

No. 1,406.—“On Sorting Railway Trains by Gravitation.”¹ By
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THE growth of the railway system, and the multiplication of branch and intersecting lines in a mining and manufacturing country like Great Britain, have brought into prominence among railway managers the question of the proper marshalling of mineral and goods trains.

As a contribution towards the elucidation of the subject, it is proposed to describe what has been done in the construction of sorting sidings on the Darlington section of the North-Eastern railway. This section has a large mineral traffic, and consists of an assemblage of branch lines, upon which the work of collection and distribution is of an intricate character.

A description will first be given of the sorting sidings at Shildon, where (the rails happening to have a convenient inclination) the movement of the trucks during sorting is effected in an inexpensive and expeditious manner by gravitation. The amount of traffic, the number of men employed, the cost of sorting, and some other particulars will be stated. Reference will then be made to the points wherein the arrangement at Shildon has been found defective, and to the way in which it is proposed to remedy these defects; and, lastly, attention will be directed to a large group of sorting sidings in course of construction at Newport, near Middlesbrough, in the designing of which the experience gained at Shildon has been brought to bear.

The sidings are a little to the eastward of Shildon, about 8 miles north-west of Darlington, on the old Stockton and Darlington railway. They occupy the first convenient site after the meeting of the lines of railway which, traversing the western part of the county of Durham, bring from that quarter coal, coke, and limestone; and they are upon the south-eastern margin of the coal-field.

The coke and limestone are extensively consumed in the iron furnaces of Cleveland, and there is a large demand for the coal and coke for general manufacturing and household purposes in

¹ The discussion upon this Paper was taken in conjunction with the preceding and the following ones, and was continued over portions of four evenings, but an abstract of the whole is given consecutively.

a wide district comprising South Durham, Yorkshire, Lancashire, Lincolnshire, many parts of the Midland Counties, and, to some extent, in London. Shipments coastwise and foreign are also made in the ports of West Hartlepool and Middlesborough. Nearly all this traffic is collected, sorted, and made up into trains in the Shildon sidings; but, on account of their inconvenience, they are not used for the sorting of a further large quantity of coke and some coal, the produce of the same coal-field, which is sent westward to the furnaces at Barrow, Carnforth, Workington, and to other places chiefly on the coast.

The mineral traffic which went through the Shildon sidings in the year 1873 amounted to about 4,760,000 tons. This was derived from about one hundred and twenty different collieries and quarries, and was ticketed to upwards of two hundred different points of delivery.

The necessity for sorting had been felt from the early days of the railway, and a group of sidings, without much preconceived plan, had consequently been laid down by degrees, as occasion required, upon the site of the present sidings, the gradient of the railway favouring the movement of the wagons by gravitation.

About the year 1865, however, the rapid increase of the traffic led Mr. Harrison, President Inst. C.E., the Engineer-in-Chief to the North-Eastern Railway Company, to reconsider the arrangement, with a view to include the old sidings in a comprehensive plan adequate to the wants of the period. The groups of sidings about to be described were accordingly designed, and, after considerable delay in obtaining additional land, for purchasing which it was found needful to obtain Parliamentary power, were carried out by the Author as Engineer on the Darlington section, and completed about four years after the date mentioned.

The *modus operandi* in passing a train through the sidings is as follows:—Upon its arrival from the colliery district, it is first turned into the long siding (A, Plate 3, Fig. 1), where it may stand clear of the main line should there be any accidental obstruction in the group of sidings B, four in number, into one of which, the way being clear, it at once proceeds. The engine is then detached, and is either passed out through the exit line R, or proceeds through the running line S to the end of the groups of sidings C and D, and takes a train forward. The ‘shunters,’ or sorters, immediately set to work to break up the train so left, and run the trucks in ‘sets’ of two or three, or half a dozen together, into the various sidings of groups C and D, according to their destination, the rails being so arranged that trucks in any one

of the four sidings in group B can run into any one of the thirty-nine sidings in groups C and D. A 'shunter' accompanies each set of trucks, riding upon one of them, but jumping off and running in advance to move any points which may not be standing open for the siding aimed at, in which he ultimately brings the trucks to a stand by the break.

In this manner complete trains are marshalled in the thirty-nine sidings of groups C and D, whence they are forwarded to their various destinations as rapidly as they accumulate. In an average day's work of twenty-four hours about two thousand trucks and wagons are sorted and despatched. With a view to exhibit more clearly the capabilities of the sidings, Mr. William Bouch, Locomotive Engineer on the Darlington section, under whose superintendence the traffic is worked, has prepared a detailed statement of the work done in one day, divided into periods of two hours each. From this it appears that from 6 A.M. December 9, to 6 A.M. December 10, 1873, the number of trucks sorted was two thousand two hundred and fifty-four, and of chaldron wagons seven hundred and thirty; together, two thousand nine hundred and eighty-four vehicles, received in ninety-four trains. The number of shunts corresponding with the number of parts into which the trains were separated was six hundred and ninety-one, averaging four and a third trucks or wagons in each. During the busiest part of the day, from 2 P.M. to 4 P.M., five hundred and seventy-five trucks and one hundred and ninety-six wagons, together seven hundred and seventy-one vehicles, were sorted, after being separated into one hundred and twenty-eight parts or 'sets,' averaging six trucks or wagons in each. In the same twenty-four hours sixty-three engines passed through the engine-running line, to take trains forward out of sidings C and D, and four mineral trains went through which did not require sorting.

The aggregate length of single line in these sidings is :—

	Yards.
In engine-running lines	4,498
In B group of sidings	1,723
In C and D „ „	11,770
In cross-over roads	707
Total	18,698

or upwards of $10\frac{1}{2}$ miles; and they cover about 16 acres of land.

Though the trucks, upon the whole, run freely by gravitation, there are bad runners as well as good runners; the former being most frequently found amongst those called 'foreign trucks,' owned

chiefly by private parties, and amounting to about $\frac{1}{4}$ th of the gross number. The superiority of the North-Eastern Company's trucks in this respect is attributed in some measure to the axles being lubricated with oil, besides having the usual supply of grease, the axle boxes being constructed so as not to embrace the lower half of the axle, but to leave it free for lubrication. There are also occasional retarding causes affecting the whole of the trucks and wagons, particularly frosty weather and high contrary winds. For these reasons two shunting engines are kept to assist in the sorting; and when on special occasions they are unequal to the work they are aided by the train engines.

Simultaneously with the sorting of each train, the trucks in it undergo an examination; and if any of them are unfit to travel, they are run into a siding set apart for damaged trucks, whence they are taken to the shops for repairs.

There are employed upon the above sidings thirty-seven sorters and examiners, ten wagon-greasers, and seven inspectors and time-keepers for about half their time; also two locomotive engines. The annual cost is as follows:—

	£.	s.	d.
Inspectors and timekeepers	281	0	4
Sorters and examiners	2,392	8	8
Wagon-greasers	452	0	5
Locomotive engines	2,000	0	0
Total	5,125	9	5

equal to 0·258d., or a little more than $\frac{1}{4}$ d. per ton of minerals conveyed.

The gradient of the railway averages 1 in 128; but it is not uniform, being steeper opposite the upper part, and consequently flatter opposite the lower part of the sidings. In the sidings themselves the variation of gradient is somewhat greater, the steepest part near the upper end being 1 in 114 and 1 in 100, the latter only for a short length, and the flattest part 1 in 125. As they have followed, with but little modification, the accidental inclination of the main line, the question may be raised whether these gradients are the most suitable for the purpose, and such as would be adopted in laying out similar work in the light of past experience, and with unfettered choice. The Author believes it may be given as the opinion of the officers of the company, that while it would be inadmissible to adopt flatter gradients, it would not be advisable, having regard to the proper control of the trucks, and the frequent occurrence of imperfect breaks, to make them steeper than from 1 in 110 to 1 in 100. In the sidings now in course of construction at

Newport (Plate 3, Fig. 4) the gradient is a uniform one of 1 in 110, except in three places, where 1 in 100 is adopted, for the purpose of giving greater initial speed to the 'set' of trucks about to be sorted.

The traffic which passes through the Shildon sidings being consigned, as already mentioned, to upwards of two hundred different points of delivery, and there being only thirty-nine sidings for its classification, many of the receivers, too, being unable to take it in whole train loads, it is obvious that some sidings must receive traffic ticketed for several distinct places. It would, consequently, be desirable that such mixed trains should start on their journey with the trucks arranged in the same order in which the various receiving points would be reached, thus obviating sorting in their delivery; and herein it must be admitted that the present arrangements are imperfect, and that they fail in affording sufficient facilities for accomplishing this object.

To meet this want, it is proposed to lay down groups of four or five short sidings, connected with the lower ends of the groups C C and D D, in which a second sorting of the trains standing in the last-named sidings may be effected; and in continuation of each group of second sorting sidings to lay down one or two long sidings, where trains may be made up with the trucks arranged in proper order. The proposed sidings and contingent alterations are shown in Plate 3, Fig. 2. Their arrangement is, however, somewhat cramped from want of room; but similar, though more complete, sidings form part of the scheme of sorting lines at Newport.

As the traffic is now worked, the flattening of the gradient at the lower part of the sidings answers very well. But when the proposed alterations are effected, and when the trucks in sidings C and D will have to start by gravitation to pass into the second sorting sidings, and again to start from these sidings into the train-sidings, the initial steeper gradient will need to be continued throughout to the lower end. It is consequently proposed to raise the rails so as to adjust them to a uniform gradient of 1 in 114 from the western part of sidings B to the eastern end of the second sorting sidings, with the exception of short lengths of 1 in 100 introduced at places proper to facilitate the starting of the 'sets' of trucks. More break power will then be required to bring the trucks to a stand; but with the breaks in good working order, it is not apprehended that any difficulty will be experienced. Worn-out and useless or imperfect breaks are, however, too commonly met with, particularly among the 'foreign trucks,' and

increased care will be needed in their rejection. Near the eastern boundary of the works there is a long siding and weigh-bridge for occasionally testing the weight of mineral trains.

There is also near Shildon an assemblage (E) of sixteen sidings opposite the upper part of those already described, but on the other side of the main travelling lines (Fig. 3), chiefly for the reception and sorting of wagons, principally empty, going in the contrary direction, or towards the collieries. Being all blind sidings at the lower end, the trains when marshalled have necessarily to depart over the same rails by which the trucks enter them when being sorted. This leads to confusion and irregularity, so that it is intended to extend the blind ends, causing them to converge in two groups, and at each point of convergence to branch off into a group of second sorting sidings, beyond which long sidings will be laid for the marshalling of trains; these will then be able to pass out on to the main line without so much interference with the sorting operations.

The cost of working these sidings was, in the year 1873,

	£.	s.	d.
Inspectors and timekeepers	281	0	4
Thirty-nine sorters and wagon examiners	2,398	17	10
Eleven wagon-greasers	408	6	2
One locomotive	1,000	0	0
Total	4,088	4	4

The number of trucks passing through these sidings exceeds, by about two hundred per day, the number passing through the sidings first described, the difference being occasioned by empties from the west side of the island returning to the collieries *via* Darlington and Shildon.

Much of the sorting of empties is rendered necessary by the trucks being owned by fifty or sixty different parties, each of whom consigns his trucks to some particular colliery. The work would be vastly simplified if the collieries could be supplied from a common stock of empties, the property of the North-Eastern Railway Company.

The length of these sidings is at present 9,200 yards, or $5\frac{1}{4}$ miles, and the land covered by them upwards of 7 acres.

The sidings for which the preliminary works are in progress near Newport, between the towns of Stockton and Middlesborough, are intended for the collection, sorting and marshalling in trains of the produce of the iron-making district of Cleveland.

The site selected having been formerly the foreshore of the river Tees, and the travelling lines being nearly on a level, the elevation required to perform the sorting by gravitation will be obtained by an embankment, the contents of which will be 450,000 cubic yards; of this quantity 320,000 cubic yards have already been deposited. The land to be embanked being contiguous to the blast furnaces of Messrs. B. Samuelson and Co., and being convenient for the deposit of slag, the bulk of the embankment is being formed with it by that firm without cost to the Railway Company. The arrangement is shown in Plate 3, Fig. 4.

As the sorting in these sidings will be performed by locomotives, unaided by gravitation, it is not proposed to notice them further. It may be proper to explain, that the coal and coke sidings are intended for the produce of the central Durham and Hartlepool district, which, as it comes on to the Darlington line at Stockton, is not sorted at Shildon.

When the sidings are completed, 'pick-up trains,' with the produce of the iron-making district, will leave the travelling lines by facing-points at P, and enter one of the four sidings Q, which have an ascending gradient of 1 in 80. Having cleared the main line, the engine will come to a stand, be uncoupled, shunted, and depart through the exit line R to the works for another load. A shunting engine will then take the train, or part of it from the siding Q, and after shunting in siding S, will push it through siding T, having an ascending gradient of 1 in 60, into siding V, whence it will return and repeat the process of feeding siding V out of the sidings Q Q. In the meantime, siding V will be emptied into one of the two sidings W W, the trucks being run down by gravitation, coupled together and just as they entered it.

The first sorting will commence in sidings W W, the train being divided according to the destination of the trucks, and each 'set' run into its appropriate siding in groups X X. Then will follow a second sorting in the sidings of the group Y Y, so that each train may have its trucks arranged in proper order for delivery; and lastly the trains will be formed ready for departure in groups Z Z.

The gradient, from the upper end at the point N to the middle of the train sidings Z Z at the point O, will be a uniform one of 1 in 110, except in three places where, to insure a greater initial velocity, 1 in 100 is introduced.

There will be a central line communicating with both groups of sidings, to give locomotive engines access to aid the motion of the

trucks when required, and a siding at M, having a weigh-bridge in the middle.

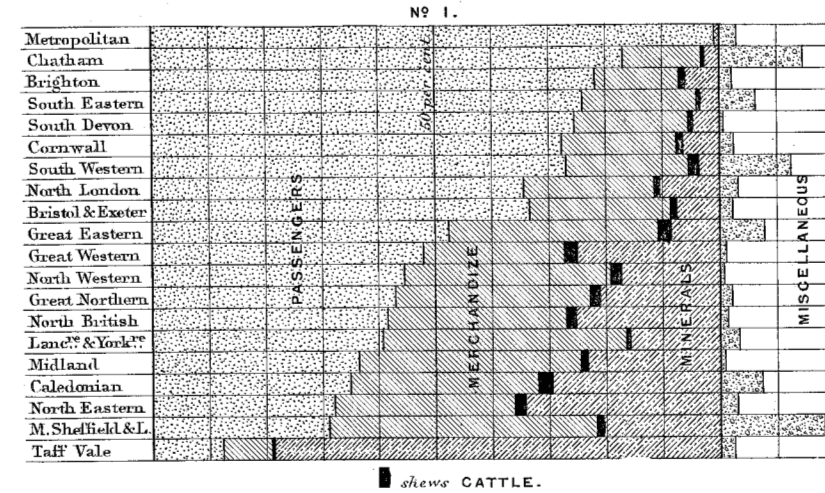
				Yards.
The aggregate length of the first sorting sidings	X X	will be		4,795
" "	second " Y Y	"		2,276
" "	train sidings Z Z	"		2,020
" "	engine lines and other sidings	"		4,986
Total				<u>14,077</u>

or 8 miles. The land occupied by these sidings will be about 13 acres.

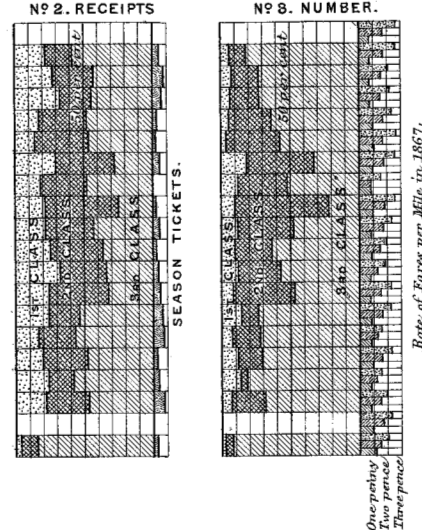
The sidings, completed and in progress at Shildon and at Newport, which form the subject of this Paper, sufficiently indicate the importance attached by the directors and officers of the North-Eastern Railway Company to a thorough sorting of trucks prior to the starting of a train. The Author would in conclusion submit, that all sorting operations, whether performed at the commencement, during the progress, or at the end of a journey, ought to be carried on in sidings provided for the purpose, in which the whole of a train may stand, and so free the main line from obstruction, involving delay and risk of accident.

The Paper is illustrated by several diagrams, from which Plate 3 has been engraved.

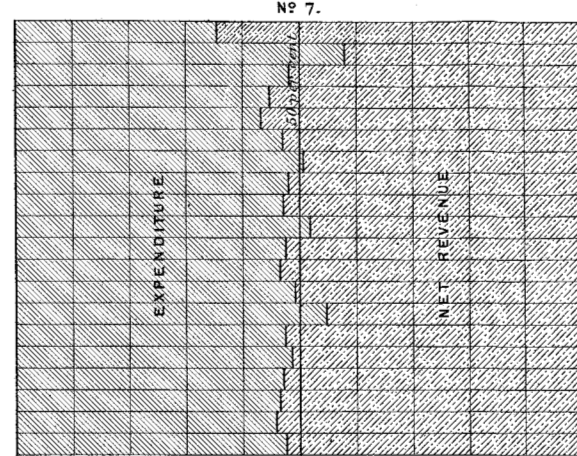
Shewing the *per Centage* of Receipts from Passengers, Merchandise, Cattle and Minerals; and per Centage from Miscellaneous Sources, in proportion to Passengers and Goods, for half year ending December, 31st 1868.—



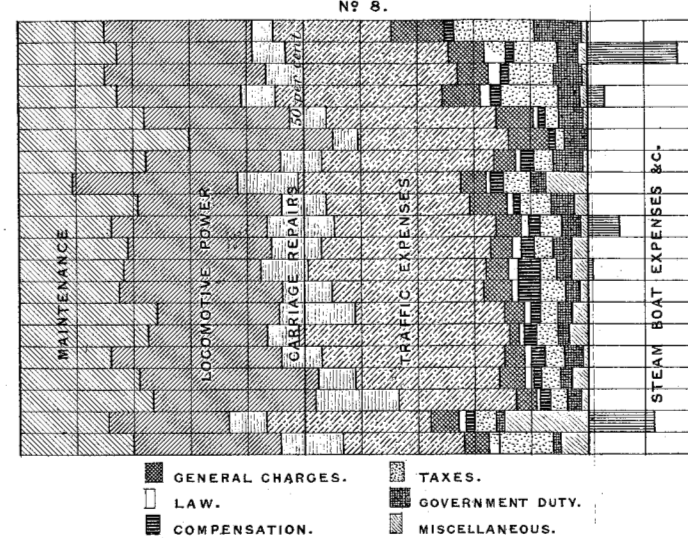
Shewing the *per Centage* of Receipts from (Nº 2); and Number of (Nº 3), 1st, 2nd and 3rd class Passengers, for half year ending December, 31st 1868.—



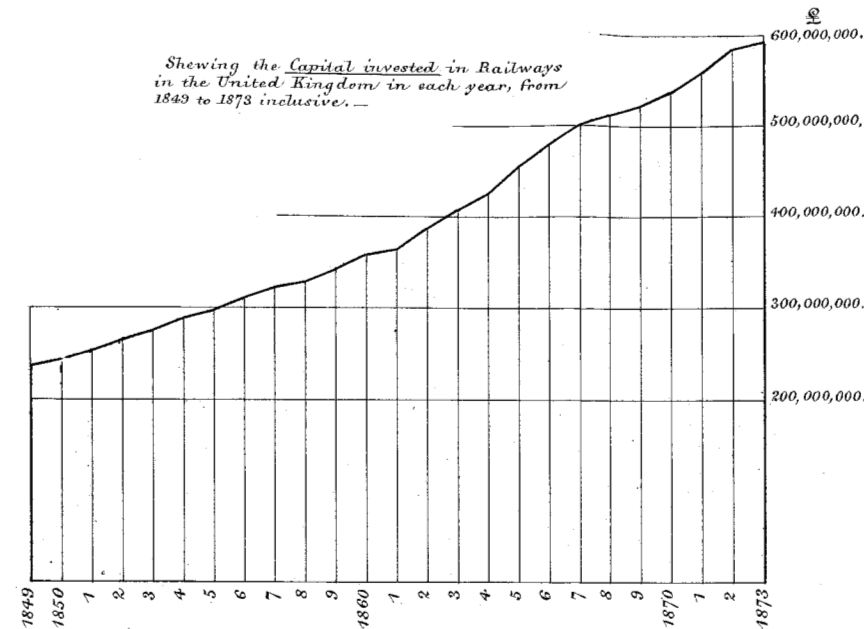
Shewing the *per Centage* of Expenditure and of Net Revenue on the Total Receipts, for half year ending December, 31st 1868.—



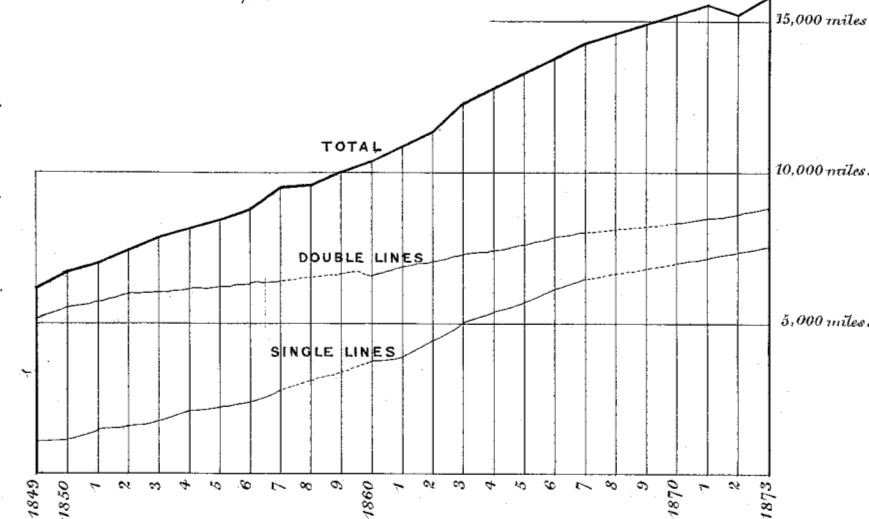
Shewing the *per Centage* of Expenditure on account of Maintenance, Power, Traffic Expenses &c. (excepting Steam Boats), and the proportion the Steam Boat Expenses bear to other expenses, for half year ending December, 31st 1868.—



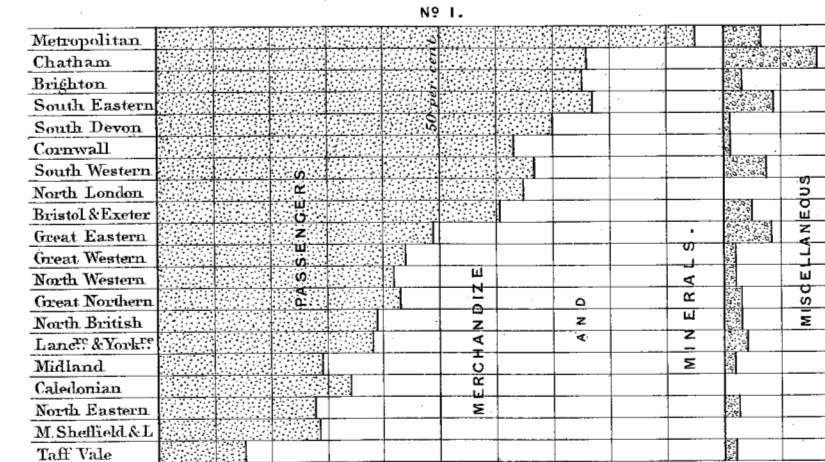
Shewing the *Capital invested* in Railways in the United Kingdom in each year, from 1849 to 1873 inclusive.—



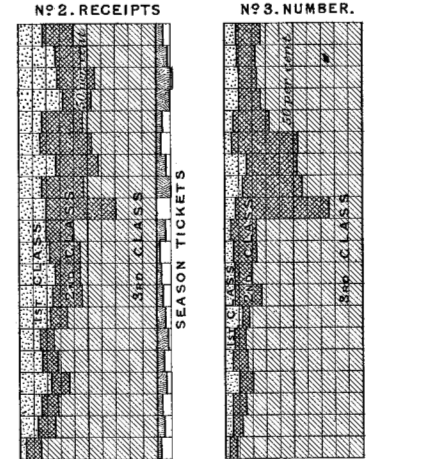
Shewing the *Length* (Single, Double and Total) opened in the United Kingdom, in each year, from 1849 to 1873 inclusive.—



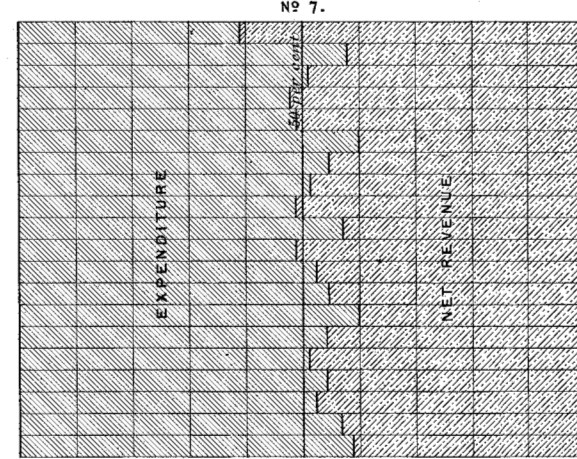
Shewing the *per Centage* of Receipts from Passengers, Merchandise, Cattle and Minerals; and per Centage from Miscellaneous Sources, in proportion to Passengers and Goods, for half year ending December, 31st 1873.—



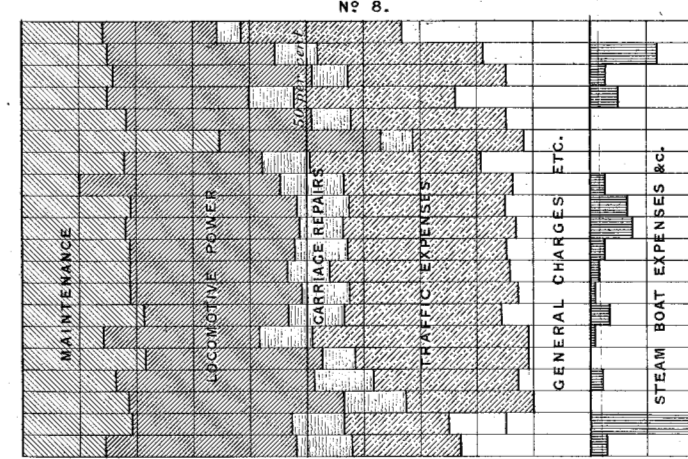
Shewing the *per Centage* of Receipts from (Nº 2); and Number of (Nº 3), 1st, 2nd and 3rd class Passengers, for half year ending December, 31st 1873.—



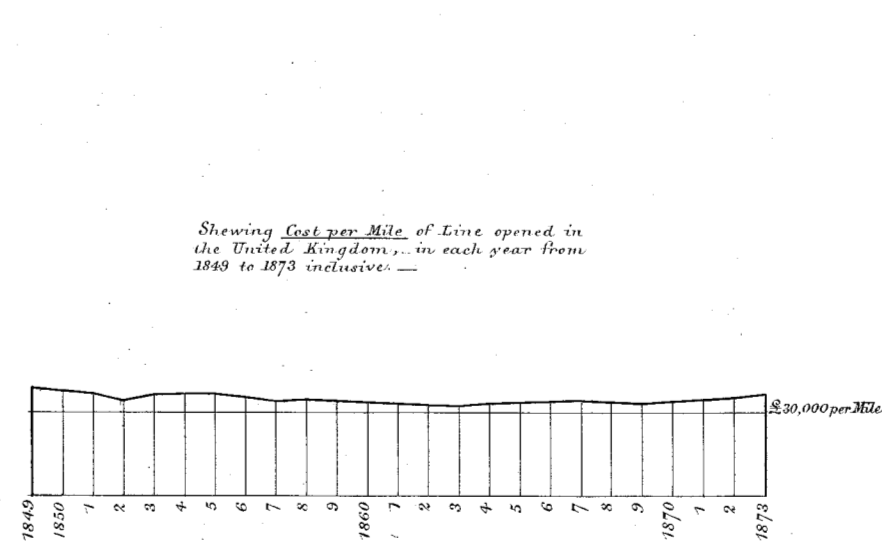
Shewing the *per Centage* of Expenditure and of Net Revenue on the Total Receipts, for half year ending December, 31st 1873.—



Shewing the *per Centage* of Expenditure on account of Maintenance, Power, Traffic Expenses &c. (excepting Steam Boats), and the proportion the Steam Boat Expenses bear to other expenses, for half year ending December, 31st 1873.—



Shewing *Cost per Mile* of Line opened in the United Kingdom, in each year from 1849 to 1873 inclusive.—



Shewing the *Gross Receipts* on the Railways in the United Kingdom, in each year, from 1849 to 1873 inclusive.—

