EARLY WESTERN RAILROADS.

BY R. HANSFORD WORTH.

(Read 8th March, 1888.)

My excuse for bringing this subject forward is to be found in the rapidity with which events are forgotten. Facts, unless put on record, are soon lost in oblivion which is almost prehistoric in its utter blankness. I have had personal experience of this when on the track of various branches of my subject, having frequently found myself just a year or so too late to recover information which is now irretrievably lost; while in a year or so more, much that I have succeeded in obtaining would have vanished also. This is the more surprising, as my subject is essentially modern; since the first locomotive which ever carried passengers ran its trial trip up the Beacon Hill at Camborne no longer ago than Christmas-eve of the year 1801, and its inventor, Richard Trevithick, died just fifty-five years ago; while the first tramway which I have to mention was not commenced until 1803, being thus in point of date two years later than Trevithick's locomotive.

I propose to confine myself, in the main, to the rail- or tramroad or way, and shall only refer to the locomotive in connection with those lines on which it has been used. The history of the invention of the high-pressure steam engine, and the first construction of the non-condensing locomotive engine, I shall regard as outside my subject, although the temptation to refer at length to our great West-country engineer is well-nigh irresistible.

It may perhaps be useful, before referring to our own locality, to give a very short sketch of the first growth of tramways in other parts of England. In or about the year 1676, rails of timber were laid in certain parts of the colliery districts, and carts with four wide rollers, in place of the ordinary wheels, were employed to run on them. Later on these rails, instead

of consisting of single pieces of oak, were built in two—one piece taking the strain or weight, and the other piece the surface wear and tear. This second piece was of course replaceable. After this bars of wrought-iron, in size about two inches wide by half-an-inch deep, were placed at the worst gradients to render the necessity for constant repairs less. These bars were fixed by means of countersunk spikes.

Later yet, in 1767, the Coalbrookdale Co. used cast-iron rails in five feet lengths, four inches wide, one and a-quarter inch thick, and each rail fastened down to the sleepers by three spikes or bolts. This rail being made L-shaped, acted as a guide as well as a bearing surface for the wheels; and from this fact the modern tramway seems to have derived its name, as such rails acted as a *trammel* for the wheels. In 1789 edge rails, such as were used at first on the Plymouth and Dartmoor Railway, were introduced.

In Devon and Cornwall, as elsewhere throughout the country, most of the earlier rail- and tramways were subsidiary to canals. The first form of tramway of which we have record in the North was employed for the carriage of coal from the pit mouth to the canal, and in the West the earlier ways were auxiliaries either to canals or harbours.

THE TAVISTOCK CANAL AND INCLINE.

In 1803, works were commenced for the canal between Tavistock and the River Tamar at Morwellham, which were completed in 1817. The canal itself is four and a-half miles long, and two miles of this length are tunnel, which at its deepest point is 460 feet below the surface. The canal does not communicate with the river Tamar directly, but by means of an inclined plane.

I went to Morwellham last Christmas to see what was left of the original plane, and I describe the remains as I then found them. If the pattern rail now left on the ground had been the same as originally used, it would have been the earliest rolled iron rail of uniform section of which we have evidence in the West. Mr. Moses Bawden has, however, kindly informed me that the present rails are not of the same pattern as those first used, although these too seem to have been of uniform section, and resembled a modern street tram-rail, or a Great

Western bridge rail inverted; they were relinquished because the flange of the wheel cut them out so soon. The canal terminates at a point 240 feet above the river level, and the inclined plane connects the two. On this incline were laid two lines of rails, and there are two winding barrels on the engine at the top. The second line of rails has been removed, but I am informed that it was used by the descending trucks.

I was very much struck with the picturesque appearance of the water-wheel and winding machinery, by which the incline was worked. The wheel itself, which was worked by the waste water of the canal, is about three feet breast, and twenty-five to thirty feet in diameter. On its axle is fitted a somewhat ponderous bevelled cog-wheel, into which gears another of similar dimensions. This is fixed on a stout wooden axle, which rises almost vertically, and moves, by the aid of another pair of bevel-wheels, another horizontal wooden axle about one foot eight inches square in cross section. On this last is fixed a large drum, on to which winds the chain, of four-inch link and three-quarter-inch iron, which was used to draw up the ascending train of trucks laden with coal, lime, &c. Another large drum, with a wire rope wound on it, is so connected with this last by a pair of ordinary toothed wheels that the descending train, laden with copper ore, was made to assist the water-wheel in drawing up the ascending trucks.

The incline at places is as steep as one in six; and I found the remains of a truck, in which one pair of wheels was four inches greater in diameter than the other, the idea being to keep the body of the truck level. On the quay at Morwellham, and also at the head of the incline, are still to be seen remains of the permanent way.

The gauge of the line was four feet three inches. It consisted of rolled iron flat-headed rails, fixed into cast-iron chairs by means of wrought-iron keys or wedges about six inches long and half an inch thick. These chairs were each secured by wrought-iron spikes to stones, either of granite or slate (killas), about two feet long by one foot wide, and six inches deep, placed about three feet apart, centre to centre. I calculate that the rail, which was only three inches deep and one inch and a-half wide at the top, would weigh about 25 lbs. per yard run.

While looking round the canal terminus I noticed an ancient

canal boat (length thirty feet, and five feet beam) made of small pieces of sheet or boiler plate-iron riveted together, the whole being evidently on the eve of dissolution. Apparently in order to hold it together it was partially slung from a cast-iron crane originally used for unlading the canal boats.

PORTREATH RAILWAY.

In 1809 the first tramway in Cornwall was opened. It ran between Portreath and the mines at Poldice; and Lord de Dunstanville laid the first rail, October 25th of that year. The line was about four miles long. Hitchin and Drew's *History of Cornwall* (1824) notes concerning it: "A rail or tramroad has been made, over which the wheels of the carriages that are constructed for the purpose run on cast-iron, which facilitates in an extraordinary manner the progress of the vehicles, and greatly lessens the force of animal exertion." Mr. Francis Michell, C.E., of Redruth, informs me that the line has been taken up, and that it consisted of two angle irons, placed face to face, and not back to back, as was usual; thus, ⌊ ⌋. These irons were fastened to stone blocks, and the gauge was about three feet.

THE HEYTOR RAILWAY.

The next railway to which I have to refer was three years later in date than the Morwellham incline, but of a more primitive character, resembling, in fact, an Egyptian quarry-road almost as much as a modern tram-line.

In 1792 Mr. James Templar obtained an Act for the construction of a canal from Bovey Tracey to Newton to communicate with the river Teign, and made it at his own expense, completing it in 1794 to Stover. This canal, known as the Stover Canal, is six and a-half miles long.

The same Mr. Templar also completed, and likewise at his own expense, a tramroad from Heytor to Stover to communicate with the canal. This tramway, opened in 1820, was made with the intention of developing the Heytor granite quarries; and at the same time workmen's dwellings were erected in a sheltered position on the flank of the tor. These dwellings are now known as "The Buildings."

The way itself consists of two parallel lines of granite blocks, each line having a rebate worked along its outer half. The gauge, or distance between the rebates, is exactly four feet. The depth of the rebate varies in places from three to six inches, and the action is precisely similar to that of the Coalbrookdale cast-iron rails, and very like that of the check or guard rail now fitted to lines on sharp curves or at crossings. The horizontal portion of the rebate carried the weight, while the vertical portion bore against the inner circumference of the wheel, and kept it in its place.

At one place at Bovey rails of iron almost precisely similar to the Coalbrookdale pattern have been used, where the line crosses a stream by means of a wooden bridge. At curves the stones do not seem to have been dressed to form, but short, straight stones were worked in, which by the constant friction of the wheels soon wore down to a sufficiently accurate shape. The stones vary much in all dimensions, but perhaps an average block would be four feet long and one foot six inches square; many of them are as long as seven feet. Points and crossings were formed in large blocks by working grooves six inches wide and two or three inches deep. At no place was any serious cutting or embankment attempted, for the greater part both being only such as were necessary to carry the road along the inclined face of a hill. No attempt was anywhere made to bond together or connect the stones.

The reason for the substitution of granite for iron in this tramway is of course evident. Where granite was to be had for the cost of production, it is not surprising that as a material it should have been adopted. And it does not follow that because the material was cheaper it was necessarily inferior. The cast-iron rails at that time in vogue were a constant source of annoyance and expense, invariably giving way at the wrong moment, and being very uncertain in their general behaviour when heavily laden. Now the Heytor granite is an exceptionally good material, and the granite-way as laid was far superior in many respects to the cast-iron rail. This tramway was thoroughly efficient, and quite up to its work; for the two large blocks of granite having the city arms upon them, at either end of London Bridge, came from the Heytor quarries over this line to Stover, and were thence shipped to London. The Waithman monument, in Ludgate

Circus, was also quarried at Heytor, and brought down over this tram-line.

I have already alluded to the Heytor granite as an exceptionally good stone. It is a fine-grained porphyritic rock which can be obtained in blocks of almost any desired size; but owing to the lie of the jointing it involves a large expenditure of labour to quarry out, and from this reason has now ceased to be extensively worked. The quarry has not, however, been altogether deserted, as a few men were employed there when last I visited it, on which occasion Mr. Barry, C.E., of Newton (to whom I must express my indebtedness), very kindly walked over the railway with me. Besides the principal quarry at Heytor, branch lines were also run to neighbouring quarries, but the whole tramway has now fallen into disuse. As to the trucks, they were merely modified road waggons. The wheels, as in all the earlier rolling stock, ran free on the axles, and I am informed by Mr. Barry that the leading truck of a train usually had shafts.

BUDE CANAL.

In 1819 an Act was obtained for the construction of the Bude Canal. This canal had at various points a series of inclined planes which were worked by steam power.

PLYMOUTH AND DARTMOOR RAILWAY.

We now come to our own more immediate neighbourhood—to the Plymouth and Dartmoor Railway, the first idea of which originated with Sir Thomas Tyrwhitt. This gentleman's statement, made at Plymouth to the Chamber of Commerce, is of considerable interest. Briefly stated, the following prospects were held forth :

The barren slopes of Dartmoor were to be reclaimed, to which end lime and sea-sand were to be imported as manures. Pauperism was to be decreased, and a flourishing colony of agriculturists was to be planted on the moor. By this means Plymouth would acquire a valuable back-country, which would materially increase her prosperity as a port. It was in fact to be an undertaking profitable alike both to the nation and to the shareholders, the latter apparently expecting an eighteen per cent. return on their capital. As the subject is of such local interest, I think it may be well to give an abstract of Sir Thomas Tyrwhitt's statement,

which is also a good example of the early railway prospectus. Sir Thomas said :

"To reclaim, and clothe with grain and grasses a spacious tract of land now lying barren, desolate, and neglected; to fill this unoccupied region with an industrious and hardy population; to create a profitable interchange of useful commodities between an improvable and extensive line of back-country, and a commercial seaport of the first capabilities, both natural and artificial; to provide employment for the poor of several parishes; and to alleviate the pressure of parochial burdens by a method, at once simply ingenious, and comparatively inexpensive, form altogether such a stimulus to adventure, and such a scope for exertion, especially to a wealthy company, as must dilate the benevolent heart of the patriot, whilst it emboldens the capitalist gladly to lend his assistance in carrying the plan into execution."

The last sentence evidently implies a doubt that the "benevolent heart of the patriot" counted for much unless the security was good. Continuing his statement, Sir Thomas Tyrwhitt divides his subject into five heads; viz., I. Plan; II. Expense; III. Funds; IV. Income; V. Benefits.

I. "*Plan.*—The road will commence at Dartmoor Prison, which lies about twelve hundred and fifty feet above the sea, and thence traverse the Moor and Roborough Down in a south-westerly direction, to the Laira at Crabtree, by a gradual fall of half an inch in three feet. The distance between the two places will not, in all probability, exceed twenty miles, according to the line marked out in the plan; and the road ought to be an ascending and descending one, or what is technically called a 'double road.'"

In a footnote to this last clause, it is explained that a double road occupies eighteen feet of land in width.

II. "*Expense.*—It is calculated that the present road may cost £2000 per mile.

III. "*Funds.*—To meet the charges, both direct and contingent, it will be necessary perhaps to raise £45,000 by subscription, in shares of £25 each."

A somewhat encouraging footnote is here appended, with a view probably to future financing operations. "Experience has proved in Scotland that not less than eighteen per cent. may be derived from railroads."

IV. "*Income.*—The principal part of this, at first, will arise from the tonnage of importable and exportable commodities.

"IMPORTABLE COMMODITIES.

"*Lime.*—In cultivating the moor and other unimproved parts on both sides of the road, this must be esteemed an indispensable article, not merely in the onset, but during the long course of successive years.

"*Sea Sand.*—Many assigning much importance to this article prefer it to lime as a manure.

"*Timber.*—In proportion as buildings accumulate around the road, as population increases, and as the wants of culture diffuse themselves, will be the want of this valuable article, to which in fact hardly any limit can be placed in a region so denuded of wood as Dartmoor.

"*Coal.*—Next to timber justly ranks this essential of domestic life.

"*Culm.*

"*Groceries.*—*Tea* and *sugar* are become absolute necessaries in the present day, and these, added to *wine*, *spirits*, *beer*, *porter*, and other *household requisites*, would be sure to give birth to a productive tonnage.

"*Furniture.*—The *colonisation* of Dartmoor will carry in its train a necessity not only for the importable commodities before spoken of, but for many others, which, though of comparatively inferior consequence, will be more or less wanted by the colonists. Amongst them is furniture.

"The use of this term [colonisation] the author hopes will not be objected to; it being equally applicable, in his opinion, to the improvements contemplated on Dartmoor as to like designs in Canada.

"*Planting.*—In the progress of colonisation the formation of plantations will become essentially requisite, as much for the sake of rural embellishment as to protect the newly-enclosed grounds and buildings.

"EXPORTABLE COMMODITIES.

"*Granite.*—Beside the weightier stone for government or private uses, the Company would be enabled to supply, with the same ease and profusion, curbs and paving stones, gate-posts, highway stones, and gravel, at a rate which, it is presumed, would undersell those procurable in any other quarter.

"*Peat.*—It is impossible to view the face of Dartmoor without feeling sensible of the numerous uses to which the superabundance of peat in this district may be applied. Amongst others, the heat given by a combination of peat with coal is allowed to be exceedingly powerful; and the author has reason to believe that iron, fused with this admixture, is less liable to crack than when coal alone is employed in the process.

"*Mining Products.*—Mr. Mawes, the celebrated mineralogist, who has investigated the forest of Dartmoor with much attention, is of the opinion that the latter contains the mineralogical productions of almost every clime, with but few exceptions. If iron, copper, and tin could be raised and smelted on the spot, without the necessity of resorting elsewhere, the saving of expense, both to Government and the public, might be decidedly pronounced incalculable.

"*Flax.*—This next article, unlike the preceding ones, is not indigenous; but experiments have proved that it may be naturalized on the soil of Dartmoor, and perhaps to an extent which will ultimately render unnecessary all foreign importations of it—for the port of Plymouth, at least, and its neighbourhood.

"*Hemp.*—If hemp can be reared on the bogs of Russia, it is without doubt equally capable of cultivation on Dartmoor and Roborough Down."

Travelling Vehicles and Parcels are also included among the sources of income, as also is the *Transfer of Convicts to Dartmoor Prison.*

Such being the benefits which, in all good faith, were stated to

be derivable from the construction of this line, it is not surprising that the matter should have been taken up by a company, and accordingly we find a Plymouth paper indulging in the following somewhat high-flown language :

"The time is at length arrived so long, and yet whether in good report or evil report, so invariably anticipated by us, when the benefits of this measure are to be thrown open to the public. To Sir Thomas Tyrwhitt, as the original projector of this railway, and his able coadjutors in this port and other places, who have advanced cautiously but steadily to their object, may be assigned a praise which future generations will gratefully rejoice to perpetuate. It is not simply for themselves, but for posterity that they have devoted their time, their talent, and their capitals to the realization of a plan which not only reflects the greatest honour on the county of Devon, but will prove to the whole of this neighbourhood an inexhaustible source of advantage. Whether nationally or locally considered, it is a theme of proud congratulation. Whilst the region around, once apparently condemned to sterility, by the use of proper manures, will take its merited rank in British agriculture."

Sir Thomas Tyrwhitt was an eminently practical and thorough-going man, but events have shown that his estimate of the agricultural value of Dartmoor was fortunately wrong. Although Plymouth has lost the valuable back-country promised her, and Dartmoor is still apparently condemned to what is called sterility, it must not be lost sight of that its value as an unenclosed space, where the public may trespass off the roads without being taken for amateur poachers, and where they can wander unfettered by hedges, or fear of damaging crops—its value, in fact, as a public park, similar to though smaller than the great American national parks, will grow and increase year by year ; while it is probable that as a sheep run and cattle pasture of the first order it is of much greater value than it ever could be as very inferior arable land.

A tender for the ironwork of the line was accepted on terms much below the estimate, and two hundred men were set to work quarrying and dressing granite on the moor, a lease of stone on Walkhampton Common having been granted by Sir M. M. Lopes.

The road as constructed consists of a single line only, and this doubtless accounts for the capital raised under the first Act, passed July 2nd, 1819, amounting only to £27,783, instead of £45,000, as estimated by Sir Thomas in his statement. On September 20th, 1819, the first general meeting of the proprietors took place, when a managing committee was elected : Mr. William Stuart, superintendent of the Plymouth Breakwater works, being

engineer; Mr. Hugh Mackintosh, of London, contractor for forming the road; and Messrs. Bailey and Co., also of London, contractors for the ironwork. It being found necessary to continue the line from Crabtree to Sutton Pool, so as to obtain better shipping facilities, an Act was passed (July 8th, 1820) authorizing this extension, the estimate for which amounted to £7200. A further Act was obtained (July 2nd, 1821) authorizing certain deviations, including a tunnel at Leigham, the estimated expenditure for the tunnel and other extra works being £5000. The total estimate was by these means brought up to £39,983.

The total length of line from Princetown to Sutton Pool is 25 m. 2 qr. 6 ch., of which in 1826 over 23 miles had been completed. In this year the contractors, both for road and ironwork, were Messrs. Johnson and Brice, of London, and Mr. Roger Hopkins had succeeded Mr. Stuart as engineer.[1]

The tunnel at Leigham, in the twentieth mile from Princetown, is 620 yards long, 9 ft. 6 in. high, 8 ft. 6 in. broad, and its greatest depth below ground is 109 feet. It has no lining, but is left as cut through the rock.

The completed portion of the line was opened for public use on September 26th, 1823. I take the following description of the proceedings on that occasion from *The Telegraph and Chronicle*, under date Plymouth, Saturday, September 27th, 1823:

"*Plymouth and Dartmoor Railway.*—Our various readers, both local and distant, will learn with the sincerest pleasure that this great work, so long the object of our hopes and fears, and well designated by a worthy nobleman as the glory of the county, is now happily open for general trade. Yesterday was devoted to the celebration of the joyous event, and its festivities commenced with a public breakfast, liberally given by Sir Thomas Tyrwhitt, the original projector of the undertaking, at his Wharf on Roborough Down, where three marquees were erected, and every elegant species of viand provided for the reception and gratification of the company, which comprised much of the respectability and worth of the port and its neighbourhood.

[1] On the 13th of October of this same year an advertisement appeared in the *Plymouth Telegraph and Chronicle*, asking tenders for the excavating and completing of the tunnel at Leigham, and also the making of certain cuttings and embankments from thence to Crabtree and Sutton Harbour. Application to be made to Mr. Roger Hopkins, engineer and mineral surveyor, 6, Tavistock Street, Plymouth.

"The South Devon Band enlivened the scene with its choicest airs; but unhappily the weather was unfavourable, which drove many away ere the departure of the procession through the tunnel could be arranged. A long file of cars partly laden with granite, and partly with stewards and other individuals, accompanied by the band, and ornamented with flags, after the breakfast set off for Plymouth, on their arrival at which place they were heartily greeted by the huzzas of a large concourse of people, anxiously waiting their arrival, being saluted on their way by some petards at Hoo Meavy, and attended throughout the progress by a numerous cavalcade on horse and foot.

"About fifty gentlemen then sat down to a handsome dinner at the Royal Hotel, who did not separate until a late hour."

In the same paper are also notices of a last and final call of 10 per cent. per share, signed by William Burt, clerk to the Company, and also a notice of a general meeting of proprietors of the Plymouth and Dartmoor Company, signed: Morley, Masseh Lopes, Edmund Lockyer, William Elford, and John Pridham.

The line, as originally laid, consisted of parabolic edge-rails[2] set in cast-iron chairs, and these fastened down to stones averaging 2 ft. 6 in. long by 1 ft. 6 in. wide, and of varying depths. Some of these rails had lap-joints, and others butt-joints; two different forms of chairs being used to suit the different joints. The gauge of the line was 4 ft. 6 in.

Short sidings, and other portions not subjected to much wear, were laid in granite stones, averaging four feet long by one foot broad. These stones were arranged differently to those used at Heytor. The wheels ran on them precisely as on the iron rails, the inner edges of the granite being dressed to take them, and the outer portion of the stone being rough-picked to below the level of the dressed portion, forming in fact a granite in place of an iron rail.

The points and crossings were made in cast-iron, and the one feature noticeable is that the crossings had a movable tongue 1 ft. 5 in. long, similar to the points.

[2] With reference to these cast-iron edge-rails, I may mention as a curious fact, that in excavating in the fourth cylinder for the new Laira Bridge, on the Plymouth and Dartmoor Extension Railway, one of these rails was brought up from the bed of the Laira. The depth to which it had sunk below the surface of the mud could not be ascertained; but owing to the hard layer of clay and stones which Mr. Rendel placed over that portion of the river, it was probably lying very near the surface.

As the old rails wore out, and when the manufacture and use of rolled-iron rails became more general, these took the place of the old cast-iron edge-rail. They were used in lengths of from ten to eighteen feet, and being all flat-footed, were not secured to the stones by chairs, but were spiked down. The joints between two rails were made with a clasp, which gripped the flanges of both, the whole being usually secured to a stone. The rails were spiked to the same stones to which the original chairs had been fastened. Besides these, other stones were packed under the rails so as to, as far as possible, ensure a continuous solid bed. The rolled-rails were of various patterns; the four more especially used, shown in the diagram, being:—

1. An ordinary bridge rail weighing 45 lb. per yard. 2. A solid rail of similar form weighing 60 lb. per yard. 3. A Vignoles flange rail weighing 53¼ lb. per yard. 4. A similar but smaller rail weighing 38⅔ lb. per yard.

The traffic over this line gradually decreased until 1880, when the portion between Princetown and the "Rock" was reconstructed for locomotive purposes, and a connection effected with the Great Western Railway at Yelverton.

The alterations were completed, and the railway opened, in August, 1883, the permanent way being the standard Great Western (narrow-gauge), of which a sketch is given for comparison with its predecessors.

REDRUTH AND CHACEWATER RAILWAY.

In 1824 the Redruth and Chacewater Railway Company was incorporated for making and maintaining a railway or tramroad from Redruth to Point Quay, with several branches therefrom; and also for restoring, improving, and maintaining the navigation of Restronguet Creek. The length of the main line was nine and a-quarter miles, and there were four branches, amounting together to about five miles. The capital was £22,500. This line was at one time laid with Barlow rails. A portion is now part of the West Cornwall line, the remainder is worked by a locomotive.

BODMIN AND WADEBRIDGE RAILWAY.

The Bodmin and Wadebridge Railway was first authorized by Act, dated 1832. It was the first line in the West on which steam-power was used, and was opened in 1834. The total length

is 14 m. 5 fur. 6 ch. In 1835 an amended Act was obtained; and in 1865 an Act for carrying out certain improvements, and among them apparently the substitution of heavier rails for those then existing. Very amusing stories are told of the harmless dangers and difficulties attendant on travelling by this, the third steam railway in the kingdom. (Some of these were narrated by the lecturer.)

The earliest permanent way consisted of wrought-iron rails of uniform single-headed section, weighing 37 lbs. per yard, and laid in chairs set on granite blocks placed 3 ft. 6 in., centre to centre. These granite blocks averaged 1 ft. 8 in. by 1 ft. 6 in. by 1 ft. deep, and the bed of the cast-iron chair measured 4 in. by 8 in. The rails were secured in the chairs by iron keys.

About 1864 these rails were partially replaced by others, weighing 56 lbs. per yard. The old permanent way was replaced in 1878–1879 by flanged Vignoles rails laid on wooden cross-sleepers, to which they were attached partly by spikes, and in parts by bolts and washers. Five miles of the way are now being taken up and relaid with the South-Western standard rails, and certain of the curves of somewhat small radius are being altered to meet modern requirements. Works are also in progress for connecting this portion with the new branch line to Bodmin from Bodmin Road, and thus with the Cornwall main line. The passenger traffic only ceased on October 30th, 1886, and the goods traffic continued up to September, 1887.

The earlier locomotives have for many years since been old iron; but a tender belonging, I believe, to the first locomotive, the *Camel*, is still to be seen at Wadebridge. A lithograph, published on the occasion of the opening of the railway on September 30th, 1834, shows the *Camel* with a train attached, containing 400 passengers. The same Roger Hopkins who was engineer to the Princetown railway seems, with his son, to have designed and superintended the Wadebridge line.

For some of my information concerning this railway I am indebted to Mr. Kidd, of Wadebridge, who very kindly answered my enquiries by giving me all the information in his power.

WEST CORNWALL RAILWAY.

The West Cornwall Railway, from Redruth to Hayle, was opened in 1835, and was worked by steam-power.

A railway from Hayle to Tresavean Mine was authorized in 1834, and powers of alteration given in 1836. This railway was at first worked by horse-power, but subsequently connected with the West Cornwall line under an Act of 1850.

THE TREFFRY RAILWAY.

Mr. J. T. Treffry, the proprietor of the port of Par, which port owed its existence to his enterprise, and who was also chief owner of the Fowey Consols and other mines in the district, formed a project to develop the resources of the neighbouring country by means of a tramway across Cornwall, from his port of Par on the south coast to his port of Newquay on the north. This railway was intended to open up the china-clay district, and to serve the granite quarries at Luxulyan, beside connecting the two coasts.

It is carried across the Rock Valley on the Treffry Viaduct, the foundation-stone of which was laid in March, 1839, and weighed ten tons. The viaduct was a little more than three years in building, the whole of this work being carried out by and at the sole expense of Mr. Treffry. The structure was made to serve the twofold purpose of a viaduct and an aqueduct. It consists of ten arches, each of 40 feet span, springing from piers 28 feet by 10 ft. 6 in. at the base. It is 650 feet in length, and 98 feet in height, and contains 200,000 cubic feet of granite. This is the oldest viaduct in the West of England now existing, and is at present utilised by the Cornwall Minerals Railway, which is formed on the basis of the original line.

With this we may be said to have reached the last of the early western railways, and to have traced the evolution of the permanent way down to modern times.

Since 1836 the principles of construction have remained practically the same, though the details have been subject to constant improvement. I have shown on the diagram the forms of rails in use in 1838, and on the other side of the sheet the result of fifty years' progress—whether the next fifty years will show an equal advance is open to great doubt; but let us hope that at least the shareholder in a modern railway may obtain a better return on his money than did his predecessors of half a century ago. They paid dearly for the experience which is ours to-day.

DESCRIPTION OF DIAGRAM.

This Diagram has been reduced by photography from the original, exhibited at the lecture, in which all the rail sections, with one exception, were drawn to their full size ; by this means accuracy has been ensured.

Morwellham sections, left-hand top corner. The section on the left represents the rail now on the ground, and shews the method adopted for fastening to the chair by means of an iron key. The right-hand section has no claims to absolute accuracy, and is merely diagrammatic, intended to give some idea of the probable form of the earliest rail used on the incline.

Wadebridge.—The first section on the left is that of the earliest form of rail used on this line, weight 37 lbs. per yard. The section to the right is that of the last rail of 1864, weight 56 lbs. per yard. The section in the centre is a Vignoles steel rail, weight 68 lbs. per yard, now replaced by South Western Railway standard-way.

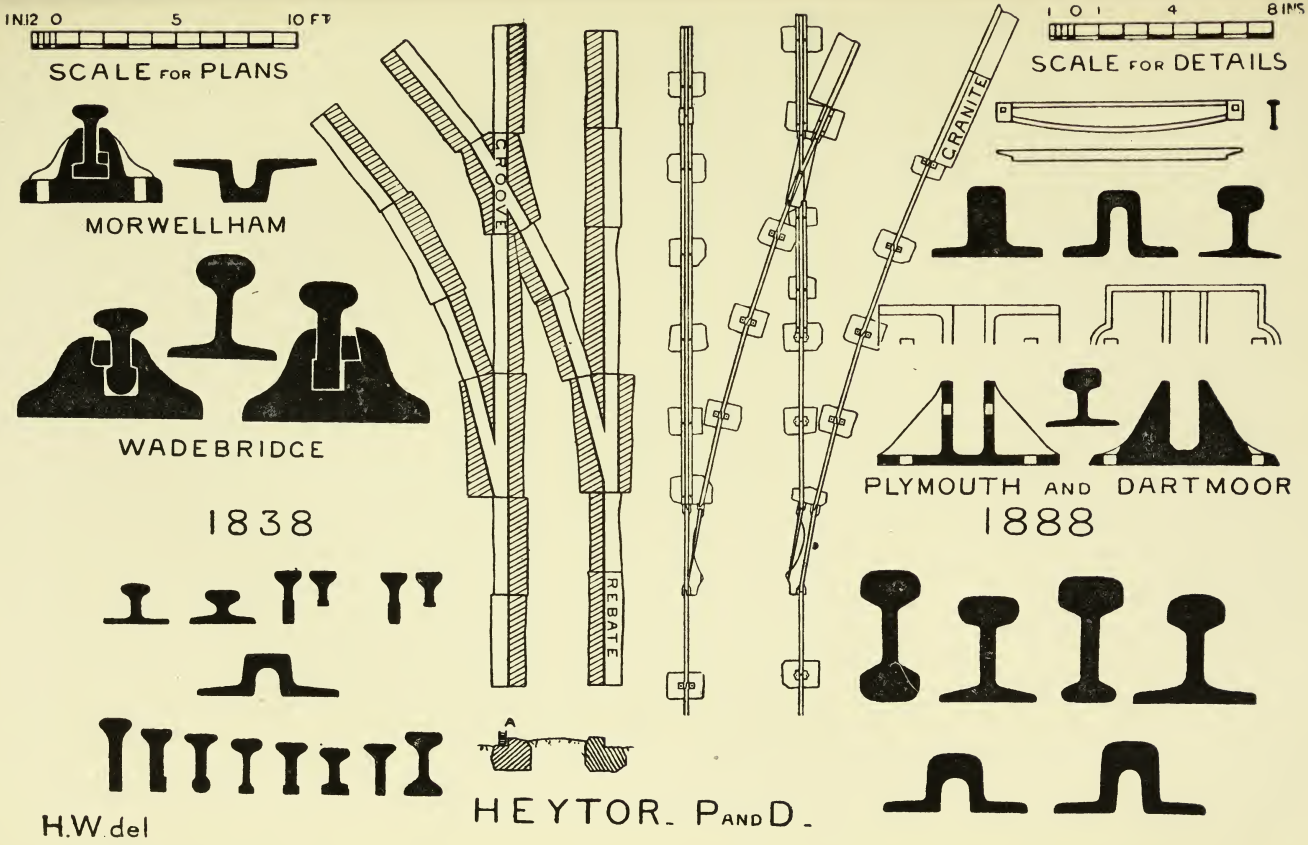
1838.—This portion of the diagram has been taken from Weale's *Public Works of Great Britain*, published in 1838. The first section in the top row on the left hand is that of the rail then in use on the *Manchester and Bolton* Railway ; the next to the right was in use on the *Croydon* Railway ; the next two were both used on the *Stanhope* Railway ; and the next two on the *Darlington*. The rail in the centre between the two rows was that in use on the *Great Western ;* and in the lower row running from left to right the rail sections are those of the following railways : *Whitby and Pickering, Greenwich, Clarence, Leeds and Selby, Manchester and Liverpool, Dublin and Kingstown, Newton and Warrington, London and Birmingham.*

1888.—Immediately opposite these, to the right, are figured some of the forms of rail now in use (1888), drawn to the same scale and in the following order : Left-hand top corner, *Princetown Railway*, 80 lbs. per yard ; *Pennsylvania U.S. Railroad; Bodmin Railway*, 75 lbs. per yard ; and *Bristol and Exeter*, 74 lbs. per yard. Below these, the first section on the left is an intermediate *Great Western*, between that of 1838 and that of 1888, weighing 40 lbs. per yard. The adjoining section represents the modern *Great Western Railway* rail, weighing 68 lbs. per yard.

Plymouth and Dartmoor.—Commencing in the right-hand top corner of the diagram, the first detail given is a plan with elevation and section of the original cast-iron edge-rail, four feet long and six inches deep in the centre. This is the only section of rail on the diagram to which the Scale for Details in the right-hand top corner does not apply. Working downwards from left to right, the next sections in order are those of a rolled iron rail, weighing 60 lbs. per yard ; ditto weighing 45 lbs. per yard ; ditto weighing 53·25 lbs. per yard. A smaller one in the centre, between two sections of chairs, is also a rolled iron rail, weighing 38⅔ lbs. per yard.

Of the two chairs, of which sections and half plans are given, that to the left weighed 10 lbs., and was used for edge-rails with lap-joints ; that to the right weighed 13 lbs., and was used for another pattern of edge-rail with butt-joints.

In the centre of the diagram are two plans, the scale for which is in the left-hand corner. All that need be said with regard to the Heytor plan is that the hatched portion is meant to represent the raised half of the stone, and the plain portion the rebate, in which the wheels ran as indicated at A on the section. The plan of the Plymouth and Dartmoor Railway explains itself ; running off to the right at the top of the diagram is shewn the commencement of a granite siding.



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