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# The Listowel & Ballybunion Railway. Some revisions and additions to its story

BY D. GORDON TUCKER

The approximately-10-mile-long Listowel & Ballybunion Railway in the south-west of Ireland, which ran from 1888 to 1924, has always attracted interest because of its peculiar construction. There have been numerous publications on the subject, and I shall be referring to many of them; but they contain many contradictions and errors, and it is my hope that I can put the record right and expand it in many respects without introducing fresh errors.

The line was built on the so-called Lartigue monorail system, in which the rolling stock straddled the single running rail, being built like panniers on a pack-horse – each vehicle of double construction, one narrow half on each side of the track. It is certain that Lartigue (Christian names: Charles François Marie Thérèse) did not invent the 'straddle' monorail system; however, his antecedents and rivals will not be discussed here as they will be dealt with in another paper.[1] His patent of 1882[2] showed a true monorail, the single rail being supported some distance above the ground on a light triangular trestle; there were no stabilizing rails, although the wheel-frames of the vehicles could have stabilizing rollers which ran on the web of the carrying rail. Even these were dispensed with in Lartigue's early practical applications.[3,4] The system was intended for light temporary goods lines. Figure 1 shows the system; it is taken from the 1882 patent. The vehicles in this drawing are pannier frameworks on which containers or bundles may be laid. The L&BR, however, had a stabilizing rail along each side of the braced A-frames on which the running rail was supported, and although claimed to be much cheaper than a conventional narrow-gauge light railway, was a permanent installation of much more substantial construction than any previous Lartigue lines. Indeed, Lartigue did not patent the new rail system (i.e. the 3-rail system) until 1886[5] and had apparently had no practical experience of it except on short exhibition lines before making the plan to build the L&BR of about 10 miles in length. So the L&BR was certainly a remarkable undertaking.



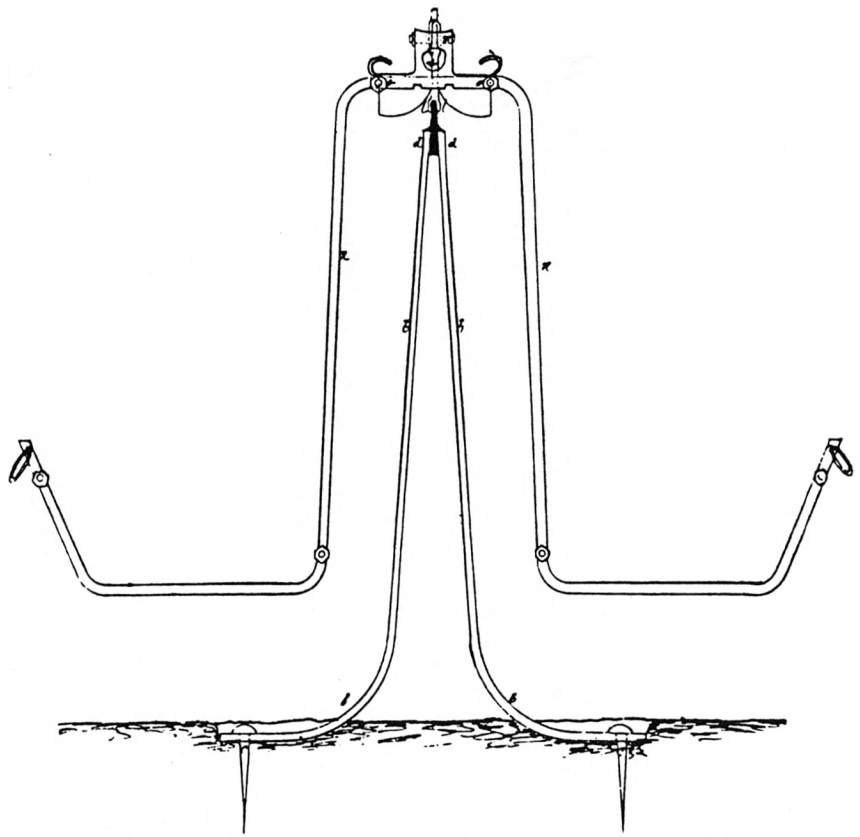

*Fig. 1 Lartigue's Monorail System as shewn in his Patent of 1882*

The system used on the L&BR is shown most clearly by the transverse cross-sectional diagram in Figure 2, which is taken from Lartigue's 1886 patent. W is a wheel with double flanges running on the single rail R, which is supported on the A-frame or trestle S. G, G are the guide rails on which the rollers B, B run. The vehicle (in this case a coach) is in two sections C, C. The central girder structure which joins the two parts of the vehicle to the wheels contains springs to smooth the motion of the coach bodies, and, if desired, the rollers B, B may have sprung bearings in order to maintain a sprung pressure of the guide rails.

Of the various published accounts of the L&BR the most important and most nearly definitive is that by Newham.[6] It is with the greatest respect that I offer some small but interesting corrections to his account, together with some amplification and some new material. Of the new material, the most significant by far are the two reports dated 2 March 1888 and 31 December 1888 made by Major General Hutchinson, Inspecting Officer of the Board of Trade,[7] which are so interesting that they are reproduced as Appendix 1 to this article. Newham mentions 'the inspection', but had evidently not seen the reports, nor realised that there had been two inspections. The system of Lartigue companies was also more complex than Newham indicates.

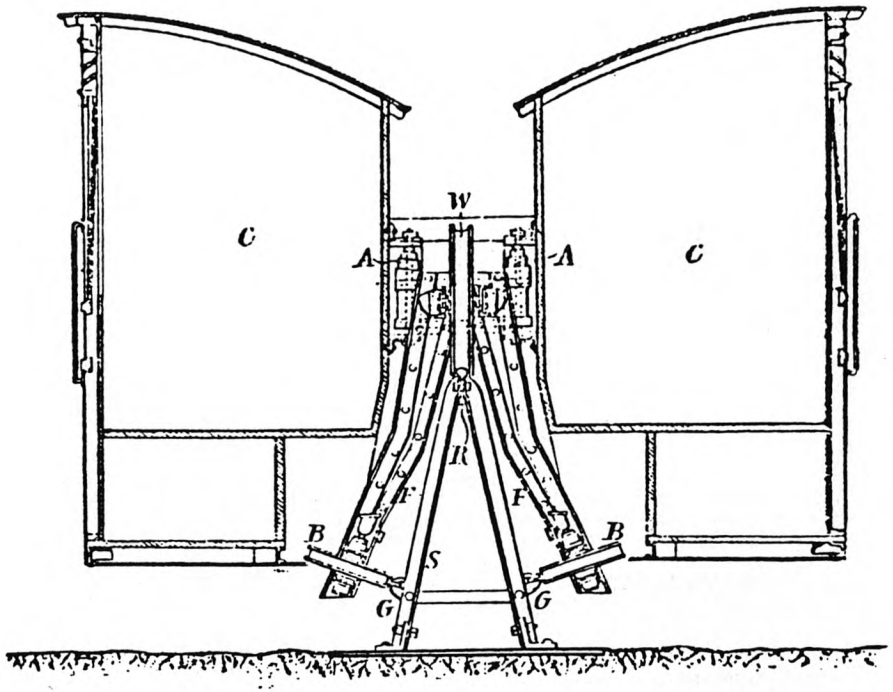


*Fig. 2 Transverse cross-section of track and double carriage as shewn in Lartigue's Patent of 1886 and as used on the Listowel and Ballybunion Railway*

The first British Lartigue company was the Lartigue Railway Co. Ltd,[8] registered on 2 December 1885, shortly after notice was given of the intention to introduce at Bill in Parliament for the railway between Listowel and Ballybunion on the Lartigue system. It was this company which set out the demonstration tracks and train at Tothill Fields, Westminster,[9] in September 1886, and it was its locomotive with two small vertical boilers (one on each side of the track) which was, after the Westminster demonstration, used in the construction of the L&BR in Ireland. Newham illustrates its surviving owner's plate (L.R.C.LD. MALLET'S PATENT LOCOMOTIVE NO. 1) without explaining what L.R.C.Ld. stood for. The association with the great French locomotive engineer Anatole Mallet is interesting; his name is well-known for the introduction of compound working to locomotives in 1876 and for the introduction of the single-bogie type of articulated locomotive on ordinary railways in 1887. The Mallet's Patent referred to on the plate is dated 1886,[10] and is devoted to the design of locomotives for Lartigue-type track; it includes compound working (which was not adopted on the demonstration locomotive nor on the L&BR) and various forms of articulated drive, one of which – the powered tender or coupled vehicle – was adopted on all these locomotives. It is interesting that the powered-front-bogie form of articulated drive, which by application to massive American locomotives made Mallet almost a household name, was also described in this patent in its application to the Lartigue system. It seems possible that it was Mallet's work for Lartigue that, while not particularly successful in itself, nevertheless paved the way for his subsequent success with articulated locomotives.



The leading technical and managerial figure in the LR Co. was Fritz Bernhard Behr, who was also Managing Director of the L&BR and later the promoter of the high-speed electric Lartigue system; he was an experienced railway engineer. It must have been his drive, rather than Lartigue's, which got the work proceeded with. The LR Co. was only a small one, however, with only £2,000 capital, formed primarily to acquire patents, and it was wound up voluntarily at the end of 1886 after the Westminster demonstrations, although not dissolved until 20 March 1906. It was bought by a new company, The Lartigue Railway Construction Co. Ltd[11] which was registered on 4 November 1886, and of which Behr was Managing Director. This company was much larger, as was necessary to cope with the construction of the L&BR, having an authorised capital of £200,000; but much of this was issued as paid-up shares to the various inventors and others who had agreements with the previous company, and insufficient fresh money was received. At the Extraordinary General Meeting of 29 August 1890 it was found desirable to reconstruct the company and it was decided to wind it up voluntarily. (It was not formally dissolved until 10 July 1906.)

The new, reconstructed Lartigue Railway Construction Co. Ltd was registered on 26 August 1890;[12] again Behr was the leading figure. Authorised capital was £125,000, and by 30 November 1892 about three-quarters of this had been raised in cash. However, on 8 June 1896 it was reported to the High Court that the company could not meet its debt to the Thames Iron Works & Shipbuilding Co. Ltd, and the court ordered it to be wound up. It was formally dissolved on 21 June 1907. Its dealings with the Thames Iron W&S Co. related to Behr's experimental high-speed electric Lartigue line and had nothing to do with the L&BR.

The Listowel & Ballybunion Railway Bill[13] passed its Second Reading on 22 March 1886 (not 2 April as stated by Newham) and received the Royal Assent on 16 April 1886. The L&BR Company had been incorporated on that day, and again Behr was Managing Director. I have not been able to investigate how its capital was subscribed, and Newham does not discuss it. Day and Wilson[14] state that the 'Lartigue Co.' put up the whole of the capital, but the official company records do not indicate that it had the necessary amount of available money to do this before 1890. Mackay,[15] writing in 1896, stated that 'the line was opened in 1888 with a capital of £11,000 5 per cent debenture stock, and £22,000 ordinary stock. Last year the line paid the interest on the debenture stock, and earned ½ per cent on the ordinary stock.' He also stated that the cost of construction was £3,666 per mile including rolling stock, which conflicts with the 'under £3000 per mile including rolling stock' stated both by the Inspecting Officer and by Newham. Newham stated that the LRC Co. had undertaken to construct the railway for the capital authorised by Parliament, namely £33,000, and if in fact Mackay was right about the actual cost (3,666 x 10, say about £37,000) this might help to account for some of the Construction Co.'s financial troubles.

The railway, as completed, was described by the Inspecting Officer of the Board of Trade in his report of 2 March 1888 (see Appendix 1). Newham was wrong in saying that he advised the fitting of Westinghouse brakes; such brakes were already fitted, and indeed had been fitted to the demonstration train at Westminster in 1886. Perhaps the misunderstanding arose because on the second inspection much later in the year it was found that the Westinghouse brakes had been removed when the carriages had been converted from 3-wheeled to double-bogie form, and the Inspecting Officer advised their restoration.

It is interesting that the vehicles had originally been 3-wheeled, as this is not mentioned in previous publications. However, Lartigue's patent of 1886[16]

describes his proposed carriages as 3-wheeled, the centre wheel being 'a broad drum' to allow for the passage of sharp curves. Nevertheless, difficulty had been found in getting the 3-wheeled vehicles round sharp curves. According to the Inspecting Officer's report of 2 March 1888 the sharpest curve was of 7 chains radius, and this would have given little trouble; assuming the fixed wheelbase of the vehicles was about 9 feet, this would have given a lateral displacement at the centre wheel of only about one-quarter of an inch, and assuming that the wheels were about 2-foot diameter, the angular error on the outer wheels would have been only 0.5° giving a misalignment of only plus-or-minus one-tenth of an inch for the double-flanged wheels to cope with.

It is clear from the report of 31 December 1888 that the difficulty arose on the points and sidings. The 'sharpest curve' of 7 chains (462 ft) radius must have referred only to the main line of the railway. On the points (the design of which is discussed below) the radius was stated in an article to be only 98 ft.[17] This really would have given trouble with the 3-wheeled vehicles: a lateral displacement at the centre wheel of nearly 1¼ inches, and an angular error on the outer wheels of about 2½° giving a misalignment of plus-or-minus half-an-inch for the double flanges to cope with. The fitting of the coaches with bogies would still leave the 3-wheeled locomotives in trouble, although their short wheelbase of 5 ft 8 in. and extra tread width on the centre wheel (2½ in. as against the 1½ in. on the outer wheels) would reduce the difficulty. (The makers' drawings – Hunslet Engine Co., order No. 9900 – confirm the figure of 5 ft 8 in.; this was the figure given by Benedict[18] and Sekon[19] although Newham said 8 ft 10 in. The figure of 2½ in. tread on the centre wheel is a correction, based on the makers' drawings, of the 2 in. given by Newham. Mallet's patent, on which the design of the locomotives was largely based, made provision for sharp curves by giving a design for a sort of spherical bearing on the outer wheels, enabling them to swivel and slide laterally whilst still being driven by coupling rods on cranks outside the frames; however, this system was not applied to the L&BR locomotives.)

Junction points for this unusual track clearly had to be of a very different design from those on ordinary railways. A turntable principle was used, but curiously this has usually been quite incorrectly described, even in the contemporary article in *The Engineer* (ref. 17) which has probably been the cause of some writers, even G. A. Sekon (ref. 19), saying that trains had to be uncoupled and vehicles turned individually in order to get them on to sidings. Even Newham's diagram is wrong in respect of the actual geometry, although not in the principle of operation. The correct kind of arrangement, along with some other schemes which were not adopted, is described in the patent specification[20] although the design requirements are not given, and in the event it was a simpler arrangement than that patented which was actually adopted. In Appendix 2 I have set out my understanding of the principles, and it will be seen that the arrangement gives true switched junctions. That the method of working there specified is the correct one is confirmed by a ciné film dating from c.1920 which is now owned by the Revd E. Boston of Cadeby in Leicestershire, and which he was kind enough to show me. However, if the curvature of the track is to be limited, the diameter of the turntable must be large and the cost therefore very large. If the curvature had to be improved from the actual radius of 98 ft to the 7 chains mentioned by the Inspecting Officer, the diameter of the turntable would have to be increased from its actual value of about 25 ft to about 53 ft – no doubt more than quadrupling the cost.

There are some surprising minor discrepancies between Newham's account and the Inspecting Officer's reports. The former does not mention the two-span river bridge and lists only two overbridges instead of five. It is hard to believe that the Inspecting Officer could have been wrong in this matter so closely



related to his inspecting responsibility. There is also a difference regarding the level crossings; Newham says there were 11, the Inspecting Officer says 26. (Examination of the 25-inch OS maps of 1898 (Sheet Nos. KERRY 4/11, 4/12, 5/13, 5/14, 10/7, 10/8, and 10/12) confirm the five overbridges but indicate only 19 'Level Crossings' by the use of those words. It is possible, however, that there were other level crossings not so labelled where minor paths crossed the track, and it is also possible that some were abandoned between the opening of the railway and the survey for the map in 1897.) There is a further discrepancy in the accounts of the way the two types of crossing were used. The Inspecting Officer is clear that the pivoted section of track was used at three public road crossings and three out of the 23 accommodation crossings. The bascule-type of flap, used to form a roadway *over* the rail, is used at the other 20 accommodation crossings. This agrees with the description (with drawings) published at the time (ref. 17), but is completely contrary to the statement made by Sekon (ref. 19) and by Day and Wilson (ref. 14); and Newham's account seems rather unclear.

There is a curious uncertainty over the number of passengers which could be carried in each coach; *The Engineer* of 1888 and Newham agree on 20 to 24 (for first and third class respectively), the Inspecting Officer says 36, and Mackay (ref. 15) compromises with 28. As each half of a coach was about 16 ft long by 3 ft 5 in. wide, the lowest figures certainly seem the most likely, and the evident error on the part of the Inspecting Officer is hard to explain.

An uncertainty over the numbers and types of vehicles is even more remarkable. The Inspecting Officer does not go into this matter, and Newham is very vague. *The Engineer* in 1888, Goodman in 1900,[21] and Sekon (ref. 19) 1924 give a detailed listing, as follows:–

| | *The Engineer* | *Goodman and Sekon* |
|---|---|---|
| First-class passenger coach | 3 | 1 |
| Third-class passenger coach | 4 | 7 |
| Guard's van/3rd-class composite | 2 | 4 'composites' |
| Horse-box/3rd-class composite | 1 | 2 'brake vans' |
| Covered goods | 2 | |
| Cattle trucks | 2 | 4 'goods wagons' |
| Open goods | 2 | |
| Step wagons | 2 | – |
| Sand wagons | 20 | 20 |
| Total | 38 | 38 |

A curious feature of Sekon's article is that he makes no mention of the step wagons, . . . yet includes a photograph of one marshalled into a passenger train. (The steps, forming a double staircase providing a means for passengers to cross from one side of the line to the other, were essential on this system.) It is likely that *The Engineer* had the correct information, although it is quite possible that some alterations were made after opening. For instance, it would have been quite simple to convert two first-class coaches to third class.

The Inspecting Officer's reports do not mention the motion of the train, but there are conflicting statements in published work. Newham quotes Fayle as mentioning that 'there was an uneasy pitching . . . . ', but in another article (ref. 18) it is claimed that 'the running is smooth but noisy . . . There is little oscillation, the guide rollers being pressed against the rails by strong spiral springs . . . '. This matter was evidently important in view of Behr's proposal to use the Lartigue system for a high-speed railway. Indeed, Behr's demonstration of an electric train travelling on a sharply-curved Lartigue track at three times the maximum speed of the L&BR (i.e. at perhaps 75 miles an hour) in 1897 showed that lateral

stability could be attained.[22] Yet during the proceedings of the Select Committee of the House of Commons which, in July 1901, was considering the application for a Bill for the Liverpool-Manchester electric high-speed monorail line, W. P. O'Neill, chief engineer of the MGW Railway of Ireland, said he visited the L&BR in 1898 and 'the oscillation and noise in the cars was enormous'.[23] He also added that 'the main difficulty was due to the subsidence of the permanent way', a matter that otherwise seems to have escaped record.

As a final point, a discrepancy between the station track layouts as given by Newham and as given on the 25-inch OS maps surveyed in 1897 should be noted. Newham shows an extra junction-point at both Listowel and Ballybunion, but these could be later additions or the OS could be wrong. But he also shows the line to the beach at Ballybunion on the east of the line to the locomotive turntable, whereas the OS shows it on the other side between the turntable line and the loco-shed, leaving Ballybunion in quite a different direction. In this case, it is hard to believe the OS is wrong

## APPENDIX 1

### LISTOWEL & BALLYBUNION RAILWAY

**Inspecting Officer's Report,** 2 March 1888

Sir, I have the honor to report for the information of the Board of Trade that in compliance with the instructions contained in your minute of the 25th January I have inspected the Listowel and Ballybunion Railway.

The railway which is a single line of 1 mile [a curious clerical error for 10 mile?] in length has been constructed on the Lartigue monorail system. It is the first railway of the kind which has been constructed in the UK, though it has been used on the Continent for the transport of mineral traffic.

The permanent way consists of a double-headed steel rail weighing .... per yard fished at the joints and riveted to the tops of the legged steel trestles. The trestles are placed at .... intervals of about 3.25 ft, are generally 3.25 feet high (though on one part of the line they are higher for a short distance) and are riveted to transverse steel sleepers 3.25 ft in length, the steel sleeper being again fastened to rectangular transverse wooden sleepers 6 ft by 6 in by 2 in where the ground is soft longitudinal sleepers being employed on bogs. The ballast is of gravel.

Longitudinal guide rails are riveted at each side of each trestle at about 2.25 feet below rail level. The steepest gradient has an inclination of 1 in 50 and the sharpest curve a radius of 7 chains. The vertical limits of deviation in several cases and the horizontal limits in one case have been departed from without any objection having been raised by the owner or occupier.

The works are very light comprising

(1) 5 overbridges widest span 17 feet constructed with stone abutments and rolled steel beams with ..... between them.



(2) river bridge with 2 spans of 34 ft each the abutments and pier being of masonry and the top trussed timber beams.

(3) 15 culverts widest span 11 feet constructed in masonry and concrete with timber ..... or flagged.

These works appear to have been substantially constructed and to be standing well. The girders have sufficient theoretical strength and those under the line showed moderate deflection under test.

There are three authorised level crossings of public roads provided with proper gates ..... and 23 occupation crossings.

These crossings have been the cause of considerable difficulty owing to the level of the rail being 3¼ ft above the ground. In the case of the public road crossings and 3 of the occupation crossings the rail has been cut and the cut portion revolves on a pivot the joints of the cut being securely locked when the line is unbroken and signals being exhibited before the line is broken. In the other 20 occupation crossings revolving flaps are provided on each side of the rail secured to upright frames connected by a wooded beam at the top. In their normal positions these flaps stand in a vertical position and act as gates the chain by which they are worked being locked by a key in possession of the recognised crossing user. When the crossing is to be used the chains are unlocked and the flaps (which are hinged at the bottom) revolve until they rest on brackets attached to the rail, a signal fastened to the crosshead being put to danger directly the flaps begin to move.

The fencing is of post and wire.

A portion of the line is through bog which appears to have been successfully treated.

The stations are at Listowel (adjoining the Listowel station of the Kerry Railway), Lisselton and Ballybunion where the necessary accommodation is provided and at Listowel and Ballybunion means of turning the engines. Lisselton is not for the present to be used as a passing place. The siding junctions are made on much the same principle as the arrangements at those level crossings where the rails are cut.

The rolling stock consists of engines and tenders 1st and 3rd class carriages, brake van cattle and horse trucks goods wagons and sand wagons. The engines have three coupled wheels and two horizontal boilers one on each side of the rail. The tenders have two coupled wheels which by an arrangement for turning steam into a special cylinder can be used for haulage on steep inclines. The weight of the engines is 6½ tons and of the tenders 4½ tons. The carriages will accommodate 36 passengers and weigh about 3 tons each.

The rolling stock is all carried like the panniers on an ass's back the main wheels running along the raised rail with guide wheels on each side near the bottom running along the guide rails to check oscillation.

The whole of the rolling stock (except the sand wagons) is fitted with the Westinghouse automatic brake.

The line is well finished and the only requirements I observed are as follows

1. Mileposts are required and gradient boards for the more important gradients.
2. A handrail and platform should be provided at the river bridge.
3. The signals at the occupation crossings should be made larger.
4. At the public road level crossings and at the siding junctions at Listowel, Lisselton and Ballybunion the first operation connected with breaking the main line should put a signal to danger.

5. The sides of the abutments of the overbridges at 4½ and 8½ miles require turning off.
6. No unnecessary time should be lost in erecting a footbridge for communicating between platforms at the Old Listowel station.

I enclose a satisfactory undertaking as to the mode of working the line.

Looking to the nature and novelty of the arrangements the speed should be restricted to a maximum of 15 miles an hour and to 5 miles an hour at the public road level crossings and siding junctions until the additional precautions of requirements No. 4 have been carried out. Considering also the novelty of the arrangements an inspection of the line should I think be made about 6 months hence in order that an opportunity may be afforded of seeing what alterations or improvements (if any) may be required.

Subject to the above requirements of the completion of which the Board of Trade should be informed so that an inspection may be ordered undertaking and conditions I can see no reason why the Listowel and Ballybunion Railway should not be opened for passenger traffic.

I am informed that the whole cost of the line and rolling stock will not exceed £3000 a mile.

I have &c. .... Hutchinson, Major General R.E.

**Further Report**, 31 December 1888

Sir, I have the honor to report for the information of the Board of Trade that, in compliance with the instructions contained in your Minute of the 25th August last, I have reinspected the Listowel and Ballybunion Railway.

I made the reinspection some time ago, but waited to hear from the General Manager – which I have only just done – as to the completion of certain requirements before sending in my report.

The requirements noted in the inspection report of the 2nd March last have now been complied with, and I found that the line was in good order and working satisfactorily so far as passenger traffic was concerned; as regards goods traffic, I was informed that this had not yet been much developed.

The great source of danger on the line will always be the occupation level crossings and the utmost care and attention will be required in keeping the machinery connected with them in good working order and in seeing that the chains securing the flaps are kept duly locked by the users of the crossings.

It was found necessary (in order to facilitate the getting round sharp siding curves) to alter the whole of the carriages and to substitute bogie wheels at each end for the three wheels which had been first provided. In doing this the Westinghouse Automatic brake has been removed from the carriage wheels, and this should in my opinion be restored with the least practicable delay as the power of the driver to be able to stop the trains with the utmost possible rapidity is an essential element in the safe working of the line.



Subject to the remarks as to the occupation crossings and carriage brakes, I can recommend the Board of Trade to confirm their sanction for the use of the Listowel and Ballybunion Railway for passenger traffic.

I have, etc. .... Hutchinson, Major General R.E.

(Note: where a series of dots .... has been inserted in the above transcriptions, it indicates either that a blank occurred in the original or that the work was illegible. The manuscript available at the Public Record Office is a chemical copy of the original letter, and is not always easy to read.)

## APPENDIX 2

### THE JUNCTION-POINTS

The design of points adopted on the L&BR was that based on a turntable carrying a curved section of track, as shown in Fig. 3. By use of a shunting spur it could cope with a more complex junction or system of sidings, but the simple junction shown adequately demonstrates the principles. One line meets the turntable radially at A; the requirement is to connect it at choice to one or other of the two lines meeting the turntable radially at B and C. This is done by swinging the turntable on its axis at O either into the position shown or round into position shown by the dotted line. The minimum spacing between B and C is dictated by the width of the vehicles or loading gauge g. At a first approximation the minimum value of this spacing ($g_1$) may be taken as equal to g. The diameter of the turntable, d (=2r), dictates the angle $\theta$ (measured in radians); to a first approximation $\theta = g/2r$. The radius of curvature (R) of the track on the turntable is also dictated by the geometry already defined, for to a first approximation we also have $2r/R = \theta$. Thus approximately

$$2r/R = g/2r$$

giving $R = 4r^2/g$ if the size of the turntable is given, or $d\ (=2r) = \sqrt{(Rg)}$ if the radius of curvature is given. These are rough formulae, but adequate to show the order of dimensions.

If this design basis gives too expensive a turntable, the size may be cut by reducing the requirement for $g_1$ to equal or exceed g – i.e. by specifying that trains may not stand close to the turntable on both lines at once. Obviously, however, the vehicles on one line must clear the *track* of the other, so that $g_1$ cannot be reduced below about 2g/3. With this provision the formula for the minimum diameter of turntable become $d = \sqrt{(2Rg/3)}$.

It was stated in contemporary accounts that the radius of curvature of the track on the points was about 98 ft – say approximately 100 ft. The width of the widest vehicle was about 9 ft. Thus by our first formula the diameter of the turntable should have been $\sqrt{900} = 30$ ft. By our second formula, the absolute minimum diameter was $\sqrt{600}$ or about 25 ft. The diameter stated by *The Engineer* was 'about 25 ft'; so clearly the L&BR had adopted the minimum-cost specification. It is apparent from the photographs available that the spacing between lines at the turntables was less than the vehicle-width.

REFERENCES

1 D. G. Tucker, 'The Lartigue monorail: country crawler to electric express', *Trans. Newcomen Soc., 55,* 1983–4
2 French Patent No. 149301 of 31 May 1882; British Patent No. 2764 of 12 June 1882. Two later patents of addition were attached to the French patent, both in the name of Henri Carpentier, who was clearly an associate of Lartigue's.
3 *Mem. et C.R. de la Soc. des Ingénieurs civils* (Paris), 1884 (2nd vol.), pp. 16–25
4 'Single-rail railway', *Scientific American Supplement, 17,* 1884, pp. 6695–6
5 Brit. Pat. No. 7809 of 10 June 1886. I have been unable to trace any earlier French patent for this design of track.
6 A. T. Newham, *The Listowel and Ballybunnion Railway,* Oakwood Press, Lingfield, 1967
7 Public Record Office(PRO), MT29/49
8 PRO BT31/3567/21855.
9 'The Lartigue Railway', *The Engineer, 62,* 1886, pp. 223 & 225
10 As far as Britain was concerned, the patent referred to on the plate must have been Brit. Pat. No. 7810 of 10 June 1886.
11 PRO BT31/3753/23402
12 PRO BT31/4863/32287
13 *Journal of the House of Commons, 141*
14 J. R. Day and B. G. Wilson, *Unusual Railways,* Muller, London, 1957
15 J. C. Mackay, *Light Railways,* Crosby Lockwood, London, 1896, pp. 104–5
16 Brit. Pat. No. 7809 of 10 June 1886
17 'Listowel and Ballybunion Railway, County Kerry, Ireland', *The Engineer, 65,* 1888, pp. 174–6
18 'The mono-rail or elevated single-rail railway', *The Indian Engineer,* Special Supplement to Vol. 20, 2 June 1894; author believed to be E. Benedict
19 G. A. Sekon, 'The Listowel and Ballybunion Railway', *Railway Magazine, 55,* 1924, pp. 353–9
20 Brit. Pat. No. 7809 of 10 June 1886. Newham appears to be in error in attributing the invention to Behr, for the patent clearly states that Lartigue was the originator, Behr merely filing the British patent on his behalf. The simplified scheme used on the L&BR was patented in France (Brevet No. 189911 of 12 April 1888) by Lartigue after the opening of the L&BR.
21 F. Goodman, 'The Listowel and Ballybunion Railway', *Railway Magazine, 7,* 1900, pp. 163–8
22 *Engineering, 64,* 1897, pp. 40–41; *Electrical Engineer, 20,* 1897, pp. 262–4
23 *Electrician, 47,* 1901, pp. 534–5

Other works which are useful, particularly for photographs:–

(a) 'Listowel & Ballybunnion Railway', *Journal of the Irish Railway Record Society, 4,* 1956, pp. 19–23, 111, and 134–6
(b) H. Fayle, *The Narrow Gauge Railways of Ireland,* Greenlake Publications Ltd., London, 1946: Chaper 2, pp. 69–73 with photographs on pp. 56, 61, 62. (Note that Fayle states that 'the carriages . . . . were all suspended on two axles', but this can at no time have been correct.)
(c) A. Garner, 'Listowel and Ballybunion Railway', *Narrow Gauge,* No. 50, March 1969, pp. 2–4 plus 3 photographs and 3 pages accurate drawings of locomotive



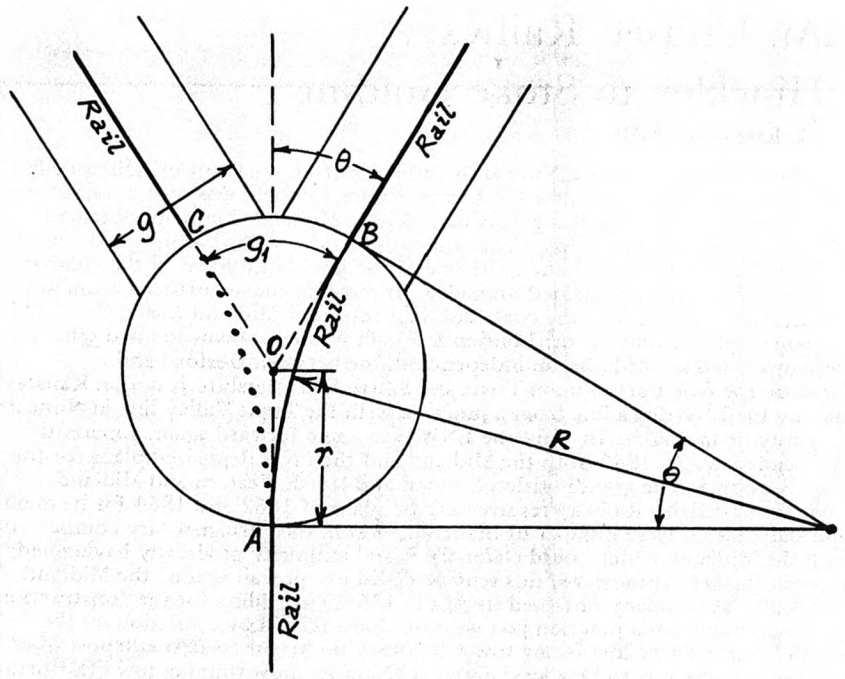


*Fig. 3 Diagram to illustrate the principle of the junction points and to serve the calculation in Appendix 2*

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I would like to acknowledge the use I have made of the facilities, and the help given by the staff, of the Public Record Office, the Science Museum Library, and the Library of the University of Birmingham. I am very grateful to Mr David Tew, the Revd Edwin Boston, and Mr Donald Boreham for taking a lot of trouble to supply me with information and for giving me photographs and documents from their own collections. Their help has been indispensable.

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'A passenger by the South Eastern Company's line at Rochester has just been sentenced at Quarter Sessions to one month's imprisonment, and two weeks' solitary confinement for 'stealing a railway ticket'.'

(*Worcester Herald* 26 Nov 1853) (*From Ronald Thomas*)