and taking them out of winding, cost, taking into account the tools employed, 4*d.* each rail, of which the contractors for rails paid 2½*d.*, and the cost of the rails and sleepers as laid down stands thus :—

	£.	*s.*	*d.*
Two 15-feet rails delivered in Dublin, weighing rather more than one-third of a ton, at 7*l.* 5*s.* 6*d.* =	2	13	4
Carriage of two rails to the works, average . . =	0	1	0
Straightening two rails . . . . . =	0	0	3
Two chairs and spikes for two rails 81½ lbs., or say, including waste, ¾ of a cwt. at 14*s.* . . . . =	0	10	6
Total cost of iron to lay two rails . . . . . =	3	5	1
One joint sleeper . . . . . =	0	7	8
Five intermediate sleepers at 4*s.* . . . . . =	1	0	0
Carriage from the stores on the works to where laid : all materials included . . . . . =	0	1	9
Laying the way, 5 yards at 8*d.* . . . . . =	0	3	4
Preparing sleepers, including piling . . . . =	0	0	9
Total cost of one pair of rails laid . . . . . =	4	18	7
Multiply for a double line by .			2
Total cost of two pair of rails laid . . . . . =	9	17	2
Multiply for one mile by . . .			352
Total cost per mile, for a double line	£3470	2	8

When the great weight and consequent durability of the rail is considered, the above is certainly a low cost per mile of the upper works of a passenger railway. The expense of laying the rails on the Drogheda line cost the Company rather more on the whole than 8*d.* per lineal yard, because on account of the novelty of the system the chief engineer desired the rails to be carefully laid, under the Company's own superintendents, who have always higher wages to pay than contractors, but the author was able to get a considerable length laid at the rate of 8*d.* per yard, even at the high wages, when the men were closely looked after.

The paper is illustrated by one drawing, No. 3796, showing the rails, sleepers, and spikes in detail, and the method of cutting the sleepers.

Mr. C. May rose, with great hesitation, to make a few observations upon the system of rails and sleepers which had been described; but, in doing this, he disclaimed any intention of applying any remarks personally to Sir John Macneill, whom it was sufficient to know, to acquire the same esteem for personally, as there must exist respect for his talents. Besides, he looked upon the discussions at

the Institution as offering opportunities for the candid expression of opinions, which could not, perhaps, be otherwise uttered without a risk of giving offence.

He could not accord with the author of the paper in styling the system of permanent way, on the Dublin and Drogheda railway, an improvement upon the ordinary mode; on the contrary, he thought that it was rather a retrograde movement. It was generally received as a fact, that the bridge-shaped rail, as compared with the double T-shaped rail, was considerably weaker, for the same amount of iron; and, speaking from memory, he believed it was in the ratio of 5 to 7: it became, therefore, necessary, with transverse sleepers, to use a rail of the weight of 83 lbs. per yard, whereas, if the double T-shaped rail had been adopted, as much strength would have been obtained with 70 lbs. per yard. Here was a difference of 13 lbs. per yard of wrought iron, which would purchase 20 lbs. of cast iron, which was exactly the weight of an intermediate chair; and the rolled plate, with the spikes and screws, would pay for the extra weight of the joint chair and the fastenings; so that no economy of material was effected. He could not approve of the fastenings; they were like all iron pins, liable to be loosened by the vibration. This had been found on the Great Western railway, where the pins and triangular spiked plates were adopted, after it was found that the coach-screws, used for fastening down the rails, would not retain their hold of the wood from their losing their thread.

With regard to the machinery for planing the seats for the rails on the sleepers, it was nearly identical with that which Mr. May had proposed to Sir John Macneill for preparing the seats for the chairs. There could not be a doubt of its efficiency or its economy.

Major-General Pasley had seen the machinery and examined the line. He thought, that the machine must induce greater accuracy than usual, in laying the permanent way, and that it ought to be more economical than when the sleepers were prepared by hand. In spite of the objections that had been raised, his confidence in the general system was not shaken, as certainly, there were few lines upon which the motion of the carriages was so smooth as on the Dublin and Drogheda railway. Still, perhaps, opinions should be suspended until it was seen whether it bore the test of time and a heavy traffic, which, up to the present period, it had not been tried by. There was one point of the plan that merited attention, that was the absence of cast-iron chairs; in many of the accidents he had occasion to report upon, the fracture of the chairs had been assigned as the primary cause. He considered any system, possessing the ordinary advantages, and

getting rid of any acknowledged source of danger, to be deserving of careful examination.

Captain Moorsom had visited the line, with an unfavourable impression of the system of employing the bridge-shaped rails, without continuous support. He had been, however, surprised by the smoothness of the motion of the carriages; the line appeared to be sound, and possessed of the necessary degree of firmness, combined with such an amount of elasticity, as prevented the engines and carriages from being injured, as on a rigid road. These advantages were certain, and, as the paper showed there was an economy in the construction, he thought the system deserved careful attention. There appeared to be but little tendency towards deviation from the direct line, or to lateral vibration, in the train of carriages upon the rails. This was shown by the inner sides of the rails being free from all traces of abrasion from the flanches of the wheels; whereas, on the Dalkey line, in many instances, strips were torn from the sides of the rails; and on the Great Western line there was scarcely a rail that was not in some degree acted upon.

Mr. C. May said, if Captain Moorsom would examine the section of the rail, he would observe that, on account of the lower part, near the flanch, being squeezed inwards, to give the dovetail form, and owing also to the fact, that the tyre of the wheels, at the junction of the flanch, and the conical part being a portion of a circle, the upper edge of the rail must be entirely cut away before the inside would be rubbed bright, as in the case of the Great Western rails, of which the sides were vertical, and not inclined inwards at the bottom. It must be remembered, also, that the trains on the Dublin and Drogheda line were much fewer and lighter, than on the Great Western, where, in the first construction, for want of sufficient width of surface, in proportion to the weights to be carried, many of the rails were stripped all along. In reference to the bridge-formed rail another important fact should be remembered; which was, that the shape was not favourable to soundness in the rail, as it required better iron and much more care in rolling, to produce as serviceable a rail as the double head, or T-shaped rail: hence arose the lamination of the early rails used on the Great Western line, and so sensible was Mr. Brunel of the value of improved iron, that, in some very large recent contracts for bridge rails, he had advised the Companies to pay a considerable increase of price in order to have an extra process in the manufacture.

Mr. Statham bore testimony to the general goodness of the line; but he thought, that if the same care had been observed in the ballasting, which was excellent, in the preparation of the sleepers, by

machinery, and in the laying of the permanent way, a lighter rail of the double T-shape, with cast-iron chairs, would have been quite as good and more economical. A double T-shaped rail, weighing 65 lbs. per yard, was as strong as a bridge-shaped rail, which weighed 83 lbs. per yard.

Mr. J. HARRIS thought the system of the double T-shaped rail and cast-iron chairs, was superior to that which had been described; with heavy rails, it was an object of economy to be enabled to reverse the surfaces, when one was abraded. He had used, with effect, a piece of hard wood, about ½-inch thick, inserted in a cavity in the bed of the chair; the rail rested upon this and was prevented from chafing, and it could always be reversed when the top flanch was worn. When the bridge rails became laminated, it was necessary to substitute new ones, and with such heavy rails, this would be a source of great expense in the maintenance of the line. He thought, that the cast-iron chairs were generally made too light. He was now using chairs weighing 39 lbs. each, for rails of 80 lbs. per yard.

Mr. C. FOX said, that experience had shown the system of bridge rails on transverse sleepers, to be wrong. On the Brighton and Chichester railway, a single line of rails of that form, 80 lbs. per yard, had been laid; but in laying down the present double line they were substituting double T-shaped rails, weighing 75 lbs. per yard, and cast-iron chairs of 24 lbs. and 28 lbs. each.

Mr. HEMANS begged to say, that Sir John Macneill was not cognizant of any statement in the paper, that he was alone responsible for any errors in it, and in bringing it before the Institution, he had been only actuated by a desire to do his part towards keeping up the interest of the meetings, by furnishing a subject for discussion.

Mr. THOMPSON thought the remarks made by Mr. C. May, must arise from his not having examined the Dublin and Drogheda railway. He could assure Mr. May, that line was not only one of the firmest railways he had ever seen, as far as its construction was concerned; but, also, that the travelling upon it was proverbially smooth and steady. He agreed, that if taken weight for weight, the double T-shaped rail was stronger than the bridge-shaped rail; but if, as in this case, the latter form could be so introduced as to bear the weight of the traffic, without undue deflection, and be so firmlyattached to the sleepers, as to cause a more than usual amount of steadiness in the motion of the carriages, he must contend, that the system possessed advantages which rendered it worthy of attention. On almost all the lines in England the exfoliating or laminating of the rails, particularly of that part where

the projecting bead or flanch of the upper table joined the web, was generally complained of; in many instances he had seen the inner bead entirely torn off. Now, with the bridge-shaped rail, such an occurrence was impossible, particularly when, as in this case, the bottom of the rail was pinched inwards. It was true, that the upper table, or surface, might, in process of time, be split by the action of the wheels; but the manufacturers stated they could produce a better quality of rail of the bridge shape, and give a more resisting upper surface, by the method of rolling them, than they could to the double T-shaped rail, which was rolled on its flat, leaving the parts which had to resist the greatest action, without the pressure requisite for consolidating the fibres. The circumstance of there being no cast-iron chairs, was, in his opinion, of great importance. It enabled the rails to be fastened directly upon the sleepers, without any intervening substance, and to use, as fastenings, the screw-pins, which had been explained. This mode of fastening had proved most successful, and was, with some little modification, being now introduced upon the Dublin and Cashel railway, an account of which he would submit to the Institution.

The transverse sleepers had been adopted by Sir John Macneill, in preference to the longitudinal system, because he found greater facility for packing them with ballast and also for draining them; and also, because it was thought, that the continuous sleepers would be more liable to be forced outwards, by the conical form of the wheels. He did not mean to assert, that the bridge rail of $2\frac{1}{2}$ inches in depth was perfect; on the contrary, he was of opinion, that the depth might be advantageously increased, and he was now having some rolled of 4 inches in depth. The machinery for preparing the sleepers had been found very effective, and was productive of great accuracy in the work, and of much economy in the general cost.

Major-General Pasley said he believed the carriages on the Dublin and Drogheda railway were, from their great length and breadth, nearly, if not quite, as heavy as those on the Great Western railway.*

* Dimensions of the carriages on the Dublin and Drogheda Railway:—

	1st Class.	2nd Class.	3rd Class.
	Ft. In.	Ft. In.	Ft. In.
Length	22 $5\frac{1}{2}$	27 10	27 $10\frac{1}{2}$
Breadth	8 0	7 10	8 2
Height from rails	9 9	..	..
Ditto from floor	5 8	5 11	6 $4\frac{1}{2}$
Capacity	32 seats	62 seats	70 persons.
Weight, about	5 tons	6 tons	6 tons.

Mr. HAWKSHAW had used, for six or seven years, a rail weighing 58 lbs. per yard, the form of which was somewhat similar to that of the bridge rail. It had an upper surface and vertical web like a T-shaped rail, but with a wide bottom flanch on either side, through which the pins passed, by which it was fastened to the sleepers. In his recent works he had abandoned this form for the double T-shaped rail, with cast-iron chairs, as he considered that system was more to be relied upon. He was of opinion, the general fault in the construction of railways was, that the rails and chairs were too light for the loads they were expected to bear; the consequence of this was, that the rails exfoliated, or the bases of the chairs not being sufficiently broad, the road was unsteady.

Mr. BIDDER always found, from common report, that the last new railway was the steadiest and the most perfect hitherto constructed, whatever system might have been adopted. Now, from experience, he found, that to obtain uniformly smooth and equable motion in travelling, a combination of circumstances must occur. The carriages must be in perfect order, the springs must be good, and the load accurately proportioned to their strength, the axle bearings must not have too much lateral play, the rails must be well gauged, the wedges well driven home, the chairs well pinned down, and the sleepers well packed; besides a number of other points, well understood by those who had charge of railways. In short, all must combine to produce that perfection which was claimed for the system under discussion, but which, he must contend, could not be secured by adopting any peculiar system of laying the rails and sleepers. He could not agree to the inference, that the lamination of the rails was produced by the weight of the carriages. On the Blackwall railway, the weight of the rails was 56 lbs. per yard, and the carriages were within half a ton of the weight of those on the Great Western railway, yet no lamination took place there. He must ascribe this to the absence of the locomotive

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Corresponding dimensions of the carriages on the Great Western Railway:—

	1st Class.	2nd Class.	3rd Class.
	Ft. In.	Ft. In.	Ft. In.
Length	24 0	27 3	27 3
Breadth	9 3	8 10	8 10
Height from rails .	9 5	9 5	9 5
Ditto from floor . .	6 0	6 0	6 0
Number of seats . .	32 sittings	72 sittings	72 sittings.
Weight	7½ tons	7½ tons	8½ tons.

The lengths are not over the buffers, but over the body; the widths and heights are from out to out.

engines, to the wheels of which he attributed the greater part of the injury received by the rails. On the Northern and Eastern railway, where the traffic was light and frequent, a rail, weighing 65 lbs. per yard, stood perfectly well, with a good speed, and engines weighing 18 tons each. He accorded in the opinion, that with the present increase of the traffic, and the augmented rate of speed, all parts of a railway must be made heavier, to insure equable motion and duration.

Mr. VIGNOLES said it must be recollected, as the Dalkey railway had been mentioned, that line was laid with the cast-off rails of the Dublin and Kingstown railway. Their weight was 42 lbs. per yard. He believed the exfoliation which was remarked upon them had occurred before they were laid on the Dalkey line. He did not think that smoothness of motion could be insured, merely by the form of the rail, or the disposition of the materials; there must be the combination of circumstances, so well pointed out by Mr. Bidder. Mr. Vignoles believed he was the first person who proposed the double T-shaped rail, with equal top and bottom surfaces, for the London and Birmingham railway. He acknowledged, that he did not, at that time, perceive the necessity for the great weight of all the parts, to insure stability and duration, as well as the equable motion of the carriages. He thought, that the latter point depended, chiefly, upon the state of repair of the axles, wheels, and springs, and he attributed the acknowledged smoothness of the travelling upon the Dublin and Kingstown railway, to the great attention given by Mr. Bergin to the construction and state of working order, of the carriages.

He could not close his remarks, without drawing attention to the great success attending the mode of construction adopted by Mr. Cubitt, in the permanent way of the South Eastern railway, which he thought was unequalled for simplicity and stability.

Mr. THOMSON remarked, that the Dublin and Drogheda railway, instead of getting rough by use, appeared to be as smooth as when first opened, and he augured well for its durability.

No. 718. "Description of the Machinery for working the Diving Bell, used for setting the Masonry under Water, at the extension of the Pier at Kilrush, in the River Shannon." By William Vanderkiste, Assoc. Inst. C. E.

The old pier at Kilrush, which is situated on the Lower Shannon, and near the mouth of that river, did not afford sufficient accommodation for the steam vessels, plying between Limerick and Kilrush, or