Mr. BARLOW said, two years ago he was induced to make an investigation of the returns published by the Board of Trade, with the object of endeavouring to find a reason for some of the anomalies which those returns appeared at first sight to exhibit. Although this subject might not be considered a strictly engineering one, yet it was of undoubted importance. As had been remarked in the Paper, the railways of this country had involved an expenditure of £500,000,000, a sum which had been provided by private capitalists, and for the use of which £40,000,000 were paid annually by the public; therefore, anything that could be said, or done, to improve the condition of a property of such magnitude was undoubtedly of importance, both to the proprietors who had found the capital and to the public who used the railways.

The first point which suggested itself, on examining the returns of the Board of Trade, was the discordance between the increase of the traffic receipts and the increase in the length of new miles of railway opened. From 1846 to 1850, which was the period of the greatest activity in construction, the average length of new lines completed annually was 886 miles, and the increase of the traffic during the same period was £1,210,571 per annum. But from 1850 to 1866, there was an average of new lines opened of only 444 miles per annum; yet notwithstanding this reduced rate of construction the annual increase in the receipts rose from £1,210,571 to £1,512,000. Taking the mileage receipts per annum, he found that in 1847 they amounted to £2,820, in 1851 they fell to £2,022, and in 1866 they rose to £2,728. That falling off was not due to any diminution in the traffic of the old lines. Those persons who, like himself, were connected with the working of the old lines of that period, knew, that while the traffic appeared to be falling off, new sidings, engines, carriages and wagons had to be supplied, showing that the traffic was actually increasing. It was evident, from these and other circumstances, that there was a constant growth of traffic; and his first endeavour had been to separate the growth of traffic upon the old lines from that which was produced by the construction of new lines. It was a difficult matter, but nevertheless, by various efforts and trials, he had found, as the average of the whole of the railways of the United Kingdom, that, by taking the first year's receipts at £1,200 per mile of new railway,—and allowing a rate of increase of £100 per mile per annum upon every mile of railway after its execution,—a calculation on that basis represented very nearly the traffic of each year. Thus in 1846 the traffic amounted to £6,887,000; in 1851 it amounted to £13,812,000; but calculated upon the basis just mentioned, it should have been £13,152,000. In 1856 the actual receipts were £20,273,000, while by calculation the figures were £22,336,000. In 1861 the receipts were £27,524,000; as calcu-

lated, they should have been £28,165,100. In 1866 the receipts were £36,967,000, while the calculation gave £37,027,000. It therefore appeared that a sum of something like £100 per mile per annum fairly represented the gradual growth of traffic on railways; for these remarks applied to a period extending over twenty years, ending in 1866, and while the returns for the two years 1867 and 1868 fell rather below the results derived from calculation, the receipts of 1869 were in excess of those results. This amount of increase was not inconsistent with what might have been expected from an examination of the condition of the country in other respects. For example, the imports and exports amounted in 1854 to £268,000,000, in 1859 to £335,000,000, and in 1864 to £488,000,000. Of course, concurrently with this increase in the imports and exports, there had been an increase in the population; and therefore, as a matter of necessity, irrespective of observation and experience, it must be expected that this increase would exhibit itself upon the traffic of the old railways.

The bearing of this analysis of the receipts might be traced in respect of the capital cost of the railways as follows:—The mean aggregate value of the rolling stock of the railways from 1861 to 1866 was £37,000,000: the mean gross traffic receipts between those dates was £33,000,000; and therefore the mean gross earnings of the railways in that period was about $\frac{9}{10}$ths of the cost of the rolling stock. He had obtained corroborative evidence that there was a proportion between the cost of rolling stock and the traffic earned. He had also found, by inquiry of engineers of experience and by other modes of calculation, that for every engine and train there was required about one-half a mile of sidings. Taking into account the cost of these sidings, together with the cost of rolling stock, it appeared that for every £1,000 of increased traffic earned annually something like three-and-a-half times that sum had to be spent in providing engines, rolling stock, stations, and sidings. Proceeding in that way, it was possible to analyse, to some extent, the capital expenditure on railways, and to determine how much was due to increase of traffic, and what arose from the construction of new lines. In 1859 the total expenditure on railways had amounted to £334,362,928. Of this outlay the rolling stock had cost £2,831, the stations £5,662, and the construction £24,424 per mile. In 1866 the total expenditure had amounted to £481,872,184; when the rolling stock had cost £3,030, the stations £6,060, and the construction £25,140, per mile. If to this cost of construction, say £25,000 per mile, were added that of the stations and the plant, it would be found that £27,601 represented about the cost of each mile of new railway, or the average cost of lines during the last twenty years. It further appeared that the gross return upon that was £1,200 per mile, being less than 5 per

cent.: whereas the expenditure for stations and rolling stock, due to increased traffic, taken at three-and-a-half years' purchase upon that increased traffic, gave a gross return of about 28 per cent. As the growth of the traffic was continuous, an insight was thus obtained into the fact of the great vitality of railway property, and the depressing influence of increasing the length of new lines with undue rapidity. Between 1846 and 1850 the length of new line made was from $\frac{1}{4}$th to $\frac{1}{9}$th of the mileage previously constructed, and during that period the receipts fell from £2,800 to £2,000 per mile. Between 1850 and 1866, the rate of increase in the length of new lines opened was reduced to $\frac{1}{20}$th and $\frac{1}{26}$th of the mileage previously executed, and with that smaller rate, the receipts rose from £2,000 to £2,700 per mile. That showed very conclusively the importance of not extending the system in so rapid a manner as was formerly done.

Referring to the latter part of the Paper, which treated of the proportion of capital in open stock and in debentures, he found, from the Board of Trade returns, that the expenditure on railways in 1866 had been £34,782 per mile; this was divided into two items—viz. ordinary share capital £16,475 per mile, and preference and debenture stocks £18,307 per mile. He also found that the gross receipts were £2,754, the working expenses £1,358, and the fixed payments for interest £915 per mile, leaving for dividend to the proprietors only £481 per mile. This amount was derived from an average receipt per train mile of about 5*s*., and the small proportion of this receipt which went to the shareholders showed the importance of endeavouring to increase that mileage receipt. With regard to mineral traffic, which only earned its fare one way, the trains going back empty, to average 5*s*. per train mile, it must earn 10*s*. in one direction, and that perhaps fairly represented what was the limit of the power of an engine of the present day with the gradients employed. It was remarkable that the receipts from goods and passengers should also be only 5*s*. per train mile. It was, however, the fact, that there was little difference whether passengers, goods, or minerals were carried, the receipts per train mile being about the same; though in the case of minerals, the receipts arose only in one direction, while in the case of passengers and goods they were earned in both directions. He thought the object of railway managers should be to improve the train mileage receipts, both for goods and passengers, and there was still, he was confident, a great field open in that direction.

Mr. R. Price Williams observed that the diagrams illustrated in an admirable manner the statistics which it was the object of the Author to direct attention to, and in his opinion the importance of such diagrams could not be over-estimated. The remarks he had to offer had reference more particularly to the maintenance, renewal,

and working expenses; a subject which he had been pursuing for the last few years, in relation to some investigations he had been making into the question of the average life values of different portions of the rolling stock and permanent way, the importance of which he was glad to find had been recognised by the Author. Before doing so, however, he might perhaps be permitted to refer to the suggestions thrown out in the Paper, for improving the value of railway property generally. It was admitted that the privileges and extraordinary powers granted to railway companies were conferred for the benefit of the public. But Mr. Price Williams was surprised to find that the Author considered the aim of all railway companies should be to encourage travelling and to fill the trains with the highest-paying passengers. This was looking at the question from a shareholder's point of view. It was quite true the remark was qualified, as it was said that this should not be done, as it too frequently was done, at the expense of the third-class passengers; but how the object in view could be attained except at the expense of the third-class passengers he failed to see. It was obvious that nothing promoted travelling more than cheapness; and these statistics showed very clearly, that there was a great preponderance of third-class traffic, both in respect to numbers and receipts. He could not agree that it was folly to encourage third-class travelling by fares much less than those of the second class, and by having third-class carriages attached to every train. On the contrary he thought the General Manager of the London, Chatham, and Dover railway could show sufficient reasons for the stimulus he had so successfully given to this class of traffic, and that the 80 per cent. which that line possessed of it would be found to be as remunerative as the rest of the third-class traffic had been shown to be, notwithstanding it only brought in 4*s.* 6*d.* per train mile. It might be quite true that 4*s.* 6*d.* per train mile was below the average of passenger receipts on some other lines; but when it was considered that the actual average cost of passenger traffic amounted only to about 2*s.* per train mile, or 2*s.* 4*d.* at the outside; and when, further, it was found that dividing the whole of the passenger-traffic expenses by the total number of passengers carried it only amounted to 6*d.* per head, he questioned whether, when looked at from a public and not from a shareholder's point of view, the 4*s.* 6*d.* per train mile even would be much longer tolerated.

Towards the end of the Paper allusion was made to two proposals which had been suggested for improving the value of railway property. One of these was an association of the railway companies, in order that they might be able to contract loans, on the security of the joint property, at a lower rate than they could individually borrow; joint stock being issued in place of the loans separately contracted. By means of the Clearing-House machinery,

and a sort of joint-purse principle, this method would undoubtedly promote the object in view. At the same time it would practically be establishing one gigantic monopoly in place of the many small monopolies which all railways necessarily were;—a gigantic monopoly, moreover, created for the improvement of railway property, or rather for the benefit of that limited portion of the community represented by the shareholder, at the expense of the general public. Such a scheme he thought would never meet with the sanction of the legislature. Indeed the failure of a similar scheme, when attempted for the railways south of the Thames, was sufficient to show this. The other plan mentioned was for Government to take upon itself the responsibility of the loan capital, thus enabling railways to borrow money on the low terms of a Government security, to lessen the charges upon revenue, and to pay interest upon loans and debentures, and gradually to extinguish them. This had, in Mr. Price Williams' opinion, much to recommend it, as the Government would incur no risk or liability beyond lending its name and its cheap money-borrowing powers. The objection was that it did not go far enough, and pointed to a much more comprehensive measure for vesting the whole of the railway property in the kingdom in the hands of the State. If railways could only succeed as commercial speculations in the shape of a monopoly, it must be conceded that it was best for the general interest that such monopoly should be vested in the nation itself. This did not involve the necessity for Government management and patronage, nor would it in any way interfere with the administrative power with which railways had been managed, and to which such a deserved tribute had recently been paid by the present President of the Board of Trade. That part of the question was one which might perhaps be better discussed at another time and in another place. It had, however, a direct bearing upon questions nearly affecting the interests and objects of the Institution—the question of cheap railways. As commercial speculations they might have little to recommend them; most of the branch lines of railway, either constructed or leased by the leading companies, being—as had been well described—suckers and not feeders. It was none the less evident, that these cheap branch railways ought to be made, and that from the want of them considerable districts of rich agricultural land in this country were still deprived of the ordinary facilities of railway locomotion, and practically were in a worse position now than before the introduction of railways; the mail coach and the carrier's wagon having long since been starved off the roads. In addition to the increased cost of cartage, the introduction of railways had, as was well known, raised both the price of labour and of materials, without giving the farmer the facilities of access afforded by railways to the markets where a fair

price could be obtained for his produce. In this way it was clear that the economy of the railway system had a practical interest and importance for engineers; as, were the existing railways to become the property of the State, the question of their proving at once a commercial success was of secondary importance, when compared with the direct and indirect benefits that would be derived by a complete system of railway communication, co-extensive at least with the mileage of roadways.

Returning to the statistical portion of the Paper, the concurrence of the outlines in diagram 19 (Plate 8), showing the annual increase of the railway mileage and the gross traffic receipts, was very striking. At the same time the dead uniform level showing the average cost of construction per mile spoke more eloquently than any words, as to the causes which had led to the present lamentable depreciation in the value of railway property.

In the diagrams illustrating the Paper, the cost of the maintenance and renewal of way, on all the railways dealt with, was given at a certain rate per train mile. He thought that the results arrived at by the train-mile principle were fallacious for the purpose of comparison with similar charges on other railways, inasmuch as the train-mileage was derived from the whole of the mileage worked over, which varied essentially in its ratio to the mileage maintained on different lines. For instance, in the case of the South Eastern railway, as their trains ran over the London and Brighton railway as far as Reigate Junction, the whole of the train-mileage over that portion of a foreign line operated to lessen the charges of maintenance on its own lines, as against those on the London and Brighton which suffered from the additional traffic passing over it. In Mr. Price Williams' opinion, the train-mileage principle was equally fallacious as a test of the relative cost of the locomotive expenses, on lines differently circumstanced, as to the nature and extent of their traffic. It might be remembered that Mr. Hawkshaw drew attention to this, in a discussion on a somewhat similar subject,[1] and observed that, in addition to the train-mileage, something more was required, which would show the relative amount and character of the work done. He would venture to instance two cases that occurred on railways dealt with in the Paper, the circumstances of which differed as much in every way, as regarded the nature and extent of their traffic, as they did in their relative cost per train-mile, viz., the London and South Western and the North London railways. In the case of the latter, the peculiarities of its enormous passenger traffic, which was of what was called an omnibus character, and its very heavy mineral traffic, required the unusually large number of three engines per mile, and

[1] *Vide* Minutes of Proceedings Inst. C.E., vol. xxvi., p. 382.

a resulting low average number of 18,400 train-miles per engine per annum; while, on the other hand, the London and South Western, with a large mileage of single line, and light traffic at its remote end, was worked with less than half an engine per mile, but with the unusually high average during the last six years of above 25,000 miles per engine per annum; that average including the engines under repair, and those engaged in piloting, shunting, and ballasting. An explanation of this kind was of itself sufficient to show that even if Mr. Adams' reputation for economical and efficient management of the rolling stock on the North London railway was not fully recognised, as it undoubtedly was, the 8*d.* per train-mile in the one case was no equivalent for the 15*d.* in the other, any more than the relative cost of the locomotive expenses per engine would be. He might mention, that although the cost per train-mile on the London and South Western appeared so very low, yet, when taken per engine it exceeded that of nearly every other line he had yet dealt with. The average cost of repairs and renewals per engine on the London and South Western during the last twenty years had been £270 per engine per annum, and the total expenses, including the running expenses and salaries, £744 per engine. On the Great Eastern, in a similar period, the cost of repairs and renewals had only averaged £226, and the total locomotive expenses £678 per engine per annum. On the South Eastern, also, in a similar period, the cost of renewals and the total expenses had been £226 and £642 respectively per engine per annum. In regard to the valuable information afforded in the Paper, as to the comparative charges for locomotive and running expenses, he would add, that although the figures were perfectly correct for two half-years, the results did not in all cases correspond to the average of a series of years. For instance, the Great Eastern locomotive expenses averaged only 8·95*d.* during a period of twenty years, whereas in the half-year ending July, 1869, they happened to be as high as 10·25*d.* On the other hand, the average of a period of years showed the London and North Western locomotive charges to be 9·25*d.* per train-mile as against the 8·25*d.* recorded in the diagram. The Midland average was, in the longer period, 9·09*d.* against 8*d.* shown in the diagram. The single instance where any large difference occurred was in the case of the Manchester, Sheffield, and Lincolnshire locomotive expenses, which appeared from the diagrams to be about 5*d.*, as against 9·26*d.*, the average of the locomotive expenses during the last twenty years. He thought there was something that required explanation in the small figure given in the diagram. He might mention, that having been at one time connected with that line, and having had facilities for obtaining accurate information, he

certainly had never known the locomotive expenses to have been at so low a figure as 5*d.* per train-mile. With the few exceptions he had enumerated, the diagrams of the cost of locomotive expenses might be taken as fair average results, as might be seen from a reference to the accompanying tabular statement (p. 344).

Mr. HEMANS, Vice-President, remarked that the Paper was one which at first sight appeared more calculated to interest directors and traffic managers of railways than The Institution of Civil Engineers. He considered, however, that the skill and mechanical arrangement, by which so much statistical information was presented to the eye, were such as brought the Paper within the province of the engineer. The diagrams showed at a glance the results given in the returns published by the Board of Trade, and were well calculated to call attention to discrepancies which would hardly be discovered in the lengthy pages of a blue-book. He concurred with the Author with respect to the inexpediency of making too great a difference in the fares on railways. He believed the tendency of society in the present day was rather to "level up" than to "level down," and that if a great difference were made between the third-class fares and the others, there would be a large proportion of third-class passengers, but low receipts. On a railway recently opened in a remote agricultural district in Ireland, of which he was the Engineer, the experiment of extremely low third-class fares was tried. In that case the line was 36 miles long, and the third-class fare was fixed at 2*s.* for the whole distance, or at the rate of less than $\frac{3}{4}d.$ per mile. This, except in special cases of suburban lines, was the lowest rate he had ever heard of. The result was not satisfactory. It was found that, though everybody appeared to come who was likely at that low rate, second-class people found it so convenient to pay 2*s.* instead of 4*s.* 6*d.*, that they dropped into the third class; and first-class people did not think it beneath them to do the same. He might observe, too, that the relative proportions of first, second, and third-class traffic upon many of the railways were almost the same as those given by the census of 1861 as the proportions of wealthy classes, of those comfortably off, and of the labouring classes in the population of Great Britain—viz., 10 per cent., 15 per cent., and 75 per cent.

With regard to Mr. Barlow's observations, and the statistics in his pamphlet lately published, Mr. Barlow found that the primary value of every new mile of railway in Great Britain and Ireland, in gross results was £1,200 per annum, and that afterwards from the growth of traffic, £100 increase for every mile per annum might be calculated. On applying the calculations, however, to Ireland only, Mr. Hemans found they would not do at all, as the receipts in that country were considerably below those in England. The primary value of new lines in Ireland would not amount to

Locomotive Expenses, per Train Mile and per Engine.

Railways.	Period of Years.	Train Miles per Engine per Annum.	Salaries, Office Expenses, &c.			Running Expenses.												Total Running.			Renewals.			Total.		
						Wages.			Coal.			Water.			Oil.												
			Per Train Mile at present time.	Per Train Mile.	Per Engine per Annum.	Per Train Mile at present time.	Per Train Mile.	Per Engine per Annum.	Per Train Mile at present time.	Per Train Mile.	Per Engine per Annum.	Per Train Mile at present time.	Per Train Mile.	Per Engine per Annum.	Per Train Mile at present time.	Per Train Mile.	Per Engine per Annum.	Per Train Mile at present time.	Per Train Mile.	Per Engine per Annum.	Per Train Mile at present time.	Per Train Mile.	Per Engine per Annum.	Per Train Mile at present time.	Per Train Mile.	Per Engine per Annum.
			Mr. Harrison's Figures.	Average of Years.		Mr. Harrison's Figures.	Average of Years.		Mr. Harrison's Figures.	Average of Years.		Mr. Harrison's Figures.	Average of Years.		Mr. Harrison's Figures.	Average of Years.		Mr. Harrison's Figures.	Average of Years.		Mr. Harrison's Figures.	Average of Years.		Mr. Harrison's Figures.	Average of Years.	
			d.	*d.*	£.	*d.*	*d.*	£.	*d.*	*d.*	£.	*d.*	*d.*	£.	*d.*	*d.*	£.	*d.*	*d.*	£.	*d.*	*d.*	£.	*d.*	*d.*	£.
London, Brighton, and South Coast	19	18,003	0·17	0·16	14	2·4	2·22	166	3·7	3·97	300	0·2	{Included in Oil and Tallow.}		0·5	0·83	64	6·8	7·02	530	2·7	3·85	298	9·7	11·03	842
South Eastern	20	17,266	0·25	0·24	16	2·5	2·11	150	3·4	3·07	216	0·25	0·24	18	0·35	0·23	16	6·5	5·65	400	2·8	3·21	226	9·7	9·10	642
London and South Western	22	21,108	0·13	0·29	23	2·0	1·79	161	2·3	2·52	232	0·2	0·27	22	0·45	0·48	36	5·0	5·06	451	2·9	3·15	270	8·0	8·50	744
Great Eastern	13	18,154	0·24	0·09	8	2·2	2·14	162	1·9	2·88	218	0·25	0·16	12	0·4	0·69	52	4·7	5·87	444	2·7	2·99	226	7·6	8·95	678
London and North Western	10	16,197	0·27[1]	1·36	93	2·45	2·19	148	1·7	1·98	134	0·1	0·06	4	0·35	0·34	25	4·75	4·57	311	3·7	3·49	232	8·7	9·42	636
Great Northern	20	19,286	0·18	0·67	56	2·3	1·81	144	2·15	2·28	196	0·2	0·38	10	0·35	0·29	24	5·0	4·76	374	4·2	2·79	236	9·4	8·22	666
Lancashire and Yorkshire	13	17,760	0·08	0·07	5	2·4	2·15	158	1·7	1·81	134	0·15	0·16	12	0·45	0·43	32	4·75	4·55	336	2·9	2·67	199	7·7	7·29	540
Midland	22	19,062	0·18	0·22	18	2·25	2·07	160	1·9	2·60	192	0·2	0·18	14	0·3	0·40	30	4·7	5·25	396	2·7	3·62	276	7·6	9·09	690
Manchester, Sheffield & Lincolnsh.	16	19,557	0·22	0·76	62	2·4	2·22	180	1·7	2·44	196	0·05	{Included in Oil and Tallow.}		0·35	0·56	46	4·45	5·22	422	3·5	3·28	268	8·2	9·26	752

[1] Includes general charges, such as cost of stationary engines, renewals of machinery, &c.

half the £23 per mile per week, which was necessary to make £1,200 per annum. Therefore, it appeared Mr. Barlow was generalizing too much when he included Ireland in his tables.

Mr. F. HILL attributed the reduction in the value of railway property not wholly to the Directors but, in large measure, to the proceedings of Parliament, which had been practically this—"If you draw a blank, you shall be left to enjoy it; if you draw a prize it shall be snatched from you." In their early days, railways as a rule were prosperous, and so they ought to have continued. The traffic had exceeded all anticipations; yet the pioneers who had advanced the capital and given their time and labour to the subject, instead of being rewarded had lost half their capital. He had no confidence that, under the present system, railway property would recover itself. Let the desire for investment and the spirit of enterprise rise, and attempts would be made to deprive improving railways of the advantages they enjoyed. When it had to be decided by Parliament whether a new line should be granted or not, there was now no one to represent the general interest, and hence, new lines were often granted such as the Trent Valley railway, and the second line to Hastings, which ought never to have been allowed.

Mr. G. W. CURRIE said, as representing the financial element in railway management, as contrasted with the scientific element, it was interesting to find this Institution engaged in discussing the details of railway economy and expenditure. Those who had found and administered the capital of railway undertakings had been accustomed to look on engineers as fertile in resources for making the intellect of man control the forces of nature, but as entertaining, perhaps, rather a contempt for the £. *s. d.* considerations which had weighed so heavily on investors. He thought it was a pregnant sign of the times to find engineers engaged in discussing the everyday details of working economy, and the means by which income might be increased, and expenditure diminished. All persons interested in the pecuniary success of railway undertakings must be grateful to the Author for the statistics which he had collected, and for the clear and able manner in which he had explained them, from which railway managers might draw useful practical deductions. To the financial suggestions contained in the Paper he regretted that he could not attach the same value. On the proposal that Government should relieve the railways, by guaranteeing a portion of their securities, he would remark that it could not be considered as a practical suggestion by any one acquainted with the actual working of political life in this country; for he doubted if there was one man in either House of Parliament, who had any following in the country, who would for a moment countenance or recommend such a proposal, and

he thought it might be dismissed as visionary. The idea that the great companies should combine to issue a consolidated debenture stock with their joint guarantee had been often mooted, and might possibly be one day carried out, but the difficulties in the way of it were so enormous, that he did not think any one could look with confidence for relief in that direction. Nor did he think that the burdens under which shareholders were groaning were to be ascribed to the form in which preference, guaranteed, or other stocks had been issued. The explanation of these burdens and difficulties was much simpler, and consisted solely in the amount of capital which had been expended. Enormous and wasteful outlay, gigantic preliminary expenses, exhausting Parliamentary contests, ruinous land purchases, improvident contracts, unnecessarily costly works, open capital accounts, great fortunes realised by professional men, accounted for the unhappy position of the shareholders in too many of them. The spending element in railway management had been active, clever, and aggressive. The controlling and economising element, or what should have been such, had been sometimes, perhaps, corrupt, often certainly inert, careless, and incompetent. Hence had arisen those vast schemes of extension which had covered the whole face of the country with works, admirable in themselves, but hopelessly unremunerative to those whose money had been embarked in them. Some stress had been laid on the results to be expected from the growth and increase of traffic, and it had been said that the prospects of railway property were brilliant and hopeful in that direction. He could not take so sanguine a view. No doubt the general growth and development of the resources of the country must lead to a gradual and certain increase; but it would be slow, and could only by rigid economy be made sure. In promoting it railway managers might be largely helped by a study of the statistics recorded in the Paper; but one thing could not be too strongly insisted upon,—the absolute necessity of rigorously closing capital accounts (with the single exception, perhaps, of providing the new plant required by a bonâ fide growth of traffic) and devoting every energy to make existing undertakings remunerative. He was afraid this was not a brilliant prospect for the members of the engineering profession; but while the heads of the profession had risen to greatness by the exercise of their splendid abilities, he would venture to say to the younger members, and to those who aspired to a similarly successful career, Would it not be safer to look for some other road to honourable advancement? for depend upon it, the palmy days of railway enterprise and of confiding shareholders were over. On the wall beneath the portraits of the great captains of the profession might be read the handwriting which appeared to Belshazzar! The glorious days of rich contracts

and engineering triumphs had departed, and now had come the lean times of vulgar economy, and of enforced attention to the details of business, such as those which had been brought forward in the Paper.

Mr. FOWLER, Past-President, observed, that nothing was more honoured in the engineering profession than economical construction. No engineer could claim a position, of which, in the Institution, he would have reason to be proud, except he could show that his works had been designed with skill and economy; and nothing would place him in a lower position than the character of being extravagant and wasteful in his designs. There were many sources of extravagance that had led to great expenditure. If those who had charge of the finances of the different railway companies could place in the hands of engineers the means of paying the contractors in cash, the ruinous outlay of the last few years would have been avoided, where financing had been the chief cause of the depreciation of the property. Among other sources of economy that was a chief one.

The Paper was peculiarly valuable and complete, and for that reason the more difficult to discuss. He would, however, remark that, unless all the lines referred to were under exactly the same conditions in regard to traffic, speed, and gradients, comparisons based on these tables and statistics were practically of little value. For instance, with respect to the permanent way and the locomotive expenses, how was it possible to compare one with the other, unless they were reduced to some common standard? He agreed that it was useless to seek for Government credit, and, if obtained, which was very improbable, Government would exact equivalents more onerous, probably, than the original burdens.

The Author had suggested that, in future, branch railways should have light rails, steep gradients, and light engines, and that the traffic should be worked cheaply; but Mr. Fowler did not see how all these conditions could be combined. True, on subsidiary lines, less money might be spent in construction, even with the certainty of an increased cost of working; but then there would be less money to spend in making good gradients, and on the permanent way; and if the gradients were steep, the rails must be sufficiently heavy to carry engines capable of working the traffic; so that a combination of all these things was more than could be hoped for. At the same time, no doubt, much might be accomplished in that direction by the landowners giving the land, or selling it at lower rates than had been customary hitherto, and by the Board of Trade permitting level crossings where a line passed a country road with little or no traffic. The works also might be made more cheaply, even if, as in America, it was necessary to re-construct or to strengthen them as the traffic increased. He did not look without

hope to the future of railways; and of late the dividends of the leading companies had been satisfactory to those who had the good fortune to be shareholders in them. The increase of traffic, from the development of trade, manufactures, and population, might be looked forward to with great confidence. The rate of increase had been considerable, and there was no reason to expect it would diminish; and that was in itself a constant source of hope for the future. There was also, in many directions, the hope of decreased cost both in construction and in working. The introduction of steel at a low price would reduce the cost of the permanent way; and he thought it possible the form of the permanent way might be simplified and cheapened as steel was introduced. No doubt steel was really a cheaper material than iron, looking to its great strength and durability, and a considerable reduction of expenditure would unquestionably follow the general use of that metal. Locomotives were constantly being simplified, and their duty was being performed at less expense; and here, again, steel came into play. It was now more than ever used for locomotives. Anything which tended to diminish the cost of the permanent way and of the locomotive charges (which were the two great sources of expense in the working of railways) must lead to economy. In carriages and other plant improvements in the direction of economy were also being made; therefore, he repeated, he looked with hope to the future. He trusted that both engineers and those who had the control of the financial operations of these great schemes would learn a lesson from the past. He did not think it proper to speak of individual railway companies, but no doubt there had been considerable mistakes made in the administration both of old and of new companies in this country.

He thought it was impossible to lay down any fixed rule as to passenger fares, as to the proportion of third-class trains, or as to the difference between second-class and third-class fares. Each individual district, and even portions of a district, must be dealt with according to the requirements of the case. Any attempt to lay down a rigid rule either for very low fares, or for a very small difference between the fares of one class and another, was a mistake. That which engineers had to look to was, in the construction of works, to study efficiency and economy to the utmost extent; whilst directors and managers, who had charge of the commercial part, had to consider how they could best develop the traffic. He did not consider it a certain criterion of economy that the traffic was worked at 30 per cent., or the contrary that it was worked at 60 per cent. of the gross receipts. It might be better, for instance, that the working expenses should be 50 per cent. than 40 per cent. Nothing was a greater mistake than to suppose that a low per-

centage of working expenses was necessarily an evidence of good working. Supposing a line had an enormous mineral traffic, and that it could only be worked at a cost of 80 per cent. or not at all, surely it was better to have that traffic than to be without it. He entirely agreed with the views repeatedly expressed by Mr. Hawkshaw, that these comparisons, unless the circumstances of each case were known, were worse than worthless.

Mr. EDWIN CHADWICK, C.B., said he apprehended that any extent of enterprise and of engineering work within the scope of the policy to which the Paper was confined, namely, of work to be done by joint-stock enterprise, for dividends obtained on the public necessities of conveyance, little more was now to be expected; whilst of engineering work on legitimate economical principles, and on proper public policy, and Governmental duty as a service in respect to the means of intercommunication, as much perhaps, in extent, if not in cost, remained to be done as had been done by railways. The policy treated of in the Paper regarded only part of a railway system, that of the trunks, or the main arteries of communication—leaving out of account the branches, the capillaries, necessary to its completion. Now, on farms of advanced culture, as also within manufacturing works, to save horse-power—one horse doing the work of three—for the removal of manure and produce, it was found worth while to lay down tramways. It was also, he found, worth while to lay down tramways, to save horse-power, for the conveyance of manure to, and of produce from, neighbouring farms. This was what was now doing extensively in America and in Canada. In Canada it was done by the landowners or the farmers themselves, who met together, raised money by debentures on rates on the land benefited, and began with the cheapest trams, wooden sleepers armed with little more than hoop-iron. This was the commencement of a capillary formation, as it were. As traffic advanced, the iron armature was strengthened, light locomotives were put on, and with progress they would probably advance to steel rails and first-class locomotion. These primary formations were, in England, prevented by lawyers' expenses, by Parliamentary expenses, by local acts, by heavy rails and expensive ways, and locomotives, on the scale of the trunk lines, and for the greatest traffic. These inappropriate constructions converted what otherwise would be the natural feeders into suckers of the trunk lines. When he said that as much probably remained to be done, in extent of capillaries, as had been done in main arterial lines of communication by rail, he said so upon particular examples, created under exceptionally favourable circumstances; but in confirmation of his view he referred to the statistics of the Post-office, which showed that whilst the mails were conveyed by railway 49,000 miles daily, they were yet con-

veyed 39,000 miles daily by mail-carts and omnibuses. In most cases tramways at the commencement would be, as it was on farms, an economy of three to one of horse-power. But the existing mail lines for carts and omnibuses were to many districts main lines, to which there might be subsidiary branch lines of tramways. Beyond these there were 72,000 miles of daily conveyance of mails, by upwards of twenty thousand postal foot messengers. When the twelve thousand post-offices were utilised for the public service, as receiving-houses for the collection and distribution of small parcels and goods by rail, as in Belgium, Switzerland, and Prussia, with vast increasing advantages of the trade and the public, much of these foot-deliveries would require to be carried on by carts and probably by public tramways. But to all this development of the proper circulating system of a country in free and healthy intercommunication, the present system of the trading companies was wholly repugnant. It had no wholesome power of assimilation or of capillary development. With it, he repeated, the natural feeders became suckers. With the trading companies their principle was the constitutionally false and economically pernicious one, that the only test of the value of a road was payment by a dividend or by a toll, and that, too, on their unwarranted scales of works and expenses. But a railway, like a common road, would often pay well, where it would not pay at all by a toll. The Waterloo bridge was a dead loss to the shareholders as a company speculation; yet he had had opportunities of learning that, by the increase of rentals of £40,000 per annum on the south side of the river alone, it would have been a "paying work" for any general owner of the district to have undertaken. The same public policy which was occasioning the abolition of tolls as a means of paying for highways, would lead to the abolition of the notion of confining railway extensions to dividend-paying lines. He had got the late Mr. Smith, of Deanston, who was a good agriculturist and agricultural engineer, to investigate the subject, which he did in Scotland, where he showed upon one example that the formation of a line of railway would add 2*s.* 6*d.* per annum to the valued rental of the land 5 miles on either side;—that this sum capitalised would pay for the formation of the line, which might be given over to be worked as a turnpike road. Now the way to open up all this work was simply to revert to the common principles, the old constitutional principles, of the formation and maintenance of the public highways as a public service, and for the payment for the service alone, and neither for revenue nor for dividends; for of all taxes he, as an economist, contended that those on intercommunication were the most wasteful, improvident, and pernicious. And this return to correct economical and legislative principles he had contended might and ought to be effected

in the interest of the ill-used shareholders, in justice to them as well as in the interest and in proper Governmental duty towards the general public. For this purpose there was a fund obtainable by the disestablishment of several hundred directorates, and by unity of administration under one competent establishment, and that a really responsible public one. But the main economy was in the reduction of the working expenses; as by making two trucks do the work of three, or making one do the work of two or more; by making one set of carriages do the work of two or three, as in instances of three lines running between the same places at the same time with carriages each only one-third full. The late Captain Laws, of the Lancashire and Yorkshire railway, estimated the saving derivable from unity of management at as much as 20 per cent.; and since his time duplicate and triplicate competing lines had been formed, and the means of saving had not apparently been diminished. The late Mr. Stewart, the Secretary of the London and North-Western railway, had stated upon examination before the railway commission, and upon careful investigation, that the saving from unity of management was at least 10 per cent. upon the gross receipts, which he said amounted to 20 per cent. on the working expenses. Quite recently Mr. Laing, the Chairman of the London and Brighton railway, was reported to have stated to the shareholders that if Parliament had allowed them to amalgamate with the South Eastern railway company, the shareholders would have had 20*s.* added to their dividend, then 10*s.*, and that would have added £1,360,000 to the value of their ordinary stock. But by the general amalgamation for which Mr. Chadwick contended, they would have had a share of more than that, from a saving of 1 per cent. and more from the increased value of public securities on all their debenture debts, and a saving from all local and general taxation, amounting to about 6 per cent. more. Now, in whose interest was all this economy avoided and all this waste maintained? Certainly not in the interest of the great body of the shareholders, nor of the bulk of the engineering profession. He had contended for the application of these same principles to telegraphic communication, that, by unity of management, by saving working expenses, by consolidation (which was the chief thing to do), by utilising the postal stations and deliveries with which no private company could compete, a capital might be saved which was divisible between the public and the shareholders, serving to compensate the shareholders in non-paying lines, as well as of those that were paying, and giving to the public reduced rates and increased accommodation. Now these economical principles had, after much conflict with the directorates, been carried in that instance in the interest of the shareholders, as well as of the public. The precedent was the same with the case of the railways, and of

the ill-used railway shareholders. The directorates generally admitted the gains derivable from a general amalgamation; only they said "let us do it ourselves." The answer was, that it was not in their bond, neither was it in their proved competency to do it. Railway administration could not be safely continued as an incident to other professions: it required undivided attention, and that responsible to the public as well as to the shareholders. Whatsoever it might have been as to the past, as to the future the interest of the younger members and of the great bulk of the civil engineering profession was now with the public and with the great body of the shareholders, in the return to sound principles of economy and of public administration in the maintenance of all the means of intercommunication as a responsible public service. This was becoming the feeling in America, as well as with the public in this country.

Mr. HAWKSHAW, Past-President, contended that these comparative statements must be taken with many other considerations attached to them, otherwise they would lead to serious mistakes. A railway, over which two hundred trains a-day travelled, might otherwise be compared with another on which there were only ten trains a-day. It was idle to compare the cost of maintenance of railways without reference to the amount of the traffic. With regard to professional prospects the bane and the antidote had been suggested; Mr. Currie said that the engineer's occupation was gone; on the other hand, Mr. Chadwick gave a more cheering prospect. There was no doubt that the persons who found the money to construct the railways in this country had benefited the property through which the railways had been carried to as large an amount or larger than the entire capital itself. This seemed to be forgotten by the public. There was no doubt, also, that the railways which had been made in this country had not produced their proprietors as large a return as they were entitled to; but, surely, that was not matter of blame to them. Railways had produced an amount of advantage to landowners which they were not entitled to, because they did not find the money, and, in the earlier days of railways, they created every possible obstruction; therefore he should be glad if he saw a way to carry out the scheme of Mr. Chadwick, and to make the landowners contribute to the cost of those lines; but he feared there was no means in this country to bring about such a state of things; and he believed that railways would be constructed in the future very much as they had been in the past. The reasons assigned for the deterioration of railway property did not appear to him sufficient. Professional men might have gained considerable sums of money by railways, and, possibly, in some cases, have been overpaid; but he did not think that was the cause of the depression of the property. It

arose from a cause which would occur again, viz., a tendency in men to overtrade. It was the same with railways as with cotton speculations, or the manufacture of goods, and other things in which men engaged to make money; and it would come to pass, from time to time, that men would embark more largely in such undertakings than they ought; they did so especially in 1844-45. He remembered the time when railway property was in a worse condition than it was at present, and when it was asserted that no more railways would be made. What had happened since? Many more miles of railway had been made, and the same result had occurred again. The fact was the mileage of railways had been increased at too great a rate, and in consequence railway property had suffered, but it would now be rectified, because, for a time, there would be no more railways; the time, however, would come when dividends would get up to 8 per cent. or 9 per cent., and then more railways would be made. Until men became prudent beyond expectation, times of quiet and improvement in railway property would be succeeded by the projection and construction of fresh lines, and then would follow the depreciation of that property. This was treating it as a railway proprietor's question. If he looked at it as a national question, he believed no mischief had occurred; on the contrary, it was much better for the country than if railways had been checked, either by Government or otherwise. He was certain that the railways were paying, if not to the proprietors, yet to the nation, a larger rate of interest than had been derived from any other investment of money. There might be one or two lines he should wish to be expunged, but he was sure, on the whole, the nation had largely gained by railways.

Mr. F. S. DUTTON said, it would be satisfactory to manufacturers of railway materials to find that, in Australia, railways were still in progress, and would no doubt for many years continue to be made to a large extent. But looking to the money expended upon and the return received from them, as the term was understood in England, they could hardly be said to pay; but that was not the light in which to look upon railway enterprise in Australia. In a settled country, with a large population, the cost of a railway and the probable returns could be estimated. In Australia, population was comparatively small and greater difficulties stood in the way of railway enterprise. Wages were higher and materials dearer than in England, because they had to be imported. It was the indirect advantage to the country which formed the inducement for prosecuting those works, and which would, no doubt, lead to their continuance for a long time to come. The importance of saving in the cost of traction, and the certainty of being able to bring produce to the coast within a required time, in a country like Australia, were almost beyond calculation; particularly in the

colony he was connected with (South Australia), where, when the harvest was plentiful, it was impossible to get the grain to the coast ready for shipment, at the very time it was most wanted for export, without the railway to bring it down. He did not despair of seeing the day when railways would be made from the south coast to the north coast; and probably many of those who were now Students of the Institution would find there a profitable and honourable field for the exercise of their talents.[1]

Mr. Dutton has, since the Meeting, furnished the following particulars respecting the South Australian railways. The permanent way in use on the Port Wakefield and Hoyles Plains tramway having a width of gauge of 3 feet 6 inches, and on the Roseworthy and Forresters, the Strathalbyn and Middleton, and the Northern Extension to Farrels Creek railways, each having a gauge of 5 feet 3 inches, consists of flat-bottomed rails, weighing 40 lbs. to the yard, and in lengths of 21 feet, fish-jointed, and fastened by dog-spikes on wooden sleepers, placed about 2 feet 6 inches apart from centre to centre. The iron material for one mile of single line comprised:—

	tons.	cwt.	
Rails . . .	63	0	
Fish-plates . .	1	14	No. 504 pairs.
Fish-plate bolts		14	No. 1,008, with nuts and washers.
Dog-spikes . .	1	8	No. 9,500, 3 ins. long, with a small proportion 4 ins. long.
Total .	66	16	

The materials had been recently purchased at the following rates per ton, delivered for shipment in London, namely: rails £6. 15*s.*, fish-plates £6. 15*s.*, fish-plate bolts £12. 10*s.*, and dog-spikes £11. 14*s.* 6*d.* The cost of the iron material for 1 mile of line on these terms amounted to £461 17*s.* 10*d.*

On the Dry Creek and Port Adelaide, and the Port Adelaide and Kapunda railways, each with a gauge of 5 feet 3 inches, the permanent way consisted of double-headed rails, weighing 65 lbs. to the yard, also in lengths of 21 feet, fish-jointed, laid on cast-iron chairs, fastened by spikes to wooden sleepers, about 3 feet apart from centre to centre. The material in a length of 1 mile of single line, exclusive of wooden sleepers, comprised:—

	tons.	cwt.
Rails	102	3
Chairs.	41	0
Fish-plates	5	8
Fish-plate bolts, nuts, and washers . .	1	11
Spikes	3	4
Wooden keys	1	12
Total	154	18

The materials had been recently purchased at the following rates per ton, delivered for shipment in London, namely: rails £7. 7*s.* 6*d.*, chairs £3. 4*s.*, fish-plates £7. 7*s.* 6*d.*, bolts £11, spikes £9; the wooden keys, including packing, cost £5. 8*s.* 3*d.* per 1,000, and the cost for 1 mile of line on the prices stated amounted to £990.

In 1868 a total of 60½ miles were open for traffic. There were twenty locomotives, of which two were quite new, four in good order, and fourteen were in various degrees of condition requiring repairs. The total mileage run by these twenty locomotives since 1856 was 1,867,563 miles. The largest number of train-miles run by any one engine was 182,632. On an average of seven years, the

Mr. CURRIE said, branch lines had been spoken of as things that were to be made without any reference to the probability of their paying a dividend on the capital sunk in them. This had narrowed the question, for if these 'capillaries' (as they were called) were not to be made in the interests of the shareholders who paid for them, in whose interest were they to be made? The question for investors was, Were they in these branch lines to rear up a flock of sheep for their own eating, or a herd of wolves to eat themselves up? The doctrine broached was that of a late chairman of the railway with which he had the honour to be connected, who held that, if a portion of the capital necessary for the construction of a branch line were provided by persons locally interested in it, the shareholders in the trunk line should find all the remaining capital, and engage further to work the branch for 50 per cent. of its gross receipts. The result of that policy had been that in nearly every instance, not only was no return received by the parent company for the capital expended, but the total receipts of the branch were not sufficient to provide for its working expenses.

Mr. JOSEPH MITCHELL observed, that no one who had directed his attention to the subject but must have been struck with the wonderful elasticity of railway traffic. In 1860, thinking it would be beneficial for Government to purchase the railways, as they had since done the telegraph, he took considerable trouble in investigating the subject, and drew up a table containing the particulars of twelve of the principal railway companies in Great Britain. The calculated increase between 1849 and 1859 was as follows:—(p. 356).

This Table was interesting because a similar comparison could not now be made, as, after 1860, what with new lines, amalgamations, and leased lines, the revenues of which were all thrown together, the progressive traffic of each section of a railway could not be ascertained. There could be no doubt, however, of the buoyancy of the traffic which must continue so long as population increased, and Great Britain was the emporium of the commerce and manufactures of the world. The 'Westminster Review' estimated the increase at £2,000,000 in 1863, and it had been much more since. Yet with all this, railway property had been, with few exceptions, most unremunerative. The Great Western, 1,386 miles in length, divided only 2 per cent.; the South Eastern, 346 miles,

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number of passengers annually carried was 370,000; and for the same period the total revenue was £110,000, and the total expenditure £98,710.

The goods carried in 1868 were: general merchandise 17,000 tons, flour and wheat 28,000 tons, metals and minerals 15,000 tons, wool 2,700 tons, miscellaneous 1,500 tons, making a total of 64,200 tons. The expenditure on 574 miles of macadamized roads had been £983,000. The export and import trade of the colony represented £5,000,000 per annum.

NAME OF LINE.	Revenue in 1849.	Revenue in 1859, including Main Lines and other lines added.	Gross increase in Traffic of 1859 over 1849.	Of which increase there is attributable to Main Lines.	And attributable to New Lines assumed or added to Main Lines.	Per centage of increase on Main Lines in 1859 over 1849.	Estimated Revenue in 1869, assuming the Traffic on the Main Lines to increase in the same ratio as during the previous ten years, and the Traffic on the New Lines to increase in half the ratio of the Main Lines.
	£.	£.	£.	£.	£.		£.
Lancaster and Carlisle Railway	212,215	363,972	151,757	151,757	..	71½	624,212
East Anglian Railway	36,766	49,963	13,197	13,197	..	36	67,950
Scottish Central Railway	63,098	162,045	98,947	90,107	8,840	142⅘	387,133
Lancashire and Yorkshire Railway	588,030	1,289,217	701,187	523,347	177,840	89	2,357,481
Bristol and Exeter Railway	198,000	353,706	155,706	114,756	40,950	58	546,979
London, Brighton, and South Coast Railway*	498,328	835,968	337,640	244,040	93,600	49	1,222,661
North British Railway	155,169	295,765	140,596	94,836	45,760	61⅛	462,565
London and South-Western Railway	520,841	913,173	392,332	236,332	156,000	45	1,289,000
Midland Railway	1,169,460	1,897,773	728,313	518,493	209,820	44⅓	2,692,609
North-Eastern Railway (1849 assumed by calculation)	962,487	1,909,315	946,828	846,988	99,840	88	3,545,583
London and North-Western (1849 assumed, excluding the miles added in 1858 and 1859)	2,197,957	3,570,797	1,372,840	989,080	383,760	45	5,091,310
Great Northern and East Lincoln Railway	111,394	1,298,475	1,187,081	1,187,081	..	141¾	3,139,063
Revenue in 1849	6,713,745			5,010,014	1,216,410		
Revenue in 1859	..	12,940,169					
Increase in revenue of 1859 over 1849	..	..	6,226,424				
Estimated revenue in 1869	..	..	..	..	..		21,426,546

* In the above Table the London, Brighton, and South Coast, and Branches, are estimated to increase in ten years 73½ per cent., viz —Main Lines, 49 per cent.; Branches, 24¼ per cent—73½ per cent. As evidence of the moderation of this estimate, the last Report of the Directors may be quoted: "In 1848 the number of passengers conveyed was 2,485,778, and in 1859, 8,395,615. In 1848 the receipts for passengers amounted to £349,977, and in 1859 to £580,931; in 1848 the annual Season Tickets amounted to £10,427, and in 1859 to £40,218; the goods traffic in 1848 amounted to £61,493, and in 1849 to £157,636. The gross revenue in 1848 amounted to £453,408, and in 1859 to £842,293, showing an increase of £388,885 in eleven years, or 86·4 per cent., being at the rate of £35,353, or nearly 8 per cent. per annum."

$2\frac{3}{4}$ per cent.; the Manchester, Sheffield, and Lincolnshire, 252 miles, 2 per cent.; the Brighton, 366 miles, $\frac{1}{2}$ per cent.; and after a long period of no dividend, it was understood 1 per cent. was to be divided on the Great Eastern, 728 miles in length; while the London, Chatham, and Dover, 137 miles, and the Metropolitan District paid nothing. He need not draw attention to the ruinous state of railway property in Ireland. In Scotland much loss had been sustained. The North British, with its 800 miles or 900 miles, had paid no legitimate dividend for many years; the Caledonian, 670 miles, 2 per cent. or 3 per cent.; the Great North of Scotland, with about 260 miles, nil; the Glasgow and South Western, 250 miles, 5 per cent.; and the Highland, with 250 miles, 3 per cent. Under such a condition of railway property, and its consequent sudden fluctuations in value, it was a fitting subject for the Institution to consider, how economy might be introduced in working and the traffic increased.

It was evident that travelling was not increased by high fares. Where there were masses of population the fares should be low; and he was glad to notice that the North Eastern Railway Company had taken the first steps in the direction of reducing fares. What must strike every one from these tables was the preponderance in the number of and revenue derived from third-class passengers. He had noticed this even in the north of Scotland, on the Highland railway, where, in the half-year ending February, 1867, the proportions were:—

Class.	Number of Passengers.	Receipts.		
		£.	s.	d.
First	60,043	13,597	0	8
Second. . . .	25,579	5,090	5	9
Third	384,359	24,708	5	6
Total . .	455,101	43,345	10	11

This nearly coincided with Mr. Harrison's tables, and showed that third-class passengers were by far the best customers of the railways; and he was sorry to say they obtained the least consideration and accommodation.

In Scotland, with a population of $3\frac{1}{4}$ millions, he felt satisfied there was not one-fourth of the passenger traffic there might be to London and England if the fares were lower and the accommodation better. From Glasgow and Edinburgh to London the fare of a first-class passenger was £3. 10*s*. Now at such rates it required a man of fortune to visit the metropolis with his wife and family. Such fares were a complete barrier. It was true the railway

managers issued excursion tickets for the autumn, but till last year they were refused to the Scotch. The reduction of fares, of course prudently, was a step that must be taken. The ill effect of the recent increase on the South Eastern and the Brighton lines was well known, and there was an instance of it which came under his own knowledge on the Highland railway. The number of passengers on that line was year by year increasing, and for the year ending November, 1867, they had increased 65,532. The Directors thought they would improve their revenue by increasing the fares 2*d*., 3*d*., and 6*d*. on return tickets, when the number of passengers diminished in the year ending November, 1868, by 105,397; and in the year ending November, 1869, by 94,493, as compared with the number in 1867, and this in a thinly-populated agricultural country.

There had been a discussion for many years about through communication in trains; and he thought it was a reflection on the ingenuity of the engineering profession that there had been little or no improvement in railway carriages since the opening of the Liverpool and Manchester railway. For long journeys at least the Board of Trade should insist on through communication, either in the centre or at the sides, in trains, with its safety and all its attendant conveniences. Through communication in trains was successfully carried out in other countries, particularly in America. A recent passenger from St. Francisco reported that he had travelled in seven days from that city to Philadelphia, on the new line, which was 3,300 miles in length, having the English gauge of 4 feet 8½ inches. There was an hotel train once a week. In the train in which he travelled there were a hundred and eight passengers. The carriages were fitted up with beds, which during the day were let down. The train was fitted with every convenience, including dining and smoking saloons, and the motion was so smooth, that the passengers could sit undisturbed at their meals. There were also private carriages for families who desired privacy. The kitchen was at the end of the train, from which any one could order what was wanted. The travelling public of Great Britain should have the same accommodation for long journeys; at any rate from London to Carlisle, to Newcastle, to Holyhead, and to Scotland; and he hoped the Board of Trade would insist on some such arrangement before long.

Mr J. H. Lloyd said there were but few occasions on which he could, without presumption, venture to address the Institution, because he did not of course pretend to have technical or professional knowledge upon such topics as generally occupied the attention of engineers. But the subject under discussion was one upon which he might perhaps be allowed to make some observations and suggestions, because twenty-five years' acquaintance

with the polity and internal mechanism of railway administration did in some degree justify, or afford an apology for, his intruding upon the notice of the meeting.

He differed from some of the speakers who had preceded him. In the first place, he thought the subject was one which did, though not directly, yet not remotely, interest and affect engineers. He knew, from personal experience, that many of the engineers who were connected with the great railway companies of the kingdom were an essential element in the management of railway affairs. They were consulted, as they naturally would be for their talent and knowledge, upon all questions of arrangement and administration which affected the prosperity of railway undertakings; and therefore it was impossible that a question such as that under discussion should be a subject alien to the interests of the Institution. This also was evident, that with respect to railways to be constructed, whether in England or on the continent of Europe, whether in British possessions or in foreign countries, the experience of engineers would be most important in determining what should be done, at what cost, and in what manner; and that information must be governed very materially by the generalised results, such as had been tabulated by the Author of the Paper. He preferred that handwriting on the wall to the metaphorical handwriting which had been alluded to. Mr. Currie had spoken of it as indicative of the utter extinction of railway enterprise, and the decadence of railway engineering; but he thought that if the illuminated letters, which spoke to Belshazzar on the wall, had no more prophetic significance than that which was attributed to the future of engineers, his successors might have been mighty potentates to this day, and Babylon still the metropolis of the East. There was yet abundant work for engineers in Great Britain, and far more in the wide world. Wherever communications were important—and where were they not?—wherever exit had to be found for mineral or agricultural wealth, wherever people sought to transport commodities from one part to another, there railways would surely in the end be made, and the engineers and pioneers of railway works would be the persons sought for to accomplish those works.

Again, he differed from some who had spoken about the unimportance of statistical results. It was true that in the application of these results, there would be varying circumstances in each case. No general rule or principle would be applicable to every particular line in every particular district; but surely, tabulated results, if they were not fruitful for anything else, were charts to indicate what course to steer, and what rocks and shoals to avoid. They were eloquently illustrative of what had been done wrongly before, and therefore eloquently instructive of what

was to be done, and what was to be avoided, in the future. The blunders of the past were lessons for the future; and the sooner men understood that, the better it would be for every great undertaking. It was easy, as had been done by one speaker, to indulge in eloquent invectives against jobbery and mismanagement. It was easy after the event to say, "You might have done this, and you might have left that undone." But to impute the faults and miscarriages of the past to any particular class of men, or section of interests, was unreasonable and unjust. It was well known that the mistakes made had been mainly caused by unwise legislation—by the erroneous notions of those who had thought it expedient to cripple and fetter railway enterprise, by restrictions and regulations and conditions, as mischievous as they were unnecessary. He wished to make a few practical suggestions.

Three questions were involved in the consideration of this subject, the construction, the financial working, and the administration of railways.

Now, the construction had no doubt been very costly; as to the cost of the preliminary parliamentary proceedings, that, in a great measure, might be obviated for the future. In 1864, an Act was passed called "The Railways Construction Facilities Act," which enabled promoters, instead of applying to Parliament for permission to construct new lines or branches, or extensions of existing lines, to go to the Board of Trade, and get a certificate, which had the effect of a special Act of Parliament, so that the power to construct such lines might hereafter be obtained at a small comparative expense. Practically no great use had hitherto been made of this Act and its provisions; but from a recent examination he could see no reason why it should not be made useful. At all events, he was sure that the authority to make railways might be obtained with much less cost than hitherto, whether through Parliament or through the Board of Trade. With respect to the construction of railways through agricultural districts, an Act was passed in 1862, called "The Improvement of Lands Act, 1862," whereby landowners could combine together, and a defined majority might determine that they would have a railway through their lands; and the Act provided that the owners of land, whose property was improved by the passage of the line through the district, might charge their estate with the amount subscribed for the line, and so relieve themselves from the personal pressure of the subscription. That was a great accommodation, and might be applied advantageously. As to the actual and physical construction of new lines, when they were merely auxiliary, leading into main lines, and feeders to those lines, there was no necessity for the expensive works hitherto thought necessary. In earlier times, when railways passed up valleys connected with main lines, there was the

same excess in permanent way, and the same heavy stock which obtained on the main line; but now the rails might be lighter, the engines lighter, and the machinery much less expensive. But on lines leading to and out of main lines uniformity of gauge must be preserved, and indeed was required by law, because trans-shipment was always an expensive and cumbersome business. There were lines, however, which did not inosculate into main lines, but were carried from mineral districts to an independent port of shipment. An instance of that was seen in the case of the Festiniog railway, which was on a very narrow gauge with steep gradients, and sharp curves: all the heavy traffic coming down and the light traffic going up. In all such cases the cost might be lessened.

With respect to the second question, the finance of railway companies, he thought great blunders had been committed. He had held from the first, that the legislature had nothing to do with the financial operations of railways. When a company wished to take land from people against their will, the legislature said, "You shall not take land against the will of the owners without complying with certain requirements:" and again, "You shall not cross the turnpike-roads and highways except under certain conditions which we impose upon you." So far right. But when the legislature took upon itself to dictate the way in which the capital should be raised and expended, it was simply preposterous. What had been the consequence? It was said, "You shall not pay interest upon capital during construction;" and "you shall tell us exactly what amount of capital, and what amount of borrowing power you require, and you shall not go beyond it," and all sorts of absurd obligations and conditions were imposed upon the companies, so that they could not do anything which they might and ought to have done. Railway companies should have had the power, from the first, to arrange their financial operations in their own way. There were two classes of persons who supplied the capital of railway companies—first, the investors, who wanted a safe though moderate return; and, secondly, the speculating class, who looked for a better return, though with some attendant risk. Of these the first might have subscribed or contributed to a loan stock, while the second would have come in as partners of the undertaking, sharing in the profit or loss. There ought never to have been more than these two kinds of capital—loan capital or what was equivalent to debenture stock, and share capital or ordinary stock. However, it had suited the wisdom of the legislature, and Lord Redesdale in particular, to meddle with these things; and the consequence had been, that because railway companies could not raise their capital as they might have done if left to themselves, as they were prohibited from paying interest on capital, and were restricted from exercising their borrowing powers

till the whole of the share capital had been subscribed, and one-half of it paid up, they resorted to financial expedients, such as Lloyd's bonds, and the like; and, in fine, the issuing of preference shares, Lloyd's bonds, &c., had loaded the undertakings with charges, the interest on which swallowed up the entire revenue.

He was thankful that a relaxation of the rigid system, which had been so detrimental to these undertakings, had at length been allowed. Further, it was obvious that debenture stock was better than debentures, as when debentures fell due money had to be obtained on some terms or other. For that purpose companies had had at times to pay as much as 8 or 10 per cent., which of course interfered with the dividend on the ordinary stock. All railway companies should convert debenture capital as soon as possible into debenture stock, bearing a uniform rate of interest and issued at par, or a discount, according to circumstances, and then the holders of that stock would have power to deal with it, as with consols, at the market price of the day. Again, the consolidation of stocks into as few classes as possible would be productive of great advantage. Mr. T. E. Harrison had been the promoter, indeed almost the originator, of a consolidation of this kind. The North Eastern Railway Company's arrangements, in this respect, were excellent, and he was happy to hear were successful. The market value of the consolidated stock would be much greater than when divided into a larger number of stocks, and in some cases fractions of stocks. The Great Western Railway Company had followed the example; they were converting the ordinary stocks of their many amalgamated undertakings into one stock, and were trying to do the same thing with the preference stocks, and he believed it would be successfully accomplished. Every engineer in railway enterprise ought to concur in the endeavour to promote such a result. A multiplicity of preference stocks was decidedly injurious, and the more they were consolidated the higher the dividends on the ordinary shares would be.

Then, on the third head—that of railway administration and railway management—he might say, having been concerned for the last twenty years in almost all the arrangements between companies for working agreements, amalgamations, facilities, running powers, &c., he believed there were no abler administrators than the railway managers. He should like to see them from time to time brought together to decide in conference upon general questions affecting the whole working of railway companies. Throwing aside all petty jealousies and rivalries, let them meet to discuss and arrange principles and rules affecting all railway administration, from which he was sure good results would ensue. As to facility clauses, the Author seemed to think that the *ultima Thule* of perfection had been arrived at; but he doubted whether it was possible

to frame them so as practically to insure the intended results. The owning company must necessarily have control of a line when another company worked over it, nor could it be superseded in the possession of the terminal stations; and the questions which arose as to the rights of companies, having facilities to work over the line and interfering with the action of the owners of the line, were both numerous and difficult. A conciliatory spirit, and arrangement amongst the managers themselves, would tend to remove some of those difficulties. Competition would always exist, and the public was benefited by it; at the same time, where it was carried to extremes, all parties suffered. A little good sense, a little combination for the purpose of doing what was best for all, could not be otherwise than advantageous.

Then there was the question of low fares and the distribution of the classes. It was difficult to determine whether high fares or low fares were best; just as difficult as it was to settle the question of high prices or low prices in commercial matters; and he did not know that any general rule could be laid down, or that the experience of those concerned in railway administration would enable them to say with confidence whether the lowering of the fares would bring traffic sufficient to make up the loss, or whether the increase of fares, or keeping them at a high rate, would better compensate the company. It depended much upon the local circumstances of the line, and must be judged with reference to those circumstances. But there was a want of better classification. It was manifest that the third-class passenger traffic was an important element on the majority of railways; at the same time that class was, no doubt, augmented by some who it might have been expected would travel in the higher classes. There were people who travelled habitually by a lower class than their social position would seem to demand. He thought it might be better to accommodate the third-class traffic, in cases where the circumstances appeared to justify it, with special third-class trains, rather than carry a number of the higher class carriages uselessly along the line.

In conclusion, he would draw attention to the bleeding artery of compensation for accidents. For the last fifteen years he had advocated the establishment of an insurance fund. A passenger might say, "I value myself at so much, and I propose to insure myself for so much." He should then pay a moderate sum (for a moderate sum would be sufficient for the purpose) towards the insurance fund, in addition to the fare. He thought it a monstrous thing that, whereas this was done in the case of valuable chattels, it should not be allowed in respect of men and women who travelled by railway. Never was there an anomaly more striking. A third-class passenger paid 1*s.* or 2*s.* to go a certain distance. All his family were dependent upon him; but if he was killed or

maimed, the compensation was very small, say £50 or £100, because he was a small man in the social scale. Whereas in the case of a passenger riding in a first-class carriage, if one such were killed, and if the negligence which caused the accident were exactly the same as in the other case the compensation might be assessed perhaps at £20,000. That, he repeated, was an anomaly which ought to be remedied by the establishment of an insurance fund of which the travelling public could at all times avail themselves. There should be a fixed amount of compensation as a minimum, and then, according to the amount to which the passenger insured, the company should be liable. In this way a fund would be provided against these contingencies, and such things as had recently happened in the case of the London and Brighton Railway Company could not occur again. They had put by a sum of £45,000 to meet the compensations claimed of them, but that sum had already been exceeded. It had most seriously affected the dividend of that Company, and he considered it was a monstrous injustice that it should be so.

Mr. HARRISON, Vice-President, referred to the diagrams accompanying the Paper as conveying at a glance a great amount of information in the most condensed and perfect form, and if similar diagrams were published periodically they would be of considerable interest and advantage to railway shareholders and investors. At the same time it was necessary that any one taking a superficial view of those diagrams should be careful not to be led away to general conclusions; persons accustomed to study the results of different railways were aware that the circumstances of different portions of the same railway varied to so large an extent, that it required minute investigation to ascertain the causes of those differences; and much more so was it when comparing different railways. An investigation of these diagrams, however, would show many salient points of difference which demanded investigation. In making similar comparisons he had been led to investigate the large differences which arose upon particular portions of one system, as compared with other lines, and with great advantage.

Some remarks had been made on the subject of passenger fares: that was a question to which he had given, for a long time, a great deal of attention; and there was none more difficult to understand, or more varied in different parts of the country. He did not believe that, at this time, there were sufficient data to determine what rate of fares would give the largest amount of revenue to a railway company, and at the same time the largest amount of public accommodation. That was the question to be solved, because the interests of the public invariably went hand in hand with the interests of the railway companies. He thought, too, that the

question of third-class passengers was one to which attention should be mainly directed, as producing not only the largest amount of revenue, but the largest amount proportionately to any other class of the revenue of most railways. Of course there were differences in this respect. In the case of the London and North-Western railway, which communicated with the richer districts of the country, the diagrams showed that the proportion of first-class passengers was very large; but in the manufacturing districts, it could hardly be said to what extent the fares ought to be reduced to induce the largest amount of traffic. He recollected, in the case of one of the investigation committees on this subject, which he believed were now rare, there arose the question of the fares on the North-Eastern railway. The effect of raising the fare, on one portion of the line, from 3*d.* to 4*d.* was entirely to annihilate a large amount of short traffic; and the effect upon the market fares coming into Newcastle was to reduce the market-train from sixteen fully-laden carriages to four; and ultimately the original fares were reverted to, after a considerable amount of injury to the traffic had been sustained. He had advocated the reduction of fares in the case of the North-Eastern railway, and they had been reduced to an extent which, on examination, was found to amount in the aggregate to about £50,000 a year. The reduction was made on the 1st of January this year, and so far there had been no loss whatever. The company had carried nearly twenty thousand passengers a week more than before, and the actual receipts had been rather greater than they were at the corresponding period of last year. He did not, however, mean to say if the higher fares had been continued, the revenue received would not have been greater. No doubt by assimilating more closely the fares of the first, second, and third classes a great change would in time be made in the classes in which people travelled. There were people who, when it was a matter of 2*s.* or 3*s.*, rode in the lower class, who, if the difference were only 6*d.*, would travel in a higher class; therefore he regarded the question of fares as one to which the attention of railway managers should be specially directed, as affecting the future prosperity of railways.

Mr. Lloyd had referred to the Act of Parliament which authorised the Board of Trade to grant certificates for the construction of railways. He did not think that Act was operative, as it required the consent of all the landowners, and over a projected line of 10 miles in length in any part of the country, it was hardly possible to get this consent. Then there was the question of cheap railways, which he believed might be made, although it would require a combination of favourable circumstances. To begin with, there must be a reasonable remuneration for the capital

expended. The minimum amount received upon a railway, made through a purely agricultural district, might be taken at £5 per mile per week. He did not know of any lower receipt than that, indeed it was usually from £7 to £10 per mile per week. Assuming £7 per mile per week for an agricultural district, that was £364 per mile per year, and if the line could be worked at 50 per cent. of the year's receipts, it would pay just 5 per cent. upon an outlay of about £3,500 per mile. Now could a line of railway be constructed that would carry a traffic yielding £7 to £10 per mile per week for £3,500 per mile? He thought so: but in that case the landowners must be prepared to give the land; and till they learnt their own interest and were prepared to do so, he did not believe cheap lines could be made to pay. In the next place the Board of Trade must permit the construction of such lines with level crossings instead of requiring bridges as the rule: and further, the gradients must be more adapted to the contour of the ground, and the permanent way must be lighter, though sufficiently strong for the small amount of traffic that would come on the line. Then again, the public must be satisfied with less luxurious accommodation; they must be prepared to travel at a slower speed, and in carriages not quite so comfortable as those on the large lines; and further, in some cases it might even be necessary that the guard should distribute the tickets, and the railway train itself be made the booking-office. If those concessions were made on the part of landowners, the Board of Trade, and the public, he was satisfied there were numerous instances throughout the country where such lines of railway could be made with benefit to the public, and with a moderate return to those who invested their money in them.

Mr. Joseph Taylor said, he thought railway companies might considerably increase their revenues by giving greater facilities to passengers; and by this he did not necessarily imply reduction of fares, but that greater facilities and convenience for travelling should be afforded. For instance, return tickets extending over four days were issued from London to Newcastle, but if a passenger broke the journey at Doncaster, or at York, the ticket was forfeited. He submitted that so long as only one journey was made over the line either way, it would be immaterial to the company, and a great convenience to passengers, if the passenger was allowed to break the journey. So, also, on the suburban lines, he was convinced that return tickets available for two or three days would bring a large accession of traffic. There were many other points connected with annual tourist, and other special tickets, that required the attention of railway companies, whose present policy seemed to be to counterbalance any reduction of fares by conditions and

hindrances that went far to neutralise the value of the concession. In short, let railway companies treat their customers on the same principle that other people in business treated theirs, and he was convinced it would be mutually advantageous.

Mr. J. T. HARRISON, in reply upon the discussion, said, although the diagrams and the subject had been considered by several speakers as important, others maintained that this was not strictly an engineering question. He took a distinctly opposite view, as engineers were called upon to give advice about railways in their conception, at their birth, during construction, and in their maintenance. At all these different stages the information to be gained by the collection of statistics was of the greatest importance to engineers. Dividends, for instance, depended materially upon the cost of construction. The cost of the line must be estimated, to see whether the probable traffic and the net revenue would be sufficient to justify a certain expenditure. Again, with respect to the working of railways, the diagrams showed that nearly 50 per cent. of the gross expenditure was for maintenance, locomotive power, and repairs of carriages and trucks, with all of which the engineer had more or less to do. The importance of looking into those questions could not be doubted—they were matters quite as much for engineers to consider as for railway managers. It had been shown that if the contractors had been paid in cash a great part of the ruinous outlay of the last few years would have been avoided. It was important, therefore, for engineers to consider the question of finance as well as other matters, because they were interested, not only in executing a railway efficiently, but also in its being a commercial success.

It had been argued that these diagrams were dangerous tools, and unless closely examined would probably lead to error. That he quite agreed with. Each case required to be considered separately. Thus, in the cases of the Metropolitan and the Cornwall railways, on the latter there were only about ten trains per day, while on the former there were upwards of two hundred. The cost of maintenance per mile of the Cornwall railway was the lowest of any line in the kingdom; but the cost per train mile was the highest, and that resulted from the small number of trains that were run. On the other hand, the Metropolitan railway was the most expensive per mile of any, while the number of trains was so great that the maintenance per train-mile was the lowest in the country. It would be impossible to devise a reliable formula, out of the statistical information obtained, which would be applicable to all cases. Any formula would be full of variables, with very few constants. The object of statistics, carefully collected and examined, from time to time, was to limit those variables on railways similar in traffic and other circumstances, and by

degrees convert them into constants. There might then be, in course of time, some formula on which to depend for forming a judgment as to railways of the same description. The accuracy of statistics was of great importance. Those now given by the Board of Trade were much more accurate that those of earlier years, consequently the statistics of one line could be compared at once with those of another. Mr. R. Price Williams had directed attention to the question of the locomotive expenditure on the Manchester, Sheffield, and Lincolnshire railway, which appeared from the diagram to be only 5*d.* per train-mile. That showed that the returns still wanted to be made in greater detail. In the abstract, the locomotive expenditure was stated at about £80,000 in the half-year; but at the end of that abstract there was given a credit of £30,000 for work done for other companies; consequently, in the account, the locomotive expenses appeared to be only £50,000, which made the difference as between 5*d.* and 8*d.* per train-mile. It should be shown what the work done for or by other companies was. It might be that some companies supplied engines for running trains over other lines; or they might have repaired engines at their works. It was impossible for him to show this upon the diagram. Again, most railways had running powers over other lines; the number of miles thus run was not defined, but they should be, since this affected the question of cost of permanent way, as had been properly pointed out in the case of the South-Eastern and the Brighton lines. It had been remarked that he looked at the question of passenger traffic rather from a shareholder's point of view than from that of the public. He had, however, merely pointed out the importance of the third-class traffic, and that, upon many railways, third-class passengers were not fairly treated. Few trains were provided for the third-class traffic, and he thought it inexpedient that railway companies should force all the third-class traffic into a few trains per day, instead of distributing it over many trains. Upon those railways where only a small difference was made between the first and second, and the second and third-class fares, the passengers appeared to sort themselves more in accordance with their social position than where the difference of fare between the classes was greater.

Agriculture would probably, within a few years, be considerably advanced in this country, and steam cultivation be extensively adopted; there would then be a greater call for facilities of communication. He was sure this would be a benefit in many parts of the country, both for the conveyance of produce from the farm, and in taking back manure and other things that were required. The facts mentioned by Mr. Chadwick, about the conveyance of the mails, showed the large extent of country that was still unprovided in respect of railway communication. At present wood

was largely used for fuel in country districts. He could not but think, if cheap railways were made, the coal traffic would become a considerable item in such places. He had himself farmed for many years 500 acres, and consumed about 25 tons of coal a year, which were conveyed 100 miles by railway; if the same rate of consumption were to obtain generally, it would amount to a large quantity, worthy the consideration of railway companies.

On the subject of cheap lines, he had been furnished by Mr. R. Price Williams with the following particulars of a light and cheap railway, which it was proposed to construct between Barry and Bridgend. It commenced by a junction with the Penarth and Barry line, a few miles south-west of Cardiff, in Glamorganshire, now in course of construction. By means of this junction, the proposed line would have access to the Harbour and Docks of Penarth, and would eventually be in direct communication with Cardiff. From the Barry junction the proposed line took a westerly direction, and traversed a district upwards of 18 miles in length, and about 8 miles to 10 miles in width, of some of the best and richest agricultural property in Glamorganshire, at present entirely unserved by railway communication; the farmers having, in some cases, to cart their produce upwards of 12 miles to the nearest market-town. For the greater portion of the length, the proposed railway traversed a table-land, descending into the valleys at either end by short gradients, in no instances worse than 1 in 40. Cuttings and embankments were, with one or two slight exceptions, dispensed with, by following a judiciously-selected contour line along the natural surface of the land. Stations and station-works would be represented by a small raised platform, an occasional siding, and a station signal, to be worked by the passengers. The gates at level crossings were intended to be normally closed against the railway, and would, in fact, constitute stations or stopping-places for passengers to be taken up and set down; the stoker would act as guard, and it would be his duty to open and close the gates. Carriages and wagons of the ordinary narrow-gauge pattern would be available for working the traffic, but the engine would be of a light special character, and suited for the requirements of the traffic, with not more than 3 tons on each wheel, when fully equipped with water and fuel. The rails would weigh 50 lbs. to the yard; in other respects the permanent way would be as strongly and as durably constructed as for the main lines. The cost per mile of railway, including the equipment with rolling stock and the value of the land, was estimated by the engineers, Messrs. Price Williams, Tolmé and Blandy, at from £3,500 to £4,000 per mile only. The land was chiefly in the hands of large landowners who, as a rule, were disposed not only to take the value of their land in shares, but, in concert with their tenants, to employ an eminent land-valuer to

assess, in the form of a graduated scale, the value of the advantages and benefits to be derived by the railway accommodation to the extent of a mile on either side of the line; and in the event of the net earnings being insufficient to pay the interest on the capital expended in the construction of the line, to charge the lands by means of this graduated scale according to the relative proximity of their lands to the station. He thought it quite possible to have cheap lines, light rails, and light engines.

He had received a letter from Mr. Willett, the manager of Mr. Thomas Nelson's contracts in the north of England, giving a description of what some of his engines had done, as follows :—

"On the temporary way from Sunderland Bridge to the South Junction, next Ferryhill, of the North-Eastern railway, the steepest gradients were 1 in 27 and 1 in 33. The engines were running daily with earth up the gradient of 1 in 33, over the cutting, and down the incline of 1 in 27. A break-truck was used for steadying the trains down the inclines, as the engines could not hold up the trains by themselves.

"Two engines, the 'Gladstone' and the 'Tom Wright,' had been employed for this work at different times. The weights of the engines, wagons, &c., were approximately :—

	Tons.
"Engine 'Gladstone,' in working order, six wheels, coupled tank . .	21
" 'Tom Wright,' " " " . .	17
Each earth wagon empty	1¾
2 cubic yards of shale in each wagon	3
Break-truck	6

"The 'Gladstone' had worked eighteen full wagons and the break-truck up the gradient of 1 in 33; and the 'Tom Wright' fourteen full wagons and the break-truck. Both engines started on the level, with about 60 yards start before coming to the incline. In one trial the 'Gladstone' conveyed twelve trucks, which with the engine weighed 120 tons, up this incline, but could not have continued the ascent had the incline been a long one; however, a load of ten trucks, or 103 tons, could have been conveyed any distance up such an incline.

"On the gradient of 1 in 27, the 'Gladstone' was just able to take away fourteen full earth wagons. Sixteen empty earth wagons and the break-truck were sufficient load for the 'Tom Wright,' with a start on the level of 50 yards or 60 yards. The actual weight in the wagons varied constantly; the state of the weather making a great difference in the powers of the engines, owing to their slipping in damp weather. The inclines were too short to afford a criterion of the consumption of fuel. The engines worked round curves of 5 chains and 6 chains radius without difficulty. The 'Carlisle' engine had brought a train of eighteen ballast trucks, each holding 8 cubic yards of ash ballast, weighing about 10 cwt. per cubic yard, from the South Junction to the top of the incline of 1 in 27."

On the question of the improvement of railway property, the remarks of Mr. Lloyd were much more to the point than any he could make. The suggestions he had made in the Paper were not so much his own as those brought forward by others, and were referred to for the purpose of eliciting discussion upon them. The only opinions he had expressed were as to the intrinsic value

of railways, and the desirability of alleviating the burdens that now bore upon them.

Mr. VIGNOLES, President, said that at present the railways of the United Kingdom were in their aggregate length about three-fourths of the total length of all the turnpike roads, which had been made to the extent of about 20,000 miles, while there were about 15,000 miles of railway. He fully agreed with the conclusion of Mr. Chadwick, who treated of the probability of railways of cheap construction being laid down over the ordinary roads in this country, which were about seven or eight times the extent of the turnpikes; but he thought it was an indispensable condition that, not only should landowners give the land, but should contribute by rates in aid. This had been done on more than one occasion in Ireland: and in one case the rate had been nearly paid off. The landowners had guaranteed a certain amount of interest, and this was in process of being cleared off. He thought Mr. Currie should have drawn a distinction between the expenditure due simply to the engineering part of the question, and that which had been forced upon the railway companies by the banking operations connected with it. During a long period of his life he had paid attention to the statistics of railways, and had found that the expenditure (*quâ* expenditure, confined to engineering construction) formed but a moderate proportion of the whole. What had the cost of works and plant to do with the fights in Parliament, and with the financial operations that had swelled the expenses in every possible way? What had they to do with the enormous prices paid for land? When he first laid out the Eastern Counties railway the sum of £150,000 was paid to one nobleman for permission to go through his estate, which was doubled in value by the making of the railway. Was it a wonder that the Great Eastern Railway Company was in its present position when it began operations in that way? He asserted that the great amount of railway capital was not chargeable to the mistakes of engineers.

He was happy to express his approval of the statistics brought forward by Mr. Harrison in the Paper, and the accompanying diagrams. For the last twenty-five years the railway statistics of Germany had been kept in the same manner, but not tabulated graphically; however, they enabled any one to construct tables like those exhibited; and there was not the same fault as in the statistics of this country—a want of details. Still there was this remarkable fact, that in almost every part of the world the working expenses seemed to average 50 per cent. of the receipts, and it was naturally so. As the traffic increased the expenses of carrying it increased. If the traffic of a line was small, the expenses were large in proportion to the receipts. If there was a large traffic, accommoda-

tion had to be provided for, and the working expenses were greatly increased. It had been a point with him for thirty years to endeavour to impress upon the Board of Trade the collection of such statistics of railways as would enable a comparison to be made every year, of the returns of one railway with those of another.

He agreed in the principle that railway companies must not look for the aid of Government for the consolidation of their debenture stocks. They must be left to do that themselves. But great injustice had been inflicted by the legislature on railway companies: they had been hampered in every way; and however injurious the French and the continental systems might be, in one respect the English system was worse; because, while affecting to give the most perfect liberty of action, the legislature had fettered and controlled the financial operations of railways in every possible way. So with regard to some continental railways; he had no doubt that Russia was now paying 50 per cent. more for the construction of her railways than she ought, because the way in which the money was raised obliged the parties who had concessions for the lines to make contracts of so onerous a character as nearly to double the cost of the railways. The practice of engineers invariably had been to execute works as cheaply as possible, but at the same time substantially. He did not know, except in a few architectural ornaments at the stations, that he could point out any unnecessary expenditure in the cost of works. It had been the pride of engineers to execute works as cheaply as possible, and at the same time substantially.

February 8 and 15, 1870.

CHARLES B. VIGNOLES, President,
in the Chair.

The discussion upon the Paper, No. 1,246, "On Railway Income and Expenditure," by Mr. J. T. Harrison, occupied both evenings.