(No. 66.)

1871.

TASMANIA.

LEGISLATIVE COUNCIL.

RAILWAY GAUGES:

CORRESPONDENCE.

Return to an Order dated December 20, 1871. (*Mr. Fysh.*)

Laid upon the Table by Mr. Wilson, and ordered by the Council to be printed, December 20, 1871.

Hobart Town, 13*th December*, 1871.

SIR,

I HAVE the honor to place in your hands two papers, prepared at my instance by Mr. Jetter, Locomotive Engineer to the Launceston and Western Railway Company, which may prove useful both to the Government and to Parliament.

The first paper discusses the question of the cost of converting the Launceston and Western Railway from the broad to the narrow gauge; and the second, the 3 feet 6 inch gauge with special reference to Rolling Stock.

I need not say that on either question I have no opinions to intimate; my sole object is, to place the views of Mr. Jetter before the Government as those of a gentleman of undoubted professional attainments and high personal character. An accompanying communication from Mr. Fitzgibbon, late Engineer-in-Chief of the Queensland Railways, certifies to Mr. Jetter's practical experience.

I have the honor to be,
Your obedient Servant,
FRED. M. INNES.

The Hon. the Colonial Secretary.

(Copy.)

The Rookery, Great Stanmore, Middlesex,
15*th February*, 1871.

MY DEAR SIR,

PERMIT me, though somewhat late in the day, to correct an omission of mine in not having furnished you with a record of the great pleasure which our connection on the Southern and Western Railway of Queensland gave me, during the three and a half years of our being together on that Line.

I would avail myself of this opportunity to testify to my thorough appreciation of the very able manner in which you performed your duties of Locomotive Superintendent upon the Railway in question; and to declare that I have never met a man more suited in *every way* for filling a similar position, whether as regards perfect knowledge, practically and theoretically, of your profession, industry, perseverance, perfect reliability, or ability of controlling and directing workmen efficiently and economically.

I only regret that our association together extended over so short a period; sufficient, nevertheless to confirm you in my esteem and regard.

I am, dear Sir,
Faithfully yours,
A. FITZGIBBON, *M. Inst. C.E.*
Late Engineer-in-Chief of Queensland Railways.

J. F. L. JETTER, *Esq.*

Launceston and Western Railway,
Launceston, 27th October, 1871.

Sir,

In accordance with your request I have the honor to hand you, enclosed, an Estimate of the cost of converting the Launceston and Western Railway from the broad to the narrow Gauge.

The first requisite is to provide suitable narrow-gauge rolling stock in readiness for working the traffic so soon as the proposed conversion is to be carried out.

There are two methods that suggest themselves; the first, that of removing one line of rails only, the sleepers and remaining line of rails being undisturbed in their present position, except so far as the adjustment of points and crossings and station arrangements are concerned.

The second is to move each line of rails ten and a half inches closer together, also without disturbing the sleepers more than absolutely necessary. The latter involves much more work than the former, but would without doubt be the most complete method.

Fang bolts having been used in the construction of this Line, the work would be more tedious than similar operations in America where only dog spikes are generally used; these can be drawn without much difficulty, whereas many of the fang bolts break off at the head or are difficult to unscrew.

If it was decided to move both line of rails, I should recommend the following course to be adopted:—

That the sleepers be uncovered so as to expose their upper face, and temporary spikes driven to mark the exact narrower gauge on each side; every preparation having been carefully made beforehand for the alteration of the points and crossings, a set of tie rods being provided for each to suit the altered gauge, so that the platelayers should have little to do but to take up each line of rails and spike them again in their new position; some rails on the curves would no doubt have to be cut, and the holes for fishbolts readjusted, but there would be no difficulty in this work with a proper supply of good tools.

On the present bridges, with the exception of Longford iron girder bridge and four flood openings of more recent construction, the rails are carried on cross sleepers, (5 inches thick by 9 inches wide, spaced 2 feet 6 inches centre to centre,) over longitudinals placed directly above the piles; with the greatly reduced maximum weights adopted on the narrower gauge, viz. 5½ instead of 12½ tons on a pair of engine wheels, there would be no risk in moving the rails inwards 10½ inches on either side.

If a large number of skilled platelayers could be obtained here as in some other places the work might perhaps be completed in a single day, but such expedition would scarcely be possible in Tasmania. The safest mode would be to complete the work in lengths of ten to twenty miles commencing at Deloraine, a certain portion of the new rolling stock having been previously transported to that station to work the traffic between that point and the break of gauge—in this way and with ordinary energy the work might be completed in a week.

The platforms and floors of the goods sheds would have to be lowered throughout the Line; this would be accomplished before the change of gauge was commenced. The lowering of platforms at stations would involve a step between the buildings and platforms.

It would be necessary to decide whether conical or cylindrical tires were to be used on this Railway, as well as on the Main Line, in order that both might be uniform.

The sum of £24,040 has been expended in rolling stock on this Line, including payments to Messrs. Waugh and Lockie, agency, carriage, &c.

For the same sum improved narrow gauge stock, equal as to number of vehicles, may be provided specially adapted to traverse curves of short radius, that they may be also available for the Main Line, including ten composite carriages to seat more than one hundred passengers beyond the accommodation afforded in the present vehicles; and twenty-four covered goods waggons in lieu of an equal number of open waggons.

Four locomotives are not sufficient to depend upon in case of emergency, or even to work the traffic and ballasting in addition; nor do ten carriages meet the requirements of holidays, &c.; any supply in excess of that at present existing on the Line would therefore be additional to this estimate.

All the rolling stock except the carriages may be made with advantage in the Colony, the ironwork being imported from England; the dead weight as compared to paying load being greatly reduced, *i.e.*, that each waggon should carry at least twice its own weight, with equal safety to the heavier stock used on the broad gauge.

It is difficult to make any but an approximate estimate of the sum that the present rolling stock would realise if sold; there is however little doubt that our present locomotives are better suited to the heavy traffic of the Victorian lines than most of their engines. A large sacrifice must however in any case be expected.

A carriage shed would be required for the erection of the new rolling stock, and additional siding accommodation; these charges should not be fairly debited to cost of conversion as they ought to form part of the equipment of the Line.

I have the honor to be,
Sir,
Your most obedient Servant,
J. F. L. JETTER.

The Hon. F. M. Innes, *M.L.C.*, *Hobart Town.*

LAUNCESTON AND WESTERN RAILWAY.

ESTIMATE of Cost of converting the Gauge to that of 3 *feet* 6 *inches.*

	£	s.	d.
New rolling stock, say	24,000	0	0
Alteration of gauge, one length of rails only being moved, at 6*d.* per yard	1980	0	0
Ditto, if both rails are moved, additional	1000	0	0
Alteration of platforms and goods sheds, including extra material	640	0	0
Contingencies	60	0	0
	£27,680	0	0
Cr. by sale of present stock, say	10,000	0	0
Cost of Conversion	£17,680	0	0

THE 3 FEET 6 INCH GAUGE; WITH SPECIAL REFERENCE TO ROLLING STOCK FOR TRAVERSING SHARP CURVES AND HEAVY GRADIENTS.

BY J. F. L. Jetter, *B. A.*, *Locomotive Engineer; late Locomotive Superintendent, Southern and Western Railway of Queensland. October*, 1871.

On the 3 Feet 6 Inch Gauge.

The merits of the Narrow Gauge system having been tested for a number of years by the satisfactory working of Railways on the 3 feet 6 inch and even narrower gauges, and being now not matters of theory but the result of actual experience, it is not intended in the present paper to enter into a comparison of narrow with broader gauges, but to give some account of the working of the 3 feet 6-inch gauge in Queensland during the last six years, with special reference to rolling stock suited for traversing sharp curves and heavy gradients.

The Southern and Western Railway of Queensland was surveyed and constructed under the able superintendence of A. Fitzgibbon, Esq., M.I.C.E., Sir Charles Fox and Son acting as Agents to the Government, and supplying the plant, rolling stock, &c.

Before referring to the rolling stock used on this Railway, some description of the Line itself will be appropriate.

The first section of the Line, 21 miles in length, from Ipswich, the present terminus, to Grandchester, passes through a country presenting no serious engineering difficulties; at the latter station commences the ascent of the little "Liverpool Range," to an elevation of 300 feet above the adjoining plain; the steepest gradient is one in fifty, and there is a tunnel of twenty-seven chains at the summit, preceded by another of seven chains in length. The Range is crossed in a distance of seven miles, the greater portion being a succession of curves of from five to twenty chains radius, necessitated by the broken nature of the country.

From the western slope of the Liverpool Range the Line passes through an easy country as far as the forty-ninth mile; some rock cuttings and iron girder bridges occur, but no work of any magnitude until the foot of the Range is reached at the 59th mile; the ascent of the Main Range commences at this point.

* The length of the Main Range incline is 15 miles 69 chains, in which there is a rise of 1196 feet with an average gradient of one foot in seventy.

* Note.—The description of the Main Range was furnished by Mr. R. D. Stephens, C.E., Resident Engineer during the construction of that section of the Southern and Western Railway.

On the incline only 3 miles 48 chains are straight, and there are 127 curves, of which 45 are of five chains radius; the total length of the 1 in 50 gradient is 4 miles 14 chains, on which however no sharper curves than six chains were admitted.

The section of the Line on the Range presents a series of short, abrupt, and often precipitous spans that have to be crossed; on such sidelong ground as generally prevails embankments would be impossible; consequently out of the fifteen miles, sixty-five chains, or nearly two-thirds of the Line, are in cutting; only about a quarter of the length is in embankment, the remaining one-twelfth being made up of either tunnels or bridges.

There are 153 cuttings, the greatest depth being 57 feet, the greatest length 28 chains, and the greatest height of bank 43 feet; there are 46 bridges, or an average of about three to the mile, but on one distance of three quarters of a mile there are eight of them.

The longest bridge is 535 feet in length; the greatest height of rail above the surface of the ground, 73 feet.

The total length of bridging is 5136 feet, or very nearly a mile; and there are also 175 culverts; on the incline there are nine tunnels, the longest being 8¼ chains, and the shortest 3 chains in length; the total length of tunnels is rather more than half a mile.

All the tunnels on the Main Range are lined with brick or stonework.

From the summit of the Range there is a slight descent of three miles into Toowoomba, from whence the Line continues across the Darling Downs to Dalby, a total distance of 130 miles.

The Warwick Branch of 60 miles joins the Main Line seven miles beyond Toowoomba, passing through some of the finest pastoral and agricultural land in the Colony.

The rails used on the Queensland Railways are flat bottomed, weighing 40 lbs. to the yard, secured with "Adam's" patent fish-plate brackets, fastened down to the sleepers with dog spikes, and to the joint sleepers with fang bolts; the present Engineers however consider fang bolts unnecessary and now use plain round spikes ⅝ in. diameter, which can be drawn in repairing the road, whereas the fang bolts generally break off when an attempt is made to remove them; with softwood sleepers they would no doubt make the most secure fastening, but with Colonial hardwood they are unnecessary as well as expensive.

The sleepers are of hardwood, 6 ft. 6 in. by 10 in. by 5 in.; on the Main Range they are spaced 2 ft. 6 in. centre to centre, on other portions of the Line 3 ft. centre to centre; the former arrangement, with light rails, makes much the better road.

The ballast is all composed of broken stone, and is laid to a width of 9 feet 6 inches, and to a depth of eight inches under the sleepers; the road is firm and remarkably free from dust.

The ballast and boxing averages about one and one-fifth cubic yards per yard forward.

The ordinary cuttings have been executed to a formation width of 15 feet, rock cuttings 13 feet, and embankments 13 feet.

The bridges are constructed chiefly of timber; some of the larger spans have iron superstructures with timber piers.

The cost of constructing this Line, over average country, has been from £6000 to £7000 per mile, including stations and rolling stock; while for difficult country, entailing many tunnels and other heavy works, the cost has amounted to between £13,000 and £14,000 per mile; it should however be borne in mind, that at the time most of the contracts were let wages and materials were very high.

The tires of the Queensland rolling stock are turned parallel on the tread, and the rails are placed vertically upon the sleepers, in accordance with the views of Sir Charles Fox; the result has been a remarkable steadiness in the running of engines and rolling stock. With special trains a speed has been attained of 38 miles per hour on straight parts of the Line, without any perceptible oscillation; those who have been accustomed to travel on locomotives elsewhere at a speed of 30 to 40 miles per hour have remarked the exceptional steadiness of the Queensland engines.

The following letter on this subject was sent to the *Times* by Sir Charles Fox, September 9th, 1869:—

"The oscillation of Railway Trains, more especially at high velocities, producing what is ordinarily called 'gauge concussion,' is a very serious source of wear to the permanent way and rolling stock of Railways, and, as a consequence, of great expense, to say nothing of the discomfort it occasions to passengers; and is, in my opinion, caused in a very great measure by the use of wheels the tires of which are portions of cones instead of cylinders.

It is well known to Engineers that the tires of Railway wheels are generally coned to an inclination of one in twenty. It is considered that these were first introduced by Mr. George Stephenson in the expectation of facilitating the passage of vehicles round curves by their adapting themselves through their various diameters to the different lengths of the two rails on which they were running.

This however is not the case in practice, as any one will find upon carefully investigating the matter; inasmuch as in a vehicle passing round a curve, the flange of the off fore wheel will be found close up to the outer rail, while that of the aft near wheel will be found running with its flange close up to the inner one, so that no benefit whatever accrues from the use of the cone, even in going round curves.

The question of passing with steadiness over straight lines seems to have been altogether overlooked in the introduction of coned wheels; for it will be obvious that with the inch 'play' allowed between the tires and the rails, unless one half of such play be constantly preserved on each side of the way, two wheels staked upon the same axle will be running upon different diameters, and consequently a struggle arises which cannot fail to result in oscillation, inasmuch as the moment one of the flanges touches a rail, that wheel, becoming larger than the opposite one, turns it off from the rail only to make the opposite one perform in its turn the same operation, when serious oscillation is the result.

As I have already stated, no advantage is found to arise in the use of conical wheels in passing round curves, and as much evil results therefrom on straight lines, I have constructed upwards of 250 miles of Railway abroad in the rolling stock of which I have departed from the usual form of wheel, and have used only cylindrical ones, and have, as I expected, been gratified with the satisfactory reports I have received of the steadiness of trains supplied with them.

Now that Main Line Companies are running their express trains at such high velocities, this oscillation is becoming a very serious matter, not only as a question of safety, but also one of great discomfort to the passenger, to say nothing of the enormous cost occasioned by this destructive action.

I would therefore venture to recommend that, should any one desire to test the correctness of the principles here stated, he should select a carriage known to be most subject to oscillation, and place under it four cylindrical instead of conical wheels, and let this carriage run in an express train, care being taken to avoid the oscillation of the two adjoining carriages with conical wheels being communicated to it, which would be effected by the introduction of two coupling links, say 10 feet long, instead of the shorter ones in general use, and he will at once perceive the advantage of using cylindrical wheels.

I have a form of tire which I find to answer the purpose very well, a section of which I should be happy to send to any one who may think it worth while to ask for it."

Whilst fully endorsing these views as correct, and confirmed by practice on the 3 feet 6 inch gauge, it is necessary to pay attention to certain details in laying the permanent way, without which the advantages of the system above described will not be attained.

Considerable wear was observed on the Queensland lines both in the rails laid on the sharpest curves, and in the leading wheels of the engines that traversed them: the writer's opinion is, that the rails were spiked too tight to gauge on these curves, the actual clearance allowed was ¼in.; and from subsequent examination of other curves of similar radius where more clearance was allowed, there is no doubt that the wear and tear may be greatly reduced without affecting the safety or steadiness of trains, by allowing the rails laid on five chain curves from 5-16 in. to ½ in. clearance above the ordinary gauge for the straight road.

Two Railways may be referred to where this practice has been carried out with advantage.

On the Santander and Ala del Rey Railway, North Spain, gauge 5 feet 9 inches, the sharpest curves, of from six to eight chains radius, were spiked from ⅝ in. to ¾ in. wide to gauge. The Engineers of this Line made many experiments with a trolly constructed with the same wheel base as the rolling stock intended to travel upon it, in order to determine the proper clearance to be allowed on the curves.

On the Pampeluna and Saragossa Line the clearance is half an inch on the 10 chain curves, and a less proportion for other curves of greater radius.

With these precautions and a proper adaptation of the rolling stock for traversing the curves adopted on Narrow Gauge Lines, I am satisfied that increased safety and steadiness of running is attained by discarding the coned tires, and the greater the speed the more is this evident.

On Lines where coned wheels are used the custom is to keep the rails tight rather than slack to gauge to prevent oscillation in the rolling stock; but this is effected at the expense of rails and tires wherever sharp curves occur.

The locomotives used on the Queensland Railways are of 15, 16, and 20 tons weight in working order; the dimensions of the last mentioned are given below, as well suited for the 3 feet 6 inch gauge and capable of working heavy trains; it has been adopted on the Narrow Gauge Lines in Canada, and has been recommended by Messrs. Mais and Patterson in their reports to the South Australian Government for the heavy traffic on the proposed Narrow Gauge Lines in that Colony.

The following are the general dimensions:—Outside cylinders, 11 in. diameter, 18 in. stroke; boiler 9 ft. 3 7-16 in. long by 3 ft. 3¼ in. outside diameter; 116 brass tubes, 1¾ in. outside diameter.

Heating surface in firebox, 109 superficial feet.
Ditto in tubes, 491 ditto.

Total ditto........... 600 ditto.

Working pressure 120 lbs. to the square inch.
Leading wheels 2 ft. diameter on single Bissell bogy.
Six wheels, coupled, 3 ft. 3 in. diameter—no flange on centre pair.

Rigid wheel base 7 ft. 2 in.
Total ditto, 10 ft. 9 in.
Height from rail level to top of boiler 6 ft. $8\frac{1}{2}$ in.
Length of buffers over all, 20 ft.
Total weight of engine, in steam, 20 tons—distributed over eight wheels.
Greatest weight on any single wheel, 2 tons 15 cwt.
Tender, on four wheels 2 ft. diameter, to contain 500 gallons of water and proportionate fuel, sufficient for a run of 30 miles on ordinary gradients.
Wheel base 4 ft. 6 in.
Ditto of engine and tender 22 ft. 6 in.
Break on all wheels of tender.
Length of engine and tender over buffers, 31 ft. 6 in.
Weight of tender loaded, 7 tons 10 cwt.

This engine will take a gross load of 70 tons up a continuous gradient of one in fifty, or 160 tons up a gradient of one in one hundred, keeping up full pressure of steam; will traverse curves of five chains radius with ease; has a very low centre of gravity, and runs with remarkable steadiness.

They required less repairs than any others used in Queensland; the first one put together ran constantly for seventeen months without any repairs.

I consider the two-wheeled Bissell bogy far superior to the four-wheeled Bissell or other four-wheeled bogies, for the following reasons:—It works radially from a fixed centre after the fashion of a pendulum, and although it has more transverse travel, thereby giving freedom in passing curves, it is quite free from the sudden jerks to which four-wheeled bogies are liable; it is placed well forward under the smoke box so as to carry but a small portion of the weight available for traction, and leads the driving wheels round the curves so smoothly that the wear of all the tires is equalised; a most important point with reference to repairs, for an engine with the leading wheels coupled, working on a Line with sharp curves, always wears the flanges of the leading tires first, and as soon as the leading tires are worn the whole of the coupled wheels must be turned up, although the driving and trailing wheels may be uninjured, thereby causing a serious waste in the tires.

In working traffic over the Main Range, a pilot engine is employed between Toowoomba and the foot of the Range, and the trains when too heavy are divided. Formerly the plan was adopted of attaching two locomotives to a single train, but from motives of precaution it was considered preferable to run two engines separately, many of the curves in the cuttings being so sharp that the driver cannot see the end of his train.

It was proposed by Sir Charles Fox that this incline should be worked by Fairlie's engines, and three were supplied for that purpose, at a cost of £9000; but they proved a failure, partly through bad workmanship and defective design—for which faults Mr. Fairlie states that he was not responsible, being absent from England whilst they were constructed.

The engines already adopted have however proved so economical, not only in first cost but in working, that I do not think they are ever likely to be superseded by double engines; and it appears more economical to run an extra engine of light weight to assist, if necessary, on an incline like the Main Range, than to work a heavier engine over the whole Line, on most parts of which it would be consuming fuel in moving itself and taking only half its full load.

Tank engines cannot be made so convenient either for working or repairs as tender engines, nor are they as well suited for long journeys, not carrying sufficient water and fuel without being cumbrous, and the working parts cannot be so easy of access.

It is worthy of note that tank engines are not used on the principal English or American Railways, except for short journeys, and shunting, or for working heavy gradients.

The engine above described has lately been constructed with 12 in. instead of 11 in. cylinders, increasing its tractive power without adding to the weight, and the tender increased to a capacity for 650 gallons of water.

The carriages adopted on the Southern and Western Railway are from 30 to 32 feet in length. Three systems have been tested to enable them to traverse curves of five chains radius: the first description have a four-wheeled bogy at each end, on the American plan; the second, a plain pair of wheels under the centre of the body, the wheels at each end being furnished with Adam's radial boxes; and the third are fitted with Clark's radial system, a most ingenious and complete plan for causing the axles to become radial to the curves they traverse.

The axles at either end of the carriage are free to take the motion of the front wheels in an ordinary road vehicle, but the axle boxes are connected with those of the centre pair of wheels by tie rods with knuckle joints; the centre pair of wheels have a transverse sliding motion under the frame, amounting to about six inches at most; the effect in traversing a curve is the same as if the wheels were attached to a flexible frame following the form of the curve, and the friction between tire flange and rail is reduced to a minimum.

I have examined these tires after running constantly over sharp curves for many months, and could not detect any wear in the flanges.

The Manager of the Coquimbo Railway in Chili, where this system has been adopted, some of the curves being as sharp as one chain or 66 feet radius, writes :—

"I cannot speak too highly of the result of the new arrangement of wheels to the carriages; in the trial in question it was admirable. The carriages which have been altered are those which formerly had the two-wheeled bogies; they were so unsteady and jolted so much I had to take them off the road; they are now perfectly easy, and at 35 miles per hour, (a high speed for us), there was no motion apparent; the same remark applies to the new waggons. On our return journey we brought with us two of the old and one of the new waggons; the oscillation of the former was so great that had they not been loaded I think they would have gone off the Line, while with the latter there was no oscillation.

There is no doubt that in running qualities this arrangement is a great success."

The following are the general dimensions of a Composite Carriage :—

	ft.	*in.*
Distance between centre of buffers	4	3
Height of centre of buffer above rail	2	6
Centre to centre of journals	5	0
Extreme width over steps	8	1½
Extreme width of body	6	6
Diameter of wheels	2	0
Height from floor to underside of roof	6	1
Total outside height above rail	9	5½
Length of body	32	0
Length over buffers	35	0
Height of doors	5	5½

Contain two first-class and four second-class compartments, and will seat 16 first-class and 32 second-class passengers.

Dimensions of Passenger Break Van :—

	ft.	*in.*
Length of body	20	0
Ditto, over buffers	23	0
Width of body outside	6	6
Height of floor from underside of roof	5	7
Total height of van above rail level	10	2½

Six wheels, 2 ft. diameter; those at each end fitted with Adam's radial boxes.

Fitted with double breaks—to act on the wheels of the van and carriages, together or separately, at pleasure.

Communication cord between guard and driver, striking a gong fixed on the tender.

These break vans are neatly constructed of teak, with double roofs, and projecting side lights to enable the guard to see along *each side of the train.*

The axle boxes are arranged for lubrication with oil below the journal, the box being oil tight and excluding dust or grit from the journals.

The vehicles do not require to be examined oftener than once in two weeks, and the brasses wear much longer for being thoroughly lubricated.

The goods waggons have a uniform outside width of 6 ft. 6 in., the ordinary length being 14 feet. Some trucks have been made 20 feet long, on six wheels, with radial motion; these carry twenty-eight bales of undumped wool.

The whole of the rolling stock is provided with solid wrought iron buffers, worked by transverse springs, and having a play of eight inches; these are light in comparison to their strength and very durable, but more costly than other kinds.

Central buffers and drawbars combined have been in use for some time, and are said to work well; it is however not easy to obtain with them equal elasticity against shocks, nor to couple the vehicles together so tightly or securely; a pin dropped through a link entering each buffer head doing duty for screw coupling.

The frames of all the imported stock are of angle iron, but hardwood has been used in a number of waggons built in the Railway shops at Ipswich.

All the tires are of the best cast steel.

Rolling stock has lately been constructed for the Novgorod and Tchudowa Railway, 3 ft. 6 in. gauge, embodying several improvements in the direction of increased carrying capacity and decreased dead weight.

The whole of the waggon stock is 17 ft. 9 in. in length, and 7 ft. 3 in. in width; the covered waggons have a height of 7 feet from floor to inside of roof, and are constructed to carry six tons, although weighing only 2 tons 13 cwt.

The low-sided goods waggons are 2 ft. 6 in. from floor to top of sides, also carry six tons, and only weigh 2 tons 4 cwt.

Much yet remains to be done in reducing the dead weight of rolling stock, and in construction improved by using the best materials of lighter sections.

It should also be borne in mind that on Colonial Railways, where the speed of travelling is considerably less than in England, and the rolling stock is not knocked about by shunting long trains of loaded waggons, often performed during the night, the same strength is not absolutely necessary.

In making rolling stock for new Lines on the 3 ft. 6 in. gauge, I should recommend wrought iron wheels 2 ft. 6 in. diameter, with rim, spokes, and nave forged solid, and cast steel tires to be used.

The axles should in preference be of steel, otherwise of the best faggotted scrap iron.

The axle boxes should be in one casting, made oil tight by a leather collar fitting on the axle, and the brass lined with white metal, or of Parsons' white brass, lubricated by brush from below the journal.

Too much care cannot be bestowed upon the wheels, axles, and axleboxes, upon which the durability of the rolling stock mainly depends.

It would be easy to refer to many serious accidents that have occurred through defective tires; out of several hundreds I never met but with one broken steel tire, and that was from an inferior maker and honeycombed in the casting.

Considerable prejudice exists against continuous breaks applied to the carriage as well as the break-van wheels.

Clark's continuous breaks have been used for the last six years on the Qeensland Railways, and have been found of the greatest assistance, especially in cases of emergency; enabling a train to pull up in a distance of one hundred yards, if necessary. The fifteen miles descent of the Main Range could not be worked without them.

Great improvements have been made in these appliances of late; one of the best forms is that patented by Mr. William Naylor, described in *Engineering*, February 3, 1871.

This break is applied by slackening a 3-16 in. chain, which is kept taut by a simple contrivance in the van, but should a coupling give way or a carriage become detached, it is self-acting.

"Le Chatelier's" break, now well known, is an admirable contrivance for working with the counter-pressure steam, enabling the driver to reverse his engine without injury to the working parts. This apparatus, which is quite as simple as the steam blower, should be fitted to every locomotive.

I will conclude with an extract from a paper on the 3 ft. 6 in. gauge by Mr. Carl. Pihl, Chief Engineer of the Norwegian Government Railways, to the Editor of *Engineering*:—

"With regard to the information received from, and opinions formed on the Queensland Railway, it is not for me to make any remark, except when they affect the system and are at variance with facts gained by experience; my intentions are not, however, to enter into any polemical discussion, as the 4 ft. 8½ in. as well as the 3 ft. 6 in. gauge systems have been in operation here for many years.

There is no doubt or uncertainty with us about the question at issue; and I will, therefore, merely give facts and results as supplementary to the information you are already in possession of from Queensland, and which may be of interest to those who wish to investigate the subject.

When it is said that the adoption of the Narrow Gauge has been enforced by the necessity for sharp curves, the conjecture is not quite in accordance with the facts of the case here, as we have hitherto been able to avoid curves of less than 11 chains. With us it has been a question of providing a railway communication at a comparatively small cost in a country of large extent, with little traffic and limited resources; and although the greater facility of traversing sharp curves is a decided and no unimportant advantage to be gained by the use of the small gauge, this consideration has not enforced its adoption here. It has been in this case the choice between a cheap and efficient railway or none.

With what success these Lines have been carried out we shall see. I will now give the cost of three separate Railways which I built at the same time, under equal circumstances, and with the same view to economy and efficiency. The one Line, the Kongsvinger Line, of 4 ft. 8½ in. gauge, with a length of fifty-six miles, has cost £6350 per mile, including stations and rolling stock, but no workshops; the Hamar-Elverum Line, of 3 ft. 6 in. gauge, and twenty-four miles only, has cost £3142 per mile, including stations, rolling stock, and small workshops; the third Line, the Trondjem-Storen Railway, also of the 3 ft. 6 in. gauge, and thirty-one and a half miles long, has cost £5300, including everything. At the present time there are fifty-six miles more (the Dramman-Randsfjord Railway of the same narrow gauge) under construction, the half of which is temporarily opened for traffic. This Line is calculated at £4563 per mile, and for this sum I have no doubt it will be completed.

On the two last-named Lines the works are comparatively very heavy, the country which we have had to go through has been difficult to deal with, and necessitated many extensive works, such as cuttings, (to a great extent in hard rock), frequent bridges and viaducts, some of timber and some of iron, several exceeding 70 feet in height and of considerable length.

Besides these, there are extensive and comparatively costly stone works along the declivities by the side of the rivers and hills.

The regular trains are run here at 14 miles an hour, including stoppages, or 16 to 20 miles between stations; the very same speed at which the mixed trains run on the 4 ft. 8½ in. gauge here.

As to the safety of fast running, engines and carriages appear to run as safely and steadily at 30 miles an hour on the 3 ft. 6 in. gauge as they do on one of 4 ft. 8½ in.; and I have run the very engine illustrated in your journal of the 21st December last, (1866), at upwards of 40 miles an hour, with as much feeling of ease and security as I have felt when running any engine on a broader gauge.

The engines, as well as the rest of the rolling stock, are constructed with an angle of stability fully as great as in rolling stock for an ordinary gauge; this, with a sufficient minimum load on the axle, being the principal condition for stability, leaves the gauge as a factor of practically small importance in limiting the speed.

The working stock, when substantially and judiciously constructed, is as durable in one case as in the other.

In stating these facts it is not my intention to advocate as high a speed on these Lines, with light engines of only 3 ft. to 3 ft. 9 in. driving wheels, as on Lines of a broader gauge; they are not designed for high speed, but to suit circumstances where this is of a secondary consideration."

JAMES BARNARD,
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