

FROM YOUTH TO OLD AGE

JAMES LIVESEY

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It is only from memory that I am able at this time of my life to jot down a private record of the incidents of my life. Perhaps the first dawn of my engineering career occurred when I was very young, say seven or eight years old. A Mr. Bradley, a friend of my Father's, who was engaged in the great cotton factory of Horrocks & Miller, took me to the factory occasionally to see the wonderful machinery in the various departments; but what impressed me most was the monster engines that drove all the machinery and the enormous boilers, both of which were of much larger proportions for the power required than is now necessary. The same power now could be obtained in less than one-fourth the capacity. I used to sit for hours in the engine room watching the dignified and silent motion of the huge beam engines so different to the rapid motion of the engines of the present day. The sight of the big engines was far more impressive, and no wonder that my mind dwelt with serious thought on what appeared to me so wonderful. Perhaps the first effort of young people is that of putting their ideas on paper in the shape of drawings; children are all fond of drawing or trying to draw what they have seen or what they imagine. They draw houses, ships, animals, and construct wonderful castles on the sands; my first attempt was to draw a steam engine, but to copy from printed drawings was much easier and it was not long before I became a really good draughtsman. At about the age of ten years I was sent to a

day school in Preston kept, I remember, by a Mr. Isherwood. There I learned the usual things taught in such schools and in those days boys were taught to write clear and distinct and that is one reason why at this late season of my life (eighty-five) I am able to write a letter that can be read without difficulty. I took great interest in mechanical drawing and in my spare hours away from school I was engaged in drawing steam engines and other machinery and soon became a first-class mechanical draughtsman. The other boys in the school were so pleased with what I did, the Master established a drawing-class and made me the master teacher for I was able to draw far better than he was.

Another useful pleasure to me was the tramway that passed close to the house where I was living, and strangely enough it passed through the most beautiful and picturesque outskirts of the town. It was not a passenger tramway but was a narrow gauge line that went from Preston to some coal mines seven or eight miles away and drawn by horses. It passed through the beautiful valley of the Ribble until it came to the river which was crossed by a strong wooden bridge and thence up a very severe incline, the wagons being drawn up by a powerful engine and other winding machinery. This was the spot that attracted me, and not being more than a hundred yards from where I lived I was a constant visitor to the engine and boiler house. I had made great friends of old Bob and old John who were constantly explaining things to me, and in time I was allowed to start and stop the huge engine that drew up the wagons. All this was a great pleasure to me and more than ever fixed my mind on mechanical work.

Time passed on with school-boy life for several years without any particular incidents except the above, until I was nearly fifteen years old. I was particularly anxious to go into the workshops. Fortunately one of the chief of Stephenson's engineers was a friend of our family, Mr. Isaac Dodds, who was at that time in charge of the works of the Caledonian Railway in Glasgow and was willing to take me under his charge. I can remember how glad I was when my Father consented, and my Mother would insist on going to Glasgow with me. It was a memorable journey because the railway in those days did not go further than Carlisle.

When we arrived we found the town in great excitement owing to the opening of the railway to Beatoch; we were among the first people to go over the line and from Beatoch to Glasgow we had to go by coach. Mr. Dodds was very kind and made special arrangements for us. The coaches in those days or the coach we travelled in was of a special construction. It was in all respects similar to the stage coaches of the present day with the body of a hansom cab bolted to it behind, - a splendid idea, for it was a perfect shelter from wind or rain with a perfect and uninterrupted view of the country. It only held two persons and we were the fortunate ones. At every call the coach made there was a rush to see if these two favoured seats were occupied.

Lodgings were found for me with some very nice people who made me very comfortable. The works were situated about a mile and a half from where I lived and I don't forget that in the winter time I had to walk that distance through the snow and be at the works at 6 o'clock a.m. Somehow

or other I never thought it a hardship because in those days boys were more hardy than they are now, and thought more about their work and their future. I had to get up at 5 o'clock every morning and in order not to trouble the people I lived with to call me at that early hour and have a cup of hot coffee ready for me, necessity became the mother of invention and evolved my first invention. I bought for a few shillings an old-fashioned alarm clock and set it to call me a little before 5 o'clock. At that time a weight attached to a chain was liberated, and tingle tingle goes the bell until the weight has run down. Now I not only wanted the clock to call me up but I wanted it to light the lamp and to warm me a cup of coffee, which it did in the most perfect and satisfactory manner. The weight in running down touched a trigger which liberated a cylinder covered with emery powder. Against this roughed cylinder was fixed the head of a wax match; a light was instantly struck, the match being supported on a wire rest near the ignition portion and at the other end firmly fixed. The lighted match passed through the wick of the lamp which was instantly ignited and not only gave light to the room but warmed the coffee in the tin above. I'm sorry I did not keep that little simple apparatus that was a very good friend to me.

My breakfast I carried in a tin can, a simple tin can filled with coffee and a square box above with the buttered toast and occasionally a hard boiled egg. There was no trouble about heating these at the works nor in eating them for in those days boys who worked had got good appetites

I remained on the railway works about two years, but it occurred to me that I must have more varied experience than could be obtained on the works of a railway. I wanted to see and be among the construction of big land

engines, millwright work and bridge building. I selected the works of Messrs. Musgrave and Sons of Bolton with whom my Father arranged for an apprenticeship of four years, paying a premium for the various departments except the drawing office. I had to pass a certain time in the pattern, fitting and erecting shops, but in addition some time had to be spent in the boiler shop, the foundry and smithy shop, all of which are absolutely necessary if you want to learn the practical part of engineering.

During my apprenticeship I visited Preston frequently to see my people and spend the week-end with them.

My Father was the proprietor of the Preston Guardian newspaper assisted by my brothers William and John. They pointed out to me the difficulty of folding the newspapers and asked if I could not devise or invent a machine that would fold the papers. An attempt had been made to accomplish this but without success, and it fell to my lot to design a machine that answered admirably, and the same is now incorporated within the printing machine and the newspapers are printed and folded at the same time. You cannot now take up a newspaper of any kind to-day that is not folded by the same machine I designed more than sixty years ago. I remember well designing the folding machine during my term in Bolton. I neglected no work. I attended or went to the works at six in the morning until six in the evening, and it was very seldom I had a quarter of a day knocked off for being fifteen minutes late. I designed and made plans of the machine after working hours and often I never went to bed but continued with my work with an hour or two's sleep on the sofa during the night, always going to my work at six o'clock, but I had my reward.

The first machine was made at Ainscow & Tomlinsons' Machine Works in Preston, with whom I had arranged for their manufacture, and was attached to my Father's newspaper, the Preston Guardian. The second was supplied to the Manchester Guardian, and the third was sent to the first great Exhibition in Hyde Park in 1851, in connection with the Illustrated London News printing machinery. An incident occurred one morning before the building was opened to the public - I must mention it. Several ladies and gentlemen entered the space allotted to the Illustrated London News and took great interest in the printing machinery, but one lady took great interest in my folding machine and asked many questions and I presented her with a folded paper. After they were gone the Manager asked me if I knew who the lady was to whom I presented the paper. No, I had not the least idea. I may just as well tell you that it was Her Majesty the Queen of England. You can imagine my surprise and delight.

When the folding machine became known to the newspaper world it gradually became a necessity. Orders came in from all parts of the country and the business became very lucrative. I was at that time very young, conducting the folding machine business as well as attending to the workshop.

After I left Bolton, and being entirely independent of money assistance, my business and ordinary life became a pleasure. My companions were fond of fishing and sport and particularly fond of yachting. They were the sons of wealthy mill owners, the Paley family; I often visited their factories and increased my knowledge of mill machinery; so much so that it enabled me to suggest and adopt what I am sure was the first introduction of compound engines and tubular boilers for marine purposes. My companions joined me in building a small steam yacht into which I introduced compound

engines and a tubular boiler. The yacht, Aurora No.2, was so called because we had a much smaller one which we bought, but it was too small and we determined to build a larger one and called it Aurora No.2. It afforded us much pleasure, and so far as I remember was about 50 tons burden. We frequently visited the Isle of Man, Scotland and Ireland, where we always managed to get some fishing. We also became steam trawlers, I believe the first steam trawler that was ever known. We had a net of about fifteen feet long with an open mouth of about ten feet wide and three feet deep; this by means of ropes was slowly dragged along the bottom of the sea and caught no end of fish, but there was not more than ten per cent. of the contents that was of any value; there was an abundance of sea-weed, star and dog-fish, jelly-fish and other abominations so that the saying of "it's all fish that comes to the net" is not quite correct.

We had many adventures and many narrow escapes, one of which I am about to relate.

The most serious was our trial trip to the Isle of Man or our intention of going there. Like foolish young men we were too anxious to have a run. and our trial trip took place long before the boat was really finished. We very soon discovered that it would have been wiser to have waited a little longer, but we were determined to have our trial. On a fine summer morning with a stiff breeze blowing we started from Lytham where the boat had gone the day before. We left soon after daylight and followed the channel marked out by the buoys until we came to the last of the buoys and then we were in the open sea with a stiff head wind blowing pretty hard. We had no crew but only a few men borrowed from Payley's Factory. These fellows soon became sea-sick and we had to act as the crew, and a pretty hard time we had

of it for we soon found out how incomplete everything was. There was no spring balance to the safety-valve lever - nothing but a loose heavy weight which we had to fasten with string. But that was a small matter in comparison with what had to follow. We found our compass had got corroded having been stowed away in a damp place; it would not work and became useless. What were we to do, for very soon we should be out of sight of land and in a pretty rough sea? The Captain, who had often been to the Isle of Man, said if we continued in a straight course dead against the wind we should see the Island, which was perfectly true. But before seeing the Island we had a number of incidents to encounter. We noticed smoke coming through the gratings on the deck from the coal bunkers below. That made our hearts beat for where there's smoke there is fire, and sure enough the coal in the bunkers was on fire. We at once got bales of water and a constant stream was poured down the bunker openings, and in half an hour less smoke came and a little later none at all. How thankful we were! The dingy or rowing boat had been got ready for it looked like the ship being on fire, and that we might have to quit. We, however, continued our voyage taking in turn to keep the engines going for the men we brought with us were utterly useless. We had to keep our eye on the cause of the coal's getting on fire again, which was simply owing to the unfinished state of everything. We had calculated on dining at the Isle of Man and only brought sufficient provisions with us for lunch and very little more. About one o'clock we had our lunch for we wanted it, having had our breakfast so early. Soon afterwards the Manx Passenger Steamer passed us and we found we were on the right course to the island, the wind still blowing dead against us, which had proved a good guide. About three o'clock we sighted the Island and thought it would not be long before we got there.

Fortunately the only part of the boat that was anything like finished were the masts and sails; we therefore hoisted the sails and tried to beat in, but the screw being such a drag we made little or no progress and found the attempt quite useless. By this time daylight had almost disappeared and darkness coming on the lights were very visible on shore, but we were helpless; we had no lights on board and no compass to steer by. The wind had not abated, and we were tossing about like an abandoned ship. We held a consultation, and since the wind had kept in the same direction, we argued that if we "put about" the sails would take us home again if nothing unforeseen occurred. We were driving before the wind at a great pace and with no lights to be seen it would be a miracle if we escaped for we might be run down at any moment. But our fears and troubles were not by any means over. My companions went with the idea of sleeping in the forward cabin with bare boards to sleep upon and sacks stuffed with shavings for pillows. I had the same accommodation in the after-cabin but there was no sleep for me. The engines were racing at a great speed owing to the speed of the ship being blown through the water, which caused the screw to revolve at a great rate; but that was not an important matter; but what did occur was important enough. There was a communication between the after-cabin where I was resting and the engine and boiler house, and at the other end of the cabin was a companion ladder leading to the deck and near to the steering-wheel which at that time was in charge of the Captain named Battle, who was quite within call and with whom I had been speaking several times. About eleven o'clock, for it was then pitch dark, I called Battle's attention to a very disagreeable smell and something like smoke in the cabin. I went on deck and took the wheel whilst Battle went to seek

the cause. In about ten minutes he came back and said: "It's very serious, sir, and must be attended to at once. The lagging of the boiler is all in a glow of fire, not in a blaze, but smouldering red hot and quite a glow of heat, and the wood part might soon be in a blaze. Don't disturb anyone but get one of the men to help you and get the pails filled with water and see if you can put out the glowing fire." In about half an hour this was accomplished to my great relief for I thought our troubles were never going to end. Nor were they, because in about two hours or so the same thing occurred again. It was coming daylight. I gave the wheel to Battle and tried to get a little rest.

It appears that not only was the fire box red hot but the heat had been communicated to the boiler itself, and the boiler being surrounded with the lagging which was composed of short hair, the clipping of horses, then covered with strips of timber. Fortunately the hair would not make a flame but would smoulder in a red hot state. About five o'clock my companions turned up having had a good rest and were thankful they had not had my experience.

The next trouble was hunger, famishing, for we had had nothing to eat since our lunch yesterday and nothing to drink but water which we fortunately had on board. The day opened out fine, but we were out of sight of land and had no idea where we were. The wind had died down but there was still a good roll on, but what could we do? We were young and had had more adventures than one and were not afraid but desperately hungry. In about an hour's time the wind came again and fortunately in the same quarter; we were then able to go along again and at about four o'clock

we sighted land and soon discovered where we were for we knew the coast like a book and Black Coombe in the distance. We made for Peel Harbour and found a train just about to start for Furness Abbey, a favourable place where we used to meet when we had Aurora No.1. We were well known there; we had a good feed, and in about an hour's time we were ready for any other adventure.

The next morning we went back to Peel Harbour to look at our poor boat, which was a far more innocent thing than we were ourselves. We thought we might make another start for home if we could get steam up, but as fast as we pumped water into the boiler it ran out, and that put a stop for a time to our further adventures, and the boat had to be towed to Preston where she started from, in a condition that served us right. Our friend Mr. Dobson who had joined us was the mate on an important vessel and on a holiday, but - "Never again with you chaps if I know it. I have had three or four years at sea and had some rough experiences, but put them all together they have not given me such a fright as I have had on this blessed trip." Nevertheless, Aurora No.2 proved quite a success. It would almost take a volume to tell you of all the adventures and escapes we had.

Life at that time was very pleasant, but I knew that one of these days I should have to make a position for myself, that the folding machine business could not go on for ever, though it had a longer existence than I had calculated upon. I have said I declined to go into the Drawing Office at Bolton simply because I was as good a draughtsman as any in the office. Nearly all the drawings - working drawings - had to pass into the workshops for the men to work to. I was determined to have copies of these

drawings and very soon learned a system of shorthand drawing by which I could take a copy of a drawing on tracing paper in a very short time. The little sketch I am about to make will give you some idea of my system. I will take a square as a simple example:

my copies simply became

a series of angles, dots

so that anyone finding one of my copies could make nothing of it; by this means I got copies of the bulk of the drawings that came out of the drawing office; that little invention has often been of use to me.

My lodgings were near the works. We had an hour for dinner; half an hour was sufficient for me. I returned to the shop I was working in and had half an hour to do my tracing. I was always a favourite with the men; they never gave me away. At night after working hours I filled in the lines and made the drawing complete. When I had finished my term Mr. Musgrave asked me if I was not sorry I had not been in the Drawing Office; he was always vexed at my not paying the £50 fee. I told him I was far from sorry for I was as good a draughtsman as any in the office, that I possessed copies of nearly all the drawings that had passed through the various departments I had been in. He looked a little surprised and possibly wondered if he could not proceed against me, but he never did.

Before leaving Bolton I went to Preston which was my real home, to make a more permanent arrangement for the manufacture of the folding machine, until I might establish a workshop of my own for their manufacture, because it was assuming a more important business than I thought it would.

After having finished at Bolton I decided to spend some of my time at the Locomotive Works of Messrs Beyer & Peacock, in Manchester. I was with

them nearly two years and gained a good deal of useful and practical knowledge. I had become useful as a practical workman and was sent in company with a foreman with two of Beattie's smoke consuming locomotives to Antwerp for the Belgian Government Railway. After the erection of those engines they had to run a certain number of miles to the satisfaction of the Government Engineers before they could be accepted. I of course assisted in the erection and afterwards I and the foreman, whose name I forget had to run the engines the number of specified miles, the first time I was engaged on such a task. Of course the French driver who had ultimately to take charge of the engines was with us. The trial run was from Brussels to Namur and back with an express train, and so far as I remember we ran the express for about a week with each engine, a fortnight in all. I gained a lot of experience and was allowed to drive the engine myself for the greatest part of the time. They were the first smoke-consuming engines introduced and had only for a short time been tested on the English railways.

During the time I spent on these engines I took every opportunity of testing the efficiency of the smoke-consuming apparatus which consisted of a chamber filled with fireclay tubes situated between the fire-box and the tubes in the boiler. In that position they were subjected to the greatest heat and became heated almost to a melting point - a perfectly white heat, which was supposed to consume the smoke as it passed through them. But I soon found out that the smoke under certain conditions could pass through these tubes without being at all consumed, and that the idea of smoke consuming is a misnomer. In going up a long gradient I used to get the fireclay tubes to an intense heat; so much so that it was painful to look at them. I then put on several shovels of coal and shut off the

air passages; the smoke then passed through the tubes; and it then came out of the chimney a mass of black unconsumed smoke, proving that heat alone will not consume smoke. Heat and a proper admission of air will prevent smoke being formed, and perfect combustion of the fuel will take place. The ordinary paraffin lamp is constructed on this principal. You have a perfect flame without smoke, and all smoke consuming, so called, ~~must~~ be on that principle. That was a lesson for me at a very early date, but very few people at that time or even now recognise it. That expedition in many ways was very useful to me. After that I think I remained with Messrs. Beyer & Peacock about twelve months, engaged on various work in the shops.

But the folding machine began to occupy a good deal of my attention, for a number of them had already been introduced.

I had a good deal of time on my hands and was fond of boating and fishing, and could manage a skiff just as well as any professional. I formed a boating club in Preston and was frequently on the river Ribble, which ran by the town, and a beautiful river it then was. I don't exaggerate when I say that the river and the valley of the Ribble, as viewed from the Public Gardens above, surpassed anything I have seen, except the view from Richmond Hill; but now all, or nearly all, that beautiful scene has gone; railways with high embankments, unsightly bridges spanning that beautiful river, tall chimneys and factories have ruthlessly established themselves in that lovely valley and destroyed what was a great joy in my young days, but unfortunately not a joy for ever.

Well, I was fond of that river and the fish I caught in it, for in those

days the river was celebrated for salmon, trout and other fish, but now that has nearly all gone. These pleasures were shared with me by my friends, who enjoyed the things that attracted me. In some of the Aurora ventures we caught ten times as many fish as the sailing boats. We gave the fish to the trawlers and to the poor people in the villages where we landed for that purpose.

We had many adventures, and it was the wonder of everyone that we were not wrecked over and over again. We had a good many near touches but we were young, venturesome, and good sailors. The Aurora No.2 was a remarkable boat and had features that were quite new and original. She was the first boat that had Compound Engines and Tubular Boilers. I and John Paley, my principal chum, designed and arranged the whole affair. We took the two high pressure engines out of Aurora No.1 and placed them in connection with a big low pressure cylinder, and thus at once made a compound engine, the first that was ever used on a steamer. It was years before our plan was adopted but now there is nothing else.

But time went on, and fortunately I had the good sense to see that this kind of life could not go on for ever. I therefore determined to make use of the knowledge and experience I had already gained after seven or eight years of practical work.

Fortunately my brother John was a very intimate friend of Mr. Mould, who had a contract at that time for a section of the Caledonian Railway. He also had the contract for the Santander and Allar Railway in Spain. I explained to him my position and what experience I had and asked him for a job. It was not long before we arranged terms for he said I was just the one to take charge of the machinery and assist in the construction of the railway.

You may be sure I was glad of this appointment as a beginning. It was interesting and a useful experience for me and I felt sure it would lead to something more important. Of course I felt a degree of pride on entering my first appointment in a responsible position, as the Chief Mechanical Engineer on the construction work of the railway, Mr. Mould being the Contractor and Don Philippe Sewell his General Manager, one of the cleverest men I ever met. There was also John Mould, the son, his assistant. We became great friends and worked pleasantly together for there was plenty of work to do.

But during the time I was under Mr. Mould and working on the construction, many incidents occurred and difficulties had to be overcome. The first difficulty I had to deal with was the supply of water for the Locomotive shops, the only available one being the overflow from the tanks of the public wash-house, which consisted mostly of soap suds. Fortunately the land from the overflow stream to the shops was on the down grade; this enabled me to arrange a number of filter tanks filled with coke. After passing through half a dozen of these tanks the water was sufficiently clear for use but not for drinking purposes; that had to be fetched from a distance.

The railway was being constructed in two sections, the upper and the lower section; the distance between the two being about 20 miles. The upper section was at a much higher elevation and very much colder, in fact for some months in the year the lower section would be summer, whilst the upper one was perfect winter.

I have passed from Santander, leaving it on a bright, warm, sunny morning and arriving at Renosa in the depth of winter with icicles from the roofs of the low buildings to the ground. I had to make the journey on

horseback, sometimes in the diligence, a rotten old machine that was constantly coming to grief. On one occasion coming from the upper to the lower section a serious accident occurred, by which two of the passengers, Catholic priests, had a very narrow escape, and I had a rough experience. Beginning to descend a long and severe gradient, the driver tried to put on the brake, which was worked by a wheel and screw, not the hand brake as used in England; the screw was stripped and turn as he would, it had no effect on the brake. There were seven or eight mules attached to the diligence which began to descend at a rapid rate this dangerous hill, constructed on the side of a mountain with a rapid river flowing through the valley below. The pace became greater and greater, and it looked as if we should all go to Kingdom Come. These old diligences have a big hood fixed high above the driver like the body of a handsome cab fixed on the top; you have a clear view of the scenery and it is a favourite place for the passengers. I had selected a seat and two Catholic priests the two other seats. It is difficult to describe your feelings with the mules galloping at a terrible speed and the high machine rocking from side to side and the sight of the river below, but all things come to an end in due time. It was impossible to check the speed; the first mile fell and down came the rest and the diligence on the top of them. I was thrown from my high perch among the plunging mules, and how I scrambled out of them with only a good shaking, goodness only knows. My two fellow passengers, the Catholic Priests, were thrown wide of the road and down the steep side of the mountain, and had it not been for two trees that arrested their downward course, they would never have been seen alive again. Fortunately for me, one of our Staff on horse-back came up in an opposite direction. I took his

horse and rode on to Las Caldas, my destination, whilst he remained to help the people in their sad plight. But accidents of one kind and another are constantly occurring on a railway under construction, and no one living has more occasion than I have to be thankful for the marvellous escapes that I have had. On one occasion, looking down a rock embankment in company with my friend, Don Philipe, we failed to notice a danger signal when bang went a blast within quite a short distance from where we stood, hurling the blasted rock high above us and in every direction. "Look out for the big ones," cried Don Philipe, and sure enough I did and managed to escape the big ones, but not altogether the smaller fragments; and my friend was also fortunate.

At this time we were busy with construction work, making ready to open the first section of 20 miles. In due time the work was sufficiently advanced for the line to be opened, but of course there was a great deal of detail work to be done before the line could be handed over to the Company.

And now I come to the opening; and how I can be writing an account of that sad event at this time of my life, goodness only knows. Of course the opening of one of the first railways in Spain and called Ferro Carril de Isabel Secunda (the railway of the Queen of Spain) was a great event and a great holiday. The locomotive that was to drive the train had the flags of Spain and England and flowers that were brought by ladies to decorate the engine which made it look as if it were going into a procession of the Battle of Flowers at a carnival rather than for serious and very serious work on the railway. I had charge of the whole affair and arranged the train. The Chairman had expressed a desire that he and some of the directors should ride on the engine if that were possible. I made arrange-

ments for them to ride on the tender and the two Civil Engineers who had charge of the construction work, Alfred and Morland Gee, two fine young fellows, I arranged should be on each side of me on the engine and I in the centre to drive, the engine-driver and fireman behind me. The train consisted of five carriages filled with the Mayor, and the Corporation and their friends. At last, all formalities being completed, the Priests having blessed the engine and the train, we started on that fatal journey. All went well for about fifteen miles, when we entered a deep rock cutting on a curve. I had not been over the line for about a week and didn't know its exact condition. In the cutting Alfred Gee said: "Livesey, drive slowly over the Las Caldas bank for we only made it up yesterday." Being on the curve I could not at that moment see the bank but very soon I did; I at once shut off steam. I saw the narrow top of that bank and saw the danger. I held on like grim death when I felt the engine sink beneath me. Then came the terrible moment of finding the engine turning over without a chance of escape. I and the engine rolling down that terrible bank together; how I escaped with my life, God only knows. The marvellous thing to me has always been how or what held me to the footplate of the engine during that terrible time. The engine turned over and over; I was pinned by some unaccountable means to the foot-plate which exposed me to the fire that came out of the fire-box. I was in the midst of it, with a result that when we reached the bottom of the bank and the dreadful roar and crash ceased, I scrambled out of the wreck dazed and distraught, my clothes on fire and blood running down my face; but that was not the worst; for the two handsome young fellows, Alfred and Morland Gee, lay crushed to death under the engine. When the engine turned over, they were thrown off and rolled down the bank and the engine rolled on to the top of them,

whilst I was pinned to the foot-plate and the engine and I rolled down the bank together. I was in a dreadful condition and had to be carried to a wine shop not far away. Hot cinders had been buried in my legs and most of my clothes burned away; the blood that was running down my face was from a mere scratch and amounted to nothing. I was removed the same day to Mr. Mould's house, about five miles away and, strange to say, I felt no ill effect except the pain caused by the burns and a slight wrench that I must have got. But the death of those poor fellows who were on each side of me, and I in the centre and saved, was very sad. Fortunately, I was driving very slowly over that bank - five or six miles an hour - when the engine broke away from the tender; the tender only gave one turn over, and stuck in the soft earth. The people on it were thrown out and rolled down to the bottom of the bank very little the worse for the rough experience. In a few days I was able to get about again and attend to my work but for about a fortnight I had to be wheeled about in a bath-chair.

When the lower section was permanently finished, it was open to the public and handed over to the Railway Company, a Spanish Company. The upper section had then to be finished, but it was not long afterwards that the funds fell short and the work had to be stopped. All the men were discharged, I among the rest, because I was on the Contractor's staff and not acting for the Railway Company, who had their own engineering staff and the other employees. I was out of a job and received no pay, and a few others than remained were in the same condition and were hopeful that the works might start again before long. Fortunately I had funds of my own and was not altogether dependent on my pay, thanks to the folding machine.

I don't know what possessed me, but I suddenly took into my head that I

would go over to England and get married, certainly the first and most unlikely time that such an idea should occur, but nothing could persuade me out of it. Mr. Mould said I was mad to think of getting married without a visible future before me and out of a job. Nevertheless, I was determined to go. Something irresistible impelled me, though to my fiancée such a suggestion had never been made. Our correspondence was more like that of a brother and sister, though the idea of getting married some day or other was no doubt present. Anyhow, I started on that extraordinary journey to England, and the first time my wife got notice of my intention was by a telegram sent from a station in France when on my way. Of course so sudden a notice naturally created a lot of difficulties but they were soon overcome and we got married. Then I began to think of the future which I had so ruthlessly disregarded and wondered what was the next step I should take. On the second or third day of our marriage we were invited to a little party of my wife's brother, who was then living in Stamford. There was a dance in the evening and whilst forgetful of everything else a telegram was placed in my hands. "The Chief Engineer of railway has got killed. You have to take his place, hurry back soon as possible." I finished the dance and in two days afterwards I and my wife were on our way to Spain. I have often wondered if the change and sudden determination to go to England to get married had any connection with the fatality that made so unexpected an opening for me. It certainly was a strange coincidence.

We had a very kindly reception on our arrival. Mr. Sewell gave a dinner party as a welcome to us and a compliment was paid by the Chairman and some of the Directors of the Railway attending and wishing us every

success. Of course I knew the railway well and my duties were very little different from the work I previously had in hand.

My journey to Spain was naturally an interesting one, because after leaving France everything is different, the language, the habits of the people, the mode of travelling, and as for the so-called hotels, you feel as if you had left civilisation behind you. Of course things are better now; I am referring to nearly sixty years ago.

Crossing the Pyrenees from France to Spain was a very strange and exciting experience to us. I think it took three or four days from the boundary until we arrived at Bilbao, travelling night and day in a lumbering old diligence drawn by mules and bullocks. At some places where the hills and roads were very steep, only bullocks were used, about ten of them in the team; they are much stronger than the mules but painfully slow. The team of mules consisted of from ten to fifteen, the leading ones being too far away for the driver's whip to reach them. A very ingenious way is adopted to wake up the lagging spirits of the poor brutes. The driver has by his side a bag of stones, about the size of walnuts. He is an expert marksman and could hit a bullseye at a distance of twenty yards. Each mule has a name like a dog and he knows it particularly when the driver cries, "Ladrone"; then follows a stone which seldom misses the mark; and others also know what is coming and wake up. But very often when the string of mules is too long there is the out-rider near the head of the mules who is supposed to guide them during the night, but the mules know the road quite as well as he does, therefore he goes quietly to sleep; the monotonous jogging of the mules hour after hour has that effect. It does seem strange that a man can sleep under such conditions but it is a fact, nevertheless.

But everything is strange and unusual in Spain; at all events, it was so in those days so long ago.

After arriving at Bilbao (now the richest town per inhabitant in the world) we had to take the coasting steamer that sailed from Bilbao to Santander. There is a long river that runs from Bilbao to Portugaletta the mouth of the river, and then you are in the bay of Biscay at its very worst. At Portugaletta we had to take the Captain on board, the Pilot leaving us, but he made no appearance. We waited hour after hour and all night but no Captain made his appearance. The mate and a couple of men in the morning went on shore, for evidently they knew his habits, and towards ten o'clock they brought him on board a good deal worse for his night's dissipation. Then we started on a voyage I should not like to undertake again. Fortunately I was a good sailor and young, and my wife was very brave, but that could not be said of my fellow passengers who were all Spaniards not altogether on a pleasure trip. Of course they were very ill but what astonished me was that during their illness, which I need not describe in detail, they continued to smoke their strong smelling cigarettes. Nothing will stop a Spaniard smoking his cigarette; he and the cigarette will go out of the world together.

At last we arrived at Santander, and thankful we were to get there. Naturally my wife, who fortunately was strong and so good, was curious to see her new home and was not a little surprised when I took her through the rooms of a big empty tobacco factory to the rooms I had made into a comfortable Flat. It was a surprise and a pleasant surprise, because every consideration for comfort and convenience had been made. The rooms were well

furnished and with a good wide balcony in front covered with grape vines and bunches of muscat grapes and commanding a view of the grand harbour and the distant hills and snow-clad mountains on the other side of the bay. That was our first home. I shall never forget ordering our best bed because all the beds in Spain were very narrow. When I gave the dimensions for one of our English five-foot beds the man stared at me and asked what it was for. I told him that in England man and wife generally slept together. "See Señor, a dangerous custom."

The most important event during the two years I remained with the Company was the birth of my son (1860) Harry who, when he came to know it, was not at all pleased with the three names that were given to him: "Fernando Harry Whitehead Livesey". Fernando, because the Spaniards begged of us to give him a Spanish name, which we could not well refuse, and being born on St. Fernand's Day that name was adopted. Then I put in a word because I previously said if ever I had a child his name should be Harry, in the first place because I liked the name and I did not want a repetition of my name in our family; then Mother had something to say, and she like myself said if ever I have a child his name shall be Whitehead after an uncle she had a great regard for, and thus the poor boy could not say a word against it when he was christened, but since then I should not like to put in writing what he has thought. He was christened on board the Himalaya transport ship then in the harbour of Santander and old George Hudson, the Railway King, was his godfather.

It was at the time of the Great Eclipse, the total eclipse of the sun and Santander was selected as the best place for observation. The Government sent out a party consisting of the Astronomer Royal and a number of Astronomer

from various parts in England. I invited Professor Lowe, of the Nottingham Observatory, to stay with me and he kindly lent me a telescope to note the eclipse. The effect on the poor inhabitants was singular; they thought the world was going to be at an end, they were terror-stricken and prayed and kissed each other as a final farewell. The animals took it quite differently; the hens quietly went to roost, thinking the day was over and that the time for rest had come, but the old cockadoodle was rather surprised and thought what a little sleep he had had when in an hour afterwards he called his family together for their morning meal. Poor old bird, he was again surprised at the shortness of the day when he and his family had to go to roost again.

I continued with my work which was a pleasure to me, because the Spaniards, if considerately treated, are a real good people. I was patient with them and gradually made them into good workmen. I had about a hundred Spaniards independent of the English engine drivers and skilled workmen, but it was not long before a good many of the Spaniards became skilled workmen and able to earn considerably more wages. At first they were glad to come for a shilling a day because they were little more than labourers. There was no difficulty in obtaining any amount of labour, and in those days women were employed to do the rougher part of the work; they unloaded coal and coke from the Lighters and no end of them were engaged as Navvies on the line, and a woman was in charge at every level crossing. A man would come to me and ask for a job. I would ask: "What kind of a job do you want?"

"Anything you like Senor."

"What were you doing last?"

"Mending boots and shoes."

"But I don't want a shoemaker, I want a carpenter."

"Senor, I can also do joiner work and I've done a bit in the Smithy."

These were the men I had to engage and very good workmen I made them. It is said the Spaniard is a lazy fellow and so he is if left to himself, but not so lazy in some respects as you would imagine. They get a living by doing a bit of any kind of work. Of course it is roughly done, but it is something to their credit; but there are thousands of our unemployed who can turn their hand to nothing; they simply idle their time away and become a nuisance and a danger. I had men who came to me for a shilling a day and before I left I was paying them 20/- a week and some even more. They took the place of a good number of the Englishmen who had to be discharged generally for drunkenness. But it is not astonishing that English workmen fall away when they get to a country where their language is not spoken. They cannot associate with the natives and if they associate with each other, they must have drink over it, and since the drink in Spain, except the wine, is of a bad and dangerous kind, the men gradually get worse and worse and have to be discharged. What drink the natives take is the local wine, good and very innocent, but too 'sour' for an Englishman.

My first dwelling was rather a curious one; it consisted of five or six rooms unfurnished in an enormous building that had been a tobacco manufactory. This building was given to me for the construction of wagons and carriages for the railway which at the time was simply under construction. I had to make a lot of structural alterations but was not long before I made it into a splendid workshop with four lines of railway running from end to end of the building. Then I built some hundreds of wagons. I arranged the building of the wagons in pairs each two opposite each other on the lines

of railway. The material was brought from the stores on a supply line and the two wagons were commenced at the same time and a premium, 20 pesetas, 15/-, was given to those who made the best job. There was great competition and if the work done was about equal, I divided the premium between them. These were men who had been jack of all trades in a rough kind of way, but it was not long before they did really good and creditable work. If you only treat men, and I may say women too, with patience, instruct them, and with kindness you will find a lot of good in them, and get a lot of good out of them.

I found the flat at the tobacco factory was too far away from the Locomotive Works and there being no suitable house near I had to build one or rather convert an old Stores into a comfortable dwelling. This was my first experience in work of that kind and developed a knowledge of my architectural instinct that became useful to me on many occasions afterwards, both at home and abroad. Fortunately the old store shed was situated on high ground, the land running down to the beautiful bay of Santander and commanding the most beautiful scenery imaginable. The bay at this point was seven or eight miles across, the land opposite rising from gardens and cultivation to the snowy mountains in the far distance; that was the view from my little house. The Villa I built at Balholm in Norway only three or four years ago reminds me of the same thing. But my little Spanish Villa was a great success; fortunately there was no architect engaged. The Spanish workmen took great interest in what I was doing because it was altogether different from customs in Spain where in those days fireplaces were unknown; alcove fireplaces with the fire on the bricks or tiles was the custom, the chimney being formed starting from the middle of the

alcove, about 7 feet, until it terminated at the required height with an opening of about three inches by twelve, a mere slit out of which very little smoke escaped, the bulk of the smoke quietly escaping into the room and escaping through the door and windows; but that applies more to the kitchen than the living rooms which in cold weather were heated by what is called a Brassaro, that is a big brass dish of ornamental design on a low stand containing live charcoal which has previously been alight outside the room for some hours until it is a perfect glow, having got rid of most of the carbonic acid gas and giving out considerable warmth. Of course I had none of this but made in the workshop English fire-places of a simple pattern. The workmen were very much puzzled and couldn't make it out at all, never having seen anything of the like before. When the first one for the dining room was finished and placed in position the men asked if they might see it started. I had filled the grate with shavings and chips of wood ready for lighting; the room was full of workmen all anxious to see the result. I put a light to the shavings and presently there was a roar of flame up the chimney. The men gave an exclamation of astonishment and crossed themselves and said how was it that the smoke would go up a chimney of only six or eight inches square while in the Spanish chimneys very little of the smoke would go up at all. I could hear them say the devil had something to do with it. But they were astonished by many things besides, and so was I. My house and garden commanded views of the railway both to the right and left. To the left was the Station of Santander about three miles away.

The morning train which consisted of about ten loaded wagons and then five or six carriages started about 9 o'clock. I was always in the garden

watching the train as it rapidly passed, there being a slight down grade. I often cautioned the men about running the train too fast past the workshops, and one morning they had rather a severe lesson. I saw the train coming along at full speed when to my amazement I saw it turned suddenly from the main line into the yard and dashed at full speed into a train of empty wagons. The driver and firemen had jumped off the engine and got a severe shaking. The crash was awful and the sight more awful still; it was like a terrible explosion, the air was filled with fragments and huge pieces of the smashed wagons. The engine was instantly turned over on its side and in that strange position was ploughing its way under the debris of the wagons, with the steam blowing off as if the boiler would burst. The train consisted of ten loaded wagons and five or six passenger cars behind. The wagons in front received the shock and most of them were smashed; they had saved the carriages and the passengers only got a good shaking.

Soon after this I began to think of leaving Spain, but it would be leaving a good many friends both English and Spanish, and the employment that was useful and interesting to me. Mr. Sewell, who was still the Manager for Mr. Mould, the Contractor, and also assisting the Railway Company was my great friend and chief. I told him I had an idea of throwing up my appointment, and seeking a further advancement on my own account. I felt that I could make a position for myself based on the experience I had gained and the success of my several inventions, my friends the folding-machine providing me with sufficient funds which I had saved to be going on with in a careful and considerate way. My wife of course was glad of a change, and

glad after a two years experience to get home again. All my arrangements were made and we left in a little steamer direct for England and had rather a rough time of it.

For a time we lived with my Father in Preston who was still at the large house commanding the beautiful scenery which I have already described, but the Tramway and my early friends old Bob and old John were no longer in evidence, the town with my Father's assistance having commenced to turn the fringe of the town overlooking the river into a park and public gardens. But this attraction was not sufficient for me and I decided to make Manchester my home and business centre.

I found the folding machine had prospered in the hands with whom I left its manufacture and business management.

On my return from Spain, I decided to have a works of my own for the manufacture of the folding-machine, and I was not long in finding suitable works that were to let and in a short time I proceeded to furnish it with the necessary machinery. Manchester, of course, was the best place to buy it. In connection with this a strange incident occurred which became the foundation of my business career. In passing along one of the main streets I noticed in the windows of one of the buildings were blinds with the name of the firm and its business which was to supply all kinds of tools and machinery for workshops.

The name of the Firm was Wheatley Kirk, Engineers and General Agents for the supply of Lathes, Drilling Machinery, etc., etc. It was not long before I was in the office interviewing the principal of the Firm, and soon arranged for the purchase of all that I wanted. I asked Mr. Kirk what was the nature of their engineering business; he told me that at first they were

engineers, but they found that an agency was more profitable and that they now made it their principal business. This idea made a great impression on me because I was told by my friends that I ought to get familiar with commercial matters because it would be of great assistance in the engineering business I was looking forward to. I thought the idea of Engineer and General Agent would just suit my purpose and was determined to establish myself in Manchester. I was not long in finding a good office to let in one of the principal streets (Corporation Street); there were two rooms and three windows to the front; on all these windows I had wire blinds made and on one of them I had painted: "James Livesey, Engineer and General Agent." Of course I had no agency; that was a thing to come, and it did come, and in a very strange manner.

I designed quite a new tube to give more heating surface within a limited space, and went to Birmingham to get these tubes made. I was a stranger in Birmingham and asked the porter at the hotel I was staying at in which part of the town I should find the Tube Works. "Not far from here, Sir. When you get out, turn to the left and go about a quarter of a mile up the main street and enquire." It was not long before I saw at the corner of a side street a sign on which was painted: "The Imperial Tube Company, Makers of Gas and Hot Water Tubes, Boiler Tubes, &c., &c." I thought the Imperial Tube Works might be as good as any and it was not long before I was in conversation with the Manager, a Mr. Wright. After describing what I wanted, he said the tubes could be made though they differed from any they had made before, and would I please leave my card, the first card I had ever left with the name of James Livesey, Engineer and General Agent, 29, Corporation Street, Manchester. I saw Mr. Wright look earnestly at the card

and he asked me if I was any relation to a Mr. James Livesey who went out to Spain as Engineer to one of the railways there. Of course this more than astonished me, and I asked him how he came to know of that Engineer, for I had never seen Mr. Wright before. "That is easily explained, for Mrs James Livesey and my wife were school-fellows together and we often talked of the Mr. Livesey in Spain." I then told him who I was. He looked at my card and asked what Agencies I represented. I told him that at present I had no agencies, but that I was going to add an agency to the engineering business I was about to create. He took a great interest in all I told him and said how strange it was that at the present moment they were on the look out for an agency in Manchester. "But I may tell you that ours is one of the most important firms in Birmingham and the proprietors are two of the principal Bankers in London, and naturally we are on the look out for an experienced business man who is well known in Manchester, but unfortunately you don't answer either of these qualifications. From what you tell me you have just returned from Spain, are a stranger in Manchester, and full of engineering, and have no commercial experience."

"Nevertheless, I think I could undertake your Agency and do a good business for you."

"I think my Directors would smile if you made the application; they are each a member of the two banks in London and meet here every month, and our next meeting is in about ten days. If you like you can make your application and I won't say a word about the conversation we have had, but simply tell them that you have placed a small order with us for a peculiar kind of tube. They may invite you to meet them and you will have to tell your own tale."

I received the invitation and the interview was rather a curious one and led to strange results. Mr. Wright had told them little or nothing beyond my calling to leave a small order for a particular kind of tube. They thought they were going to receive a middle-aged man of business-like appearance; but when I was introduced I could see they were rather surprised at seeing a young man of gentlemanly appearance and anything but like what they expected. Of course they began to question me at once asking if I was well established in Manchester and what kind of business I was engaged upno. I saw they were rather poking fun at me and were more than surprised when I told them that I was a stranger in Manchester and had very recently returned from Spain and had decided to make Manchester my business centre - that I had just taken an office there and was starting business as an engineer and general agent and gave them other particulars that interested them, and that I thought I should be able to do a good business for them. They were naturally puzzled and asked me if I would step into the adjoining room. In about ten minutes they recalled me and said:

"We have talked over this strange application of yours which is altogether different to what we expected and differs entirely from the usual business methods. Nevertheless we are going to make you a business proposal and you will think it about as strange as we think your application for our agency, which is perhaps one of the most important ones in connection with any tube works in Birmingham. The proposal is a tentative one - that you should act for six months not as our definite or permanent agent, but simply as an assistant with full authority just as if you were definite agent, and that in the meantime we should await results."

It would take nearly a volume to relate all that occurred in that six

months, but long before the six months had expired I had so increased their business that I was appointed as their definite agent, and they were as much surprised as when first they saw me. But there was one incident that surprised them more than anything else. A certain railway, - I must not mention names, - advertised for tenders for all the tubes used on the railway, boiler tubes, steam and gas tubes and for every other purpose that tubes are required, but strange to say the order was always given to the same firm and neither the Imperial Tube Company nor any of the others could ever succeed in getting their tender accepted. They, the Directors, pointed this out to me almost as a joke, wondering if I could turn the tables in their favour. The time came when the tenders were advertised. I put in my tender on behalf of the Company and it was a proud day for me when I sent it to Birmingham accepted, - the Directors could not understand it, but I had surprised them before with the amount of business I had done for them.

But after about two years I decided to go to London and start business there. I had of course to give up the Tube agency, but the Directors wished to keep my name on the lists. They appointed an assistant agent, and gave me a small percentage on all the business done in Manchester, and they insisted on my taking the London agency, which I did. But my engineering business gradually increased until I was obliged to give up these agencies and one other that I had accepted. I had gained a lot of business experience that is always useful and in fact necessary for any engineer who wants to make a position for himself. I found afterwards when the time came how valuable it was to me when I had to deal with large contracts and contractors, agents and merchants to the extent of millions sterling.

My office in Manchester where I conducted the agency and folding-machine business, which, now that I was able to attend to it personally, increased considerably.

Mr. W.H. Smith, the great publisher and newsagent, hearing that I had come from Spain, sent for me to give me an order to furnish a very large room with seven or eight folding machines and a steam engine to drive the machines. This was a big and important order and was given to me carte blanche. Mr. Smith said: "I know you by reputation. I know your father, and I know you will treat me with every consideration." This order led to strange things. I had to supply not only the folding-machines but a steam engine and boiler as well. I was not satisfied either with the steam engines and boilers as then made, and designed what I considered an improvement on the existing type.

My first engineering business was the erection of a large timber works at Corunna in Spain for Messrs. Sorenson, merchants in Santander, who were friends of mine during the time I was in Spain, who during that time supplied me with the timber for building the wagons and other work. Therefore they knew that I was well acquainted with all that concerned the manipulation of timber. They gave me carte-blanc in dealing with the Corunna works which I filled with machinery up to date, and which was supplied by Messrs. Robinson of Rochdale and Ransom Sims of Ipswich. It was a useful experience to me and gave me an insight into much larger and more important works I had afterwards to deal with.

Whilst in Manchester I was often invited to visit a particular friend of our family, Mr. W. Owen and family, of Rotherham. Two of the sons were

great friends of mine and my visits were a real pleasure and Mr. Owen took great interest in me. They were large manufacturers of railway wheels and axles, etc. We used to talk on business matters until Mr. Owen suggested that I should leave Manchester and go to London and take up his agency there. He was convinced that London offered a better opening for me than Manchester. He suggested that he would allow me £800 a year for three years, that is, if the business did not yield that amount he would make up the difference. I accepted his offer and established myself in London almost a complete stranger. Nevertheless, with the Tube and Mr. Owen's agency and the folding-machine I was fairly well off. Mr. Owen's agency produced me considerably more than the £800 a year. These agencies brought me in contact with railway engineers, secretaries and directors; but the time arrived when I determined to give them up and go in for my legitimate engineering.

Strangely enough, a Mr. Edwards, who was a draper in the north of London, called at my office with a model of a wrought iron railway sleeper. My attention had never before been called to iron railway sleepers, and I was a little surprised that a draper in the north of London should call my attention to it. I saw he was an intelligent man but evidently knew nothing of the permanent way of railways. His model of course was absurd, but my attention was called to it and I suggested quite a different form and told him to get a model made, which he did and brought it to me. It looked a much more practical thing, but my attention having been called in that direction, it was not long before I invented different kinds of railway sleepers and got Edwards to get the models made for me; but there was one, when I saw the large model, that struck me with some little surprise for it appeared a more

important thing than when I ordered the model to be made, and so it proved. Of course I was busy with my other work, but Edwards saved me by attending to what I designed. I determined to take out a patent for this and for other things as my patent No. will show. I had no idea of what was going to be the result, and I told Edwards that I would give him a small interest in the patent if ever it came to anything, and that the patent should be in our joint names, which was rather a foolish thing for me to do, but he learned a good deal from what he had to do for me and was to a certain extent useful to me. All this gave me pleasure and brought my inventive faculties into play as the long list of my inventions will show. At that time I found there were two or three inventions of iron sleepers, but they had made very little headway and never interfered with me. But an incident occurred which I must mention though it will take longer than I like to tell about it, but it had a most important bearing on the future success of my patents. With my agencies I did a large business with the great Railway Contractors, Brassey, Ogilvie and Enfry. Mr. Ogilvy and I became great friends, and I often called at No.4, Great George Street to have a chat and a mutton chop about noon with my old friend. Well, one day I told him that I had turned my attention to the permanent way of railways and that I had invented an iron sleeper that might interest him.

"Then bring it me though I know more about timber sleepers than I do of iron."

Soon afterwards I took him a full-sized wrought iron sleeper.

"Well", he says, "it is a curious looking thing, and I cannot give any opinion upon it."

In a few minutes afterwards, a rough looking man, a Mr. Young, was shewn in.

"Hullo, Young! When did you arrive?"

"I only came yesterday, and have now come to report myself."

"Well, I am glad you are come, for my friend here, Mr. Livesey, has brought me a queer looking iron sleeper for me to look at, but I can give no opinion. You have a look at it for you know more about iron sleepers than anyone I know for you have been laying some on the Central Argentine Railway where you have just come from."

Mr. Young did look at it, and gave a very decided opinion of it in not very polite words.

"No, Mr. Ogilvie," he said, "it's no good," etc.etc.

So they had other matters to talk about some of which interested me. Young and I went out together and I walked with him to have a chat, but he was rather a rough kind of man and was down on London engineers who, he said, had no great experience in turning out work that wanted practical experience.

"And", says he, "may I make bold to ask what practical experience you have had on railways, for that sleeper doesn't show it."

"Well, I think I have had some practical experience on railways, particularly abroad. I was the chief engineer on the railway out of Santander, and there had some rough experience."

"Well, I'm d---- for I now know who you are and all about you, for my brother Jim was your head man and his letters to me told me all about you and the railway. I'm sorry now I had to say so much against that sleeper, but I don't like the idea of a thin wrought iron thing like that. Haven't you thought of a cast iron sleeper? That's what we want, but it must be a good one - better than what we have been trying on the Central Argentine Railway.

it's not a good one."

"Of course I have thought of a cast iron sleeper and taken out a patent for one as well as for the wrought iron one."

"Never mind that, but tell me about the cast iron one."

"But it's quite difficult to describe it."

By that time we had got near to Charing Cross, and knowing Spring Gardens and the big smooth flags, the idea occurred to me to make a rough drawing on the flags with the brass ferule on my umbrella; it was not at all a difficult job, and Spring Gardens in those days was a quiet out of the way street principally for Government buildings. Young could easily understand the drawing I had made and was more than pleased with the novel features it possessed.

"Haven't you had any made?"

"No, not even a model."

"Then let me advise you to get a pattern made and a casting. Have it full size, and then you must show it to Mr. Ogilvie; it looks like being the very thing we want."

I was not long in getting it made and it appeared to me to be much better than I had anticipated. It was taken to Mr. Ogilvie's office and Young was asked to be there. He was very pleased with it and said it was far away better than what he had begun to lay down.

"Then you are not pleased with what we have sent you?" said Mr. Ogilvie.

"No, far from it, because it is a weak sleeper, and has a bit of a spring for keeping in the key which is more like clock work than for a railway.

"Tell me, Young, what are the points of advantage in this sleeper?"

"In the first place, it doesn't want skilled labour to put the sleeper to-

gether and into the road; a native could easily do it. This key can only go in one way and that's the right one and the same with the tie bar key which is locked up by the rail and cannot be stolen. Then the rail key is the same and wants no spring to keep it in its place, the rail itself is made the spring and the key can never come out."

This of course was a very satisfactory interview and Mr. Ogilvie said that they could not send out a new thing that had never been tried and that it would want some consideration. Soon afterwards I saw him again and saw that he had been thinking a good deal about it, and he told me that he could get permission to lay down a hundred yards of my sleepers on the main-line of the Great Eastern Railway if I would send the sleepers, which of course I was willing to do. I knew the Engineer of the railway, and Mr. Ogilvie had great influence and I knew he was anxious about it. It was a great privilege to get such a concession. Well, to make the story short, the trial proved a great success and Mr. Ogilvie gave me an order for nine thousand tons! This was the first but not by any means the last. I was careful to make no mistakes, a misfortune that often occurs to inventors who are too anxious to bring out their inventions before being properly tested and every detail carefully worked out.

The Anderston Foundry of Glasgow, Mr. Muir and partners, who were personal friends of mine, and gave me what assistance I wanted, cast the experimental lot of sleepers, but before I gave them the order I had arranged with a Foundry in London to make a model, and to erect a testing machine exactly the same as the one at the Anderston Foundry so that I might carry out my experiments. It was fortunate I did so because it took some time having regard to the expansion and contraction of the metal to make the

model or pattern as perfect as possible. Of course I understood the necessity of this having served eighteen months in the pattern shop and also in the Foundry at Bolton.

I may mention that this shows how necessary it is for a would-be engineer to go through the various departments in the workshop for the foundation of his career.

I succeeded after several alterations in the pattern in producing a sleeper of remarkable strength. The sleepers that are cast for shipment abroad are tested by a falling weight of two cwt. A sleeper with a piece of rail keyed in position is bedded in a bed of sand and the falling weight is let to drop upon the rail until the sleeper is broken. The weight is caused to rise a great distance and then released and drops on the rail. The first drop is 12 inches and each foot afterwards until destruction. Before the introduction of my sleeper the specified test used to be from four to five feet, but my sleepers would stand more than twice this which was a great surprise to everyone and was to some extent the reason of its great success. At the time I was busy testing the sleepers in the London Foundry I invited Mr. Muir, the head of the Anderston Foundry, to come and see what I was doing, for I had kept my experiments quite private. He was astonished to see a testing machine just the same as the one at the Anderston Foundry, and more than astonished at the result of the testing, for at a fall of 9 feet the rail was smashed, but not the sleeper; but he was afterwards still more astonished when he received an order for nine thousand tons of my sleepers.

Now let me see where I am in my history for I get a good deal mixed having so many things to remember. I find on referring to the back pages

that I have written a volume about the railway sleeper, but since the folding-machine and the sleeper were more than bread and cheese to me, I don't hesitate to go back in memory to those early days now more than seventy years ago which were so interesting and valuable to me, and to leave some record of what I had, through perseverance and determination, accomplished. But I have yet a good deal more to say. It was well known amongst engineers how successful I had been and my opinion was asked about the possibility of an elastic permanent way. The idea was a good one, but very often good ideas, when put into a practical form, do not come out as expected. Nevertheless I was determined to make an exhaustive trial which cost me several hundred pounds. I got permission to lay about a quarter of a mile of experimental sleepers on the main line of the North London Railway which at that time had the heaviest traffic out of London. It was fortunate for me that I was born nearly eighty-six years ago for no such permission could be obtained now-a-days. Anyhow I got everything ready to make a complete experiment and arranged it as follows. I got a length of about twenty yards or more with the rail laid on a cast iron sleeper metal to metal; then another length with the rail resting on wooden blocks in pockets on the sleeper; then another length with the rail resting on blocks composed of two pieces of wood with a piece of india-rubber sandwiched between them. Now I was approaching something like a little elasticity, but I went still further and placed the rail in steel springs thus: which gave a decided elasticity with a motion of not more than quarter of an inch. Now the thing was complete and the result carefully noted. It became known to engineers, who were greatly interested. They came and watched the trains

passing over the sleepers and some came more than once for the experiment continued for more than a month and it was declared that an elastic permanent way was the way of the future, but I having more time and opportunities for noting what took place, had my doubts about it which after a time were set at rest by the steel spring sleepers having to be taken out of the track. After a time the sleepers with the sandwich india-rubber blocks had to be taken out; then followed the wooden block sleepers and lastly the rail resting on the iron bed of the sleeper itself without anything being interposed. It appeared that the elastic movement of the rail gave a slight movement to the sleeper which necessitated the road being constantly under repair, and gradually the same thing occurred with the other sleepers, but to a less degree; but the iron to iron sleeper which astonished me and everyone else became the one for the future. It was an interesting and rather costly experiment but was valuable to me.

It proved how necessary it is to make a thorough practical test before attempting to bring out any ideas you may have for a patent. I have patented a number of ideas that appeared feasible but that would not stand a practical test and were not proceeded with. It is difficult, however, to convince an inventor that his baby is not a good one; he cannot and will not believe it until his pocket is empty and then he begins to blame everyone but himself.

I was introduced to Mr. C. O. Barker, the Secretary of the Great Southern Railway of Buenos Ayres, and very soon we became good friends until his death a good many years afterwards. He was not at all satisfied with their consulting engineer and unofficially sought my opinion on many things connected with the railway until it appeared that I was really acting as the consulting engineer.

At that time the Directors contemplated the extension of the railway some hundreds of miles into the interior of the country with important branch lines. The railway at that time was only about 70 miles long, but now it is more than 3,000 miles. Previous to this Mr. Barker suggested the idea of introducing steel rails for he knew that I had given great attention to the manufacture of steel and particularly to the manufacture of steel rails which at that time were in the experimental stage. He asked me to give my opinion as to the introduction of them for the great extension of the railway system. It appeared to me rather an important and interesting question, and after thinking it over I determined to write a very complete report that he might lay before the Directors. I was thoroughly conversant with the manufacture of iron rails and had watched carefully the result of the experimental introduction of steel rails that was being carefully watched and considered by all the railways.

I was determined to write a complete and simple report divested of all technicalities that the Directors could clearly understand it. I described and illustrated the various processes for the manufacture of iron rails from the bundle of faggots or the putting together strips of wrought iron and making them into a bundle of a given weight like a bundle of fire lighters; these were put into a furnace and heated to an intense degree and then rolled and re-rolled until the finished rail appeared. I illustrated this to show how it was that iron rails had to be taken out of the road when only partly worn out owing to the giving way of some part of the rail because of the imperfect welding of some of the faggots.

Now the manufacture of the steel rail is entirely different. The pig iron is melted into a Bessemer Converter; it is then poured into a mould

and when set, whilst still of a great heat, is passed through and through the rollers until it is a finished rail. It is perfectly homogeneous in all its parts and does duty until it is worn out. I illustrated the fracture of a steel rail as well as the fracture of an iron rail to show the difference. The price of the steel rail at that time was about £18. per ton, or three times that of the iron rail. I then went into the comparative cost and took the life of the steel rail at three times that of the iron rail and was surprised to find that it would be much cheaper to adopt the steel than the iron rail.

It was not long before I was appointed the Company's Chief Engineer. But previous to this, Mr. Andrew Carnegie had been introduced to me, and at that time he was greatly interested in the manufacture of steel and had the idea of its introduction for steel rails into his works at Pittsburg. We saw a great deal of each other and visited Sheffield and some of the principal ironworks in England, and he took note of all he saw - he was very keen on anything that was new to him. One day we were standing on St. James's railway station platform soon after the opening of the District Railway. I called his attention to the rails and told him they were a new kind of rail with the top of the rail as hard as if made of steel. He was greatly interested and asked me what I knew about it. I told him it was the invention of a friend of mine, an engineer who had engineering works at Rotherham in Yorkshire. I said his invention was patented in England and no doubt in America. He asked me if I would invite him to come to London so that he might have a talk with him. I did so, and an appointment was made for them to meet at my office. Mr. Carnegie was very soon on the subject, and asked if there was an American patent which, fortunately for my friend there was, and it was not long before Mr. Carnegie had purchased the American rights. Mr. Carnegie suggested there should be a written tentative

agreement until a more formal one could be drawn up and requested Mr. Dodds just to draw up a simple form of purchase. He went to my desk whilst my friend and I had a chat, for we had many things to talk about. Meanwhile Mr. Dodds was engaged but appeared to be a long time about it until Mr. Carnegie got rather impatient and told Mr. Dodds that he was a long time about it.

"I am not accustomed to commercial agreements," said Mr. Dodds; "If it had been a specification for some kind of machinery I should have no difficulty."

"Never mind, Mr. Dodds, I will draw it up and save you the trouble."

I gave Mr. Carnegie a sheet of foolscap paper, and in about ten minutes he presented it to Mr. Dodds and said:-

"Just cast your eye over that and if you see a serpent in it I will take it out," - a well known American expression that signifies anything that is tricky or not quite honest. The purchase afterwards was completed and drawings given of the furnaces required for treating iron rails, and the furnaces were built, but in the meantime steel rails began to appear and Mr. Carnegie never converted a single rail by the Dodds process. Many a time we had a laugh over that deal. Afterwards when I visited Pittsburg I saw the furnaces standing idle.

Referring again to my report on the steel rail question, I sent a copy of it to my friend Mr. Sandford Fleming, the Canadian Government Engineer, who was greatly impressed with its contents. He and I had worked together as engineers on railways that were being constructed in Canada. There was one from Halifax to Pictou, to that important colliery district, rather an interesting little railway because it was more of a private than a public affair and was in a measure owned by well-known political people, Sir M. Tupper and

others who afterwards became great men in Canada. Mr. Sandford Fleming had occasion to visit England to consult with me about the material for the railway that had to be sent from England. There was one little incident worth mentioning. My friend took a great fancy to a new patent rail clip joint instead of the ordinary fish plate. It was rather an experiment than otherwise. Nevertheless it did not make a bad joint, - good enough to let my friend have his own way. I got them manufactured and sent out but soon after their arrival I received a telegram that rather alarmed me as follows: "Clips too light." It was one of the first telegrams that passed through the first Atlantic Cable. That message meant that the clips were useless. I immediately went to the telegraph office to see if it were correct. I told them that I thought there must be a mistake and would they have the message repeated. "Yes, Sir, but it will cost you £20!" Seeing how concerned I was, they suggested that it would only cost me a few shillings to have it repeated from the reception office in Ireland, and not even so much if any mistake had been made; and in a few hours they would send word to my office. I waited those few hours with some anxiety when a message came to say there had been a mistake and that it ought to read "Clips too tight." That eased my mind altogether because I knew they did not know how to put them on, which was verified a few days afterwards by another telegram saying "Clips all right." My friend in a letter he sent afterwards explained the trouble which was that being something quite new the men didn't know how to put them on, but with a little more patience they soon found how to do it and there the matter ended, excepting one shipment brought them barrels of ink bottles instead of the steel clips.

About this time the Canadian Government had decided on the construction of important extensions of their railway systems, which meant a lot of work for my friend Mr. Fleming, now Sir Sandford Fleming. He had a great wish for me to assist him and he suggested a thing that was very welcome to me, that I should visit the principal railways in the United States and take note of all the best features of their railways. This was a very important mission and was the foundation of my practical career. I had letters of introduction both from Mr. Fleming and my friend Mr. Carnegie to the best railways in the States. I also took notice of what was doing in Canada and had more than one adventure on the Grand Trunk Railway. On one occasion the journey was very wearisome. I asked one of the passengers if he could tell me what time we should reach Montreal. He smiled and said: "We never ask that question, but always ask what day we might arrive at Montreal." Very soon I had proof of that idea for the train had already been stopped twice to get it on the line again. The third time after waiting about half an hour I got out to see what was the matter and after walking up the line about a hundred yards I saw a broken rail on the track and an attempt being made to put the line in order. I told the foreman that I was not surprised at the rail breaking when the rails had no fish plates and the joints off the sleepers. (Sketch wanted here.) He quite agreed with me. The wretched condition of the Grand Trunk Railway at that time was well known.

Having seen all I wanted to see about the Canadian Railways, I pushed on to Pittsburg where I should meet my friend Mr. Carnegie and get letters of introduction from him to the various railways I had to visit. I cannot from memory take them in their proper order, but fortunately the first I

had to visit was the Pennsylvania Central that runs from Pittsburgh to Portland. Fortunately Mr. Carnegie and the President of the railway to whom I was introduced were going with a special inspecting car to inspect some parts of the line and particularly the coal mines that were on and belonging to the railway. There was a big surprise for me. I expected of course to go down into the mines in the usual way, but instead of that we got into a narrow gauge open wagon drawn by a pony and entered a tunnel, and it was not long before we were in the midst of the coal and the colliers at work. This was a great surprise and for half a mile and more we continued the inspection and came out into daylight. I was less surprised when I considered it afterwards, because when I inspected the Sabara Coal and Iron Mines to which I shall have to refer later on in Spain, where I saw a mountain of coal and also a mountain of iron ore, both the coal and the iron ore were being quarried from the surface just the same as what I had seen in America.

After inspecting the wonderful natural formation which Nature had thrown up from below we continued our journey stopping at various places to examine some of the bridges and other features of the railway until we came to Altoona, the Crewe of the Pennsylvania Central Railway, and which was the place I was making for. I was pleased and surprised to find the Locomotive Superintendent and Mechanical Engineer of the railway was an Englishman who had held an important position at the Crewe Works on our London and North Western Railway. We soon became good friends because he had received instructions to show me every attention and give me whatever information I wanted. I stayed about a week. Mr. Carnegie and Mr. Thompson

went on and left me with my friend, Mr. Worsdell, But the kindness and consideration of these people is almost beyond belief. There was a fine hotel at the station to which my luggage was taken. I had to enter my name in the visitors' book and was told that my rooms had been engaged by telegram. I was shown into a sitting-room and an adjoining bedroom. The following morning I found a note for me on the breakfast-table to say that it was too dark the previous evening to see the most interesting part of the railway, and that a special car would be waiting at ten o'clock to take me to make what examination I liked of this part of the railway which embraced about ten miles of the line. It was an interesting journey and occupied most of the day. The day following I spent with Mr. Worsdell in the shops which contained features quite new to me. Mr. Worsdell having had the best of English experience was anxious to see what could be introduced in the American railways, but found there was very little that could be made use of. He showed me a locomotive he had built on English lines which differed entirely from the American Locomotive.

It was quite a disappointment, and no part of its construction could be avoided. The American locomotives were more flexible and better adapted to worse roads and more severe curves than on our English roads. But strange to say the earliest locomotives on the English railway were after the American type, but simplicity of construction gradually made its way until we arrived at something like the present standard.

There were many interesting things Mr. Worsdell showed to me of which I took careful note in my sketch-book. I made hand-sketches of the construction of the carriages, wagons, etc., and copious notes of all I saw at the Altoona Works, the Pennsylvania Central Railway being considered at

that date the most advanced of any line in America. I left Altoona with a good deal of regret. They had been very kind to me and promised to send me tracings of whatever I thought would be useful to me. I then visited other railways and received the same kindly attention, but there was little more to learn than what I had gained at Altoona. Nevertheless, there were points of detail on other railways worth noticing.

One curious thing I remarked was that at each place I visited I was asked if they might look through my note and sketch book and if they might copy anything that might be useful to them. They discovered there were many things worth noting on the Pennsylvania Central Railway, and No.2 Railway and No.3 came under the same observation.

What impressed me most was the perfect organisation of the workshops; they were all arranged on a definite system, well considered and with many interesting details, all with a view of saving labour, all so different to our workshops at that date. Perhaps the most interesting was in the timber developments where the debris - sawdust, shavings, and the like - disappeared like magic, and not littered on the workshop floor like we see in England. Under or near to each machine was a tube of considerable dimension which extended to the boiler house, and by means of a vacuum all the debris or waste was drawn and delivered ready to put in the furnaces. The floors of all the workshops were kept clear and clean. It reminded me of my experience when in the pattern shop at home during my apprenticeship, where I was often up to my knees in shavings and the shop floor littered with sawdust and the like. Twice in a week a man with a barrow came to sweep up and clean the place. But labour-saving in America was one of the first considerations, and very frequently it led to the introduction of special

machinery of great value and utility. I don't think I could give a better example than I saw at the Carnegie Steel Works in Pittsburg on one of my visits there. In New York and Pittsburg ground space is limited, necessitating buildings of great height, and ingenious device. What I saw at the Carnegie Works was a wonder and a surprise, and it would be difficult to convey anything like an accurate idea of what I saw, which was the machinery for rolling and conveying rails to their destination.

You saw in the mouth of a great furnace, the door of which was opened by machinery, showing a great block of iron heated almost to a blinding extent. You saw it begin to move and gradually it creeps on special revolving rollers until it is delivered into the jaws of a huge pair of rollers which reduces its size until it passes into the jaws of another set of rollers, still further reducing its size. This goes on from stage to stage until it passes through the finishing rollers a perfect and finished rail. But now comes the most extraordinary performance. The rail has continually travelled along, never for an instant stopping, and still at a red heat, but it has to be delivered on the stack of rails, which is about 100 yards away. It would appear as if it were endowed with life and intelligence for it continues to be silently moving along on the level ground, when it appears before obstructions of every kind - lines of rails, a locomotive and wagons. Yet the rail never stops. There is something like a ladder which takes hold of the rail and you see it mounting upwards and passing over all these obstructions and quietly descending on the other side, but like our modern "Tank" it goes on until it reaches the stack or pike of rails, when by mechanical means it is deposited. I have seen many wonderful things but never anything that gave me greater surprise or a more useful lesson.

And although it is out of the continuity of my story, I cannot refrain from giving an instance when the sight of that wonderful movement assisted me in accomplishing something on the same lines but dealing with corn instead of iron. A friend of mine, Mr. Thomas of Buenos Ayres, who was always engaged in some useful enterprise, instructed me to design a very large and novel grain elevator for the storage of about two thousand tons of grain. The ordinary grain elevator was well known but the features about the new one were very peculiar and required a good deal of consideration. The whole of the immense building was composed of hexagonal iron bins about 40 feet deep and 10 feet diameter. Taking a bird's eye view it resembled a huge honeycomb.

Unless the grain is constantly moved it begins to heat and its value is destroyed. The problem was therefore how to draw the grain from one bin and empty it into the next bin and into a bin 20 yards away, or any other bin in the building. The recollection of the moving rail at the Carnegie Works came to my assistance; now it became a question of moving grain. This was accomplished by wide travelling bands on which the grain from any one of the bins was received and conveyed to a given point to be taken by travelling buckets to the highest part of the building, to be run from above to any one of the empty bins.

Everything being so novel, there was very little data for me or Mr. Walker of Leeds, who assisted me, to work upon. The bins were to be of iron but of what thickness? What was the lateral pressure of a column of grain 40 feet high and 10 feet diameter? No one knew. The lateral pressure of water could easily be calculated, but it would not apply to

grain. Sir Benjamin Baker was the most likely man to solve this problem, but on looking into it he said there was no data to work upon and therefore he could not help me; But "God helps those who help themselves." I soon saw I could only arrive at it by experiment, and that was to fill a strong sack of about 10 feet high and 3 feet wide with grain. I soon saw there was no necessity for a strong sack for there appeared very little lateral pressure at all, and I discovered that if the sack had been made of fine linen or brown paper it would have been strong enough. The bins therefore were made of thin iron plates, which proved to be amply sufficient. Altogether it was an interesting and instructive piece of work and in practice it gave great satisfaction.

Soon afterwards I left America to make use of what I had seen and learned and to give to Mr. Sandford Fleming the benefit of my visit and the information I was sent to collect. We worked together for many months and were the best of friends. Of course all my expenses were paid, but I would accept no fee because I had made the visit of great use and it proved the real foundation of my career.

I was the first English Engineer that had visited America and the only one who possessed complete information of the best features of American practice. It was useful and valuable to me because at that time I was just beginning with my first engagement on one of the principal South American railways, and fortunately the American practice was much more suited to foreign railways than the English practice.

It really was the foundation of my success, as the number of foreign railways that afterwards fell to my lot testifies. A singular instance of this has just come to my memory. A railway in Brazil was placed in my hands in a very peculiar way which I will afterwards explain.

in the morning. You can imagine my anxiety and my pleasure when the engine went round the curves in the most perfect manner and before noon the Locomotive was on board the steamer. I thought how valuable my visit to America had been.

Now I must refer to the curious incident that placed the business of the railway into my hands. A Mr. Thomas who had been a ship owner at Rio and who had made a fortune there, retired and came to live in London. He had made a number of good friends in Brazil, and among them was the Betime family, well known in Brazil, very wealthy and with considerable influence. One of the family, Señor Betime was a Government engineer and had charge of the roads. He and his friends conceived the idea and got a concession for a railway of about 40 miles, which I believe had to pass through a good deal of their property. They wrote to their friend, Mr. Thomas, who was then residing in London, to make enquiry as to what the railway would cost. Mr. Thomas being a friend of Mr. Drabble, the Chairman of the Great Southern Railway of Buenos Ayres. went to him for some information; but Mr. Drabble at once told him that he must go and consult Mr. Livesey, our Consulting Engineer, and gave him a note of introduction. He at once came to me and a strange interview we had.

"But, Mr. Thomas," I said, "you can give me no particulars about this railway."

"That is true," said he, "because their letter is so vague, I cannot make head or tail of it; they simply ask what a railway of about 40 miles would cost."

"Don't they tell you where it is?"

"No, they simply give me the length of the line."

"Now, Mr. Thomas, I can tell you this, that a railway through a tolerably easy country could be made for three thousand pounds per mile, and yet within ten miles of that railway another railway would cost thirty thousand pounds per mile; therefore, without some definite information, how can I give you any idea of what your friend's line would cost?"

An idea occurred to me, for I was not going to let business slip through my hands without an effort. Having no information to guide me, it occurred to me that I would write a specification for three imaginary railways: No.1, No.2, and No.3, the cost varying from three to eight thousand pounds per mile. I told Mr. Thomas I would think about it and that in about a week's time I would send him some particulars to send to his friends.

I sent him three specifications which he sent to his friends, and in about six weeks he got an acknowledgement but nothing more. Of course I was disappointed. But about a month afterwards I received an invitation from Mr. Thomas to dine with him. I went, and he introduced me to his wife and his friend, evidently a foreigner, a friend from Brazil. When Mrs Thomas retired and left us to our coffee, Mr. Thomas said: "Now Mr. Livesey, I'm going to surprise you. My friend, Señor Betime, has come from Brazil about the railway. They found that your No.2 specification just fits in with what they want, and you will have carte blanche for the construction of the line. The money will be at Messrs Baring Bros., who will honour all drafts you may make upon them."

Senor Betime was a perfect gentleman and only spoke a little English. We had to settle a lot of preliminaries, which occupied a week, when he left for Paris; he was more at home there because he spoke French perfectly

and Paris had more attractions than London. He knew nothing about railways and left everything to me. He came over, however, about once a month and stayed about a week. He and my family became great friends, because my wife and children spoke French and we made his visits a pleasure. He remained about twelve months, by which time the line was finished, and with ten thousand pounds yet in the Bank, the total cost being ten thousand pounds less than my estimate.

A few years after that I had to undertake an extension of another 50 kilometers; rather a long story but it only shows what can be done if you try.

Now I must get on the main line again, and go back to Altoona and Mr. Worsdale.

A great deal of what I have described is only indirectly connected with railways, but since I am giving the incidents that have occurred during my long life, they refer not only to railways but to many outside events that have been attractive, interesting and sometimes profitable. Unfortunately, speaking from a very imperfect memory, I cannot give them all in their proper sequence, but simply give them as they occur to me as separate items that come into my recollection. I have given particulars of my interesting connection with the Betim Brazilian Railway which turned out so satisfactorily. I will therefore refer to another railway in Venezuela, to which my attention was called by Mr. Henderson, now Lord Farrington, and Mr. Cuthbert Quilter, who since became a Baronet.

I was asked to look over some documents relating to a proposed railway in Venezuela. On examination, I found that something very interesting might arise out of them. They related to a railway from La Guaira,

the port, to Caracas, the capital of the country. It appeared that the railway had been under construction for a number of years but owing to the extraordinary difficulties of the country through which it has to pass very little had been done. About eight or nine years previous an English Company had undertaken its construction but very soon abandoned it. The prospect of a good traffic and the anxiety of the President Señor Gusman Blanco, to have the railway constructed caused a French Company to take hold of it, but they soon had to give it up. Then the Americans took it in hand; they also gave it up; the difficulties, it appeared, being too great. On carefully looking through the documents I came to the conclusion that it would be quite impossible to give any definite answer until a thorough examination had been made on the spot. I therefore asked for six months and undertook to send out an engineer and assistant and also an accountant and assistant. The Agents of the President were against this and wanted an immediate answer and made an attempt in other quarters to get it undertaken, but without any success. Therefore they were obliged to accept such terms as were offered to them. I therefore had instructions to make the examination.

I selected the engineers and accountants and gave them very complete instructions so that I might be able to report on the engineering features of the railway and also its commercial aspect. The President was very anxious about it and gave every assistance because for a number of years the scheme had been in abeyance.

The examination was very complete and showed very clearly what a difficult railway I had to consider. The commercial part was easy enough and showed satisfactory results which was an encouraging feature,

but the engineering part wanted great consideration, and many new features had to be ventured upon to make a safe and successful line. It took fully six months before I could send in my report with an estimate of the cost, which rather surprised my friends, who said it was a big risk to run over such a difficult undertaking. I told them that I was risking more than they were, for I considered my reputation was far more valuable than their money, and that I was prepared to take shares to cover all the engineering expenses. The President also agreed to take a large block of shares. Therefore I got instructions to go ahead. It took two years or more of hard, anxious and difficult work to accomplish, but I succeeded and made a success. I need not go into the engineering detail but it was a line of severe gradients and curves, and at places I had to cut a shelf or ledge out of the solid rock for the roadway and out of the carriage window you might let a biscuit drop for two thousand feet. Some of the Engine drivers had to return home; they dare not face it. Lady Brassey when on a voyage in the "Sunbeam" called and went over the line when it was finished and wrote a long and interesting account of the most wonderful railway she had ever seen, and sent me her manuscript to revise before publishing it in the "Voyage of the 'Sunbeam'".

But President Gusman Blanco was splendid. He was a man of great determination, spoke English and French and had seen a great deal of Europe. He assisted in every way he could, and when the railway was finished, he assisted in the organisation of the Staff and was determined that it should be a success. We found, however, that the merchants were still sending their goods to La Guaira by the road instead of the railway, which left

nothing but the passenger traffic. We told the President of this. He gave that peculiar smile of his which no one liked to see: "I will soon put the matter right, and you may depend on having every kintal of goods sent by the railway." He at once summoned the merchants to a conference and spoke very plainly to them. He said: "I understand you are sending your goods by the road instead of by the railway. No one was more anxious than you were to have the railway and we waited for years and never thought it would be finished. We drew up a tariff of little more than one-half of what you were paying for the road to which you all gladly agreed, and now you think of getting the Railway Company to reduce that tariff and are sending your goods by the road. But you are greatly mistaken. I daresay you have made your contracts and I don't want to be hard upon you, and will give you a fortnight and after that if any one of you attempt to send a kintal of goods by the road into prison he goes. I think you know what that means." After the fortnight we had all the traffic we could carry.

Another instance of his interest in the railway was that being in a train on its approach from La Guaira to the station at Caracas, the train was kept for about ten minutes outside the station. On its arrival the President sent for the Station Master and asked him the reason for the train being kept outside the station. He was told they were getting a beam of timber across the line which took longer than they expected. "You will go to prison for a fortnight and make better calculations another time." I could give other instances all to the same effect shewing what a powerful and determined man he was, and no President either before or since has advanced that country more than he did.

My business increased rapidly and I had many railways and other things

to attend to, and now I look back and wonder how I managed it all.

Having had the principal railways of Peru and Chili, including the Transandine (Peruvian railway), perhaps the most wonderful railway in the world, placed in my hands, my son at that time was able to assist me. We had to work out many problems and overcome many difficulties, and to direct and make many trial surveys before the definite line could be located. We had to ascend the Andes, the great range of mountains extending the whole length of South America with the Pacific on one side and the Atlantic on the other. The object of the railway was to get a through communication overland from the Atlantic to the Pacific, from Buenos Ayres to Valparaiso, the first of the railways crossing the Andes. It was a great task, but we accomplished it. It would take a volume to describe the engineering and the many difficulties that arose from its inception to the completion of the railway, but there are certain features of interest worth recording.

Naturally the railway had to traverse a difficult and dangerous country that could best be described by Jules Verne. The summit tunnel was ten thousand feet above sea level, and no railway at that date presented the difficulties that had to be overcome. Within the zone of the railway and at an elevation of nearly ten thousand feet exist two remarkable Lakes, Titicaca and Poopoo. A river called the Desaguadera of many miles in extent connects these two lakes which are on the same level, in consequence a very strange phenomenon exists, that at one season of the year the river runs one way and at another season it runs the other way. Various theories have been suggested, but I do not think any proper conclusion has been arrived at. The lake of Titicaca is, I am sure, one of the wonders of the world; it is in fact an inland sea at an elevation of 10,000 feet. Its length is

is longer than from Dover to London and width from Dover to Calais. At that great elevation, singular to say, it is never frozen, nor are the steamers that ply upon it ever interfered with by the frost. It is on the Pacific side of the Andes which is always warmer than on the Atlantic side which at that elevation is perpetual snow. Lake Poopoo is a much smaller lake. Both these lakes interested me a good deal and I sent out Sir John Coade's son with a party of engineers to examine and make a survey of the river to see if it could be made navigable. If it could, great advantages would arise, but it was found impracticable. They were in that latitude for eighteen months and never interfered with by frost or snow. But that inland sea is always a marvel to me. The level of the lake varies according to the season of the year and other causes that are strangely unknown. It has been suggested that that is the reason of the river running in such a strange manner.

Nearly all the railways I have been connected with had incidents of one kind and another that were curious, interesting, and sometimes very painful.

The Taltal Railway in the Nitre district gave me some consideration. The most direct survey was along the bed of an ancient river that had never seen any water in the memory of any of the inhabitants, and there was no record of the time when there was any water in the river.

The country from Taltal, the port, was very mountainous, and excepting in the old bed of the river, I could not get a survey of an inclination of less than 1 in 20, the limit of traction for locomotives; any gradient beyond that has to be overcome by other means - the rack or haulage by wire ropes etc. I was therefore obliged to accept the bed of the so-called river for the railway track. There was a continual incline of 1 in 20 for ten miles

and special brake apparatus was required, but unfortunately on one fatal occasion this was not sufficiently attended to and a dreadful accident was the result. At the top of the incline there was standing a ballast train of fifteen loaded wagons - the locomotive and a gang of plate-layers. For some reason that never could be accounted for unless it was that the brakes on each wagon had never been put down which was the custom before a train started on the down grade, the brake of the locomotive alone being sufficient to arrest the progress of the train. In this instance the train got out of control and descended with increasing rapidity until the speed must have been something awful before it reached the bottom of the 10-mile incline. The roar of the train was heard at the bottom and the men waiting there witnessed such a catastrophe as no imagination could describe. The train came like a flash, left the rails at the bottom, struck a bed of rock on an incline, and with a bound was sent up like a rocket, and came down with an indescribable crash, smashing the locomotive and the wagons, and killing every man on that fatal train.

On almost every railway there are incidents of disaster and unexpected events. The Taltal did not escape. It was a rainless country and during years, not in the memory of the eldest inhabitant, had there been a drop of water in the old river bed, but strange to say, when the railway was finished and all appeared so satisfactory, a storm came on such as had never been known before, the water rushed down the bed of the river and swept a good deal of the line away, but strange as it may appear, the same thing had often occurred on other railways after the line had been opened. Many theories have been advanced, but no definite reason could ever be given.

There is a saying that you cannot fit a square thing into a round hole.

The harbour of Taltal has a very irregular rock bottom, and being an open roadstead, the sea was not always like a pond. I had to build a substantial iron pier, but how to get a foundation for the iron piles was a puzzle. It was a long time before I could hit upon the right thing, but I did a thing that had never been done before - fitted the square end of an iron pile into a round hole. The square was a little larger than the hole and the pile had to be driven by a heavy falling weight, the corners of the square cutting slightly into the rock, and so firmly were they held that nothing could move them, and there they are now. We got over difficulties very often in a very peculiar way, but I have never yet been able to find a word that would rhyme with silver. Engineers very often meet with incidents which run them into a siding off the main line.

Perhaps the most important work that I accomplished was the entire change of the sanitary conditions that existed at the time my attention was called to that important subject. I then lived at a detached house I purchased in Upper Phillimore Gardens, Kensington, one of the healthiest streets in London, and yet I had frequent and serious illness in my house, which I could not account for. I thought something might be wrong with the drains and sent for Mr. Jennings, who was the great authority in those days for all connected with house sanitation. He came and went into every detail connected with the water supply, the drains, the closets, etc. I accompanied him throughout and took special note of all I saw.

After we had finished Mr. Jennings said: "I will send in my report." In the meantime I made a study of all that I had seen, but waited to see the expert's report, which, when it came, astonished me more than a little. The suggestions he made showed me that we were all in the dark ages as

regards sanitary matters, and especially as regards house sanitation. After reading his report I sent for Mr. Jennings and asked him if he seriously meant what he suggested, because it came as a surprise to me to see what he proposed, and I told him so. I told him that all was wrong as wrong could be and that I saw my way to alter it all. I told him I would give him the contract for putting my house right, and making what I considered a death trap into a habitable dwelling. I knew that it would be a big job and that I should have to clear out for two or three months. I saw how important it was not only for myself but for every householder. The death-rate showed under what unhealthy conditions we were all living and I felt inclined to give Mr. Jennings a good shaking; but instead of which I told him that in a week's time he must begin to carry out the instructions I should give him, which was to clear out every pipe, every water tank, baths, closets, etc. etc. and begin again. I don't think I could do better than to reprint from an article I wrote in the Engineering newspaper on this subject, which caused quite a sensation. I think part of that article might be continued here.

RELATING TO THE SANITARY CONDITION OF OUR
HOUSES IN RELATION TO THE PRESERVATION
OF HEALTH, AND THE INDIVIDUAL COMFORT
AND WELL-BEING OF THE COMMUNITY.

There is no lack of information on what to eat, drink and avoid, - the only difficulty being, where doctors so greatly differ, how to steer a safe course between their opposite theories; but it is surprising what comparatively little attention has, until lately, been bestowed upon the more important study - how to render our houses

perfectly healthy by removing those evils which we are now beginning to discover are the source of so much illness in families, in the shape of typhoid fever, throat affections, and other serious ailments, and by introducing those improvements which science, aided by mechanical ingenuity, has now placed within our reach. It is not too much to assert that one half of the sickness and premature mortality in families is the result of defective drainage, impure water supply, neglected or ill-regulated ventilation, and other cognate causes.

In nearly all cases these illnesses could be traced to some grave defect in the sanitary arrangements, but unfortunately some of the most poisonous gases may pervade a house without our knowledge, as they cannot be detected by the ordinary senses of sight and smell. If all sewer gases and poisonous elements existed in the form of smoke they might easily be seen, and very few houses would be found to be entirely free from them.

Very numerous indeed are the families afflicted with illness of this kind, and who are yet quite at a loss how to account for it, but it is only too apparent to those who have carefully investigated the subject what are the real causes, and there can be no doubt that when these are explained and brought home to his understanding, every careful householder will at once look into a matter in which he is personally concerned, and seek to remedy, so far as lies in his power, a state of things fraught with so much danger.

So large a proportion of the population spend most of their time indoors, whether engaged in their professional avocations, trades, etc., or in taking rest, that it is of the utmost importance their houses,

offices, and workshops should not only be free from dangerous gases, and the water they drink as pure as possible, but that they should also have a "constant service" of fresh air supplied to them.

No doubt the proper arrangement of the drainage and water-supply pipes in a house is a matter which the general public could hardly have been expected to enquire into or understand, unless they had their attention drawn specially to it, and, unfortunately, those who might have been supposed to look after such important details have been content to leave them in other and less skilful hands; but on the question of ventilation it might have been expected that there would be a more general interest felt by householders.

In the hope that a just appreciation of the present unsatisfactory state of the drainage and water supply, ventilation, lighting, heating, etc., of our dwellings, and of the benefits to be derived from a little study of the same, may lead to a general improvement, I shall now point out as briefly as possible what are the chief defects and deficiencies in these very important matters, and show how they can most easily be remedied.

Many able works have been written on these matters, but as a rule they have either been too voluminous or too scientific to be of much practical service to the general public.

I shall endeavour, therefore, to divest the subject of all technicalities, and treat it in such a manner that any one may, without special knowledge, see for himself what is the condition of things in his own house and seek the remedy, instead of leaving it to other people.

House Drainage

There are very few householders who have not been troubled at some time or other with the drain and water pipes, and who have not had some experience of the necessity which often arises for making alterations at considerable inconvenience and expense, simply because these pipes were not properly arranged when the house was built.

Of nine-tenths of the houses it may safely be said that the arrangement of the drainage and water supply pipe is most defective, and utterly opposed to all reason, as will presently be shewn.

It has hitherto been difficult to understand why there should exist such an amount of sickness as prevails in the better class of houses, situated in some of the more favoured positions in London and other large towns, and where the laws of health are generally regarded; but it is now discovered that it is in a great measure attributable to the bad system of constructing the drains, allowing poisonous gases to escape freely into the house, contaminating the drinking water, and causing other serious evils.

When a person has frequent cases of illness in his household (fever and so on) it may either occur to him, or else his doctor advises him, to look to the drains; a local builder or a plumber is thereupon called in to make an examination, but generally speaking very little permanent good results. Flushing the drains, cleaning out the cisterns, and the use of carbolic powder or other disinfectants is recommended, and thought sufficient, but very few take the trouble to go to the root of the matter; they simply battle with the effect instead of seeking for the cause.

Considering the great importance of the subject, I strongly advise every householder to examine for himself the simple but most vital points that I shall now bring under notice.

In the first place, it would scarcely be credited that in most houses, and even in the case of detached houses (for which there cannot be any possible excuse), the main drain is run through the house, and that the drains from the closets, sinks, wash-basins etc., are connected directly to this drain in one part of the house or other. Nothing can be more dangerous than such a practice, as even with the best materials and workmanship it is almost impossible to have the house free from sewer-gases where such an arrangement exists.

It is true that all pipes leading to the drains are supposed to be "trapped" in some form, but this is not invariably the case, and even so, these traps are frequently quite useless, for reasons that will afterwards be explained, and the pipes are left completely open for the free passage of the poisonous gases from the drains into the house.

Sometimes the connection between some of the pipes in the house and the main drain is separated at some convenient point in the house - that is, the pipes, instead of continuing directly to the drain, empty themselves into a trap containing a good quantity of water. This, of course, prevents the sewer-gases going at once up the pipes into the house, but the water in the trap absorbs those gases to a great extent, and they are given off again in some measure into the house.

A great source of danger is the emptying of the traps by means of suction from some of the adjoining pipes. When a considerable flush of

water is sent down one of the pipes, a bubbling kind of noise is heard in others connected with it, the reason being that a body of water, etc., passing down a pipe acts as a piston, and if the pipes and traps are not properly ventilated, so as to admit the air, a vacuum is necessarily created, and the water is thus drawn out of the traps, producing the bubbling noise referred to, and which serves, indeed, as a note of warning that the trap is being emptied, leaving the pipe directly open to the drain.

Other sources of danger are the overflow-pipes leading from cisterns, baths, closets, etc. Under almost every bath and water-closet pan is placed (on the floor) a lead or zinc tray for the purpose of preventing any accidental overflow running on to the floor, from which a small pipe is very often connected, either directly to the soil pipe, or to some pipe running into it. This is also the case with the overflow-pipes from the cisterns, and as these overflows may only occur at long intervals of months or years the water in the traps evaporates, leaving the pipes perfectly open. This is one of the causes of water contamination, and affords as well a direct inlet for sewer gases, causing the unpleasant smell so often noticed in bath-rooms and closets.

The soil-pipe itself is often defective. Owing to expansion and contraction, and perhaps also to inferior workmanship, the joints, after a lapse of time, open, and there is leakage, the escaping gases finding their way into the house.

Then, again, the down pipes conveying rain water outside the house, to the main drain, are seldom trapped, and it frequently happens that the top of one of these pipes, taking water from a lower wing or part of the building, comes near some window, and that the sewer-gases are conveyed

by that means into the house.

For carrying away the surface rain water, drains are provided outside the house, and usually in the areas. These drains are mostly furnished with what is known as a "bell" trap, but it appears to be little understood that these so-called "traps" are, in many situations, sources of the greatest possible danger, for the reason that the amount of water they contain, which acts as the trap, is very small, three or four days of dry or hot weather being sufficient for all the water to evaporate, and a passage is then opened for the gases to escape and flow freely into the house through some adjacent window or door.

In many houses, both in the country and in provincial towns, washing, dairy, and culinary operations are carried on in underground rooms or cellars, generally having a large drain or sink in the brick or stone floor, to carry away the dirty water or other refuse liquids into the main drain or cesspool.

In too many cases this sink or channel is not trapped, and it will be obvious that offensive smells and dangerous gases find their way into the house from this source, being drawn up by the heat in the rooms above; and not only so, but milk and butter also readily absorb poisons of this nature.

It certainly appears marvellous that all these evils should exist when a very small degree of intelligence might have prevented them; but for the want of this, and perhaps the saving of a few pounds to the builder, thousands of people suffer, and our death-rate is far higher than it would be if our sanitary arrangements and water supply were based on common sense principles.

There is required little or no scientific knowledge either to under-

stand or carry out a proper construction in the first instance, and it is satisfactory to find that the public are now awaking to a sense of the dangers by which they are constantly surrounded.

Having described the evils which exist more or less in every house, and from what causes they arise, it will now be pointed out in what manner they can be remedied.

The chief source of danger is the main pipe (commonly called the soil pipe) which leads from the closets to the main drain or cesspool, and it will readily be understood that all pipes running into this become mediums for the conveyance of sewer-gases into the house at various points even if such pipes be trapped, because it has already been explained that water absorbs the gases and gives them off again; secondly, there is often a back pressure sufficient to force the gases absolutely through the water; thirdly, for want of a ventilating pipe traps are often emptied by suction.

It will, therefore, be seen how dangerous it is to have any connection with this main pipe, and on no pretext should this be permitted in new constructions. This pipe should be a separate and independent drain, and in every case, where possible it should be carried at once outside the house, and thence into the main drain, and at its end there should be either a flap-valve or a syphon trap provided.

When it is not convenient to carry this pipe outside the house, and it has to be placed inside, let it be so arranged as to be accessible at all points where possible for examination. From the top of it there should be a ventilating pipe carried to some height above the roof, care

being taken not to bring it near windows or chimneys; but if it should be difficult to avoid this, and no other arrangement be possible than to carry it up a chimney-stack, let it be taken several feet above the top of the chimneys, to prevent the escaping gases entering the house by means of the down draughts, which, it is well known, frequently occur in chimneys, especially when the fires are not burning. This pipe should be provided with a self-acting air-extractor at the top, so that the gases may be more readily and certainly drawn out.

With regard to the position of the closets the great mistake is often committed of placing them too near the centre of the house. They should always, where practicable, be built out at the side of the house.

In the case of detached or semi-detached houses, the drain pipe should be carried outside, but if it must run through under the house, it will be obvious that the greatest care must be exercised in its construction.

It has been already explained that the down pipe should be accessible, and, by preference, the horizontal drain pipe should also be so arranged that it may be easily got at for examination, but if there is a difficulty about this, let it be very carefully made of the best material and workmanship and by preference with iron pipes.

Having dealt with this part of the subject, I have now to consider the best arrangement for the general waste pipes from various parts of the house, such as bathroom, wash-basins, sinks, &c.

1st. All the overflow pipes from the cisterns and bathroom had better be carried straight through the nearest wall and project a few inches on the outside, to empty into the open air.

2nd. The wash or waste water pipes from the bath, sinks, etc. should not be connected with any main drain pipe, but empty themselves into the open air into one or more earthenware receivers of special construction, provided with an efficient trap, readily accessible, and thence into the main drain.

It will at once be seen that, with this arrangement, no sewer gases can possibly enter the house, as the pipes have no connection with the drain, and the ends of them are open to the air.

3rd. All pipes conveying dirty water, etc., must, of necessity, be more or less foul, owing to greasy matter adhering to them, and it is on that account necessary to have a trap of simple construction near the mouth of the pipe to prevent any disagreeable odour arising.

4th. Any rain water pipes, the tops of which come near a window, should have efficient traps containing a good body of water fixed in such a position that they may at all times be accessible for examination.

The same may also be said for those drains that carry away the surface water.

I have now described what arrangement I should recommend for new construction, and where it can also be carried out on existing premises, and the expense and trouble of the requisite alterations would not be objected to, it would be far more satisfactory to have, as nearly as possible, the same arrangement, because it is the only sure way of getting entirely rid of all nuisance and danger. If, however, it would be extremely awkward to disturb the present drains, or if for other reasons the plan proposed

be inadmissible, the best thing to be done is to make the outside drains complete by having efficient traps substituted for the existing ones.

Next, to ventilate the closet pipe.

The water closet seats should be made so that the apparatus underneath may be at once got at for examination and repair.

The overflow pipe from the lead tray underneath should either be carried at once through the wall, or, rather than have it connected with the main drain pipe, it would be better to close it altogether and run the risk of a slight overflow, which seldom occurs, than have dangerous gases coming up through it. A strip of paper might be pasted over the hole or mouth of the pipe, which would prevent the gases coming through, but it would have to be looked to occasionally.

The same remark applies to the provision for an accidental overflow from the bath.

With regard to the overflow pipes from the water tanks, it is of importance that they be carried at once into the open air.

It should also be seen that all the pipes conveying away the waste water are properly trapped near their orifice, and the traps so placed as to be always accessible.

The foregoing remarks refer chiefly to the connection between the drains and the house, which is evidently of more importance to the householder than anything else. At the same time it is very essential that the drains themselves should be in good order - that is, free from deposit; because if they are allowed to collect and retain foul matter, such matter will decompose and give rise to dangerous gases. The most effective way to prevent this is by the systematic flushing of the drains; merely holding

up the handle of a water-closet, or letting a water-tap run, or even emptying an ordinary bath, is of very little use, as the flow of water is too slow and gradual to produce much effect especially when, as in most cases, the drain is at some distance. What is required is to discharge a considerable bulk of water suddenly and directly into the drain.

Although it can scarcely be hoped that these expedients will completely remedy the evils arising from a bad method of constructing the drains, and which can in most cases only be accomplished by an entire reconstruction, yet it is certain they will be found to effect a very considerable improvement, and that the air in the house will have a freshness and healthy tone about it which was not observable before.

(NOTE: The substance of this article was published as a communication to "Engineering" by me in the year 1875, 42 years ago, since which there has been much written and said to the same purpose, shewing that the subject has now engaged public attention.)

It must be remembered that all this took place more than forty years ago, when we were in the dark ages as regards sanitation, but the articles in Engineering newspapers and the interest Dr. Brudenel Carter, the sculptor-writer in the Times newspaper, and others took in my work caused immediate public attention, and not many years elapsed before all that I recommended was adopted and is now the standard for all household sanitation, and the death-rate has been reduced fully 30%. I have always considered it the most important and valuable work I have done. I spent over £2,000 in establishing a work to show how it should be done because I felt that reading articles and talking would not go very far in advancing such an important work.

Now I must refer to my railway work, and to the Costa Rica Railway which gave me some trouble.

Messrs Keith were the contractors. It was a difficult railway and had more important bridges per mile than any other railway I had to deal with, and the work throughout wanted a lot of careful consideration. I was sorry for the contractor because I saw that he had underestimated for the work to be done, but he had to do it. Though losing money, he never tried to evade it, and the work progressed. The contract embraced two extra concessions, one for a small branch railway and the other for a tramway in and about the city of San José.

We saw that the branch railway was only to serve one estate of no great importance, but those who gave the concession no doubt as a personal favour, had no idea of what it would cost, because it ran through a most difficult part of the country necessitating bridges of great importance. The traffic to be secured was almost nil but the expense

of the line and its maintenance would have been very great. We therefore applied for its abandonment, but we were at once refused. Mr. Keith, who was well known to the Government, also tried, and for a time without success; but ultimately he succeeded, but not without a quid pro quo. I knew he had to make a great sacrifice, but my directors thought he was rather trying it on and were quite unable to realise the difficulties Keith had to contend with, but later on they were taught a very severe lesson. They thought I was rather leaning to Keith and didn't like it. I didn't mind because I knew there was something coming that would make them sit up. They found that the Tramway was not paying, but was being a great loss to the Company. They tried to get the concession abandoned through their agent and attorney in Costa Rica. Neither Keith nor I interfered in any way but left the Directors to manage it themselves. For many months with various offers, no advance could be made. Time went on and more offers made, but those who granted the concession knew that they could get their pound of flesh and something more, and it resulted in the Company having to give up the tramway and all belonging to it besides what they had already advanced. They then began to see the difficulty and the cost of obtaining any concession from people who held you in their grasp. It was a bitter lesson to the Directors who had looked with some suspicion on what Mr. Keith had done in obtaining the abandonment of the branch line. In my settling up with the Contractor I allowed him ten thousand pounds towards the expenses he had been at in obtaining that concession and other items he was entitled to. The Directors didn't like their defeat in the sacrifice they had been obliged to make, nor did they like my award.

Mr. Hodgson, who was the chief resident engineer during the construction of the railway, was a fair dealing man and the Directors had great confidence in him. When the railway was completed and all settled up he returned home. The Directors called a meeting to which I was not invited in order to get all the information they could in regard to the ten thousand pounds which I had allowed and particulars as to how Mr. Keith got the abandonment of the branch line. With regard to the former, Mr. Hodgson said he was surprised that the amount was not larger because he knew what Mr. Keith had to sacrifice and that the Directors might know the difficulty of getting any concessions by the sacrifice of the tramway and all belonging to it. Mr. Hodgson then spoke of the value to the Company of what Keith had done to get the abandonment of the small and useless section of the railway.

The railway, he said, would never have paid a dividend, and that Mr. Livesey insisting on its abandonment and at so small a cost when the advantages were considered, was not only justifiable but was something the Company had to be thankful for. The Directors did not like their defeat; they saw how wrong they had been.

When you look at the list of railways that fell to my lot, together with those that came to me when Harry and Mr. Henderson became partners and took a great part of the load off my back, you will not be surprised at the work I had to do. The capitalists in London knew of the experience I had had in my early association with Mr. Carnegie and the Canadian railways and the position of engineer to the Great Southern Railway of Buenos Ayres, and one or two other important undertakings, brought to me concessions for railways and other works for me to examine and report thereon. Some

of the concessions were worth considering and others had no commercial value. For those I thought worth considering, I received instructions to send out engineers to make such an examination of the country and the probability of the traffic being sufficient to make the undertaking a commercial success. I had to direct these expeditions and to give such instructions that would enable me on the report of my engineers to say Yes or No. It was a very responsible position, because it involved millions of capital. The preliminary examination was always interesting and the chief work had to be done by the engineers sent out. The real work I had to undertake. I had to send out engineers to make a complete survey of the line so that an estimate of its cost might be arrived at which would enable me to draw up a specification on which a contractor could base his tender.

A Company had to be formed, Directors appointed, Lawyers and Accountants engaged. My report was of course the basis on which everything else had to be considered. The Lawyers and I had to attend board meetings and discuss every detail with the Directors so that they might understand what their obligations would be.

When two or three different railways were in hand, I found it very difficult to give time during the working hours for the consideration of all the detail that had to be considered. If you want to avoid mistakes, you must have time; that was our difficulty until I invented a kind of overtime that gave us all the time we wanted. I arranged with Whitehall Club to give me the use of two rooms there were adjoining, to provide dinner for five people, myself, John Morris and his partner, Mr. Crisp, a shorthand clerk, and an accountant. We dined at eight

o'clock, and at 9 when the bell rang for work, and by agreement until 12 o'clock. We got through more careful work than could have been done in the City in days when everything is bustle and hurried work. What with one thing and another, I had quite as much as I could manage; nevertheless it was a pleasure to me.

But outside railway work I had to give time to other engagements that came my way. My friendship with Mr. Carnegie was always a valuable asset and one day a gentleman called at my office with a letter of introduction from my friend. He told me that Mr. John A. Wright, a friend of his who was a large owner and the Managing Director of a well-known Iron Works in Pennsylvania, had come to England to arrange for the building of a very extensive steel works in connection with the iron works already existing. I had a long talk with Mr. Wright who said Mr. Carnegie had advised him to place his business in my hands. I soon saw that Mr. Wright was a practical man; he explained his views so clearly. Having given me an outline of the business he asked what I had to propose. He said he knew very little about the manufacture of steel because it was only just coming into general use and taking the place of iron. I told him I thought the best thing would be for me to take him to the principal iron and steel works in this country; he would then see his way more clearly. He was glad of the suggestion and we arranged a big excursion. We visited half a dozen of the principal works including the works at Crewe; they had begun to make steel on their own account. He was greatly interested with all he saw especially with what they were doing at the Crewe works, and on our return we had a long talk over what we had seen. He told me he was greatly pleased, and

in some respects disappointed, because he thought the organisation and general arrangement of the works was not what he expected; but there were many things that interested him; he expected to find everything on a larger scale, and determined that the plant and machinery for the new works must be far in advance of anything he had seen. I had instructions to that effect. He was particularly struck with what he saw at Crewe; a most extraordinary model of a steam hammer that required no anvil; but it was not a practical machine. But what had pleased him more than anything was a very large model constructed with a pair of locomotive cylinders for reversing the rolls of the usual rolling mills or machines. The existing plan of reversing the rolls was a very clumsy and unmechanical device and so thought Mr. Ramsbottom, the Chief of the Crewe Works, who was determined to see if the rolls could not be reversed as quickly as in a locomotive and on very much the same lines. My attention was particularly called to this which led to a number of unexpected incidents. A rolling-mill, so-called, is the most important machine in an iron and steel works, and almost everything that is manufactured from crinoline steel to an armour plate has to pass through the rolling mill. A lump of red-hot iron drawn out of the furnace has to pass forwards and backwards through the rolls of the machine until it is reduced to the form required, whether it be for a steel rail or a substitute for the whale-bone for all the hideous paraphernalia under the costume of a lady's dress. I must stop at that and not go into any interesting detail.

And now I must get to the more serious part of the everlasting story.

Mr. Wright gave me the ground plan of the existing Iron Works together with a plan of the land intended for the new steel works which was a continuation of the land already occupied. Altogether it was opening out into a very big and responsible affair. The money for all the machinery and other expenses was placed at my disposal, and with Mr. Wright's assistance, we sketched out a plan for the position of the various machines and the general arrangement of the works and its connection with the existing iron works. I was sorry when Mr. Wright went back again to America, for now I had to go on with all the detail of this big affair. There was the hydraulic plant; that had to be far more extensive than anything we had seen at the big works in this country, but more on the lines of the hydraulic plant I had seen at the Carnegie Works in Pittsburg. Then there were the rolling mills, the Bessemer converters, the blowing engines, the reversing engines, the big steam hammer, the shears, the Tyre rolling machinery, and a lot of smaller machines, all so arranged that the work should flow continuously from the unfinished to the finished work, from the beginning to the end, without the entanglement that so often exists of work being moved backwards and forwards instead of flowing continuously in one direction. Mr. Wright had assisted me in the general arrangement with instructions that all the plant must be on a more extensive scale than anything we had seen, and his ideas turned out to be correct.

Now I had to start on a more complete plan, get out the specifications and order the machinery. I first began with the Bessemer converters and invited Messrs. John Hick of Bolton and Messrs. Galloway of Manchester. These were the only two to whom Bessemer had granted a licence, with the under-

standing that their prices should always be the same. That was with the idea that they should not compete with each other and bring the prices down and thus interfere with the Royalties that had to be paid. Mr. John Hick was a friend of mine, and the reputation of his Firm was of the best. Galloways I only knew as a Firm of good standing. I received tenders from both, but I saw the Manchester people had given me a slight advantage by delivering F.O.B. Liverpool, whereas the Bolton Firm was delivery on railway at Bolton. A few days afterwards Mr. Hick called, as he said, to take away the order, but I told him that Manchester quotation was a little more favourable than his and I told him how. He considered for a time and said: "I will give you delivery at Liverpool." I said I would consider it. Then came Galloway's Agent who made sure he would get the order by their quotation being the most favourable; but I told him that Mr. Hick had been and was willing to give the same terms. He then asked if the payment would be cash. I told him it would. Then he said he would allow 5% for cash. I told him I would consider it. Soon after my friend Mr. Hick appeared and I told him what had taken place. Then he told me that the two Firms had entered into a solemn agreement that their tenders should always be exactly the same with no favour in any whatever. Now, he said, these people have acted dishonourably and broken a contract that we solemnly agreed upon. "Therefore, my friend, I am not going out of this office without the promise I shall have the order on any terms you like." Then I said, 'You entered upon an agreement that from a business point of view I don't consider was quite right, for it enabled you to put on any profit you liked and no doubt you took advantage of it, which

enables me to do the same, and since you leave the terms to me, you will have to deliver f.o.b. Liverpool with 10% discount for cash." "You are very hard upon me, Mr. Livesey, but I will agree and I will break up the agreement I entered into with Messrs. Galloway." I said, "We have yet to go into the question of the Blowing Engines, which is a bigger thing than the converters, and I know you are quite free to give me what quotation you like and I shall look favourably upon it." Then there was the Hydraulic Machinery which I gave to Walker & Co. of Leeds. I arranged for the largest plant that had ever been made, also gave them the reversing engines, which had taken more consideration than all the other things put together. Mr. Ramsbottom's small model was the beginning of it. Mr. Wright was so impressed with it. But when we discussed with Mr. Ramsbottom the probable dimensions that it would assume to be capable of dealing with the big rolling mill we had fixed upon, he said he had never contemplated such dimensions and could not realise it; his only idea was for making a rolling mill of very much smaller dimensions. We had several meetings, but Mr. Ramsbottom still hesitated and said he could not advise nor be responsible for such a costly experiment as it would be. Mr. Wright and I and Mr. Walker of Leeds discussed the question and determined the dimensions and price of the engines to work and reverse larger rolls than had ever been made before, excepting those for armour plates. We determined to go ahead and told Mr. Ramsbottom of our determination, and that we had taken all the responsibility but that he must give us such assistance as he could. We had also arranged that the engines should be tested before being sent away if satisfactory. It was

a big venture and naturally we were anxious about it. Time went on and the engines were constructed and looked a noble pair bolted down and secured and ready for working in the big shop that had been arranged for them. A bridge had been constructed over the engines like the bridge on a big steamer, and the day appointed for the test Mr. Ramsbottom of course was invited. He was not a little surprised when he looked down on the enlargement of his own ideas. It was not long before all was ready for the signal to start. Mr. Ramsbottom and in fact all of us were anxious as to what would occur, and we walked on that bridge with no little anxiety looking down on the big engines below. I gave the signal to start, the engines worked as smoothly as possible, but the dreaded moment was the reversing of the Engines. I gave the signal to reverse; we held our breath. When those ponderous engines reversed with a dignity and smoothness that was quite unexpected, Mr. Ramsbottom gave an exclamation: "Good God, I couldn't have believed it."

Many months elapsed before all could be dispatched for the equipment of the new Steel Works, but ultimately all was accomplished, and a year afterwards I received an intimation to attend the anniversary. It was a great compliment to me, because the invitation went beyond a mere compliment and included a cheque for One Hundred Guineas to give me a pleasant reminder of how satisfactory all had been. Of course I had long ago had a settling up for the work I had done.

I have referred to my engineering work in Spain, but have forgotten to mention my connection with the West Galicia Railway in the North of Spain. My friend Mr. Mould, who was the contractor for the railway I

was on in Spain, had taken a contract for the construction of a small railway from Caril to Santiago; he asked me to take an interest with him, which I did and got my friend Sir James Kitson also to take an interest and one or two others.

When the short line was finished it soon became apparent that it ought to be continued to Corunna connecting it with the railway to Vigo and other railways in the interior. We formed a Company to carry this out: Sir James Kitson, myself, Sir Weatman Pearson and another. We constructed the additional section and were a little disappointed that the traffic did not come up to our expectations; but we all held on for years with very little return for the money invested. I held nearly one fourth of the shares and gradually but very slowly the traffic increased until it gave a fair return on the capital invested. I held shares and debentures which before the War brought in quite a nice little return. There were no engineering difficulties to contend with, the only trouble being the slow movement towards progress of all Spanish affairs. Nevertheless, I always liked the Spanish people. My son Harry is really a Spaniard because he happened to be born there, but he is not a bit like one.

Sir James Kitson, afterwards Lord Airedale, and I were fast friends and often embarked in rather speculative affairs, but we had no occasion to regret our various adventures. We were both members of the Iron and Steel Institute which afforded us good dinners and the annual meetings and excursions to foreign countries two of which afforded me considerable pleasure, one to Spain and the other to America, - the one to Spain in the year 1896, (See Journal of the Iron and Steel Institute) when the annual

meeting took place at Bilbao, the greatest iron mining centre in the world. To me it was a re-visit for that part of Spain, Bilbao and Santander was, as the early part of the history will tell you, the part of Spain where I passed the most interesting few years in the early period of my life; therefore a visit to Bilbao recalled many old associations. Previous to the visit I had arranged to form a company to purchase a mine that was offered to me. We formed it into a limited liability Company and called it the Triano Ore Company, Bilbao.

(to be continued)