and the steam pressure which I observed in most was 55 lbs. to the inch. I believe, however, on some engines they work with a higher, and on others a lower, pressure; but 55 lbs. was what the valve was screwed down to in those I noticed, and I was informed it was the general pressure.

The following are the returns which I have received from the company. The number of engines is about 100, all six wheel, from 19 to 21 tons weight, loaded with water and coke. On the driving wheels the weight is from $8\frac{1}{2}$ to 9 tons, and nearly balanced on the leading and trailing wheels, that is, about $5\frac{1}{4}$ or $5\frac{1}{2}$ on each of the other pair. Of their engines, almost all are in a fit state to take a train. The play of the wheels on the rails is about $\frac{1}{8}$ inch; the pressure worked with 50 lbs. to the inch; the cost of the engines from £1800 to £2000; consumption of coke 31 lbs. per mile for passenger engines, and 40 lbs. for goods; and the total expense of locomotive power about 15d. per mile; but it has been more, and is decreasing. The distance between the centres of the cylinders is $2\frac{1}{4}$ feet, and the engines do not work expansively. Their engines have no particular kind of motion when the road is good. They have no top-heavy engines. Some of the goods engines are coupled, and work very well, and all the engines have flanches on the driving wheels. The gross average load of the passenger trains, including engines and tender, is 116 tons, and of goods from 300 to 400 tons.

The extreme length of the frame of the engines is 22 feet, and 13 feet to $13\frac{1}{2}$ feet the distance of the extreme axles. The driving wheels are 6 feet and 7 feet diameter, but chiefly the latter; the other wheels are $3\frac{1}{2}$ to four feet; cylinders, 14 to 16 inches diameter; and stroke 18 inches.

They have had very few detentions from derangement or failure of machinery, and only five or six broken axles, one from defective welding, the rest from bad iron. Two or three of these fractures have been in coupled engines. In all these cases they were unable to proceed with their trains, but no accident happened to any one. They have had no engines run off the rails.

(To be continued.)

A few Statistical Facts on the Revenue and Expenditure of the two most expensive long, and two moderately expensive Railways.

By JOHN HERAPATH, ESQ.

At a time when so much is said upon the question of good and bad railways, and when traffic and expenditure are matters of warm discussion, I have thought a few calculations and observations on the recent reports may not be unacceptable. For the purpose I have in view, I have selected two of the most costly long lines, the Birmingham and Great Western, and two of those which are considered reasonable in their cost of construction, namely, the Grand Junction and South Western.

It will be seen that, in my comparisons, I have had labor which has not been lessened by the very dissimilar manner in which the

companies keep their accounts; but, if it will at all aid those to form sounder notions who are anxious to embark in railway property—for I can hardly expect it will be of much service to old railway stagers—I shall consider that my time has not been misspent.

I trust that my readers will distinctly bear in mind that my computations are based upon the data furnished by the last reports of the companies, for the genuineness of any of which data I do not hold myself answerable. If there has been any cooking in any of the accounts, the sin of it is none of mine. All that I hold myself accountable for is the calculations, which I have endeavored to make, and which I hope will be found, correct.

By the last half-yearly reports of the London and Birmingham, Grand Junction, South Western, and Great Western, Companies, the amounts called up in shares and loans, excluding shillings and pence, are—

	London and Birm.	Grand Junction.	South Western.	Great Western.
Shares,	3,615,897	1,780,490	1,825,507	3,009,311
Loans,	2,278,654	483,362	630,100	3,332,025
Totals,	5,894,551	2,263,852	2,455,607	6,341,336

This is what I consider pure capital, disentangled from other items with which the accounts are encumbered. For instance, in the London and Birmingham account is a sum of £9,561 for “premium realized on the reserved new £32 shares,” which, though put into the capital account, appears to me to be more of a contingency than, *bond fide*, a part of the capital. Again, in the Grand Junction, there is about the same sum made up of sale of refused shares, and of materials which, not having included at the time I made the calculations, though the sale of the refused shares forms certainly a very legitimate element of the capital, is not comprehended in the above statement. So £24,449, made up of “profit on shares,” and “interest,” carried to capital in the South Western, I have not called part of the capital, for the same reason as in the London and Birmingham, namely, that it appears to me to be a kind of accidental windfall, rather than legitimate capital. The same might be said of about £3000 in the Great Western account, for “registration fees” and “rents.” This company is the only one of the four which does not exhibit a capital account, but gives simply a balance sheet of receipts and expenditure, including the half year’s traffic and expenses. In the South Western, £296,545 belonging to the Gosport Branch is at present tantamount to a loan, having only 5 per cent. interest now paid on it. In August next it will be converted into shares, and receive a dividend. At present, however, it diminishes the share capital, and augments the debt, of the company, from 27.15 per cent. to 60.60, as in the following summary:

Thus, for every £100 of actual capital raised by shares, the

London and Birmingham	} have severally	£63.03
Grand Junction		27.15
South Western		34.52 or 60 60
Great Western		110.72

of borrowed money taken up either on mortgage or loan notes. It appears, therefore, that an amount of debt nearly equal to two-thirds of the entire property of the shareholders stands against the London and Birmingham Railway; and a debt of something more than a fourth of their property against the shareholders of the Grand Junction; and in the South Western, of above a third; while in the Great Western the debt exceeds, by nearly eleven per cent., the whole property the shareholders have in the concern. It is not for us to say whether the legislature did, or did not, contemplate such very large debts as are here contracted. Fortunate, however, it certainly is, that in the first, and particularly the last, of these lines, that their per cent. profit upon the whole capital and debt together, exceeds that of their debt; for, were it otherwise, the shareholders would be in a most melancholy position. As it is, it is a great advantage to them to be in debt, and we should recommend them to keep so as much and as long as they can.

The Grand Junction have, by a little dexterity, reduced their capital to only £2,203,300. For, finding their shares at a high premium, they very adroitly hit on an expedient of paying off their debt at a considerable saving to the company, and, at the same time, with great benefit to the shareholders. For instance, they created 17,624 quarter shares, representing in capital only £410,600, and they say to the receivers of these, "Now, if you will take upon yourselves to pay the interest of the debt, and the debt itself, as it falls in, we will give you the full dividend upon these quarter shares, and, when you shall have paid off the debt, we shall save in capital near £100,000." As yet, only 2*l.* 10*s.*, or £44,060, have been called up, and these quarter shareholders stand in this position:—they are receiving at the rate of 3*l.* per annum on the 2*l.* 10*s.* paid up, out of which they have to pay 1*l.* 2*s.* 6*d.* per annum, for interest, leaving 1*l.* 7*s.* 6*d.* net for their clear dividend on their 2*l.* 10*s.* share, or about 54 per cent. But, as a set off, they have still to pay about 27*l.* 8*s.* 6*d.* on each of these quarter shares, besides the already paid sum of 2*l.* 10*s.*; that is, the quarter shares will cost somewhere about 30*l.* each.

In the same way, the London and Birmingham Company are paying the full dividend on their quarter shares, on which only 5*l.* has been paid. I have never, however, heard with what prospective advantage to the company this was done. The Grand Junction plan is a good contrivance eventually for saving capital to the company, though at present at the expense of the other shares; but the London and Birmingham plan appears to me to be now damaging the original holders, and with no prospective benefit.

Supposing *D* to be the per cent. amount of debt on the capital actually paid, or the per cent. interest on it, *i* the per cent. interest on the capital and debts together which the profits would pay, and *s* the per cent. dividend on the shares or capital alone after paying the interest, we have the following simple equation from which to deduce any one from the rest, namely:—

$$100s + Dd = (100 + D)i.$$

$$\text{Whence } s = i + \frac{i-d}{100}D \text{ and } i = \frac{100s + Dd}{100 + D}$$

By the second equation it appears that if the debt was about one-fourth of the paid-up capital, and the interest of the debt was 5 per cent., and the concern paid 11½ per cent., the shareholders ought to divide nearly 13½ per cent. This, as we shall presently see, is the case with the Grand Junction, considering their loan as a debt; but they have only divided 12, in consequence, chiefly, of the heavy sum they have laid by for depreciation and a reserved fund, and the operation of the quarter shares.

If we were to go closer into details, they ought to have a better dividend than we have given them, because we have not taken in the whole of their half-year's income, nor £9000 balance on the preceding account, while we have comprehended every item of their expenditure for the half-year, and have only reckoned the debt 25 per cent., whereas it exceeds 27.

If the debt was two-thirds of the paid-up capital and interest together, and the profits would return 10 per cent. on the whole debt and capital, the shares, with 5 per cent. interest on the loans, might divide near 13½ per cent. on the paid-up capital. This is nearly the position of the London and Birmingham Company. Owing, however, to the large sum set apart for depreciation and the quarter shares, on which, as I have said, only 5% capital is paid up, receiving the full dividend as if 25% had been paid, the old shares only receive 9½% per share, or about 10½ per cent. Such is the unfortunate operation of these preference shares and the depreciation fund. It is true we have reckoned the debt larger, and, therefore, more advantageous than it is to the shareholders, and have taken the interest divisible upon the total cost greater than it really is; but after making due allowances for all this, the dividend on the shares would cover 13 per cent., if it was not for the operation of the preference shares and the depreciation fund.

With the South Western they only pay 5 per cent. interest on the Gosport branch, that is, on an additional £296,500, which reduces their paid-up capital to £1,529,000, and increases their debts to £926,600, or to above 60 per cent. of it. On the total of capital and loan, we shall find presently that this company can pay 6½ per cent. Therefore, allowing 5 per cent. upon the debt, which is ¾ths of the paid-up capital, and we shall have 7.80 for the dividend per cent., which might be made on the shares. The amount divided is near 7½ per cent., very nearly the full one, and they hold a balance of £8750 in hand.

The Great Western would pay 5.8 per cent. on the loans and capital, and has 110.7 per cent. of paid capital in loans. Therefore, if 5 per cent. be paid on these, the dividend ought to be 6.7 per cent. on the shares. At the last meeting, a dividend of 6 per cent. was declared.

The length of line run by the London and Birmingham, including the Aylesbury branch, is $119\frac{1}{2}$ miles; of the Grand Junction, including the Liverpool and Manchester, and Chester and Crewe, it is about $133\frac{1}{2}$; of the South Western, taking in the Gosport branch, $92\frac{1}{2}$; and of the Great Western, including the Bristol and Exeter, and Cheltenham Union, 169 miles. Hence, taking the receipts earned during the past half-year, exclusive of other sources of revenue, and the expenditures, we have—

	Length worked miles.	Half-year's		Half-year's		Per cent. of expend. on receipts.	P. ct. on cap. and $\frac{1}{2}$ yr's profit loans for $\frac{1}{2}$ year of		per cent. on		Cost per mile.
		Receipts.	Expend.	Receipts per mile.	Expend. per mile.		Receipts	Expen.	Capital and loans.	Paid up cap. alone	
		£	£	£	£	£	£	£	£	£	£
L.&B.	119 $\frac{1}{2}$	429023	134684	3590.2	1132.3	31.685	7.2782	2.3061	4.9721	6.53	52396
Gr. J.	133 $\frac{1}{2}$	238207	104988	1784.2	784.6	43.975	10.5220	4.6375	5.8845	6.80	21525*
S. W.	92 $\frac{1}{2}$	153162	70284	1651.3	757.8	45.889	6.2372	2.8622	3.3750	3.91	26475
G. W.	169	337008	152787	1994.2	904.1	45.336	5.3145	2.4094	2.9051	3.35	53968

* This is given by Mr. Moss, the Chairman. The other costs per mile are computed upon the number of miles constructed.

This table affords us some very instructive information.

Many persons, for example, imagine that the amount of traffic per mile per week, as given in the Railway Magazine at the request of some high authorities, is indicative of the value of the line. Taking an extreme case, this would be true, for if a line had no traffic at all, it evidently could be of no value. But the gross amount of traffic, or the amount per mile, goes a very little way towards deciding the merits of a line. For instance, we have here the London and Birmingham at the head of all the railways in receipts, and more than double of another railway, the Grand Junction, which divides upon its whole cost, and with the dead weight of the Chester and Crewe hanging upon it, near 2 per cent. more. Receipts, therefore, are poor criteria of the merits of a line. They are good tests of the quantity of business done, and of the foundation on which profits may be made, but go no further.

Others, again, think the expense per mile a proof of the economy or extravagance of a company in the management of their affairs. This is a position equally as absurd as the preceding. The London and Birmingham is, upon this principle, nearly twice as extravagant as the South Western, and yet it would pay, upon the whole cost, near 3 per cent. per annum more dividend. Again, the Grand Junction is, if expenses per mile are a test, less economical than the South Western; nevertheless, it pays a good way towards double the dividend. A little reflection would tell us that the mileage expenses are influenced more by the amount of business done, than by the economy

of management. But there are some, and even public writers, who have such crude notions upon railways, as to make high mileage expenses a ground of complaint against companies.

Equally absurd is another point on which much stress has been laid. I allude to the expenses per cent. of the traffic upon the receipts. Many persons exclaim, if one company transacts their business at a higher per centage than others, that things are worse managed there than where the per centage expense is much less. Referring to our table again, and we shall perceive the unsoundness of this doctrine. The Grand Junction is near 40 per cent., on the per centage expenses, more expensive than the London and Birmingham, and nevertheless can divide upon its whole cost at the rate of $11\frac{1}{2}$ per cent., while the London and Birmingham cannot divide 10. Again, the South Western is apparently paying a higher per centage expense on its receipts than the Great Western, and the receipts per mile are much less; and yet it pays at the rate of $6\frac{1}{2}$ per cent. on its cost, while the Great Western cannot pay at the rate of 6 on its cost, though it has divided, and apparently justifiably, at the rate of 6 on the paid-up capital.

The fact is, the per centage expenses depend upon two things, the fares and the amount of business. Other things alike, if the fares are higher, the per centage expenses will be less, and *vice versa*. Again, the more business, the less in proportion is the expense at which it can be done, simply because the standing expenses will bear a less proportion to the receipts, when great, than they will when little. For my part, I would rather see, where there is a scope for business, the per cent. expenses high, for the probability is there would be much more trade and profit.

The fact is, receipts or expenses per mile, or per centage expenses on receipts, are all fallacious foundations upon which, separately, to ground an opinion in favor of any line. *Railways are strictly commercial enterprises, and it is the annual per centage of profit alone on the capital, as in any other undertaking, that determines its value.* The smaller, therefore, this capital is, the more likely the line is to pay, and hence every effort should be made, in the construction of the line, to keep the cost down. Had the London and Birmingham, with its immense trade, (nearly double that of either of the other lines,) been made at anything like its original estimate, or like the cost of either the Grand Junction or South Western, it would, with its economy of working, have paid a magnificent dividend. The same, no doubt, would be the case with the Great Western, when it comes into its full receipts, which will not probably be for these two or three years. Never was economy of construction more forcibly exemplified than in the comparison of the London and Birmingham and the Grand Junction. With more than a double business, and an expenditure proportionably much less, the Grand Junction leaves the London and Birmingham far in the rear of profitable undertakings, for no other reason than that the total mileage cost of construction of the one has been about 143 per cent. more than that of the other. But the Grand Junction, nearly the lowest of the four in the amount

of its business, having been constructed the cheapest, stands at the head of them all as a commercial speculation.

Railway Mag.

Observations upon the Comparative Advantages and Inconveniences of the Employment of Iron Wire, or Bar Iron, in the Construction of Suspension Bridges of great span. By M. LE BLANC, Chief Engineer of Bridges and Roads.

Cables of iron wire, and chains composed of bars of wrought iron, may be compared with reference to their economy and their durability. As regards economy, the question scarcely deserves discussion, and it is easy to prove *à priori* that, in all possible cases, iron wire has the advantage over wrought iron. In fact, the Council of the Ponts et Chaussées has adopted the principle, that cables of iron wire should be submitted to a tension of 12 kilogrammes ($26\frac{1}{2}$ lbs.) per square millimetre (.0016 square inches) of section; but for bar iron it was decided that the *maximum* of tension shall not exceed 8 kilogrammes (17.6 lbs. nearly). This principle is founded upon the comparative resistance of iron wire, No. 18, ordinarily employed in the construction of cables, and of iron bars 3 to 6 centimetres (1.2 to 2.4 inches) in diameter.

The natural consequence of this principle is, that the section of a chain should be greater by one-half than that of a cable, for the same tension; this involves a proportional increase of its weight. In cables of iron wire no joints are used, or, at most, but a single one, as in the bridge of Argentat; and this joint, made up of two small eyes, weighs but little—on the contrary, they are numerous in chains, and, where the system is rather complicated, as I shall prove it should be in bridges of great span, each one of these joints weighs at least 140 kilogrammes, (309 lbs.) On the supposition that the suspension rods are 1.2 metre apart, ($47\frac{1}{4}$ inches,) as there is a joint for each rod, there will be 233 kilogrammes (514 lbs. nearly) for a bridge of 180 metres (590 feet) span. This additional weight, together with that of the bars themselves, which, as we have just seen, is one-half greater than that of the cables, produces an excess of tension which must again be resisted, whence there arises a new increase of section, and, consequently, of weight, in the chains. In applying these principles to individual cases, it is found that the weight of the unit of length of a system of chains exceeds double that of a system of cables.¹ Now, as the price of iron wire is once and a half that of bar iron, it is plain that the use of iron wire is more economical than that of wrought-iron.

I have proved that the total tension is much greater when chains are used; it follows that greater strength must be given to the moorings, and to the intermediate piers, when the bridges have several openings, or bays—a new cause of increase of expense.² It appears

¹ In the comparative proposals which I presented for the bridge of Roche Bernard, I showed that these weights are in the proportion of 11 to 25; in order to replace 11 kilogrammes (24 lbs.) of iron wire, which, at 1*l.* 50*c.*, cost 16*l.* 50*c.*, we must employ 25 kilogrammes (55 lbs.) of wrought iron with 25 francs.

² In bridges of several bays, the cables, or chains, should be fixed to the intermediate