Mr. BURLEIGH had very few remarks to offer, in addition to the Paper, but was most desirous of hearing the result of the experience of others, on the lasting properties of crossings in various situations. As a general rule, he found, that switches lasted about four months, at places where the break was not frequently applied. The crossings on the up line, at stations, lasted about six months, during which time, two sets of wing rails were generally worn out, as they ordinarily lasted about half the time of the point rails in crossings; this length of duration was nearly similar at most of the stations. At the Welwyn Station, the fixed rails of the switches were found to last only about three months, which might, perhaps, be attributed to their being placed on a curve, and being subjected to heavier blows from the passing trains. The crossings at that station lasted about five months; but two sets of wing rails were worn out during that period, although in situations where the break was not usually applied. At the Hitchin Station, where the traffic was very heavy, the fixed rails of the switches on the up line, were renewed about every two months, and in one case, that of a three-throw switch, they were renewed about once a month. This was in a situation where the break was frequently applied to stopping trains. The crossings at this station, on the up line, were renewed at intervals of about four months, during which time, two sets of wing rails were put in. He could, if necessary, multiply the instances of the short duration of these particular portions of the permanent way, but the periods he had given, might be received as the general result of the traffic on the up line.

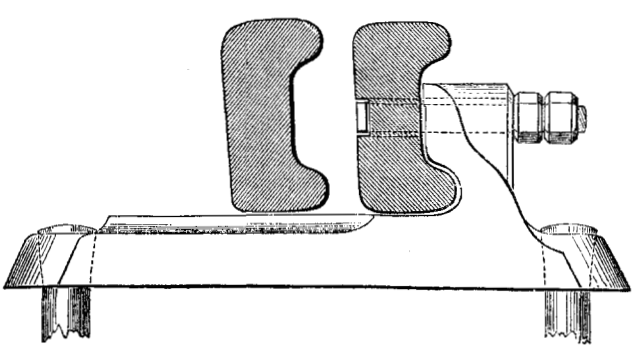
It was an important subject, both commercially, and as regarded safety in travelling; for he believed, that the points and crossings were the most fertile sources of railway accidents, as they generally arose from the fracture of tyres, axles, and springs, in consequence of sudden and violent concussions at high speeds. The breaking of the crossing chairs was a very ordinary occurrence, which was not always discovered at the time, owing to the chairs being hidden beneath the ballast. It was also not an uncommon occurrence for the point rails of crossings to break off near the extremity, in which case, the wheels must strike heavily. Switch chairs were also subject to breakage, as they were, in his opinion, usually made much too weak; and the hinge chair was, generally speaking, a very loose contrivance. He considered, that this was a matter which required a greater amount of attention than it had hitherto received, as the hinge could hardly be made too strong. As little could be effected in that way with cast iron, it had led to the introduction of the wrought iron chair, which was preferable, although more expensive in the first instance. These wrought iron chairs were forged, but he proposed to roll bars, corresponding with the

half-section of the chair, and to make a weld in the chair for the crossing chairs: where the rails were parallel, they might be easily rolled by one process. He believed that description of chair would prove light and strong, and would be found to be very economical.

Mr. CARR considered the remarks in the Paper very much to the purpose, with regard to the wear and tear of those particular portions of the permanent way. His own experience had been principally on the northern portion of the Great Northern Railway, where the traffic was heaviest. He had already exhibited to the Institution an improved crossing, the chief feature of which consisted, in filling up the hollow on the inside of the wing rails, so as to afford support to the part where the wheels bore partially on them, and thus to preclude the possibility of shearing off the overhanging flange, which frequently occurred with ordinary crossings. The point rails were similarly filled, and also blocked out, so as to render the point one solid piece, of much greater strength than usual. The joint of the point rails, being on a chair, obviated the necessity of bolting the rails together, whilst it dispensed with the splice-joint of the ordinary construction. A loose block was also introduced between one wing rail and the point, in each of the point chairs; this alteration allowed the wing rail, the loose block, and the point, to be all wedged firmly in the chair by one key. Thus, although the upper surfaces of the filled wing rails and the solid point might be worn down, they could not be crushed, and the deficiency of metal which might be produced by wear, could be easily restored, by heating the rail, and slightly hollowing the side; whereas in the common crossing, the overhanging flange being liable to be sheared off, or crushed, entirely destroyed the rail; so that, in the one case, a few shillings would restore the crossing, whilst in the other, it was entirely destroyed, and must be replaced by a new one.

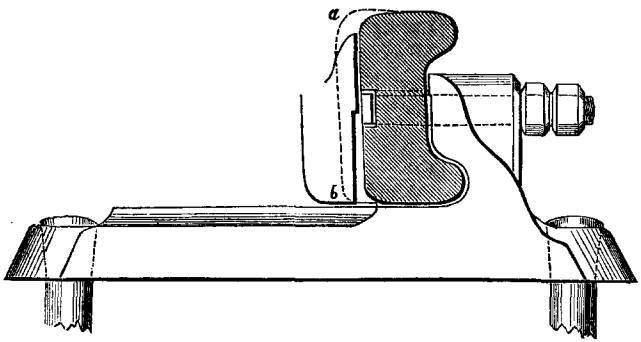
CARR'S SWITCH.

Fig. 7.



Section near the heel.

Fig. 8.



Section at the point.

His new switch was made on the same principle, and out of the same rails as the crossing, the object, in both cases, being, to prevent the shearing off of the overhanging flange, where the edge of the wheel first caught the stock, or wing rail. Sections of the switch were shown in Figs. 7 and 8; in the former, near the heel, and in the latter, at the point.

With reference to the durability of switches and crossings, great care was requisite to avoid hasty conclusions, drawn from insufficient data. The same consideration of all the facts bearing on the particular case, was as requisite with regard to switches and crossings, as to the general maintenance of the line.

Mr. NIXON, while acknowledging the correctness of the principle of construction, proposed by the Author, could not understand the asserted rapid destruction of switches and crossings. There was a large amount of traffic on Irish railways, which, generally, were single lines, and he had noticed, that the points and crossings were nearly as good as when they were laid down. He would mention one in particular, where there were four trains each way per day, with engines of 30 tons weight besides other trains with light engines, and the switches and crossings had already lasted over six years, without any apparent deterioration.

Mr. JOSEPH CUBITT remarked, that many cases might be pointed out, of the destruction of crossing points in two months, where, from peculiarity of the situation, they were subjected to severe trial; but their average duration was much greater. Some points of the ordinary construction had been in use, for one or two years, on the main lines of the Great Northern Railway; they were, however, well made from good materials, and well adjusted.

Mr. BURLEIGH admitted, that he had taken some extreme cases; the traffic on the up line of the Great Northern, being much heavier

than on the down line, and the wear and tear, being 50 per cent. greater; principally owing to the large quantity of coals carried. The duration of switches and crossings, was in the proportion of six months on the up line, to nine months on the down line; but they did not always last for the same time, even in the same situation: the quality of the iron would make a considerable difference. On other lines, the switches, no doubt, lasted much longer than he had stated, but then the traffic was also much lighter. On the Irish line referred to, there were only eight trains per day, whereas on the Great Northern line, there were forty-four per day each way, and the traffic tonnage, both of goods and coals, was very heavy; every truck, loaded with coals, weighing from 10 to 12 tons.

Mr. R. STEPHENSON, M.P., V.P., coincided in the opinion of the importance of the question of the duration of points, switches, and crossings; the wear and tear must, of course, be in proportion to the amount and weight of the engines, the nature of the traffic, and the velocity of the rate of travelling, influenced, to some extent, by local circumstances, and by the quality of the materials employed; all these circumstances must vary considerably on different railways. Two or three months was not, therefore, to be considered as the ordinary average duration of crossings, because they had only lasted that time, on some particular line. With regard to the Irish railway referred to, the traffic upon it was generally considered not to be enough to pay the working expenses, therefore it could not be compared with the Great Northern, or other lines, where the traffic amounted to 2,000, or 3,000 tons per day, with shuntings going on in all directions, and involving a very great amount of wear and tear. He believed, that the destruction of points and switches was very great, especially where the trains continually passed over at high velocities; it was, however, probable, that the Author had given exceptional cases as examples, rather than the average of the wear throughout the railways of the kingdom. The wear and tear of crossings had certainly become a serious item of expenditure, and was not confined to the terminal stations; it was, therefore, important to examine the question, and to try by what means it could be reduced.

He had often remarked, that improvements were occasionally re-invented, as new circumstances arose, and such was the case, with regard to the plan proposed in the Paper. On the original Stockton and Darlington Railway, and, he believed, even before that period, his father, Mr. George Stephenson, had tried the same expedient with cast iron, which was now proposed to be tried in wrought iron. It was originally used on an incline-plane, in order to throw the weight on the flange, and thus to save the wear and tear of the points. The destruction of cast iron was, necessarily, very rapid, and in order to diminish it, the crossings were eventually made of

wrought iron. But there was a difficulty even then, in welding on the raising point, by which the flange was relieved from the effect of the blow; there was also a manifest imperfection in the form, which permitted the tyre of the wheel to strike the point of the crossing. To obviate, in some degree, the evil, steel points were proposed; and now, the Author had introduced a new form of rail, in which the point formed a part of the rail itself; that which was formerly attempted to be done with cast iron, was now effected by means of wrought iron, and the former objections were, to some extent, removed. That, however, in his opinion, was the least of the many evils still attached to points and crossings, and even by the proposed plan, whilst the blow was certainly removed from the point, another difficulty was created, by the wheel travelling on its flange, which was of a larger diameter. Now one wheel, during one revolution, must slide as much as $3\frac{1}{2}$ inches, and the torsion upon the axle, might be quite as prejudicial as a blow.

He had called attention to these points, chiefly with the object of inducing discussion; although he had no doubt, that the Author, who had given a correct account of his individual experience, would be able to meet the objections, and to show good reasons for the proposed modifications of the ordinary points and crossings.

Mr. BURLEIGH, alluding to the difficulty suggested, of the sliding of the wheel, whilst running on its flange, and the tendency to produce torsion of the axle, said, that in case it should be found as objectionable in practice as in theory, the difficulty might be obviated, by inserting a flange bearer on the opposite side of the crossing, between the main and check rails; thus causing both wheels to run upon their flanges.

Mr. R. STEPHENSON, M.P., V.P., considered this, a sufficient answer to the difficulty he had suggested.

Mr. C. SANDERSON inquired, whether the iron was merely flattened, or the laminæ opened, and on that account, the points and crossings required to be taken up. He had known crossings to last for three years on the Great Western Railway, but at the end of that time, they had become distorted, and the metal was disintegrated longitudinally; he considered three months was a very short duration for points and crossings.

Mr. BURLEIGH replied, that the parts of both points and crossings exposed to the blows of the wheels, were both crushed down and disintegrated. In some cases, the iron was more channelled out than crushed, but that, probably, depended upon the quality of the iron; in either case, the effect was to render it unsafe for the carriages to travel, if the condition of the crossing was neglected.

Mr. HAWKSHAW said, he had tried points of that description, and found, that where the weight was thrown upon the flange of the wheel, they had answered well enough for a time; although the

tyres of the wheels had sometimes been injured. But, when the engines were made much heavier, he was compelled to abandon them, as he had thought it was dangerous to throw the whole weight, which should be borne by the flat part of the tyre of the driving wheel, upon the flange alone. Great care was necessary, in watching the effect upon the tyre.

He thought the discrepant results of duration under wear and tear, would be found compatible, if all the circumstances of each case were taken into account; and this was necessary, in order to form a correct judgment. There were portions of railway in England, on which the traffic was fifty times greater, than on the Irish line which had been alluded to. On the Lancashire and Yorkshire Railway, the points were, in some instances, worn out in twelve months; but in those cases, there were, probably, three hundred trains, or locomotives, passing over them every day.

Mr. BURLEIGH considered, that a tyre would be less liable to be broken, in running over a crossing on its flange, than if it mounted, and ran upon its outer edge only. In the former case, the blow would be less severe, as the flange would rise up a gentle incline, while in the latter case, the blow would be given abruptly.

Mr. NIXON said, the line to which he referred, was the Cork and Bandon Railway, which was in a better position than had been represented. He had known the Great Southern and Western, of Ireland, for more than nine years, and the switches and crossings on that line, were almost as good as when they were first put down. The traffic averaged £28 per mile, whilst that of the Great Northern, did not exceed £70 per mile.

Mr. R. STEPHENSON, M.P., V.P., said, it was not the income per mile that should be taken as the standard of the traffic, in respect to wear and tear; it was the weight, or rather, the number of wheels, combined with the weight. Coals, which were carried at a half-penny per ton per mile, would cause more destruction of the permanent way, than passengers at two-pence per mile. There was, probably, no Irish line which produced more than £28 per mile; but there were railways in England, producing ten times that amount.

Mr. C. MAY hoped the discussion would have the effect of directing attention, to the necessity of employing the best quality of materials for this kind of work. He had made some hundreds of sets of crossings and switches, and he knew, that bad material, although it required as much labour as material of the best quality, lasted only one-third of the time. There were situations, such as the entrance to the Derby Station, which were subjected to an incredible amount of wear and tear; as many as fourteen hundred engines passed over it in the course of forty-eight hours, or an average of one engine every two minutes, with an enormous amount of shunting; the consequence was, that the points only lasted six

weeks. He recommended the use of the Low Moor iron for points and crossings, as the ordinary qualities of iron, offered so little resistance to wear and tear.

Mr. BIDDER, V.P., agreed, that the quality of the materials for works of this description, was not sufficiently attended to, and he had been constantly endeavouring to induce Directors to employ a better description of iron; but there was as much difficulty in obtaining exactly the quality of iron absolutely contracted for, as in persuading Directors, that the cheapest article was not the best. On the Birmingham and Derby line, rails of 56 lbs. to the yard were laid down; they were well manufactured, and of a good material, and, when he last saw them, were not much the worse for wear. He believed, that they were not all taken up yet, but most of them had been replaced, because they were too light for the present description of traffic. The same system had been pursued on the Blackwall Railway; the iron was subjected to an additional hammering, at a small increase of cost, and the consequence was, that when the rails were taken up, after many years' wear, they were found to have suffered very little. The only way to obtain a better description of iron rails was, to contract for them at 85 lbs. to the yard, and to make an arrangement with the manufacturer, to supply them at 75 lbs. to the yard, of a better quality. On the Blackwall Railway, upwards of three hundred passenger trains per day, travelled between London and Stepney, besides a large goods traffic. He did not know the length of time the points lasted, but he entirely concurred in the opinion, that to form a judgment upon the matter, correct information must be had of the amount of traffic, together with all the concomitant circumstances relating to the subject.

Mr. POLE, through the SECRETARY, described some improvements he had endeavoured to effect in railway crossings.

He agreed with some of the speakers, that the rapidity of their destruction had been rather exaggerated, and believed, that much depended on the quality of the material used. He had known Contractors for the maintaining of permanent way, (often wiser in their generation than Railway Directors), who found it their interest to use the best quality of iron they could procure for such articles, regardless of price; and the result was, that the duration was measured by years instead of months, amply repaying the extra first cost incurred. Still, however, it could not be denied, that the wear and tear of the points and wings of crossings, was very great, and he had, therefore, endeavoured to meet this evil, in the best way that circumstances would allow. He had not attempted to introduce any new general form, or principle of crossing, but had preferred improving the construction of the simple and well-known kind ordinarily in use, by increasing the strength, stability, and durability, of certain of its parts, and giving greater facilities for its economical repair.

The 'point,' or angular junction piece, as ordinarily made, was much too weak. Figs. 9 and 10 showed the usual construction, from which it would be seen, that the end of the point, which ought to be of considerable strength and substance, to resist the heavy blows and strains it was subject to, consisted merely of a thin single rail web, the rapid destruction of which was inevitable. Moreover,

COMMON POINT.
Fig. 9.

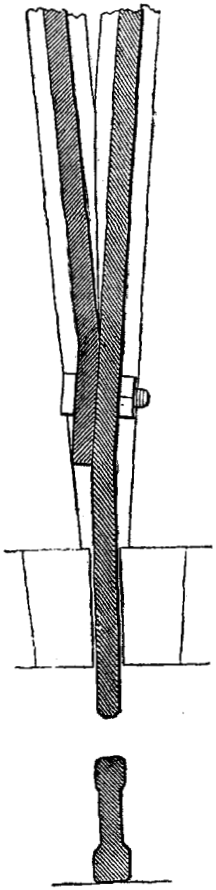


Fig. 10.

POLE'S IMPROVED POINT.
Fig. 11.

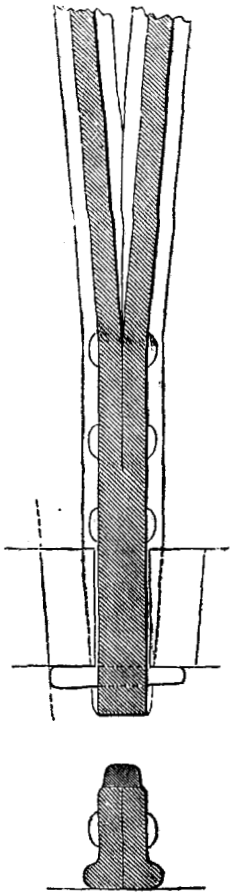


Fig. 12.

the loose joint of the second rail was continually a source of trouble; and another serious evil was, that no effectual means were usually adopted for securing the point in its end chair. It, accordingly,

soon became loose, and the consequence was, not only the accelerated destruction of the point itself, but a greatly-increased cause of concussion and damage to the rolling stock passing over it.

The improvement he had introduced, was, as shown in Figs. 11 and 12, to carry each of the two converging rails completely through, to the extremity of the point, and to connect them firmly together laterally, by welding, riveting, or any other suitable means; the union being also further secured, by welding a piece of flat steel on the top face. The point as thus made, was very strong and durable; it had the advantage of being equally good for both lines, as on whichever road a wheel was running, the moment it arrived at the junction angle, it began to travel on its own rail. In order to secure the steadiness and stability of the point, the part passing through the chair was formed slightly wedge-shaped, and keyed up with a transverse key, which was prevented from shaking loose, by its head abutting against the side, or wing rail. The point was thus permanently held as steady and firm, as any part of the line.

He conceived, that several advantages would arise, from making the point and wing rails of crossings, much shorter than it was usual to have them; for these parts being peculiarly liable to wear, a better description of material should be used for them, than for ordinary rails; and it was obvious, that the shorter the pieces, the less quantity of expensive metal would be required. When the parts in question were worn out, a less quantity of material had to be thrown aside, and the renewal became, therefore, more economical. The wear extended only over a small space, and, therefore, the use of long rails involved much waste of iron. The renewal, or repair of short wings, or points, would be quicker done, and would involve much less disturbance of the line, than long ones, particularly as short pieces, ready prepared for their places, could be conveniently kept in store. The use, however, of short rails for these purposes, upon the ordinary plan, was justly considered as very dangerous, on account of their liability to get loose, which might, in important situations, cause the most serious accidents. Hence, it had been always thought more prudent, to make the wing and point rails of considerable length, in order to tie them safely into the remainder of the line. With the view of removing this risk, and, at the same time, of securing the advantages of short rails, he had connected the crossing to the continuing rails of the line, by means of 'double fish chairs,' as shown in Fig. 13. These not only allowed the point and wings to be conveniently and quickly renewed, or repaired, when necessary, but also formed perfectly secure joints, as in addition to the hold of the fishing pieces, the end of every rail had a firm support under it, by which the risk of accident by displacement, was rendered extremely remote.

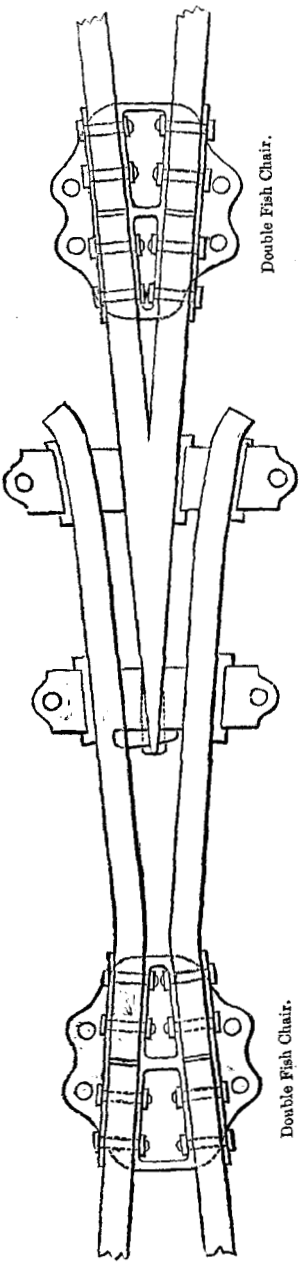


Fig. 13. POLE'S IMPROVED POINT.

The improvements above referred to, had been tried, and found to work well, and crossings containing them had been made, in considerable numbers, for several lines. It was not found, that they added materially to the cost of the crossings, into which they were introduced.

Mr. CARR transmitted, through the SECRETARY, a statement, relative to maintenance of way, which he thought would be found to possess some interest.

Nothing could be more deceptive, than to estimate maintenance, or to compare the cost of one line with another, without the most careful comparison, with regard to the original construction, (especially the ballasting and drainage,) and the comparative traffic. He had kept a distinct account, for twelve months, of the cost of maintenance of eighteen miles of the up and down lines of the Great Northern Railway, and the result showed, that the permanent way expenses increased rather more rapidly, than the tonnage which passed over it. The labour of maintenance of the up line was to the down, as 1·98 to 1: the gross weight passed over the rails, being as 1·74 to 1. The great difference in the traffic on the two lines, was due to the coals carried up towards London, and, as might be supposed, more damage was done per ton by such extreme loads, than by ordinary goods and passenger trains; this would account for the deterioration increasing more rapidly than the tonnage.

The gross weights, passed over the different sections of the Great Northern Railway, as taken in 1854, were per day :—

North District—Peterborough to Doncaster .	11,767 tons.
South ditto —London to Peterborough . .	10,385 „
Loop line	2,636 „
East Lincolnshire	1,652 „

From this Table, it was perfectly evident, that no opinion could be formed as to what ought to be the cost of maintenance of the Great Northern Railway, without a thorough knowledge of the circumstances of the different sections, and their relative mileage. The same was true with regard to all other lines of the same extent, but it was even of still greater importance, when one line was compared with another, to consider the peculiar circumstances, and the different destructive influences.

A most complete Table of the published cost of maintenance, had been prepared by Mr. Brydone, showing the relative expenditure in maintenance and renewals, on eighteen railways. The highest charge during three years, was, for one half-year, at the rate of £547 per mile per annum,—the lowest, £89 : the highest average during the three years, being £397,—the lowest, £109. These figures, however, did not enable any opinion to be formed of the economy of maintenance in those particular cases, without full information as to the nature of the works, and the amount of traffic, and whether the line was really maintained in a good state, or was allowed to deteriorate.

The cost of maintenance was the expenditure of such an average annual sum, as would preserve the whole of the works in their normal state, for an unlimited time. Maintenance was too often spoken of, on the contrary, as an expenditure which did not include the cost of what was called renewal, at certain periods; whereas there was no real distinction between renewal and maintenance.

If Railway Companies would boldly meet the question of maintenance, without fear of the consequences to the present value of their shares in the market, a much more healthy state would be induced, and Resident Engineers, having the charge of maintenance of way, would be free to compare notes, and could establish some general rule for comparison, which, it was to be feared, could not now be done, without injury to him who told the whole truth; for there was, at present, as great a desire to cut down the apparent cost of maintenance, as there usually was, to reduce a parliamentary estimate.

The following Table was, in his opinion, calculated to throw some little light on the relation of tonnage to maintenance :—

GREAT NORTHERN RAILWAY.

Retford to Doncaster District.

Cost of Maintenance of 18 Miles of Permanent Way, during the Year 1853.

	Up Line.	Down Line.	Total.
Labour for 12 months . . . . . days	3,850	1,939	5,789
giving per mile per annum . . .	213·888	107·722	321·610
,, ,, per day . . .	0·712	0·359	1·071
(taking 300 working days to the year.)			
Cost of labour per mile per annum, at an average of 2/8 per man per day . . .	£. s. d. 28 10 4	£. s. d. 14 7 3	£. s. d. 42 17 7
Proportion of day's labour on up line to down line.	1·985	1	
Gross weight passing over the district, during two weeks	Tons. 72,116	Tons. 41,377	Tons. 113,493
Proportion of gross weight passed over up line, to down line	1·742	1	

The destruction of the rails was in about the same proportion as the labour; the rails destroyed on the up line, being to those on the down line, as 2 to 1; but perhaps little inference could be drawn from this, as none but defective rails would fail in three years; however, the fact was, that the heavy traffic on the up line, seemed to tell upon the defective rails, about as fast again as the ordinary goods and passenger traffic on the down line.

He believed, that the most important feature in the case, as regarded maintenance accounts, was the fact of the capital accounts being still open; till they were closed, little dependence could be placed on what was published on that subject.

Mr. Simpson,—President,—said, that the Institution was much indebted to the Author, for the interesting facts he had brought forward, and he hoped they would have the effect of eliciting further information on the subject, and also of directing attention to the employment of a better description of iron for these purposes. He was convinced, that great improvements were still needed, in many parts of railway construction, in order to insure regularity and rapidity, as well as safety and comfort in travelling. The Directors of every Railway Company should be made aware of the importance of the points, which had been brought out in the discussion upon this Paper.