, towering over all were the great almendrons, with their smooth, silvery stems, bearing aloft noble clusters of pure white blossom. The forest was haunted by myriads of gay insects, butterflies with wings of dazzling lustre, birds of brilliant plumage, humming-birds, golden orioles, toucans, and a host of solitary warblers. But the glorious sunsets seen from his cottage-porch more than all astonished and delighted the young engineer; and he was accustomed to say that, after having witnessed them, he was reluctant to accuse the ancient Peruvians of idolatry.



ROBERT STEPHENSON'S COTTAGE AT SANTA ANNA.

But all these natural beauties failed to reconcile him to the harassing difficulties of his position, which continued to increase rather than diminish. He was hampered by the action of the Board at home, who gave ear to hostile criticisms on his reports; and although they afterwards made handsome acknowledgment of his ser-

vices, he felt his position to be altogether unsatisfactory. He therefore determined to leave at the expiry of his three years' engagement, and communicated his decision to the directors accordingly.<sup>1</sup>

On receiving his letter, the Board, through Mr. Richardson, of Lombard-street, one of the directors, communicated with his father at Newcastle, representing that if he would allow his son to remain in Colombia the Company would make it "worth his while." To this the father gave a decided negative, and intimated that he himself urgently needed his son's assistance, and that he must return at the expiry of his three years' term,—a decision, Robert wrote, "at which I feel much gratified, as it is clear that he is as anxious to have me back in England as I am to get there."

At the same time, Edward Pease, a principal partner in the Newcastle firm, privately wrote Robert to the following effect, urging his return home:—"I can assure thee that the business at Newcastle, as well as thy father's engineering, have suffered very much from thy absence, and, unless thou soon return, the former will be given up, as Mr. Longridge is not able to give it that attention it requires; and what is done is not done with credit to the house." The idea of the manufactory being given

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<sup>1</sup> In a letter to Mr. Illingworth, then resident at Bogota, dated the 24th March, 1826, Robert wrote as follows:—"Nothing but the fullest consent of my partners in England, could induce me to stay in this country, and the assurance that no absolute necessity existed to call me home. I must also have the consent of my father. I know that he must have suffered severely from my absence, but that having been extended so far beyond the period he was led to expect, may have induced him to curtail his plans; which, had they been accomplished, as they would have been by my assistance, would have placed us both in a situation far

superior to anything that I can hope for as the servant of an Association however wealthy and liberal. What I might do in England is, perhaps, known to myself only; it is difficult, therefore, for the Association to calculate upon rewarding me to the full extent of my prospects at home. My prosperity is involved in that of my father, whose property was sacrificed in laying the foundations of an establishment for me; his capital being invested in a concern which requires the greatest attention, and which, with our personal superintendence, could not fail to secure that independence which forms so principally the object of all our toil."

up, which Robert had laboured so hard to establish before leaving England, was painful to him in the extreme, and he wrote to Mr. Illingworth, strongly urging that arrangements should be made for enabling him to leave without delay. In the mean time he was again laid prostrate by another violent attack of aguish fever; and when able to write, in June, 1827, he expressed himself as "completely wearied and worn down with vexation."

At length, when he was sufficiently recovered from his attack and able to travel, he set out on his voyage homeward in the beginning of August. At Mompox, on his way down the river Magdalena, he met Mr. Bodmer, his successor, with a fresh party of miners from England, on their way up the country to the quarters which he had just quitted. Next day, six hours after leaving Mompox, a steamboat was met ascending the river, with Bolivar the Liberator on board, on his way to St. Bogota; and it was a mortification to our engineer that he had only a passing sight of that distinguished person. It was his intention, on leaving Mariquita, to visit the Isthmus of Panama on his way home, for the purpose of inquiring into the practicability of cutting a canal to unite the Atlantic and Pacific—a project which then formed the subject of considerable public discussion; but Mr. Bodmer having informed him, at Mompox, that such a visit would be inconsistent with the statements made to the London Board that his presence was so anxiously desired at home, he determined to embrace the first opportunity of proceeding to New York.

Arrived at the port of Cartagena, he found himself under the necessity of waiting some time for a ship. The delay was very irksome to him, the more so as the place was then desolated by the ravages of the yellow fever. While sitting one day in the large, bare, comfortable public room of the miserable hotel at which he

put up, he observed two strangers, whom he at once perceived to be English. One of the strangers was a tall, gaunt man, shrunken and hollow-looking, shabbily dressed, and apparently poverty-stricken. On making inquiry, he found it was Trevithick, the builder of the first railroad locomotive! He was returning home from the gold mines of Peru penniless. Robert Stephenson lent him 50*l.* to enable him to reach England; and though he was afterwards heard of as an inventor there, he had no further part in the ultimate triumph of the locomotive.

But Trevithick's misadventures on this occasion had not yet ended, for before he reached New York he was wrecked, and Robert Stephenson with him. The following is the account of the voyage, "big with adventures," as given by the latter in a letter to his friend Illingworth:—

"At first we had very little foul weather, and indeed were for several days becalmed amongst the islands, which was so far fortunate, for a few degrees farther north the most tremendous gales were blowing, and they appear (from our future information) to have wrecked every vessel exposed to their violence. We had two examples of the effects of the hurricane; for, as we sailed north we took on board the remains of two crews found floating about on dismantled hulls. The one had been nine days without food of any kind, except the carcasses of two of their companions who had died a day or two previously from fatigue and hunger. The other crew had been driven about for six days, and were not so dejected, but reduced to such a weak state that they were obliged to be drawn on board our vessel by ropes. A brig bound for Havannah took part of the men, and we took the remainder. To attempt any description of my feelings on witnessing such scenes would be in vain. You will not be surprised to learn that I felt somewhat uneasy at the thought that we were so far from England, and that I also might possibly suffer similar shipwreck; but I consoled myself with the hope that fate would be more kind to us. It was not so much so, however, as I had flattered myself; for on voyaging towards New York, after we had made the land, we ran aground

about midnight. The vessel soon filled with water, and, being surrounded by the breaking surf, the ship shortly split up, and before morning our situation became perilous. Masts and all were cut away to prevent the hull rocking ; but all we could do was of no avail. About 8 o'clock on the following morning, after a most miserable night, we were taken off the wreck, and were so fortunate as to reach the shore. I saved my minerals, but Empson lost part of his botanical collection. Upon the whole, we got off well ; and, had I not been on the American side of the Atlantic, I 'guess' I would not have gone to sea again."

After a short tour in the United States and Canada, Robert Stephenson and his friend took ship for Liverpool, where they arrived at the end of November, and at once proceeded to Newcastle. The factory, we have seen, was by no means in a prosperous state. During the time Robert had been in America it had been carried on at a considerable loss ; and Edward Pease, very much disheartened, wished to retire from it, but George Stephenson being unable to raise the requisite money to buy him out, the establishment was of necessity carried on by its then partners until the locomotive could be established in public estimation as a practicable and economical working power. Robert Stephenson immediately instituted a rigid inquiry into the working of the concern, unravelled the accounts, which had been allowed to fall into confusion during his father's absence at Liverpool, and very shortly succeeding in placing the affairs of the factory in a more healthy condition. In all this he had the hearty support of his father, as well as of the other partners.

The works of the Liverpool and Manchester Railway were now approaching completion. But, strange to say, the directors had not yet decided as to the tractive power to be employed in working the line when opened for traffic. The differences of opinion among them were so great as apparently to be irreconcilable. It was necessary, however, that they should come to some decision without further loss of time ; and many board meetings

were accordingly held to discuss the subject. The old-fashioned and well-tried system of horse haulage was not without its advocates ; but, looking at the large amount of traffic which there *was* to be conveyed, and at the probable delay in the transit from station to station if this method were adopted, the directors, after a visit made by them to the Northumberland and Durham railways in 1828, came to the conclusion that the employment of horse-power was inadmissible.

Fixed engines had many advocates ; the locomotive very few : it stood as yet almost in a minority of one—George Stephenson. The prejudice against the employment of the latter power had even increased since the Liverpool and Manchester Bill underwent its first ordeal in the House of Commons. In proof of this, it may be mentioned that the Newcastle and Carlisle Railway Act was conceded in 1829, on the express condition that it should *not* be worked by locomotives, but by horses only.

Grave doubts still existed as to the practicability of working a large traffic by means of travelling engines. The most celebrated engineers offered no opinion on the subject. They did not believe in the locomotive, and would scarcely take the trouble to examine it. The ridicule with which George Stephenson had been assailed by the barristers before the Parliamentary Committee had not been altogether distasteful to them. Perhaps they did not relish the idea of a man who had picked up his experience in Newcastle coal-pits appearing in the capacity of a leading engineer before Parliament, and attempting to establish a new system of internal communication in the country.

The directors could not disregard the adverse and conflicting views of the professional men whom they consulted. But Stephenson had so repeatedly and earnestly urged upon them the propriety of making a trial of the locomotive before coming to any decision

against it, that they at length authorised him to proceed with the construction of one of his engines by way of experiment. In their report to the proprietors at their annual meeting on the 27th March, 1828, they state that they had, after due consideration, authorised the engineer "to prepare a locomotive engine, which, from the nature of its construction and from the experiments already made, he is of opinion will be effective for the purposes of the Company, without proving an annoyance to the public." The locomotive thus ordered was placed upon the line in 1829, and was found of great service in drawing the waggons full of marl from the two great cuttings.

In the mean time the discussion proceeded as to the kind of power to be permanently employed for the working of the railway. The directors were inundated with schemes of all sorts for facilitating locomotion. The projectors of England, France, and America, seemed to be let loose upon them. There were plans for working the waggons along the line by water-power. Some proposed hydrogen, and others carbonic acid gas. Atmospheric pressure had its eager advocates. And various kinds of fixed and locomotive steam-power were suggested. Thomas Gray urged his plan of a greased road with cog-rails; and Messrs. Vignolles and Ericsson recommended the adoption of a central friction-rail, against which two horizontal rollers under the locomotive, pressing upon the sides of this rail, were to afford the means of ascending the inclined planes.

The directors felt themselves quite unable to choose from amidst this multitude of projects. Their engineer expressed himself as decidedly as heretofore in favour of smooth rails and locomotive engines, which, he was confident, would be found the most economical and by far the most convenient moving power that could be employed. The Stockton and Darlington Railway being now at work, another deputation went down personally

to inspect the fixed and locomotive engines on that line, as well as at Hetton and Killingworth. They returned to Liverpool with much information; but their testimony as to the relative merits of the two kinds of engines was so contradictory, that the directors were as far from a decision as ever.

They then resolved to call to their aid two professional engineers of high standing, who should visit the Darlington and Newcastle railways, carefully examine both modes of working—the fixed and the locomotive,—and report to them fully on the subject. The gentlemen selected were Mr. Walker of Limehouse, and Mr. Rastrick of Stourbridge. After carefully examining the working of the northern lines, they made their report to the directors in the spring of 1829. They concurred in the opinion that the cost of an establishment of fixed engines would be somewhat greater than that of locomotives to do the same work; but they thought the annual charge would be less if the former were adopted. They calculated that the cost of moving a ton of goods thirty miles by fixed engines would be 6·40*d.*, and by locomotives, 8·36*d.*,—assuming a profitable traffic to be obtained both ways. At the same time it was admitted that there appeared more grounds for expecting improvements in the construction and working of locomotives than of stationary engines. “On the whole, however, and looking especially at the computed annual charge of working the road on the two systems on a large scale, Messrs. Walker and Rastrick were of opinion that fixed engines were preferable, and accordingly recommended their adoption to the directors.”<sup>1</sup> And in order to

<sup>1</sup> Mr. Booth's Account, pp. 70-1. While concurring with Mr. Rastrick in recommending “the stationary reciprocating system as the best” if it was the directors' intention to make the line complete at once, so as to accommodate the traffic expected by them, or a quantity approaching to it

(i. e., 3750 tons of goods and passengers from Liverpool towards Manchester, and 3950 tons from Manchester towards Liverpool), Mr. Walker added,—“but if any circumstances should induce the directors to proceed by degrees, and to proportion the power of conveyance to the demand,

carry the system recommended by them into effect, they proposed to divide the railroad between Liverpool and Manchester into nineteen stages of about a mile and a half each, with twenty-one engines fixed at the different points to work the trains forward.

Such was the result, so far, of George Stephenson's labours. The two best practical engineers of the day concurred in reporting substantially in favour of the employment of fixed engines. Not a single professional man of eminence could be found to coincide with the engineer of the railway in his preference for locomotive over fixed engine power. He had scarcely a supporter, and the locomotive system seemed on the eve of being abandoned. Still he did not despair. With the profession against him, and public opinion against him—for the most frightful stories went abroad respecting the dangers, the unsightliness, and the nuisance which the locomotive would create—Stephenson held to his purpose. Even in this, apparently the darkest hour of the locomotive, he did not hesitate to declare that locomotive railroads would, before many years had passed, be "the great highways of the world."

He urged his views upon the directors in all ways, in season, and, as some of them thought, out of season. He pointed out the greater convenience of locomotive power for the purposes of a public highway, likening it to a series of short unconnected chains, any one of which could be removed and another substituted without interruption to the traffic; whereas the fixed-engine

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then we recommend locomotive engines upon the line generally; and two fixed engines upon Rainhill and Sutton planes, to draw up the locomotive engines as well as the goods and carriages." And "if on any occasion the trade should get beyond the supply of locomotives, the horse might form a temporary substitute." As, however, it was the directors' determination, with a view to the

success of their experiment, to open the line complete for working, they felt that it would be unadvisable to adopt this partial experiment; and it was still left for them to decide whether they would adopt or not the substantial recommendation of the reporting engineers in favour of the stationary-engine system for the complete accommodation of the expected traffic.

system might be regarded in the light of a continuous chain extending between the two termini, the failure of any link of which would derange the whole.<sup>1</sup> But the fixed-engine party were very strong at the board, and, led by Mr. Cropper, they urged the propriety of forthwith adopting the report of Messrs. Walker and Rastrick. Mr. Sandars and Mr. William Rathbone, on the other hand, desired that a fair trial should be given to the locomotive; and they with reason objected to the expenditure of the large capital necessary to construct the proposed engine-houses, with their fixed engines, ropes, and machinery, until they had tested the powers of the locomotive as recommended by their own engineer. George Stephenson continued to urge upon them that the locomotive was yet capable of great improvements, if proper inducements were held out to inventors and machinists to make them; and he pledged himself that, if time were given him, he would construct an engine that should satisfy their requirements, and prove itself capable of working heavy loads along the railway with speed, regularity, and safety. At length, influenced by his persistent earnestness not less than by his arguments, the directors, at the suggestion of Mr. Harrison, determined to offer a prize of 500*l.* for the best locomotive engine, which, on a certain day, should be produced on the railway, and perform certain specified conditions in the most satisfactory manner.<sup>2</sup>

<sup>1</sup> The arguments used by Mr. Stephenson with the directors, in favour of the locomotive engine, were afterwards collected and published in 1830 by Robert Stephenson and Joseph Locke, as "compiled from the Reports of Mr. George Stephenson." The pamphlet was entitled, 'Observations on the Comparative Merits of Locomotive and Fixed Engines.' Robert Stephenson, speaking of the authorship many years after, said, "I believe I furnished the facts and the arguments, and Locke put them into shape.

Locke was a very flowery writer, whereas my style was rather bald and unattractive; so he was the editor of the pamphlet, which excited a good deal of attention amongst engineers at the time."

<sup>2</sup> The conditions were these:—

1. The engine must effectually consume its own smoke.
2. The engine, if of six tons weight, must be able to draw after it, day by day, twenty tons weight (including the tender and water-tank) at *ten miles* an hour, with a pressure of

The requirements of the directors as to speed were not excessive. All that they asked for was, that ten miles an hour should be maintained. Perhaps they had in mind the animadversions of the 'Quarterly Review' on the absurdity of travelling at a greater velocity, and also the remarks published by Mr. Nicholas Wood, whom they selected to be one of the judges of the competition, in conjunction with Mr. Rastrick of Stourbridge and Mr. Kennedy of Manchester.

It was now felt that the fate of railways in a great measure depended upon the issue of this appeal to the mechanical genius of England. When the advertisement of the prize for the best locomotive was published, scientific men began more particularly to direct their attention to the new power which was thus struggling into existence. In the mean time public opinion on the subject of railway working remained suspended, and the progress of the undertaking was watched with intense interest.

During the progress of this important controversy with reference to the kind of power to be employed in

steam on the boiler not exceeding fifty pounds to the square inch.

3. The boiler must have two safety valves, neither of which must be fastened down, and one of them be completely out of the control of the engine-man.

4. The engine and boiler must be supported on springs, and rest on six wheels, the height of the whole not exceeding fifteen feet to the top of the chimney.

5. The engine, with water, must not weigh more than six tons; but an engine of less weight would be preferred on its drawing a proportionate load behind it; if of only four and a-half tons, then it might be put on only four wheels. The Company to be at liberty to test the boiler, &c., by a pressure of one hundred and fifty pounds to the square inch.

6. A mercurial gauge must be affixed to the machine, showing the

steam pressure above forty-five pounds per square inch.

7. The engine must be delivered, complete and ready for trial, at the Liverpool end of the railway, not later than the 1st of October, 1829.

8. The price of the engine must not exceed 550*l*.

Many persons of influence declared the conditions published by the directors of the railway chimerical in the extreme. One gentleman of some eminence in Liverpool, Mr. P. Ewart, who afterwards filled the office of Government Inspector of Post Office Steam-jackets, declared that only a parcel of charlatans would ever have issued such a set of conditions; that it had been *proved* to be impossible to make a locomotive engine go at ten miles an hour; but if it ever was done, he would undertake to eat a stewed engine-wheel for his breakfast!

working the railway, George Stephenson was in constant communication with his son Robert, who made frequent visits to Liverpool for the purpose of assisting his father in the preparation of his reports to the board on the subject. Mr. Swanwick remembers the vivid interest of the evening discussions which then took place between father and son as to the best mode of increasing the powers and perfecting the mechanism of the locomotive. He wondered at their quick perception and rapid judgment on each other's suggestions; at the mechanical difficulties which they anticipated and provided for in the practical arrangement of the machine; and he speaks of these evenings as most interesting displays of two actively ingenious and able minds, stimulating each other to feats of mechanical invention, by which it was ordained that the locomotive engine should become what it now is. These discussions became more frequent, and still more interesting, after the public prize had been offered for the best locomotive by the directors of the railway, and the working plans of the engine which they proposed to construct had to be settled.

One of the most important considerations in the new engine was the arrangement of the boiler and the extension of its heating surface to enable steam enough to be raised rapidly and continuously, for the purpose of maintaining high rates of speed,—the effect of high-pressure engines being ascertained to depend mainly upon the quantity of steam which the boiler can generate, and upon its degree of elasticity when produced. The quantity of steam so generated, it will be obvious, must chiefly depend upon the quantity of fuel consumed in the furnace, and, by necessary consequence, upon the high rate of temperature maintained there.

It will be remembered that in Stephenson's first Killingworth engines, he invented and applied the ingenious method of stimulating combustion in the furnace, by throwing the waste steam into the chimney after per-

forming its office in the cylinders, thereby accelerating the ascent of the current of air, greatly increasing the draught, and consequently the temperature of the fire. This plan was adopted by him, as we have seen, as early as 1815; and it was so successful that he himself attributed to it the greater economy of the locomotive as compared with horse-power. Hence the continuance of its use upon the Killingworth Railway.

Though the adoption of the steam-blast greatly quickened combustion and contributed to the rapid production of high-pressure steam, the limited amount of heating surface presented to the fire was still felt to be an obstacle to the complete success of the locomotive engine. Mr. Stephenson endeavoured to overcome this by lengthening the boilers and increasing the surface presented by the flue-tubes. The "Lancashire Witch," which he built for the Bolton and Leigh Railway, and used in forming the Liverpool and Manchester Railway embankments, was constructed with a double tube, each of which contained a fire and passed longitudinally through the boiler. But this arrangement necessarily led to a considerable increase in the weight of those engines, which amounted to about twelve tons each; and as six tons was the limit allowed for engines admitted to the Liverpool competition, it was clear that the time was come when the Killingworth engine must undergo a further important modification.

For many years previous to this period, ingenious mechanics had been engaged in attempting to solve the problem of the best and most economical boiler for the production of high-pressure steam.

The use of tubes in boilers for increasing the heating surface had long been known. As early as 1780, Matthew Boulton employed copper tubes longitudinally in the boiler of the Wheal Busy engine in Cornwall—the fire passing *through* the tubes—and it was found that the production of steam was thereby considerably

increased.<sup>1</sup> The use of tubular boilers afterwards became common in Cornwall. In 1803, Woolf, the Cornish engineer, patented a boiler with tubes, with the same object of increasing the heating surface. The water was *inside* the tubes, and the fire of the boiler outside. Similar expedients were proposed by other inventors. In 1815 Trevithick invented his light high-pressure boiler for portable purposes, in which, to "expose a large surface to the fire," he constructed the boiler of a number of small perpendicular tubes "opening into a common reservoir at the top." In 1823 W. H. James contrived a boiler composed of a series of annular wrought-iron tubes, placed side by side and bolted together, so as to form by their union a long cylindrical boiler, in the centre of which, at the end, the fire-place was situated. The fire played round the tubes, which contained the water. In 1826 James Neville took out a patent for a boiler with vertical tubes surrounded by the water, through which the heated air of the furnace passed, explaining also in his specification that the tubes might be horizontal or inclined, according to circumstances. Mr. Goldsworthy Gurney, the persevering adaptor of steam-carriages to travelling on common roads, applied the tubular principle in the boiler of his engine, in which the steam was generated *within* the tubes; while the boiler invented by Messrs. Summers and Ogle for their turnpike-road steam-carriage, consisted of a series of tubes placed vertically over the furnace, through which the heated air passed before reaching the chimney.

About the same time George Stephenson was trying the effect of introducing small tubes in the boilers of

<sup>1</sup> Some correspondence took place between Boulton and Watt on the subject, when the latter was scheming the application of the steam-engine to locomotive purposes. In a letter to Boulton, dated the 27th August, 1784, Watt said, "Perhaps some means may

be hit upon to make the boiler cylindrical *with a number of tubes passing through*, like the organ-pipe condenser, whereby it might be thinner and lighter; but," he added, "I fear this would be too subject to accidents."

his locomotives, with the object of increasing their evaporative power. Thus, in 1829, he sent to France two engines constructed at the Newcastle works for the Lyons and St. Etienne Railway, in the boilers of which tubes were placed containing water. The heating surface was thus considerably increased; but the expedient was not successful, for the tubes, becoming furred with deposit, shortly burned out and were removed. It was then that M. Seguin, the engineer of the railway, pursuing the same idea, is said to have adopted his plan of employing horizontal tubes through which the heated air passed in streamlets; and for which he took out a French patent.

In the mean time Mr. Henry Booth, secretary to the Liverpool and Manchester Railway, whose attention had been directed to the subject on the prize being offered for the best locomotive to work that line, proposed the same method, which, unknown to him, Matthew Boulton had employed but not patented in 1780, and James Neville had patented but not employed in 1826; and it was carried into effect by Robert Stephenson in the construction of the "Rocket," which won the prize at Rainhill in October, 1829. The following is Mr. Booth's account in a letter to the author:—

"I was in almost daily communication with Mr. Stephenson at the time, and I was not aware that he had any intention of competing for the prize till I communicated to him my scheme of a multitubular boiler. This new plan of boiler comprised the introduction of numerous small tubes, two or three inches in diameter, and less than one-eighth of an inch thick, through which to carry the fire, instead of a single tube or flue eighteen inches in diameter, and about half an inch thick; by which plan we not only obtain a very much larger heating surface, but the heating surface is much more effective, as there intervenes between the fire and the water only a thin sheet of copper or brass, not an eighth of an inch thick, instead of a plate of iron of four times the substance, as well as an inferior conductor of heat.

“When the conditions of trial were published, I communicated my multitubular plan to Mr. Stephenson, and proposed to him that we should jointly construct an engine, and compete for the prize. Mr. Stephenson approved the plan, and agreed to my proposal. He settled the mode in which the fire-box and tubes were to be mutually arranged and connected, and the engine was constructed at the works of Messrs. Robert Stephenson and Co., Newcastle-on-Tyne.

“I am ignorant of M. Seguin’s proceedings in France, but I claim to be the inventor in England, and feel warranted in stating, without reservation, that until I named my plan to Mr. Stephenson, with a view to compete for the prize at Rainhill, it had not been tried, and was not known in this country.”

From the well-known high character of Mr. Booth, we believe his statement to be made in perfect good faith, and that he was as much in ignorance of the plan patented by Neville as he was of that of Seguin. As we have seen, from the many plans of tubular boilers invented during the preceding thirty years, the idea was not by any means new; and we believe Mr. Booth to be entitled to the merit of inventing the method by which the multitubular principle was so effectually applied in the construction of the famous “Rocket” engine.

The principal circumstances connected with the construction of the “Rocket,” as described by Robert Stephenson to the author, may be briefly stated. The tubular principle was adopted in a more complete manner than had yet been attempted. Twenty-five copper tubes, each three inches in diameter, extended from one end of the boiler to the other, the heated air passing through them on its way to the chimney; and the tubes being surrounded by the water of the boiler, it will be obvious that a large extension of the heating surface was thus effectually secured. The principal difficulty was in fitting the copper tubes in the boiler-ends so as to prevent leakage. They were manufactured by a Newcastle coppersmith, and soldered to brass screws which were screwed into the boiler-ends, stand-

ing out in great knobs. When the tubes were thus fitted, and the boiler was filled with water, hydraulic pressure was applied; but the water squirted out at every joint, and the factory floor was soon flooded. Robert went home in despair; and in the first moment of grief he wrote to his father that the whole thing was a failure. By return of post came a letter from his father, telling him that despair was not to be thought of—that he must “try again;” and he suggested a mode of overcoming the difficulty, which his son had already anticipated and proceeded to adopt. It was, to bore clean holes in the boiler-ends, fit in the smooth copper tubes as tightly as possible, solder up, and then raise the steam. This plan succeeded perfectly, the expansion of the copper tubes completely filling up all interstices, and producing a perfectly watertight boiler, capable of withstanding extreme internal pressure.

The mode of employing the steam-blast for the purpose of increasing the draught in the chimney was also the subject of numerous experiments. When the engine was first tried, it was thought that the blast in the chimney was not sufficiently strong for the purpose of keeping up the intensity of the fire in the furnace, so as to produce high-pressure steam with the required velocity. The expedient was therefore adopted of hammering the copper tubes at the point at which they entered the chimney, whereby the blast was considerably sharpened; and on a further trial it was found that the draught was increased to such an extent as to enable abundance of steam to be raised. The rationale of the blast may be simply explained by referring to the effect of contracting the pipe of a water-hose, by which the force of the jet of water is proportionately increased. Widen the nozzle of the pipe, and the jet is in like manner diminished. So is it with the steam-blast in the chimney of the locomotive.

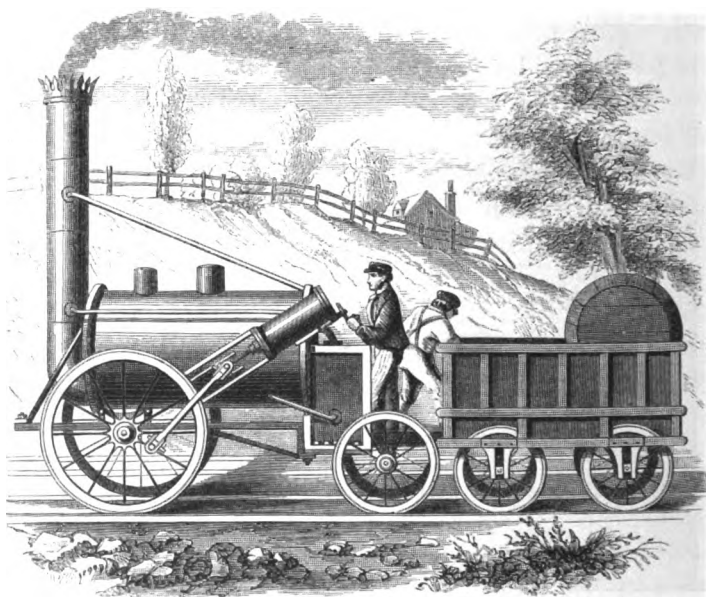
Doubts were, however, expressed whether the greater

draught obtained by the contraction of the blast-pipe was not counterbalanced in some degree by the negative pressure upon the piston. Hence a series of experiments was made with pipes of different diameters; and their efficiency was tested by the amount of vacuum that was produced in the smoke-box. The degree of rarefaction was determined by a glass tube fixed to the bottom of the smoke-box, and descending into a bucket of water, the tube being open at both ends. As the rarefaction took place, the water would of course rise in the tube; and the height to which it rose above the surface of the water in the bucket was made the measure of the amount of rarefaction. These experiments proved that a considerable increase of draught was obtained by the contraction of the orifice; accordingly, the two blast-pipes opening from the cylinders into either side of the "Rocket" chimney, and turned up within it, were contracted slightly below the area of the steam-ports; and before the engine left the factory, the water rose in the glass tube three inches above the water in the bucket.

The other arrangements of the "Rocket" were briefly these:—the boiler was cylindrical, with flat ends, six feet in length, and three feet four inches in diameter. The upper half of the boiler was used as a reservoir for the steam, the lower half being filled with water. Through the lower part the copper tubes extended, being open to the fire-box at one end, and to the chimney at the other. The fire-box, or furnace, two feet wide and three feet high, was attached immediately behind the boiler, and was also surrounded with water. The cylinders of the engine were placed on each side of the boiler, in an oblique position, one end being nearly level with the top of the boiler at its after end, and the other pointing towards the centre of the foremost or driving pair of wheels, with which the connection was directly made from the piston-rod to a pin on the outside of the wheel. The engine, together with its load

of water, weighed only four tons and a quarter; and it was supported on four wheels, not coupled. The tender was four-wheeled, and similar in shape to a waggon,—the foremost part holding the fuel, and the hind part a water-cask.

When the "Rocket" was finished, it was placed upon the Killingworth Railway for the purpose of experiment. The new boiler arrangement was found perfectly suc-



THE "ROCKET"

cessful. The steam was raised rapidly and continuously, and in a quantity which then appeared marvellous. The same evening Robert despatched a letter to his father at Liverpool, informing him, to his great joy, that the "Rocket" was "all right," and would be in complete working trim by the day of trial. The engine was shortly after sent by waggon to Carlisle, and thence shipped for Liverpool.

The time so much longed for by George Stephenson had now arrived, when the merits of the passenger loco-

motive were about to be put to the test. He had fought the battle for it until now almost single-handed. Engrossed by his daily labours and anxieties, and harassed by difficulties and discouragements which would have crushed the spirit of a less resolute man, he had held firmly to his purpose through good and through evil report. The hostility which he experienced from some of the directors opposed to the adoption of the locomotive, was the circumstance that caused him the greatest grief of all; for where he had looked for encouragement, he found only carping and opposition. But his pluck never failed him; and now the "Rocket" was upon the ground to prove, to use his own words, "whether he was a man of his word or not."

Great interest was felt at Liverpool, as well as throughout the country, in the approaching competition. Engineers, scientific men, and mechanics arrived from all quarters to witness the novel display of mechanical ingenuity on which such great results depended. The public generally were no indifferent spectators either. The populations of Liverpool, Manchester, and the adjacent towns felt that the successful issue of the experiment would confer upon them individual benefits and local advantages almost incalculable, while populations at a distance waited for the result with almost equal interest.

On the day appointed for the great competition of locomotives at Rainhill the following engines were entered for the prize :—

1. Messrs. Braithwaite and Ericsson's<sup>1</sup> "Novelty."
2. Mr. Timothy Hackworth's "Sanspareil."
3. Messrs. R. Stephenson and Co.'s "Rocket."
4. Mr. Burstall's "Perseverance."

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<sup>1</sup> The inventor of this engine was a Swede, who afterwards proceeded to the United States, and there achieved considerable distinction as an engineer.

His Caloric Engine has so far proved a failure, but his iron cupola vessel, the "Monitor," must be admitted to have been a remarkable success in its way.

Another engine was entered by Mr. Brandreth of Liverpool—the “Cycloped,” weighing three tons, worked by a horse in a frame, but it could not be admitted to the competition. The above were the only four exhibited, out of a considerable number of engines constructed in different parts of the country in anticipation of this contest, many of which could not be satisfactorily completed by the day of trial.

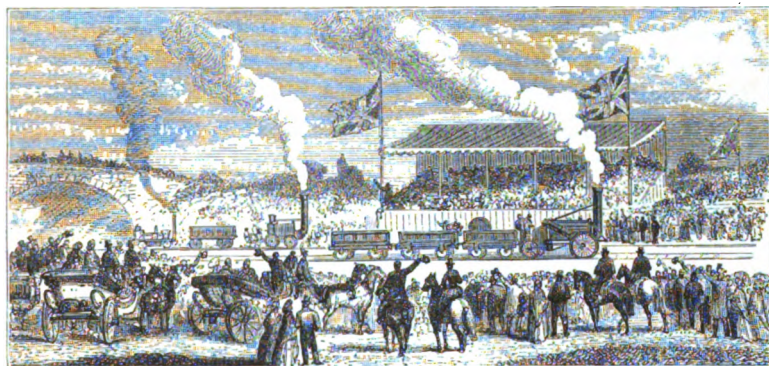
The ground on which the engines were to be tried was a level piece of railroad, about two miles in length. Each was required to make twenty trips, or equal to a journey of seventy miles, in the course of the day; and the average rate of travelling was to be not under ten miles an hour. It was determined that, to avoid confusion, each engine should be tried separately, and on different days.

The day fixed for the competition was the 1st of October, but to allow sufficient time to get the locomotives into good working order, the directors extended it to the 6th. On the morning of the 6th, the ground at Rainhill presented a lively appearance, and there was as much excitement as if the St. Leger were about to be run. Many thousand spectators looked on, amongst whom were some of the first engineers and mechanics of the day. A stand was provided for the ladies; the “beauty and fashion” of the neighbourhood were present, and the side of the railroad was lined with carriages of all descriptions.

It was quite characteristic of the Stephensons, that, although their engine did not stand first on the list for trial, it was the first that was ready; and it was accordingly ordered out by the judges for an experimental trip. Yet the “Rocket” was by no means the “favourite” with either the judges or the spectators. Nicholas Wood has since stated that the majority of the judges were strongly predisposed in favour of the “Novelty,” and that “nine-tenths, if not ten-tenths, of the persons

present, were against the "Rocket" because of its appearance."<sup>1</sup> Nearly every person favoured some other engine, so that there was nothing for the "Rocket" but the practical test. The first trip made by it was quite successful. It ran about twelve miles, without interruption, in about fifty-three minutes.

The "Novelty" was next called out. It was a light engine, very compact in appearance, carrying the water and fuel upon the same wheels as the engine. The



LOCOMOTIVE COMPETITION AT RAINHILL.

weight of the whole was only three tons and one hundredweight. A peculiarity of this engine was that the air was driven or *forced* through the fire by means of bellows. The day being now far advanced, and some dispute having arisen as to the method of assigning the proper load for the "Novelty," no particular experiment was made, further than that the engine traversed the line by way of exhibition, occasionally moving at the rate of twenty-four miles an hour. The "Sanspareil," constructed by Mr. Timothy Hackworth, was next exhibited; but no particular experiment was made with it on this day. This engine differed but little in its construction from the locomotive last supplied by the

<sup>1</sup> Mr. Wood's speech at Newcastle, 26th October, 1858.

Stephensons to the Stockton and Darlington Railway, of which Mr. Hackworth was the locomotive foreman.

The contest was postponed until the following day; but before the judges arrived on the ground the bellows for creating the blast in the "Novelty" gave way, and it was found incapable of going through its performance. A defect was also detected in the boiler of the "Sanspareil;" and some further time was allowed to get it repaired. The large number of spectators who had assembled to witness the contest were greatly disappointed at this postponement; but, to lessen it, Stephenson again brought out the "Rocket," and, attaching to it a coach containing thirty persons, he ran them along the line at the rate of from twenty-four to thirty miles an hour, much to their gratification and amazement. Before separating, the judges ordered the engine to be in readiness by eight o'clock on the following morning, to go through its definitive trial according to the prescribed conditions.

On the morning of the 8th of October, the "Rocket" was again ready for the contest. The engine was taken to the extremity of the stage, the fire-box was filled with coke, the fire lighted, and the steam raised until it lifted the safety-valve loaded to a pressure of fifty pounds to the square inch. This proceeding occupied fifty-seven minutes. The engine then started on its journey, dragging after it about thirteen tons weight in waggons, and made the first ten trips backwards and forwards along the two miles of road, running the thirty-five miles, including stoppages, in an hour and forty-eight minutes. The second ten trips were in like manner performed in two hours and three minutes. The maximum velocity attained during the trial trip was twenty-nine miles an hour, or about three times the speed that one of the judges of the competition had declared to be the limit of possibility. The average speed at which the whole of the journeys were performed was fifteen

miles an hour, or five miles beyond the rate specified in the conditions published by the Company. The entire performance excited the greatest astonishment amongst the assembled spectators; the directors felt confident that their enterprise was now on the eve of success; and George Stephenson rejoiced to think that, in spite of all false prophets and fickle counsellors, the locomotive system was now safe. When the "Rocket," having performed all the conditions of the contest, arrived at the "grand stand" at the close of its day's successful run, Mr. Cropper—one of the directors favourable to the fixed-engine system—lifted up his hands, and exclaimed, "Now has George Stephenson at last delivered himself."

Neither the "Novelty" nor the "Sanspareil" was ready for trial until the 10th, on the morning of which day an advertisement appeared, stating that the former engine was to be tried on that day, when it would perform more work than any engine on the ground. The weight of the carriages attached to it was only about seven tons. The engine passed the first post in good style; but in returning, the pipe from the forcing-pump burst and put an end to the trial. The pipe was afterwards repaired, and the engine made several trips by itself, in which it was said to have gone at the rate of from twenty-four to twenty-eight miles an hour.

The "Sanspareil" was not ready until the 13th: and when its boiler and tender were filled with water, it was found to weigh four hundredweight beyond the weight specified in the published conditions as the limit of four-wheeled engines; nevertheless the judges allowed it to run on the same footing as the other engines, to enable them to ascertain whether its merits entitled it to favourable consideration. It travelled at the average speed of about fourteen miles an hour, with its load attached; but at the eighth trip the cold-water pump got wrong, and the engine could proceed no further.

It was determined to award the premium to the successful engine on the following day, the 14th, on which occasion there was an unusual assemblage of spectators. The owners of the "Novelty" pleaded for another trial; and it was conceded. But again it broke down. Then Mr. Hackworth requested the opportunity for making another trial of his "Sanspareil." But the judges had now had enough of failures; and they declined, on the ground that not only was the engine above the stipulated weight, but that it was constructed on a plan which they could not recommend for adoption by the directors of the Company. One of the principal practical objections to this locomotive was the enormous quantity of coke consumed or wasted by it—about 692 lbs. per hour when travelling—caused by the sharpness of the steam-blast in the chimney, which blew a large proportion of the burning coke into the air.

The "Perseverance" of Mr. Burstall was found unable to move at more than five or six miles an hour; and it was withdrawn from the contest at an early period. The "Rocket" was thus the only engine that had performed, and more than performed, all the stipulated conditions; and it was declared to be entitled to the prize of 500*l.*, which was awarded to the Messrs. Stephenson and Booth accordingly. And further to show that the engine had been working quite within its powers, George Stephenson ordered it to be brought upon the ground and detached from all incumbrances, when, in making two trips, it was found to travel at the astonishing rate of thirty-five miles an hour.

The "Rocket" had thus eclipsed the performances of all locomotive engines that had yet been constructed, and outstripped even the sanguine anticipations of its constructors. It satisfactorily answered the report of Messrs. Walker and Rastrick; and established the efficiency of the locomotive for working the Liverpool and Manchester Railway, and indeed all future railways.

The "Rocket" showed that a new power had been born into the world, full of activity and strength, with boundless capability of work. It was the simple but admirable contrivance of the steam-blast, and its combination with the multitubular boiler, that at once gave locomotion a vigorous life, and secured the triumph of the railway system.<sup>1</sup> As has been well observed, this wonderful ability to increase and multiply its powers of performance with the emergency that demands them, has made this giant engine the noblest creation of human wit, the very lion among machines. The success of the Rainhill experiment, as judged by the public, may be inferred from the fact that the shares of the Company immediately rose ten per cent., and nothing further was heard of the proposed twenty-one fixed engines, engine-houses, ropes, &c. All this cumbersome apparatus was thenceforward effectually disposed of.

Very different now was the tone of those directors who had distinguished themselves by the persistency of their opposition to George Stephenson's plans. Coolness gave way to eulogy, and hostility to unbounded offers of friendship, after the manner of many men who run to the help of the strong. Deeply though the engineer had felt aggrieved by the conduct ex-

<sup>1</sup> When heavier and more powerful engines were brought upon the road, the old "Rocket" becoming regarded as a thing of no value, was sold in 1837. It was purchased by Mr. Thompson, of Kirkhouse, the lessee of the Earl of Carlisle's coal and lime works, near Carlisle. He worked the engine on the Midgeholme Railway for five or six years, during which it hauled coals from the pits to the town. There was wonderful vitality in the old engine, as the following circumstance proves. When the great contest for the representation of East Cumberland took place, and Sir James Graham was superseded by Major Aglionby, the "Rocket" was employed to convey the Alston express with

the state of the poll from Midgeholme to Kirkhouse. On that occasion the engine was driven by Mr. Mark Thompson, and it ran the distance of upwards of four miles in four and a-half minutes, thus reaching a speed of nearly sixty miles an hour—proving its still admirable qualities as an engine. But again it was superseded by heavier engines; for it only weighed about four tons, whereas the new engines were at least three times that weight. The "Rocket" was consequently laid up in ordinary in the yard at Kirkhouse, from whence it has since been transferred to the Museum of Patents at Kensington, where it is still to be seen.

hibited towards him during this eventful struggle, by some from whom forbearance was to have been expected, he never entertained towards them in after life any angry feelings; on the contrary, he forgave all. But though the directors afterwards passed unanimous resolutions eulogising "the great skill and unwearied energy" of their engineer, he himself, when speaking confidentially to those with whom he was most intimate, could not help pointing out the difference between his "foul-weather and fair-weather friends." Mr. Gooch says, that though naturally most cheerful and kind-hearted in disposition, the anxiety and pressure which weighed upon his mind during the construction of the railway, had the effect of making him occasionally impatient and irritable, like a spirited horse touched by the spur; though his original good nature from time to time shone through it all. When the line had been brought to a successful completion, a very marked change in him became visible. The irritability passed away, and when difficulties and vexations arose they were treated by him as matters of course, and with perfect composure and cheerfulness.



RAILWAY v. ROAD.

## CHAPTER XIII.

OPENING OF THE LIVERPOOL AND MANCHESTER RAILWAY,  
AND EXTENSION OF THE RAILWAY SYSTEM.

THE directors of the Railway now began to see daylight ; and they derived encouragement from the skilful manner in which their engineer had overcome the principal difficulties of the undertaking. He had formed a solid road over Chat Moss, and thus achieved one " impossibility ;" and he had constructed a locomotive that could run at a speed of thirty miles an hour, thus vanquishing a still more formidable difficulty.

A single line of way was completed over Chat Moss by the 1st of January, 1830 ; and on that day, the " Rocket," with a carriage full of directors, engineers, and their friends, passed along the greater part of the road between Liverpool and Manchester. Mr. Stephenson continued to direct his close attention to the improvement of the details of the locomotive, every successive trial of which proved more satisfactory. In this department, he had the benefit of the able and unremitting assistance of his son, who, in the workshops at Newcastle, directly superintended the construction of the engines required for the public working of the railway. He did not by any means rest satisfied with the success, decided though it was, which had been achieved by the " Rocket." He regarded it but in the light of a successful experiment ; and every succeeding engine placed upon the railway exhibited some improvement on its predecessors. The arrangement of the parts, and the weight and proportions of the engines, were altered, as the experience of each suc-

cessive day, or week, or month, suggested ; and it was soon found that the performances of the "Rocket" on the day of trial had been greatly within the powers of the improved locomotive.

The first entire trip between Liverpool and Manchester was performed on the 14th of June, 1830, on the occasion of a board meeting being held at the latter town. The train was on this occasion drawn by the "Arrow," one of the new locomotives, in which the most recent improvements had been adopted. George Stephenson himself drove the engine, and Captain Scoresby, the circumpolar navigator, stood beside him on the foot-plate, and minuted the speed of the train. A great concourse of people assembled at both termini, as well as along the line, to witness the novel spectacle of a train of carriages drawn by an engine at the speed of seventeen miles an hour. On the return journey to Liverpool in the evening, the "Arrow" crossed Chat Moss at a speed of nearly twenty-seven miles an hour, reaching its destination in about an hour and a half.

In the mean time Mr. Stephenson and his assistant, Mr. Gooch, were diligently occupied in making the necessary preliminary arrangements for the conduct of the traffic against the time when the line should be ready for opening. The experiments made with the object of carrying on the passenger traffic at quick velocities were of an especially harassing and anxious character. Every week, for nearly three months before the opening, trial trips were made to Newton and back, generally with two or three trains following each other, and carrying altogether from two to three hundred persons. These trips were usually made on Saturday afternoons, when the works could be more conveniently stopped and the line cleared for the occasion. In these experiments Mr. Stephenson had the able assistance of Mr. Henry Booth, the secretary of the Company, who contrived many of the arrangements in the passenger

carriages, not the least valuable of which was his invention of the coupling screw, still in use on all passenger railways.

At length the line was finished, and ready for the public opening, which took place on the 15th of September, 1830, and attracted a vast number of spectators from all parts of the country. The completion of the railway was justly regarded as an important national event, and the ceremony of its opening was celebrated accordingly. The Duke of Wellington, then Prime Minister, Sir Robert Peel, Secretary of State, Mr. Huskisson, one of the members for Liverpool and an earnest supporter of the project from its commencement, were among the number of distinguished public personages present.

Eight locomotive engines, constructed at the Stephenson works, had been delivered and placed upon the line, the whole of which had been tried and tested, weeks before, with perfect success. The several trains of carriages accommodated in all about six hundred persons. The "Northumbrian" engine, driven by George Stephenson himself, headed the line of trains; then followed the "Phoenix," driven by Robert Stephenson; the "North Star," by Robert Stephenson senior (brother of George); the "Rocket," by Joseph Locke; the "Dart," by Thomas L. Gooch; the "Comet," by William Allcard; the "Arrow," by Frederick Swanwick; and the "Meteor," by Anthony Harding. The procession was cheered in its progress by thousands of spectators—through the deep ravine of Olive Mount; up the Sutton incline; over the great Sankey viaduct, beneath which a multitude of persons had assembled,—carriages filling the narrow lanes, and barges crowding the river; the people below gazing with wonder and admiration at the trains which sped along the line, far above their heads, at the rate of some twenty-four miles an hour.

At Parkside, about seventeen miles from Liverpool,

the engines stopped to take in water. Here a deplorable accident occurred to one of the illustrious visitors, which threw a deep shadow over the subsequent proceedings of the day. The "Northumbrian" engine, with the carriage containing the Duke of Wellington, was drawn up on one line, in order that the whole of the trains on the other line might pass in review before him and his party. Mr. Huskisson had alighted from the carriage, and was standing on the opposite road, along which the "Rocket" was observed rapidly coming up. At this moment the Duke of Wellington, between whom and Mr. Huskisson some coolness had existed, made a sign of recognition, and held out his hand. A hurried but friendly grasp was given; and before it was loosened there was a general cry from the bystanders of "Get in, get in!" Flurried and confused, Mr. Huskisson endeavoured to get round the open door of the carriage, which projected over the opposite rail; but in so doing he was struck down by the "Rocket," and falling with his leg doubled across the rail, the limb was instantly crushed. His first words, on being raised, were, "I have met my death," which unhappily proved true, for he expired that same evening in the parsonage of Eccles. It was cited at the time as a remarkable fact, that the "Northumbrian" engine, driven by George Stephenson himself, conveyed the wounded body of the unfortunate gentleman a distance of about fifteen miles in twenty-five minutes, or at the rate of thirty-six miles an hour. This incredible speed burst upon the world with the effect of a new and unlooked-for phenomenon.

The accident threw a gloom over the rest of the day's proceedings. The Duke of Wellington and Sir Robert Peel expressed a wish that the procession should return to Liverpool. It was, however, represented to them that a vast concourse of people had assembled at Manchester to witness the arrival of the trains; that report would exaggerate the mischief, if they did not complete

the journey ; and that a false panic on that day might seriously affect future railway travelling and the value of the Company's property. The party consented accordingly to proceed to Manchester, but on the understanding that they should return as soon as possible, and refrain from further festivity.

As the trains approached Manchester, crowds of people were found covering the banks, the slopes of the cuttings, and even the railway itself. The multitude, become impatient and excited by the rumours which reached them, had outflanked the military, and all order was at an end. The people clambered about the carriages, holding on by the door handles, and many were tumbled over ; but, happily, no fatal accident occurred. At the Manchester station, the political element began to display itself ; placards about " Peterloo," &c., were exhibited, and brickbats were thrown at the carriage containing the Duke. On the trains coming to a stand in the Manchester station, the Duke did not descend, but remained seated, shaking hands with the women and children who were pushed forward by the crowd. Shortly after, the trains returned to Liverpool, which they reached, after considerable delays, late at night.

On the following morning, the railway was opened for public traffic. The first train of 140 passengers was booked and sent on to Manchester, reaching it in the allotted time of two hours ; and from that time the traffic has regularly proceeded from day to day until now.

It is scarcely necessary that we should speak at any length of the commercial results of the Liverpool and Manchester Railway. Suffice it to say that its success was complete and decisive. The anticipations of its projectors were, however, in many respects at fault. They had based their calculations almost entirely on the heavy merchandise traffic,—such as coal, cotton, and

timber,—relying little upon passengers; whereas the receipts derived from the conveyance of passengers far exceeded those derived from merchandise of all kinds, which, for a time, continued a subordinate branch of the traffic. In the evidence given before the Committee of the House of Commons, the promoters stated their expectation of obtaining about one-half of the whole number of passengers which the coaches then running could carry, or about 400 a day. But the railway was scarcely opened before it carried on an average about 1200 passengers daily; and five years after the opening, it carried nearly half a million of persons yearly. So successful, indeed, was the passenger traffic, that it engrossed the whole of the Company's small stock of engines.

For some time after the public opening of the line, Mr. Stephenson's ingenuity continued to be employed in devising improved methods for securing the safety and comfort of the travelling public. Few are aware of the thousand minute details which have to be arranged—the forethought and contrivance that have to be exercised—to enable the traveller by railway to accomplish his journey in safety. After the difficulties of constructing a level road over bogs, across valleys, and through deep cuttings, have been overcome, the maintenance of the way has to be provided for with continuous care. Every rail with its fastenings must be complete to prevent risk of accident, and the road must be kept regularly ballasted up to the level to diminish the jolting of vehicles passing over it at high speeds. Then the stations must be protected by signals observable from such a distance as to enable the train to be stopped in event of an obstacle, such as a stopping or shunting train being in the way. For some years the signals employed on the Liverpool Railway were entirely given by men with flags of different colours stationed along the line; there were no fixed signals, nor electric

telegraphs; but the traffic was nevertheless worked quite as safely as under the more elaborate and complicated system of telegraphing which has since been established.

From an early period it became obvious that the iron road, as originally laid down, was quite insufficient for the heavy traffic which it had to carry. The line was in the first place laid with fish-bellied rails of only thirty-five pounds to the yard, calculated only for horse-traffic, or, at most, for engines like the "Rocket," of very light weight. But as the power and the weight of the locomotives were increased, it was found that such rails were quite insufficient for the safe conduct of the traffic, and it therefore became necessary to relay the road with heavier and stronger rails at considerable expense.

The details of the carrying stock had in like manner to be settled by experience. Everything had, as it were, to be begun from the beginning. The coal-waggon, it is true, served in some degree as a model for the railway-truck; but the railway passenger-carriage was an entirely novel structure. It had to be mounted upon strong framing, of a peculiar kind, supported on springs to prevent jolting. Then there was the necessity for contriving some method of preventing hard bumping of the carriage-ends when the train was pulled up; and hence the contrivance of buffer-springs and spring-frames. For the purpose of stopping the train, brakes on an improved plan were also contrived, with new modes of lubricating the carriage-axles, on which the wheels revolved at an unusually high velocity. In all these contrivances, Mr. Stephenson's inventiveness was kept constantly on the stretch; and though many improvements in detail have been effected since his time, the foundations were then laid by him of the present system of conducting railway traffic. As a curious illustration of the inventive ingenuity which he

displayed in contriving the working of the Liverpool line, we may mention his invention of the Self-acting Brake. He early entertained the idea that the momentum of the running train might itself be made available for the purpose of checking its speed. He proposed to fit each carriage with a brake which should be called into action immediately on the locomotive at the head of the train being pulled up. The impetus of the carriages carrying them forward, the buffer-springs would be driven home, and, at the same time, by a simple arrangement of the mechanism, the brakes would be called into simultaneous action; thus the wheels would be brought into a state of sledge, and the train speedily stopped. This plan was adopted by Mr. Stephenson before he left the Liverpool and Manchester Railway, though it was afterwards discontinued; and it is a remarkable fact, that this identical plan, with the addition of a centrifugal apparatus, was recently revived by M. Guérin, a French engineer, and extensively employed on foreign railways.

Finally, Mr. Stephenson had to attend to the improvement of the power and speed of the locomotive—always the grand object of his study,—with a view to economy as well as regularity in the working of the railway. In the “Planet” engine, delivered upon the line immediately subsequent to the public opening, all the improvements which had up to this time been contrived by him and his son were introduced in combination—the blast-pipe, the tubular boiler, horizontal cylinders inside the smoke-box, the cranked axle, and the fire-box firmly fixed to the boiler. The first load of goods conveyed from Liverpool to Manchester by the “Planet” was eighty tons in weight, and the engine performed the journey against a strong head wind in two hours and a half. On another occasion, the same engine brought up a cargo of voters from Manchester to Liverpool, during a contested election, within a space of sixty minutes. The

"Samson," delivered in the following year, exhibited still further improvements, the most important of which was that of *coupling* the fore and hind wheels of the engine. By this means, the adhesion of the wheels on the rails was more effectually secured, and thus the full hauling power of the locomotive was made available. The "Samson," shortly after it was placed upon the line, dragged after it a train of waggons weighing a hundred and fifty tons, at a speed of about twenty miles an hour; the consumption of coke being reduced to only about a third of a pound per ton per mile.

The rapid progress thus made will show that the inventive faculties of Mr. Stephenson and his son were kept fully on the stretch; but their labours were amply repaid by the result. They were, doubtless, to some extent stimulated by the number of competitors who about the same time appeared as improvers of the locomotive engine. But the superiority of Stephenson's locomotives over all others that had yet been tried, induced the Directors of the railway to require that the engines supplied to them by other builders should be constructed after the same model. Mr. Stephenson himself always had the greatest faith in the superiority of his own engines over all others, and did not hesitate strongly to declare it. When it was once proposed to introduce the engines of another maker on the Manchester and Leeds line, he said, "Very well; I have no objection: but put them to this fair test. Hang one of ——'s engines on to one of mine, back to back. Then let them go at it; and whichever walks away with the other, *that's the engine.*"

The engineer had also to seek out the proper men to maintain and watch the road, and more especially to work the locomotive engines. Steadiness, sobriety, common sense, and practical experience, were the qualities

which he especially valued in those selected by him for that purpose. But where were the men of experience to be found? Very few railways were yet at work, and these were almost exclusively confined to the northern coal counties; hence a considerable proportion of the drivers and firemen employed on the Liverpool line were brought from the neighbourhood of Newcastle. But he could not always find skilled workmen enough for the important and responsible duties to be performed. It was a saying of his, that, "he could engineer matter very well, and make it bend to his purpose, but his greatest difficulty was in engineering *men*." He often wished that he could contrive heads and hands on which he might rely, as easily as he could construct railways and manufacture locomotives. As it was, Stephenson's mechanics were in request all over England; the Newcastle workshops continuing for many years to perform the part of a training school for engineers, and to supply locomotive superintendents and drivers, not only for England but for nearly every country in Europe; preference being given to them by the directors of railways, in consequence of their previous training and experience, as well as because of their generally excellent qualities as steady and industrious workmen.

The success of the Liverpool and Manchester experiment naturally excited great interest. People flocked to Lancashire from all quarters to see the steam-coach running upon a railway at three times the speed of a mail-coach, and to enjoy the excitement of actually travelling in the wake of an engine at that incredible velocity. The travellers returned to their respective districts full of the wonders of the locomotive, considering it to be the greatest marvel of the age. Railways are familiar enough objects now, and our children who grow up in their midst may think little of them; but

thirty years since it was an event in one's life to see a locomotive, and to travel for the first time upon a public railroad.

In remote districts, however, the stories told about the benefits conferred by the Liverpool Railway were received with considerable incredulity, and the proposal to extend such roads in all directions throughout the country caused great alarm. In the districts through which stage-coaches ran, giving employment to large numbers of persons, it was apprehended that, if railways were established, the turnpike-roads would become deserted and grown over with grass, country inns and their buxom landladies would be ruined, the race of coach-drivers and hostlers would become extinct, and the breed of horses be entirely destroyed. But there was hope for the coaching interest, in the fact that the Government were employing their engineers to improve the public high roads so as to render railways unnecessary. It was announced in the papers that a saving of thirty miles would be effected by the new road between London and Holyhead, and an equal saving between London and Edinburgh. And to show what the speed of horses could accomplish, we find it set forth as an extraordinary fact, that the "Patent Tally-ho Coach," in the year 1830 (when the Birmingham line had been projected), performed the entire journey of 109 miles between London and Birmingham—breakfast included—in seven hours and fifty minutes! Great speed was also recorded on the Brighton road, the "Red Rover" doing the distance between London and Brighton in four hours and a half. These speeds were not, however, secured without accidents, for there was scarcely a newspaper of the period that did not contain one or more paragraphs headed, "Another dreadful coach accident."

The practicability of railway locomotion being now proved, and its great social and commercial advantages ascertained, the extension of the system was merely a

question of time, money, and labour. A fine opportunity presented itself for the wise and judicious action of the Government in the matter,—the improvement of the internal communications of a country being really one of its most important functions. But the Government of the day, though ready enough to spend money in improving the old turnpike-roads, regarded the railroads with hostility, and met them with obstructions of all kinds. They seemed to think it their duty to protect the turnpike trusts, disregarding the paramount interest of the public. This may possibly account for the singular circumstance that, at the very time they were manifesting indifference or aversion to the locomotive on the railroad, they were giving every encouragement to the locomotive on turnpike roads. In 1831, we find a Committee of the House of Commons appointed to inquire into and report upon—not the railway system—but the applicability of the steam-carriage to common roads; and, after investigation, the Committee were so satisfied with the evidence taken, that they reported decidedly in favour of the road locomotive system. Though they ignored the railway, they recognised the steam-carriage.

But even a Report of the House of Commons—powerful though it be—cannot alter the laws of gravity and friction; and the road locomotive remained, what it ever will be, an impracticable machine. Not that it is impossible to work a locomotive upon a common road; but to work it to any profit at all as compared with the locomotive upon a railway. Numerous trials of steam-carriages were made at the time by Sir Charles Dance, Mr. Hancock, Mr. Gurney, Sir James Anderson, and other distinguished gentlemen of influence. Journalists extolled their utility, compared with “the much-boasted application on railroads.”<sup>1</sup> But notwithstanding all

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<sup>1</sup> Letter of Mr. John Herapath in ‘*Mechanics’ Magazine*,’ vol. xv. p. 123.

this, and the House of Commons' Report in its favour, Stephenson's first verdict, pronounced on the road locomotive many years before, when he was only an engine-wright at Killingworth, was fully borne out by the result, and it became day by day clearer that the attempt to introduce the engine into general use upon turnpike-roads could only prove a delusion and a snare.

Although the legislature took no initiative step in the direction of railway extension, the public spirit and enterprise of the country did not fail it at this juncture. The English people, though they may be defective in their capacity for organisation, are strong in individualism; and not improbably their admirable qualities in the latter respect detract from their efficiency in the former. Thus, in all times, their greatest national enterprises have not been planned by officialism and carried out upon any regular system, but have sprung, like their constitution, their laws, and their entire industrial arrangements, from the force of circumstances and the individual energies of the people. Hence railway extension, like so many other great English enterprises, was now left to be carried out by the genius of English engineers, backed by the energy of the British public.

The mode of action was characteristic and national. The execution of the new lines was undertaken entirely by joint-stock associations of proprietors, after the manner of the Stockton and Darlington, and Liverpool and Manchester companies. These associations are conformable to our national habits, and fit well into our system of laws. They combine the power of vast resources with individual watchfulness and motives of self-interest; and by their means gigantic undertakings, which elsewhere would be impossible to any but kings and emperors with great national resources at command, were carried out by the co-operation of private persons. And the results of this combination of means and of

enterprise have been truly marvellous. Within the life of the present generation, the private citizens of England engaged in railway extension have, in the face of Government obstructions, and without taking a penny from the public purse, executed a system of communications involving works of the most gigantic kind, which, in their total mass, their cost, and their public utility, far exceed the most famous national undertakings of any age or country.

Mr. Stephenson was, of course, actively engaged in the construction of the numerous railways now projected by the joint-stock companies. During the formation of the Manchester and Liverpool line, he had been consulted respecting many projects of a similar kind. One of these was a short railway between Canterbury and Whitstable, about six miles in length. He was too much occupied with the works at Liverpool to give this scheme much of his personal attention. But he sent his assistant, Mr. John Dixon, to survey the line; and afterwards Mr. Locke to superintend the execution of the works. The Act was obtained in 1826, and the line was opened for traffic in 1830. It was partly worked by fixed engine-power, and partly by Stephenson's locomotives, similar to the engines used upon the Stockton and Darlington Railway.

But the desire for railway extension principally pervaded the manufacturing districts, especially after the successful opening of the Liverpool and Manchester line. The commercial classes of the larger towns soon became eager for a participation in the good which they had so recently derided. Railway projects were set on foot in great numbers, and Manchester became a centre from which main lines and branches were started in all directions. The interest, however, which attaches to these later schemes is of a much less absorbing kind than that which belongs to the early history of the railway and the steps by which it was mainly established.

We naturally sympathise more with the early struggles of a great principle, its trials and its difficulties, than with its after stages of success; and, however gratified and astonished we may be at its results, the interest is in a great measure gone when its triumph has become a matter of certainty.

The commercial results of the Liverpool and Manchester line were so satisfactory, and indeed so greatly exceeded the expectations of its projectors, that many of the abandoned projects of the speculative year 1825 were forthwith revived. An abundant crop of engineers sprang up, ready to execute railways of any extent. Now that the Liverpool and Manchester line had been made, and the practicability of working it by locomotive power had been proved, it was as easy for engineers to make railways and to work them, as it was for navigators to find America after Columbus had made the first voyage. Mr. Francis Giles himself took the field as a locomotive railway engineer, attaching himself to the Newcastle and Carlisle and London and Southampton projects. Mr. Brunel appeared, in like manner, as the engineer of the line projected between London and Bristol; and Mr. Braithwaite, the builder of the "Novelty" engine, as the engineer of a line from London to Colchester.

The first lines, however, which were actually constructed subsequent to the opening of the Liverpool and Manchester Railway, were in connexion with it, and principally in the county of Lancaster. Thus a branch was formed from Bolton to Leigh, and another from Leigh to Kenyon, where it formed a junction with the main line between Liverpool and Manchester. Branches to Wigan on the north, and to Runcorn Gap and Warrington on the south of the same line, were also formed; and a continuation of the latter, as far south as Birmingham, was shortly after projected under the name of the Grand Junction Railway.

The last-mentioned line was projected as early as the year 1824, when the Liverpool and Manchester scheme was under discussion, and Mr. Stephenson then published a report on the subject. The plans were deposited, but the Bill was thrown out on the opposition of the landowners and canal proprietors. When engaged in making the survey, Stephenson called upon some of the landowners in the neighbourhood of Nantwich to obtain their assent, and was greatly disgusted to learn that the agents of the canal companies had been before him, and described the locomotive to the farmers as a most frightful machine, emitting a breath as poisonous as the fabled dragon of old; and telling them that if a bird flew over the district when one of these engines passed, it would inevitably drop down dead! The application for the Bill was renewed in 1826, and again failed; and at length it was determined to wait the issue of the Liverpool and Manchester experiment. The Act was eventually obtained in 1833, by which time the projectors of railways had learnt the art of "conciliating" the landlords,—and a very expensive process it proved. But it was the only mode of avoiding a still more expensive parliamentary opposition.

When it was proposed to extend the advantages of railways to the population of the midland and southern counties of England, an immense amount of alarm was created in the minds of the country gentlemen. They did not relish the idea of private individuals, principally resident in the manufacturing districts, invading their domains; and they everywhere rose up in arms against the "new-fangled roads." Colonel Sibthorpe openly declared his hatred of the "infernal railroads," and said that he "would rather meet a highwayman, or see a burglar on his premises, than an engineer!" Mr. Berkeley, the member for Cheltenham, at a public meeting in that town, re-echoed Colonel Sibthorpe's sentiments, and "wished that the concoctors of every

such scheme, with their solicitors and engineers, were at rest in Paradise!" The impression prevailed amongst the rural classes, that fox-covers and game-preserves would be seriously prejudiced by the formation of railroads; that agricultural communications would be destroyed, land thrown out of cultivation, landowners and farmers reduced to beggary, the poor-rates increased through the number of persons thrown out of employment by the railways,—and all this in order that Liverpool, Manchester, and Birmingham shopkeepers and manufacturers might establish a monstrous monopoly in railway traffic.

The inhabitants of even some of the large towns were thrown into a state of consternation by the proposal to provide them with the accommodation of a railway. The line from London to Birmingham would naturally have passed close to the handsome town of Northampton, and was so projected. But the inhabitants of the place, urged on by the local press, and excited by men of influence and education, opposed the project, and succeeded in forcing the promoters, in their survey of the line, to pass the town at a distance. The necessity was thus involved of distorting the line, by which the enormous expense of constructing the Kilsby Tunnel was incurred. Not many years elapsed before the inhabitants of Northampton became clamorous for railway accommodation, and a special branch was constructed for them. The additional cost involved by this forced deviation of the line could not have amounted to less than half a million sterling; the loss falling, not upon the shareholders only, but upon the public.

Other towns in the south followed the example of Northampton in howling down the railways. When the first railway through Kent was projected, the line was laid out so as to pass by Maidstone, the county town. But it had not a single supporter among the townspeople, while the landowners for many miles round

continued to oppose it. A few years later the Maidstone burgesses, like those of Northampton, became clamorous for a railway; and a branch was formed for their accommodation. In like manner, the London and Bristol (afterwards the Great Western) Railway was vehemently opposed by the people of the towns through which the line was projected to pass; and when the Bill was thrown out by the Lords—after 30,000*l.* had been expended by the promoters—the inhabitants of Eton assembled, under the presidency of the Marquis of Chandos, to rejoice and congratulate themselves and the country upon its defeat. Eton, however, has now the convenience of two railways to the metropolis.

During the time that the works of the Liverpool and Manchester line were in progress, our engineer was consulted respecting a short railway proposed to be formed between Leicester and Swannington, for the purpose of opening up a communication between the

town of Leicester and the coal-fields in the western part of the county. Mr. Ellis, the projector of this undertaking, had some difficulty in getting the requisite capital subscribed for, the Leicester townspeople who had money being for the most part interested in canals.



George Stephenson was invited to come upon the ground and survey the line. He did so, and then the projector told him of the



MAP OF LEICESTER AND SWANNINGTON RAILWAY

difficulty he had in finding subscribers to the concern. "Give me a sheet," said Stephenson, "and I will raise the money for you in Liverpool." The engineer was as good as his word, and in a short time the sheet was returned with the subscription complete. Mr. Stephenson was then asked to undertake the office of engineer for the line, but his answer was that he had thirty miles of railway in hand, which was enough for any engineer to attend to properly. Was there any person he could recommend? "Well," said he, "I think my son Robert is competent to undertake the thing." Would Mr. Stephenson be answerable for him? "Oh, yes, certainly." And Robert Stephenson, at twenty-seven years of age, was installed engineer of the line accordingly.

The requisite Parliamentary powers having been obtained, Robert Stephenson proceeded with the construction of the railway, about sixteen miles in length, towards the end of 1830. The works were comparatively easy, excepting at the Leicester end, where the young engineer encountered his first stiff bit of tunnelling. The line passed underground for a mile and three-quarters, and 500 yards of its course lay through loose running sand. The presence of this material rendered it necessary for the engineer, in the first place, to construct a wooden tunnel to support the soil while the brickwork was being executed. This measure proved sufficient, and the whole was brought to a successful termination within a reasonable time. While the works were in progress, Robert kept up a regular correspondence with his father at Liverpool, consulting him on all points in which his greater experience was likely to be of service. Like his father, Robert was very observant, and always ready to seize opportunity by the forelock. It happened that the estate of Snibston, near Ashby-de-la-Zouch, was advertised for sale; and the young engineer's experience as a coal-viewer and practical

geologist suggested to his mind that coal was most probably to be found underneath. He communicated his views to his father on the subject. The estate lay in the immediate neighbourhood of the railway; and if the conjecture proved correct, the finding of the coal must necessarily prove a most fortunate circumstance for the purchasers of the land. He accordingly requested his father to come over to Snibston and look at the property, which he did; and after a careful inspection of the ground, he arrived at the same conclusion as his son.

The large manufacturing town of Leicester, about fourteen miles distant, had up to that time been exclusively supplied with coal brought by canal from Derbyshire; and the Stephensons saw that the railway under construction, from Swannington to Leicester, would furnish a ready market for any coals which might be found at Snibston. Having induced two of his Liverpool friends to join him in the venture, the Snibston estate was purchased in 1831; and shortly after, Stephenson removed his home from Liverpool to Alton Grange, for the purpose of superintending the sinking of the pit.

Sinking operations were immediately begun, and proceeded satisfactorily until the old enemy, water, burst in upon the workmen, and threatened to drown them out. But by means of efficient pumping-engines, and the skilful casing of the shaft with segments of cast-iron—a process called “tubbing,”<sup>1</sup> which Stephenson was the first to adopt in the Midland Counties—it was eventually made water-tight, and the sinking proceeded. When a depth of 166 feet had been reached, a still more formidable difficulty presented itself—one which had baffled former sinkers in the neighbourhood, and deterred

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<sup>1</sup> Tubbing is now adopted in many cases as a substitute for brick-wallings. The tubbing consists of short portions of cast-iron cylinder fixed in segments. Each weighs about 4½ cwt., is about

three or four feet long, and about three-eighths of an inch thick. These pieces are fitted closely together, length under length, and form an impermeable wall along the sides of the pit.

them from further operations. This was a remarkable bed of whinstone or greenstone, which had originally been poured out as a sheet of burning lava over the denuded surface of the coal measures; indeed it was afterwards found that it had turned to cinders one part of the seam of coal with which it had come in contact. The appearance of this bed of solid rock was so unusual a circumstance in coal mining, that some experienced sinkers urged Stephenson to proceed no further, believing the occurrence of the dyke at that point to be altogether fatal to his enterprise. But, with his faith still firm in the existence of coal underneath, he fell back on his old motto of "Persevere!" He determined to go on boring; and down through the solid rock he went until, twenty-two feet lower, he came upon the coal measures. In the mean time, however, lest the boring at that point should prove unsuccessful, he had commenced sinking another pair of shafts about a quarter of a mile west of the "fault;" and after about nine months' labour he reached the principal seam, called the "main coal."

The works were then opened out on a large scale, and George Stephenson had the pleasure and good fortune to send the first train of main coal to Leicester by railway. The price was immediately reduced there to about 8s. a ton, effecting a pecuniary saving to the inhabitants of the town of about 40,000*l.* per annum, or equivalent to the whole amount then collected in Government taxes and local rates, besides giving an impetus to the manufacturing prosperity of the place, which has continued to the present day. The correct principles upon which the mining operations at Snibston were conducted offered a salutary example to the neighbouring colliery owners. The numerous improvements there introduced were freely exhibited to all, and they were afterwards reproduced in many forms all over the Midland Counties, greatly to the advantage of the mining interest.

Nor was Mr. Stephenson less attentive to the comfort

and well-being of those immediately dependent upon him—the workpeople of the Snibston Colliery and their families. Unlike many of those large employers who have “sprung from the ranks,” he was one of the kindest and most indulgent of masters. He would have a fair day’s work for a fair day’s wages; but he never forgot that the employer had his duties as well as his rights. First of all, he attended to the proper home accommodation of his workpeople. He erected a village of comfortable cottages, each provided with a snug little garden. He was also instrumental in erecting a church adjacent to the works, as well as Church schools for the education of the colliers’ children; and with that broad catholicity of sentiment which distinguished him, he further provided a chapel and a school-house for the use of the Dissenting portion of the colliers and their families—an example of benevolent liberality which was not without a salutary influence upon the neighbouring employers.



STEPHENSON'S HOUSE AT ALTON GRANGE.





*Robert Stephenson*

*Engraved by W. and A. Nichol, after a photograph by G. C.*

*London: W. and A. Nichol, 1850.*

## CHAPTER XIV.

ROBERT STEPHENSON CONSTRUCTS THE LONDON AND  
BIRMINGHAM RAILWAY.

OF the numerous extensive projects which followed close upon the completion of the Liverpool and Manchester line and the locomotive triumph at Rainhill, that of a railway between London and Birmingham was the most important. The scheme originated at the latter place in 1830. Two committees were formed, and two plans were proposed. One was of a line to London by way of Oxford, and the other by way of Coventry. The object of the promoters of both schemes being to secure the advantages of railway communication with the metropolis, they wisely determined to combine their strength to secure it. They resolved to call George Stephenson to their aid, and requested him to advise them as to the two schemes which were before them. After a careful examination of the country, Stephenson reported in favour of the Coventry route. The Lancashire gentlemen, who were the principal subscribers to the project, having confidence in his judgment, supported his decision; and the line recommended by him was adopted accordingly.

At the meeting of gentlemen held at Birmingham to determine upon the appointment of the engineer for the railway, there was a strong party in favour of associating with Stephenson a gentleman with whom he had been brought into serious collision in the course of the Liverpool and Manchester undertaking. When the offer was made to him that he should be joint engineer with the other, he requested leave to retire and

consider the proposal with his son. The two walked into St. Philip's churchyard, which adjoined the place of meeting, and debated the proposal. The father was in favour of accepting it. His struggle heretofore had been so hard, that he could not bear the idea of missing so promising an opportunity of professional advancement. But the son, foreseeing the jealousies and heartburnings which the joint engineership would most probably create, recommended his father to decline the connection. George adopted the suggestion, and returning to the Committee, announced to them his decision; on which the promoters decided to appoint him the engineer of the undertaking in conjunction with his son.

This line, like the Liverpool and Manchester, was very strongly opposed, especially by the landowners. Numerous pamphlets were published, calling on the public to "beware of the bubbles," and holding up the promoters of railways to ridicule. They were compared to St. John Long and similar quacks, and pronounced fitter for Bedlam than to be left at large. The canal proprietors, landowners, and road trustees, made common cause against them. The failure of railways was confidently predicted—indeed, it was elaborately attempted to be proved that they had failed; and it was industriously spread abroad that the locomotive engines, having been found useless and highly dangerous on the Liverpool and Manchester line, were immediately to be abandoned in favour of horses—a rumour which the directors of the Company thought it necessary publicly to contradict.

Public meetings were held in all the counties through which the line would pass between London and Birmingham, at which the project was denounced, and strong resolutions against it were passed. The attempt was made to conciliate the landlords by explanations, but all such efforts proved futile, the owners of nearly

seven-eighths of the land being returned as dissentients. "I remember," said Robert Stephenson, describing the opposition, "that we called one day on Sir Astley Cooper, the eminent surgeon, in the hope of overcoming his aversion to the railway. He was one of our most inveterate and influential opponents. His country house at Berkhamstead was situated near the intended line, which passed through part of his property. We found a courtly, fine-looking old gentleman, of very stately manners, who received us kindly and heard all we had to say in favour of the project. But he was quite inflexible in his opposition to it. No deviation or improvement that we could suggest had any effect in conciliating him. He was opposed to railways generally, and to this in particular. 'Your scheme,' said he, 'is preposterous in the extreme. It is of so extravagant a character, as to be positively absurd. Then look at the recklessness of your proceedings! You are proposing to cut up our estates in all directions for the purpose of making an unnecessary road. Do you think for one moment of the destruction of property involved by it? Why, gentlemen, if this sort of thing be permitted to go on, you will in a very few years *destroy the noblesse!*' We left the honourable baronet without having produced the slightest effect upon him, excepting perhaps, it might be, increased exasperation against our scheme. I could not help observing to my companions as we left the house, 'Well, it is really provoking to find one who has been made a "Sir" for cutting that wen out of George the Fourth's neck, charging us with contemplating the destruction of the *noblesse*, because we propose to confer upon him the benefits of a railroad.'"

Such being the opposition of the owners of land, it was with the greatest difficulty that an accurate survey of the line could be made. At one point the vigilance of the landowners and their servants was such,