CHAPTER VIII.

RESIDENCE IN NEWCASTLE.

(ÆTAT. 24–25.)

State of the Locomotive in 1828 — Efforts to improve the Locomotive — The Reports of Messrs. Walker and Rastrick — A Premium of £500 offered by the Directors of the Liverpool and Manchester Railway for the best Locomotive — Mr. Henry Booth's Invention of the Multitubular Boiler—Commencement of the 'Rocket' Steam Engine—A Tunnel across the Mersey—Survey for a Junction Line between the Bolton and Leigh and Liverpool and Manchester Railways — Survey for Branch Line from the Liverpool and Manchester Railway to Warrington—Robert Stephenson's Love Affairs—His Access to Society in Liverpool and London — Miss Fanny Sanderson — Proposal that Robert Stephenson should live at Bedlington—Mr. Richardson's Expostulations—No. 5 Greenfield Place—The Sofa à la mode — Marriage.

THE great and immediate work before Robert Stephenson, when at the opening of 1828 he once more took up his residence in Newcastle-upon-Tyne, was to raise the efficiency of the locomotive so that, on the completion of the Liverpool and Manchester line, it should be adopted by the directors as the motive power of their railway. At that time the prospects of the locomotive were most discouraging. The speed of five or six miles per hour attained on the Killingworth and Darlington lines by no means justified an enthusiastic support of the travelling engines. It was true that they had not been built with a view to speed, but for the

purpose of obtaining cheap carriage for coals. Indeed, not many years before, the problem had been to make them move at all. But progression having been accomplished, the next thing was to increase their powers.

No engineer questioned the possibility of improving the locomotive; but improvement comes slowly, when each experiment leading to it costs several hundreds of pounds. No railway company could be asked to pay for costly trials. That they would use the new machine when inventors and manufacturers had made it a serviceable power was all that could be expected of the directors of railways. As for the public at large, there was amongst all ranks a general opposition to the new method of conveyance. Dislike to novelty, and suspicion of a system not perfectly understood, combined to make enemies for the locomotive. So far was this the case that, notwithstanding the commercial success of the Stockton and Darlington Railway, the Bill for the Newcastle and Carlisle line was obtained in 1829, only on condition that horses, and not locomotives, should be used in working it.

The proprietary of the Liverpool and Manchester Railway shared largely in feelings which were almost universal with the less enlightened multitude. In October 1828, a deputation of the directors visited Darlington and the neighbourhood of Newcastle to inspect the locomotives, and come to a conclusion as to the advisability of employing them between Liverpool and Manchester. 'By this journey,' says Mr. Booth, the treasurer and historian of the Company, 'one step was gained. The deputation was convinced, that for the immense traffic to be anticipated on the Liverpool and

Manchester line, horses were out of question. The debatable ground being thus narrowed, how was the remaining point to be decided? Was a capital of £100,000 to be invested in stationary engines, or were locomotives to be adopted?'

Whilst this question was under discussion, and for several months preceding the October trip just mentioned, Robert Stephenson had been racking his brains to settle another and much more important matter — How to improve the locomotive? how to increase at the same time its power and speed? It was as clear to him, as it had been to his father, that above all things it was requisite to increase in the locomotive the capability of rapidly generating steam. Sufficient heat, with adequate means for rapidly applying that heat to the water, was the desideratum. Eventually the multitubular boiler and the steam-blast of the 'Rocket' gave the required conditions; but previous to their attainment, Robert and his father made numerous failures in attempting to build a really satisfactory travelling engine.

To increase the heating surface, they introduced into the boilers of two engines made for the St. Etienne Railway small tubes that contained water; but the scheme was futile—the tubes soon becoming furred with deposit and burning out. In other engines they with the same object inserted two flues, each with a separate fire. On this principle was constructed 'The Twin Sisters' — the name being suggested by the tubes. A third method adopted was to return the tube through the boiler. A fourth plan — in which may be perceived a nearer approach to the multitubular system — was adopted in a boiler made, at the beginning of 1828,

with two small tubes branching off from the main flue. The sketch for this last engine was sent from Liverpool by George Stephenson to his son on January 8, 1828, and in the postscript the sanguine father says—'The small tubes will not require to be so strong as the other parts of the boiler, and you must take care that you have no thick plates and thin ones, as is often the case with those which come from Bedlington. *You must calculate that this engine will be for all the engineers in the kingdom — nay, indeed, the world — to look at.*'

During his residence at Liverpool, George Stephenson had the great advantage of close personal intimacy with Mr. Booth, the treasurer of the Liverpool and Manchester Railway. Mr. Booth was not only an enthusiastic advocate of the locomotive, but he had a strong natural taste for mechanics, and would probably have distinguished himself had he made engineering a pursuit instead of a pastime. As it is, the multitubular boiler, as a practical agent, must be attributed to him, whatever may be the merit due to such claimants as M. Seguin and Mr. Stevens. Mr. Booth was consulted on all the plans introduced by the Stephensons, and his name continually appears in the letters which passed between the father and son. Writing to Robert, on January 31, 1828, George, referring to *the* experiment then in hand, says—'With respect to the engine for Liverpool, I think the boiler ought not to be longer than eight feet. The engine ought to be made light, as it is intended to run fast. Mr. Booth and myself think two chimneys would be better than one, say eight inches in diameter and not to exceed fifteen feet.' In conclusion the father adds—'I trust the locomotive engine will be pushed.

Its answering is the most important thing to you, and recollect what a number we shall want — I should think thirty.'

On April 15, 1828, George Stephenson, still sanguine as to the result of the boiler with diverging tubes, wrote to Robert —

I am quite aware that the bent tubes are a complicated job to make, but after once in and well done it cannot be any complication in the working of the engine. This bent tube is a child of your own, which you stated to me in a former letter. The interior of a watch looks complicated, but when once well fit up, there needs very little more trouble for one hundred years, and I expect the engine you are fitting up will be something similar to this watch with respect to its working parts.

Five days later George Stephenson, with regard to this same engine, wrote a letter to his son, which is important, as it bears on a question that has been a subject of much warm controversy amongst engineers.

Liverpool: April 20, 1828.

DEAR ROBERT,— I duly received yours dated the 16th inst. I do not think there can be much difficulty in cleaning the refuse matter of the fire from the locomotive-engine boiler. I would make the nozzle pipe that goes in from the blast to be a kind of grating rather than of a conical shape, and to project about two feet into the fire. The grating to be on the upper side. The nozzle piece to be made with a flange, fitting very nicely to the plate at the front of the fire to prevent the escape of air, and kept on by a bolt and cotter, or two screw-bolts. This nozzle piece could easily be taken out at any time and the fire cleaned at the hole. This I think may be done while the engine is working upon an easy part of the road. It appears to me it will be found better to feed one time with coke and the next with coal. I think the one would revive the other.

I do not think there can be so much difficulty in firing on this plan as on the old one.

If you wish me to see the boiler tried before it is put into its seat I will endeavour to come.

If this new engine is found to answer, it will be the bestway to alter all the Darlington engines to the same plan. By doing so the last engine will not be found too heavy for the road.

This engine with the bent tubes, like other attempts made in that year to improve the locomotive, was a failure. Time was running short; the period for opening the new line was fast approaching, and yet George Stephenson and his son had not hit on the way to build such an engine as should sweep the ground from under the advocates of stationary machines.

Writing from Liverpool to Mr. Longridge at the close of the year 1828, Robert communicated the success attending the result of his new boiler made to burn coke.

Liverpool Railway Office: Dec. 1, 1828.

My Dear Sir,— It was arranged that I should leave this place to-morrow, but the directors of the Liverpool and Manchester have resolved to-day that my father and I are to meet the deputation which was recently in the north, and enter into detailed calculations relative to the much-contested question of locomotive and stationary engines. Since I wrote you last we have had my new boiler tried at Laird's Boiler Manufactory in Cheshire. You are probably aware that this boiler was made to burn coke. The experiment was completely successful— indeed, exceeded my expectations. Six of the directors went the other day to witness a second experiment. They were all perfectly satisfied. The enemies to the locomotives . . . . said the experiment had answered to the fullest extent. The boilers were shipped to-day in the steam-boat viâ Carlisle, from which place they will be forwarded to Newcastle. . . . . I have had two letters from Forman about the locomotive engine, and he has given us the order at last, but nothing can be done to it until I reach the manufactory.

I am really as anxious to be at Newcastle again as you can be to see me. I cannot say that I like Liverpool. Do not answer

——'s letter until I see you, as he has left me one also, full of such close queries on engineering that I rather hesitate giving him the information in such an offhand manner as he calculates upon.

I am much pleased that you are interesting yourself in the suit of Locomotive *versus* Stationary. It is a subject worthy of your aid and best wishes; but you must bear in mind, wishes alone won't do. Ellis has got settled, and I have got up a proposal in my father's name, which is now before the directors of the Canterbury Railway Co. I expect at a general meeting next Thursday, which will be held at Canterbury, they will decide upon it. I cannot explain it fully in a letter, and therefore defer it till I see you. I have thanked Mr. Booth as you requested.

In January 1829, Mr. James Walker, then of Limehouse, and Mr. James Urpeth Rastrick, then of Stourbridge, were commissioned by the Liverpool and Manchester Railway directors to visit Darlington and the Newcastle country, and report to them on the advantages and disadvantages of the locomotive system. Mr. Walker and Mr. Rastrick were practical engineers of high reputation; and they conscientiously discharged the duties which they undertook. The task assigned them was not to argue on the possibility or probability of speedy improvements in the locomotive. They were to inspect the travelling engines, observe their capabilities, and judge them as they were, not as they might or would be. On the Stockton and Darlington line the two commissioners found locomotives travelling at paces varying between four and six miles an hour. An engine weighing, with its tender, fifteen tons, would drag twenty-three and a half tons' weight of carriages, containing forty-seven and three-quarters tons of goods, at the rate of five miles per hour. So much, and no more, could the locomotive of

1829 accomplish. Of course Messrs. Walker and Rastrick well knew that the locomotive was in its infancy. Still they had to concern themselves with the present, and not the future. On March 9, they delivered in their separate reports, which recommended the adoption of stationary engines.*

Robert Stephenson strongly disapproved the reports He saw in them an obstacle raised to the success of the locomotive, upon which the extension of the railway system depended. Writing to a friend on March 11, two days after the delivery of the hostile reports, he said—'The report of Walker and Rastrick has been received, but it is in favour of fixed engines. We are preparing for a counter-report in favour of locomotives, which I believe still will ultimately get the day, but from present appearances nothing decisive can be said: rely

* In his summary of these reports Mr. Booth says: 'The advantages and disadvantages of each system, as far as deduced from their own immediate observation, were fully and fairly stated, and, in the opinion of the engineers themselves, were pretty equally balanced. The cost of an establishment of fixed engines between Liverpool and Manchester, they were of opinion, would be something greater than of locomotives to do the same work; but the *annual charge*, including interest on capital, they computed would be less on a system of fixed engines than with locomotives. The cost of moving a ton of goods thirty miles, that is, from Liverpool to Manchester, by fixed engines, they estimated at 6·40d., and by locomotives at 8·36d., supposing in each case a profitable traffic *both ways*. But with a system of locomotives the cost of the first establishment need only be proportioned to the demands of trade, while with stationary engines an outlay for a complete establishment would be required in the first instance. And it was further to be considered that there appeared more ground 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.'—*Henry Booth's Account.*

upon it, locomotives shall not be cowardly given up. *I will fight for them until the last. They are worthy of a conflict.*'

The 'battle of the locomotive' had indeed begun, and Robert Stephenson was fighting bravely in the contest; but with characteristic prudence he postponed his counter-statement to a triumphant course of counter-action. It was no time for words, at least for words in the shape of a paper controversy. Amongst the directors there was, in spite of the reports, a strong party, if not a majority, in favour of the locomotive. Led by Mr. Booth, and influenced by the enthusiasm of their chief engineer, they gave the most liberal interpretation to the admission of Messrs. Walker and Rastrick, that there was ground 'for expecting improvements in the construction and work of locomotives.' Would it not be well, they asked, to stimulate inventors by a premium to make the expected improvements in time for the opening of the line? The consequence was that on April 20, 1829, the directors offered a premium of £500 for an improved locomotive engine. The following circular announced the conditions and stipulations of the offer:—

Railway Office, Liverpool: April 25, 1829.

STIPULATIONS and CONDITIONS on which the Directors of the Liverpool and Manchester Railway offer a Premium of £500 for the most improved Locomotive Engine.

1st. The said engine must 'effectually consume its own smoke,' according to the provisions of the Railway Act, 7th Geo. IV.

2nd. The engine, if it weighs six tons, must be capable of drawing after it, day by day, on a well-constructed railway, on a level plane, a train of carriages of the gross weight of twenty

tons, including the tender and water tank, at the rate of ten miles per hour, with a pressure of steam in the boiler not exceeding 50 lbs. on the square inch.

3rd. There must be two safety valves, one of which must be completely out of the reach or control of the engine-man, and neither of which must be fastened down while the engine is working.

4th. The engine and boiler must be supported on springs, and rest on six wheels; and the height from the ground to the top of the chimney must not exceed fifteen feet.

5th. The weight of the machine, with *its complement of water* in the boiler, must, at most, not exceed six tons; and a machine of less weight will be preferred, if it draw after it a proportionate weight; and if the weight of the engine, &c., do not exceed five tons, then the gross weight to be drawn need not exceed fifteen tons; and in that proportion for machines of still smaller weight — provided that the engine, &c., shall still be on six wheels, unless the weight (as above) be reduced to four tons and a half, or under, in which case the boiler, &c., may be placed upon four wheels. And the Company shall be at liberty to put the boiler, fire-tube, cylinders, &c., to the test of a pressure of water, not exceeding 150 lbs. per square inch, without being answerable for any damage the machine may receive in consequence.

6th. There must be a mercurial gauge affixed to the machine, with index rod, showing the steam pressure above 45 lbs. per square inch, and constructed to blow out a pressure of 60 lbs. per inch.

7th. The engine to be delivered complete for trial at the Liverpool end of the railway not later than the 1st of October next.

8th. The price of the engine which may be accepted, not to exceed £550, delivered on the railway; and any engine not approved to be taken back by the owner.

N.B.—The Railway Company will provide the *engine tender* with a supply of water and fuel for the experiment. The distance within the rails is four feet eight inches and a half.

Never was premium more opportunely offered. It

set engineers throughout the kingdom on the alert. Now was the time for a house to put itself at the head of the trade. If an efficient locomotive could be produced at the crisis, locomotives would be universally accepted as the tractive power for iron roads; and the manufacturers who should produce the engine would, for years to come, have a monopoly of the best business throughout Europe. Robert Stephenson was keenly alive to the nature of the contest. Throwing aside his unfinished criticism of 'the reports' of Messrs. Walker and Rastrick till a more convenient time, the young engineer grappled with the task before him. As he walked from 'the works' to his lodgings, he racked his brains with thinking what ought to be done. At times he was despondent. He had so often felt triumph in the belief that he had discovered how to increase the heating surface of the boiler, and keep an ever-glowing and fierce furnace in the fire-box. As often he had been disappointed. The last fifteen months of his Newcastle labour had been an unbroken series of apparent victories followed by actual defeat. He wrote to his father; and for weeks George Stephenson held an ominous silence. One morning, however, Robert received a momentous budget from Liverpool — a design for a new engine and a letter from his father. The design was the original sketch, drawn by Mr. T. L. Gooch, of the multitubular boiler.* The letter explained the scheme, viz. to pass heated air, current from the furnace, through nu-

* When Mr. Smiles was engaged on his biography of George Stephenson, Robert Stephenson gave him the following account of the origin of the Multitubular Boiler. The reader will not fail to remark Robert Stephenson's characteristic modesty in passing over, without a word, his share in the undertaking.

'After the opening of the Stockton and Darlington, and before that of the Liverpool and Manchester, Rail-

merous small tubes fitted in the boiler and surrounded with water, and thus, by offering to the water an ex-

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way, my father directed his attention to various methods of increasing the evaporative power of the boiler of the locomotive engine. Amongst other attempts he introduced tubes (as had before been done in other engines), small tubes containing water, by which the heating surface was naturally increased. Two engines with such tubes were constructed for the St. Etienne Railway, in France, which was in progress of construction in the year 1828; but the expedient was not successful; the tubes became furred with deposit, and burned out.

'Other engines with boilers of a variety of construction, were made, all having in view the increase of the heating surface, as it then became obvious to my father that the speed of the engine could not be increased without increasing the evaporative power of the boiler. Increase of surface was in some cases obtained by inserting two tubes, each containing a separate fire, into the boiler. In other cases the same result was obtained by returning the same tube through the boiler. But it was not until he was engaged in making some experiments, during the progress of the Liverpool and Manchester Railway, in conjunction with Mr. Henry Booth, the well-known secretary of the Company, that any decided movement in this direction was effected, and that the present multitubular boiler assumed a practicable shape. It was in conjunction with Mr. Booth that my father constructed the "Rocket" engine.

'At this stage of the locomotive engine, we have in the multitubular boiler the only important principle of construction introduced in addition to those which my father had brought to bear at a very early age (between 1815 and 1821) on the Killingworth Colliery Railway. In the "Rocket" engine, the power of generating steam was prodigiously increased by the adoption of the multitubular system. Its efficiency was further augmented by narrowing the orifice by which the waste steam escaped into the chimney; for by this means the velocity of the air in the chimney — or, in other words, the draught of the fire — was increased to an extent that far surpassed the expectations even of those who had been the authors of the combination.

'From the date of running the "Rocket" on the Liverpool and Manchester Railway, the locomotive engine has received many minor improvements in detail, and especially in accuracy of workmanship; but in no essential particular does the existing locomotive differ from that which obtained the prize of the celebrated competition at Rainhill.

'In this instance, as in every other important step in science of art, various claimants have arisen for the merit of having suggested the multitubular boiler as a means of obtaining the necessary heating surface. Whatever may be the value of their respective claims, the public, useful, and extensive application of the invention, must certainly date from the experiments made at Rainhill. M. Seguin, for whom engines had

tensive heating surface, obtain the means of generating steam with unprecedented rapidity.

At length the problem had been solved. Robert Stephenson immediately was in correspondence with his father as to the details of the new undertaking. It was determined that twenty-four copper tubes should be inserted in the boiler of the new engine, each tube being of a diameter of three inches. In subsequent engines the heating surface was increased with great effect by reducing the size of the tubes, and doubling and even trebling their number. A point, however, was soon reached, where the diminution of the tubes, although it increased the extent of heating surface, had the evil consequence of diminishing the draught from the fire-box to the chimney.*

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been made by my father some few years previously, states that he patented a similar multitubular boiler in France several years before. A still prior claim is made by Mr. Stevens, of New York, who was all but a rival to Mr. Fulton in the introduction of steam-boats on the American rivers. It is stated that as early as 1807 he used a multitubular boiler. These claimants may be all entitled to great and independent merit; but certain it is that the perfect establishment of the success of the multitubular boiler is more immediately due to the suggestion of Mr. Henry Booth, and to my father's practical knowledge in carrying it out.'

* Unprofessional readers may like to glance at the following lucid explanation of the structure and rationale of the multitubular boiler, taken from 'Tredgold on the Steam Engine.'

'By causing all the flame and heated air to pass through a great number of small tubes surrounded by the water, a very great and rapid means of heating the water is obtained, as a very large heated surface is thus exposed to the water. The first locomotive engines had merely a large flue passing from the fireplace to the chimney. It was bent round at the end and returned again to the back, the chimney being placed at the same end as the fireplace. The fire was contained in the commencement of the flue, which was made larger for the purpose. This is the general principle of the construction of the boilers for stationary engines, where the size and weight of the boiler are not of so much importance, and the flues can be made

Robert Stephenson was soon busy at work on the new engine, afterwards famous under the name of 'The

large enough to get a sufficient area of heated surface in contact with the water. But as in a locomotive engine all the machinery has to be moved at a great velocity, the size and weight of the boiler are obliged to be diminished very much, and some other means has to be adopted to obtain the requisite heating surface.

'The "Rocket" engine, made by Mr. R. Stephenson, which was the engine that gained the prize for the best locomotive at the opening of the Liverpool and Manchester Railway in 1829, was the first engine made with tubes in this country.

'The former locomotives, with only a flue through the boiler, had never been able to travel faster than about eight miles an hour, as they had not sufficient heating surface in the boiler to generate steam for supplying the cylinders more rapidly; the speed attainable by a locomotive being limited only by the quantity of steam that can be generated in a given time. The introduction of tubes into the boiler is one of the greatest improvements that has been made in the construction of locomotives, and was the cause of the superiority of the "Rocket" engine to those that competed with it, and to all former engines. The velocity it attained at the competition trial was 29 miles an hour, and the average 14¼ miles an hour.

'The tubes of the "Rocket" engine were three inches in diameter, and only twenty-four in number. In the engines made subsequently the size was reduced, and the number of them doubled and trebled, by which means the heating surface was very much increased, and with it the power of the engine. The smaller the tubes are, the greater is the heating surface obtained, as small circles have a much larger circumference in proportion to their area than large ones. But when the tubes are diminished in size, the total area of passage through them from the fire-box to the chimney is also diminished; and consequently if the diameter of the tubes were much diminished, the draught of the fire would be checked from the passage to the chimney being too small. The heating power of the boiler would thus be injured, although the amount of heating surface exposed to the water was increased, and the abstraction of the heat from the hot air more perfect. . . . . .

'The tubes open into the upper part of the smoke-box, and the hot air passes from them up the chimney. No smoke is produced, except at first lighting the fire, as the fuel used is coke, which does not cause any smoke in burning, but only a light dust. The height of the chimney is obliged to be small, as it can never exceed 14 feet height from the rails; so that the draught produced by it is not at all sufficient to urge the fire to the intense degree of ignition that is necessary to produce steam at the pressure and in the quantity that is required, and some other more powerful means has, therefore, to be adopted to produce the draught. This is done by making the waste steam issue through a

Rocket,' which won the £500 premium offered by the directors of the Liverpool and Manchester Railway.

The young engineer had, however, other objects of interest besides the locomotive, in 1828 and 1829.

In the early part of 1828 he was busy constructing machinery for the Colombian Mining Association, and engaging workmen for the mines. In the same year also he afforded his father personal assistance in superintending some of the works on the Liverpool and Manchester Railway. In the March of 1828, he went to Runcorn in Cheshire to advise on a proposed tunnel under the Mersey. In June he was at Canterbury. A few weeks later he was making a survey for the junction line between the Bolton and Leigh and the Liverpool and Manchester lines. At the same time, also, he was busy with a survey for the branch line between the Liverpool and Manchester Railway and Warrington, eventually the first line constructed under his sole direction and manage-

pipe, called the blast-pipe, which is directed into the centre of the chimney, and is gradually contracted throughout its length to make the steam rush out with more force. This pipe is made of copper one-eighth of an inch thick, and is 3¾ inches in diameter inside at the bottom where it joins on to the cylinders, and tapers to 2½ inches at the top.

'The waste steam rushes out of the pipe with great force up the chimney, carrying the air with it, and causing a very powerful draught through the tubes and the fire. A whole cylinder full of steam is let out at each stroke, and the two cylinders deliver their waste steam alternately; so that when the engine is running fast, an almost constant current of steam in the chimney is produced, and the interval between the blasts can scarcely be perceived. By this method the fire is not blown, as is usual, by forcing air into it, but by extracting the air from the flues and drawing air through the fire. In the first locomotives no means were used for increasing the draught of the chimney, and their power of generating steam was consequently very limited. The introduction of the steam-blast for urging the fire, and of the tubes for conveying the air through the water, are the principal causes of the great power of the present locomotives.'— *Tredgold on the Steam Engine.* Edinburgh, 1838.

ment. These undertakings were 'the trifles' with which he filled up the time left on his hands by the superintendence of the engine manufactory at Newcastle.

Sometimes he fretted under the caprices of directors and projectors, and once or twice he nearly lost his temper with a 'board.'

Writing from Liverpool on August 27, 1828, he informed an intimate friend —

I had prepared this morning to get my things packed up for going off to Newcastle to-morrow morning, but there was a meeting of the directors of a short line of railway which I have got the management of near Bolton. The plans and section had been previously laid before them with an estimate. To-day they came to a resolution that, although the line pointed out by the engineer was the best, they were alarmed at the expense of it, and in consequence ordered a fresh survey and section to be made, so as to reduce the expense, even at the risk of having a less advisable line. This is one way of doing things, but proud as I am I must submit. I have tried in my cool and solitary moments to look with patience on such proceedings, but, by heavens, it requires a greater store than I have. I would patiently bear this alteration if they did it from principle; but knowing, and indeed hearing, them say from what the alteration does really spring, I cannot but consider it unworthy of Liverpool merchants. I plainly perceive a man can only be a man. As soon as ever he aspires to be anything else he becomes ridiculous. Come, come, away with moralising thus gloomily. Affairs go on smoothly in London, at least, the last time I heard from thence, and as I have not written anything disrespectful since, they cannot have undergone any material change.

Those who hold that love is merely the amusement of idleness will find it difficult to account for the fact that Robert Stephenson at twenty-five years of age, pressed as he was with various and weighty affairs, found leisure for indulging the tenderest of human affections. His

father and stepmother had early impressed upon him the advantages of early marriage, and when they endeavoured to withhold him from sailing for Colombia their arguments concluded with an assurance that he ought to be thinking of a wife. In his farewell letter from Liverpool, before starting for South America, he laughingly promised Mrs. Stephenson to marry as soon as he returned to England, after the appointed three years of absence. In America he of course saw but little of ladies' society. Beyond an occasional ball at Mariquita he had no means of becoming acquainted with women more cultivated than Señora Manuela, the fat negress who presided over the cuisine of his Santa Ana cottage. His Colombian letters abound with expressions of dissatisfaction at being thus isolated from the poetry and refinement of woman's influence.

On returning to England, he availed himself of every attainable means of entering society. At Liverpool, as well as in town, he was well received in the families of those affluent merchants who were interested in the progress of mechanical science. In many quarters there was a flattering and not unnatural preference shown for him over men his superiors in rank and wealth, by ladies anxious for the establishment of their daughters.

In March 1828, writing to a friend, he said: 'If I may judge from appearances I am to get the Canterbury Railway, which you know is no inconvenient distance from London. How strange! Nay, why say strange, that all my arrangements instinctively regard Broad Street as the pole?'

The attraction in Broad Street was Miss Fanny Sanderson, the daughter of Mr. John Sanderson, a gentleman

of good repute in the City. Robert Stephenson had been introduced to the young lady before leaving England for South America, and even at that date he had entertained for her sentiments which, if not those of love, closely resembled them. On returning from Colombia, amongst his first calls made in London he paid a visit to Broad Street, where he met with a cordial reception from Miss Sanderson, and an urgent invitation from her father to be a frequent visitor at his house. He waited some time, however, before he committed himself to the position of a suitor. In the October of 1828 he wrote to a friend, who was also Miss Sanderson's cousin: 'When in London I met my father by pure chance, and as he remained a day I had him introduced to Fanny. He likes her appearance, and thinks she looks intelligent. I took him to the house without her having the most distant idea of his coming. She did not appear confused, and the visit passed off extremely well.'

But it was not till the close of 1828 was near at hand that Robert Stephenson asked the lady to become his wife.

Having made his offer and been accepted, Robert Stephenson did not wish for a long engagement. Indeed, there was no reason for deferring the marriage. Mr. Longridge was very anxious that the young couple should settle at Bedlington; and Robert Stephenson so nearly complied with his partner's wishes, that he arranged to take a house there, and even made preparations for furnishing it. But to this plan his father and stepmother as well as other friends were so averse that he relinquished the scheme, although the alteration delayed his marriage for some months.

At length a suitable house was found — a small and unassuming dwelling (No. 5 Greenfield Place, Newcastle). The surrounding land has, during the last thirty years, been built upon in every direction, and the inhabitants of Greenfield Place would at the present date look in vain from their windows for a picturesque landscape, but when Robert Stephenson took his young bride there, the outskirts of Newcastle had few more pleasant places.

Between January and June in 1829, he spent much of his time in Broad Street. Wherever he was stationed — at Liverpool or Canterbury or Newcastle — it was to London that his thoughts turned, and under the pretext of 'business' he made frequent visits to the capital. The visits were brief, but they could scarcely be called flying visits, as the journeying to and fro had to be effected by stage-coaches. The men of grave years, given over—heart, soul, and strength—to business, to whom Robert Stephenson looked for support, and who had hitherto regarded him as 'a promising young man,' shook their heads ominously. Mr. Richardson, taking a paternal interest in him, even went so far as to reprove him for wasting on a pair of bright laughing eyes the time that might be more profitably spent in paying court to the magnates of Change. Robert Stephenson deemed it prudent to defend himself against the reproaches of the worthy quaker, who, after reading the exculpatory epistle, laid it aside to be kept—but not until he had inserted at the proper place, '3 mo. 31, 1829,'—the giddy lover (in his sane moments most careful to date his letters, and mark off with a dash the spot on the outer sheet to be occupied by a seal) having actually omitted to put down the date.

29 Arundel Street, Strand.

'DEAR SIR,—You do me injustice in supposing that the ladies in Broad Street engross the whole of my time; I am at present so ardently engaged in the Carlisle opposition that I have neither time to visit Broad Street or the Hill (i. e. Stamford Hill, Mr. Richardson's residence), though a visit to either place would give me great pleasure. You are really too severe when you imagine, or rather conclude, that I neglect business for considerations of minor importance. I am well aware that it is only by close attention to my business that I can get on in the world. If any appearance of neglect on my part has been observed by you, I should esteem it a mark of friendship to have it pointed out by you. The valuation of the mill would have been forwarded to you immediately on my arrival in London but for the reason I stated in my last, the 28th. John Dixon having told me that you thought I was lazy, induced me to forward it to you in an unfinished state, inasmuch as concerned the tenor of occupation, which I have not been able to determine satisfactorily. I saw John Leigh this morning, who it appears had a lease of the mill from Lord Turner. He mentioned that some circumstances had removed the lease from his hands, but on what terms he was holding the establishment was not satisfactorily explained by him. Further than this, I fear I have no means of furnishing you with the requisite information. There seems to be some outs and ins which are not easily come at by ordinary enquiries.

Yours most respectfully,
ROB. STEPHENSON.

As soon as we get through the Carlisle business, I will let you know when I shall be at Stamford Hill.

In spite of hard work and petty annoyances, however, he contrived to enjoy himself in London. The preparations for marriage were modest, and precluded all unnecessary expense; for Miss Sanderson had no fortune, and Robert Stephenson—though he was confident and hopeful for the future—was far from a rich man. His

principal occupation was the superintendence of a factory which, instead of being a lucrative concern, absorbed all the money that he and his father could gather together. So the young people prudently adapted their expenditure to their means. They determined to keep only one domestic servant, and even debated whether they should spend money on a drawing-room sofa. Robert Stephenson opposed the outlay as unnecessary, and therefore bad in principle. 'Reason or no reason,' he wrote to a friend in Newcastle, 'Fanny will have a sofa à la mode in the drawing-room. I shall see you soon, when we will talk this over.' Of course the 'talking over' resulted in his compliance with the lady's wish. In May the young people shipped from London for Newcastle a piano, which in due course was placed in the little drawing-room in Greenfield Place.

In June Robert Stephenson went up to London from Newcastle to be married. On the 4th of that month, writing to an old friend, with characteristic frankness he avowed how profoundly his feelings were moved by the prospect before him—

> I was very much upset (he wrote) when I parted with you on Gateshead Fell. So many new feelings and novel reflections darted across my mind. It was no ordinary feeling that I was not to meet you again before my relation, and indeed connection, with the world would be materially changed. These sentiments you can appreciate more readily than I can describe them.

The near approach of his wedding unsettled him for the performance of business, but did not make him less anxious to attend to the many calls on his time and care. The evening before his marriage he received depressing

intelligence of a serious accident to one of the bridges on the Liverpool and Manchester line. On that same evening also he wrote to his good friend, but stern monitor, Mr. Richardson :—

London: June 16, 1829.

DEAR SIR,— When speaking of the 'Tourist' steam-packet, I forgot to ask to whom the report of the boilers and flues was to be addressed. I have written to-day full particulars to Dickinson, saying that you would drop a line informing him how to address the report.

I am reluctant to trouble you thus much, but hope you will excuse me. *I am perhaps excusable for neglecting some little particulars last night.* You will have the goodness to inform Mrs. Richardson that, unless something very extraordinary take place, I shall be married to-morrow morning. Afterwards I shall proceed by way of Wales to Liverpool, where I purpose arriving on Monday next.

I remain, dear Sir,
Yours most respectfully,
ROB. STEPHENSON.

On Wednesday, June 17, 1829, the bells of the parish church of Bishopsgate rang for Robert Stephenson's marriage. As far as bystanders could see, he had made a wise selection of a wife. Mrs. Stephenson was not beautiful, but she had an elegant figure, a delicate and animated countenance, and a pair of singularly expressive dark eyes. A near relation, who knew her intimately from childhood, bears testimony: 'She was an unusually clever woman, and possessed of great tact in influencing others, without letting anyone see her power. To the last her will was law with her husband; but, though she always had her way, she never seemed to care about having it.'

CHAPTER IX.

RESIDENCE IN NEWCASTLE—CONTINUED.

(ÆTAT. 25–28.)

Wedding Trip — Battle of the 'Locomotive' — 'The Oracle' — Construction of the 'Rocket' Steam Engine — The Rainhill Contest — Particulars concerning the 'Rocket' — History of 'the Blast-Pipe' — Triumphant return from Liverpool to Newcastle — Answer to Mr. Walker's Report — Letters to Mr. Richardson — Numerous Engagements — More Locomotives — Opening of the Liverpool and Manchester Railway—Robert Stephenson appointed Engineer to the 'Warrington' and 'Leicester and Swannington' Lines —Discovery of Coal Strata, and Purchase of Snibstone—London and Birmingham Railway—Robert Stephenson employed to carry the Line through Parliament — Opposition to the Line — 'Investigator's' Pamphlet — Robert Stephenson's Evidence before the Lords' Committee — Rejection of the Bill in 1832 — Calumnies — Public Meeting at Thatched House Tavern in support of the London and Birmingham Railway — Bill passes Parliament in 1833 — Robert Stephenson appointed sole Engineer-in-Chief to the London and Birmingham Railway — Leaves Newcastle-on-Tyne — Pupils.

ROBERT STEPHENSON'S wedding trip was a short one. No sooner had he introduced his bride to her new home in Greenfield Place than he devoted all his energies to the superintendence of 'the works,' and especially to the construction of the 'Rocket.' The great and decisive battle of the locomotive, to be fought at Rainhill during the ensuing October, was fast approaching. He had to carry out the instructions which he had received from Mr. Booth and his father. A fearful

responsibility it was for so young a man, still only five and twenty years of age. He knew that on the result of the contest his after-success would greatly depend. The 'Rocket' was to him what 'Chat-Moss' had just been to his father. It was a grand trial of his capability as a practical engineer.

In making the drawings and calculations for the new engine, he was assisted by Mr. G. H. Phipps, who recalls with enthusiastic admiration the fine qualities displayed by his 'chief' at that trying period. Punctual to a moment, and methodical to nicety, the young engineer was always at his post, and ready for every emergency. No mishap found him unprovided with a remedy. And in laying his plans he did not disdain to profit by the practical experience of men, who in all that concerned the science of engineering were mere artizans. 'Come, this is a touchy point,' he would cry good-naturedly, shaking his head after discussing a difficult question; 'let's call in "the oracle."' 'The oracle' was Mr. Hutchinson, a practical engineer, and the superintendent of the factory, to whom the subsequent success of 'the works' was greatly due, and who eventually became a partner in the concern. On his judgement Robert had such reliance, that he invariably spoke of him as 'the oracle.' Had Robert Stephenson been an ordinary man, endowed only with the mere cunning which often passes current for genius, he would have picked the brains of 'the oracle' without letting him be aware of the operation.

At length the tubes, with their thickened ends brazed in, were screwed into the ends of the boiler. The work looked well enough, but no sooner was it tested by

hydraulic pressure than from the extremities of the tubes jets of water flew out upon the dismayed beholders. Here was a conclusion to months of toil and hope. For the first time in the protracted labour Robert Stephenson's self-command gave way, and, hastening to his office, he wrote a hasty report to his father of 'another failure.' Scarcely, however, was the letter posted for Liverpool, when his nobler nature reasserted itself, and he looked about for a way to overcome the difficulty. In a happy moment the right plan occurred to him. The brass screws could not be relied upon, but the copper of which the tubes themselves were made might be trusted. Forthwith he bored, in the ends of the boiler, holes exactly corresponding to the size of the tubes. Into these holes the tubes were inserted, and steel ferrules, or hollow conical wedges, were driven into their ends. By this means the copper of each tube was forced powerfully against the circumference of the hole, and caused to fit perfectly water-tight. The steam having been raised, the result equalled Robert Stephenson's most sanguine expectations, and he despatched another letter to his father, announcing his success. That second letter was crossed on its way to Liverpool by one from his father telling his son to try the very same means which had already proved successful.

The engine was at last taken from 'the works' on Tyne side and conveyed to the Killingworth Railway for trial. Much as there was yet to be effected before the locomotive should be raised to its present state of efficiency, a decided progress had been made. The capability of evaporation had been so raised that, while in the Killingworth engines of 1829 the evaporating power was 16 cubic feet of water per hour, in the 'Rocket' engine, at the

Rainhill experiments, it was 18·24 cubic feet per hour. The vast room still left for improvement may be appreciated, even by an unprofessional reader, when it is stated that the evaporative capability of Stephenson's patent locomotive (of 1849) was 'seventy-seven cubic feet of water per hour, or nearly five times the power of the engine of 1829.'*

After trial at Killingworth, the 'Rocket' was taken to the Tyne and shipped for Liverpool, an insurance of £500 having been effected against the peril of the voyage, which was unusually rough and bad. The vessel arrived at Liverpool so long after her time that she had been given up for lost, and the sum for which the locomotive had been insured had been actually paid to 'Robert Stephenson and Co.' when the ship and her cargo entered Liverpool water safe and sound.

At length October arrived, and on Tuesday, the 6th day of the month, the famous locomotive display at Rainhill began. The story of the competition has been often told, but it is a story that will bear repetition.

The running ground was a dead level, about ten miles from Liverpool, on the Manchester side of the Rainhill Bridge, at a place called Kenrick's cross. The whole country round was alive to the great event. From 10,000 to 15,000 people of both sexes and all ranks assembled to witness the novel contest. To accommodate the ladies, amongst whom was Robert Stephenson's wife — anxious and hopeful for her husband — a booth had been erected at either end of the race-course a few yards from the rails. Bands of music enlivened the entertainment.

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* Nicholas Wood's 'Address,' 1860.

On the course appeared four locomotive carriages—

No. 1. Messrs. Braithwaite and Erichson's, of London, 'The Novelty,' weight 3 tons 15 cwt.

No. 2. Mr. Hackworth's, of Darlington, 'The Sans Pareil,' weight 4 tons 8 cwt. 2 qrs.

No. 3. Mr. Robert Stephenson's, of Newcastle-upon-Tyne, 'The Rocket,' weight 4 tons 3 cwt.

No. 4. Mr. Brandreth's, of Liverpool, 'The Cyclops.'

Mr. Burstall of Leith had entered his 'Perseverance,' but it did not make its appearance on the 6th, in consequence of an accident which it had sustained on its way to Liverpool.

Mr. Brandreth's ingenious horse-power locomotive was worked by two horses in a frame which, whilst they themselves moved not more than a mile and a quarter per hour, propelled their load of five tons at the rate of five miles an hour. This curious contrivance was an object of general admiration; but as a mere freak of ingenuity, not fulfilling the requisitions of the directors, it of course did not contest for the prize.

The 'Novelty,' 'Sans Pareil,' and 'Perseverance,' not being ready at the appointed time, the race was put off, much to the dissatisfaction of spectators. Two days having been spent in preliminary exercise and mishaps,* 'The first systematic trial of the power of the engines, under the inspection of the judges, took place on Thursday, when Mr. Stephenson's engine, the "Rocket," was brought out to perform the assigned task.' The distance appointed to be run was seventy miles. When fairly started, the engine was to draw, at the rate of at least ten miles per hour, a gross weight of 3 tons for every ton of

* 'Liverpool Times,' Monday, Oct. 13, 1839.

its own weight. The prescribed seventy miles were to be accomplished on a level plane of one mile and a half; consequently the course had to be travelled over by the successful locomotive forty times—the same number of stops being made—with consequent loss of momentum which had to be regained.

On Thursday, the 8th, the 'Rocket,' weighing with the water in her boiler 4 tons 5 cwt., began her seventy miles at 10·30 A.M., and accomplished the first thirty-five of them in three hours and twelve minutes. The average rate therefore of this first burst was nearly eleven miles per hour. After a quarter of an hour spent in taking up a fresh supply of water and coke, the engine started again, and accomplished the second thirty-five miles in two hours and fifty-seven minutes, making an average speed of twelve miles per hour. Thus, all stoppages included, the entire time from the commencement to the end of the running was under six hours and a half. At its fullest speed the engine frequently carried its burden at more than eighteen miles per hour, and occasionally it exceeded the rate of twenty miles per hour. It had therefore beaten all previous locomotives, and more than fulfilled the stipulations of the directors.

It remains to speak of the other competing locomotives, the 'Novelty,' the 'Sans Pareil,' and the 'Perseverance.' Scarcely had the 'Novelty' commenced running when an accident to its machinery, or pipes necessitated a stoppage for repair. Another trial, on a subsequent day, was only the occasion of another accident. It was therefore withdrawn from the contest. The 'Sans Pareil,' built by Mr. Hackworth of Darlington, was also unfortunate. On being furnished with its complement of water, it was

found to exceed the stipulated weight by 5 cwt. Still, though it was thus disqualified for competition, it was permitted to display its powers over the course. Its speed averaging fourteen miles per hour, with the appointed load, was satisfactory; but an accident stayed its operations at the eighth trip. As for the 'Perseverance,' it was so far inferior to its antagonists — never travelling more than six miles per hour—that its name was scratched from the list shortly after the commencement of the running.

The result was that the 'Rocket' was proclaimed the winner, and the premium was consequently awarded by the directors to Mr. Booth and the Messrs. Stephenson, the former being the inventor of the multitubular boiler, and the latter the manufacturers of the successful locomotive.

One principal feature of the 'Rocket' was the efficiency of its blast, which scarcely in a less degree than the boiler contributed to the victory at Rainhill. With regard to the blast there has been much animated and some acrimonious discussion; and more than one person has been pointed to as the first to devise it. In the first locomotive that ran with smooth wheels on smooth rails — namely, the first of Mr. Hedley's Wylam engines— the waste steam was emitted over the wheels at the side. In the second of Mr. Hedley's Wylam locomotives, built, as the reader recollects, prior to George Stephenson's first locomotive, a different course was employed. To obviate the noise and render the smoke less objectionable, a chamber was constructed in the boiler, into which the waste steam was conveyed from the cylinder by an eduction pipe that was turned upwards. From this

chamber the steam in an expanded state passed through another pipe into the chimney. This arrangement precluded anything like an efficient blast, but doubtless the passage of the steam up the chimney, as far as it was in any way influential, quickened the draught. This is a fact which should be remembered. In the second Wylam locomotive the waste steam was emitted into the chimney.

In George Stephenson's first Killingworth locomotive engine the waste steam (either from the first, or at a date shortly subsequent to the completion of the *engine*) was conveyed through a pipe directly into the chimney, without passing through any intermediate receiver; and the noise of the steam forcing its way through the exit pipe and up the chimney, soon procured for the engine the sobriquet of 'Puffing Billy.' No attempt had been made to deaden the noise. There was the blast in unquestionable action, although of trivial efficiency.

In the history of mechanical science there are few points more singular than that the origin of such a power as 'the blast in the steam locomotive' should be involved in obscurity. Amongst the Wylam workmen, it is a matter of firm belief that the ability of the waste steam to quicken the draught through the fire-box was discovered by accident. They state that two workmen, the brothers John and Henry Bell, the one still managing, in the autumn of 1860, a fixed engine at Blaydon, the other driving, at the same date, a locomotive on the Wylam line, effected the discovery in the following manner:—It was their duty periodically to clean the boiler of the Wylam locomotive, and also the exit pipe communicating between the receiver and the chimney. This pipe had a tendency to become furred up, and every

time the men scoured off the deposit they also removed some of the metal. The pipe thus gradually became thin, and in the course of years needed repair. After the fashion of Northumbrian engine-drivers, who tinker up their engines as unconcernedly as a Suffolk ploughman ties up his horses' tails, the Bells inserted a small rim of iron into the enlarged pipe, thus rendering the mouth far more contracted than it was originally. The current of vapour passing through the narrow orifice, was, of course, much quickened by the alteration. Its upward passage was proportionately accelerated; and with corresponding increase of velocity, the air rushed in from below through the fire-box to fill the vacuum caused by the ascending steam. So marked was the effect of 'the iron rim' on the speed of the engine, that when the men took their first drive on it, after the work of cleaning and repairing, they were for a few seconds positively alarmed by the speed of their progression. This is one story. Another tradition, credited by the present representative of the Stephenson family, is that James Stephenson hit on the secret also by accident. According to this tradition, James Stephenson, whilst acting as driver, turned the eduction pipe of the first Killingworth engine into the chimney for the purpose of abating the nuisance of the waste steam, which, on being emitted from the side of the locomotive, covered him with moisture and interfered with his line of sight.

Certain it is, that the first Killingworth engine, at a very early date of its existence, had 'the blast;' that is to say, the steam went into the chimney in distinct puffs. The assertion that George Stephenson himself 'applied the steam-blast' to his first locomotive *in order* to increase the draught and the heating power of the fire, is

improbable. The statement that the blast, when so applied, 'more than doubled the power of the engine,' is unquestionably erroneous — although it was made to Mr. Smiles in all good faith by Robert Stephenson himself. The fact is, the size of the chimney and the small power of the engine, the chimney being altogether out of proportion to the power of a two-horse engine, precluded the possibility of having so efficient a blast. Mr. Nicholas Wood, a scientific engineer, intimately acquainted with the locomotive in question, has publicly stated*—'The blast in the chimney, which afterwards formed so important an element in the evaporation of steam, was then comparatively inoperative, from the imperfect mode in which it was applied, and from the low rate of speed at which the engine moved.'

Of course George Stephenson knew that the tendency of the ascending vapour was to quicken the draught up the chimney. But not the less is it true that the influence of the blast was scarcely appreciable in the Killingworth engines. Years were to elapse before George Stephenson was to awaken to a knowledge of the full capability of the blast. The inability to generate a sufficient supply of steam was, from 1814 to 1829, the reason why the locomotive, instead of being generally adopted on railways, was regarded by sound judges as having only a slight advantage over the stationary engine — an advantage not great enough to secure for it a wide popularity. Throughout the greater part of that time, George Stephenson saw clearly that the two great needs of the locomotive were — more heat, and better means

* Mr. Nicholas Wood's 'Address.'

of diffusing that heat. Without a fierce fire, and a large heating surface, it was impossible to generate the requisite amount of steam. He therefore racked his brains to invent a boiler offering a wide field of contact for the heat and the water, and to construct bellows that should make his fire-box a perpetual furnace. The reader, of course, bears in mind the agreement between George Stephenson and Mr. Losh and the Messrs. James as to boiler tubes, in 1821. In a former part of this work a letter appears, which shows how George and Robert Stephenson, in seeking to send an adequate current of air through the fire of a locomotive, fixed their thoughts on an artificial and not a natural draught. There are extant many letters between the father and son, which accord with the one referred to. Such was the state of things in 1828. Such, too, was the case in 1829, until, *whilst the 'Rocket' was being built*, George Stephenson became alive to the full importance of a principle which, notwithstanding the structure of his own early locomotives, he had for fifteen years at least not duly estimated.

During the building of the 'Rocket' Mr. G. H. Phipps had an engagement at the factory at Newcastle, having charge of the drawing office, and he was Robert Stephenson's active coadjutor, and trusted friend. During a temporary absence of Robert Stephenson from 'the works,' Mr. Phipps received the following letter from George Stephenson:—

Liverpool: August 13, 1829.

DEAR PHIPPS,—As I understand Robert is gone to Canterbury, I may mention to you that I have put on to the coke engine a longer exarsting pipe, riching nearly to the top of the chimeney, but find it dose not do so well as putting it into the chimeney lower down. I think it will be best near the level of

the top of the boiler, by doing so it will look neater. the coke engine is doing extremely well—but the 'Lankshire Witch' is rely doing wonders. A statement of her performance you will see in the paper in a few days.

I am, dear Phipps,
Yours truly,
GEO. STEPHENSON.

Had George Stephenson been for fifteen years aware of the full value of 'the blast' as a natural bellows, he would scarcely at so late a date have thought of putting the mouth of his 'exarsting pipe' nearly at the top of the chimney. But it was at this very time — August 1829 — that George Stephenson, whilst he was making experiments on the eduction pipe, to see if the rapid current of its vapour could not be employed with greater effect for the creation of chimney draught, hit upon the full importance of a principle which for years he most probably had regarded lightly.

No time was lost in giving the 'Rocket' the full benefit of the new discovery. When the engine astonished the spectators at Rainhill, the draught of the chimney was accelerated by two blast-pipes. 'Mr. Robert Stephenson's carriage,' says the 'Liverpool Courier,' Wednesday, Oct. 7, 1829, 'attracted the most attention during the early part of the afternoon. It ran, without any weight being attached to it, at the rate of twenty-four miles in the hour, shooting past the spectators with amazing velocity, emitting very little smoke, but dropping red-hot cinders as it proceeded.' The 'Sans Pareil' had also at Rainhill a very powerful blast, but causes independent of the waste-pipe shut it out from success.

The combination of the multitubular boiler and the blast was most felicitous, and achieved the triumph of the

locomotive. They acted and reacted upon each with beautiful effect. A good fire was a necessary condition for the proper action of the multitubular boiler; that good fire was secured by the forcible jets of the exhaust-pipe; those forcible jets were a consequence of the boiler being able to supply the cylinders continuously with steam. Without the blast the multitubular boiler would have been comparatively inoperative; and, apart from the multitubular boiler, a strong, continuous, and regular blast was impossible.

Robert Stephenson went home from Liverpool triumphant. It was a happy meeting between him and his wife in Greenfield Place, whither she had preceded him. He was a made man. Henceforth there was no fear for the locomotive; its speedy and universal adoption had been secured. Not less certain was it that Robert Stephenson and Co. would for many years be the first locomotive manufacturers in the world; but the victory, far from inducing the engineer to relax, only spurred him to increase his exertions. He resolved to lose no time in producing engines superior to the 'Rocket.' Having, however, done so much in the way of professional action, he could afford a little time for professional polemics. As long as the locomotive required him to labour in the workshop, he had abstained from controversy; but now he took pen in hand with the purpose of convincing the public mind that the reports of Messrs. Walker and Rastrick were not supported by the facts which they, previous to the production of the 'Rocket,' had undertaken to examine. It might seem that the time was past for replying to statements which had been exploded by events. But the fact was, Mr. Walker's report had taken

a firm hold of the public mind, and its author was by no means disposed to modify his views in deference to recent improvements.

On December 17, 1829, Robert Stephenson wrote to Mr. Richardson —

I am now engaged in preparing an answer to James Walker's report on locomotive and stationary engines. I am induced to do this from the industrious manner with which he has been circulating his report in every quarter of England. He left one with Kingsford, the solicitor at Canterbury, doubtless with some object.

In the February of 1830, therefore, Robert Stephenson, in conjunction with Mr. Joseph Locke, published 'Observations on the Comparative Merits of Locomotive and Fixed Engines.' In this treatise *facts* were closely adhered to, and idle speculation was studiously avoided. Robert Stephenson did not want to startle uninformed readers with the marvels which he hoped to accomplish, but to tell them how much he could assuredly achieve. He was, therefore, content to say: 'On a level railway, a locomotive engine weighing from four to five tons, will convey twenty tons of goods, exclusive of carriages, at the rate of twelve miles an hour.' The moderation and caution of the writer were characteristics that marked his entire professional career, and contributed in no small measure to his success.

A glance at the following extracts from Robert Stephenson's letters to Mr. Richardson will give the reader a vivid picture of a portion of his professional life during the next few months after the Rainhill contest.

Newcastle-on-Tyne: Dec. 17, 1829.

DEAR SIR,— I was sorry that you passed through Newcastle before I returned from Liverpool, as I had many things to

mention respecting railways which are projected in Cheshire and Lancashire. . . . The proprietors of the Warrington and Newton Railways a little time ago proposed a line from the former place towards Birmingham, but at the outset only intended taking it up as far as Sandbach, a distance of twenty-two miles from Warrington; the remaining distance to Birmingham is, I believe, about 53 miles. Should this line go on, it will join the Liverpool and Manchester sixteen miles from Liverpool, through the medium of the Warrington and Newton Railway, and will consequently be of great advantage to both these lines now in progress. I made a survey about three weeks ago, and lodged the plans in the customary manner. This plan or line of communication to Birmingham did not meet the views of the Liverpool people. They therefore employed Vignoles as engineer to survey a line from Liverpool to Runcorn, where they proposed making a bridge over the Mersey at an enormous cost, and in this direction opening a communication to Birmingham. The Liverpool directors were not agreeable that my father or I should be concerned in the Sandbach line, as it would be opposed by the Marquis of Stafford; and as my father might be employed to oppose the line in Parliament, he and I would thus be brought into direct collision, which would certainly not be very pleasant. Having made this survey, I was of course bound in honour to sign the plan and section. What will be the result in Parliament I cannot guess. There will doubtless be a strong opposition, and perhaps a fatal one. It is averse to my feelings to be concerned with any undertaking which might interfere with Mr. Locke's views, as his kindness to my father has been very great. Being, however, engineer for the Warrington directors, I could not refuse with any appearance of consistency to attend to an extension of this line — an extension which, if made, will be of immense benefit to that which I am now executing. I heard from Liverpool the other day that another Birmingham line had been suggested which was likely to obtain supporters. It is to pass underneath the Mersey opposite Liverpool, continue on to Chester, and thence to Birmingham, in the same route as the line my father laid down in 1825. I am not aware of the merits of this line, but it strikes me that it will be a more expensive one than that from Warrington by way of Sandbach, and it will certainly never be of so much importance to the Liverpool and

Manchester line. There are several other branch railways projected in Lancashire. The trials at Rainhill of the locomotives seem to have set people railway mad. . . . . We are getting rapidly on with four locomotive engines for Liverpool, which I am confident will exceed the 'Rocket' in powers. One of them will leave here about New Year's Day, and the other three about the end of January.

Yours very faithfully,
ROB. STEPHENSON.

Liverpool: Jan. 3, 1830.

MY DEAR SIR,— On my arrival here I found your letter written after you left Newcastle.

I wish much I had seen you at Newcastle, were it only for receiving your instructions concerning the Duke of Norfolk's coal-field and railway to Sheffield, which I intend visiting on my way to London the latter end of this month. I am at present engaged in getting up the parliamentary plans and estimate for the Warrington and Sandback railway. As soon as they are finished I shall proceed to Canterbury. By that time I hope the line will be ready for opening. . . . .

Liverpool: Jan. 25, 1830.

MY DEAR SIR . . . I have consulted my father on the subject of the Carlisle end of the railway. He is quite agreeable to take the west end of the line and leave it chiefly to my management for something between £500 and £700 a year. They would not expect my whole time to be devoted to it, as an assistant to be always attending would be requisite; so that it would not require me to confine my attention to that neighbourhood entirely. I should then have the Lancashire and the Warrington and Newton to attend to. Amongst them I should divide my attention, and I see no difficulty in doing that, when I have a confidential assistant at each place to see that my plans are carefully and strictly attended to. . . . .

Canterbury: April 28, 1830.

DEAR SIR . . . . I regret we are too high for the Darlington Bridge, but I am afraid we are a great deal too high for the

winding engine at St. Helens, Auckland, but we really cannot compete with those engine-builders in the neighbourhood of Newcastle, who not only work for nothing, but who make bad workmanship. The engine you require for St. Helens is the same power as one we made for the Liverpool Railway Company, and will require more workmanship. For the Liverpool engine we had £1,600, but I daresay you will soon have offers for £1,000; but it is useless attempting to make engines for such prices, because I know it is impossible to make a good and substantial job without reasonable prices.

22 Broad Street Buildings: May 6, 1830.

DEAR SIR,— I returned from Canterbury on Tuesday, and would have answered your letters that day had I not been unwell.

The Warrington business is closed in the Lords, and the Leicester committee sits to-day, when my business in London for this session will be ended. I intend leaving London for Liverpool, where, according to your letter of the 1st inst., you will probably be. . . . .

The opening of the Canterbury Railway went off remarkably well, without a single mishap. The paper will be forwarded to you by Joshua. I have not seen any detailed acount published.

Still only twenty-six years of age, Robert Stephenson had made a distinguished position for himself, and every succeeding year was henceforth to add to his dignity and worldly prosperity. In the spring of 1830 was opened the Canterbury and Whitstable line, constructed under Robert Stephenson's supervision, his father being responsible for the engineering. The same season saw the Bill for the Warrington Railway safe through both Houses of Parliament, and Robert Stephenson forthwith began to construct the line as engineer-in-chief—he having made the survey, sections, and estimates for the parliamentary application. In the same session permission was sought

to make another line from Leicester to Swannington ; and the leave being granted, Robert Stephenson was appointed principal engineer to that undertaking also. He had thus two railways on his hands, whilst at the same time he continued to direct the operations of the Newcastle factory, and was actively engaged in improving the locomotive.

The heads of most young men would have been turned by such a tide of success. It was, however, remarked that Robert Stephenson did not forget the modesty of bearing which characterised him in youth. Indeed, conscious as he was of his power, he in a certain way mistrusted himself, and feared that he might fail from want of experience, if not from want of innate force. Whilst he was in London, during the progress of the Warrington Bill through Parliament, he was accosted by an old comrade of his South American adventures, whom he had not seen since quitting Colombia. His friend, of the same age as himself, had recently returned from America to seek fortune in his native land. 'And here I am back in Old England,' he said, 'looking about for something to do, whilst the business which fills your hands is on every man's lips.' The friends dined together at an hotel in Bridge Street, and over a bottle of wine talked of past times, and discussed their future prospects. 'Of course you congratulate me on my advance towards fortune,' Robert Stephenson said earnestly, 'but I can assure you I sometimes feel very uneasy about my position. My courage at times almost fails me ; and I fear that some fine morning *my reputation may break under me like an egg-shell!*'

As the works on the Liverpool and Manchester line

were being brought to a conclusion, the directors busied themselves with plans for a public celebration of their labours. In August 1829 Mr. Huskisson visited Liverpool, and was present at an inspection of the line, and at a celebration preliminary to greater rejoicings in the following year. Writing by the hand of his secretary to Mr. Longridge, George Stephenson (August 23, 1829) thus described the preliminary entertainment :—

We had a grand day last Friday — Huskisson visited the greater part of the line with the directors, of course I was one of the party. We first went to the great viaduct, thence along the line to the bridge at Rainhill: then to the commencement of the deep cutting at Olive Mount, where we were met by the locomotive engine, which took the whole party, amounting to about 135, through the deep cutting at the rate of nine miles an hour, to the great delight of the whole party: the engine really did well. We next went to the tunnel, where a train of waggons was in readiness to receive the party. Many of the first families in the county were waiting to witness the procession which, accompanied by a band of music occupying one of the waggons, descended in grand style through the tunnel, which was brilliantly lighted up, the gas-lights being placed at intervals of twenty-five yards. The whole went off most pleasantly, without the slightest accident attending our various movements. Huskisson expressed himself to me highly delighted with what he had seen. Mr. Huskisson and the directors dined with Mr. Lawrence in the evening; the engineer was one of the party, and a most splendid set-out there was, I assure you. The evening was spent in a very pleasant manner.

So pleased was Mr. Huskisson with this demonstration in 1829, that he exerted all his influence to assemble people of high importance to witness the formal opening of the line in the following year. Of that later event the engineer could not say—'The whole went off most pleasantly, without the slightest accident attending our various movements.'

On September 15, 1830, the Liverpool and Manchester Railway was opened with an imposing ceremonial and a disaster that struck to the heart of the country. Amongst those who assembled to witness the event were some of the highest personages of the land, the Duke of Wellington and Sir Robert Peel being conspicuous amongst a crowd of celebrities.

The morning of September 15, 1830, was fine and bright, and the towns of Liverpool and Manchester were in a state of great excitement. For several days exertions had been made to clear the entire line of obstructions — such as earth-waggons, machinery, and masses of timber — which were collected at various points of the route. The 'points and crossings, at that time by far the most defective part of the railway system, were all carefully removed, excepting at Huyton (about six miles from Liverpool) and at the two termini, so that with these exceptions there was one unbroken line of rails through the whole way, the risk of carriages leaving the line being thus reduced to a minimum.

At Parkside, the half-way point on the line, adequate preparations were made for renewing the supply of water to the tenders of the engines. The arrangements for obtaining fresh water not being perfected at Manchester, the requisite supply was provided at Eccles (about four miles distant from the great cotton town) — directions having been given that the engines and tenders should be replenished at that station, after performing the entire journey. The time occupied by the engines and tenders in running out the four miles from Manchester to Eccles, getting a fresh stock of water, and returning to Manchester, would (it was calculated) be less than the time which the

visitors conveyed to Manchester by the trains would require for a lunch provided by the Company in a building adjacent to the terminus. The directors, also, having good reason to fear that persons would put obstructions on the rails, stationed men at intervals along the entire line to see that the way was kept clear.

Every precaution for safety and expedition having thus been taken, the procession was formed of eight trains. The following order of progress was drawn out by Joseph Locke, with the assistance of Mr. T. L. Gooch, his coadjutor in arranging the day's proceedings.

	Directed by	Flagmen	Brakesmen
Northumbrian	George Stephenson	Mark Thompson	Jas. Scott J. Melling, jun.
Phœnix	Rob. Stephenson, jun.	Jas. Thompson	James Wood Hugh Greenshields
North Star	Rob. Stephenson, sen.	W. E. Gillespie	Thomas Harding Thomas Heaton
Rocket	Joseph Locke		Jno. Wheatley Jno. Gray
Dart	Thos. L. Gooch	Saml. Bennet	Jos. Copeland Jno. Cummins
Comet	Wm. Allcard	Josh. Richardson	Jas. Cummins Jno. Melling, sen.
Arrow	F. Swanwick	Jno. Birkinshaw	Gordon M'Leod Wm. Day
Meteor	Anthony Harding	Wm. Gray	Jno. Harding Thos. Ilberry

The principal train was drawn by the 'Northumbrian' engine, under the care of George Stephenson. It consisted of four state-carriages, built for the occasion, open at the sides, and made with the awnings and roofs so high that passengers could walk about with ease. This train, containing the Duke of Wellington, Sir Robert Peel, and other personages of high distinction, was placed alone on the southern line of rails. The seven other trains were placed upon the northern line, an interval of about

six hundred yards being allowed between each train and the one following it.

The trains were started by bomb of cannon; and for the first half of the journey all went well. At the commencement the speed was slow, but as the carriages passed through Olive Mount cutting the pace astonished the thousands who lined the slopes. Crowds who had assembled at the bridges along the line testified their satisfaction with renewed cheers. At Parkside, where a stop was made for a fresh supply of water, an accident, however, occurred that altogether changed the character of the day's proceedings. Mr. Huskisson, who had made the journey in the first of the seven trains on the northern line, left his carriage at the station, and, crossing over to the state-carriages on the southern line, paid his respects to the Duke of Wellington, with whom he had for some time been at variance. The soldier and the Member of the House of Commons had just time to exchange words of reconciliation — the Duke retaining his seat, and Mr. Huskisson standing on the line — when the 'Rocket' engine, conveying its train at a moderate pace, swept up, and bore the latter gentleman to the ground, crushing his thigh bones. Without delay the injured man was lifted into one of the state-carriages, and conveyed at the rate of thirty-six miles an hour to Eccles, where in the vicar's house he expired during the evening of the same day.

The dismay of the passengers in the other trains, as on reaching Parkside they received the sad news, was followed by uncertainty as to what course it would, under the circumstances, be best to pursue. Some thought it would be more delicate to return to Liverpool and leave the day's journey uncompleted. Others, think-

ing of the multitude who awaited their arrival at Manchester, and the panic their non-appearance would create in that city, argued in favour of proceeding. The debate lasted so long that an hour and a half slipped away before the 600 or 700 passengers left Parkside. Finally, it was decided to go on to Manchester. The engines on the northern line were once more set in motion—the three state-carriages on the southern line (one carriage of the original train together with the 'Northumbrian' engine was engaged in Mr. Huskisson's service) having been previously attached by chains to the two leading locomotives on the northern line. No new difficulty awaited the expedition until it reached the commencement of the three miles of cutting, through which the line enters Manchester. At that point, to the surprise and terror of the engine-drivers, the slopes of the cutting on either side, and *the railway itself*, were found in the possession of a dense mass of people. Through this multitude the trains had to pass before they could reach Manchester. The authorities of the town and populous district had taken the precaution of calling out a large military force to guard the station from the encroachments of the mob. But a Lancashire mob is never docile; and just then political discontents had made the lower orders especially unruly. The delay in the arrival of the trains, vague rumours of a fearful accident, and anxiety to behold 'the Duke,' whom they cordially detested, had put the excited populace beyond the control of the military. Pushing out into the country, the crowds soon outflanked the soldiers, and took possession of the rails.

It was a trying position for Robert Stephenson, who headed the procession with the Phœnix engine, to which

were attached the five carriages that constituted its train at starting. The state-carriages on the south line (from the windows of one of which the Duke of Wellington surveyed the rabble) had been once more annexed to the 'Northumbrian.' Slackening speed, Robert Stephenson proceeded cautiously. But caution had its disadvantages; for the more reckless of the multitude caught hold of the carriages and climbed up their sides whilst they were slowly rolling along. To complete the confusion, the political animosities of the mob broke out in acts of insult and violence. At various points of the cutting placards reflecting on the ministry were exhibited, and weaving machines were set out for inspection with brief announcements upon them of the prices of labour and bread. Brickbats also were aimed at the state-carriages. Eventually the trains reached Manchester without accident or loss of life; but only to find the station occupied by another mob. All communication between the different trains was cut off. Many of the excursionists left their seats, and fought their way through the crowd to the apartments where the Company had provided lunch. The Duke of Wellington refused to descend from his carriage, to which the mob continued to press. For some time he kept the rioters in good humour by shaking hands with their women and children; but the uproar round the state-carriages increased so much and rapidly, that, to secure the Duke from risk of assault, it was thought necessary to remove him from the tumult. Without much difficulty the 'Northumbrian' engine was brought round, and the train of state-carriages, containing their due complement of occupants, slowly wormed

its way out of the station and through the excited multitude.

At Eccles, on the return of the Duke's party, another mishap was added to the tale of accidents. At that station four of the seven engines from the northern were found on the southern line, taking in a fresh stock of water. Had it been possible to carry out the programme, of course these four engines would have returned to Manchester and taken up their position on the northern line before the 'Northumbrian' started; but it had been found necessary to carry off the Duke without delay at any cost of trouble and confusion. The consequence was that 'the points and crossings' having been all removed except at Huyton and the two termini, there were only two moves on the board open to the players — either to take the state-carriages back to Manchester, where the Duke would certainly be received with insults, and not improbably with a shower of brickbats, or to drive the four engines before the 'Northumbrian' to Huyton (six miles from Liverpool), where they could be passed over to the northern rails and find their way to Manchester. The latter course was taken.

The four engines were ordered on before the state-train to Huyton, and the managers of the remaining three engines of the northern line, after taking in water at Eccles, conveyed to Manchester the pleasant intelligence that they were left to convey the excursionists back to Liverpool. It was not till late that these three engines (the 'Rocket,' the 'North Star,' and the 'Arrow') reached Manchester. Darkness was rapidly coming on. In those early days of the railway system signal lamps had not come into use. To lessen the chances of collision, which

were strong in the case of three separate trains following each other closely, the carriages were formed into one train, and the three engines were connected. This long train worked through the crowd, and safely reached Eccles, where the train was stopped for the purpose of enquiring after Mr. Huskisson. On starting again, the couplings of some of the carriages broke, and had to be supplied with strong ropes. At Parkside the train was met by three of the engines which had gone on to Huyton: and these three engines, having at Huyton crossed to the north line, were ready to assist in drawing the carriages. It was determined still to adhere to the plan of having only one train. Two of the recently arrived engines were annexed to the load, and the third engine, the 'Comet,' was directed to precede them at the distance of half a mile, clearing the way before them, and signalling obstacles by holding out a lighted tar-rope.

All went on favourably till Rainhill was reached, when the ascent brought the train to a standstill. To lighten the load the male passengers quitted their seats and walked up the incline, when the engines, relieved of more than half their living burden, managed to get to the summit of the rising ground. On the old racing level of Rainhill a good pace was attained, a wheelbarrow (maliciously placed on the line) being at that point run over and broken to pieces by the pilot-engine. Broad Green embankment and Olive Mount cutting were in like manner passed safely; and the train, after leaving the locomotives at Edge Hill, rattled through the tunnel to the terminus, the mile and a quarter of archway being brilliantly lighted with gas, and the feelings of an anxious multitude, who for hours had been waiting for

the arrival of the excursionists, breaking forth in deafening cheers.*

An old friend of Mr. Stephenson makes the following statement:—

'Eventful as Robert Stephenson's life had been, the year 1830 was perhaps as much marked as any by important occurrences. In that year the Leicester and Swannington Railway was commenced, to which undertaking he was appointed engineer, the object of the line being chiefly to convey to Leicester the coal from the collieries then existing in the neighbourhood of Swannington. Early in 1831, during the progress of the Railway, the Snibston Estate, lying close to the line, was advertised to be sold by public auction. Forming his opinion from the geological features of the country, and from the coal seams which had been already worked near the surface, on a very limited scale, Robert Stephenson was satisfied that other and more valuable seams existed under the Snibston Estate. This opinion he urged upon his father so forcibly, that the latter persuaded two of his Liverpool friends, Mr. Joseph Sandars and Sir Joshua Walmsley, to join him in purchasing the Snibston Estate. In 1831 operations were commenced, and two shafts were sunk on the dip, or east side of the estate, but after getting through the keuper, or new red sandstone formation, which in that part of the district overlies the coal measures, they came upon a narrow strip of "green whinstone," which had descended in a fused state from the neighbouring volcanic hills of the Charnwood Forest range. This deposit proved a most formidable obstacle;

* The foregoing particulars of the opening of the Liverpool and Manchester Line are taken from a written communication made by Mr. T. L. Gooch.

but after a long process of sinking, during which so much time was expended that even Mr. Stephenson's perseverance was nearly exhausted, the sinkers drove a bore-hole through it, and proved the coal measures underneath. This strip of "whinstone" was 20 feet thick, and so hopeless had the task of penetrating it at one time appeared, that a second pair of shafts were commenced to the westward, and in these latter pits this serious difficulty was not encountered. After two years of labour Mr. Stephenson's foresight was rewarded by discovering at a depth of 200 yards from the surface an excellent seam, called the "main coal," which was shortly afterwards worked scarcely more to the advantage of the speculators than to the benefit of Leicester, the inhabitants of which town had in a great measure depended for coal on Derbyshire, the coal being brought to Leicester by canal. Upon the opening of the Leicester and Swannington Railway, the price of coals in Leicester fell nearly 40 per cent., whereby the town gained nearly £40,000 a year. The Snibston Colliery, under the intelligent management of Mr. Vaughan, has proved to be a most lucrative concern.'

In 1830 Robert Stephenson became a member of the Institution of Civil Engineers. In that same year (1830), in consequence of the success of the Stockton and Darlington line, the triumph of the locomotive, and the satisfactory state of works on the Liverpool and Manchester Railway,* a project was revived that had slept for the pre-

* A note ought to preserve a story connected with the construction of the Liverpool and Manchester Railway. The excitement of the public mind on the subject of railways gave a new turn to the eccentric humours of disordered intellects. Many were the delusions and extravagances of

ceding five years. As early as 1824 a proposal was made to lay down a railway between London and Birmingham. The route of the proposed railway was surveyed in 1825, but in those hard times for speculative enterprise the project was set aside. The year 1830, however, witnessed *two* proposals, instead of one, for an iron road between Birmingham and the capital. The one set of projectors advocated a line by Coventry; the other adventurers being in favour of a route through Banbury and Oxford. George Stephenson being applied to for an opinion by the competing parties, decided in favour of the Coventry route. The consequence of this decision was that the rival Companies, instead of aiding the external enemies who were ready to destroy both of them, prudently joined their forces, and with united influence applied to Parliament for a line through Coventry. George Stephenson was at first employed in conjunction with his son as engineer to make the surveys and plans, and carry the line through Parliament.

The agreement (signed September 18, 1830) between the Company and the engineers, stipulated that George

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persons afflicted with railway mania. One inoffensive elderly gentleman, residing in a suburb of Liverpool, conceived a passion for tunnelling, and a noble ambition to surpass the achievements of George Stephenson. Without making any unnecessary noise he hired a number of workmen, and amused himself for awhile with driving tunnels under the surface of his own grounds. At length, wishing to astonish the 'professional hands,' he burrowed beyond the boundaries of his own property, and bored into the great railway tunnel, then near its completion. George Stephenson had heard nothing of the monomaniac's proceedings; he was, therefore, not a little astonished one morning, as he passed along his tunnel, to hear a noise of a human voice cheering over his head, and on looking up to see, through a hole knocked in the brickwork of the tunnel, the protruded face, glowing with exultation, of an elderly gentleman, who persisted in demonstrations of satisfaction and exclamations of 'How are you?'

Stephenson was to receive for his time actually expended on the work seven guineas per diem, and Robert Stephenson five guineas, free of all expenses. George Stephenson's appointment, however, was little more than nominal. The surveys were made by Robert Stephenson, who in the subsequent parliamentary battles was the engineering authority of the projectors, and ultimately, on the Bill being obtained, was made 'engineer-in-chief' for carrying out the works, his father being in no way whatever associated with him. It is right that this fact should be borne in mind, as a succession of writers have credited George Stephenson with the construction of the first of our existing 'great railways,'—the first railway connecting London with a distant seat of industry. In some inaccurate works the 'London and Birmingham Railway' is spoken of as having been constructed by George Stephenson, in others by George Stephenson and Son, in others by Messrs. Stephenson. The line was, however, constructed by Robert Stephenson alone, and to him is

* As public interest may be gratified, and undesirable discussion obviated, by the publication of the agreement just alluded to, it is here printed.

'Birmingham: Sept. 18, 1830.

'Memorandum of Agreement entered into between Messrs. George Stephenson and Son, of the one part, and the Committee of the London and Birmingham Railway Company, of the other part.

'First, the said George Stephenson and Son undertake and agree, so far as their best and utmost exertions will enable them, to make the necessary plans, sections, and book of reference for the proposed railway from Birmingham to London, and to do everything that is necessary for that purpose in time to comply with the Standing Orders of the House of Commons, so as to enable the solicitors to insert the necessary notices in the newspapers during three weeks before the sitting of Parliament, and to affix necessary notices on the doors of the several sessions houses at the next Quarter Sessions, and to deposit the plan and book of reference, &c., with the clerks of the peace of the several counties, and in the Private Bill Office, on or before the 24th day of October next, and in

due the entire merit of overcoming all the gigantic obstacles to its construction.

Robert Stephenson made three distinct surveys for the London and Birmingham line, besides several minor surveys of different portions of the country, for the purpose of ascertaining whether the route could not be improved. The first survey was made in the autumn of 1830. In 1831 a second line was marked out, almost identical with the one eventually executed. The plans and sections having been deposited, and the requisite amount of shares subscribed for, an application was made to Parliament, and a Bill to enable the Company to make their proposed railway was read the first time on February 20,

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every other respect to comply with the Standing Orders of the Houses of Parliament, so far as the duty of an engineer extends.

'In consideration of which the Committee agree to pay to Mr. George Stephenson the sum of seven guineas a day during the time that he shall be occupied in the business, and to Mr. Robert Stephenson the sum of five guineas a day during such time as he shall be employed in the business, and to pay the usual charges to surveyors employed by Messrs. Stephenson and Son, and to pay to Messrs. Stephenson and Son the usual travelling expenses.

'And the said George Stephenson and Son agree that Mr. Brunton shall be the resident engineer at the London end, and fully undertake and bind themselves not to be concerned in any line of railway whatever that can be injurious to this Company's line, or any part of it, during such time as they are employed as engineers to this Company.

'(Signed) John Corrie, on behalf of the London and Birmingham Company.
Geo. Stephenson.
Rob. Stephenson.

'Witness to the signature,
'Josiah Corrie.'

The appointment made legally binding by this unartistic and loosely drawn agreement, was an appointment of George and Robert Stephenson to lay out—*not* to construct and make—the contemplated line. It referred only to the survey and parliamentary engineering. In the following year it was superseded by another agreement. It was, therefore, in reality a most unimportant feature of the history of the London and Birmingham line; but it has misled numerous writers into thinking that the elder Stephenson was united with the younger in designing and carrying to triumphant completion the vast engineering operations on the railway in question.

1832. The third survey was made in the autumn following the last date.

The two first surveys were no slight addition to the labours and responsibilities of a young engineer, with the construction of two lines of railway already on his hands, besides the superintendence of a large engine-factory in Northumberland, and extensive mining operations in Leicestershire. In every parish through which Robert Stephenson passed, he was eyed with suspicion by the inhabitants, and not seldom was menaced with violence. The landed gentry were not alone in expressing aversion to a set of men tramping through their fields, and proposing to drive a road, with their leave or without it, across their property. The aristocracy regarded the irruption as an interference with territorial rights. The humbler classes were not less exasperated, as they feared the railway movement would injure those industrial interests by which they lived. To the residents of a market town on a turnpike road, with its ten or fifteen coaches per diem, dropping passengers at its chief hotels, a railway engineer and a ruiner of trade were convertible terms. 'Suppose railroads answered,' asked critics, 'what would be the result? would not the wealthier residents of the neighbourhood invariably travel up to London to make their purchases, and leave the poor country shopkeepers to starve?'

Nor was the opposition confined to the rural population. In London, journalists and pamphleteers, whilst they professed to discuss the new project dispassionately and 'without prejudice,' distributed criticisms which at the time of their delivery were manifestly absurd, and prophecies which time has signally falsified.

'Investigator' * (in 1831), taking for the motto of his pamphlet 'No argument like matter of fact is,' undertook to prove by *facts*, that a railroad between Birmingham and London could not answer. The success of the Liverpool and Manchester Railway he accounted for by the peculiarities of the trade between those two towns, and maintained that the same system of locomotion which was admirably adapted for bales of cotton wool would fail when employed for the general convenience of the public.

Touching on the dangers and inconveniences of railway travelling 'Investigator' says —

> That there are other dangers, and most formidable ones too, besides accidents to the engine, there have been too many and too melancholy proofs on the Liverpool and Manchester line. There was the late Mr. Huskisson, there was the engineer's own brother, and there has been a number of others; the amount of whom there is said to be considerable reluctance in disclosing. In short, during the few months that elapsed between September 15, and December 15, 1830, there occurred more fatal accidents upon the thirty-one miles of railway between Liverpool and Manchester, than upon all the road between Birmingham and London in as many years.†

The causes of greater danger on the railway are several. A velocity of fifteen miles an hour is in itself a great source of danger, as the smallest obstacle might produce the most serious consequences. If, at that rate, the engine, or any forward part of the train, should suddenly stop, the whole would be cracked by the collision like nutshells. At all turnings there is a danger

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* Remarks on the Proposed Railway between Birmingham and London, proving by Facts and Arguments that that Work would cost Seven Millions and a Half; that it would be a Burden upon the Trade of the Country, and would never pay. 'No argument like matter of fact is.' By Investigator. London: T. M. Richardson, 23 Cornhill; J. Ridgway, 169 Piccadilly.

† The reader must bear in mind 'Investigator's' motto—'No argument like matter of fact is.'

that the latter part of the train may swing off the rails; and, if that takes place, the most serious consequences must ensue before the whole train can be stopped. The line, too, upon which the train must be steered admits of little lateral deviation, while a stage coach has a choice of the whole roadway. Independently of the velocity, which in coaches is the chief source of danger, there are many perils on the railway: the rails stand up like so many thick knives, and anyone alighting on them would have but a slight chance for his life. On a road crowded with engines, the escape from the rails would avail him but little, as before he could recover himself from a slight stunning, a train on the next rails would be up, and before the conductor could arrest the progress of that he would be cut asunder. . . . . Another consideration which would deter travellers, more especially invalids, ladies, and children, from making use of the railways, would be the want of accommodation along the line, unless the directors of the railway chose to build inns, as commodious as those on the present line of road. But those inns the directors would have in part to support also, because they would be out of the way of any business except that arising from the railway, and that would be so trifling and so accidental that the landlords could not afford to keep either a cellar or a larder.

Commercial travellers, who stop and do business in all the towns, and by so doing render commerce much cheaper than it otherwise would be, and who give that constant support to the houses of entertainment which makes them able to supply the occasional traveller well and at a cheap rate, would, as a matter of course, never by any chance go by the railroad; and the occasional traveller, who went the same route for pleasure, would go by the coach-road also, because of the cheerful company and comfortable dinner.

Not one of the nobility, the gentry, or those who travel in their own carriages, would, by any chance, go by the railway. A nobleman would really not like to be drawn at the tail of a train of waggons, in which some hundreds of bars of iron were jingling with a noise that would drown all the bells of the district, and in the momentary apprehension of having his vehicle broke to pieces and himself killed or crippled by the collision of those thirty-ton masses.

An unfair attempt has been made in various quarters to throw obloquy on the aristocratic classes of the country, by representing them as the especial opponents of the earlier railways. As the chief owners of property required by the projectors of the new roads, the functions of opposition were principally discharged by them; but their antagonism to the novel system was admired and encouraged by all sections of society. Corporations of provincial boroughs, tradesmen of petty towns, small yeomen, trustees and mortgagees of turnpike tolls, in short, all holders of vested interests, were zealous to crush at their first appearance undertakings which were sure to disturb and not unlikely to prejudice existing arrangements. Small proprietors fought against the Stephensons to their utmost. The great ones of the earth could do no more. At this date the reader laughs at 'Investigator's' arguments and fears; but thirty years since, before railways were affairs of familiar knowledge, many a reader who now despises 'Investigator' would have thought him very clever, sound, and practical.

In spite of the prevailing antagonism to railways the Bill for the London and Birmingham line passed the Commons in 1832 after hard fighting. In the House of Lords, however, the result was different. The Lords' Committee came to the conclusion, 'That the case for the promoters of the Bill having been concluded, it does not appear to the Committee that they have made out such a case as would warrant the forcing of the proposed railway through the lands and property of so great a proportion of the dissentient landowners and proprietors.'

In the parliamentary progress of the Bill, Robert Stephenson was subjected to searching cross-examination,

but, ready as well as resolute, quick as well as patient, he was a difficult witness for opposing lawyers to deal with.*

* The following extracts from the evidence will give the reader some idea of the duels fought on this occasion between Robert Stephenson and Mr. Harrison, who, in conjunction with Mr. D. Pollock, appeared as counsel for the trustees of the tolls of the Sparrow's Herne Road.

'Cross-examined by Mr. Harrison.

'"That piece of board would also have to be put on the top of the embankments?"

'"It would."

'"The line given in the section deposited with the clerk of the peace, is not the line that will ultimately be the line of the railroad?"

'"It is the surface of the embankment before the metaling is laid on."

'"Any embankment would be two feet higher than what is described?"

'"Yes."

'"Have not marks been put in describing the line of the surface?"

'"Yes."

'"And have they not since been scratched out?"

'"I believe not."

'"Were they on the section deposited in the other House?"

'"Yes."

'"Any individual who looks at the section will see that this line is ultimately not to be the surface line by two feet?"

'"It is the line that is always put on the section to represent the surface invariably."

'"Do you mean to state that?"

'"I do not know a single exception to it."

'"Do you mean to state that the line so marked on the section has not always invariably been considered at all times as the surface line?"

'"Certainly, in my practice it never has."

'"Then how came you to describe it as the surface?"

'"It is the surface of the embankment before the rails are put on it."

'"Will not common people suppose that the surface of the embankment means the top of the place on which the things travel?"

'"I do not think any engineer would ever so consider it; they always look on the line laid down in the sections as top of the cuttings."

'"If every one of the engineers have made a mistake in supposing the direct contrary, should you attribute it to their ignorance?"

'"There was not a single discussion that took place on that point with me. The engineers that were employed to make the estimate went through the estimate without asking a question as to what the line represented."

'"That is not an answer to my question. If all the engineers employed by the opposers of the Bill to examine the line as to the injury done to their land, and estimate the quantity of it taken by the embankments—if they have all considered that that is the surface on which the carriages run, do you attribute that to their ignorance?"

'"Not to their ignorance, but to a disposition to increase the cost of the work."

It was, however, a trying ordeal — trying alike to his temper and his knowledge. His want of professional

'"Do you think that they would wilfully do that?"

'"I do not believe that any impartial engineer would suppose the line to mean anything different to what I suppose it to mean."'

On a subsequent day Mr. Harrison, having in vain endeavoured to show that Robert Stephenson's 'borings' were wrong, and his estimates for bridges and arches altogether incorrect, proceeded to throw out insinuations which were immediately seized upon by Dr. Lardner, and formed an important feature of his well-known attack upon the Stephensons in the 'Edinburgh Review' for October, 1832.

'"In page 115 there is a clause preventing any horse being driven or ridden on the railroad. Is that to preclude the use of horses in dragging carriages on the railroad?"

'"I suppose it is."

'"Are persons to be allowed to draw railway carriages by horses?"

'"I conceive that is totally incompatible with a line where locomotive engines are used."

'"All the engines are to be approved by the Company?"

'"Yes."

'"The engines are not to be exclusively furnished by the Company?"

'"No."

'"Are you and your father great manufacturers of steam-engines?"

'"We do manufacture them."

'"For this railroad, do you not, and for others?"

'"For any railroad."

'"You are the persons who are to be applied to?"

'"I do not know that that may be the case. *I am only engineer for the time being.*"

'"As long as you and your father are the engineers, you are the people to decide what engines shall be used by other people?"

'"If there is any fear of prejudiced opinions being given by us, I apprehend the committee may easily find a remedy by calling in other engineers to decide the point."

'"There would be no remedy in the Bill?"

'"He would still be the Company's engineer."

'"The engines to be used are to be approved of by the engineer for the railroad company; and there is no appeal from this decision, if he says he does not like the engines?"

'"I may not be the engineer for the Company. I apprehend I may be done with the railroad as soon as the railroad is completed, if I am there so long. I may not be the resident engineer."'

On the next day Mr. Harrison resumed his cross-examination of the young engineer, whom, in his zeal for his clients, he had depicted as one who would recommend his own inferior locomotives, and exclude by base influence the superior productions of rival manufacturers. On the present occasion the counsel endeavoured to break down Robert Stephenson's evidence on the subject of 'friction,' by the statements advanced in his 'Answer' to Mr. Walker's report three years before.

'"You stated from sixteen to twenty feet of elevation is equal to a mile. Is it not more than that?"

experience was superciliously suggested, his answer was a curt statement of *what he had done*. It was insinuated

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' " I am quite convinced it is not more."

' " Then it is not twenty-six ? "

' " I am quite sure it is not."

' " I only caution you, in order that you may be supposed to commit yourself too hastily to that answer. Do you stand by that answer ? "

' " That elevation — that is, equal to a mile going round. It depends very much on the friction of the wagons employed on the railroad."

' " What is the friction on a level ? "

' " It varies from 6 lbs. to 9 lbs. What I consider 8 lbs. is amply sufficient for friction on level ground. I am quite sure I am overstating the thing when I say 8 lbs."

' " Eight is equal to the friction for a ton, you say ? "

' " Eight is supposed to be so. You might overhang a pulley and it would draw a ton. The experiments I have made with wagons make it considerably less. They are liable to get out of order."

' " You abide by your answer, and state distinctly it is not twenty-six feet, but sixteen and twenty ? "

' " Yes, I do."

' " Now you published some calculations on it, did you not ? "

' " No, I did not."

' " Did you not publish some experiments in reply to the report made by Mr. James Walker ? "

' " Yes."

' " Was it not put at 1 to 200 on a plain surface ? "

' " If I had taken the greatest advantages of the circumstances that were allowed me in reply to Mr. James Walker's report, I should have stated it at eight. He took it at twelve or thirteen: upwards of thirty per cent. more than experiments proved to me to be correct."

' " He took it at twelve. Did you not in your answer put it at 1 in 200 ? "

' " Yes; which is the friction actually existing on the coal wagons in the north of England on a very bad railroad, when compared with good ones. On the Liverpool and Manchester I am quite sure there is not a wagon moving with the friction of 8 lbs. to a ton."

' " What would that be instead of 1 to 200 ? "

' " It will be 1 to 280."

' " Instead of its being 1 to 200, the calculation you put it at, you now put it at 1 to 280 ? "

' " It is calculated to give an unfavourable impression. The reason I put it at 1 to 200 at that part was this — that the wagons on the railroads in the north of England are employed there with axle-trees of considerably larger size than in the Liverpool and Manchester. There the bearings are put on the outside of the wheels; the size of the axle-trees are reduced to each one inch and three-quarters. For coal wagons in the north of England the diameter of the axle-trees is a full three inches."

' " These are reasons for taking it at 1 to 280 ? "

' " Yes; from the improvement in the wagons."

' " The construction of wagons in the north creates a greater degree of friction ? "

' " Most decidedly."

that he and his father would supply the petitioning Company with inferior locomotives, and shut out from competition the superior engines of rival manufacturers. His reply was that the Company would know how to take care of themselves.

Of the exertions made by Robert Stephenson to get the Bill through Parliament the following story will afford

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'"That was the report of Mr. James Walker on the Manchester and Liverpool Railway?"

'"Yes, it was."

'"The Court of Directors desired him to take into consideration the difference between locomotive power and stationary engines?"

'"Yes."

'"He made a report, on which you made observations, putting it at 1 to 200?"

'"Yes."

'"You would not wish to be bound by that?"

'"*Certainly not; I am making calculations on recent facts.*"

'"At that time you took from the Liverpool and Manchester?"

'"Mr. James Walker went to the north of England by way of examining circumstances connected with locomotive engines travelling and stationary engines working there. He took the friction at twelve and a half; and he cannot produce a single instance where it was twelve and a half. I took the friction of wagons in the district he had been examining."'

Unable to shake the witness, the counsel proceeded to suggest that so young a man necessarily lacked experience, and was, indeed, merely his father's puppet.

'"Have you ever," was the enquiry, "constructed a public work of that sort yourself?"

'"Yes; the Warrington Railway and the Leicester Railway."

'"What length is the Warrington?"

'"Only five miles."

'"Is it constructing or constructed?"

'"It is completed some time."

'"What is the length of the Leicester?"

'"Sixteen miles."

'"Is it now at work?"

'"More than twelve or thirteen miles of it ought to have been opened yesterday, but they deferred it till the 9th of this month."

'"Between what points is it?"

'"Between the town of Leicester and the coal field of Swannington."

'"Where is Swannington?"

'"Near Ashby de la Zouch.'

'"The only two you constructed yourself?"

'"The only two under my own charge."'

(*Vide Minutes of Evidence taken before the Lords' Committees to whom was referred the Bill, intituled, 'An Act for making a Railway from London to Birmingham.'*)

an example. The opposing counsel directed all their powers before the Commons' Committee to show that Robert Stephenson was ignorant of the geological conditions of the country, and consequently proposed to make his cuttings through the Tring Ridge at so small an angle that the sides of the excavation would fall in upon the way. The argument of course was that, since this mistake had been made by the engineer, the estimates were enormously beneath the sum required for the undertaking, as the increase of the angle of a cutting would greatly increase the labour and expense at which it could be completed. It was to no purpose that Robert Stephenson offered to stake his reputation that his calculations were reliable. The barristers ridiculed his assurances, and the Committee were evidently impressed by the objection. Leaving the Committee-room with his examination still unfinished, though he had been subjected for three days to a cross-fire of questions, Robert Stephenson took counsel within himself what he should do. He remembered that there was at Dunstable a cutting through the same formation. The cutting was Telford's work. How could he ascertain the angle of Telford's cutting? How could he establish the point? The question was soon answered. He had not been in bed for four nights, and he had work before him that would keep him in town till past midnight; but nevertheless he determined to visit Dunstable before again entering the Committee-room. At midnight he supped, and then had a short nap, from which he roused himself to get into a post-chaise with his friend Mr. Thomas Longridge Gooch. By dawn the two young men were at Dunstable. By ten o'clock they were in counsel's chambers in London,

with the intelligence that they could go into the Committee-room and testify that the angle of Telford's cutting, which had stood the test of time, was the same as the angle of the cuttings provided for in the estimates.

But toil, patience, forbearance, were all thrown away. The result of the enquiry, foreseen as it was by those who were better acquainted with the animus of the Committee, had not been anticipated by Robert Stephenson, and he was deeply chagrined at the rejection. His mortification was so manifest that Lord Wharncliffe, the chairman of the Committee, took him aside and said with characteristic kindness, 'My young friend, don't take this to heart. The decision is against you; but you have made such a display of power that *your fortune is made for life.*' These words of sympathy and commendation, coming from a nobleman who, as one of the 'grand allies,' had been amongst his father's earliest employers and patrons, went to the young man's heart, and with emotion he often recalled them in after life, when he reviewed the earlier battles of his career, or himself held out an aiding hand to struggling merit.

The adverse decision which called forth Lord Wharncliffe's generous sympathy was the signal for the enemies of the two Stephensons to renew their efforts to make both father and son the objects of public suspicion. Robert Stephenson was no exception to the rule that envy is the shadow of success. At this date it would be an ungrateful and a useless task to drag into notoriety the persons who from private pique or professional jealousy used unworthy means to lower the reputation of the two greatest engineers of this or any other age. Robert Stephenson wisely paid no attention to malicious rumours.

But when a distinguished scientific writer, who had been misled by detractors, availed himself of his position, on the staff of the 'Edinburgh Review,' to give the stamp of authority to erroneous statements, Mr. Charles Lawrence, the chairman of the 'Liverpool and Manchester Railway,' officially published a complete refutation of the writer's groundless accusations.*

Notwithstanding the rejection of their Bill, the projectors of the London and Birmingham Railway Company were not disheartened. On Friday, July 13, 1832, the first Friday after the rejection of the petition, a public meeting of persons favourably disposed to the Railway was held at the Thatched House Tavern. Sixteen peers and thirty-three members of the House of Commons were present. The chairman of the Commons' Committee was one of the representatives of the Lower House, and Lord Wharncliffe, the chairman of the Lords' Committee, presided at the meeting. Two resolutions were put and carried unanimously. The first resolution, moved by the Earl of Denbigh, and seconded by Sir J. Skipwith, M.P., was —

That, in the opinion of this meeting a railway from London to Birmingham will be productive of very great national benefit.

The second resolution, moved by the Earl of Aylesford, and seconded by Sir Edward D. Scott, Bart., M.P., was—

That the Bill for effecting this important object having passed the House of Commons after a long and rigorous examination of its merits, it must be presumed that its failure in the

* Liverpool and Manchester Railway. Answer of the Directors to an article in the 'Edinburgh Review' for October 1832. Liverpool, 1832.

House of Lords has arisen from apprehensions on the part of landowners and proprietors respecting its probable effect on their estates, which this meeting firmly and conscientiously believes to be ill-founded.

This demonstration had an immediate effect on the country. It was felt by those who had opposed the measure from jealous anxiety for the interests of property, that they had not much to fear from the new road, when landed proprietors of high character and hereditary possessions could be found to support such resolutions. It was learnt also that Lord Sefton and Lord Derby, the strenuous opponents of the Liverpool and Manchester line, had become so far converts to the railway system as to have been supporters of the London and Birmingham project. The opposition, which refused to be influenced by such authority, was found not unwilling to listen to other considerations. The bribe reached where reason could find no entrance. In some cases enormous sums of money were paid for the acres of obstinate landowners. The consequence was that in the session of 1833, on the renewal of the petition (Robert Stephenson having in the meantime made a third survey of the line) a Bill was obtained, giving the directors power to construct their line.

It now remained for the directors to appoint an engineer for the accomplishment of the task. Robert Stephenson had high hopes of getting the post. His energy in making the survey, and his conduct as a witness before committees, had won for him many new and powerful friends. But he was still young—*very* young—to be engineer-in-chief to such an undertaking. In the directory, there were of course several persons who honestly mistrusted *young* genius.

Writing to Robert Stephenson on May 28, 1833, Mr. Creed, one of the secretaries of the Railway, says — 'Nothing is said as to the appointment of engineer or solicitor, but I think *you* may be easy on that head. You have friends here and at Birmingham who appreciate your merits and services.' It was not, however, till just four months after the date of this letter that Robert Stephenson signed the contract that secured to him the post for which he had fought so zealously. In his note-book, under date September 20, 1833, is the following entry: — 'Signed contract with the London and Birmingham Railway directors, before Mr. Barker, at the Hummums, Covent Garden. Dined with Stanhope directors.'

On receiving the appointment of engineer-in-chief to the London and Birmingham Railway, Robert Stephenson broke up his modest establishment in Greenfield Place and took a comfortable house on Haverstock Hill, Hampstead Road, where he continued to reside for many years. From this time London became his home, and though he frequently visited Newcastle (the spirit of which enterprising and noble town had contributed greatly to form his character) and continued till his death to superintend the affairs of the engine manufactory, he never again had a home on the banks of the Tyne.

His residence in Newcastle had been broken by repeated periods of absence, during which he superintended works for his father, made trips to London and the continent, constructed the Warrington line, and the Leicester and Swannington Railway, surveyed the route for the London and Birmingham line, and directed the first operations at the Snibston colliery. These periods of absence reduce the time of his Newcastle life to a comparatively short term.

Still into that brief space much work and happiness had been compressed.

Numerous engagements left him little time for society. His domestic life, therefore, was strictly private, only three or four close friends being admitted to his house. One of those few intimate associates still lives to recall the happy evenings they occasionally spent in Greenfield Place, with music, talk, and cigars.

To these evening parties the pupils at the works were frequently invited. To limit the number of these pupils it was soon found necessary to raise the premium. Even at the increased rate there were found too many candidates for admission to 'the works;' and Robert Stephenson, whose sense of duty would not allow him to pocket a premium and give just nothing in return for it, resolutely declined to receive more than such a number of pupils as he conscientiously believed would profit by the opportunities offered them of acquiring information.

Inasmuch (Robert wrote from Dieppe, July 11, 1833, to his partner Mr. Richardson) as my own feelings are concerned, I should have no objections to receiving another apprentice into our establishment. The objections that exist are these. We have at present as many, indeed more, young men than we can sufficiently employ. If we increase the number (which we have very frequent opportunities of doing) we should only be doing the young men injustice, because they would not have proper and sufficient experience to learn the profession. They would be inadequately employed, and would consequently contract habits not calculated to advance them in after life. We are at present under an engagement to take a friend of Mr. Lock's (the Marquis of Stafford's agent), and when he comes our office will be really too full, even when I look forward to the London and Birmingham Railway going on. Taking young men, although it may be a profitable part of our business, is one that incurs great responsibility, which we feel is now as great as it ought to be. If

these objections had not existed, it would have afforded both my father and self very great pleasure to take any young man introduced by you.

One of the pleasant features of Robert Stephenson's career was the strong personal attachment he formed for his pupils when they were young men of capacity and character. He never forgot or lost sight of them. A pupil of the 'right sort' was sure to win his approval and notice, and the pupil who had so earned his good opinion was sure to reap advantage from it. On the other hand, Robert Stephenson never considered himself either bound, or at liberty, to recommend for advancement an old apprentice, when he could not do so *honestly*. 'I can do nothing for you, unless you like to stop here as an ordinary workman,' he said to more than one pupil when his time was out: but then the young men to whom he so spoke merited no other treatment.

CHAPTER X.

CONSTRUCTION OF THE LONDON AND BIRMINGHAM RAILWAY.

(ÆTAT 29–34.)

Appointment as Engineer-in-Chief to the London and Birmingham Line — Contract Plans — Drawing-Office in the Cottage on the Edgeware Road, and subsequently at the Eyre Arms, St. John's Wood — Health and Habits of Life — Staff of Assistant and Sub-Assistant Engineers — The principal Contractors — Primrose Hill Tunnel — Blisworth Cutting — Wolverton Embankment and Viaduct — Kilsby Tunnel — Interview with Dr. Arnold at Rugby — Conduct and Character of Navvies — Anecdotes — Robert Stephenson proposes the Extension of the Line from Camden Town to Euston Square — Proposition first rejected and then adopted by Directors — Act of Parliament obtained for Extension of the Line — The Incline from Camden Town to Euston Square originally worked by Stationary Engines and Ropes — Lieut. Lecount's Comparison of Labour expended on the London and Birmingham Railway, and Labour expended on the Great Pyramid — Conduct of a certain Section of the Directors to Robert Stephenson — Opening of the Line — Dinner at Dee's Royal Hotel, Manchester — Robert Stephenson's Anger with a Director — Dinner and Testimonial given to Robert Stephenson at Dunchurch — Brunel uses Robert Stephenson's System of Drawing on the Great Western — Robert Stephenson's Appointment as Consulting Engineer.

THE labours of three surveys having been accomplished, the inordinate demands of landholders of every rank and condition having been satisfied, and a defeat as iniquitous on the part of the conquerors as any to be found in the chronicles of parliamentary warfare having been sustained, the London and Birmingham Railway Company had at length obtained their Bill. They had gained their

point on a new trial: but when Parliament reverses the unjust decision of a preceding session, the injured party has still to pay the costs of previous injustice. The sum of £72,869 recorded in the Company's books as paid for obtaining their Act of Incorporation is an eloquent memorial of a conflict that stirred Westminster thirty years since.

The Bill however was won, the Royal assent being granted on May 6, 1833. Mr. Isaac Solly, the first chairman, was succeeded in 1834 by Mr. George Carr Glyn, M.P., under whose able direction the line was completed, and was brought to its present high state of prosperity. The appointment of an engineer was the next affair for consideration. Three years' indefatigable attention to the interests of the Company gave Robert Stephenson a claim upon their gratitude. His display of capacity during successive examinations before parliamentary committees had raised him high in the esteem of his profession and the public. A strong party, composed principally of his father's Liverpool antagonists, spared no pains, however, to snatch from him the appointment of engineer-in-chief. 'He is a promising young man, but still he is only a *young man*,' these gentlemen repeated in every quarter, forgetting that public railways were young things, and that the men best qualified to construct the new roads were all young men—the pupils of George Stephenson, who was himself still in the middle period of life.

Fortunately Robert Stephenson's enemies were borne down by more prudent and more honest directors; and on September 7, 1833, the board resolved — 'That Mr. Robert Stephenson be appointed engineer-in-chief for the

whole line at a salary of £1,500 per annum, and an addition of £200 per annum to cover all contingent expenses, subject to the rules and regulations for the engineers' department, as approved by the respective committees.' * On Mr. Brunel's appointment as engineer to lay down the Great Western Railway, with an annual stipend of £2,000, Robert Stephenson's smaller salary was increased to the same amount, the directors of the London and Birmingham line rightly thinking that their character was concerned in treating their engineer not less liberally than Brunel was treated by a similar association.

In their next published report, dated September 19, 1833, the directors thus speak of their engineer's appointment—'The directors, considering it indispensable that, in the execution of the works, one engineer should have entire direction, and that his time and services should be exclusively devoted to the Company, have under these conditions appointed Mr. Robert Stephenson engineer-in-chief for the whole line; and they are persuaded that to no one could this charge be more safely or more properly confided. He has received instructions to stake out the line without delay, and the directors have reasons to expect that the railway will be completed in about four years from the commencement of the work.'

Having at length secured the post, Robert Stephenson quitted Newcastle and came to the scene of his next five years' labour. For a short time he resided in a furnished cottage in St. John's Wood; but as soon as it was fitted

* The above resolution was, for the purpose of this work, extracted from the Minutes of the London and Birmingham Railway, by the late Admiral Moorsom, R.N., who at the time of his lamented death was chairman of the Company, to which at its first outset he acted as secretary.

up and ready for his reception, he moved into the house on Haverstock Hill, which continued to be his home as long as his wife lived.

He had undertaken a stupendous task. Up to that time no railway of similar magnitude had been attempted. The line from Liverpool to Manchester was by comparison a trifling work. Its length was little more than a quarter of the length of the new road, and its most important works, including the Sankey viaduct (with nine arches each of fifty feet span thrown over the Sankey valley, and running seventy feet above the Sankey canal), its principal tunnel, 2,250 yards long, and its firm highway over the bogs of Parr Moss and Chat Moss, are in respect of magnitude not to be compared with the Kilsby tunnel, the Blisworth cutting, and the Wolverton embankment and viaduct.

A man of iron nerve would have experienced some uneasiness at the commencement of such an undertaking. But Robert Stephenson, unlike his father, had throughout life to contend with a distrust of himself, which was partly due to innate modesty of disposition, and partly attributable to a delicate nervous organisation. Though the climate of South America had saved him from pulmonary consumption, he had by no means acquired the soundness of constitution which young men ordinarily enjoy. He was never a really strong man; and the exertions of the four preceding years brought him to London in 1833 in a very unsatisfactory condition of health.

Had circumstances left him free to follow his own inclinations, Robert Stephenson, instead of taking a conspicuous position in London society, would have passed his whole

life at Newcastle in comparative retirement. Naturally no man was more averse to the turmoil of public life; no man more prized the tranquillity of home. He had also become intensely fond of the mechanical part of his profession. His labours in the Newcastle factory had been attended with so much genuine pleasure, that he did not without reluctance give them up for a more ambitious career; and in his later years he repeatedly declared to his intimate companions the regret he felt at not having remained at Newcastle as a builder of locomotives, though he had risen to be the most successful civil engineer of his time.

The engineer wished to ascertain with accuracy the amount of the work before him. To effect this, before cutting a turf, he went over every inch of ground, and endeavoured to calculate the exact cost of every operation necessary for the accomplishment of his task. Hitherto, in laying down railways, engineers had been accustomed to do their work piecemeal, making a commencement, working up to difficulties, and then seeing how those difficulties should be overcome. In laying down the Liverpool and Manchester Railway, George Stephenson had at the outset of the undertaking only a general notion of the labour before him. The details were not considered till their consideration could no longer be deferred. Robert Stephenson saw that this plan of leaving each day to take care of its own evils was little calculated for so vast an undertaking as the London and Birmingham line. If the 112 miles of the proposed railway between Camden Town and Birmingham were to be completed within four or five years, the works must be advanced at various points simultaneously, and the engineer-in-chief

must, at their commencement, have an accurate knowledge of their minutest details.

Robert Stephenson also resolved on making plans of every part of the entire line, with unprecedented minuteness and completeness of detail. He not only had a full survey made, showing every natural feature of the route, but prepared complete drawings for every work that was to be executed, in all its details, accompanied with full descriptions and specifications and accurate calculations of all the labour and material it would require. As each portion of the line was thus mapped out it was let to a contractor, who engaged to complete the work for a certain sum, and at the same time specified the exact sum charged for each portion of the contract. In those days there were no gigantic contractors, a contract for £100,000 being regarded as very large. Men who in he course of a few years made enormous fortunes were then modest speculators, and had not sufficient funds in hand to keep a regiment of 'navvies' at work for more than a month. The first contractors on the London and Birmingham line were paid monthly, and in facilitating these monthly payments the accuracy of the contract plans was of the greatest service. As the end of each month came round, the assistant-engineer appointed over each division of the line marked out the exact quantity of work each contractor had accomplished, and for that quantity payment was made.

It is difficult to give the reader any adequate idea of the labour expended on these plans; for they had not only to be made with the greatest attention to accuracy, every separate calculation relating to them being three or four times verified, but when they were made they had

to be multiplied. The original contract drawings, signed by the engineer-in-chief and the contractor, were preserved as documents of legal testimony; and of each of them three copies were made — one for the use of the committee, one for the engineer-in-chief, and one for the assistant-engineer superintending the district in which the work was situated. The entire line, as far as contracts were concerned, was divided into thirty separate divisions, each requiring distinct drawings, estimates, and specifications. All these works, with two or three unimportant exceptions, were let to various contractors between May 1834 and October 1835. From these data it may be seen that the demands on Robert Stephenson's drawing establishment were very heavy. It was calculated that, for eighteen months, as many 'as thirty drawings per week, each requiring two days' work from one pair of hands, were turned out from the engineer-in-chief's office.'

Robert Stephenson was fortunate in having good subordinates. Reserving a district, extending nine miles from Maiden Lane, Camden Town, for his own especial supervision, he divided the remaining 103 miles into four districts, each district having an assistant-engineer to superintend it, and each assistant-engineer being supported by a staff of three sub-assistants. For purposes of construction the line was thus apportioned—

District No. I.

This district, reserved for the engineer-in-chief's especial personal supervision, extended from Camden Town for about nine miles, and on its completion comprised the Camden Town station, the Primrose Hill tunnel, the tunnel under Kensal Green, and the bridge over the River Brent. The principal engineer of this district, under Mr. Stephenson, was John

Birkinshaw, who was assisted by Mortimer Young, whose place was subsequently filled by Timothy Jenkins.

District No. II.

Assistant-engineer G. W. Buck; sub-assistant engineers, Mr., now Sir J. Charles Fox, F. Young, and Capt. Cleather, R.S.C. This district, extending from Harrow to Tring (23 miles) concluded with the Watford tunnel.

District No. III.

Assistant-engineer, John Crossley; sub-assistant engineers, S. S. Bennett, E. Jackson, J. Gandell, and M. Farrell. This district, extending from Tring to Wolverton (22 miles), included the Tring cutting and the Wolverton viaduct.

District No. IV.

Assistant-engineer, Frank Forster, who (on his succeeding to the post of assistant-engineer of District No. V.) was succeeded by G. H. Phipps; sub-assistant engineers, H. Lee, E. Dixon, C. Lean, and J. Brunton. This district, reaching over Wolverton and Kilsby (24 miles), included the Kilsby tunnel.

District No. V.

Assistant-engineer, Thomas Longridge Gooch, who (on his appointment to be the chief-engineer of the Manchester and Leeds Railway) was succeeded by Frank Forster; sub-assistant engineers, John Reid, B. L. Dickenson, M. Monteleagre, R. B. Dockray, and Lieut. P. Lecount, R.N. Extending from Kilsby to Birmingham: this district had for its principal works the Avon and Lawley Street viaducts.

The foregoing table assigns more than three sub-assistant engineers to the three last districts. There were, however, only three sub-assistants acting on any one district at the same time.

Robert Stephenson's first drawing office, whilst he was preparing the contract plans, was a small cottage standing on land which the Company purchased, near the point where the railroad passes under the Edgeware Road. This modest tenement was soon found to be too small for the

engineer's purpose. Luckily the Eyre Arms Hotel, St. John's Wood, was just then vacant. The Company hired it for their engineer's use, and 'the great room,' familiar to many of the London public as a place of assemblage for lectures, soirées, and political business, was speedily furnished with drawing-tables and peopled with between twenty and thirty draughtsmen. Amongst the gentlemen employed at the Eyre Arms was Mr. G. P. Bidder, who recently filled the office of President of the Institution of Civil Engineers.

Eventually the line was let out in the manner indicated by the following table:—

Name of Contract	Original Contractors	Date	Second Contractor
Euston Extension	W. and L. Cubitt	Dec. 1835	
Primrose Hill	Jackson and Sheddon	May 1834	The Company, Nov. 1834
Harrow	Nowell and Sons	May 1834	
Watford	Copeland and Harding	May 1834	
King's Langley	W. and L. Cubitt	Sept. 1835	
Berkhamstead	W. and L. Cubitt	Sept. 1835	
Aldbury	W. and L. Cubitt	Sept. 1835	
Tring	T. Townsend	Sept. 1834	The Company, Oct. 1837
Leighton Buzzard	James Nowell	Sept. 1835	
Stoke Hammond	E. W. Norris	Sept. 1835	
Bletchley	John Burge	Sept. 1835	
Wolverton	William Soars	Oct. 1834	The Company, June 1837
Wolverton Viaduct	James Nowell	Feb. 1835	
Castlethorpe	William Soars	Oct. 1834	Craven & Sons, July 1835
Blisworth	William Hughes	Feb. 1835	The Company, Dec. 1836
Bugbrook	John Chapman	Feb. 1835	
Stowe Hill	John Chapman	Feb. 1835	
Weedon	Edward Boddington	May 1835	W. and J. Simmons, May 1836
Brock Hall	J. and G. Thornton	May 1835	
Long Buckby	J. and G. Thornton	May 1835	
Kilsby	Jos. Nowell and Sons	May 1835	The Company, Feb. 1836
Rugby	Samuel Hemming	Nov. 1835	The Company, Oct. 1837
Long Lawford	W. and J. Simmons	Feb. 1835	
Brandon	Samuel Hemming	Feb. 1835	The Company, Jan. 1838
Avon Viaduct	Samuel Hemming	Nov. 1835	
Coventry	Greenshields and Cudd	Nov. 1834	The Company, May 1837
Berkswell	Daniel Pritchard	Nov. 1834	
Yardley	Joseph Thornton	Aug. 1834	
Saltley	James Diggle	Aug. 1834	
Rea Viaduct	James Nowell	Aug. 1834	

In this table may be seen the fortune attending the engagements of several contractors. The chief contracts —those, namely, for the tunnel at Primrose Hill, the Kilsby tunnel, and the Blisworth cutting—returned to the hands of the Company unfinished, and were perfected by the Company without the intervention of contractors: and in addition to these larger works, numerous smaller operations were beyond the powers of the commercial agents. It is not difficult to account for this collapse of contractors. Railway enterprise was still only in its infancy, and, though allowance had been made in estimates and contractors' agreements for a large rise in the price of labour, iron, and other materials, that allowance fell far short of the enormous and rapid advances made in the value of those commodities. Again, railway work was new, and the engineers were scarcely more prepared than the contractors for some of the difficulties with which they had to contend.

The Primrose Hill tunnel was one case of unexpected difficulty. The tunnel, passing under the high ridge between Hampstead and Primrose Hill, near Chalk Farm, is driven through a formation of blue clay, the extreme mobility of which, on exposure to moisture, offers peculiar difficulties to engineers. Years before the construction of the London and Birmingham line an attempt to drive a tunnel through this formation had terminated in failure, in consequence of the clay bearing down the brickwork. Warned by this case, Robert Stephenson proceeded at Primrose Hill with the greatest caution. As soon as a length of about nine feet of the excavation was finished, that portion of the tunnel was supported with strong timbers, and carefully lined with brickwork in mortar

before any more earth was removed. Even this care, however, was insufficient. The pressure of the clay first forced out the mortar from the joints, and then crushed the bricks of the arch. To meet this difficulty, Robert Stephenson used only the hardest possible bricks, and laid them with Roman cement instead of mortar. This cement dries and becomes hard much sooner than mortar. The consequence of this change of material was the construction of a firm and durable lining of brickwork before the weight of the clay above was able to break in the walls of the passage. The experiment having proved successful, Robert Stephenson made himself doubly secure by making the brickwork much thicker than the estimates proposed it should be. In some portions of the Primrose Hill tunnel the thickness of the brickwork is only eighteen inches, but the larger portion is laid with a thickness of twenty-seven inches. And throughout the work costly Roman cement is used. No reader of these particulars will be surprised to learn that the difference between the estimated cost and the eventual cost of the tunnel was £160,000. The Primrose Hill contract was let for £120,000; it was not accomplished without an outlay of £280,000. No wonder, therefore, that the Company had to take back the work from the contractors unfinished.

Again, the operations of the Blisworth cutting exceeded the limits of the estimates so far that there was no prospect of their completion until the Company parted with their contractor. This excavation, which according to the estimate was to have contained 800,000 cubic yards, was not finished till nearly 1,000,000 cubic yards of earth and rock had been removed. At this

point of line 700 or 800 men, under the immediate command of the assistant-engineer, Mr. Phipps, were for many months continually employed. For blasting the limestone, there was for some time a weekly consumption of 2,500 lbs. of gunpowder.

The Wolverton embankment, another of the contracts which came back to the Company for completion, gave the engineer much anxiety. In an embankment a mile and a half long, exclusive of the Wolverton viaduct, some difficulty was anticipated; but human foresight could not have provided for all the disasters attending its construction. The embankment on the north side of the viaduct gave comparatively little trouble. Composed of blue clay, lias, limestone, gravel, and sand, it stood well, except at one place where it slipped, not from its own weakness, but because the ground gave way beneath its enormous weight. On the south side of the viaduct, however, a grievous mishap occurred, in the form of 'a slip,' that was not overcome for months. No sooner was the way seen how to fill up the slip, than Robert Stephenson was informed that the troublesome embankment had caught fire. In its composition was a portion of alum shale, containing sulphuret of iron. This material decomposing afforded a striking instance of spontaneous combustion. Great was the consternation of the peasants at beholding a railway on fire. Roguery was, they were convinced, at the bottom of the catastrophe.

This same embankment was also the cause of difficulty and litigation, which must be detailed at some length.

It would be a mistake to suppose that, with the passing of their Act, there was an end of vexatious opposition

to the London and Birmingham Railway Company. Beaten in Parliament, in a great measure through their bribery being exceeded by the bribery of their opponents, the persons interested in the Grand Junction Canal would not consent to relinquish the fight without another struggle.

The 85th, 86th, and 87th sections of the Act had reference to the rights and privileges of the Grand Junction Canal, over which the London and Birmingham Company proposed to carry their railroad in the parish of Wolverton. The 85th section provided that—

Nothing in the Act contained should diminish, alter, prejudice, affect, or take away any of the rights, privileges, powers, or authorities, vested in the Company of proprietors of the Grand Junction Canal, or authorise or empower the plaintiffs to alter the line or level of the canal or towing-path thereto, or any part thereof, or to obstruct the navigation of the canal or towing-path thereto, or any part thereof, or to obstruct the navigation of the canal, or any part thereof, or to divert the waters therein, or which supply the canal, or to injure any of the works thereof, and that it should not be lawful for the plaintiffs to make any deviation from the course or direction of the railway, as delineated in the maps or plans.*

With regard to the bridges which the Railway Company was empowered to make over the canal, the 86th section enacted that they should be—

Good and substantial bridges over the canal and the towing-path thereto, with proper approaches to each such bridge, and the soffit of each such bridge should be at least ten feet above the top-water level of the canal at the centre of the water-way, and no part of the arch over the towing-path should be less than eight feet above the top-water level of the canal, and each such bridge should be of such width and curve as should leave

* Railway and Canal Cases. Nicholl, Hare, and Carrow's Reports, vol. i. p. 224.

a clear, uniform, and uninterrupted opening of not less than twenty-two feet for the water-way, and eight feet for the towing-path under each bridge.

The Railway Company was also

Required during the progress of constructing each such bridge over the canal, and of the necessary repairs or removal thereof, from time to time, and at all times, to leave an open and uninterrupted navigable water-way in the canal of not less than sixteen feet in width, during the time of constructing and putting in the foundation walls of the abutment of each of the bridges, and of the new towing-path along the same, up to one foot above the top-water level of the canal, and which time should not exceed fifteen days; nor should less than twenty-two feet for the water-way, and eight feet for the towing-path, be left during the remainder of the period of constructing or repairing or removing each such bridge, and that the then present towing-path should remain undisturbed until the new towing-path wall should be erected, and the grounds made good and properly gravelled and open for the free passage of horses under each bridge.

The 87th section fixed certain penalties to be paid by the Railway Company, and specified the manner in which the Canal Company might recover such penalties, in case any of the provisions of sections 85 and 86 should be neglected. Such were the precautions taken by the Act to preserve uninjured the property of the Canal Company.

The country at Wolverton, through which the London and Birmingham line now runs, lies high upon the south bank. Southward of the canal the railway passes through extensive cuttings until it arrives within 150 yards of the water. At that point it enters upon an embankment which leads to the viaduct over the canal, and extends 2,450 yards beyond it upon the northern side. The entire embankment, comprising the small distance

on the south side and the large extent on the north, contains 927,000 cubic yards of earth. In order to construct the 2,450 yards of the northward embankment, Robert Stephenson decided to convey 600,000 cubic yards of earth across the canal from the many deep cuttings in the southward country. To convey this enormous quantity of earth across the water, it was necessary to make a temporary passage of communication, the construction of which involved the necessity of sinking piles into the bed of the canal. In the December of 1834 the embankment on the south bank had been carried within twenty yards of the water, and it was time to commence the embankment on the opposite side. Robert, therefore, took his preliminary steps for constructing the temporary bridge. At this juncture the Canal Company intimated that the Act did not empower the railway engineer to interfere with the water way. Thinking the best way to avoid a dispute was by prompt action, to change the discussion on what he *might do* into a discussion on what he *had done*, Robert Stephenson concentrated a strong body of engineers and navvies at Wolverton, and without advertising his proceedings in the papers or sending a notice of them to the office of the Canal Company, proceeded to drive piles on the night of December 23. Relays of men carried on the work without intermission by day-light and torch-light. The piles were driven into the bed of the river; other piles or supports were driven into the land on the north side, for the purpose of sustaining the bridge; beams were laid from the piles in the water to those on the north shore; and by noon on December 25 (the toil having been carried on through Christmas Eve into Christmas Day) the

temporary bridge was completed. The indignation of the Canal Company at such a desecration of Christmas Day may be imagined. Forthwith the directors of the powerful interest held counsel, and the result of their deliberations was that on December 30 Mr. Lake, their engineer, and a strong party of workmen, proceeded to the bridge (which had been carried over the canal in little more than a day and a half) and removed the piles which supported it.

The next step was a petition on the part of the Railway Company to the Court of Chancery to restrain the Canal Company from interfering with the operations of the said Railway Company, and particularly from 'putting down, taking up, or destroying all or any or either of the works to be made by the plaintiffs, their servants or workmen, *for the purpose of making, constructing, or otherwise hindering or preventing or delaying* the plaintiffs in making and constructing a passage of communication over and across the canal at Wolverton aforesaid, in order to construct and complete the beforementioned embankment, and for transporting, by means of such communication, the earth and materials whereof the same embankment is to consist, over and across the canal,' the plaintiffs of course undertaking to observe all the stipulations, conditions, and provisions, of the 85th and 86th sections of their Act, so as not to injure the property of the Canal Company.

The case was argued, January 19, 1835, before the Master of the Rolls, Sir C. C. Pepys, Mr. Pemberton and Mr. Bacon being in support of the motion, and Sir C. Wetherell and Mr. Turner appearing on the other side.

For the Canal Company it was not contended that the

piles and works of the temporary passage injured in any way the bed of the canal, obstructed navigation, or impeded the tow-paths. The defendants only maintained that the Act gave the Railway Company no right to make such bridge, and therefore they would not let the foundations of such temporary bridge be put in the bed of their water-passage. It was true the 8th section of the Act authorised the Railway Company to 'make or construct, upon, across, under, or over the railway or other works, or any lands, streets, hills, valleys, roads, railroads, or tram-roads, rivers, *canals*, brooks, streams, or other waters, such inclined planes, tunnels, embankments, aqueducts, *bridges*, roads, ways, passages, conduits, drains, piers, arches, cuttings, and fences,' as they should think proper for the purpose of carrying out their undertaking. But it was maintained that the 85th and 86th sections restricted the privileges granted by the 8th clause.

Of course the counsel in support of the prayer contended that, whereas the 8th clause authorised the plaintiffs to construct any temporary bridge necessary for making their line, the 85th and 86th clauses referred only to permanent and not temporary bridges, and therefore could in no way be construed as qualifying the prior permission. Much to the delight of Robert Stephenson, who sate in court throughout the hearing of the cause, the Master of the Rolls in a lucid and admirable judgement granted the injunction.

But the most obstinate and costly of all the contests involved in carrying out the works came off at the Kilsby Tunnel, about six miles from the Rugby station. Robert Stephenson's original plan was to lead his road from Birmingham to London by way of Northampton, but the inha-

bitants of Northampton raised so effectual an opposition to the scheme, that the engineer was necessitated to choose a route along which adverse influence was less powerful.

The consequence of the opposition was hurtful alike to the town and the Company. The inhabitants of the town, after repenting their folly, had to petition humbly for a branch line, and the Company were driven to bore a way for their rails through the Kilsby ridge at the stupendous outlay of more than £320,000. The length of this costly passage, situated about six miles on the London side of the Rugby station, is just 2,400 yards. A few facts, briefly stated, will enable the reader to form some conception of the labour expended upon it. Thirty-six millions of bricks were used in its construction. The two shafts by which it is ventilated and supplied with light are sixty feet in diameter, and the deeper of them contains above a million of bricks. These two enormous shafts the walls of which are perpendicular, were built from the top downwards, small portions of the wall (from six to twelve feet long and ten feet deep) being excavated at a time, and then bricked up with three feet depth of bricks, laid with Roman cement. At one time 1,250 labourers were employed in building the tunnel. To lodge and cater for this army of navvies, a town of petty dealers soon sprung up; sheds of rude and unstable construction rose on the hill above the tunnel, and in them a navvy could obtain at a high rent the sixteenth part of a bed-room. Frequently one room containing four beds was occupied by eight day and eight night workmen, who slept two in a bed, and shifted their tenancies like the heroes of a well-known farce.

The disasters of the Kilsby excavation were dimly

foreseen and predicted by Dr. Arnold. On his first visit to Rugby after the Bill for the London and Birmingham Railway had received the Royal assent, Robert Stephenson called on the great schoolmaster to offer him his respects. The young man brought no letter of introduction, and either was, or imagined himself to be, received with coldness and hauteur. Dr. Arnold was certainly polite, but perhaps formal, his manners being of a school with which, at that period of his life, Robert Stephenson was not familiar. Anyhow the interview left on the mind of the engineer an unpleasant impression, which was doubtless in some part due to Arnold's last words: 'Well, sir,' he said, pointing in the direction of the Kilsby ridge, 'I understand you carry your line through those hills. I confess I shall be much surprised if they do not give you some trouble.'

In due course the trouble came. Trial shafts sunk at various points ascertained that the line of the proposed tunnel ran for the most part through lias, shale, and beds of rock with sand. They proved also that in places there would be a considerable quantity of water. The difficulties apprehended were not trivial; but Messrs. J. Nowell and Sons felt that they could cope with them at an outlay short of £99,000, and for that sum they undertook the work. It was not long before they had reason to repent the bargain. To afford exit for the soil removed, Robert Stephenson ordered the sinking of eighteen working shafts. The second of these shafts came upon a bed of gravel and sand, containing a great deal of water, overlaid by forty feet of clay. Repeated borings discovered this quicksand to be a basin, lying along one side of the hill, and extending 400 yards over the line of

the tunnel. As the evil fortune of Messrs. Nowell and Sons and their employers would have it, this treacherous basin had been missed by the trial shafts only by a few feet. Ruin stared the contractors in the face, and Mr. Nowell, whose health had for some time been declining, died shortly after the discovery of the quicksand, his death being doubtless accelerated by the fulfillment of Dr. Arnold's prediction.

The calamity which had prostrated, if not killed, their principal contractor was not without its influence on the directors. Amongst them were those who seized it as an occasion for insinuating that their 'young engineer' was at fault, and that, had he had more experience, the trial shafts would have discovered the dangerous spot. The consternation of both committees (the London committee and that which sate at Birmingham) was at its height when Captain Moorsom, in his official capacity of secretary and business adviser, was deputed to visit Kilsby, hold an interview with Robert Stephenson, and urge upon him the propriéty of calling in further engineering advice. Without delay Captain Moorsom acted upon his instructions, and arriving at Kilsby, hastened to the office, where he found Robert Stephenson holding a consultation with his assistant and sub-assistant engineers.

When Captain Moorsom made his presence known, and stated with delicacy the anxiety of the directors, and the satisfaction they would feel in calling in other engineering advice, Robert Stephenson answered cordially and without irritation, 'No; the time has not come for that yet. I have decided what to do. I mean to pump the water all out, and then drive the tunnel under the dry sand. Tell the directors not to be frightened, and

say that all I ask is time and fair play. If I can't get rid of the water, I'll then think about going to other engineers for help.'

Captain Moorsom then knew but little of Robert Stephenson. He had seen him occasionally in parliamentary committee-rooms, and had heard him spoken of by friends as a young man fortunate in the possession of extraordinary intellects — spoken of by enemies as a young man fortunate in the possession of an extraordinary father. From that time, however, Captain Moorsom became Robert Stephenson's enthusiastic supporter; and, returning to the directors, he told them to rest assured that their engineer deserved their entire confidence.

With the aid of 13 steam-engines, 200 horses, and 1,250 'navvies,' the engineer again set to work. A short distance from the line of the tunnel, shafts, cased with wooden tubbing, were forced through the sand, and from them headings were driven into the sand, through which the water flowed freely to the pumps. For nine months was the pumping continued, and for the principal part of that time each minute saw 1,800 gallons of water sucked from the basin. At length the difficulty was overcome. The tunnel was then shot under the sand, and the gentlemen who had anticipated the failure of their 'young engineer,' and who during the protracted trial had never ceased to worry him with impertinent criticisms, received a welcome and salutary lesson.

In November 1836, another trouble occurred in the irruption of an enormous body of water into a part of the tunnel where there were no pumps. The water rose rapidly, and (to save a portion of the tunnel) it was necessary forthwith to complete the lining of brickwork.

To effect this workmen were floated up the tunnel on a large raft; and, as fast as hands could move trowels and adjust bricks, the task was accomplished. Before it was completed, however, the water rose so high and with such increased rapidity, that the men on the raft were in danger of being jammed up against the roof of the tunnel. To save the party, Mr. Charles Lean, sub-assistant engineer, jumped into the water, and, swimming with a tow-line between his teeth, tugged his men to the foot of the nearest working shaft, through which they were drawn from their perilous position 'to bank.'

When the reader bears in mind that the last few pages relate only to three or four out of thirty or forty contracts, and also remembers that great exertions were made to carry out all the contracts simultaneously, he will not be surprised at learning that 'the navvies' in Robert Stephenson's army were numbered by thousands.

The original Act for the London and Birmingham Railway empowered the Company to make a line 'commencing on the west side of the high road leading from London to Hampstead, at or near to the first bridge westward of the lock on the Regent's Canal at Camden Town, in the parish of St. Pancras, in the county of Middlesex, and terminating at or near to certain gardens, called Nova Scotia Gardens, in the parish of Aston juxta Birmingham and Saint Martin Birmingham, in the county of Warwick.' At the time of the parliamentary contests the projectors thought it would be more prudent not to alarm the public mind with a proposal to carry their road nearer London. As it was, the timid were predicting all sorts of evil consequences from an iron-way, by which all the evil-doers of London could in a moment

fly beyond the police. A consideration, however, that had yet more weight with the Company was Lord Southampton's opposition to their undertaking.

When their petition was rejected by the peers, Lord Southampton had been a principal cause of their defeat. His lordship owned much of the land between Camden Town and the streets of the capital, and it was under a strong conviction that his property would be prejudiced by the railway that he opposed the project. To conciliate this powerful enemy, the projectors determined to interfere as little as possible with his estate. Scarcely, however, had the line been begun, when Lord Southampton began to entertain different views with regard to railways. The success of George Stephenson's lines, the Stockton and Darlington and the Liverpool and Manchester, was admitted to be beyond a doubt. The value of land adjacent to them had everywhere increased, in some places had increased enormously. London residents began to see that it would be to their interest to get the London and Birmingham terminus as near them as possible; and Lord Southampton perceived that the extension of the line through his estate would greatly increase its value.

Robert Stephenson was the first to detect the change in public feeling, and to suggest to the directors the advisability of getting another Act of Parliament, empowering them to carry their line to Lancaster Place, Strand, abutting on the Thames. Nervous and retiring, he could not get up courage to proffer this advice until he had talked the matter over many times with Mr. Charles Parker, the solicitor of the Company, and his own intimate and valued friend. Mr. Parker rallied him for being 'afraid of the board,' and urged that it was his

duty to tell the Company what he honestly believed would promote their interests. In consequence of Mr. Parker's repeated exhortations Robert Stephenson laid his views before the directory, and for so doing was rewarded with an emphatic and almost unanimous snubbing by the gentlemen assembled, who feared to take so bold a step. He was told that he was an engineer; and it would be more becoming in him, as an engineer, to confine his attention to the matters of his profession, and not to concern himself with the affairs of others. Indignant, and for the moment humiliated, Robert Stephenson hastened to Mr. Parker, and communicated the result of his Quixotic attempt to benefit the Company. Again his friend rallied him, and, laughing at his mortification, told him that before the next meeting of the committee his suggestions would have favour with those same directors who had displayed such want of courtesy. The solicitor was no bad judge of the question and the men. Before many weeks had passed Robert Stephenson's scheme was supported both by the London and the Birmingham committee, and more especially urged forward by Mr. Wilson, the agent for Lord Southampton. In due course a new Act empowered the Company to extend their line, 'commencing in a field on the west side of the high-road leading from London to Hampstead, being the site of the depôt or station intended to be made for the use of the said railway, in the parish of St. Pancras, in the county of Middlesex, and thence passing across the Regent's Canal, between the first and second bridge westward of the lock at Camden Town, into and through the said parish of St. Pancras, and terminating in a vacant piece of ground in a place called

Euston Square, on the north side of Drummond Street, near Euston Square, in the same parish.' Thus part of the engineer's scheme was adopted. If the whole design had been approved, Robert Stephenson would have had the further credit of originating the system which has extended the lines across and through the metropolis.

Euston Square lies much lower than Camden Town; and the portion of the railway that lies between those points was worked for some years by ropes and stationary engines, on account of the steepness of the incline, and for no other reason. The trains from Euston Square were drawn up the incline at the rate of twenty miles an hour by an apparatus consisting of 10,000 feet of rope (six inches in circumference) and two stationary engines. These engines and their ropes cost £25,000. The up-trains were disjoined from the locomotives at Camden Town, and were carried down the inclination by gravity alone into the Euston station, and were prevented from attaining too great speed by the use of powerful brakes. The line between Euston Square and Camden Town was thus worked till the July of 1844, in which month locomotives were employed to draw the laden carriages up the incline.* It may interest some readers to know that

* The late Admiral Moorsom, R.N., amongst other papers supplied by him for the biography of his friend, furnished the following extract from the Minutes of the London and Birmingham Line: —

'Friday: July 12, 1844.

'On and after Monday next the use of the rope will be wholly discontinued, and all the trains taken from Euston by the locomotive engines.

'It will be necessary to notify to the locomotive department at Camden the weight of the engines, thus—

'When likely to be 16 carriages, one signal about 8 minutes before the time of departure.

'If likely to be 21, *one* signal 8 or 10 minutes, and a second 4 or 5 minutes before the time.

'(Signed) H. P. Bruyeres.'

the stationary engines, discarded from Camden Town, are at the present time doing duty in a silver mine in Russia.

Thus Robert Stephenson and the army under his command began and completed in less than four years and three months the first metropolitan railway that was worked by locomotives. The first sod was cut at Chalk Farm on June 1, 1834, and the line was opened on September 15, 1838. On an average 12,000 men were throughout that space of time employed upon the works, i.e. rather more than 107 men to each mile. Estimating the labour expended upon the vast operations of these 12,000 men, Lieut. Lecount, R.N., one of the assistant engineers of the line, says —

> The great Pyramid of Egypt, that stupendous monument which seems likely to exist to the end of all time, will afford a comparison. After making the necessary allowances for the foundations, galleries, &c., and reducing the whole to one uniform denomination, it will be found that the labour expended on the great pyramid was equivalent to lifting fifteen thousand seven hundred and sixty-three million cubic feet of stone one foot high. This labour was performed, according to Diodorus Siculus, by three hundred thousand, and according to Herodotus, by one hundred thousand, men, and it required for its execution twenty years. If we reduce in the same manner the labour expended in constructing the London and Birmingham Railway to one common denomination, the result is twenty-five thousand million cubic feet of material (reduced to the same weight as that used in constructing the pyramid) lifted one foot high, or nine thousand two hundred and sixty-seven million cubic feet more than were lifted one foot high in the construction of the pyramid. Yet this immense undertaking has been performed by about twenty thousand men in less than five years.

The reader will observe that Lieut. Lecount in making his calculation takes, not the average number of workmen

employed on the line, but the highest number acting together at a time of special exertion.

It should be borne in mind that throughout this period, although the majority of the Directors did him full justice for integrity and talent, yet Robert Stephenson was harassed with the vexatious opposition of a section of those directors whom he was so zealously serving. It would do no good at this date to rake up the animosities of a generation fast disappearing from the world; but it is right, for the consolation and encouragement of honest men suffering under similar persecution, to publish the fact that, in addition to the anxiety and toil imposed upon him by his responsible position, he had to endure ungenerous treatment from his employers.

At length, after innumerable delays and an enormous excess of expenditure beyond the estimates, the line was opened with suitable, but modest, ceremony. The Committee of London Directors, accompanied by the principal officers of the line and a few friends, made a trip in one train to Birmingham and dined with the Birmingham committee at Dee's Royal Hotel, Robert Stephenson taking charge of the engine during the excursion.

To him the day was far from being a day of pleasure. In bidding adieu to a work magnificently completed, which had taken up several of the best years of his life, he felt that sadness which Gibbon experienced whilst penning the last lines of his history. To this depression was added the irritation of an insult offered to his father by one of his own principal enemies. That very morning, before mounting the engine to drive to Birmingham, Robert Stephenson had read in a newspaper an article full of base insinuations against, and reflections upon, his father.

In the evening a party of about one hundred people assembled at Dee's Royal Hotel. The banquet passed off heavily, and on the following morning Robert Stephenson met, after breakfast, the person who was supposed to be the author of the article which had caused him so much pain, and immediately asked him whether he had written it. The charge was admitted; and Robert Stephenson, having expressed in the strongest terms his opinion on the subject, left the room. The writer of the article, who was also a director of the Company, appealed for protection to Mr. Glynn, the chairman, who was not present at the scene. The latter replied briefly that if directors chose to attack the engineer of the Company or his father in the public journals, they must do so in their private capacity and at their own risk. Some years afterwards the director met Robert Stephenson on the station platform at Rugby, and, expressing his regret for the old quarrel, extended his hand to the engineer, who instantly accepted it, and the feud was forgotten.

A more agreeable celebration of the successful conclusion of the London and Birmingham line was a dinner given to Robert Stephenson towards the close of the previous year (December 23, 1837), at Dunchurch in Warwickshire, when the acting and assistant engineers presented the engineer-in-chief with a silver soup-tureen and stand, worth 130 guineas, as an expression of their affectionate admiration. Mr. Frank Forster was in the chair, and Lieut. Lecount, R.N., the historian of 'the works,' in the vice-chair. George Stephenson was present as a guest. The host of the 'Dun Cow,' Dunchurch, had never before entertained so distinguished a party.

An anecdote connected with the 'Dun Cow' dinner

must not be omitted. The subscription for the soup-tureen and stand was confined to the engineering officers of the Company — a restriction which excluded several persons who were anxious to subscribe. Mr. Charles Capper, who, having merely supplied a quantity of machinery to the line, could only be regarded as a sub-contractor, in vain endeavoured to force his contribution on the committee, who declined to accept it because, if they set aside 'the line' agreed upon, they should not know where to draw another. At the dinner, however, the enthusiastic sub-contractor was present in all his glory and admiration for Robert Stephenson. 'Anyhow,' he exclaimed to some of the committee, as he entered the room, 'you will allow me to dine with Mr. Stephenson.' As the dinner was public, there was of course no opposition. In the dining-room the testimonial was placed on a buffet for inspection; and as the guests assembled, they surrounded the soup-tureen and criticised it. At length the sub-contractor, with a glow of triumph in his face, exclaimed, 'It is a handsome tureen, but it wants a ladle.' And as the critic spoke, he supplied the deficiency by taking from his pocket a large and very handsome ladle, and putting it into the silver vessel.* The ladle formed part of the testimonial, and Robert Stephenson in after life was very proud to tell his friends how he became possessed of his large soup-ladle.

Thus was completed the construction of the London

* The following inscription was put on the tureen: —

'To Robert Stephenson, Esquire, Engineer-in-Chief of the London and Birmingham Railway, a tribute of respect and esteem from the members of the Engineering Department who were employed under him in the execution of that great work. Presented on the eve of their gradual separation.'

and Birmingham Railway, with which line Robert Stephenson maintained his connection up to the time of his death, acting as its consulting engineer with a salary of £100 per annum, and his expenses when called to attend on the line. It was the first of our great metropolitan railroads, and its works are memorable examples of engineering capacity. They became a guide to succeeding engineers; as also did the plans and drawings with which the details of the undertaking were 'plotted' in the Eyre Arms Hotel. When Brunel entered upon the construction of the Great Western line he borrowed Robert Stephenson's plans, and used them as the best possible system of draughting. From that time they became recognised models for railway practice. To have originated such plans and forms, thereby settling an important division of engineering literature, would have made a position for an ordinary man. In the list of Robert Stephenson's achievements such a service appears so insignificant as scarcely to be worthy of note.