

ON
THE USE OF LOCOMOTIVE POWER,
ON
GRADIENTS OF 1 IN 17, AND CURVES OF
300 FEET RADIUS,

ON
ALLWAYS IN AMERICA.

By THOMAS SEBASTIAN ISAAC.

WITH AN ABSTRACT OF THE DISCUSSION UPON THE PAPER.

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No. 990.—“On the use of Locomotive Power, on Gradients of 1 in 17, and Curves of 300 feet radius, on Railways in America.”¹ By THOMAS SEBASTIAN ISAAC.

IN the discussion that followed the reading of Mr. Drysdale's Paper before the Institution, in April 1856, “On the Steep Gradients of Railways,”² doubt was expressed, whether locomotives would be able to surmount an inclination of 1 in 20, or 1 in 17. The Author is enabled to furnish evidence, not only that the locomotive has successfully surmounted these gradients, but that it has actually scaled an incline of 1 in 10, with a load greater than its own weight. The inclines described are on railroads in America, with which the Author has been professionally connected; and the facts adduced have come under his own immediate observation.

The extension of railroads has been so rapid in America, and the demand for speedy construction so urgent, that Civil Engineers have been compelled to resort to various expedients to facilitate the execution of the works. Time has been an element of so much importance, that the work of track-laying has been pressed forward, with the utmost possible rapidity; and where the iron and other materials for the track could only be delivered from one end, as fast as the track itself was laid, the delay of only a few months, from the non-completion of any portion of the road-bed, would have been, in many cases, too serious a matter to be willingly submitted to. Where bridges were unfinished, rivers were trestled, to admit of the passage of the locomotive, with its burden of iron; where tunnels were behind-hand, the hills were scaled by inclines, in order that the pressing exigencies of the moment might be met. Of the expedients thus resorted to, the introduction of unusually steep gradients has probably furnished the most interesting results to the Engineer. The information gained from this source is the more valuable, on account of the great range of the gradients that have been submitted to actual experiment.

¹ The discussion upon this Paper extended over portions of two evenings, but an abstract of the whole is given consecutively.

² Vide Minutes of Proceedings Inst. C.E., vol. xv. pp. 349 to 364.

The Company that has pre-eminently taken the lead in the application of locomotive power to steep gradients, is the Baltimore and Ohio railway, which extends from the city of Baltimore, on the Chesapeake bay, to Wheeling, on the Ohio river. Of all the lines of railway which extend westward, from the Atlantic coast to the great valley of the Mississippi, and have had to grapple with the various ranges of the Alleghany Mountains, there is not one which has had to encounter so many and such formidable obstacles, both in its location and in its construction, as this road. Though somewhat of a digression, it may not be altogether devoid of interest to state, that the Baltimore and Ohio Railway Company was the first chartered in America, the first in operation there for passengers and merchandise, and has been the pioneer in almost all improvements that have been introduced upon American railroads. The Company was organised under its charter in 1827, and a portion of the line was opened in May 1830.¹ Horses were at first used as the motive power, but locomotives were employed as early as August 1830. When it is considered, that the railroad system in England was but then in its infancy, and that locomotives were running on this section of the Baltimore and Ohio Railroad before the opening of the Liverpool and Manchester line, one cannot fail to be struck with the daring enterprise which, at that early day, could project and undertake the construction of a railway 380 miles long, through a region where the difficulties, even in the present advanced state of engineering science, seem to be of the most gigantic kind.

Although the railway was undertaken at this early period, legislative and financial difficulties prevented the commencement of the western half, until 1849, and it was not until 1851, or three years prior to the opening of the Sumnering incline, that the great incline over the main range of the Alleghany Mountains was completed, and successfully worked by locomotives. The maximum gradient of this incline is so much exceeded by that of the Ciovi, which was opened in December 1853, and falls so far below the gradients which it is the more immediate object of this Paper to describe, that only a passing sketch will be given. The Author considers a brief notice to be due, however, on account of its great

¹ It should be stated, that a deputation from the Board of Engineers of the United States, consisting of W. G. MacNeill, G. W. Whistler, and J. Knapp, visited this country in the year 1828, for the purpose of examining the Public Works, but more especially the existing railways, and those in course of construction. (See Memoir of W. G. MacNeill, Minutes of Proceedings Inst. C. E., vol. xiii, p. 110.) As a consequence of this visit, Messrs. Stephenson and Co., of Newcastle upon Tyne, received an order for a locomotive engine from "The Delaware and Hudson Canal Company," which was delivered on the 20th October, 1828. Subsequently, on the 25th June, 1831, they supplied a locomotive engine to "The Mohawk and Hudson Railroad Company." *Ibid.*

length, and the ease and success with which it is worked. This incline rises 1,690 feet in fifteen miles, eleven continuous miles of which have an inclination of 1 in $45\frac{1}{2}$. It reaches a height of 2,626 feet above the sea, and after winding amongst the summits of the Alleghanies, for a distance of twenty miles, descends on the western side, with an inclination of 1 in $45\frac{1}{2}$, for nine continuous miles. The passage of this mountain-chain involves altogether sixty miles of railway, twenty miles of which have a gradient of 1 in $45\frac{1}{2}$, and nine miles have a gradient of 1 in 50; both are worked by locomotive power, at a speed of from fifteen to twenty miles per hour for passenger trains, and of from ten to fifteen miles per hour for goods trains. In addition to the disadvantages arising from its great length, this incline labours under others connected with its curves, the character of the region which it traverses having necessitated the frequent introduction of curves of 600 feet radius; so that at the time of its construction, the difficulties in the way of its successful operation were altogether unprecedented. The Author cannot state the exact amount of traffic that annually passes over it. To convey some idea, however, it will suffice to say, that it is situated near the middle of one of the main thoroughfares of American commerce; and that the tonnage of goods carried on the Baltimore and Ohio Railway in 1857 was equivalent to two hundred millions of tons carried one mile. The Company own two hundred and thirty-six engines, and their rolling stock, if coupled together, would cover a length of twenty miles.

With the exception of a few locomotives especially constructed for passenger trains, no extra provision has been made for the working of this incline, beyond increasing the number of the engines. The same engines are used to work it, as were previously employed for the ordinary traffic of the line. They weigh, when in running order, about 24 tons each, and run on eight wheels, all of which are coupled. The diameter of the cylinders is 17 inches, the length of the stroke is 2 feet, and the diameter of the wheels is $4\frac{1}{2}$ feet. Each engine is provided with a tender, the weight of which, when furnished with the full complement of fuel and water, is about 13 tons. Several of these engines are stationed at the foot of the mountain on both sides, and as the goods trains arrive, an assistant engine is employed to take over a portion of the train, or is coupled on to the regular engine, to aid in the transit.

Before returning to the more immediate object of this Paper, it will be necessary to state, that while Mr. Latrobe, the chief Engineer of this line, was pushing the western portion to completion, he encountered, in 1852, at two different tunnels, difficulties altogether beyond control, which seemed to threaten serious delay.

in the westward extension of the line. To provide for the passage of the trains, he caused temporary inclines to be constructed over both the tunnels. The one first made was that over the Kingwood Tunnel. It had a maximum gradient of 530 feet per mile, or a rise of more than 1 in 10. Over this incline, which was in operation for several months, the iron and other materials for upwards of forty miles of railway, and the United States mails, were conveyed by locomotive power. The same engines were employed as have been already described. One car, weighing with its load of iron about 13 tons, was allotted to an engine; and as each tender, with sufficient fuel and water for the passage of the hill, weighed 12 tons, the total load dragged up this unparalleled gradient was 25 tons, at a speed of from eight to ten miles per hour.

At the second point, called the Board Tree Tunnel, instead of a continuous incline to the top, Mr. Latrobe deemed it advisable to adopt a series of inclines of a zigzag form, on which the upward motion of the train was alternately reversed, the engine at one time pulling, and at another pushing the cars. There were three of these zigzag inclines on the eastern ascent, and five formed the descent on the western slope of the hill. The greatest height above the tunnel was 300 feet, and the total length of the inclines was 12,000 feet, or about $2\frac{1}{4}$ miles. The gradients varied from 293 to 340 feet per mile, or nearly 1 in 18 to 1 in $15\frac{1}{2}$, and the minimum radius of curvature was 300 feet. The ordinary freight engines were employed. Two loaded cars, weighing together 25 tons, were allotted to an engine; the load, therefore, including the tender, was 37 tons.

Mr. Latrobe, in his report of 1853, speaks thus of this incline, "The working of the switch tracks, at the Board Tree Tunnel, was successful and safe: on one, or two occasions, as many as fifty cars, with 400 tons of freight, and two passenger trains, have been taken over the hill in a day, by four first-class locomotives; each round trip making a run of ten miles. No accident, involving more than a short detention, happened during the working of these gradients, for nearly five months."

The track over both these inclines was taken up as soon as the tunnels were completed; but it was relaid in 1855 and in 1857, respectively, in consequence of the necessity of arching the tunnels throughout. The maximum gradient at the Kingwood Incline was reduced, on this second occasion, from 530 to 300 feet per mile. Over this the traffic of the road was carried, until the arching was completed. These two inclines, therefore, although unprovided with engines especially adapted for the purpose, fully demonstrate the feasibility of traversing gradients, altogether unprecedented, by the locomotive alone. The experience gained in working them, not only establishes the fact, that a rise of 300 feet

per mile, and curves of 300 feet radius, can be worked with comparative facility; but seems to point also to a limiting gradient, beyond which it is impossible for the locomotive to go, with any useful effect, even for a temporary purpose.

Since the construction of the Kingwood Tunnel and the Board Tree Tunnel Inclines, evidence has been accumulating from other sources. Steep gradients and sharp curves have been introduced upon the Virginia Central Railroad, on a more extended scale; and such uninterrupted success has attended their operation, for a period of more than four years, that indisputable proof is now furnished, of the possibility of extending railways into localities, where economical considerations will not admit of the ordinary method of construction, and into regions which, without the introduction of such expedients, must otherwise, from their physical conformation, be for ever debarred from the advantages of the railroad system. The Mountain Top Incline, on the Virginia Central Railroad, crosses the Blue Ridge Mountains, at Rock Fish Gap, in Virginia, at an elevation of 1885 feet above the sea. The supervision of its location and construction was intrusted to the Author, by Mr. Charles Ellet, the chief Engineer of the road. Its object was to connect the eastern and western portions of the line, interrupted at this point by the Blue Ridge Mountains, through which a tunnel had been in the course of construction for four years, at the time this incline was commenced, in 1853. As the track over the mountain was expected to be in operation for four years, it was substantially built, and especial provision was made to adapt the locomotives to their unusual duty. The introduction of zigzags was avoided, although merely economical considerations would have urged their adoption. They involve unnecessary delay, and increase the liability to accident. The portion of the incline, therefore, immediately crossing the mountain, is a continuous track, of four miles and one-third in length. From the points of connection with the termini of this incline, the main line of railroad descends for several miles on both sides, with gradients varying between 70 and 80 feet per mile. The maximum gradient, on the Mountain Top Track, is 1 in 17·86, and is employed on the lower half mile of the eastern slope, upon straight lines and curves with a radius of 570 feet, and upwards. With this exception, the gradient upon all straight lines and similar curves is 1 in 18·87. The minimum gradient, with a single exception, is 1 in 22·22, and is introduced upon curves of 300 feet radius. It has one curve with a radius of 234 feet, upon which the gradient is also 1 in 22·22.

* The general character of the line may be judged from the following Table:—

Total length of curves of 300 feet radius				1.100 miles
"	"	320	"	.189 "
"	"	360	"	.189 "
"	"	440	"	.113 "
"	"	478	"	.237 "
"	"	570	"	.237 "
"	"	of a greater radius than 570 feet		1.070 "
"	of straight lines			1.194 "
Total length				4.329 miles

On the eastern slope, from the point of connection with the main line, an elevation of 610 feet is surmounted, in a distance of 2.87 miles. The average gradient on this portion therefore is 1 in 20½. The western slope makes a descent of 450 feet in 10,000 feet. The introduction, for a short distance, of a gradient of 1 in 30, reduces the average on this side to the ruling minimum of 1 in 22.22. In addition to this main incline over the mountain, it was found necessary to introduce steep gradients and sharp curves at four other points, to pass a second tunnel and certain unfinished portions of the main line; so that the distance worked by the mountain engines is 8 miles. The average gradient over the whole 8 miles is 1 in 29½. The westward trip makes a total ascent of 900 feet, with a total descent of 531 feet; so that, in the round trip of 16 miles, a height of 1,431 feet is surmounted, and an equal descent is made.

The engines chiefly used to work these gradients are mounted upon six wheels, all of which are coupled. The wheels are set near together, in order to facilitate turning round the sharp curves of the road; the distance between the centres of the forward and hindmost axles being only 9 feet 4 inches. By a peculiar arrangement, in the method of connecting the wheels, a certain amount of flexibility is obtained, which is of additional advantage in traversing the curves. The diameter of the cylinders is 10½ inches, the length of the stroke is 20 inches, and the diameter of the driving-wheels is 3½ feet. These engines are furnished with a tank over the boiler, capable of holding 100 cubic feet of water, and on the top of the tank there is storage space for 100 cubic feet of fuel. The foot-board is also lengthened, and is provided with suspended side boxes, for the further storage of fuel. When supplied with sufficient wood and water, for a trip of eight miles, each engine weighs about 24½ tons. The regular mountain-train consists of three loaded cars, on eight wheels; or four, or five cars, when only partly loaded. When the track was first opened, the weight of each loaded car was a little more than 14 tons, but an

additional ton of freight, per car, has since been added, so that the usual weight of a mountain-train is $45\frac{1}{2}$ tons. Greater loads have been taken over, and a speed of sixteen miles per hour has been attained; but no experiments have ever been made to determine the maximum power of the engines. The speed of the ordinary trains has been limited, by regulation, from the very commencement, to a maximum of eight miles per hour. The total weight of engine and train is about 70 tons. This mass is moved over the westward trip, overcoming an ascent of 900 feet, and making a descent of 531 feet, with a consumption of three-quarters of a cord of wood. The return trip, in which the ascents and descents are reversed, is made with a consumption of one-half a cord. One-third of a cord is consumed in one portion of the westward trip, in overcoming an elevation of 660 feet in 2.62 miles.

In the system of working that has been adopted, and brought to such perfection, on this incline, one feature, altogether novel in its application to such steep gradients, is the method of accomplishing the descent. All the cars, which cross the mountain, are provided with a break to each wheel, of sufficient strength to lock the wheel, if necessary; and a brakeman is stationed at each end of every car, who is not allowed to leave his post during the transit. No steam is used on the descent, except on an emergency, but the motion of the train is regulated entirely by the breaks; those of two cars being found sufficient for that purpose, in ordinary weather. When the ground is covered with snow, or ice, it is necessary either to have recourse to the air-cocks of the engines, or to supply sand to the breaks. Although the introduction of such a system of breaks is a very necessary precaution, it is questionable whether their too exclusive use is advisable. Judging from personal observation of the use of the air-cocks, on the steep inclines of the Baltimore and Ohio Railroad, and subsequently, of the system of breaks on the Mountain Top Track, the Author is inclined to think a judicious combination of the two systems far preferable to the exclusive use of either. On inclines worked by stationary engines, a trail-piece has frequently been appended to the rear car, which prevents the descent of any portion of the train, in case of the breaking of a coupling during the ascent. On the Mountain Top Incline, this trail-piece has been dispensed with; but to prevent the possibility of accident, two short pieces of strong chain are hooked between the contiguous carriages, which on an emergency would act as a powerful additional coupling.

There is a superintendent of this incline, whose duty it is to accompany the trains, to see that all the regulations are observed, and to exercise a vigilant supervision of the whole operation. No precaution is neglected to insure safety, and the ascent and descent

are made so smoothly, that but for the diminished rate of speed, there is nothing in the motion of the train itself, to indicate to the passengers, that such steep gradients, or sharp curves, are being traversed.

On the main portion of the incline, there are six viaducts of trestle-work, across six mountain gorges, of a total length of nearly half a mile. They are of timber, and, with one exception, are situated on sharp curves. Three of them are on curves of 300 feet radius. On these, for the sake of greater security, a guard rail is placed parallel to and immediately inside the inner rail, to prevent the carriages from leaving the track.

The only point of access to this incline, by an ordinary road, is at the summit; and as, in order to avoid great delay, it was necessary that the rails should be laid over the mountain, before a connection could be made with the main track of the railway, all the iron and other materials had to be hauled a great distance by teams, to the summit, the last two miles overcoming an ascent of 1,100 feet. From the summit, as the track progressed, the materials were distributed on each side of the mountain, by small four-wheel cars, which were regulated in their descent entirely by breaks.

This line has been worked for upwards of four years, without a single accident, since the opening of the road to the public; and the engines have only failed to perform their allotted daily duty on one occasion, when the train was caught in a snow-drift near the summit. The winters have been unusually severe, and the mountain has been covered with snow for months together, but neither snow nor ice has presented any impediment to the safe passage of the mountain-trains.

The tunnel was completed and the rails were laid through it in September, 1857; and yet, when the Author left America, in April, 1858, more than six months after the completion of the tunnel, the Virginia Central Company were still using the incline over the mountain. The cause of this was the refusal, on the part of the Company, to accept the tunnel and its approaches, from the hands of the State authorities, by whom the tunnel was constructed, unless the State would agree to refund a comparatively trifling outlay, contingent upon a possible sliding of a portion of the road-bed. The fact of its being preferred to work the incline over the mountain, rather than run the risk of a trivial expenditure, is a sufficient proof, in itself, of the facility and economy of the working of the incline.

One feature in the Mountain Top Track, that will not have failed to excite attention, is the unusual severity of the curves. It is to be regretted, that a series of experiments, which it was at one time intended to institute, with regard to the resistance of the

curves, should have been prevented, by unforeseen circumstances. It has, however, been clearly proved, that this resistance has been underrated in America. Mr. Latrobe, in his calculations for the zigzag tracks over the Board Tree Tunnel, made an allowance of 31 feet per mile, between the straight portions of the line and the curves of 300 feet radius. This allowance was based on the results of some experiments made by him, which seemed to indicate, that the resistance to traction on a level, was doubled by a curve of 400 feet radius. On the Mountain Top Incline a difference of 43 feet, and on a portion of the eastern side of 58 feet, per mile was allowed, between the straight lines and curves of 300 feet radius; and yet even this was found to be insufficient. The speed was always diminished on leaving a straight portion of the track, and on entering a curve of minimum radius, although the resistance of gravity, on the latter, was $25\frac{1}{2}$ lbs. per ton less than on the former; a fact evidently proving, that the resistance of the curve must have exceeded $25\frac{1}{2}$ lbs. per ton of engine and train. It is probable, that Mr. Latrobe's experiments give a sufficiently approximate measurement of the increase of friction of the curves, due to carriages of American construction. Assuming, therefore, his allowance of 13 lbs. per ton, as the additional friction of the train, on a curve of 300 feet radius, the additional friction of the engine, due to such a curve, must have exceeded 49 lbs. per ton of its own weight. This friction will of course vary in engines of different construction. No experiments have been instituted, as far as the Author is aware, to find the increased resistance offered by curves to locomotives themselves.

While on this subject, it may be as well to mention two expedients that have been resorted to, for diminishing this friction. On the Baltimore and Ohio Incline, and on the Mountain Top Track, it was found necessary to elevate the outer rail far above the height deduced from any formula, previously employed. The ordinary formula gives results sufficient to counteract centrifugal force, but not to prevent the friction, due to the parallelism of the axles, which is produced by the flanges of the outer wheels against the inner edge of the outer rail. On the Baltimore and Ohio Inclines, for a speed of ten miles per hour, instead of about 2 inches, as required by the formula, the outer rail, on a curve of 300 feet radius, was gradually raised till it was about 9 inches above the inner one. On the Mountain Top Track, for a speed of eight miles per hour, an elevation of $6\frac{1}{2}$ inches was given. Besides this, on the latter road, a sponge, saturated with oil, was kept in contact with the flanges of the two forward wheels of each engine, by which means the inner edges of both rails were slightly lubricated. These expedients so far reduced the friction on the latter road, as to cause no perceptible diminution of speed on

leaving a straight portion of the line, with a gradient of 236 feet per mile, and on entering a curve of 300 feet radius, with a gradient of 238 feet per mile.

Shortly before his return to this country, the Author revisited the Mountain Top Track, for the express purpose of examining its condition. He was agreeably surprised to find, that the wear and tear, in spite of a combination of circumstances tending to produce greater destruction, was less than upon the other portions of the line. It is laid with a T rail weighing about 62 lbs. to the yard, and although the friction previously mentioned seemed, at first, to threaten a comparatively speedy destruction, the greater elevation of the outer rail and the use of oil have proved effectual remedies against undue depreciation arising from this source.

The Virginia Central Company have also constructed a shorter incline, at a point about 100 miles further west. This second track is one mile and a half in length: the gradients vary between 250 and 300 feet per mile, or from 1 in 21.12 to 1 in 17.6, and the curves have a minimum radius of 400 feet. This minimum has been adopted, partly because local circumstances did not necessitate a less one, and partly to admit of the use of the ordinary engines of the line, which do not traverse curves of 300 feet radius with facility. This incline has been in operation for two years, and it is likely to be in use for several years to come, as the traffic at this point will not justify the expense of constructing the more costly works, which the incline is built to avoid, until the western connections of the road are completed. Over this incline, one of the common freight-engines in use on the main road, running on eight wheels, only four of which are coupled, and with not more than 16 tons available for adhesion, has taken a load of 36 tons, at a speed of five miles per hour, according to information obtained from Mr. Whitcomb, the present chief Engineer of the line. The same engine has drawn a similar load over the Mountain Top Track.

The success that has attended the working of these inclines, and especially of the one over the Blue Ridge Mountains, has exceeded the most sanguine expectations. The annual reports of the Company speak in glowing terms, of the satisfaction with which the Company and the public have witnessed the regularity and safety of the entire operation.

The Author does not propose to institute any comparison, between the results obtained on the inclines described in this Paper, and those which have been previously laid before the Institution. Indeed, it is extremely difficult to procure sufficiently reliable data, on which to base an estimate of the performances and the cost of working in each case. In many instances, the statements furnished

are so evidently obtained from experiments made under the most favourable circumstances, with every precaution taken to insure the exertion of a maximum power and the attainment of a maximum speed, as to be clearly inadmissible for the purpose. So many inclines, on the other hand, are worked in connection with the other portions of the lines on which they are situated, as to preclude the possibility of keeping separate returns, and the data obtained from these sources are therefore uncertain and not to be relied upon. But even if accurate data were procurable, so little similarity exists between the conditions of the inclines themselves arising from diversities of climate, differences of curvature, and other local circumstances, that the most justly-drawn comparison would still be liable to objection. The Author will therefore content himself with presenting the following calculations of the ordinary performances of the engines on the Mountain Top Track. The usual weight of each train is $45\frac{1}{2}$ tons, and of each engine $24\frac{1}{2}$ tons, making a total weight of 70 tons. The speed reaches eight miles per hour up the eastern slope, which is 2.37 miles in length, with an average gradient of 1 in $20\frac{1}{2}$. The resistance due to this speed and gradient is 121.64 lbs. per ton. Therefore

$$\frac{121.64 \times 70 \times 8 \times 88}{33000} = 181\frac{1}{2} \text{ horse-power, including the engine in the load.}$$

$$\text{Or } \frac{121.64 \times 45.5 \times 8 \times 88}{33000} = 118 \text{ horse-power, not including the engine; giving,}$$

$$\text{in the latter case, } \frac{118}{24\frac{1}{2}} = 4.8 \text{ horse-power per ton of motor.}$$

To overcome the maximum gradient on the Mountain Top Track, with an ordinary load, requires an exertion of 5.4 horse-power per ton of motor.

With regard to the question of adhesion, it will be found, from an examination of the facts already given, that on the Baltimore and Ohio Incline, with a gradient of 1 in 10, the weight of the engine was about four and three-quarter times the resistance of gravity and the friction of the load. On one, or two occasions, when the rails were very greasy, the engine and the train slid backwards with locked wheels, from near the top to the bottom of this incline, without damage. The wheels of the engines had chilled tyres, a circumstance which considerably decreased their adhesion. When to this is added the difficulty of furnishing sand behind the train, without previous provision for that purpose, the sliding of the train with locked wheels is satisfactorily accounted for.

The engines on the Mountain Top Track, with an ordinary train, exercise an adhesive power of one-sixth of their weight. This power is always maintained, in the severest weather, by the use of a fine clean sand. The Author has witnessed their working,

in every emergency due to climate, and has noticed that a little sand, supplied in front of the engines, has always enabled them, with ease and without delay, to overcome the effects of fog, snow, sleet, and rain frozen on the rails. Trains have been taken over, which required an adhesion of nearly one-fourth of their weight, but this was in fine weather. From his own observation, he thinks that an adhesion of about one-sixth of the available weight of the engine, can always be relied on; and that the use of a fine clean sand will maintain it in the most severe weather. During the winter of 1856-57, the snow filled many of the cuts on this incline, to the depth of several feet. To open a passage for the trains, two of the engines were coupled together, and they worked their way up, with the greatest ease, without any snow-plough and without sand.

Stationary power seems to be so generally superseded by the locomotive, that it is almost needless to draw any comparison between them. There are so many practical inconveniences necessarily attendant upon the former, that the latter must, in spite of any disparity in the item of cost, always maintain a superiority. The rope cannot well be applied where curves are necessary, and the localities, mostly in need of inclines of any length, generally require curves. There are probably few mountain passes that cannot be overcome by the introduction of gradients of 1 in 17; and since experience has satisfactorily proved, that the locomotive can draw a load nearly double its own weight up such a gradient, at a speed of eight miles per hour, and that it is possible even to traverse curves of 800 feet radius, by reducing the inclination to 1 in 22.22, there can be but little occasion for the adoption of a motive power altogether out of the control of those on the train.

In conclusion, the Author would state, that the experience gained on the Mountain Top Track furnishes additional evidence to that already gained from other sources, of the superiority of light engines with light loads, over heavy engines with heavy loads.

The Paper is illustrated by a diagram plan and section of the Virginia Central Railway.

Mr. ZERAH COLBURN remarked, that on the Baltimore and Ohio Railway, the ordinary goods-engines had cylinders 19 inches diameter, with a length of stroke of 22 inches; they had eight driving-wheels, each 3 feet 7 inches diameter, and all coupled. The passenger-engines principally employed on the inclines of 1 in 45 $\frac{1}{2}$ had cylinders 19 inches diameter, with a length of stroke of 22 inches; they had six driving-wheels, each 4 feet 2 inches diameter, all coupled, and a leading-truck, or bogie, on four small wheels. The coupling, or draw-bar, between the engine and the tender, was about 12 feet in length, and proportionably heavy. It was connected to the framing at some distance in front of the fire-box, and nearly under the centre of gravity of the engine. This facilitated the passage of the engine over curves of small radii. The centres of the front and hind wheels were only 11 feet 3 inches apart, and the intermediate wheels were without any flanges. The springs were so adjusted, as to equalize, as nearly as possible, the weight on the driving-wheels. The adhesion of the driving-wheels had been found, from experience in the United States, to be beyond the limits usually assigned. Instances were known, where the effective adhesion had been as much as two-fifths of the nominal weight on the driving-wheels; it being assumed, that the actual pressure exerted by the driving-wheels upon the rails often varied considerably, when the engine was running, as compared with the weight ascertained by the weighing-machine, when at rest. On the Cleveland and Pittsburgh Railway, on the 1st August, 1857, a train of fifty loaded waggons, each on eight wheels, and weighing upwards of 756 tons, or with the engine and tender, 800 tons, was drawn up a continuous incline, two miles in length, of 1 in 132. The engine weighed 26·8 tons, with only 19·2 tons on the six coupled driving-wheels. The gravity of the entire train would be 13,575 lbs., whilst the friction, which could not average less than 5 lbs. per ton, would increase the amount to 17,575 lbs, or to more than two-fifths of the weight upon the driving-wheels, when the engine was in running order, but at rest.

Mr. Colburn, in making a series of trials on the New York and Erie Railway, had driven a train of eighty loaded waggons, each on eight wheels, weighing with the engine and tender 1,270 tons, up a continuous incline of 1 in 480, with curves of 1,145 feet radius. The gravity being 6,000 lbs., and the other resistances at least 8,300 lbs., easily deducible from the known friction of waggons, the entire resistance was 14,300 lbs. The weight on the driving-wheels of the engine, whilst at rest, was 40,500 lbs.; hence the adhesion was 0·35 of the insistent weight. It was to be borne in mind, however, that when an engine was running, especially upon inclines, there were many circumstances to increase the weight on the driving-wheels. The draught through the

draw-bar tended to lift the engine from the front wheels, and thus to increase the load on the driving-wheels. In going up an incline, the water rose at the back end of the boiler; the difference of level upon an incline of 1 in 10, being 19 inches in the ordinary length; and the base of the centre of gravity was thrown further back upon the driving-wheels. These circumstances materially affected the running condition of the engine, and they should be provided for, in building engines expressly for working steep inclines. If the engine was making steam freely, and blowing off strongly, the reaction of the escaping steam against the air sensibly increased the weight of the engine. On the other hand, the absolute insistent weight of an engine was less upon an incline than on a level. An engine, weighing 20 tons upon a level, would press with only 18 tons upon the rails, on an inclination of 1 in 10. If the maximum adhesion was taken at two-fifths of the weight of an engine, supported by coupled wheels, and the steam tractive power was equal to the adhesion, such an engine, without any attached load, could rise up an incline of 436 in 1,000, or a gradient of 2,305 feet per mile. This being taken as an ultimate, although not an impossible case, would assist in explaining the performances of the engines on inclines of 1 in 10 and 1 in 17, as described in the Paper.

Mr. ISAAC stated that, at the time of construction of the Mountain Top Incline, it was found necessary, on account of the uncertain supply of water at the foot of the mountain, to place a tank on the eastern slope, on a gradient of 1 in 18.87. During the first two, or three summers, the ascending trains were in the habit of stopping daily, and the engines were able to start again without difficulty. There was one engine kept in reserve on the mountain, which was only used when necessity arose. It had eight wheels, all coupled; the cylinders were 18 inches in diameter, with a length of stroke of 22 inches; the wheels were 3½ feet in diameter, and the gross weight of the engine was 27 tons. This engine had crossed the mountain six times in one day, with a load of 49 tons each time. Although very rigid and not adapted to the curves, it made the trip in one hour from Turntable to Greenwood, and in one hour and a quarter from Greenwood to Turntable, the distance each way being eight miles. One of the lighter engines had taken a load from Turntable to Greenwood in half an hour.

In reply to questions from different members, Mr. Isaac observed that Mr. Elliot had published a statement of the cost of working, based on the fuel and oil consumed, and the wages of the workmen. Fuel on the mountain cost two dollars per cord. It was difficult to make a just comparison of the various fuels, and to obtain correct information as to the water evaporated. The same cause that prevented

the experiments on the resistance of the curves being made, ill-health, which necessitated his removal from that part, also rendered impossible the comparative experiments on different fuels, and an accurate record being kept of the water evaporated. At first pine-wood was used, but oak had been extensively adopted latterly, the effective pressure of the steam, above that of the atmosphere, usually amounted to from 100 lbs. to 120 lbs.

Mr. D. K. CLARK said, that on most English Railways, the results of experience showed a resistance of 12 lbs. per ton gross on a level.* Some of the statements which had been made, as to the working of railways in the United States, seemed to indicate a resistance of not more than 5 lbs. per ton gross, after allowing for gravitation on the incline; yet the permanent way of American lines was admittedly inferior, in all respects, to that of the English lines. The first of the results given in the Paper showed a traction resistance of about 150 lbs. per ton gross. In contrast with this, he stated, that (on the Great North of Scotland Railway, near Aberdeen,) the Kitty Brewster Incline of 1 in 59, which had many sharp curves, had been worked, for the last three years, by two tank locomotives, having cylinders 15 inches in diameter, with a length of stroke of 24 inches, and four wheels coupled, each $4\frac{1}{2}$ feet diameter. The pressure of the steam was 150 lbs. The load on the driving-wheels was 15 tons, on the leading wheels 10 tons, and the gross weight, in working order, was 25 tons. Starting the trains from the foot of the incline, one of these engines could take up nineteen waggons, weighing, when loaded, about 11 tons each—making a total gross weight of train, behind the engine, of 209 tons—at ten miles per hour. The greatest load that had been taken was twenty-one waggons, of a gross weight of 231 tons, at five miles per hour. The average ordinary train taken up the incline, consisted of eighteen waggons, each weighing 8 to 11 tons gross; the total weight being, say, 160 tons gross, at ten miles per hour. But excursion trains of loaded carriages, weighing, when empty, $5\frac{1}{2}$ tons each, and $7\frac{1}{2}$ tons when loaded, making a gross load of, say 200 tons, had also been taken up. The resistance of the train, indicated on the piston, after allowing for gravitation on the incline, amounted to 13 lbs. per ton gross, of engine, tender, and train, which contrasted favourably with the estimated traction-resistance, of 150 lbs. per ton gross, on the American incline.

With reference to the influence of curves upon resistance, he had found, by experiments on the Caledonian Railway, that, at a speed of forty-five miles per hour, the traction-resistance was greater, by 20 per cent., on the portions of the line having curves under one mile radius, at the rate of one curve in $2\frac{1}{2}$ miles, than on the practically straight parts of the line.

Mr. P. W. BARLOW, remarked, that the Whitstable Branch of the South-Eastern Railway, after leaving the main line, rose for upwards of $1\frac{1}{2}$ mile, at an average gradient of 1 in 50. It was then nearly level, until the summit was attained, from which it descended for $\frac{7}{8}$ of a mile, at an average inclination of 1 in 30. For the next $1\frac{1}{8}$ mile it was level, and then again descended for $\frac{5}{8}$ of a mile at the rate of 1 in 54, reaching Whitstable on a slightly-rising gradient. The total length of the line was 6 miles 12 chains. It had originally been worked by stationary engines and rope traction; but as the traffic was intermittent, it had been determined by him, when Engineer of the South Eastern Railway, to substitute locomotive power, an alteration which had been quite successful. Bury's four-wheel coupled-engines, having cylinders 14 inches in diameter, with a length of stroke of 24 inches, the wheels being 4 feet 6 inches in diameter, were still in use on this branch. They took four trucks of coal up the Clowes Wood incline of 1 in 30, the gross weight, including the engine and tender, being about 50 tons.

On the Folkestone Harbour Branch of the same line, which had an inclination of 1 in 30, for upwards of $\frac{3}{4}$ of a mile, four-wheel tank-engines, constructed on Mr. Crampton's plan, were employed. The wheels were 4½ feet in diameter, all coupled; the cylinders were 16 inches in diameter, with a length of stroke of 24 inches; the weight of the engine was 26½ tons, and the pressure of the steam was 120 lbs. per square inch. These engines took fourteen carriages up the incline, equal to a gross weight of 100 tons, including the engine.

Mr. C. H. CHURCHY remarked, that the peculiar construction of the engines and carriages, in the United States, tended to lessen the resistance in passing round curves, for which the 'bugie' frames were particularly suited. It was well known that in New York, and in other American cities, the railways were brought into the streets, horse-power being then employed, and that the trains were conducted round the turnings of streets with great facility.

As to the cost of construction of American Railways, it appeared from official returns, which had been carefully compiled, that in the State of Massachusetts the average cost of the principal lines had amounted to £10,599 per mile, or £9,489 per mile, exclusive of rolling stock. In the State of New York these figures were respectively £11,200 and £9,762 per mile. A large proportion of the American railways consisted of single way, the cost of which ranged between £5,000 and £14,000 per mile. Considering the rough character of many of the American lines, and the almost entire absence of ballast, it would be agreed, he thought, that their cheapness was more imaginary than real.

Mr. PRADOCK mentioned the case of the Manchester, Sheffield, and Lincolnshire Railway, on which there was an average gradient of 1 in 136 for upwards of 22 miles. As a matter of course, being a main-trunk line, upon which there was a large traffic, the employment of heavy engines was absolutely necessary. Ordinary inside-cylinder engines were used, the cylinders being 18 inches in diameter, with a length of stroke of 21 inches, and there were six wheels, each 5 feet in diameter, all coupled. These engines weighed, when in working order, without the tender, 35 tons. They were worked at a pressure of 130 lbs. to the square inch, and would draw a load of forty waggons, weighing 500 tons, independent of the weight of the engine and tender, at a speed of eighteen miles per hour.

Capt. W. S. MOONSON thought the statement, that two-fifths of the weight of the engine had been obtained as adhesive capability, was in advance of the general experience in England. He had always considered that one-fourth was as much as could be relied on, in this country, in all states of the rails. On the West Cornwall Railway, there were gradients of 1 in 13, 1 in $9\frac{1}{2}$, and 1 in 7. The latter were never attempted to be worked by locomotive power. But, in 1813-4, when no return loads down the incline could be had, loads of about 13 tons had been conveyed, by locomotive power, up the incline of 1 in 13, which had been constructed for the conveyance of fuel to mines, for a distance of about $\frac{1}{2}$ of a mile. The engine employed had four wheels coupled, and cylinders 13 inches in diameter. He believed that plan was preferable to the employment of stationary power. On the South Devon line there were gradients varying from 1 in 41 to 1 in 51, with S curves of 15 chains radius. As a practical fact, it might be recorded, that the engines would take seven loaded waggons up an incline of 1 in 41 on straight portions of the line, but when they came to curves of 15 chains radius, the same power and speed with seven waggons on the straight lengths could be maintained with only six waggons on those curves. About the year 1849, a series of experiments had been made on the Lacey Incline, of 1 in $37\frac{1}{2}$, on the Birmingham and Gloucester Railway. An engine had been allowed to attain a speed of 30 miles in descending, and was then brought up in 30 seconds, by the application to the wheels of the engines of a peculiar kind of brake, which had been designed by Mr. McConnell.

Mr. HAWKSHAW, F.R.S., said, probably the steepest gradients in this country, over which a large traffic was conveyed, at comparatively high speeds, were those on the line between Manchester and Oldham, a distance of 7 miles. For $1\frac{1}{2}$ mile, there was an inclination of 1 in 48 and 1 in 50. The line was then tolerably

level, until, on approaching Oldham, gradients were encountered for about $\frac{1}{2}$ mile of 1 in 39 and 1 in 27. This latter incline was originally worked by rope-traction; but about five years back, the locomotive had been substituted, and no difficulty was found in taking up considerable loads.

He did not think that adhesion equal to one-fourth of the weight of the engine could be obtained, but that one-sixth, as stated by the Author of the Paper, was more nearly correct. To a certain extent, what the engine would take up depended upon its weight, and upon the speed. The frictional resistance would vary from 15 lbs. per ton to 8 lbs. per ton. A light engine, on an inclination of 1 in 10, would do little more than move itself forwards; but if the weight of the engine amounted to 30 tons, the adhesion might be so increased, that the engine would have power sufficient to take up 16 or 17 tons. Engines might be constructed with larger cylinders and boilers and heavier machinery than had hitherto been applied, by which a greater amount of adhesion would be obtained. But the advisability of doing this was dependent on peculiar circumstances, which must be dealt with in each particular case. Mr. Brunel had lately constructed, for the Vale of Neath Railway, tank-engines, weighing upwards of 40 tons, in which all the wheels were coupled, so that there was a large amount of adhesion. It was an expensive mode of traction, but would accomplish the object intended.

Mr. HEMANS considered, one great point of interest in this Paper was the zig-zag mode of construction for traversing mountains; a plan which seemed to him to be preferable to, and more economical than sharp curves. He had recommended that system for a line over the Alps, although some persons seemed to be afraid of it. He would be glad to be informed, by the Author, how those portions of the line, in extension of the zig-zags, on which the direction was changed, were laid out—whether straight, or curved, and whether level, or inclined. He was of opinion, that they should be on a gradual curve, in the vertical plane, and be made to incline the reverse way to the descending arms of the zig-zag; so that in the case which had been mentioned, where the whole train slipped, on a gradient of 1 in 10, with the wheels locked, the progress of the train would be arrested, irrespective of the breaks, or other mechanical means, which might not be sufficient to insure safety at the time of need. Such a system would also be advantageous in the ascent, as the train would receive a certain amount of impetus after mounting each incline, to start it up the succeeding ones. If the portions of the line referred to were made level, then a greater length would be necessary, and in the situation in which they were placed, long horizontal lines would be often very difficult to construct.

Mr. ISAAC replied, that the zig-zags on the second incline of the Baltimore and Ohio Railway were constructed merely for temporary purposes, so that no special provisions were made, with respect to the point alluded to.

Capt. MOORSOM stated, that the zig-zag method of crossing high mountains had been recommended by Mr. DRAKE, M. Inst. C.E., in 1847, for adoption in Ceylon. More recently, as was well known, Mr. T. J. BARKLEY, M. Inst. C.E., under the sanction of Mr. R. STEPHENSON, M.P., had carried out the system, on the Great Indian Peninsular Railway, for ascending the Bhore Ghaut.

Captain MOORSOM thought, it was only desirable under special circumstances, and in peculiar positions, as for instance where a narrow and excessively steep ravine had to be passed, and where it was impossible to make a continuous line, except at great cost, or by the introduction of excessively sharp curves. He saw no objection to the extended, connecting portions, wherever the direction had to be changed, being straight and horizontal; for the action of the breaks was so powerful, that if the breaks were applied on descending an incline, the train would be instantaneously checked on reaching a level portion of the line.

Mr. COOME said, that thirteen years ago, the late Mr. George STEPHENSON, when laying out a railway in Spain, from the Bay of Biscay to Madrid, had reported in favour of the zig-zag system, which he believed was then for the first time proposed. He had been informed, that Mr. BRUNELL had in his possession copies of the plans and sections which had been made for traversing the Guadarama Pass, by means of the zig-zag system.

Mr. BUDMAN, F.R.S., said, in closing the discussion, he would add a few remarks, as to the circumstances under which steep inclines could with propriety be adopted. As a mechanical question, there was no difficulty in apportioning the power of the engine to the amount of adhesion required to traverse any particular gradient. He thought that an available tractive force of one-fourth the weight of the engine ought to be provided; but that they were not justified in reckoning upon more than one-sixth, under all circumstances; and when sleet fell, he did not believe it was anything like so much. But inclines of 1 in 10, or 1 in 17, or even 1 in 40, would only be resorted to from necessity, owing to the impossibility of obtaining better gradients, except at very great expense, as such gradients were attended with a heavy cost for working expenses. On gradients of 1 in 150 and 1 in 200, heavy loads could be carried by the locomotive, at small comparative cost, compared with the exceptional cases which had been alluded to. On the Middlesborough and Guisborough branch of the Stockton and Darlington Railway, where there was an exceptional gradient of 1 in 40, for about two-fifths of the

length of the line; although the traffic was of the most favourable description, being all down-hill, with full loads, the whole of the receipts of that portion of the line, taken at one penny per ton per mile, were absorbed by the working expenses, nothing whatever being left for interest on the cost of the rolling stock. If the loads had been up-hill, he believed that the working expenses alone would have amounted to threepence, or fourpence per ton per mile, and with gradients of 1 in 10, to from one shilling to eighteen-pence per ton per mile. In fact, it was questionable, under such circumstances, whether horse power and carts would not beat the locomotive, in point of economy, though of course on a long line of railway, it would be most undesirable to introduce a break of gauge. It was undoubtedly more economical to employ locomotive power on the Canterbury and Whitstable branch, where the amount of traffic was so inconsiderable. On the Oldham Incline, the necessity of preserving an unbroken communication was a justification for the use of the locomotive, the cost of which in such a case must be considerable. On the incline of 1 in 26 near Liège, a perfect system of stationary engines had been in use for many years. The Belgian government, feeling the inconvenience of that system, had abandoned it, and substituted the locomotive; but such was the uncertainty of the power, in meeting the irregularities incident to the traffic, that the stationary engines had been again resorted to. Mr. Cabrey had introduced a very efficient system of breaks, by applying a shoe to the wheels, and he believed some of a similar character were about to be tried on the North-Eastern Railway. In conclusion, he expressed the opinion, that there was no difficulty in designing engines to surmount any gradient that was required. The question was only one of cost of working, and reduction of the speed. The Engineer must be entirely guided by the local circumstances. If it was desirable to avoid a break in the communication, then, on the one hand, a long and expensive tunnel had to be set against the great and constant cost of working the locomotive engines up steep gradients, and the engineer had to decide between the two.

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25 Great George Street, Westminster, S.W. •

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THE INSTITUTION OF CIVIL ENGINEERS.

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He must have practised on his own account in the profession of a Civil Engineer, for at least five years, and have acquired a considerable degree of eminence in the same.

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ADMISSION FEE.—	Associate	.	.	.
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	£.	s.	d.
Non-Resident Graduate	2	2	0
Resident Graduate	2	12	0
Non-Resident Associate	2	12	0
Resident Associate	3	3	0
Non-Resident Member	3	3	0
Resident Member	4	4	0

The Session of the Institution commences annually on the second Tuesday in November, and continues till the end of May. The Ordinary General Meetings are held every Tuesday during the Session, at eight o'clock in the evening. At these meetings original communications are read, descriptive of some engineering work, or on any branch of the allied sciences; and afterwards the merits of the communications are fully and freely discussed. These papers and discussions are embodied in an annual volume, of which every Member is entitled to receive a copy. Each Member, Associate, Graduate, and Honorary Member has the privilege of introducing one visitor to these Meetings.

Roads and Railways

IN

NEW SOUTH WALES AND INDIA,

WITH REMARKS

EXPLANATORY OF THE ADVANTAGES

LIKELY TO RESULT FROM THE EMPLOYMENT,

UNDER CERTAIN CIRCUMSTANCES,

OF

ANIMAL POWER

INSTEAD OF

STEAM POWER.

BY

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MADRAS

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MOUNT ROAD,

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PRINTED AT THE ASYLUM PRESS, BY WILLIAM THOMAS.

INTRODUCTION.

THE two first Sections of the present paper comprise the substance of two papers read to the Philosophical Society of New South Wales in 1856 and 1857.

The object was to bring clearly before the community the nature and extent of the advantages afforded by Railways of different kinds for the transport of passengers and goods; and, while pressing these on the notice of the public, to clear away a misconception, which appears to prevail pretty generally, that there are no limits to the beneficial or profitable action of the Locomotive Engine as a moving power.

For this purpose it was necessary to investigate carefully the comparative cost of transport upon the different kinds of Roads, and by the use of different descriptions of power.

The result of this investigation, so far as regards the Colony of New South Wales, is shown in the second section, where it is proved that, under conditions analogous to those therein specified, Horse power would be cheaper than Steam power.

On my arrival at Madras, I found the Government engaged in pressing forward the works upon several lines of Railway; and although the conclusions which I had drawn from my investigations

Australia led me to doubt whether the ordinary interest upon the capital expended would be realized by the traffic upon these lines; yet, as the indirect benefit to the population at large *might* be great, and as the political advantage accruing from the rapidity and certainty of the transport of Troops and Military Stores was indubitable, I did not think it necessary to enter upon any enquiry as to the character of the lines in progress.

Of late, however, various schemes have been brought forward for the extension of the Railway system. Some of these contemplate the construction of branches, or extensions of the main lines, upon the same gauge, and with the same rolling stock; others propose to have lighter rails, with a narrower gauge, but the motive power is still to be the Locomotive Engine; others again, propose to lay down rails upon the existing roads, and to use animal power instead of steam. Under these circumstances I have thought it advisable to re-print the papers read by me in New South Wales, and to add a third section, descriptive of all those peculiarities of the Indian climate, and of the habits and customs of the people, which may have any influence upon the profitable working of the Indian Railways.

SECTION I.

RAILROADS.

A BRIEF OUTLINE OF THE DEVELOPMENT OF THE RAILWAY SYSTEM IN ENGLAND, WITH SUGGESTIONS AS TO ITS APPLICATION TO THE COLONY OF NEW SOUTH WALES.

A HISTORY of the last thirty years would be very incomplete which excluded from consideration the vast changes which have been wrought in the state of society by the introduction of railroads. Socially, politically, and morally, these changes have been very great; and it would be a curious and an interesting study to trace the effects which have resulted from the introduction of this easy and rapid system of locomotion; some of which have originated directly from the forces put into action for the completion of the railways themselves, and for maintaining them in effective operation; but more of which must be traced to feelings and motives lying deep in man's nature, but which have been stimulated into activity by circumstances connected more or less intimately with the physical changes of which the railway system has been productive. We are as yet in the infancy, or, at all events, in the youth of this system; and if the past presents much of importance to the historian and moralist, the future offers as wide, or a wider, opening to the speculative philosopher. With questions such as these, however, it would be premature to deal. If railways are in their youth elsewhere, here they are in their infancy; and it will be more immediately interesting and useful to investigate the steps by which other countries have arrived at a position so far in advance of ourselves, than to speculate upon the possible changes which may take place here, when we have availed ourselves of the experience of others, and, by the exercise of skill, energy,

and perseverance, have brought these causes into action, which have produced so marvellous an effect elsewhere, but which, for the present, are with us dormant.

In the short compass of a paper like this, it would be impossible to give anything like a history of the various steps by which the common cast-iron tram of the coal districts, on which horse traction only was used, has developed itself into the wrought iron railway, traversed by steam engines of great weight and power. A sketch is all that can be attempted, and is, indeed, all that is required; for our object in this Colony should be rather to avail ourselves of the principles which have been established during the course of a long series of experiments, than to follow blindly in a track which would lead to waste of both time and money, and very much check the development of the resources of the Colony.

In tracing the extension of the railway system in England, it may be as well to look back some hundred and fifty years, and to enquire what was the state of the roads about the end of the seventeenth century. From all the accounts which have been handed down to us, it would seem that roads in England at that time were very similar to those tracks which are in this Colony dignified by the name; badly laid out with reference to the country through which they passed, and worse constructed. In the year 1700, however, the demand for increased facilities for transport forced the Legislature to consider the means by which an improvement could be made in the condition of the main lines of communication; and the system of turnpike trusts commenced, which, in the course of little more than a century, covered England with a network of roads, the aggregate length of which was not less than 24,000 miles.

Under the turnpike system, however, the improvement in the state of the roads was very slow; the introduction of a better scheme of management produced, of course, some beneficial effects, but this could not compensate for the want

of experience in the construction and management of the roads, or of a knowledge of the general principles which have been the result of many experiments, some of which have proved successful, others, most unsuccessful. We must not be surprised, therefore, to learn that in the year 1800, after the labour of a century had been bestowed upon the roads, they were in an indifferent state; that the rate of travelling upon them was slow, and the cost of transport great.

In the middle of the last century, attention was drawn to the advantages afforded by water transport, and a very large capital was expended upon canals leading from the great manufacturing towns to the metropolis, and to the sea-ports. The effect of the cheapness of this means of communication was very visible in the increase and development of manufacturing industry, and in the enhanced value of land in the vicinity of these great channels of trade.

The necessity of adopting some means by which the traction on ordinary roads could be lessened, was first felt in the Northern Colliery District; and wooden tramroads were first laid in the neighbourhood of Newcastle, at the end of the seventeenth century. These, after a time, were exchanged for cast-iron, which was found, from its durability, to be cheaper than wood. Wrought iron rails were subsequently adopted, when the demand for increased supplies of coal made it necessary to substitute steam for horse power.

In 1826, the commencement of the railway era, the condition of England, so far as regards the means of internal communication, may be summed up as follows. The country was traversed by about 25,000 miles of turnpike roads, upon which coaches travelled at a speed of from eight to twelve miles per hour, and on which goods were conveyed by waggons, at an average cost of about $9\frac{1}{2}d.$ per ton per mile. In addition to these, there was a network of canals, the aggregate length of which exceeded 3000 miles, upon which goods were conveyed at the cost of about $\frac{1}{4}d.$ per ton per mile.

There were, in the coal, and some of the other mineral districts, several hundred miles of iron tramways and railways for the conveyance of minerals to the port of shipment, or to the principal markets.

At that time, however, the demand for increased facilities for communication between Manchester, the centre of the cotton manufacture, and Liverpool, the port of entry of the raw material, was so urgent as to induce the formation of a Company for the purpose of constructing a railway between the two towns, upon which passengers and goods should be conveyed in carriages propelled by steam power; and after some delay, on account of the new and expensive character of the work, the Liverpool and Manchester railway was opened in 1830.

The length of this line is 32 miles, the original cost about £840,000, or on an average, £26,250 per mile. The returns during the year 1831 were sufficient to give a dividend of about 10 per cent. upon the above capital, a return which is sufficient of itself to show the enormous development of the traffic between the two towns; but which, when analyzed, exhibits the peculiar feature of a much greater extension of the passenger than of the goods traffic.

This successful experiment on the part of the Manchester and Liverpool Company had the effect of stimulating others to follow their example; numerous Companies were formed, which, availing themselves of the experience which had been gained during the progress of the works at Liverpool, and of the daily improvements made in the machinery of the locomotives, and in all the other details of railway engineering, commenced the construction of lines from the metropolis towards every part of the country, and in 1855 the length completed amounted to 8,240 miles, at a cost of 281 millions. All this has been executed in about twenty-five years, so that about 300 miles of railway have been constructed annually, at a cost of about nine millions, or at the rate of about £30,000 per mile.

It would be useless to go at any length into the details of the modifications and improvements which have been made in the construction of the locomotive engine, and in the arrangements for accommodating the different descriptions of traffic. It will be easily understood that the stimulus given to the mechanics of the whole world by the introduction of locomotive power upon railways was not without its fruits. Alterations and improvements have been made, and are daily making, not only in the construction of the engines, but in all the minor details of the railway. Most of these have for their object the development and extension of the peculiar advantages of steam traction; namely, the increase of speed, and of power, for the purpose of meeting the enormously increased amount of traffic. A few examples will suffice to convey an idea of the nature of these alterations.

The locomotive which gained the prize of £500, offered by the Directors of the Liverpool and Manchester Railway, weighed 4 tons, 5 cwt., and the tender with water and coke, weighed 3 tons, 4 cwt. The conditions of the experiment were, that the engine should not weigh more than 6 tons; that if it weighed more than $4\frac{1}{2}$ tons, it should rest upon six wheels; that it should draw three times its own weight at a rate of ten miles per hour, and should not cost more than £550. In the experiment the Rocket, built by Mr. Robert Stephenson, drew a gross load of 17 tons, including its own weight, at the average rate of 14 miles per hour. When, however, engine power was practically applied to railway purposes, it was soon found that the wheels of the engine were apt to slip on the rail in wet weather with even on ordinary load, and in all weathers, when the load was increased beyond a certain proportion to the weight of the engine. To remedy this the engines were made heavier, so as to augment the friction upon the rail, and this addition to the weight was accompanied by a corresponding increase of power and speed.

These additions to weight and velocity involved alterations in the construction of the railway. The light rails used upon the Liverpool and Manchester line, which weighed 35lbs. per yard, were not, of course, strong enough to support the increased load brought upon them; and rails weighing 45, 60, 75, and 90 lbs. per yard have gradually been introduced. The increased power of the engine, and the hold on the rail obtained by throwing additional weight on the driving wheels, enable the train to ascend gradients, which before were worked by stationary or auxiliary engines; but, on the other hand, the increased velocity has made it advisable to pay greater attention to the plan of the road, the curves of which are now described with a larger radius than heretofore, for, when great speed is required, some sacrifices must be made in order to secure a line as straight as possible.

This is a brief sketch of what has taken place in England. The different stages in the scale of progression may be summed up as follows:—

1st. —Muddy tracks.

2nd. —Turnpike roads.

3rd. —Tramroads of wood.

4th. — Do. of iron.

5th. —Railroads with light rails, worked by locomotive engines at low speed.

6th. —Railroads with heavy rails, traversed by engines of great weight and power, drawing loads of 150 tons, at a rate of from 25 to 50 miles per hour.

It must not, however, be assumed that these changes were either general or simultaneous; that the muddy lane ceased to exist when the turnpike road was put in operation; or that these latter have been altogether banished by the railroad; on the contrary, every change had to undergo the most determined opposition. At the first introduction of railways, the owners of property, who are now eagerly striving to get the

lines as near them as possible, exerted all their influence to keep them at a distance. It is only within the last fifteen years that more enlightened ideas have prevailed, and that people have been made aware that every additional facility given to locomotion confers a most important benefit upon the country. It is true that in many instances the works of the railways have been executed at a cost which the returns have not justified, and the capital expended has yielded but a scanty return of interest; but this has been principally due to an unwholesome system of competition, which has induced an outlay upon works where the amount of traffic, though sufficient to pay the expense of working the line, and maintaining the road, is not adequate to the payment of interest upon the capital laid out.

The experiments which have been carried on for the last thirty years in various parts of the world, have been uniform in certain results, which may, therefore, be safely laid down as general principles for our guidance in discussing the policy of adopting railroads as our principal means of internal communication. It has been shown that increased facilities of communication have an immediate tendency to augment traffic; the augmentation, however, takes place to a much greater extent in passengers than in goods. Increased facility of communication is also in all cases productive of economy; this, however, is shown more in the transit of goods than of passengers. In the case of the latter, though there is often an actual reduction in the cost of conveyance, yet the principal saving is in time. With regard to goods, the actual reduction in the cost of transport is enormous, while the benefit is still further enhanced by the certainty and rapidity with which they are conveyed. A reference to the traffic returns of English railways will establish these facts beyond a doubt; and there is no question that were we in possession of similar returns from other countries the result would be the same. This brief sketch of the introduction of the railway system in England, and of its extraordinary and rapid development,

will not, I trust, be uninteresting; and it will be most useful if it should have the effect of introducing a more close investigation of all the causes which have had an influence in producing such a state of things, with a view to the application of the results of such an investigation to the circumstances of the Colony.

In carrying out an investigation of this kind, however, care must be taken to keep constantly in view the very marked differences between the state of things in the Colony and the mother country.

In England the population is densely packed together, and the manufacturing and agricultural interests are enormously developed. In this Colony, on the contrary, the population is thinly scattered, and the agricultural and manufacturing interests are yet in their infancy.

There is thus, instead of an analogy between the state of things in the two countries, a marked and striking difference. We cannot, therefore, assume without proof, that because it has been found advisable in England to expend some three hundred millions in improving means of communication already comparatively excellent, it will be to our benefit to expend in New South Wales a tithe of that sum for the same purpose; but that such an expenditure will be most beneficial I firmly believe. The very marked differences which exist between the mother country and this Colony appear to me to strengthen rather than to weaken the groundwork upon which this belief is based; and I trust, before I conclude, to be able to make you partakers of my convictions. In order to this, it will be necessary, in the first place, that a clear and definite idea should be formed of the nature of the benefit which the country is supposed to derive from improved means of communication, more especially from railroads; and it would be desirable, if possible, to make some approximation to the amount of this benefit, as measured according to some pecuniary standard. Now, the benefit which the

proprietor of a railway derives from it is measured by the clear annual return of profit resulting from the payment made for the conveyance of passengers and goods, after all the cost of transport, and that of the maintenance and repairs of the road have been defrayed; but while this is a correct representation of the benefit which an individual or a private Company can derive from the ownership of a railway, the case becomes very different when the Government, acting for the community at large, undertakes the construction of such works.

In this case, the direct benefits, which are measured by the profits of the railway as a speculative investment of capital, and the indirect benefits, which are those resulting to society at large from the use of the railway, are merged together, the community being both proprietor and employer of the railway; and the amount of these latter, taking their monetary value only into consideration, is very far in excess of the former, as I shall be able to prove.

Take, for instance, the English railroads. The direct return to the shareholders is estimated to be on an average from 50 to 55 per cent. of the gross receipts; that is, the cost of transport and management, together with that of keeping the road in repair, absorbs about from 45 to 50 per cent. of these receipts, leaving the above balance as profit. It is now found, however, that while the traffic is continually increasing, as is shown by the annual returns, the shareholders are receiving but a very small interest on their capital; that is, the direct benefit, as before defined, is small. With regard to the indirect benefit, we have, luckily, the means of arriving at the amount of the saving in the cost of conveyance of goods, in the fact, that the average cost of cartage upon a good turnpike road was $9\frac{1}{2}d.$ per ton per mile, while on the railway it varies from $2d.$ to $3d.$; that is, there is a saving of upwards of 70 per cent. in the cost of transport of goods; while in the conveyance of passengers, if the actual

miles from a market, and assume the produce available for sale to be 800 bushels of grain of some sort. This, which would weigh about 20 tons, would, at the rate of 2s. per ton per mile, cost, for transport only, £200, or 5s. per bushel; and the farmer would, of course, be utterly unable to compete with the foreign producer. Even the farmer in Michigan, who has to bring his grain, or the flour produced from it, a distance of nearly 2000 miles to New York, and from thence 12,000 or 14,000 miles by sea to New South Wales, would be able to undersell a farmer living not more than 100 miles from Sydney, whose only communication is by the ordinary roads of the Colony. Place, however, the farmer within a few miles of a railway, and every thing is reversed; his produce is conveyed to Sydney for £50 instead of £200 or for 1s. 3d. per bushel instead of 5s. He is, therefore, in a position to undersell the foreign producer; and, a market being insured for the produce of his farm, the land in the neighbourhood assumes a value proportionate to its quality; and a rise in the price of land of from 300 to 400 per cent. may fairly be expected.

With regard, however, to these calculations as to the amount of indirect benefit, it will be seen that they are based upon the assumption that the cost of transport upon the railroad will be 6d. per ton per mile. It is true that this is the charge at present on the Paramatta Railway, but it is to be observed, that out of this sum of 6d. the Government receives upwards of $2\frac{1}{2}$ d. as interest of capital. If, then, the charge for transport were reduced by this amount, the benefit to the community would be enhanced to an equal, if not to a greater extent, by the stimulus given to production, and the increase in the value of property.

The inference which I am disposed to draw from what I have here stated is, that in undertaking the construction of railways by the Government upon a large scale, it would, perhaps, be wise to relinquish altogether the idea of obtaining

any direct benefit from them in the shape of interest of capital, and to be content with the indirect returns accruing from the saving in the cost of transport, and the increase in the value of property. With regard to the former, it would give evidence of its existence in the general development of business of every kind; but the latter would assume a tangible shape, and would pour more money into the Treasury than would compensate for the capital sunk in constructing the railway. If, for instance, the Government, being the owner of 200 millions of acres of land, were to sink the value of one-fourth of this in the construction of railways, by which the value of the remaining three-fourths would be doubled, the actual money profit to the Colony by the transaction would be equivalent to the present value of 150 millions of acres of land, irrespective of all other advantages.

In advocating a large outlay upon the railways as the only mode by which this Colony can ever be made capable of supporting a dense population, and, therefore, as the only means by which it can be made prosperous and powerful, I must not be understood as pledging myself to the adoption of any particular scheme. It is a matter of comparative unimportance whether we adopt the wide or the narrow gauge. I do not think it is necessary, under our present circumstances, to insist upon uniformity of gauge as a matter of necessity, although it would, I admit, be desirable to establish some uniform system. What we do require is the railway or tramway, (for in principle they are identical) that is, the hard, uniform, and comparatively level surface upon which carriages can run without much friction or resistance. The nature of the road is altogether independent of the power which is to be used to transport goods and passengers upon it. This may either be steam or animal power, the character being determined by the nature and amount of the traffic on the road, or by peculiar considerations which may make it more economical to use one kind of power than another. It

is true that in the consideration of any particular scheme, the description of power to be employed must have much influence upon the details; but a railway is still a railway, though the carriages are drawn by horses, and the benefit to the country through which it passes may be quite as great in such a case as if locomotive power were employed. It may be asked, what power will it be desirable to employ in this Colony? To this the simple answer would seem to be, that which is the cheapest, provided it be sufficient. In England the amount of traffic upon the different lines, and the demand for speed on the part of the passengers, has made the universal adoption of steam power a matter of necessity; but before we assume this to be the case in New South Wales, a proper calculation must be made as to the relative cost and efficiency of the different kinds of motive power. I do not, of course, mean to infer that cheapness is to be the only consideration; but I do mean to say that, in the present condition of the Colony, it would be unwise to incur any great additional expense for the purpose of increasing the speed of transit beyond ten or twelve miles per hour for passengers. If, then, horse power can be shown to be cheaper than steam, and, though slower, competent to the conveyance of the traffic which is likely to come upon the line for some years to come, I should certainly recommend that it should be employed.

In discussing the question of the relative expense of the two systems of locomotion, the actual cost of working the line in each case is not the only matter to be considered. The cost of constructing the road in either case must enter into the comparison. For instance, for steam power the line must be straighter in plan; less steep and abrupt, and less undulating in section; the rails must be heavier, and all the work upon the road more massive and substantial; while even upon the more solid road, the wear and tear of the heavy locomotives going at speed, will be far greater than that

caused by horse traffic. Taking all things into consideration, I should be disposed to believe that the line prepared for locomotive power would cost at least double of that laid down for horse power; and the wear and tear will probably be larger in the same proportion. This, however, as I said before, must be determined by calculation and experiments; and I hope on some future occasion to be able to lay before you the results of some which are now in progress.

I have in the present paper confined myself as much as possible to the general question, on the satisfactory elucidation of which the adoption of railroads as the ordinary means of communication must depend. Hereafter, I trust full accounts will be laid before the Society of the practical working of the different systems which may be tried, and the members will then be in a position to render valuable service to the Government, by classifying and analyzing those returns, from which only we can hope to deduce results applicable to the peculiar circumstances of the Colony.

SECTION II.

In a paper which I read to the Society last year, I gave a sketch of the development of the railway system in England, together with some general remarks upon the advantages which might be anticipated from the application of a similar, or, perhaps, I should say analogous, system to New South Wales.

These advantages I was in a position to assert would be very great; but, as my object at the time was to bring the question in its broadest features under the consideration of the Society and the public, I abstained from any attempt to discuss it in detail. I expressed no opinion as to the particular character of road, or as to the power which it might be advisable to employ upon it.

These, as I said at the time, were matters which ought to be determined by observation and experiment; and it is with a view to bring under the notice of the Society such facts and observations as have been elicited in various ways during the last twelve months, that I now lay before the members this, which may be looked upon as a supplement to my former paper.

I may remind the members, in the first place, that the subject of railways has been under the consideration of a Committee of the Legislative assembly, and that facts and opinions have been elicited during the examination of several witnesses, all of which, having been printed, are now in the possession of the public. In addition to this published matter, I have been placed in possession of a mass of information having reference to the employment of horse power, both on common roads, or wooden trams, and on iron railroads; all of which has an important bearing upon the questions which will have to be determined, namely, the character

of the road which it would be advisable to construct, and the nature of the tractive power to be employed upon such road.

I have also been furnished with a report on the railroads of the United States, addressed to the Committee of the Privy Council by Captain Douglas Galton, R. E., which contains much valuable information.

Having then, such a mass of information at my disposal, I feel that I am now in a position to discuss those questions upon which, in my former paper, I declined to express an opinion; and as the subject is daily assuming more and more importance, whether it be regarded as a mere question of economy, or as one, upon the proper solution of which the future advancement of the Colony must mainly depend, I do not think that the Society can be called upon to consider one of greater interest. Before I proceed to enquire into the character of the roads which it would be desirable to substitute for those at present in existence, I may as well attempt to give a more detailed sketch of the latter than I attempted to do in my former paper. The following general description, from personal observation, will apply to both the Western and Southern roads.

From the terminus of the railroad at Paramatta, or Liverpool, these roads pass, for a certain distances (some twenty or thirty miles) through enclosed property. They are, as a general rule, badly laid out; that is, but little attention has been paid to the form and inclination of the ground; the culverts and bridges have in very many instances been constructed of perishable materials, and with little reference to the quantity of water which would have to pass through them: little or no attention has been paid to drainage; the soil being generally a strong tenacious clay or loam, and the road having but in few instances been metalled, these portions of the line are in wet weather almost impassable.

In dry weather the clay gets baked and hard, and the power expended in moving a load upon these roads is then a

minimum ; but the surface is at that time covered with a soft impalpable dust, which is not only most unpleasant to travellers, but also causes a great resistance to traction. From the point where these roads enter the bush, that is, when they cease to be fenced in, they do not improve. The difficulties which are opposed to locomotion do not diminish, though they vary in character according to the nature of the country through which the roads pass. The observations which were made as to the faulty direction of the road, the absence of drainage, the bad construction of culverts, &c., apply with as great force to the roads through the bush as to those through enclosed land.

Where the bush is not too dense, it may occasionally be possible, where the usual track is very much cut up by traffic, to diverge, for the purpose of escaping some particular obstacles ; yet, when the weather is wet, the ground in the bush is as saturated with moisture as the road itself, and where the crust of vegetable mould, consolidated with roots and vegetable fibres, is once broken through, the sub-soil is incapable of resisting the action of the wheels, and constant accidents take place.

When the road passes through a sandy soil, the draft, which is very heavy in dry weather, is less so in wet ; but the drains are speedily choked by the sand brought down by the rain.

In rocky soil the inequality of surface is a constant impediment to traction, both in wet weather and dry ; in the former the hollows are filled with mud, and the road consists of alternations of mud holes and hillocks, the effect of which is most injurious upon both cattle and carriages, and in the latter, though the holes are full of dust or sand instead of mud, the rocky obstacles remain as prominent as ever.

This description, which from personal observation I can testify applies to the Southern and Western roads, is, I believe, equally applicable to the Northern line from Maitland, with

the additional obstacles arising from the more numerous water-courses, in that line, which, not being bridged, become impassable in wet weather, and which, besides the delay and hindrance to communication they occasion, entail annually the loss of several lives. The correctness of this account of the state of the main lines of communication throughout the Colony will, I think, be vouched for by many of the members now present; and it will not, therefore, be a matter of surprise that the cost of conveyance upon these roads should vary from a minimum of 1s. to a maximum of 2s. 4½d. per ton per mile; or that the average rate upon the Northern roads should be 1s. 10½d. per ton per mile, on the Western roads 1s. 11½d. per ton per mile, and on the Southern 1s. 11½d. per ton per mile.

The loss and inconvenience which such a state of things occasions cannot of course be measured by the difference of cost between the transport on these roads, and that upon either a good turnpike road, or a railroad; allowance must be made for the delays which constantly take place. It is not an uncommon occurrence for a drag to be upwards of a month in going from Sydney to Goulburn, a distance of 125 miles; or six weeks between Sydney and Braidwood, a distance of 185 miles. The farmer is often prevented from sending down his wheat at the time when the market would suit him, the roads being too bad to permit him to venture his teams upon them; or the price of transport so high as to swallow up all the profit on his crop.

As, however, the difference of cost of conveyance upon these roads and upon a good turnpike or railroad is the measure of the minimum amount of injury done to the Colony, it may be as well that I should give an approximate estimate of its money value.

Along the Northern road 25,800 tons of goods are moved for various distances which, when reduced, give 1,188,770 tons moved one mile for £110,658, or, at the average rate of

1s. 10½d. per mile. Now the cost of moving goods upon a good turnpike road should not exceed 9½d. per ton per mile, which would be a saving of 1s. ½d. per ton per mile, or in round numbers of £32,887; while, on a railroad, this quantity of goods might be moved for 6d. per ton per mile, or less, and the saving in this case would be £81,059.

Along the Western road the traffic is equivalent to 1,615,725 tons moved one mile for a sum of £156,737, or at a rate of 1s. 11½d. The saving then, in this case, at the rates stated above, would be £92,800 in the case of a turnpike road, and £116,344 in the case of a railroad.

On the Southern road the traffic is equivalent to 1,916,022 tons moved one mile for £188,672, or at the rate of 1s. 11½d. per ton per mile. The saving in this case would amount to £112,830 in the case of a turnpike road, and to £139,709 in the case of a railroad.

Along these three lines, which may be termed the main arteries of communication, the loss to the inhabitants of the different districts, occasioned by the badness of the roads, amounts, on the transport of goods alone, to £268,517 per annum; and, were a railroad the means of communication, the saving, by the use of it, would amount to £338,175 per annum. This, I have said, is the minimum amount. I have allowed nothing for the increased expense to passengers, I have said nothing of the diminished value of land, I have merely taken the returns of existing traffic, and have shown that the saving in the expense of conveying it would justify an outlay of Capital on these three lines, the length of which amounts altogether to 843 miles, of £5,370,310, in making turnpike roads, or of £6,768,500, in the construction of railways; that is, of £6,370 per mile upon the one, or £8,000 per mile upon the other. I have assumed 9½d. per ton per mile as the fair charge upon a good turnpike road; this was the average charge in England previous to the construction of railways, and it covered, not only the cost of transport,

but also the tolls, which produced a sum adequate to maintain the road in repair, and, in many instances, to the payment of some interest upon the capital expended upon the formation of the road. In this Colony, however, the sum taken as the average cost of transport is chargeable with but a very small amount of the repair of the road, the tolls received upon the different roads do not amount on an average to more than £5,600 or to £13 per mile on the whole length of the road charged with toll, while the Legislature has appropriated, during the present year, a sum of £29,000 towards the maintenance and repair of these roads, which sum ought properly to be added to the amount of saving which would accrue were the roads placed in a proper state, and which would represent an additional capital of £580,000.

The state of the roads, then, is such as not only to occasion a heavy annual loss to the community, but to saddle it with a heavy amount of taxation in addition. By what means can so unsatisfactory a state of things be remedied?

There are three modes of doing this which naturally present themselves.

1st. By the construction of turnpike roads; that is, of roads properly laid out, drained, and macadamized, and maintained out of the proceeds of tolls.

2nd. By the construction of railroads on which horse power will be used.

3rd. By the construction of railroads on which the traction will be performed by steam power. The preference to be given to any one of these schemes over the others must be determined by a comparison of the advantages and disadvantages attendant upon each, and by a correct estimate of the charge which it will be necessary to impose upon goods and passengers, in order to cover the cost of traction, that of keeping the road in repair, and the interest of the capital

expended in making the road. To an analysis of these matters I will now proceed to draw your attention.

1st. As to turnpike roads.

These, when in^d their best condition, are tracks broad enough for different vehicles to pass each other, laid out at as gradual a slope as the nature of the country will permit, properly drained, and covered with a stratum of hard broken stone of sufficient thickness to resist the action of the traffic, and to protect the foundation of the road from the rain falling on its surface. Upon such a road, when properly constructed and kept in repair, a horse will draw from 15 to 20 cwt. net weight, and the cost of conveyance will be from 9½*d.* to 12*d.* per ton per mile, including of course in this the sum paid for tolls, out of which the cost of maintaining the road in repair must be defrayed, as well as the interest on the capital expended in its construction. The amount of the capital required will, of course, depend upon a variety of circumstances; the character of the country, the nature of the soil, the quality of the materials, and especially the price of labour. Taking, however, all these matters into consideration, the cost of constructing properly one mile of road may be estimated roughly at £3,000 per mile.

The cost of a railroad which is intended to be worked by horse power, will not differ much from that of a turnpike road. The heavy expense of cuttings and embankments for the purpose of diminishing gradients, which, when locomotive power is employed, are works of absolute necessity, is, in this case, not required. I am aware that, in making this statement, I am placing my opinion in opposition to that of Engineers of some experience; but the difference between us is more in appearance than reality, and is due to the fact that we look at the subject from different points of view; my object being to show how a given amount of goods and passengers can be conveyed from one point to another at the least possible cost, and their's being to explain how the greatest result can be derived

from a given amount of power. It is, of course, unquestionable that the advantage gained by the substitution of the hard and smooth iron rail for the soft and rough material of the road, is a maximum when the road is absolutely level. In this case, we learn by experience that a horse can draw on a railroad, about eight times the load which he can move along a turnpike road. On an ascent the power which the horse has to exert is compounded of that which is necessary to overcome the force of gravity, and of that which balances the friction of the road, &c. The force of gravity is, of course, the same on both road and railroad, and varies in proportion to the steepness of the slope of the road; while the friction is a constant quantity, or nearly so; that of the turnpike road being eight times as great as that of the railroad. While, therefore, the ratio between the effective power of a horse on a railroad and on a macadamized road, when both are on a level, is as eight to one, this ratio is reduced to three to two when the road is on an ascent of one in twenty, and to seventeen to thirteen when the ascent is one in ten. It is, therefore, evident that, to get the full benefit of the power employed upon a railroad, the gradients should be as easy as possible. If, however, the cost of reducing the road to this state, that is, of making the extra cuttings and embankments, be great, the interest of this extra charge may exceed the saving in the cost of the motive power; in this case it would evidently be unwise to expend money for such a purpose, the interest of which must be met either by an increased charge upon the conveyance of goods and passengers, or by a general tax upon the whole community. Taking this view of the subject, it is evident that the solution of the question must depend upon the quantity of goods and passengers conveyed. If the traffic is heavy, a small saving in the cost of traction per ton or per passenger may be sufficient to cover a large amount of interest; but when the traffic is small, and when the cost of locomotive power bears but a small proportion to the sum chargeable as interest, or to the

cost of maintaining the road, it is evidently desirable to reduce these items to a minimum.

In comparing the cost of constructing a macadamized road with that of making a railroad, when the gradients are the same, all that is required is to determine the relative cost of covering the former with metal, and of laying down the rails on the latter; the items for fencing drainage, including bridges, culverts, &c., will be the same, or nearly the same, in each, the advantages being a little in favour of the railroad, as, from its narrowness, the width of bridges, culverts, &c., would not be so great as upon the turnpike road. Now the cost of broken stone depends on a variety of circumstances. Mr. Brady, in his evidence before the Committee of the Legislative Assembly, says that it is worth 10 shillings per square yard, or for a road 18 foot wide, £3 per running yard, or £5,280 per mile. This statement, however, must have reference to the vicinity of Sydney, and cannot be admitted as an element in determining the cost of such work elsewhere. On the Southern road, the Surveyor estimates the cost of macadamizing at from £2,500 to £3,500 per mile. It will, however, be safer to calculate the actual amount of labour which would be expended in preparing and spreading metal of good quality, and this may be roughly stated as follows:-

1st. *Quarrying*.—A man should quarry $2\frac{1}{2}$ cubic yards per day, and this quantity will not vary much, whether it be necessary to use powder or not. The cost of quarrying a yard of metal will, therefore, be about two-fifths of the daily wages of a labourer.

2nd. *Breaking*.—A man will break half a yard good metal per day, or perhaps more, say three-fifths of a yard. The cost then of breaking will be $1\frac{1}{3}$ of the daily wages of a labourer.

3rd. *Cost of Carting*.—This would depend upon a variety of circumstances: but, taking an average load of two

miles, the cost per yard might be put at 4s. 6d., while that of spreading might amount to 1s. 6d.

Summing up these various items, it would seem that the cost of quarrying and breaking would amount about 12s. 6d. per cube yard. Labour being valued at 6s. 6d. per day; add to this 4s. 6d. for cartage, 1s. 6d. for spreading, and the cost per cube yard, would be 18s. 4d. If the average thickness of metal be taken at six inches, and the width of the road at six yards, one cube yard will cover a running yard of road, and the cost of metalling will be about £1,613 per mile.

What then will be the cost of a single line of railway, including, of course, a sufficient number of sidings, &c., to accommodate the traffic in both directions? These latter may be assumed, on an average, to increase the length of the single way, from 1,760 yards to 2,000 yards per mile, and the cost of the work will resolve itself into that of the following items:—

First.—RAILS AND CHAIRS.

Second.—STONE BLOCKS, OR WOODEN SLEEPERS, AS BEARERS FOR THE CHAIRS.

Third.—FIXING CHAIRS AND LAYING THE ROAD.

Fourth.—MAKING GOOD THE BALLASTING AND ROADWAY BETWEEN THE RAILS.

1ST.—RAILS AND CHAIRS.

As a 35 lb. rail was considered to be sufficient for the Liverpool and Manchester Railway when worked by locomotive engines, the same weight of rail will be amply sufficient for a mere horse track; then $2 \times 35 \times 2,000 = 140,000$ lbs., or say 68 tons will be the weight of rails required for each mile of road; and this, at £12 per ton, will amount to £756. The chairs, if placed at five feet apart, will weigh about 20 tons, and, allowing for breakages, may be charged at £10 per ton; making a total for chairs and rails, of £956, or say £1,000 per mile.

2ND.—STONE BLOCKS, OR WOODEN SLEEPERS.

In many parts of the country it would be advisable to use stone blocks to carry the chairs; these were formerly used very generally on railroads in England, but it was found that the jar of the heavy engine upon them caused displacements and breakages; this, however, would not be the case in a mere horse road, and the cost for repairs would be very much lessened by the employment of stone instead of wood; but if stone blocks cannot be procured, then cross sleepers at every five feet, carrying a longitudinal bearer 8×6 , would answer every purpose. When such bearers are used, the rails might be made very much lighter; but without making any allowance for this, the cost of sleepers and wooden rails would not exceed £500 per mile.

1,200 Sleepers at 1s. 6d.	£ 90
4,000. Cubic feet of squared timber, 8×6 at 2s.	£ 400
	£490

Say £500 by proper arrangements, by making use of steam power, and by applying a variety of mechanical expedients to the preparation of the timber, this cost might be very much reduced. The cost, then, of the materials of the road would not exceed £1,500.

3RD.—FIXING CHAIRS AND LAYING RAILS.

The cost of the labor of doing this may be put at £300 per mile. I believe that the charge for this, on the locomotive railroad, is about £500; but, looking to the extra care and attention which is required on such a road, I do not think that I have under-estimated the cost.

4TH.—MAKING GOOD THE BALLASTING AND ROADWAY BETWEEN THE RAILS.

A very heavy item in fixing the rails of a locomotive railway, is the "Ballast" as it is called, or the bed upon which the sleepers rest. This should, if possible, be composed

of gravel, or some material which, while it admits of being moved so as to be forced under the sleepers, forming thus a solid bed for them, is porous, so as not to retain moisture, and not susceptible of being acted on by the weather. Gravel is, in fact, the best kind of ballast, and of this material it is usual to place a thickness of 1 foot 6 inches to 2 feet under the sleepers. This, however, which is almost a matter of necessity when locomotives are used, would be a needless expenditure when the road is intended for horse power. In the former case the road has not only to withstand the action of the load, that is of the goods, and the trucks in which they are conveyed, and this at a speed at least double of that which could ever be attained on a horse road, but it has to withstand the action of the power itself, in the shape of the locomotive engine, which may be represented as equal to a load of from four to six tons upon each wheel, moving with a velocity of from 25 to 30 miles per hour. No precaution can be too great to take, which may enable the road to withstand the action of such a force, whether we look to the permanency of the road itself, or to the fatal effects which must necessarily ensue from any failure which might cause the train to leave the rails. But in a horse road the action of the disturbing forces is so slight, that when the road is laid upon cross sleepers, with longitudinal bearers, these might be placed at once on the surface of the ground, and when stone blocks are employed, they might be bedded in the soil, no particular precautions being taken to insure their stability.

I find that in the American lines, when it has been difficult to procure ballast, a ditch has been dug at each side of the road, the soil from which has been banked up so as to cover the centre of the sleeper, but sloped off on each side, leaving the ends of the sleepers exposed in order to allow the rain to draw off rapidly.

Looking, therefore, at the difference above stated between the railroad for locomotive, and that for horse power,

the cost of the ballast may be merged into that of the horse track, the material required for which will on a length of 2,000 yards, allowing a depth of 12 inches and a width of 6 feet, amount to 1,280 cubic yards, and taking this at an average of 5s. per yard, the cost will be £337 per mile.

Summing up these various items, viz :—

	£	s.	d.
Rails and Chairs..... ..	1,000	0	0
Sleepers or Blocks..... ..	500	0	0
Labour, fixing..... ..	300	0	0
Ballast or road, ...	310	0	0
Would give	£2,110	0	0

as the cost of forming the track for a railway, while that of macadamizing the turnpike road would amount to £1,613. The difference, or about £527, would be the excess of the cost of the railway above that of the macadamized road, and if the cost of the latter be put at £3,000 per mile, that of the railroad may be taken at £3,500.

Having thus arrived at an approximation to the cost of the turnpike road, and the horse railroad, it only remains to determine the cost of a railway for locomotive: for this we have a variety of data.

We have the average cost of English and American railways; and we have the actual cost of railways already executed in this Colony; and if the comparatively easy line between Liverpool and Paramatta has cost upwards of £11,000 per mile, we may feel sure that in the more difficult country, where the cuttings must be deeper, the embankments higher, the bridges more numerous, £12,000 will be a very moderate estimate.

The comparison, then, between the different modes alluded to in the former part of this paper, of remedying the evil arising from the miserable condition of our present lines of

communication, so far as the first cost of each is concerned, will stand as follows :—

	First cost per mile.	Annual charge for Interest per mile.
	£	£
Turnpike Road	3,000	150
Horse railroad.....	3,500	175
Locomotive railroad.....	12,000	600

The next matter for consideration will be the annual cost of maintenance of way, as it is termed, namely, that of keeping the road in a proper state of repair, by applying labour when it is needed, and by renewing the materials as they decay.

In all cases, the outlay for these purposes must depend, to a certain extent, on the amount of traffic; but, if we assume this to be such as to require the renewal of the metal upon a macadamized road every ten years, and that of the iron rails of the railway every twenty years, while the wooden sleepers may be taken to last eight years, the relative outlay may be roughly estimated as follows :—

On the turnpike road a single station man will, on an average, with light traffic, take charge of four miles of road; and his wages will amount to £100 per annum, or £25 per mile. The total cost of metal has been put at £1,613; one-tenth of this, or £161-6s. will be the annual cost of the metal, so that the total annual charge per mile for maintenance will, on the turnpike road, be £186-6s.

On the horse rail the labour would be trifling in comparison, as the station man would only be called upon to look after the general drainage, and would never have to fill in ruts, &c., however, to make ample provision, two men

may be allowed to every three miles of road, which, at the ordinary rate of labour, would give £66-10s.-6d. per mile. The charge for rails and chairs has been taken at £1,000 per mile; and as these are supposed to last twenty years, the annual renewals will cost £50.

The charge for sleepers was put at £500 per mile, and if these last eight years, the annual charge for renewals will be £62-10s. Should stone blocks be used, this charge would almost vanish.

I have not made any allowance for the maintenance of the horse track between the rails, as I consider the amount of labour allotted is amply sufficient to make good the very slight damage which would be done by the feet of the horses. The total charge for maintenance of way on the horse railway will be as follows:—

	£	s.	d.
Renewal of rails.....	50	0	0
Do. sleepers.....	62	10	0
Labour .. .	66	13	4
	179	3	4

On the locomotive railroad the charge for renewals, assuming the rails and sleepers to last as long as on the horse road, will be $2000 \div 20 = £100$ per annum per mile for rails, and say $150 \div 8 = £18-10s.$ for sleepers. For the cost of labour we must be dependant upon the data afforded by the returns from the English railroads, and the experience which the Paramatta railway will afford.

From the returns which have been furnished, I find that the contract price for labour only was £16 per mile per fortnight, or £416 per mile per annum, or 1s. 10d. per train mile. In America the cost is about half of this, amounting to 11½d. per train mile, while in England the cost varies from 13·92d. to 3·072d., and the average may be put at 7·66d. per train mile.

The greater the amount of traffic upon the road, the greater, of course, will be the absolute cost of maintenance of way, but the loss will be the rate per train mile, as there are several items which are almost constant, or which, at all events, do not vary with the amount of traffic.

Under these circumstances, if the charge per mile of road is put at £250 annually, that is at £166 less than is now actually paid on the Paramatta line; and if to this be added the cost of re-laying rails and sleepers, before estimated at £118-10s. per mile, the total charge for maintenance of way will be £368-10s. The proportionate cost, therefore, of the maintenance of way on these three descriptions of road will be as follows :

	£	s.	d.
Turnpike road.....	186	6	0
Horse railroad	179	3	4
Locomotive road	368	10	0

Having thus established an approximation, at all events, to the two great items of permanent charge on the different kinds of roads, the only question which remains to be investigated is the actual cost of transport. I mean, the cost of the power employed in haulage; including in such cost all incidental and contingent expenses, such as the repair and renewal of rolling stock, coaching, traffic and station charges, &c.

In entering upon the investigation, I will commence with the locomotive railway; for, with regard to this, we have not only the experience of the English and American railways to guide us, but we are also in possession of the returns of the cost of working the line of railway from Sydney to Paramatta and Liverpool.

The actual cost of locomotive power may be classified under the following heads :

- 1st. Interest of purchase money of rolling stock.
- 2d. Repair and renewal of do.

3d. Cost of working, including wages of Engineers, Drivers, Firemen, &c. and charge for fuel, oil, &c.

4th. Station expenses, that is, the wages of persons employed in various capacities, but not actually engaged in working the locomotives.

The whole of these charges are (with the exception perhaps of No. 4) directly proportional to the amount of the traffic upon the road. In order, therefore, to estimate their amount, some specific number of passengers, and of tons of goods, must be assumed as likely to pass over the railway. The total tonnage passing up and down the Southern road between Goulburn and Sydney is shown by the annexed return to amount to 30,543 tons. Of this, however, 10,000 tons pass down the railway from Liverpool, and an additional 10,000 tons is assumed as the amount of the Campbell-town traffic, 10,000 may therefore be assumed as the existing amount of the traffic along the line of road from Campbell-town to Goulburn, a distance of about 90 miles.

It is difficult to form any probable estimate of the number of passengers. The replies to queries sent to the mail contractor show that the maximum capacity of the vehicles employed by him is adequate to the conveyance of twenty passengers per day, or between six and seven thousand per annum over the whole distance.

If then, we assume 30,000 tons per annum, or thereabouts to be the probable amount of goods traffic from Campbell-town to Goulburn, that is about 100 tons per day up and down, and that the present number of passengers is also trebled, or that 60 per day are conveyed by the different trains, we shall have some definite data upon which to estimate the relative cost of conveying them by locomotives, or by horse power on railroads, or by horse power upon common roads.

Basing the estimate of rolling stock required upon the data supplied by Mr. Brady in his report on the comparative

cost of haulage by steam and horse power, the cost of rolling stock would stand thus :—

	£	s.	d.
4 Engines at £3,000	12,000	0	0
4 Second Class Carriages at £350	1,400	0	0
4 Third Do. at £250	1,000	0	0
4 Brake vans at £250	1,000	0	0
30 Waggon at £150	4,500	0	0
	19,900	0	0

Say £20,000.

The charge then under the first head of interest of cost of rolling stock will be, interest at 5 per cent. on £20,000 : £1,000 or £11-2s. per mile of road.

The second and third heads are, in the accounts of English railways, combined together, though data are given by which the actual charges for locomotive power can be separated from those for repairs and renewals.

On reference to these returns, it would appear that the cost of locomotive power, inclusive of repairs, amounts, on the English lines, to about one shilling per train mile, while the repairs may be averaged at 5d. ; so that the actual cost of locomotive power is in England about 7d. per train mile.

On the Paramatta line, the returns show that the charge for locomotive power, including repairs, was 23-518 per train mile, and if we assume, what was, I believe, the case, that the charge for repairs was unduly enhanced in the particular period to which the return had reference, yet it is very evident, that the charge for both working and repairs must be much heavier here than in England. From the returns of English railroads, it would appear that the charge of 7d. per mile for locomotive power would be divided between wages, materials and superintendence, in the proportion of 2-27 to the first, 4-37 to the second, and -36 to the third ; while on the Paramatta line the charge for materials was 12-30 per mile, or about three times the amount of the English charge,

the item superintendence amounted to 1·85, or six times that in England, while the labour, including the charge for repairs, was 19·308, or nine times the amount of the English charge. Looking to the relative cost of labour here and in England, we may assume, without much risk of error, that the charges in this country will be about three times as heavy as those in England, and, therefore, that the charge for locomotive power would be 3s. per train mile, and if the train miles be assumed to be equivalent to the number of miles actually traversed by goods and passenger trains, running twice a day, the charge will, for two trains per day, be 6s. per mile, or for the year of 313 days £93·18s. or say £95. The fourth item of station expenses averages, in England, about 11·85 per train mile; on the Paramatta line the charge was 20·11, and if we take 18·00, as the fair amount, the total charge would be £46·19s. per mile. The cost, therefore, of working the locomotive line will be .

	£	s.	d.
Interest per mile.....	11	2	0
Locomotive power.....	95	0	0
Coaching charges and station expenses...	46	19	0
	153	1	0

The cost of traction upon a horse railway, may be inferred, so far as the goods traffic is concerned, from a return which has been furnished to me by the Engineer of the Australian Agricultural Company, Mr. Whyte; as well as by information obtained by me, relative to the working of a contract system, previous to that now adopted.

From Mr. Whyte's paper, it appears that the actual cost of moving 18,565 tons of coal an average distance of 1·963 miles, and of hauling back the empty waggons amounted to 2·83 per ton per mile one way, or 1·115 for each mile travelled by the power; in this charge, is included an item for the repair of harness, and also an allowance, though apparently too small, for the depreciation of horse stock.

By the returns formerly procured by me, it appears that the contractor who supplied the whole power delivered 516 tons daily, which were equivalent to 1,418 tons drawn one mile by 86 horses; each horse, therefore, drew 39 tons net weight, one mile daily, besides taking back the empty wagon to the pits. Starting, however, from the data afforded by these returns, we may infer that one horse will move from 50 to 60 tons daily over one mile of road, and as, according to the supposition upon which the former calculation was based, 100 tons have to be conveyed daily over each mile, two horses per mile will be required for the goods traffic, and, allowing for losses, accidents, &c., $2\frac{1}{2}$ horses per mile of road would be a sufficient stock. The carriages or trucks for goods would contain about three tons each, and about 150 of these would be required for the conveyance of 100 tons daily, over a distance of 90 miles.

For the passenger traffic of sixty persons, backwards and forwards daily, four carriages would be required in constant work, and two additional, to provide against contingencies. These carriages would be drawn by two horses, and the number of these required to secure the regular working of the passenger traffic, would be, allowing for contingencies, about 60; eighteen sets of harness would be wanted.

The capital expended in what may be termed the rolling stock, would be

	£	s.	d.
6 Carriages for passengers, at £250 each.....	150	0	0
60 Horses at £35.....	2,100	0	0
18 Sets of Harness at £15.....	270	0	0
150 Goods Trucks at £100.....	15,000	0	0
210 Horses at £25.....	5,250	0	0
180 Sets of Harness at £3-10s....	630	0	0
Say £25,000.	£24,750	0	0

The interest of £25,000 at 5 per cent. would be £1,250, £18-18s. per mile of road. Repairs and renewals of the carriages may be put at 10 per cent. on the cost, as may also that of the harness; while the horse stock must be put at 20 per cent. The charge for repairs and renewals therefore will be—

	£	
Passengers' Carriages.....	1,500	
Goods trucks	16,000	
Harness.....	{ 270	
	{ 630	
	<u>£17,400</u>	
10 per cent. on.....	£17,400	1,740
Horse, passengers	2,100	
Horses,.....	{	
Do, Goods.....	{ 5,250	
	<u>£7,350</u>	
20 per cent. on.....	7,350	1,470
Total repairs and renewals.....		<u>£3,210</u>
Equal to £35-18s.-4d. per mile of road.		

The cost of working the traffic so far as the goods are concerned, has been shown to be rather less than 1-415 for labour, maintenance of horses, shoeing, &c. Let it be put, however, at $1\frac{1}{2}$ d. per ton per mile, then, as 80,000 tons have to be conveyed in the course of the year, the cost per mile will be £187-10s.

The cost of working the passenger traffic may be roughly estimated as follows:—

	£	s.	d.
4 Coachmen at £180.....	720	0	0
12 Grooms at £108.....	1,296	0	0
48 Horses keep at £50.	2,400	0	0
	<u>£4,626</u>	0	0
or £51-8s. per mile.			

The charge thus for working will be as follows :

	£	s.	d.
Interest per mile.....	13	18	0
Repairs and renewals	35	13	4
Working..	187	10	0
	51	8	0
	238	18	0
Total	288	9	4

The charge for station expenses will be trifling in comparison to that on a locomotive line, as all the arrangements would be more analogous to those on the turnpike road. If, therefore, the cost of working be put at £300 per mile, this will leave an ample margin for all charges.

The cost of the conveyance of goods on a turnpike road has been put at 9½d. per ton per mile ; this, however, includes the charge for tolls, which is supposed to be sufficient to pay the cost of keeping the road in repair, and also the annual interest of the money borrowed to construct it.

The charge for locomotive power would thus be reduced to 7½d. per ton per mile, which, for 30,000 tons, would give £637-10s. per mile for the goods traffic only. The cost for passenger traffic would be about double that on the horse rail, or £140 per mile, giving a total of £1,077-10s. per mile for working expenses.

The general comparison between the cost of conveying the given quantity of goods and passengers, by either of the three kinds of conveyance, will stand as follows :

	Turnpike Road.			Railroad.					
				Horse.			Locomotive.		
	£.	s.	d.	£	s.	d.	£.	s.	d.
Interest.....	150	0	0	175	0	0	600	0	0
Maintenance ...	186	6	0	179	3	0	368	10	0
Cost of working.	1,077	10	0	300	0	0	153	1	0
	£ 1,413	16	0	654	3	0	1,121	11	0

An analysis of the above table will show, that, while on the turnpike road, and on the horse railroad, the interest of the first cost of the road will be paid by a charge on the traffic, amounting to one penny per ton per mile on goods, and $\frac{1}{2}d.$ per mile on passengers, the charge on the locomotive railway, to cover the interest of capital, will be $3\frac{1}{2}d.$ per ton per mile on goods, and $2d.$ per passenger per mile.

Taking, however, the last item, namely, the cost of working, the charge on the turnpike road will be $7\frac{1}{2}d.$ per ton per mile for goods, and $1\frac{1}{2}d.$ per passenger per mile; (this latter charge is too low, but I have been anxious not to exaggerate), on the horse railroad, the charge for working would be $1\frac{1}{2}d.$ per ton per mile for goods, and $\frac{1}{2}d.$ per passenger per mile; while on the locomotive line, the charge for working would be less than one penny per ton per mile for goods, and $\frac{1}{2}d.$ per mile for passengers. As the traffic increases upon the road, the advantage which the horse road possesses over the locomotive road, will diminish rapidly.

As the interest of capital expended is a constant quantity, any increase in the traffic will diminish the charge, per ton or per passenger, which will be required to pay this interest. It is evident, however, that a large amount of business must be done upon a railroad, in order to cover the fixed and permanent charges upon it.

The fixed charges must, in this country, be heavier than they are either in England or America, for labour is much dearer here than in either of these two countries, and the interest of capital is certainly higher than in England; though not, probably, than it is in America. It becomes, then, a matter of the utmost importance to us, in deciding upon the adoption of some improved system of internal communication, to weigh carefully the various circumstances which may operate in developing such an interchange of products and people from one part of the country to another, as will defray all the charges upon such improved communication. The example of

England, of the United States of America, and of the North American Colonies, are all held out to us, as justifying the assumption, that, where improved means of communication are provided, traffic is sure to be created; and to this, as a general rule, I am quite prepared to assent; but the question we have to consider is, what will be the probable amount of such increase.

Now we may at once set aside the example of England and the United States. The circumstances of those two countries are so diametrically opposed to those in which we find ourselves placed, that to reason from that which has happened in either of them from the construction of railroads, to what will follow from the construction of similar works here, would lead us into error. The position, however, of the British North American Colonies is so far different from that of the mother country, or the United States, as might induce a belief that a system which has been applied with success in Canada, may possibly answer here.

Is there, then, any such an analogy between the present state and future prospects of New South Wales, and those of Canada, as to justify us in expending upon our internal communications, a sum larger than our present necessities require, in the confident expectation that, in a few years, the traffic upon such lines of communication will increase to an extent sufficient to enable us to reduce the charge for transport to a level with those which would be sufficient to pay the whole charge upon a cheaper system, but one fully adequate to our present wants.

The North American Colonies, extending, as they do, from the Atlantic to Lake Superior, cover an area of 455,000 square miles, and support a population of $2\frac{1}{2}$ millions. These Colonies border for a length of about 1,800 miles upon the United States of America, with which they carry on an increasing trade, and the population of which amounts to upwards of 30 millions. The communication of the North American Colonies with England and Europe can be made in ten days by steam, and in twenty-five or thirty by sailing

vessels. The land, especially that in the vicinity of Lakes Erie and Ontario, is of good quality, well calculated for the growth of wheat, and other cereal crops, for which there is a ready demand, either in the Colonies themselves, or in the United States, or in England and Europe.

Land, therefore, especially that in the vicinity of railroads, is eagerly bought up, and brought under cultivation, as there is a certainty that, although the price of wheat may be influenced to a certain extent by the quality of the harvest in England, or on the continent of Europe, the value of the crop will be sufficient, at all times, to remunerate a farmer who pays ordinary attention to his land.

The construction of a railway, by lessening the cost of conveying produce to market, encourages, both in Canada and the United States, the settlement of the land in its vicinity; thousands flock to avail themselves of the advantages thus held out to them, and the result is an amount of traffic which is not only sufficient to defray the cost of working the railway, but also to pay the interest on its construction. If, however, the settler in Canada had to depend upon the consumption of Montreal and Quebec, that is, if he had not the certainty of a better, or at all events, a larger market for his produce, the amount of land disposed of would be much less, and the passenger and goods traffic upon the railways would not be sufficient to justify the cost of constructing them.

In New South Wales, the population, by the last Census, was 289,000, and the annual increase may be taken to be 8 per cent. This population is spread over an area of about 230,000 square miles. There is a large quantity of good land in various parts of the Colony, well adapted for the production of cereal and other crops; but the distance is too great to allow the settler to look to the English and European market for the disposal of his surplus produce. He has the markets of India and China at no great distance, but these countries will not take his wheat in exchange for the rice and tea which he pur-

chases from them. He must, then, so far as the sale of cereal produce is concerned, depend upon the home market; and this, though the population is increasing rapidly, affords but a limited demand. He may, it is true, if the cost of conveying his produce to the coast be much lessened, compete with the farmers of the adjoining Colonies in the market of Melbourne, but the demand there is not large, nor is it permanent, as the Government of Victoria is already taking steps to construct railroads, and facilitate the means of communication throughout a country, much of which is admirably fitted for the production of cereals.

In estimating, therefore, the increase which is likely to take place in the existing traffic upon any given line of road, we must not merely be able to say that it opens up a tract of country admirably suited for farming operations, but we must be prepared to show that there will be adequate inducements to settlers to purchase and occupy such lands, productively, in numbers sufficient to create a traffic for the railway.

In some parts of the country, as, for instance, in the neighbourhood of Newcastle, there will be an increasing trade in coal, which will be brought by the railroad to Newcastle, as the port of shipment. In other parts of the country there may be, and indeed there are, local sources of traffic, which only require cheap means of conveyance to admit of a large development; but the principal receipts of the railroads in New South Wales, must, for many years to come, be derived from the movement of pastoral and agricultural produce from the interior, to the port of shipment, or place of consumption, and supplies of different kinds, and of imported articles of comfort or luxury, from the capital to the settler.

The pastoral products do not admit of any rapid development; though their extension is certain, and may be eventually very great; and I have already shown that as the agricultural products can only command a limited market, their increase cannot be dependent upon to an extent sufficient to create a

traffic for any great length of railway. I am, therefore, of opinion that the analogy between Canada and New South Wales is not close enough to justify the inference that railways will succeed here, because they have done so there.

The conclusion which I consider myself justified in drawing from the facts and calculations exhibited in this paper are as follows:

1st. The cost of transport by a turnpike road is in excess of that by a railroad, whether such road be worked by horse power or steam.

* 2nd. The cost of steam power is much less than that of horse power upon railroads, but this cheapness is, with a limited amount of traffic, more than compensated for by the increased cost of construction and maintenance, if such roads be compared with those on which horse power may be used.

3rd. That the circumstances of the Colony are not such as to lend us to expect so large a development of internal traffic as would compensate, by the saving on the cost of motive power caused by the employment of steam, for the increased charge for the interest of capital, and maintenance of road.

4th. That the railway on which horse power is used would, under the present, and probable future circumstances of the Colony for several years to come, be the cheapest means of conveyance both for passengers and goods; and that it would be, therefore, advisable to adopt it on all the main lines of communication.

APPENDIX.

RAILROADS.

RESULTS OF EXPERIMENTS AT NEWCASTLE.

Cost of $1\frac{1}{2}$ miles near Newcastle including land, laying, originally with wood, and relaying with iron rails, 35 lbs. to the yard, 30,500 or £6,332 per mile. The next mile cost £1,800.

The contract price for the carriage of the coal from the pits to Newcastle, and delivery on boardship, is at the rate of 1s. 3d. per ton, or, on an average, about $5\frac{1}{2}$ per ton per mile.

The lengths of the branches are 3, $2\frac{1}{2}$ and 2 miles, but the same price is paid for all. For this, the Contractor finds horses, harness, drivers, grease, and men and boys attending the Staiths, but he does not keep the waggons or the permanent way in repair. The Contractor delivers about 510 tons daily, of which 200 tons come $2\frac{1}{2}$ miles, and 260 come 3 miles, equal to 1,418 tons, drawn one mile. To do this work the Contractor has 40 horses, four of which are kept at Newcastle, to haul the coal up to the Staiths.

He employs seven drivers, five men at the Staiths, to assist in shipping the coal, and four boys. In order to find the actual charge for locomotive power, the four horses kept to work the Staith, and the five men and four boys unemployed for the same purpose, should be deducted from the establishment, the estimate for which will then stand as follows :—

	£	s.	d.
30 Horses at say £1 per week.....	30	0	0
7 Drivers at £3.....	21	0	0
Grease for waggons.....	4	10	0
Boy for greasing.....	1	0	0
	£62	10	0

for this sum 3,000 tons can be drawn from the pits to Newcastle, or 8,508 tons can be drawn one mile, the actual cost being 1s. 3d. or a little more, per ton per mile. To this, however, must be added—

1st. Interest upon the capital of the Contractors, which may be calculated as follows :

	£	s.	d.
30 Horses at £40.....	1,200	0	0
Harness for do. at £5.....	150	0	0
	£1,350	0	0

and this at 10 per cent. will amount to £135 per annum.

2d. Sinking fund for re-placing stock, at 30 per cent. per annum £480.

3d. Supervision or payment for Contractor's labour, say £500 per annum.

4th. Interest of cost of rolling stock ; this stock for the conveyance of 120 tons of coal at each trip, would amount to 70 carriages, and if each carriage is put at £50, this will give £3,500 interest upon this at 6 per cent. £210.

5th. Repairs and sinking fund, say 15 per cent. upon above amount £520.

If all these items were added together, the amount will be as follows :—

	£
Locomotive power..... $62\frac{1}{2} \times 5$	3,125
Interest.....	135
Sinking fund.....	480
Supervision.....	500
Interest of Rolling Stock.....	210
Repairs and replacement.....	525
	£5,135

or say £100 per week, for which, as has been shown before, 8,500 tons can be drawn one mile. The cost, therefore, of conveying goods upon a railway by horse power, may be put at 289, or rather more than 29 per ton per mile, this includes taking the carriages back.

The experience gained by the working of the Newcastle coal mines is sufficient to show the relative advantages of the different kinds of roads. It appears that the coal was formerly brought into Newcastle by carts along ordinary bush road, and three horses brought in twenty tons per week. When a wooden tramway was laid down four horses brought in 30 tons per day, or 120 tons per week. When iron rails are substituted for the wooden tram, five horses can bring in 100 tons per day, or 500 tons per week.

Thus, on a bush road, a horse will draw 7 tons per week. On a wooden tram, a horse will draw 45 tons, and on an iron Railway 120 tons per week.

This is conclusive against the employment of wood, at all events, as a tramway. The friction would possibly be less upon an edge rail of wood, but still the difference between wood and iron would probably double the cost of traction, and altogether neutralize any benefit which might be derived from the comparative cheapness of wood.

In Mr. Bell's paper there is an estimate of the comparative cost of horse and steam traction ; and there is no question but that, with such an amount of traffic, steam power would be much cheaper than horse power. According to his calculation, the engine would have to travel 288 miles per week. Now, the cost in England per train mile, including repairs, &c., is 1s. 3d. per mile. The experience of the Paramatta rail road gives, I believe, 4s. 6d. per train mile. If we assume 2s. 6d. as a fair price, looking to the great expense of every thing in the Colony, $288 \times 2.6 \div 20 = £36$, the cost per week of locomotive power, &c., and as 3,000 tons have been brought down, the cost per ton will be 2.70 pence, or the cost per ton per mile will be, as near as possible, 1 penny. This, however, does not include interest upon rolling stock, including engines and carriages ; neither does it provide for repairs and re-placements, or for supervision.* In fact, the cost of conveying about 100,000 tons per annum would be so far as mere traction is concerned, by steam, £600-13s.-4d. per mile, and by horse power, £1,166-13s.-4d. Against this, however, must be placed the interest of the outlay on the construction of the road ; which, if put at 12,000 for the steam road, and 4,000 for the horse road, would be £600 and £200, and the increased cost of maintenance of way, which for the steam road, may be put at £250 per mile, and for the horse road at £100. The comparison will therefore stand as follows :—

	Steam.	Horse.
Interest.....	600	200
Traction.....	600	1,166
Maintenance of way....	250	100
	1,516	1,466

* In fact, it is the mere cost of locomotive power, and it must therefore be compared with the horse power, which has been shown to cost rather more than 3d per mile.

With a smaller amount of traffic, such as is likely for many years to pass over the Southern and Western roads, the comparison will be much more in favour of horse power.

Particulars of the actual cost for traction of coal on the Australian Agricultural Company's Railway, near Newcastle, New South Wales, from the 1st January to the 31st March inclusive, 1857.

Tons.	Length of	M.	Q.	P.	Y.	Ld Yds.
From D Pitt .. 3,104	Railway.	2	0	0	42½	20,081,200
From M Pitt.....0,531	Do.	2	1	1	21½	27,431,000
From F Pitt.....3,870	Do.	0	3	0	18½	5,820,480
<u>18,505</u>						<u>52,335,830</u>

Average mileage per ton 1'908.

The above quantity is delivered at the coal Stalls by contract, including grease and oil, at the uniform rate of 3d. per ton all through, which also includes the haulage of the empty waggons back to the pits; making the cost for manual labour and lubrication alone, to average 1'53 pence per ton each mile for the loaded waggons one way.

The Company furnish horses, harness, and provender. Cost of maintenance during three months.

£	s.	d.	Summary of Cost.	Average Cost.
			Haulage on 18,505 tons at 3d.....	202 1 3 1'53
300 bushels of maize at 5s.97 10 0			Cost of maintenance.....	184 4 0 1'21
12½ tons of hay at £5.....	03	10 0	Added ½ of original stock for depreciation per annum...	13 7 3 '00
Run in paddock.....	0	16 0		
Horse shoeing bill.....	10	3 0		
Saddling bill.....	4	0 0		
				<u>420 12 0 2'83</u>
			181 4 0 or say in round numbers nearly 3d. per ton.	

Original cost of Stock and Plant.

	£	s.	d.
10 horses at £25 each.....	250	0	0
15 sets of harness and gears £70.....	1050	10	0
	<u>427</u>	10	0

27th April 1857.

(Signed) ROBERT WHYTELL,
Manager A. A. Co.'s Collieries.

ABSTRACT showing the total tonnage, the rate per ton the distance conveyed, and the cost of carriage for goods on the Western roads annually.

Distance. Miles.	Road. To Sydney from	Sundries.	Grain.	Total Tonnage.	Rate per ton for the whole distance.	Cost of Convey- ance.	Rate per ton per mile.		
		Tons.	Tons.				£	s.	d.
163	Molong.....	4,415	...	4,415	18	79,470	0	2	8
100	Orange.....	487	...	487	15	7,305	0	1	10½
150	Rylstone.....	520	...	520	14	7,280	0	1	10½
120	Bathurst....	4,623	...	4,623	9	41,607	0	1	0
36	Windsor.....	5,160	1,875	7,025	3	21,075	0	1	8
629	Total.....	15,195	1,875	17,070	Total.	150,737	0	0	1½

Average rate per ton per mile 1s. 10d.

(Signed) GOTHIER K. MANN.

ABSTRACT showing the total tonnage, the rate per ton, the distance conveyed, and the cost of carriage for goods on the Southern roads annually.

Distance. Miles.	Road. To Sydney from	Sundries.	Grain.	Total Tonnage.	Rate per ton for the whole distance.	Cost of Convey- ance.	Rate per ton per mile.		
		Tons.	Tons.				£	s.	d.
380	Albury.....	198	...	198	45	8,710	0	2	4½
185	Queenbryan... ..	614	...	614	13	7,982	0	1	4½
125	Goulburn.....	8,570	...	8,570	13	111,410	0	2	1
84	Beirima.....	818	80	898	7	6,286	0	1	8
50	Picton.....	800	167	976	4	3,868	0	1	7½
33	Campbell-town...	5,000	5,000	10,000	3	30,000	0	1	9½
20	Liverpool.....	10,000	108	10,108	2	20,000	0	2	0
877	Total.....	26,000	5,355	31,315	Total.	188,072	0	12	11½

Average rate per ton per mile 1s. 11d.

October 1856,

(Signed) GOTHIER K. MANN.

Abstract showing the total tonnage, the rate per ton, the distance conveyed, and the cost of cartage for goods on the Northern roads annually.

Distance	Road.	Tons	Tons.	Total Tonnage.	Rate per Ton	Cost of Cartage	Rate per Ton	Distance
Miles.	To Maitland from				£ s.	£	£ s.	d.
300	Warrakilla	674	...	674	28 0	18,872	0 1	10 1/2
300	Wellington	210	...	210	18 0	3,780	0 1	2 1/2
100	Nunah	400	...	400	15 0	6,000	0 2	0
125	Casillia	454	...	454	9 0	4,086	0 1	3 1/2
100	Murrayundi	780	...	780	7 10	5,460	0 1	6
70	Muswellbrook	634	...	634	6 10	4,124	0 1	10 1/2
30	Singleton	22,648	...	22,648	5 0	113,240	0 2	0
1,076	Total ..	25,800	...	25,800	Total.	110,653	11 10	4
40	Wollombi	300	2,400	2,700	£ 2 0	5,400	0 1	0

Average rate per ton per mile 1s. 8d.

Note.—The traffic from Warrakilla and Wellington does not pass through Nunah and Casillia, but comes upon the Northern road near Murrayundi. The Wollombi traffic passes along about five miles of the Maitland road only.

(Signed) GOTTLIEB R. MANN.

SECTION III.

The principles which regulate the comparison which has been drawn, in the former sections of this paper, between the cost of transport on different kinds of roads in Australia, are of general application; and, looking to the fact that the Government of India, although it has expended large sums upon roads and railways, as well as upon canals, when opportunities of constructing these were afforded, has yet many thousand miles of road to make, and fresh lines of communication to open, I cannot but think that an enquiry into the circumstances which influence the cost of transport in India, and a comparison of the advantages presented by different modes of communication, would be useful, not merely to the Government, but to the capitalists who may be disposed to invest money in works of this kind, and who, of course, would wish to derive from such investment the largest returns.

Such an enquiry, and such an investigation will make a very useful corollary to the conclusions deduced, in the former sections, from English and Australian experience, and will, I think, tend to prove that the local features of the country, the character of its climate, the peculiarities of the people, and the nature of their industrial system, influence, far more largely than many are apt to think, the discussion of questions which would seem, to most, to be simple matters of engineering experience.

Before, however, I enter upon this enquiry and comparison, I must promise that the facts which I propose to classify and arrange, as the basis of any inferences I may draw, have reference to the Presidency of Madras, which occupies by far the largest portion of the southern extremity of the Peninsula of India. There is, however, a marked similarity between the state of things in the different Presidencies; and, with some trifling allowances for local peculiarities, I think that what I have to say about railroads in Madras, will be found applicable to the whole of India.

GENERAL ASPECT OF THE COUNTRY.

The Peninsula of India extends from Cape Comorin in latitude 8° N. to latitude 20° or 21° N., at which point its width is about 14° of longitude or 800 miles or thereabouts.

A range of mountains from 6 to 8000 feet high runs parallel to the Western Coast at a distance of about 50 or 60 miles from the sea. This range is broken through at one point where there is a gap of about 40 miles in width, the height of which is not more than 1,200 feet above the sea. The fall of the ground to the westward is therefore rapid, while, speaking generally, there is a gradual and much more gentle slope to the eastward, which is interrupted, occasionally, by abrupt secondary ridges rising to a height of 2 or 3000 feet. Nearer the East Coast the land slopes gradually towards the sea, at the rate of about 4 feet per mile, in great plains, where there is but little to catch the eye, or to relieve the monotony of the landscape. It follows, from what has been said above, that the rivers flowing to the West Coast have short and rapid courses; though, as they flow through a narrow belt of alluvial soil near the sea, they are often navigable for small craft for some miles from the mouth. Those that flow to the eastward have a much longer course, and, as they drain a much larger area of country, they bring down, during the rainy season, a very heavy body of water; as, however, the supply is but temporary, as will be seen when I speak of the climate, these rivers do not afford any facilities for water communication in their unimproved state.

CLIMATE.

The position of the Peninsula, within the northern tropic, exposes it to the action of the periodical rains. These are modified in their action by the relation of the Peninsula to the great mass of the continent from which it projects, and assume the form of two distinct monsoons. The south-western, which is by far the most extensive in its action, commences about the middle of May, and, so far as the Peninsula of India is concerned, expends its force principally upon the

West Coast, and the range of mountains parallel to it, where, during the months of June, July, August, and part of September, there is a steady down-pour with an occasional break; the average rainfall may be put at 180 inches.

Of course a large proportion of this water returns rapidly to the sea on the West Coast; the effect being to lessen the saltiness of the sea to such an extent as to kill the fish, and all the plants which are naturalized in salt water, for several miles from the coast, and to cause thereby a most disagreeable putrescent effluvia along the coast, and for three or four miles out to sea.

A portion of the rain of the south-west monsoon is discharged upon the eastern slopes of the mountain range, and drains into the water-courses which form the heads of the large rivers, such as the Godavary, Kistnah, and Cauvery, which discharge themselves into the Bay of Bengal; causing heavy floods in the lower portions of those rivers. In October the wind veers to the northward of east, and is called the north-east monsoon. It brings with it the rain which it has sucked up in the Bay of Bengal, and discharges it upon the eastern slopes of the Peninsula. The amount, however, of this discharge, which continues at irregular intervals through November and December, is not nearly so great as that of the south-west monsoon. The average of twenty years gives thirty-one inches as the amount of rain at Madras during the north-east monsoon, and further inland the average is much less, not exceeding thirteen inches.

Rain may be said to fall from May to December in some part or other of the Peninsula; but the $4\frac{1}{2}$ or 5 months from January towards the end of May, may be termed emphatically the dry season.

No vegetation takes place, except in situations where water can be found to irrigate the soil; the sky is cloudless, there is nothing to impede the action of the sun upon the ground, which is baked to the hardness of a brick where the aluminous element prevails, and is reduced to a dust where its consistency is less compact.

CULTIVATION

From the foregoing description of the climate, it may be inferred that the productiveness of the country depends altogether upon the periodical rains. Should nature pause in her action for a single season, the result of this short cessation would be such a wide-spread famine as would destroy millions upon millions of people, and reduce the country to a desert. Complaints are commonly made of the insufficiency of the monsoon, and comparisons are drawn between the existing state of things, and that of which history or tradition hands down the records, where the rain fell more regularly and in larger quantities. I am disposed to give some credit to these statements, and to trace the diminution in the quantity of rain to the mode in which the country has been denuded of timber.

To return, however, to the character of the cultivation as influenced by the climate. On the West Coast the rain falls with such regularity, and the atmosphere generally is so moist, that few or no attempts are made to retain the water discharged upon the range of mountains bordering the coast. On the east side of these mountains, however, the case is very different. Here the rain is scanty and irregular, and care is taken to secure as much as possible of the drainage of the country. In every water-course, or line of drainage, dams will be seen following each other in regular succession, till all, or nearly all of the drainage water is caught, and retained for agricultural purposes; the surplus, which finds its way into the rivers, is again stopped by weirs or dams constructed across them, from distance to distance, and channels are taken from above these dams by which the water of the river is distributed as extensively as possible. When all this has been done, there is but a small proportion of the cultivated land which is susceptible of irrigation; the remainder is dependant upon the ordinary action of the rains, and is sown with what are termed "dry crops;" namely, various kinds of millet, and raghi, and also with oil seeds, gram, and other

leguminous plants. This dry cultivation imposes upon the farmer the obligation of completing his agricultural operations rapidly : he cannot plough before the first rains have softened the ground ; he cannot sow till he is pretty certain of continual showers of rain. The result is that he is compelled to maintain, or at all events to employ, a pair of bullocks for every five, or at the least, for every eight acres of land which he cultivates, as he would not be able, with less animal power, to carry through the various ploughings and hoeings which the land demands. The crop springs up rapidly under the influence of rain, and of a sun nearly vertical, and is ready for reaping in four or five months. It is then reaped, trodden out by bullocks, as was done in the time of Moses, and winnowed by the wind in a manner as old-fashioned as the threshing. When all this has been done, the farmer, unless he has land which he can irrigate, and from which he can get a second crop, has no work for his bullocks during the five or six months of the dry season ; they are, consequently, employed in conveying produce to market, and the farmer or cultivator, leaving his land to take care of itself (which it does by producing a plentiful crop of coarse grass and weeds) attaches his bullocks to a light cart or bandy, and becomes a common carrier, being satisfied, of course, with very small profits, as every penny which he receives, in addition to the amount required to maintain his bullocks, is clear gain.

POPULATION.

The population of the Madras Presidency may be put at 24,500,000, of which about 16,800,000 are employed in agriculture. About 450,000 are congregated in Madras and its suburbs. There are, however, few large towns, though in each district there are three or four towns, about which the population congregates more densely than in the rural districts.

As a general rule, the population is more generally diffused over the face of the country than is the case in England,

where the agricultural portion of the community forms a much smaller portion of the whole than is the case in India.

WAGES.

A necessary result of this dissemination of the people, and of their employment in the rude processes of agriculture, is that wages are low every where. The capital expended by the different Companies upon Railways and irrigation works, has, by increasing the demand for labor, raised, *locally*, the rate of wages; but, even now, in parts of the country a little distant from the lines of Railway from $2\frac{1}{2}$ Rupees to 4 Rupees per month or from $2\frac{1}{2}$ d. to 3d. per day, may be considered as the ordinary and average rate of wages; while, generally speaking, the whole of the agricultural labour is paid for in kind. The hire of a pair of bullocks and a man to drive them, and to plough at the same time, is 5 annas or $7\frac{1}{2}$ d. per day.

ROADS.

Though men and cattle may be hired at a very low rate, as shown above, yet the cost of transporting commodities must depend very much upon the character of the road over which the traffic is to pass. The main lines of road throughout the Presidency are, generally speaking, in a fair state of repair, much money having been spent upon them. The principal obstacles to ready communications are the nullahs and water-courses, many of which are not bridged; during the rainy season these are torrents altogether impassable; while in the dry season, the river beds are filled with a loose drifting sand, across which the ordinary carts or bandies, carrying about half a ton, require to be assisted by many men. The cross roads are in pretty good order, for the character of the traffic which passes along them, indeed, during the dry season, roads though deep in dust, do not oppose any great obstacle to the movement of goods or produce. A great proportion of the work of transport is accordingly done in that season; the cost of conveyance being about $2\frac{1}{2}$ annas or 3d. per ton per mile.

During the rainy season the cost of conveyance is much enhanced : in the first place, the roads are soft and damaged by the rain ; the bridges are carried away by floods, culverts blown up, &c. The actual labour and risk of conveyance is therefore much greater. In the second place, the rainy season being the working period of the agriculturists the whole of the animal power of the ryot is expended upon his cultivation, and he cannot spare any to be employed upon road traffic, and there is, therefore, less competition. To set against this, however, there is less traffic at that time of year, and I am disposed to consider the figures above given as the cost of conveyance, and which were taken from a return furnished by the Commissary General, of the contract price for Government transport, to be a fair average for the whole year.

RAILROADS.

Of these, the Madras, or South Western line is completed from coast to coast, a distance of 406 miles. The North Western, which is eventually to communicate with Bombay, is open for a distance of 41 miles from its junction with the Madras line. The Great Southern of India line is finished from Nogaipatam to Trichinopoly, a distance of about 80 miles, but it has yet to be connected with the Madras line by an extension of about 80 miles, which will meet the South West line at a point about 250 miles from Madras. A branch from the Madras line, about 80 miles in length : leads to the Military station of Bangalore : this is just completed. When the whole of these lines are finished there will be a complete chain of Railway communication connecting the principal Military stations in this Presidency, with the great depôt at Madras ; and this latter will communicate directly with Bombay.

CANALS.

Of these there are but few. The Irrigation channels in the deltas of the Kistnah and Godavary are used with great advantage for local traffic ; and there is a coast canal, con-

meeting the backwaters of some of the rivers to the north and south of Madras; while the Irrigation Company has on hand a project for completing a line of water communication between Kurnool, on the 'Toombukdra, and the sea on the East Coast.

As a general rule, however, the country is altogether unfitted for this kind of communication, owing to the difficulty of securing, either at or below the summit levels, a sufficient supply of water to furnish the lockage, and to meet the very large demand on account of evaporation.

I have given this short sketch of the Madras Presidency, and of the existing means of communication, in order to facilitate the comparison which it will be necessary to make between the result of the Railway system here and elsewhere.

In the earlier sections of this paper, I have laid great stress upon the indirect benefits arising out of the Railway system; which, both in England and Australia, afford a full compensation to the country at large for the capital sunk in the Railway. The holders of Railway shares are losers, of course, to the extent of the difference between the dividend paid, and the ordinary interest upon the capital invested; but every man who travels by rail, and every man who has goods to send to market, saves a very large percentage of the amount he would have had to pay, had his means of communication been limited to turnpike roads.

In India, however, so far as the conveyance of goods is concerned, the *indirect* benefit is by no means so great as that which is enjoyed by English or Australian merchants. Here the cost of moving goods is about 24*d.* per ton per mile on the road, while on the rail it may be put at 1½*d.*; that is, the cost per rail is to that per road as 2 to 5, while in New South Wales it is as 1 to 4, and in England 1 to 5.

The benefit to travellers in India is very great; the facilities afforded by the Railway have made thousands travel, who in former times never dreamed of moving from their homes.

Still, however, the poverty of the people, the very low wages which they receive, taken in connection with the fact that a very large proportion of such wages is paid in kind, would seem to point to the conclusion that years must elapse before any very great extension of passenger traffic will take place, except in the vicinity of large towns. At the present low fare of $\frac{3}{4}$ of a penny per mile for 3rd class passengers, the Madras Cooly would only be able to travel $9\frac{1}{3}$ miles for his daily wages; while an English labourer would earn enough in one day to carry him 30 miles. A reduction in the Madras rates would, I have no doubt, increase the number of passengers; but it is very questionable whether it would increase the net receipts. If, indeed, the cost of working the Railway in India bore the same ratio to the cost of working in England, as the rate of wages in India does to that in England, the lowness of the Madras rate would not have much influence on its net receipts; but in India the cost of freight has to be added to that of the Coal or Coke used; the wages of skilled labour, as Engine Drivers, &c., are higher than in England; and though the ordinary labour employed about the stations, and on the maintenance of way, is cheaper than in England, it is not cheaper in proportion to the difference of wages, for one Englishman will probably do the work of at least three Natives. On the whole, it will, I think, hardly admit of a doubt that the amount of traffic required to pay the interest of the capital expended upon the construction of the Railway, as well as to defray the costs and charges of maintenance of way, and of locomotive power, must be far greater in India than in England and elsewhere.

Now the interest of capital is one of the heaviest charges against the proceeds of Railway traffic, as has been shown in the earlier sections of this paper; and when the traffic is comparatively light, and not likely to increase to any great extent, it may be more to the advantage of the Government, and of the country generally, that a description of road should be

constructed which, involving a smaller outlay of capital, but requiring a somewhat more costly description of locomotive power, would, at its charge little, if at all, in excess of that of the Railway, furnish a return sufficient to keep the road in thorough repair, pay the interest of the capital expended upon its construction, and provide an amount of tractive power fully adequate to the wants of the people, though the time expended would, of course, be very much in excess of that required by the locomotive line.

I propose, then, in the remainder of this section, to investigate carefully the relation between the outlay and the returns upon various kinds of roads in the Presidency of Madras; namely, the Railway, worked by locomotive engines; the Railway worked by animal power; and the macadamized road. The first step towards this comparison must be the determination of the amount of passenger and goods traffic which is to be taken as a standard quantity, and in order to simplify the calculations, and, indeed, to substitute matter of fact, for matter of inference, I propose to take the amount of traffic upon some given line, or portion of a line of existing Railway, as this standard.

The Madras or South West line of Railway, extending from Madras to Beypore, a distance of 406 miles, partakes too much of the character of a great Trunk line to justify the adoption of the whole, or of any portion of it, as a standard of comparison, whether as to outlay, or as to the amount of traffic; but the North West line, or the portion of it already completed, viz., 41 miles, may be fairly looked upon, at present, in the light of a branch; and an enquiry into the cost of moving the passengers and goods, stated to have passed over this line, by some more simple system of conveyance, will afford satisfactory data as to the relative advantages of Railways or other roads.

I may observe that the Madras Railway, though it only paid, during the first half of 1863, interest to the amount of

·66 per cent. or 13s. 7d. per hundred pounds of capital expended upon *the whole line*, did, I have no doubt, pay the full interest of five per cent. upon the cost of the 40 or 50 miles nearest to Madras; but it would be difficult, if not impossible, to attempt to deal with the line in sections, and to attribute to each its fair share of expenditure and receipts. It is only necessary to say that, with an amount of traffic equal to 595,000 passengers, and 96,000 tons of goods in the half year, the amount of interest was only, as stated above, ·66 per cent. for the half year, so that 1,200,000 passengers and about 200,000 tons of goods would only pay the cost of traction, of maintenance of way, and $1\frac{1}{2}$ per cent. upon the outlay of capital.

The following is an abstract of the nature and amount of the traffic on the North West line, for the half year ending 30th June 1868; and the numbers given will, when doubled, from the standard amount of traffic upon which the calculation of the cost of conveyance on the different kinds of roads will be based; the actual cost of the working of the Railway being taken.

Passengers.

1st Class.....	194	$\times 2 =$	388
2d Do.	1,411	$=$	2,822
3d Do.	75,999	$=$	151,998

Goods.

Tons.....	15,711	$\times 2 =$	31,422

The first and second class of passengers will be merged into one of say 3,220. The 2nd class of passengers will consist of 152,000, and the goods will be taken as 32,000 tons. I will now proceed to enter upon a detailed examination of the cost of construction, of maintenance of way, and of locomotive power upon the macadamized road, upon the Railway, for animal power, and upon the Railway for locomotive power, with reference to the above amount of traffic.

1st. MACADAMIZED ROAD.

CONSTRUCTION.

The data as to the cost of constructing such a road as this have been furnished by the Public Works Department, and the amount given below may be considered a fair average of the cost of such roads throughout the principal parts of the Presidency.

Width of road.....	30 feet.
Width of metalling.....	24 „
	£ s. d.
Cost of earthwork... ..	168 14 0
Do. of metalling.....	163 16 0
Bridges and Culverts.....	302 14 0
Sundries	40 0 0
	£673 4 0

If an addition be made to this sum for the cost of superintendence, &c., bringing it up to £750 per mile run, this will be an ample allowance for any contingency.

2nd. RAILWAY FOR HORSE POWER.

CONSTRUCTION.

The cost of the earthwork, and of the bridges and culverts, would be rather less on the railroad than on the macadamized road; for, while it is not intended to modify the gradients in any way, or to add to the cuttings and embankments, except on very special occasions, the width of the road may be less. I do not, however, propose to make any deductions on this account, but shall assume the cost of the earthwork and bridges and ballasting, at the same sum as given for the macadamized road, viz., £750 per mile; setting the metalling against the ballast of the Railway. The cost, therefore, of the railroad will be found by adding to the cost of the macadamized road, that of the purchase of rails, chairs, and sleepers, and that of the labour of fixing them.

In the second section of this paper, I have assumed that a rail of 35 to the yard would be required; this was the weight of the rail used at first on the Manchester and Liverpool line; but it seems to me that, for horse traction, a rail of 28 lbs. to the yard would be amply strong enough; and as 2000 yards, or an addition of 240 yards to the mile, will be sufficient to cover all sidings, &c., $2 \times 28 \times 2,000 = 112,000$ lbs., or 50 tons per mile, will be the weight of the rails. These can be delivered at Madras at £8-10-0 per ton, and an additional 30 shillings per ton, making a total of £10 per ton, will cover the charge for conveyance, so that £500 will be the cost per mile of the rails delivered upon the road. Timber sleepers have been found to decay rapidly in this climate; I should therefore lay much greater stress than I have done in the description of Australian Railways, and upon the employment of stone blocks as supports for the rail: in many parts of this Presidency, when the gneiss crops out on the surface, the stone block would be far cheaper in first cost, and far more durable than any other description of sleeper; but, as these may not be attainable generally, I propose to allow for the use of the iron pot sleepers, which have been employed on the Railway. For the horse traction line these may be made lighter than for the locomotive line, but I propose to allow for the same weight and price, that is £1 per pair of sleepers with the connecting tie rod. I shall allow, however, for a bearing of five, instead of four feet: the cost, under these conditions, of chairs and sleepers will be £1,200 per mile.

The cost of laying the railway may be put as on the locomotive line, at $4\frac{1}{2}$ per yard run, the cost for 2,000 yards would therefore be £37-10-0.

In order to make the action of this railroad perfect, it should be provided with a line of Telegraph; and the cost of this, judging from the amount expended upon that on the Madras line of railroad will be £90 per mile.

The whole cost of this railroad for animal power per mile will be as follows :—

	£	s.	d.
Earthwork including Ballast or metal.	330	10	0
Bridges, Culverts, &c.....	302	10	0
Rails.....	500	0	0
Chairs and Sleepers.....	1,200	0	0
Fixing Rails.....	37	10	0
Telegraph.....	90	0	0
Stables and rest Houses.....	50	0	0
Sundries.....	40	0	0
Superintendence, &c.....	76	0	0
	<u>£2,627</u>	<u>0</u>	<u>0</u>

LOCOMOTIVE RAILWAY.

The cost of this may fairly be put at the same rate as that charged for Railways in New South Wales, namely, £12,000 per mile: this has been the cost of the South West line, and it will in this case, include the cost of the rolling stock required to work the amount of traffic taken as the standard. The comparison, therefore, between the capital expended per mile upon the different kinds of roads, and the annual charge on account of interest will be as follows:—

	Cost per mile.			Interest.		
	£	s.	d.	£	s.	d.
Macadamized road.....	750	0	0	37	10	0
Railroad for animal power.....	2,627	0	0	131	7	0
Railroad for steam power.....	12,000	0	0	600	0	0

The next matter for consideration will be the cost of maintenance of way, that is, the annual outlay required to maintain the road in a state of thorough repair.

This must, of course, so far as the macadamized road is concerned, depend upon the amount of traffic, while the quality of the materials employed will have some action upon the annual charge. A fair approximation, however, may be arrived at by a reference to the amount commonly allowed for maintenance upon the great trunk lines of road in this Presidency, and 300 Rupees, or £30 per mile, would be considered sufficient for a road upon which the standard amount of traffic is conveyed. The cost of repairs upon a road over which 1,872 vehicles pass per day, has, in an average of five years, amounted to £119-14-9.

In order to be on the safe side, therefore, I propose to allow £55 per mile for the maintenance of the macadamized line of road in thorough repair.

On the road for animal power, an allowance must be made for the wear and tear of rails and sleepers. The actual wear of the road itself will be very much less of course than that of the macadamized road: for the iron rail takes the action of the wheel; if, then, the rails and sleepers are renewed in twenty years, one-twentieth of the whole cost may be provided as an annual charge; and as this cost is £1,700, one-twentieth of that sum will be £85. One-half of the ordinary sum of £30 will be sufficient to cover the cost of other repairs; so that 85+15= £100 will cover the cost of the maintenance of the Railway for animal power.

The maintenance of way upon the Railway for steam power must necessarily include an allowance for the renewal of rails, chairs, &c., and by taking the duration of these at twenty years, as in the Railway for animal power, an advantage will be given to the locomotive line; as the action of the heavy engine, going at the rate of from 20 to 30 miles per hour, must wear away the rail much more rapidly than the

light and slow action of the animal power. Assuming, then, 5 per cent. to be the annual deterioration of the rail and sleepers, and the cost, as on the Madras line, to be £3000 per mile, the annual charge for renewal of rails and chairs will be £150.

The other items under the head of maintenance are grouped together in the returns, and the cost may be put on an average at about £100 per annum per mile, while the charge for superintendence may be put at £5. The cost of maintenance of way on the steam power line will therefore be as follows : —

	£	s.	d.
Renewal of Rails and Sleepers..... ..	150	0	0
Labour, Ballast, &c..	100	0	0
• Superintendence	5	0	0
	£225	0	0

The annual charge upon the three descriptions of road under the head of interest of capital, and maintenance of way, will be as shown in the accompanying table.

	Macadamized Road.			Railroad, animal power.			Railroad, steam power.		
	£	s.	d.	£	s.	d.	£	s.	d.
Interest..... ..	37	10	0	181	7	0	600	0	0
Maintenance..	55	0	0	100	0	0	255	0	0
Total....	92	10	0	281	7	0	855	0	0

Having thus arrived at the cost of constructing the different lines of road, as well as at that of maintaining them in a good state of repair; all that remains to be done is to determine the actual cost of traction upon each. To do this,

however, would involve the solution of a variety of very complicated questions. It will be far more simple, therefore, to show, for the ordinary roads and for the existing railroad, the actual charge for the conveyance of passengers and goods. In the case of the Railway, the returns show the actual charge for locomotive power under several different heads; while on the muledriven road, the contract price per passenger or per ton of goods includes not only the charge for power, but a variety of other items to which I shall allude hereafter.

With reference to the Railway for animal power, I propose to submit a detailed estimate, on a liberal scale, of the cost of working it, as, in this country, I cannot obtain any direct information to guide me.

The cost of conveying goods upon the ordinary roads has been shown to be 3½ per ton per mile. This sum includes the interest upon the first cost of the vehicle and the cattle; the maintenance in repair of the vehicle; the maintenance of the cattle, and the hire of the persons employed to drive them; it will also include a premium of insurance and upon the carriages and cattle, so that they may be replaced in case of destruction or death by accident or disease. It also includes or should include, some premium of insurance against the risk incurred as a carrier, and who is responsible for the goods under his charge. In addition to all these, it must include such a fair amount of profit as the Contractor has a right to expect, besides the simple interest on his capital.

The charge for conveying 1st class passengers may be put at 6d per mile. This is arrived at by taking the cost of conveyance, by the Transit Company, from Tripatore to Bangalore, a distance of 80 miles; the transit is capable of accommodating two persons inside, and a servant on the box by the driver. Each person may take 40 lbs. of baggage, and the total charge by the Company is 40 Rupees, or 80 Shillings, that is one Shilling per mile, or sixpence for each passenger.

A class of passengers analogous to the third class on the Railway is conveyed to and from places in the vicinity of Madras, at a reasonably rapid rate, in vehicles drawn by bullocks or ponies; each of these vehicles is capable of containing four people, and the rate of charge varies from $2\frac{1}{2}d.$ to $3d.$ per mile for the whole vehicle; taking the largest sum, the cost per mile for each passenger would be $\frac{3}{4}d.$; but it would be safer to estimate the average cost at $1d.$ per mile per passenger, and this may be taken as a fair charge for such work in any part of the Presidency; as the Madras prices are probably in excess of those of the country districts. The cost then of conveying 3,220 first class and 152,000 second class passengers and 32,000 tons of goods will be as follows:—

	£	s.	d.
3,220 at $6d.$ =	80	10	0
152,000 at 1 =	633	6	0
32,000 at $3\frac{1}{4}$ =	600	0	0
Total...	£1,313	16	0

The returns for the North West Railway, for the same amount of traffic, exhibit the expenditure under the various heads of classification, as shown in the following table:—

	£	s.	d.
Locomotive Department.....	1,906	5	$2\frac{1}{4}$
Fuel.....	3,054	12	0
Coaching.....	1,259	1	$0\frac{1}{4}$
Tickets.....	12	2	$4\frac{1}{2}$
Repair of vehicles.....	116	2	$5\frac{1}{4}$
Electric Telegraph.....	11	9	0
General charges.....	117	6	6
Total...	6,476	18	$6\frac{1}{4}$

This sum, divided by 41.25, the length of the line will give $157-0-3\frac{1}{4}$ as the cost of conveying the whole of this traffic over one mile of Railway. No attempt is made to distinguish the actual cost of conveying the different classes of passengers

or of goods; in fact any attempt of the kind would merely be a matter of guess work. The above may be taken as *facts*, which do not involve any calculation.

I have now, however, to form an estimate of the cost of conveying the same quantity of goods, and the same number of passengers, along a Railway by means of animal power.

The number of first class passengers has been put at 3,220, or, roughly, 10 per day, or 5 each way. To convey these, one first class carriage would be required, which would travel at the rate of 10 miles per hour. It would be drawn by two horses, and would be capable of accommodating 16 passengers. The distance of 41.25 miles would be divided into five stages, each pair of horses going a stage out and a stage back, or about 16 miles per day, a spare carriage would be required and a spare pair of horses.

The capital expended would be .

	£	£	s.	d.
3 Carriages. at 250	750	0	0	
12 Horses..... at 45	540	0	0	
10 Sets Harness. . . at 10	100	0	0	
Total	£1,390	0	0	

152,000 second class passengers divided by 365, will give 416 as the daily number conveyed both ways. It will, however, be necessary to reckon upon some extra pressure occasionally; and carriage accommodation must be provided for, say, 240 each way, or 480 altogether. Each carriage will contain 30 passengers, and will be drawn by two horses at the rate of about 6 miles per hour; travelling the same distance as the horses drawing the first class carriages.

The total number of carriages and horses required for the actual work will, therefore, be 16 carriages, and 80 horses; but it may be as well to estimate for 20 carriages and 100 horses.

The capital expended, then, upon rolling stock and animal power will be—

	£	£	s.	d.
20 Carriages..... at 250	5,000	0	0	
100 Horses..... . . . at 40	4,000	0	0	
16 Sets Harness.. . . at 10.	160	0	0	
Total...	£9,160	0	0	

32,000 tons of goods may be put at 100 tons per day, or 50 tons each way.

Three tons may be allowed for each truck, and 31, therefore, would be required; each would be drawn by three bullocks, 6 extra trucks might be allowed to meet casualties; and a few extra bullocks should be purchased. As the daily journey of a bullock may be put at ten miles, the distance of 41·25 would be divided into four stages; so that 12 bullocks would be required for each truck, $40 \times 12 = 480$ would be in daily use, or say 500 to cover contingencies.

The trucks ought not to cost more than £100 each, and the bullocks £15 the pair.

The capital, therefore, expended upon the rolling stock and animal power for the goods traffic will be

	£	s.	d.	£	s.	d.
40 Carriages at.....100	0	0		4,000	0	0
500 Bullocks at..... 7 10	0			3,250	0	0
Total...	7,250	0	0			

The total amount of dead and live stock required for the conveyance of passengers and goods along a Railway worked by animal power would be as follows;—

	£	s.	d.
1st class passengers... ..	1,300	0	0
2d class „	9,160	0	0
Goods	7,250	0	0
Total ...	£17,800	0	0
Say £18,000.			

The annual charge may be estimated as follows:—

	£	£	s.	d.
Interest upon £18,000 at 5 per cent.		900	0	0
Wear and tear of carriages and repairs, 15 per cent. on.....	9,750	1,462	10	0
Cost of re-placing horses and bullocks, 15 per cent. on.....	7,790	1,168	19	0
Repairs and re-placing harness, 20 per cent. on.....	260	52	0	0
Keep of 112 horses, at £24 each...		2,688	0	0
Keep of 500 bullocks, at £8 each...		4,000	0	0
Hire of 20 coachmen, at £50 each...		1,000	0	0
Hire of 166 bullock drivers, at £10 each.....		1,660	0	0
Repairs of stables, at 5 per cent. on 2,000		100	0	0
Telegraph, &c., charges as on locomotive line.....		11	9	0
General charges, including Clerks, &c., ...		442	11	0
Total.....		13,485	9	0

This sum, divided by the total distance 41·25 miles, will give the charge per mile for locomotive power £302·12·10, and the general comparison between the cost of conveying the standard number of passengers and tons of goods per mile of the three kinds of road will be as follows:

	Macadamized Road.			Railroad for animal power.			Railroad for steam power.		
	£	s.	d.	£	s.	d.	£	s.	d.
Interest.....	37	10	0	131	7	6	600	0	0
Maintenance.....	55	0	0	100	0	0	255	0	0
Cost of working....	1,318	16	0	302	12	10	157	0	3½
	1,406	6	0	534	6	4	1,012	0	3½

The above relation between the total charge upon each description of road approximates closely to that which was shown to exist in Australia under circumstances widely differing from those which obtain in India, though there is a marked difference in the items which make up this total. I have, in calculating the cost of *working the animal power* Railway, made allowances for a variety of extra expenses; and I feel confident that the sum shown in the above table will be ample to cover the whole cost of working the line, and of paying an interest of 5 per cent. upon the capital expended. Under these circumstances, it is evident that, until upon any given line of road the amount of traffic very far exceeds that which passed over the North West line of railroad in the first half of 1863, it will be far cheaper to employ animal power than steam in the movement of passengers and goods.

It remains to be seen what charge it will be necessary to impose upon the traffic, in order to cover the whole of the charges upon the road; namely, interest of capital, maintenance of way, and cost of transport. An analysis of the cost of conveying the different descriptions of traffic will show that the following is pretty nearly the ratio of the outlay upon each

First class passenger..... . 066

Second class do. 430

Goods..... . 504

and if the whole charge of £534 per mile be divided in these proportions between the different heads of traffic, the charge upon the first class passenger must be such as would return £35-4-10½, that upon the second class, such as would yield £229-12-4¾, and that upon goods such as would give £269-2-8¾. Now the charge of £35-4-10½ divided by the number of first class passengers, viz., 3,220, would give 2·6 pence as the charge per head per mile. In the same way, £229-12-4¾ divided by 152,000, the number of second class passengers, would give 1·38 farthings, as the exact charge per head per mile; while £269-2-8¾ divided by 32,000 would give 2·018 pence as

the charge per ton per mile. A first class passenger, however, might very fairly be charged at the rate of 3 pence per mile, and a second class at a half-penny, while the charge for goods might be put at $1\frac{1}{2}$ ¢ per ton per mile; at these rates, with the standard amount of traffic, the gross returns would be £556-18-1, or £22-18 in excess of the amount shown above to be sufficient to cover the interest of capital, maintenance of way, and cost of conveyance. Provision, however, has been made for the conveyance of upwards of 11,000 first class passengers, 110,000 second class, and 44,000 tons of goods without any extra charge; and should the traffic increase to this extent, the returns at the rates mentioned above would be,

	£	s.	d.
1st class passengers to	137	10	0
2nd " Do.	305	16	8
Goods	275	0	0
Total	£808	6	8

And the profit upon the capital expended, which, at the rate of £2,627 per mile of road for construction, and $£18,000 \div 11.25$ or £136 for live and dead stock, would amount to £3,063, would not be less than 13 per cent.

The true conclusion to be drawn from what has been stated is, that with an amount of traffic larger than that which is likely to pass over most of the leaders of the Railways now in progress, a Railway worked by animal power would be a much cheaper mode of communication than either a macadamized road, or a Railway worked by steam power.

If, however, this would be the case when the traffic is already heavy upon the line of road, the advantages of animal power over steam would be still more marked when the traffic is comparatively light, and requires to be developed gradually. A Railway worked by steam must be provided with engines of power sufficient to drag the largest train over the steepest gradient on the line; and though the consumption of fuel is,

to a certain extent, proportioned to the load the engine has to convey, yet, as this load is in very great measure composed of the dead or unprofitable weight of engines and carriages, the saving of fuel is not very great; while the other items which make up the working expenses, are in great measure independent of the load, and form a mileage charge.

With a Railway worked by animal power the case is different; here the power required is strictly in proportion to the load; no more horses or bullocks are kept than will be sufficient to meet the demands of the public for conveyance; and if these demands are casual or intermittent, arrangements can easily be made to meet the casual portion of the demand without the expenditure of capital, or the imposition of a permanent charge upon the promoters of the line of Railway. Again, the power of a locomotive engine must be proportioned to the maximum effort it has to make; that is, it must be competent to overcome the steepest gradient in the line with a full train behind it; it must, therefore, have an amount of power more than sufficient to do the work of the more level portions of the line; in fact, it is necessary to have an engine of 100 horse power, which it might have to exert for a mile or two; while an engine of 50 horse power would be amply sufficient to do the remainder of the work.

This is not the case with a Railway worked by animal power; if there be a hill too steep to be surmounted by a carriage drawn by the ordinary team of horses or bullocks, the simple plan is to have a spare pair at the bottom to help the carriages over the hill. This, however, will seldom be necessary with horse teams; for a horse has a reserve of muscular energy, which enables him to exercise, for a short time, a much greater amount of power than is wanted for his ordinary work.

It is not, of course, probable, that the ratio between the passengers and goods traffic, which I have assumed as the standard for calculation, will obtain upon ordinary branch

lines. The passenger-traffic will be less than the standard, while the goods-traffic will exceed it; looking, however, to this fact that I have estimated the cost of the rolling stock and the animal power, at a high figure, and have been very easy in my demands upon the animal power, it is more than probable that, when worked by a Company or an individual, the charge of $1\frac{1}{2}\%$ per ton per mile will be found sufficient to cover all expenses, and to give an interest upon the capital expended of at least 5 per cent.

I think, then, that I am justified in applying to by far the larger number of branches from the main lines of Railway in India; the following conclusions which are very nearly identical with those which are expressed, in the second section of this paper, with reference to Australian Railways.

1st. That the cost of transport upon a macadamized road is hugely in excess of that upon a railroad, whether such railroad be worked by animal or steam power.

2nd. That the actual cost of steam power is much less than that of animal power upon railroads, but that this cheapness is, with a limited amount of traffic, more than compensated for by the increased cost of construction and maintenance of the railroad worked by steam.

3rd. That the circumstances of the country are not such as to admit of so large a development of traffic upon the branch lines of railroad as would compensate, by the saving in the cost of motive power, for the increased charge under the heads of interest of capital, and maintenance of way, consequent upon the adaptation of the road for steam power.

4th. That, as a general rule, it would be far cheaper, and, therefore, more advantageous in every respect, to construct the branch lines of Railway with a view to their being worked by animal power.

W. T. DENISON

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1840

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1860.

“TIMES” City Article, 20th July, 1869.

“It appears from the financial speech of the Secretary of State for India that it is contemplated during the next ten or twenty years to construct 7,000 additional miles of railway in that country, being nearly double the amount thus far completed. Supposing the outlay to be at the same rate as hitherto, the cost will be £126,000,000, and even if, as seems to be hoped, a reduction of one-third can be achieved by the work being carried on by the Government, instead of through the agency of companies, the minimum required will still be £84,000,000. Taking 15 years as the average of time over which the outlay is to be spread, it will thus be necessary to raise about either six or eight millions a year throughout the whole period. The Indian Government calculate that because they can now get money at 1 per cent. they may hope to effect the whole operation at that rate, and thus avoid the necessity of guaranteeing 5 per cent. to public companies. In the City of London, however, there will be little response to this sanguine anticipation.”

INDIAN RAILWAYS.

To the Editor of “Engineering.”

SIR,—An article in the number for this month of the *Westminster Review*, on “Indian Railway Reform,” appears to require notice, as the writer affects to have access to special sources of information, writes as if in the confidence of the high authorities of the Indian Office, and yet evinces so many prejudices and gives expression to so many misapprehensions, that his statements and conclusions are calculated to cause a misunderstanding of the very important subject which he treats.

His doctrine on the land question, as conveyed in a repetition which he now publishes of an article which he wrote ten years ago, “that the land of every nation belongs to the people as a whole, that Government as their representative is the supreme landlord, and that it cannot alienate in perpetuity any part of its trust to individuals,” would be impossible of application in Europe without a revolution, and shows how much disposed he (the reviewer) is to radical measures.

With this disposition he at present proposes to dispense with the existing railway organisation in India, but he scarcely even sketches in outline the arrangement which he would substitute for the system which he proposes to abolish.

After expressing his opinion on the intellect of the late Marquis of Dalhousie, and that the men "brought up in his lordship's school" have been influenced by his lordship's views, the reviewer takes safer ground, and notes that the 4,000 miles of lines now open in India are a poor result after so many years.

It does not require much argument to show that railways should have been much more extended in India, and that one mile for each 275 miles of territory in a country without any other roads is inadequate for the requirements of traffic and communication. Without suggesting a comparison between the active commerce in England and the comparatively inert traffic in India, it may be useful to note that in England, already covered by a network of roads and canals, that one mile of railway for every six miles of country has already been provided at a cost per mile even exceeding the Indian rate for the trunk lines, whilst India, without roads or canals, has only one mile of railway for every 275 square miles of country.

It is happily now not necessary to argue the question, as there is a general concurrence with the urgency of the need for further extension of railways in India, and in the certainty that lines of railway, constructed with due economy, should be as advantageous and profitable to the State as such lines would certainly be to the inhabitants of the country.

The failure in the past, shown by the fact that there are now only 4,000 miles open in the vast extent of the Indian empire, has to be deplored; but the reviewer's extraordinary assumption that the blame cannot rest with any member of the Government services to which he appears to belong, and must attach, of course, to the gentlemen whom he politely terms "adventurers," meaning not the directors of the late East Indian Company, in whose employment he was, but the present railway directors, has to be noted.

It is, however, clear that the railway companies could not, under the existing system, have proceeded with a greater extent of railways than the State authorised, and it must be admitted that one-fourth of the extent of railways required has not yet been sanctioned. It can be shown that some of the railway companies have time after time represented to Government the advisableness of proceeding with inexpensive extensions, but that Government has not even yet authorised the commencement of the works, so that the greatest failure in Indian railway operations, utterly inadequate extent of lines

so far constructed, rests not with the companies but with Government.

For the secondary failure, that the cost of the works executed has been frequently excessive, the companies must take their share of blame; but the reviewer has gone too far in assuming that they are solely responsible for all defects of management, as under the several contracts Government had the most absolute control over expenditure, and has throughout maintained a staff of officers who have audited and authorised every item of expenditure, and every arrangement for works, and have passed and sanctioned every one of the designs and specifications, which, on further experience, have been found to be defective as well as those which have been proved to be sufficient.

The present writer has, in a memorandum written within this month, submitted that the main cause of the excess of outlay on Indian railways has been that the works were often commenced and carried out on incomplete and insufficient surveys, on which suitable designs and correct estimates could not have been framed.

That there has been waste and extravagance approaching to the waste and extravagance on English lines is certain, but it does not follow that the excesses have approached to the amounts which the *Westminster Reviewer* of this month assumes. The original estimates for the whole system are no guide in the matter, an even if the estimates from the preliminary surveys had been trustworthy, many works which were not in the first place thought of, have since, with the full concurrence of Government, been carried out by the railway companies. Towns have been built for the accommodation of European mechanics, extensive workshops have been constructed, and all the great rivers of the continent have been bridged. The most costly portions of the main trunk lines have been constructed, and the extensions on the central plains, every mile of which would have counted towards a reduction of the general average, have been in many cases omitted, and yet the reviewer quotes as the proper limit for outlay the estimates (guesses) at a mileage rate, which were made before the requirement of a railway in the tropics, or the magnitude of the traffic to be accommodated were duly appreciated.

The reviewer, however, passing over any such considerations, speaks of Lord Dalhousie's estimates of the cost per mile for a whole system, and says that it would "be edifying to compare with the estimates actual realisations." Either

- the reviewer knows nothing of what has been done or else he argues with extreme unfairness.

Whilst enlarging on losses to Government from the cost of the Indian railways, the writer in the *Westminster Review* omits to note the large indirect profits which the State has derived from their construction. The free carriage of the mails, the increase in the land revenue to Government on the districts opened to the outer world by the railways, the saving by the transport of troops and military stores, and the reduction of garrisons rendered safe by the direct communication afforded by the railways already built, appear to be trifles in the estimation of the reviewer, but are, notwithstanding, of such magnitude, as in the belief of many to more than counterbalance the whole of the present extra payments by the State on the guaranteed account.

The reviewer, however, treats the whole question on the narrow grounds of the advantage of obtaining the possible profits from a possible or impossible hard bargain, but does not show that when the railways were commenced and carried on before and during the mutiny that the necessary funds could have been obtained on any less liberal system than was adopted by Government.

The reviewer says that it would ill become him to speak of the late Board of Directors otherwise than with the "respect which he sincerely feels for their august memory;" but still he labours to show that "they were persuaded to egregiously stultify themselves;" and, to make out his case, he passes over the fact that, although the guarantee was to be extended to the whole outlay, that the fullest control over the outlay was retained by Government, which took upon itself to decide upon the course for each line, as well as on the fitness of the designs for adoption.

After attributing the faults—some well founded and some exaggerated—to the railway companies solely, the reviewer proposes, as a remedy, to hand over to the direct management of the Government the construction of the railways yet to be built. The works to be carried out by the Indian Public Works Department, of which the reviewer says that "its warmest partisans will scarcely say that the result of its management has been altogether satisfactory," and that "it must be admitted to be singularly slow in bringing its products to maturity;" "children who were looking on when the Grand Trunk road was begun had full time allowed them for growing into middle-aged men before it was finished;" and "if in railway affairs Government action must needs be

marked by similar procrastinations, it were better perhaps that the guaranteed company should be continued in tranquil possession of the field."

The reviewer further describes the Public Works Department up to this time as utterly unable to accomplish the important works which it has in hand, but he proposes to hand over to it a vast amount of additional work of a description of which its members have had no experience, and which in any other country it would be considered a folly to entrust to any other than the railway construction branch of the engineering profession.

In elaborating a case against the companies, the reviewer passes over the fact that the works heretofore have been under Government control, and notes that the boards sitting in London can know little of what their servants are doing in India, and states that a local government would more readily find out defects. The results in the Railway and Public Works Departments, however, on more full information and consideration, will be found to show that the members of the local governments can no more than distant boards of directors, prevent the waste of money on defective designs, and on bad workmanship, without the assistance of a fit organization for the purpose.

Members of ephemeral local governments, Civil Service judges, promoted from the mofussil courts, or eminent revenue officers, who take little in life to engineering, are scarcely likely to do much good by personal inspection of works, and it would appear that the boards and Government had better, instead of counting upon personal inspections, adopt a system by which they may secure professional advice or direction for the engineering operations on which they purpose spending the money of the State.

For the past, matters will not be made better by any endeavour to show that failures have been caused by the non-performance by distant boards of duties which they could never have been expected to perform, which non-professionals, if even on the ground, could at best only perform imperfectly, but which it is now proposed that the members of the local governments should undertake.

If such work could have been performed by the members of the local governments who were resident near to the railway works in India, they would have much to answer for, in that they did not exercise their power, power which it will not be possible under any system to increase.

Instead, however, of condemning railway boards and

members of Government for the faults of the old system, it would be better to consider the amendments which may be made to guard against future failures.

To a Government about to expend 30 millions sterling on Indian railways the question is one of grave importance, and deserves to be treated otherwise than with a view to the petty interests or jealousies of any service coveted or otherwise.

Government has at command the highest professional ability and character which England can afford, and will find economy in obtaining such services rather than in experimenting with untrained establishments.

For the direction of Indian operations on the scale now contemplated there appears to be room for, and a want of, an additional power, which need not interfere with existing establishments, but which would control, advise, and direct the several departments.

Such an authority, a board of engineers, intrusted with full powers by Government, would be able to advise Government authoritatively on every engineering question, to insure the completion of surveys, to reject crude or incomplete designs or defective estimates, to sanction or to reject proposals for constructing operations, to examine the organisations on each line, and to notice for Government and for the home boards, the neglects, inefficiencies, or the merits of the officials in charge of, and responsible for, operations on the several lines.

Such a board would be looked to by the chief engineers, and by the Government consulting engineers on the several lines, for advice in any difficulties, and for an immediate and authoritative decision of questions on which rooms of foolscap are now every month consumed in an endless and often resultless correspondence—questions which must now often puzzle the unprofessional members of the local governments, or else be decided on in the name of government by a secretary, who may have many eminent qualities without being a safe guide or authority on professional matters.

Such a board might have charge of and be responsible to government for the construction of the State railways, and would afford to Government and the companies an additional security against a recurrence of mistakes by errors in designs and neglects in executions, such as have too often, to whomsoever due, to be deplored in the past history of Indian public works.

It has to be remembered, as regards State railways, some of which being for military purposes only, may have to be built without the intervention of companies, that hence, as

well as Indian management, has to be provided for. Whatever may be the shortcomings heretofore attributed to home boards, it is beyond dispute that they have bought, inspected and shipped to India, vast quantities of necessary materials of the best description, and at rates of cost which testify to the high character and business qualities of the gentlemen whose services the guarantee system enabled Government to obtain.

The great proportion of the whole outlay, which has been for these purposes judiciously expended in England, appears to have escaped the notice of the *Westminster Reviewer*, as he speaks of a rate per mile on the original estimates, but does not notice the extent of double line already laid with costly permanent way, and the large amount of sidings which on every Indian railway has been found necessary for a traffic of a magnitude which was unexpected, is still growing, and will continue to grow until the great Indian railways, notwithstanding past extravagances, become not only profitable to their shareholders beyond the guarantee, but a source of large direct revenue to the State.

* For such results the time will come when the workers on and for Indian railways—the directors who in England have, without reward, given their time and thought, and the workers under them in India—will be deemed to deserve other treatment than the *Westminster Reviewer* would accord to them. “Adventurers,” and the “servants of adventurers,” is a description of the British gentlemen who have been engaged on the Indian railways unworthy even of the anonymous reviewer.

The railway services, heretofore, as a rule, slighted by Government, denied any share of the honour which the State confers on all other of its services, working without hope of rank or pension, have yet furnished as much honest zeal, high intelligence, and, sad to say, have already filled as many British graves in Indian jungles as any service, during the time employed by the State in the subjugation or improvement of the great Indian Empire.

As one of the measures advisable for the safe and economical management of the great system of Indian railways, there are, happily, grounds for the hope, with the expressions of which this somewhat hastily written paper will conclude, that the whole question of railway administration in India, will now be considered by British Statesmen with the broad liberality of view which has, heretofore, in all other departments, insured the adoption of measures which have rendered

the British government of India the most just, the most generous, and the most successful in the world.

Yours, &c.,
FRANCIS MATTHEW.

Charing Cross Hotel, London,
July 7, 1869.

INDIAN RAILWAYS.

To the Editor of the "Standard."

SIR,— In view of an approaching parliamentary discussion, will you allow me space in your columns to refer to a matter connected with our railways in India, which is attracting considerable attention, and which has been commented on very freely by the Indian press? I allude to the proposal that the government should make the railways by its own direct agency, and thus do away with the intervention of companies or contractors.

This proposal, which at first assumed only the shape of a rumour, has recently received strong confirmation; and it is to call the attention of the public to the gigantic blunder which the government appears bent upon committing, that I have trespassed on your space. That so retrograde a policy should have commended itself to the serious consideration of a Liberal government, whose very name is supposed to be synonymous with progress, cannot easily be accounted for, except on the ground of an imperfect acquaintance with the subject, and a too ready acquiescence in the narrow-minded views put forward by a happily select few, who have devoted their time and talents to the solution of the problem, "How not to do it."

The little interest which Indian affairs excite in this country has already been too long a matter of notoriety. Gradually, however, the system of guaranteed railways has called into existence in England a large and enlightened public body, who, as shareholders in these undertakings, have of late years learnt to feel a direct and personal interest in the welfare of our Eastern dominions. It would be in the highest degree unwise of the government to step in and interpose a check on a system which has acted so well in the past, and which promises in the future to bind together the interests of England

* This letter also appeared in the "Morning Herald."

and India in a manner so strongly conducive to the well-being of both countries.

When the great pro-consul Lord Dalhousie, as Governor-General, sent home a comprehensive and carefully considered scheme for supplying India with railways, he recommended that they should be allotted to and undertaken by separate companies. Although it had, even at that time, been proposed to construct railways through the agency of government, Lord Dalhousie was most strongly opposed to such a course. He properly regarded the introduction of railways into India as partly a commercial enterprise, and as such he fully realised the fact that these undertakings were better placed in the hands of English capitalists. He foresaw that by this means the extensive introduction of British capital would be ensured to India, as well as a large addition to the European population, hitherto almost exclusively restricted to the officials connected with the government services.

Lord Dalhousie's views, which were ultimately adopted, led to agreements being entered into, during the year 1853, with certain companies for the construction of railways under the guarantee of the government; and the result shows that at the close of 1868, by the aid of British capital and British enterprise, about 4,000 miles of line had been completed, at a cost nearly approaching £80,000,000. What railways India would now have possessed, had their construction been undertaken by government, it is more easy to conjecture than to define.

It is, of course, contended that circumstances have altered so greatly since railways were initiated that the time has arrived for the inauguration of a new system; that the system that now obtains confers upon contractors large profits, which might be saved by the State; and that the government have gained the experience necessary to enable them to carry out the work. This may be accepted theoretically, but, practically, he that believes in it must be of a confident nature indeed. One is apt, in this matter-of-fact age, to look to the past as an earnest of the future, and I should be only too glad if the government would show us either roads, canals, irrigation works, or harbour improvements efficiently or promptly carried out, as a test of their capabilities for constructing railways.

A recent writer, advocating the new system, naively remarks (after promising that the government can command all the necessary resources of money, knowledge, and skill), "all that is required is a well-organised system of administration,

so as to procure the proper application of all resources to the great object in view." Exactly, Sir Oracle, and this, I contend, is precisely what the government cannot show they possess. Judging from what has been done, a child born but yesterday may reach his manhood, and see his hair silvered by time, ere he beholds a locomotive run over two hundred miles of a railway made through the "direct agency" of government.

The State has, as most of your readers interested in this subject are doubtless aware, undertaken the construction of one railway—that from Lahore towards Peshawar—and already it is shown that the course of government railways does not promise to run smooth. It would appear that the authorities have hit upon the device of utilising as far as possible what is designated with more pomp than accuracy the "Grand Trunk Road" by widening the embankment for the reception of the rails. The amount of saving, if any, which is doubtful, would be but small, whilst the danger would be very great of laying the rails upon the old road, which is exposed to serious injury from floods. The road which, notwithstanding the twenty years or more which the government have spent on its construction, is entirely destitute of bridges, is, moreover, exceedingly ill adapted for a railway, the gradients being very unfavourable. Yet, whilst this is under consideration, a large staff of engineers are, perforce, kept in comparative idleness, and that at an enormous expense. The *Friend of India*, writing on the subject, expresses a belief that it would be more economical to adopt the route most approved by the engineer (Mr. Leo Smith), but adds, that "if railway and road must be near each other it will be cheaper to move the road to the railway than the railway to the road," otherwise it appears that the result will be a defective railway and a bad road.

That the most disastrous delay will occur should the government resolve to undertake the construction of the new lines (estimated to cost within the next thirty years no less a sum than £100,000,000) does not admit of a moment's doubt; and what does this delay entail? It is admitted that the railways already made in India have developed to an extent unthought of the resources of the country, that they have strengthened its military position, and improved the social and moral condition of its inhabitants. It is a fact, that year by year the returns of traffic show a vast and steady increase—an increase that has been fostered by the energy and promptitude with which railway works have been prosecuted, and an increase

that may reasonably be supposed to continue in the same ratio, provided future extensions are carried out with equal speed and certainty. And how do the government propose to aid this most desirable work? The outlay on the Indian railways has, for the past nine years, averaged very nearly £7,000,000 per annum. Under the new system it is proposed to spend £3,000,000 per annum only, or not one-half; and this in the face of a crying want for increased facilities of transport, with a famine of bread destroying the very life of the empire, and with a famine of cotton paralyzing the industry and blighting the prosperity of the Lancashire operatives.

Generally, it may be received as a fact that any scheme for carrying out railway extension in India by the government, even if shown to be practicable, will inevitably lead to a delay that will retard the progress of trade, dwarf the usefulness of existing lines, and prevent in a great measure the introduction of British capital and enterprise into India.

Let the government look to their roads and irrigation improvements—they will have quite enough to do—and leave in the hands of those best competent to undertake them the vast works entailed in the development of a complete system of railway communication. The very organization in which the government is deficient can be commanded by any one of the railway companies, each of which has an efficient staff on the spot, and available at a moment's notice.

There is one line that we may reasonably suppose is not included in those proposed to be undertaken by government, viz., the Indus Valley line, to connect the Seinde and Panjab Railways, and supersede the antiquated notion of navigating such a river as the Indus by steamers.

It could scarcely enter into the imagination of even the wildest theorist to introduce a foreign element into the middle of one of the existing company's lines, and especially as the company concerned virtually hold a concession for the traffic on the entire through route from Kurrachoo to the East Indian Railway at Delhi.

It would be impossible within the limits of this letter to enter, in detail, on the many objections that exist to the government undertaking the construction of railways in India, and I will therefore reserve those for a future occasion. A few words more and I have done.

The importance of the cotton trade of India is becoming enormous. This trade has been estimated as worth £30,000,000 per annum if proper facilities were afforded for its development. India has already proved herself a most formidable

rival to America as regards her capabilities of producing cotton; and what the trade might ultimately become it is difficult to estimate. It is admitted in Lancashire that the quality of Indian cotton has greatly improved, and it continues to command a very high price notwithstanding that the war in America was brought to a close more than three years ago. Nevertheless, the government would appear to be lending their ears to the advice of unwise counsellors, the result of which can only be to delay indefinitely the completion of the network of railways so necessary for the development of the cotton trade, and to check the production of a staple that might bring work to thousands in this country, enhance the prosperity of the empire, and place the now silent looms of Lancashire and the far north once more in active operation.

My name may not be entirely unknown to you, and the stake I hold in this country, and the interest I cannot repress for all that concerns our Indian possessions, must be my excuse for the length of this communication.

I am, Sir,

Your very obedient servant,

JOHN SMITH.

London, July 16.

"TIMES," 27th July, 1869.

The following relates to Indian Railway finance:

"London, July 26.

"Sir,—I think that most people who have had much to do with Indian finance and Indian loans will agree readily with what is said in your city article of to-day, and think that the Duke of Argyll may be 'going ahead' somewhat too fast in his idea that he can raise at 4 per cent. all the money he wants to make 7,000 miles of new railways in India, and that he can have 1 per cent. as compared with the former plan of the railway companies borrowing at 5 per cent. under guarantee. I presume that when he looks to borrowing at 4 per cent. he must mean to do so in London, for it was only the other day that when Sir Richard Temple brought out his 4 per cent. loan in Calcutta he did so at 90, or equal to nearly $4\frac{1}{2}$ per cent.; and though he might, perhaps, be able to borrow in India itself a moderate amount annually for reproductive works like railways, irrigation works, &c., I doubt if he could do it to any large extent under $4\frac{1}{2}$ per cent., if at that, and

though in London moderate amounts may have been raised at 1 per cent. by the plan of making dividends payable at the Bank of England, like dividends on Consols (numerous old Indians believing, in consequence, that East India Stock and Consols are much the same thing), it is to be doubted greatly if this can be done for such large amounts for a series of years, and with so many other claims on the 'national savings,' the reservoir from which so many different borrowers are supplied.

"I had the pleasure of hearing the Duke of Argyll's statement, and a pleasure it was, for his sketch of the progress of India since the mutiny was, on the whole, very favourable, and he speaks so well and clearly that you not only hear his words, but understand his thoughts. For good or for bad, the new system of government making the new railways is inaugurated, and properly managed, I believe with you, that it will prove for good; but many people will begin to ask how, 'If the India Office are to make 7,000 miles of railway, at a cost of at least 70 to 80 millions, what is the India Office composed of?' It is only to day that we read of the great saving effected by Mr. Baxter at the Admiralty, and the inefficient state until now of that great public department. Will not the Council of India stand now in more need than ever of having put on it some business men who know the India of to-day and its wants, instead of being limited, as at present, to military men and civilians, however able they may be?"

"A CALCUTTA MERCHANT."

INDIAN RAILWAYS.

To the Editor of the "Standard."

SIR, Having read with much interest a letter in your impression of the 20th July, on the subject of Indian railways, I venture, as one not altogether unqualified, to speak a word on the subject, to point out the dangers which appear to menace those already in existence, and to make the realisation of those not as yet commenced a matter of increasing uncertainty.

Happily, the importance of an extension of the Indian railway system needs no argument. The public mind has long ago recognised its necessity, and hitherto government alone has thrown obstacles in the way of progress; but it would appear that government now contemplates not only taking in hand those railroads which public enterprise and money have already nearly completed, but also, with a spirit more valorous than discreet, constructing those which are as yet

only projected. In the former case the shareholders, as an aggrieved and injured body, will, doubtless, make their disapprobation known; in the latter the projected lines will not only be "railroads of the future," but of a very dim and distant future indeed. In some eyes, however, this very distance will "lend enchantment to the view," for government likes a good perspective, and a wide margin is always an agreeable detail in official eyes.

It is a remarkable fact that whenever India or Indian affairs are mentioned in public it is with a sort of apology, a kind of timid deprecation, conscious of a scarcely courteous and scantily veiled impatience. "I have had the most valuable contributions from the ablest official and non-official men in India, sent to me for publication in my magazine," said an eminent publisher the other day, "but I could make no use of them; the English public generally is bored by India! the English people are utterly and profoundly ignorant and careless as to Indian politics, statistics, and enterprise." Strange, but true, "the brightest jewel" in England's crown, a jewel that many have looked at with envious eyes, is a matter of languid tolerance rather than of pride and glory to its possessors. And every one who has paid the slightest attention to the subject must have observed the shoulder-shrugging, dispensing even with the courteous grimace of patience, with which any mention of Indian affairs is greeted in "the House." Not a "jewel in the crown," but a thorn in the flesh; a grievance; an infliction; in the comprehensive slang of young England—"a bore." The sooner Indian affairs can be shunted the better; they stop the regular parliamentary train, shove them into a siding, and let them wait until the line is cleared. Many of your readers will know this is a true picture.

Now, Sir, in the old Londonhall Street days, there was one place at least where poor India, her hopes and prospects, her interests and sufferings, were not only tolerated, but discussed with an animation and interest worthy of the theme, by men recruited from all ranks of society. In the old "Company's" days there was a local habitation and a name for India; now it appears to be the wish of some to give India a name indeed (and a bad one) and then emphatically to do as the proverb does to the dog—"hang it."

As an "outsider" I cannot presume to lift, even in thought, the sacred veil, or penetrate the governmental gloom which now-a-days enshrouds everything connected with the official affairs of India; but this much I do not hesitate to say—that

if ever, like the spectre of the Commandatore in *Don Giovanni*, this ghost of the old India House presides unseen at those official orgies, where red tape, pigtails, buckram, formula, etiquette, *et hoc genus omne*, tie the arms and legs and stiffen the backs and necks of the presiding deities of those saturnalia, he must be a very philosophical ghost indeed if he do not groan in the spirit, and gnash his skeleton teeth at the blunders and bungling, the buckram and bondage, of which he is a silent but not uninterested spectator.

What is it but this which makes our government of India like the car of Juggernaut—ponderous, heavy, rolling slowly and dispassionately over thousands in its stolid, unseeing, unknowing, unheeding progress? Progress! Perhaps; but a progress so incommensurate with the requirements of an ardent age like ours, that the world, having got ahead a thousand miles or so, will scarcely pause to look round and see if this Indian tortoise has put its best foot foremost; nor will lamentations be very loud if that interesting animal be found “nowhere” in the race.

But if the lump of public leaven which, however small, still does to a certain degree leaven the whole lump; if the salt of public criticism and inquiry is to be summarily shut out of this matter; if the public is to be altogether excluded from a voice in Indian affairs; if the 60,000 shareholders who, under the present system, have a right to make themselves heard, are to be silenced once for all, then we may look for an exhibition of helplessness, obstinacy, bungling, incapacity, red tape, formula, and hopeless stupidity, such as the British nation, and the British nation only, “delights to honour;” then, shut up safely within their doors of cedar of Lebanon, the fossil members of the Indian Council may indulge in tea, toast, and twaddle to their hearts’ content, whilst the world gives them the go-by.

We had, sir, brilliant results during the Crimean war from a plethora of cooks and a multitude of counsellors; and there have been people found to declare that the flattering flavour of those notorious times still lingers on their palate.

Let us, for a moment only, try to imagine the delay, the hopeless confusion, the injury to trade, the lamentable waste of time which must inevitably accrue if here a bit of line belongs to a company and there a bit to government; if the official hand meddle here a little and modify there a little, with a sweet and benovolent unconsciousness of the ultimate evils likely to result from such mixings and moddings; if, here—

after, there be brawling and bitterness, here petty jealousy and there yet paltrier spite, we shall know that the whole machinery has been thrown out of gear, because some Utopian scheme has flashed across the genial (but impractical) brain of some well-meaning man in office, and we shall know whom we have to thank for a "pavement" of good intentions, resulting in a "confusion worse confounded."

I have seen nothing tangible in the shape of a proposal as to the organisation of the future. Every practical man will feel that an "amalgamation" of the two systems is an impossibility. Economy, sir, by all means, and I, as a proprietor, should be very glad if the profits of the contractors were less and that of the proprietors greater than they are; but I protest, in the name of common sense, against a piece of impotent patchwork. Let us have no hybrid management in the matter of Indian railway government. *Aut Cesar, aut nullus*. Only, if it be Cesar, let it be remembered we shall expect nothing less than heroic results!

With the characteristically ungrateful treatment of old gloves, a writer in the last number of the *Westminster Review* gracefully acknowledges the obligations of the country to those gentlemen who have honourably borne the heat and burden of the day, and who, with honesty, energy, and patience, have initiated, organised, and administered the Indian railways by stigmatising them as "adventurers;" and, lest there should be any misconception of his meaning, designates their subordinates "the servants of adventurers." This is a graceful tribute in classic language, and, no doubt, those "adventurers" and their "servants" will be grateful accordingly. It would appear as though the balance of justice in the writer's mind required for so many bullpences received so many kicks given.

With a rare and fanatical injustice the same writer wails out a rather plaintive lament over "the very little" that has been already accomplished in India. He must know (for there is an indefinable something which tells us that he has lifted the veil and burned incense on those sacred altars) that every delay, every obstruction, has been due to the faltering and indecision of government alone; that it has required a bombardment of arguments and proofs to gain official consent to even the most urgently necessary of the works in hand.

We, the insignificant portion of the community, the drones in the hive—the *mobile vulgus*, commonly called "the public"

we are to know nothing until everything has been settled by the powers that be, beyond recall. In the debate on Indian affairs in the House of Lords, on Friday evening, if debate it can be called, all the noble lords who spoke represented either present or past officialism, and the current of their thoughts naturally ran in the same groove. It is to be hoped, when the subject of Indian railways comes on for debate in the Commons, some common sense will be shown in the discussion, and that members qualified to speak in behalf of the commercial and non-official community will not fail to point out the many objections which exist to the retrograde policy contemplated by the government. Let us trust that the country will not be sacrificed whilst yours are consumed in departmental organisation, in drilling and establishing that stuff which is to accomplish nothing short of an entire revolution in the Indian Public Works Department.

A great writer has said that there is no waste so lamentable as waste of time. We are accused of having wasted money—certainly the lesser evil of the two—but it remains to be proved what brilliant results would accrue in the shape of economy in time and money should the scheme of governmental railway construction in India be realised. The writer in the *Westminster Review* talks a great deal about economy. He touches the Englishman's tender point; we all prick up our ears when the talk is of money; but it should be remembered that there is such a thing as penny wisdom and pound foolishness.

If the railways of the future are to be made by government; if roads are to be shifted to railways, and *vice versa*; if engineers and surveyors are to devote months at a time to contemplation, revision, re-contemplation, correction, and amendment; if whole districts are to starve, countries to perish, trade to die a natural death; if Indian cotton is to be an unknown quantity at Manchester and Liverpool, whilst government officials are waiting for that wisdom in council and that promptitude in execution with which kind heaven has not hitherto signally blessed them; then, sir, I think it very likely before the iron roadways are completed, that eternal bore, Macaulay's *New Zealander*, will be the "man of the period," and pigtails, buckram and red tape will have definitively died the death.—I am, Sir, your obedient servant,
SCRUTATOR.

29th July, 1869.

INDIAN RAILWAYS.

To the Editor of the "Morning Herald"

SIR,—A perusal of the debate which took place in the House of Lords on Friday night, on the subject of the Indian Budget, brought vividly to my recollection a famous speech of the late Lord Brougham, in which he gave utterance to an expression of his regret that no response had ever been made to the prayer that the Lords of the Council might be endued with "grace, wisdom, and understanding." If he were living now, how much more would it strike him that this prayer is still unanswered.

It is not many days since that I read in your columns a letter on "Indian Railways" signed "John Smith," which had reference to a proposal that the government should itself in future assume the responsibility of constructing the lines, but I am free to confess that up to Friday last I could not readily believe that such a step was really intended.

The speech of the Secretary of State for India has proved to me, however, that the government do not hesitate to inaugurate a system that I venture to predict will fail miserably. The authorities seemed prepared to sacrifice to the ambition of the few persons whose aim it is to place all public works of whatsoever kind under the Public Works Department, the best interests of India, and to make us a jest and a bye word amongst the nations upon earth.

Your correspondent said very truly that "generally it may be received as a fact that any scheme for carrying out railway extension in India by the government, even if shown to be practicable, will inevitably lead to a delay that will retard the progress of trade, dwarf the usefulness of existing lines, and prevent in a great measure the introduction of British capital and enterprise into India;" and it would appear to be an not little short of insanity for any government to allow itself to be the means of bringing about so disastrous a state of affairs.

As your correspondent has indirectly promised to pursue the question further, I will merely refer to the debate of Friday in a few words. The Duke of Argyll, presuming his speech to have been correctly reported, may be congratulated

on a sublime indifference to the past, and an almost childlike belief in the future. He said, referring to the railways:— “It is generally supposed that these undertakings have been undertaken by private enterprise, but he hardly thought that could be said, seeing that the State guarantees 5 per cent. on the capital expended, thus taking all the chance of loss from a less receipt without having any hope of profit from a larger receipt. The result of this operation is that the government, without the slightest chance of gaining any advantage, guarantees to these railways a return which they do not realise. Why should not the government raise the money for constructing these railways by their own direct action at 4 per cent., instead of raising it on the credit of the companies at 5 per cent.?” He could see no reason, and the India Council, after a full discussion, agreed with him in this opinion.”

Passing over without comment the first part of the foregoing quotation—the answer to which would flow readily to the lips or pen of any one even pretending to a knowledge of the subject—I come to the statement that the government have guaranteed the lines “without the slightest chance of gaining any advantage.” Can any man in his senses, even a Secretary of State, shut out the fact that the government have gained, and gained immeasurably beyond the amount of the guarantee, by the introduction of railways into India? Why even Lord Halifax, a supporter of the new system—no mean authority—and albeit certainly not an enthusiast, stated on Friday night, that “he believed nothing had led to more improvement in India, and that the railways had done more than anything else to break down the barriers of caste and prejudice, to extend civilisation, to unite the empire, and place our power on a more solid foundation.”

Surely the Duke of Argyll must have given utterance to his views not dreaming of contradiction (“You, when I open my mouth let no dog bark”). And as he was not contradicted, it may reasonably be presumed that he knew his audience.

It has become almost proverbial, in connection with certain public works carried out many years ago on his grace's estates in Scotland, to exclaim, “God bless the Duke of Argyll,” and this may, perhaps, have moved an honest ambition in that statesman's breast to extend to other countries the benefits already bestowed on his native land.

With this no one could quarrel; but, unfortunately, a reproduction of the works I have alluded to, which must be

familiar to your readers, would hardly be received with corresponding favour in India, and again most unluckily the alternative appears to have been railways. As these great works will, however, be beyond the personal control of the Duke, and, in a great measure, dependent in India on the caprice of the "powers that be," I would charge His Grace, in all sincerity, to "fling away ambition," and to be wise in his generation.

The following picture presented to us by the writer of an article entitled "Our Indian Railways," in the *North British Review* of December last, might well deter even the strongest heart from courting an almost certain failure. Speaking of the difficulty of communication, and especially as regards an inland spot, he says:

"The advent of a railway to a station of this kind, resembles a special intervention of Providence. Such interventions, it must be confessed, too rarely manifest themselves in India in the shape of ordinary roads and bridges. For these works, although probably existing in the form of designs of various dates and many shapes, prepared by the Public Works Department, seem incapable of getting beyond that embryotic stage.

"Engineer officers, overflowing with honest zeal, may have prepared project after project to supply works, whose cost might in a few years be recouped out of the increased land revenue they would assuredly bring in. But such well-aimed efforts can seldom survive the deliberations and discussions they have to undergo at the hands of the many authorities whose sanction is required for the funds necessary to carry them out. Stilled soon after their entrance into the region peopled by secretaries and members of council, they find a premature grave in the pigeon-hole of some government office book-case.

"In vortical catacombs of this kind, which garnish the walls of public offices in India, there repose in peace the neatly labelled remains of projects innumerable; some of them possibly unsound, but many well worthy to be revived and embodied.

"The intermittent manner in which public works are carried on by the government in India renders it doubtful whether it be desirable for the state to retain in its own hands the construction of certain lines required to complete the present railway system. As a reason for such a course, it has been urged that these lines, being chiefly needed for

political purposes, do not offer the hopes of commercial success which are likely to induce individuals to take them in hand.

"And this reason may, in some cases, possess certain force. At the same time, should these works be carried out by direct government agency, there is a risk of their progress being interrupted or retarded by the many contingencies which await all efforts of the Public Works Department. Above all, the funds required for each year's operations must be liable to such uncertain conditions of supply as the failure or abundance of opium, or the high or low price that it happens to yield to the Indian revenue; or not impossibly to the caprice or whim of some Minister of Finance, whose short exile from the House of Commons is insufficient to render him acquainted with the country whose finances he regulates; and whose efforts are usually engrossed in cutting down all expenditure so as to enable him to show a good surplus in his annual budget."

I desire to add nothing to this realistic quotation, and will, therefore, subscribe myself your very obedient servant,

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CHUTNIE.

London, *July* 27, 1869.

"THE 'MILLIONIST,' 31st *July*, 1869.

Is the new plan announced, but not yet matured, by the Indian Government with respect to the construction in future of railways in Hindostan, a safe and sound one, either as respects Indian finance or the interest of existing shareholders in the lines already made? The question is one pregnant with importance to all parties, and demands other elements of judgment to decide it than are furnished by officials whose perfunctory duties alone call on them to consider the subject. If equal results could be got from capital borrowed at 4 per cent as from works on which 5 per cent is guaranteed and paid, nothing more need be said. But there is a further question: is it quite clear that English funds will flow into India railway enterprise without a special inducement? We are

strongly inclined to think not, especially as the Government proposes to take the construction of the lines into its own hands. Whoever knows, even in the slightest degree, the jobbery, peculation, extravagance, and general wastefulness of Government works, would hesitate long in investing his money in such hands without a good guarantee. And if this be true as regards the home country, with how much greater force does it apply to India? We may say absolutely that the present shareholders, some fifty or sixty thousand in number, live in England. Out of many millions invested probably only a few thousands are held in India, although the security is a Government guarantee of 5 per cent. Where does the Duke of Argyll expect to get the money? Not in India, of course, but in England.

A 4 per cent. guarantee was at first vainly offered for the inauguration of a railway system in India. No response came from British capitalists. Then 5 per cent. was proposed, but was passed by, and only subsequently, when money became temporarily plentiful, did the London market respond. It responded freely, but that was in consequence of fair terms being offered; and under the system thus begun, combining private administration and Government security, the construction of railways in India has steadily progressed. Why not let well alone? This tendency to eternal meddling is pernicious, and upon the slightest, sometimes the most fanciful, and often on no grounds at all, enterprises of great pith and moment misapply and effort is in a great degree lost. We do not write on behalf of this class of shareholders or that class of possible investors; as individuals these persons are perfectly able to look after their interests, and the Government can no more depreciate the value of the shares of existing Indian railways than it can coerce the money market to come into its proposed terms. We speak on behalf of India and of its progress and prosperity in the future.

Now acquainted with the subject will have much hesitation in saying that money for railway extensions in India cannot, under ordinary circumstances, be got in England at 4 or even $4\frac{1}{2}$ per cent. The guarantee, it must be understood, is not that of the British but of the India Government; and as nearly everything connected with the future of our Indian Empire is more or less wrapt in doubt, the guarantee itself is much less than perfectly secure. But this, it may be said, is a question for the India Office and the authorities of Bengal. That is so; but it is also a matter of importance to every one

interested in India. Suppose this ambitious attempt of the Government to take the further construction of the railways into its own hands should fail—what then? The result is very likely, and it might disastrously affect the investments already made, notwithstanding the guarantee. On the other hand, it would throw back railway works in India for an indefinite time, and retard the development of general prosperity in the peninsula. This latter is a consideration far paramount to that with respect to questions of per centages and guarantees; but both are inseparably bound up together. The truth seems to be that the present minister for India and other official men, his predecessors, looking superficially upon the credit of the Indian Government as being better than 5 per cent., but either unaware or not taking into account the enduring influences which discriminate between a temporary loan and a permanent investment, have jumped to the conclusion that because short loans can be had at the lower rate, therefore large and lasting investments may be had on similar terms.

We have not heard any emphatic complaints of neglect of economy in the construction of the great trunk lines in India so far as completed; and the Government certainly dispenses with no means of control over their working as a guarantee to itself for the guarantee it grants. Not a sixpence worth of grease for the wheels can be expended without, as we understand, an official order and sanction; and this stringent supervision seems very well calculated to dwarf profits. But in the case of future lines made by Government itself, what jobbery, what peculation, what uncontrollable waste and extravagance! To describe the working of railway lines by a Government staff in India is a task we decidedly shrink from attempting; in England, under the vigilant eye of public opinion, and always responsible to the Cerberus of Parliament, it is just possible that if the entire railway system were in the hands of the State it might be worked fairly; but in India, no. The thing is impossible, and that conviction alone would suffice to deter capitalists from investing on so much worse terms than at present.

But this suggests another consideration. Indian railways, unlike those of England, have been blocked out upon a consistent plan: a few great trunk lines first, to be followed subsequently by connecting and subsidiary branches. A portion only of the former has been as yet completed, and this under the 5 per cent. guarantee; some thousands of miles yet

remain to be made of the trunks, and nearly all the branches. Under the proposed change the additions will be in possession of, and be worked by, the Government, while the portions already in operation will remain in the hands of the companies. Is this feasible? Can arrangements for a harmonious working of the two parts be safely left to the Government in India, or is it ultimately contemplated to buy out the existing shareholders?

From any point of view that this scheme, plausible as it is, may be regarded, it seems worse than dubious; and in the interest of Indian railway enterprise, of the 80 millions of capital already invested in these undertakings, and of the future prosperity of that great empire, we venture to demand a more comprehensive and careful deliberation of it than is likely to be given by the India Office. Because, well-intentioned as we cheerfully admit that department to be, it is notoriously deficient in practical knowledge of India, and is only too prone, unless gently pressed, to reject wholesome advice. If a policy at once so mischievous and so retrograde as that which is contemplated be persisted in, it cannot but lead to a radical change in the composition of the Council of the Secretary of State for India.

THE INDIAN STATE RAILWAYS AND THE HOUSE OF LORDS.

To the Editor of the "Daily News,"

SIR,—Sixteen years ago the court of directors requested Lord Dalhousie to draw up a comprehensive scheme of railways for India, and he transmitted his celebrated minute of April, 1853, which became the basis of the system, and resulted in the sanction of about 5,000 miles of rail to be constructed through the agency of guaranteed companies. More than 4,000 miles are now open, and the rest is in rapid progress. An extension of the system is now deemed necessary to the security and improvement of the empire, and the Secretary of State last year called on the Government of India for a full exposition of their views on the subject. This has elicited a despatch recommending the early construction of about 7,000 miles of additional rails at the different

Presidencies. The despatch and the reply of the Secretary of State were laid on the table of the House of Lords on the 23rd instant, when His Grace stated that he acquiesced in the advice of the Indian Government, and had resolved to try the experiment of dispensing with the intermediate agency of the companies, and to raise the funds required for the new lines on their own credit, and to expend them by their own officers. This determination was based on the assumption that the money could be obtained more cheaply and expended more economically than under the present system; and this plan was represented as likely to ensure a material improvement in the finances of India.

Both these propositions are open to controversy. During the debate one noble lord stated that he never could perceive why the Government should have guaranteed 5 per cent., and another peer considered it absurd to be paying 5 per cent. to the shareholders when the money could be obtained at 4 per cent. With equal pertinence it might be asked why the Government of India should be paying 5 per cent. on a large portion of their promissory notes, when they could obtain funds at 4 per cent. Simply because at the period when the obligation was contracted, funds could not have been obtained on better terms. In 1847, when the system of Indian railways was struggling into existence, the court of directors offered the East India Railway Company a guarantee of 4 per cent. It failed, as a matter of course, for the Indian Four per Cents, were then at a discount of 15 per cent. After a twelvemonth had been wasted in the effort, they found themselves reduced to the alternative of relinquishing the enterprise or conceding 5 per cent. Times have changed; and the East India Company has in the present year obtained a million of stock at $4\frac{1}{2}$ per cent., and it has previously obtained money on debentures at $4\frac{1}{2}$. There can, moreover, be little doubt that in the present exuberance of capital in England any railway company could obtain funds, to a certain extent, at $4\frac{1}{2}$ on the guarantee of the Secretary of State. Regarding the acquisitions of money direct, it should be borne in mind that, although the Government of India can procure it at 4 per cent., their stock of that value has always been at a discount, and sometimes a very heavy one, during the twenty years of railway construction, and that they have been obliged, on one occasion, to give 5 per cent., and even $5\frac{1}{2}$ per cent., for money. Indeed, it is only a few months since the Finance Minister in India con-

gratulated the Government on the success of a new loan of two millions, which he obtained in Calcutta at $1\frac{1}{2}$ per cent. The rate of interest, whether on funds raised through the guaranteed companies or not, depends on the fluctuations of the money market, and another turn of the political or commercial kaleidoscope may dissipate the pleasing vision of 4 per cent. At all events, he must be gifted with extraordinary credulity who will assert that during the next 10 or 15 years the Secretary of State will always be able to command funds at 4 per cent., to the extent of eighty-four millions.

It has likewise been assumed that while the lines constructed by the companies have cost £18,000 a mile, they could be constructed by the State at £12,000, by which a saving of forty-two millions would be effected on the 7,000 miles of proposed lines. But the fair and legitimate measure of comparison is not the amount which the railways have cost in times past, but the sum for which the companies are now able to construct them. At the commencement of the enterprise the engineers had to feel their way in the dark, in an untrodden field of labour, with no local experience to guide them, and the expenditure was necessarily, and in some cases excessively, high. The same thing would have occurred if the Government had made the railroads themselves. The actual cost was found to be double the estimate, just as the cost of the Great Ganges Canal exceeded the original calculation a hundred fold. The interruptions and devastations occasioned by the Sonthal revolt and the Sepoy mutiny were calculated to have cost three millions. The East India Railway Company lost more than 15,000 tons of material in endeavouring to convey them in native boats, and were constrained to construct an expensive steam and transport fleet for the conveyance of that which can now be led at a fourth of the cost. But what is the present scale of expenditure, when experience has been matured, and the requirements of the undertaking have been clearly ascertained? The Oude Railway Company—the youngest of the family—are constructing a lighter line, as it regards rails and engines, for less than £12,000 a mile; and the chord line of the East India Railway Company, now approaching completion, will be found, with its heavy rails and powerful engines, to entail an expenditure of only £12,000 a mile; that is to say, the cost is £16,500 for a double line, from which the usual charge of about £4,500 a mile for making it double has to be deducted in the calculation. This is precisely the sum for which the Government calculate they

can construct the lines by their own officers. Far be it from me to impugn the resolution which has been adopted, to try the experiment of making the lines by the State. The new system may result in improvements, only we must bid adieu to the forty-two millions of savings.

During the debate it was remarked that if the government undertook the construction of the lines there would be single responsibility and single management, and consequently a considerable reduction of expense. Past experience does not warrant this conclusion. The contracts with the companies give the government on both sides the water the absolute control of every movement. Not a contract can be concluded, and not a single farthing spent, without official authorisation. If there has been waste, therefore, the government ought to take its full share of the blame. But the fact is that, except in trivial matters, the government in times past has too often been more ready to sanction than to control the costly proposals of the railway staff. With regard to the rail of the greatest magnitude, it may be asserted without contradiction that the magnetic pole of economy is not in the Council Chamber in Calcutta, but in the Board-room in London, where every item of expenditure is subjected, week by week, to the most laborious and jealous scrutiny. The double government has in no instance fostered extravagance. The intervention of the Board has been invariably employed to check it, and in one instance it was successful in saving a million, after this outlay had received the sanction of the government in India. When a check like this is removed, and the expansion of expenditure comes to depend upon the fiat of the single officer who happens to be secretary to the government of India in the new Railway Department, and he has to face, unaided, the importunities of railway officials, each ambitious to render his department perfect, with little regard to expense, it is to be feared that he will not long be able to resist the incessant pressure.

In his place in the House of Lords, Lord Lawrence, while he advocated the new system of State railways, paid a high compliment to the "original companies," and affirmed that, "but for the energy and spirit with which they took up the subject the railways would never have been in existence." To judge from present appearances, the proposed system is not likely to be characterized by the same zeal and promptitude. The Jubulpore line, 225 miles in length, was completed by the East India Company about two years ago, within two

months of the period proscribed by the contract; whereas the Lahore and Peshawar line, the first undertaken by government, exhibits a lamentable instance of dilatoriness. After it has been sanctioned more than a twelvemonth, and the engineering staff has been collected on the spot, not a single mile has been staked out, and even the course of the line has not been determined on.

The case of the Great India Peninsula line is adduced to show the disadvantages of the present system. That line was constructed with so little regard to stability, that it is found necessary to expend another million and a-half in rebuilding bridges and strengthening the works. But the responsibility of this failure rests quite as much with the Government consulting engineer, who urged the construction of the line on the most parsimonious scale, as with the company's engineer, who was anxious to earn the merit of having made the cheapest line in India. The consequence is that in some places the line cannot be maintained in efficient working order without a very heavy additional outlay, and thus cheap construction is overbalanced by dear maintenance. But this exceptional instance of default ought not to be allowed to throw discredit on all other lines. It is unfair and un-English to rest the argument for the establishment of a new system upon the condemnation of the existing companies without an impartial investigation by unprejudiced judges of all the distinctive circumstances of the undertaking, or the unexpected difficulties with which it had to cope, and without affording the directors an opportunity of vindicating their proceedings. It would then be apparent with what zeal and energy they have laboured to restrain expenditure, and to promote the prosperity of the great national enterprise entrusted to them. When they are charged with mismanagement, let it be remembered that on the longest of the lines, and that best known to the Governor-General, who travels on it, while the rates and fares are decidedly lower than in England, the working expenses were less in proportion to the receipts than on any of the great railways in this country.

I am, &c.,

July 31.

MARQUESS.

THE "MORNING HERALD," 5th August, 1860.

The Duke of Argyll in the Lords had prepared us for Mr. Grant Duff in the Commons upon the financial state of India. But the volunteer declaration in the Upper House was, of course, not intended to supersede the usual discussion of the subject in the representative chamber. The House of Commons, though it cannot check Indian expenditure, is entitled to control it in the sense of approval or disapproval of the Government policy; and it would be strange indeed, if "the faithful and the few" hon. members who care about the question should be shut out from an expression of opinion concerning it.

The Under-Secretary of State, moreover, is evidently not the man to allow the wind to be taken out of his sails, or suffer any interruption of his usual course. He had prepared his budget speech and was determined to deliver it, come what might. Otherwise, after the statement of his chief, he would have been justified in doing very little more than lay the resolutions before the House. So he not only made a speech, but made a long one, and exhausted his subject, not without risk of a similar effect upon his hearers. Determined to begin at the beginning wherever he might happen to end, he informed a House audibly anxious for information that the Indian empire covers a very large portion of the earth's surface, and is inhabited by various races of men. There is a certain elementary Mr. Pinnock who, in an "Abridgment of Geography for the Use of Schools," has said something of the kind before; but the ignorance of hon. members of all matters relating to India is so proverbial that it was prudent perhaps on the part of Mr. Grant Duff to impart this preliminary fact. The Under-Secretary also suggested previous reference to Pinnock by the accuracy with which he stated the population of the empire. Most speakers refer in round numbers to "the hundred and fifty millions whose destinies are committed to our charge." Others, remembering the native states, say "the hundred and eighty millions under our rule or influence," and there has been a tendency of late to take the combined number at two hundred millions. But Mr. Grant Duff does not trifle with facts in this manner. He speaks boldly of the "hundred and forty-seven millions of our fellow subjects," and the "fifty millions more who are amenable to our influence," giving one the idea of a man who has not been sufficiently long acquainted with his authorities to take liberties

with them. His exordium was, on the whole, very creditable but he could not dwell upon generalities for ever, and had to settle down presently into the sober statistics with which the Duke of Argyll had already made us acquainted. The main points of these are, that the past year showed a deficit of more than a million, and that the present year will show a modest surplus of £50,000; that if the expenditure is increasing, so is the revenue, though the increase in the latter would be more satisfactory were it mainly made up from less objectionable sources than opium and salt.

With regard to the various items, on the one side and the other, the speaker was wonderfully explanatory, and it is strange if he did not tell his audience a great deal more than the majority knew before of the details of Indian administration. With regard to policy he had little more to say than was already understood. The Government is prepared to spend a great deal upon public works, and fully adopt the policy of Sir Stafford Northcote in distinguishing the remunerative from the unremunerative, allowing the former only to be paid for out of loans, and sparing money for the latter out of income, being a check upon the imagination. Mr. Duff held out no hope of being able to enter into the views of those who have asked for the disbursement of ten millions a year for the promotion of the cotton cultivation. On the whole—notwithstanding that the Government have to raise a little sum of eight millions on loan between the present time and 1872, and, as Mr. Duff expressed it, are “running near the end of their tether” as regards their borrowing powers—the Under-Secretary is of opinion that the financial position is “not so very bad;” for the country is making immense progress, ought to be very well off, and would be but for exceptional drawbacks; while mental is following material improvement, and the civilisation of Europe is stirring the Indian mind to its very depths.

In the debate that followed—which was not concluded on Tuesday night—some important criticism was passed upon the policy of the Government. Thus Mr. Crawford condemned the practice of exercising the powers of borrowing without direct communication with the public, instead of taking advantage of competition and raising money upon more advantageous terms; and, without altogether opposing the proposed policy with regard to the future construction of railways, he complained, with justice, that the new system should be based upon a condemnation of the old. For, whatever fresh con-

ditions may have arisen to justify a change in the present arrangement between the Government and the companies, this at least is clear—if India would be now without railways without the Government guarantee, India would equally be without railways had that guarantee not been accepted by private capitalists. Let it be admitted that the double responsibility has not worked well; still it is a double responsibility, and each side should take its share of blame for shortcomings. The *Hornet and Mail* put the position very well the other day when it said: "Why the Government and the companies should always pull against one another like ill-coupled hounds we can no more understand than that the companies should, according to the Duke of Argyll, be alone to blame for defects of construction, when the representatives of the Government have been constantly inspecting and reporting on the progress of works, and a Government director has been keeping guard at each board table in London." Our contemporary also doubts, with Mr. Crawford, whether the Government would be always able to borrow the necessary money at 4 per cent., and so save 1 per cent. by ceasing to deal with the railway companies; while Mr. Crawford went so far as to deny that there are sufficient grounds for supposing that the Government will carry on the work of construction at less cost. This is one of those cases in which—in proverbial phrase—a great deal may be said on both sides; but it is certainly unfair to condemn the railway companies alone for waste and extravagance. It should be remembered, too, as Mr. Crawford reminded the House, that the railway companies carried on their works during the mutinies—which the Government could never have done—and that the progress then made was of great importance to the state. Sir Stafford Northcote also expressed his opinion that there had been a want of cordiality and generosity in the manner in which the railway companies had been treated. "Even assuming," said Sir Stafford, "that such companies were to be altogether dispensed with, still there should have been some acknowledgment of the fact that we should never have had this great network of railways so well constructed, and so ably worked, in so short a time, had it not been for the assistance of the companies. Though they might find fault with some details of management, and with the principle upon which the system was founded, still they should speak a little more gratefully of those who had initiated the plans of so great a man as Lord Dalhousie, and who had carried them out so successfully."

THE "OVERLAND MAIL," 6th August, 1869.

The *Money Market Review* publishes the following as a well-timed letter. We cannot accept all that the writer puts forth about the Public Works Department, but the letter is entitled to a position among the Indian records of the week:—

SIR,—The proposal of the Duke of Argyll that the Government should for the future undertake the construction of railways in India can scarcely have surprised anyone who remembers for how many generations his Grace's family has been identified with works of public utility. Doubtless his Grace, grown accustomed to the veneration and gratitude with which his countrymen have been wont for ages to regard the name of M'Callum More, has become fired with a more extended ambition, and desires to raise for himself a monument whose foundations shall rest in the hearts of the hundred and fifty millions of British subjects who people the vast territories of Hindostan. The motive is not an unworthy one, and the object which the duke holds out as an inducement to adopt the imperialist notion of placing railway construction under a Government department is one which is highly creditable to his Grace's good intentions. Economy is the object desired, but it appears to me that the mode by which it is sought to be obtained bears but scant testimony to the noble duke's wisdom or experience.

I make bold to say that if the Duke of Argyll were practically acquainted with the history of the Indian Public Works Department, it would be the very last thing that would enter his mind to entrust to that department a work which is at once foreign to its experience and altogether beyond its resources. The history of the Public Works Department in India is a history of delays, procrastinations, and failures; a history of chiselparing economy; of great conceptions and stilted realisations; a record of designs for useful and necessary works subjected to a game of shuttlecock played by the officials of a hydra-headed executive; a game usually drawn and seldom leading to any result. I do not mean to say that the Public Works Department has nothing to show as the result of its long existence. I have myself seen works in India of which any Government might well be proud. The roads over the Ghats on the Bombay side of the peninsula, and some of the trunk roads in other parts of the country, are evidence enough of what Government engineers can in time

accomplish; but I do not believe there exists in any part of India a single public work, worthy of the name, which has not been the work of an entire generation. In addition to the railways, the crying wants of the country are roads and irrigation works. In the energetic prosecution of the two latter, the Government have a splendid opportunity of redeeming the errors of past inaction; and a field, assuredly, sufficiently large to tax their resources to the utmost. I have said that railway construction is foreign to the experience of the Public Works Department. No one can deny this. Some time since the Government decided on making the Lahore and Peshawar Railway without the intervention of a company. This decision was, I should observe, reasonable enough, as the Peshawar line—whatever it may ultimately become,—has not at present much to recommend it on commercial considerations; and the case was, therefore, one which might fitly be chosen by Government to test its own capacity to undertake such a work. And what has been the result? Instead of placing the work in the hands of an officer already in the pay and service of the state, the Government forthwith adopts the very course which would be taken by a company under the circumstances, and engages a civil engineer—of great ability I admit—to superintend the undertaking, with a staff (also of civil engineers) to assist him in carrying it out. But whereas, in the case of a company, the work would have been prosecuted forthwith, will it be credited that all those engineers engaged by the Government at libéral — I do not say excessive—salaries have been kept for months and months doing literally nothing, while the Government is engaged in the edifying task of trying to satisfy itself as to the propriety of sacrificing the usefulness and success of the railway for the sake of a possible saving which it has occurred to somebody might be gained by combining the railway with what by courtesy is called the “Grand Trunk Road”—a “grand” road, truly, without a bridge! And this is a specimen of what we may expect if the policy put forward by the Duke of Argyll be adopted. The new system proposed is confessedly an experiment. I think that even the most strenuous opponent of the Government policy can hardly deny that it is only right and proper that Government should make the experiment. The Peshawar line affords ample opportunity for doing so. If, as that line approaches completion, the Government can point to it as a good, a cheap, and a quickly-constructed railway, there can be no opposition to the Government extending

its operations over a wider field, as there will then be little or no argument on which to base an opposition; but in the meanwhile, in the interest of the entire community, I would lodge my strongest protest against the adoption of a policy which would permit the possibility of the history of the Public Works Department repeating itself in the case of the railways, to the serious and irreparable injury both of India and Great Britain.

I am, Sir,

Your obedient servant,

NULLA VERBOSA REPROMPTUM.

London, July 28, 1869.

“STANDARD,” 6th August, 1869.

The following letter has been addressed to the Secretary of State for India in Council by the Chairman of the Scinde Railway Company in reference to the proposed Indus Valley Railway to connect the upper and lower portions of that company's line. Notwithstanding anything that may be said in favour of the proposal of making railways by the direct agency of government, the company's claims for the concession of that line would appear to be unanswerable, as the case is clearly one to which the reservation of the government of India in favour of actual or implied engagements with existing companies was applicable.

“Scinde Railway Office, Gresham House,

“Old Broad Street, London, July 8th, 1869.*

“THE UNDER-SECRETARY OF STATE FOR INDIA.

“SIR,—I have the honour to acknowledge the receipt of Mr. Melvill's letter of the 1st inst., stating, in reply to my letter of the 23rd ult. (No. 3284), that the question of constructing a railway through the Indus Valley, to connect the Scinde and Punjab lines, is still under consideration. The subject being under consideration, the present appears a fitting opportunity

* This letter appeared also in “Allen's Indian Mail,” the “Morning Herald,” the “Overland Mail,” &c., &c.

for laying before the Secretary of State for India in Council the views of the directors regarding it, and for reminding him of the claims of the Scinde Railway Company for the concession for its construction. The Indus Valley Railway forms a necessary and integral part of the trunk line between Karachi and Delhi, of which both extremities are in the hands of this company. The intervening portion of the route, moreover (from Kotree to Mooltan), has also been placed in the hands of this company, who at present conduct the traffic by means of the Indus Steam Flotilla, and the very necessity for completing the railway has in fact arisen out of the inadequacy of the flotilla to maintain an efficient connection between the upper and lower portions of the company's line. This company, who, it is to be observed, originally proposed the line, have already, with the sanction of the Secretary of State for India, and at considerable expense, taken surveys of the country through which it would pass; and they have the various plans and sections in their possession. They have in their service a chief engineer of great skill and experience, who enjoys the confidence alike of the directors and of the government, and who might well be entrusted with the execution of the undertaking. Mr. Harrison, the engineer in question, is moreover supported by an efficient staff, the members of which have acquired considerable experience, some of them having taken part in the survey of the Indus Valley line itself, and whose services will be lost to the company after the completion of the Delhi railway, unless it should in the meanwhile be decided to proceed with the construction of the Indus Valley line. I would here draw attention to an extract from a dispatch from the Government of the Punjab to the Government of India, under date the 18th October, 1868, in which it is stated that the Indus Valley line 'is absolutely necessary as constituting what has been appropriately termed the 'missing link,' the fitting in of which alone can secure for the Scinde and Punjab lines, already completed, the prospect of becoming ultimately remunerative, and enable them to fulfil efficiently the object for which they were formed; the navigation of the river Indus having been proved to be wholly inadequate to the object in view.' The dispatch concludes by observing that 'if the concession of a guarantee is sanctioned, it should be given to the Scinde Railway Company, and the construction be entrusted to one chief engineer, subordinate either to the Government of Bombay or to the government of this province, as the supreme

government may be pleased to decide, but hereafter, to save the unnecessary expense of a double agency, the entire system of the Seindo Railway Company from Kurrachee to Delhi, 1,120 miles long, should be managed by an agency with its head-quarters at Lahore.' The arrangement thus recommended by the Punjab Government is in strict harmony with the policy adopted in regard to the proposal to amalgamate the company's several undertakings into one; and I may state that the strong encouragement which the government has extended to that proposal has led the shareholders to believe that they would receive authority to construct the Indus Valley Railway to connect the upper and lower portions of their line so soon as the Secretary of State should be of opinion that the proper time for the commencement of active operations had arrived. The Board are aware that a proposal has been made for the construction of some of the future extensions of the Indian railway system by the direct agency of government, but they trust that the case of the Indus Valley Railway will not be considered one to which such an arrangement could with propriety be applied. The directors submit that under any circumstances the employment of any agency, other than the company's own, to connect the sections of the company's line already constructed, would injuriously affect the interests of the shareholders, and would otherwise entail considerable public inconvenience, but the inexpediency of such a course becomes still more apparent when regarded in connection with the proposal to merge the several undertakings in one, as all the arguments which have been so strongly urged both by government authorities and by the directors in favour of an amalgamation, are equally conclusive against the propriety of establishing an entirely separate agency in the very centre of the company's system. There is reason to believe, however, that a scheme for the irrigation of Seindo is being considered by the government in connection with the construction of the lower portion of the Indus Valley Railway. If this be the case there may be, *prima facie*, a reason for delaying a decision as to the lower half of the undertaking, between Kotree and Sukkur, or for adopting, in the case of that part of the line, a principle different from that which would otherwise commend itself. But it does not appear to the Board that the consideration of that question affects in any degree the upper half of the line, between Mooltan and Roree, or that it need involve any delay in proceeding with that portion of the undertaking. If the upper

half of the line were constructed the worst part of the navigation of the Indus would be avoided, as well as the necessity of making the passage of the rapids at Sukkur; and the efficiency of the company's flotilla would thus be more than doubled; while the time when the Scinde and Punjab lines will be sufficiently remunerative to relieve the State of further payments of guaranteed interest would be immeasurably hastened.

I am, Sir,

Your obedient servant,

(Signed) W. P. ANDREW, Chairman."

"ALLEN'S INDIAN MAIL," 18th August, 1869.

We publish elsewhere Mr. W. P. Andrew's letter to the Secretary of State for India on behalf of the Sindh Railway Company's claim to construct the line of railway from Mooltan to Sukkur and Kotree. Mr. Andrew certainly advances some good reasons for allowing the company of which he is chairman to carry out the programme of their own designing. The line between Mooltan and Kotree would fill up the present gap between two sections of what is virtually and will soon be formally one undertaking. It has been surveyed at the cost of the Sindh Railway Company, whose staff of trained engineers could begin the work at any moment. Its construction would ensure an early return for the money laid out on the Sindh and Punjab railways; and the Punjab Government has enforced this last argument by urging the concession of a guarantee for that purpose to the Sindh Company, on condition that the whole line from Karachi to Delhi should be placed under one agent dwelling in Lahore. To our thinking the demand is entirely reasonable, and accords with the spirit of the new rules proclaimed in the Indian Minister's recent dispatch. The Indus Valley line may fairly be classed among the extensions which the Duke of Argyll proposed to leave in the first place at the disposal of the existing companies. If the Sindh Company is ready to begin work upon it under due conditions of time and outlay, we should think that the Government would act with equal fairness and wisdom in keeping under one management the several sections of what would practically

be one line. There is open of course to Government the alternative of buying out the company altogether; but as that is probably out of the question, Mr. Andrew's claim deserves all attention, and his management of the existing lines forms an additional argument in his favour.

"HIERAPATIE'S JOURNAL," 31st July, 1869.

The Duke of Argyll proposes that the Government, instead of companies, shall in future construct railways in India, and that the money shall be raised at 4 per cent. interest instead of 5; that some 7,000 miles of new and additional railway shall thus be constructed, which is about double the length made.

We wish the Indian Government may get money at 4 per cent., but we have no hope of it. When money in large amounts is continually wanted, a liberal rate of interest is necessary, and 5 per cent. upon Indian security, and under such conditions, does not seem too much.

As to the Government itself making the new Indian lines, it should be considered whether the Government is likely to make lines of railway as substantially or as well as companies managed by persons having a knowledge of the business. Take for example the greatest and most important of the Indian lines, the East Indian. It is well known that the construction of this line is excellent, but why so? Simply because the business has been well attended to and skilfully managed. Would the Government have constructed it as well? We doubt it. In all probability, instead of costing less it would have cost more in the hands of the Government, while it could not have been better constructed than it is. People commonly think that they could build their own houses better than contractors do for them, and that they could save the contractor's profits, but they only find out their mistake when they are so unwise as to undertake the work. "Wise men buy, fools build houses," and something similar will apply to railway-making by those who can hardly be supposed to be well up in the work. It is much better for the Indian Government to confine itself to guaranteeing lines than to attempt to build them itself.

THE "RAILWAY RECORD," July 13th, 1869.

INDIA—THE BACKWARD PATIE.

On Friday last the Duke of Argyll, as Secretary of State for India in Council, laid on the table of the House of Lords certain despatches received from the Government of India, on the subject of the construction of railways in India, and in doing so made a statement in regard to the finances of the Indian Empire; in other words, the Indian Budget, which it has been the custom hitherto to lay before the House of Commons, was submitted in its general and broad outline to the Upper House. As a whole, the finances of India must be regarded as in a very satisfactory condition, and the extraordinary increase in the revenues of India must be accepted as in the highest degree remarkable, whilst at the same time the declared policy of the Secretary of State for India, in reference to the future railway works in that empire, presents itself to our mind as one of the most striking illustrations of the *non sequitur* school of reasoning that it has been our misfortune of late years to encounter.

In the year immediately preceding the mutiny in India (1856-57) the total Indian revenue stood at £33,378,000. In the year 1867-68 it stood at £18,534,412; in other words there was an increase of £15,150,000, which in fact amounted to 45½ per cent. In the year before the mutiny the imports were £28,680,000; in the year 1867-68, they were £41,291,000; being an increase of £15,500,000. The exports in the former year were £20,500,000, and the latter £36,000,000, being an increase of £23,500,000. It is not necessary that we should point out in detail the specific articles of export in which the enormous increase has been more specially manifest, but the export of raw cotton attracts attention from its striking magnitude. For instance, in the year before the mutiny, the export of raw cotton amounted to £1,400,000 only; but in 1867-68 it had increased to no less than £8,318,000! Without, therefore, enumerating the few remarks which suggest themselves to us regarding the policy of the Duke of Argyll in reference to the construction of the future railways of India being taken in hand by the Government, it is impossible to conceal from ourselves the conviction that those vast figures representing the increase in the imports and exports of India would never have been attained without the establishment of

the facilities of transit, both for men and merchandise, which have been provided by the system of railways in that empire. Nor is it necessary that we should do more than simply remind our readers of the unceasing exertions which were necessary to overcome the *vis inertia* of the old East India Company, which for a long time obstinately refused to listen to the proposals of the early promoters of railways in India, when capital was abundant and was prepared to embark in these works without any guarantee at all; but the favourable opportunity being allowed to pass away, the necessity for railways in India becoming year after year a more deeply settled conviction, the guarantee became a *sine quâ non*. To the efforts of private individuals and the necessities of Lancashire are we entirely indebted for the introduction of railways in India, and certainly not either to the old East India Company or to the Board of Control. Indeed, Lord Lawrence, in the recent debate, admitted that India either would not have had railways at all, or at all events, not at so early a period, had it not been for the exertions of private individuals.

It is notorious, moreover, that the companies which undertook the construction of railways in India, have not unfrequently been harassed rather than assisted in the prosecution of the works, by the interference of governmental officers unacquainted with railway construction, and there would be something amusing in the tone of surprise affected by the Government of India at the excessive cost of railways in that country, if it were not painfully true that the cost of these works has been greatly augmented by the action of the government itself and its subordinate officers.

Yet in spite of all this no one will deny that the outlay has been productive of vast profit to the country, not only commercially but morally. To use the words of Lord Halifax (Sir Charles Wood) in the recent debate: "Nothing has created a greater revolution in India than the construction of railways, which have done more to break down caste, and to diffuse European notions, and with them civilization throughout India, than anything else."

Shortly before leaving India, the late Viceroy (Lord Lawrence) took occasion, in an official resolution, to express "his satisfaction at the steady progress towards completion of the system of railways undertaken by the Scinde Company, and his appreciation of the labours of those by whom the construction of the Delhi line had been so far and so rapidly advanced." By a curious caprice of fate, as dispensed by an Indian Secre-

tary, the very company thus commended by the highest official authority, would appear to be the first whose interests are to be wantonly sacrificed as a reward for its past exertions.

In the recent report of Mr. Danyers it has been shown that the burden of the guarantee system upon the revenues of India is gradually recomping itself; and there is little doubt that in a few years it will certainly disappear on the existing authorised capital, as the commerce of the country becomes more and more developed, leaving the government free to act in reference to the future extension of the system, upon any principle which may be proved to be the most economical and efficient. From the statement of the Duke of Argyll on Friday last, his Grace appeared to consider himself justified in assuming that the most economical and most efficient mode of constructing future railways in India would be to carry out the work by the government, instead of through the agency of companies. The British public, unfortunately, are very imperfectly supplied with data in favour of this view of the case, and it would be in the highest degree desirable before a decision is arrived at upon a matter of such importance, that the House should be furnished with the cost of public works in India exclusively in the hands of government, the time occupied in their construction, and the detailed financial results. Similar details of public works in this country conducted by government, would, we fear, fail to support the correctness of the general proposition, that public works conducted by government are either more economically or more efficiently carried out, than by the agency of private enterprise, whilst, in reference to the construction of railways in India it is beyond dispute that the engineering staff of the different companies conducting operations in that country, have nothing to learn from military engineers, but on the contrary, constitute a body of teachers to the authorities who are empowered to interfere with and curtail their operations. We apprehend that in any event, the government will, from the very necessity of the case, be obliged to contract for the work; the existing staff of the private companies must become the servants of the government, and where the profit to the government—the “large margin” of which the Duke of Argyll spoke with so much unction, is to be found—we confess ourselves unable to realise even in imagination!

In another part of our paper of to-day will be found an exceedingly sensible and well-written letter on this subject, which is deserving of very serious consideration.

But the Duke of Argyll is fertile in assumptions. The *Times* of Wednesday has the following on the financial portion of the scheme :—

"It appears," says the City article, "from the financial speech of the Secretary of State for India that it is contemplated during the next ten or twenty years to construct 7,000 additional miles of railway in that country, being nearly double the amount thus far completed. Supposing the outlay to be at the same rate as hitherto, the cost will be £126,000,000, and even if, as seems to be hoped, a reduction of one-third can be achieved by the work being carried on by the Government, instead of through the agency of companies, the *minimum* required will still be £81,000,000. Taking fifteen years as the average of time over which the outlay is to be spread, it would thus be necessary to raise about either six or eight millions a year throughout the whole period. The Indian Government calculate that because they can now get money at 4 per cent. they may hope to effect the whole operation at that rate, and thus avoid the necessity of guaranteeing 5 per cent. to public companies. In the City of London, however, there will be little response to this sanguine anticipation. The sums raised during the past fifteen years under the 5 per cent. guarantee and the prospect of future profits have not been obtained without difficulty, and throughout the whole time complaints have been heard that the constant drain was injurious to the prosecution of enterprise both at home and in other countries of as much importance as India to our commerce. Hence it will be prudent to assume that an average of 5 per cent. will be the lowest that can be contrived. With regard to the expediency of the work being henceforth carried on directly by the government, instead of, as heretofore, by a double and constantly conflicting agency, there will probably be little difference of opinion."

The concluding paragraph of the foregoing extract is open to objection. For ourselves, we believe that it is not expedient, if it were within the capacity of the Indian Government, to construct the future railways of India; whilst at the same time we cannot bestow our unqualified approval on the double and frequently conflicting agency which has hitherto been in force. We, however, believe the guarantee system to be capable of some modification by which the evils of red tape might be greatly mitigated, and greater economy secured in the construction of the lines.

But the financial part of the question is, to our way of

thinking, secondary to the retrograde policy which seems to find favour with Indian statesmen, to whose generally enlarged views we have long been accustomed to bow with respectful attention.

We had fondly hoped that the encouragement of the principle of private enterprise in India, so highly prized by Lord Dalhousie, by Lord Canning, and by other distinguished Indian statesmen, and, which has borne such good fruits was too highly esteemed to be lightly set aside, and treated with indifference. Irrigation works and railway works are to be taken into the hands of the State. The government only the other day bought up a colliery company at the par price of its shares. Is it intended to buy up the tea plantations? The cinchona and the coffee? or to purchase the existing railway companies? We are surely going back to the policy of the old East India Company, and not acting in the light of 19th century policy! as Lord Dalhousie said:—"All the rest of the world are progressive, India alone stands still." Nay, not standing still. If the policy enunciated by the Duke of Argyll the other night is to be indeed acted upon, India is about to tread the path of retrogression.

The policy which we should advocate as best adapted to the advancement of India and the development of her immense resources, is one which should invite and not discourage private enterprise to her coal fields and iron deposits, to the utilization of her numerous valuable vegetable productions to the purposes of manufacture, and to make the hand of government felt only for the preservation of peace and order, and the collection of revenue; together with those other duties of a good government as the equal administration of the law, freedom of religious opinion, the diffusion of education and the like. The rest should be left to private enterprise, unshackled and untrammelled with the interference of a too paternal government.

"RAILWAY TIMES." 31st July, 1860.

The remarks of the Duke of Argyll, as Secretary of State for India, are exciting general attention. In common with youthful statesmen generally, who have grown up to manhood, and to reputation, since the commencement of the existing system, his Grace is at a loss to comprehend how, in presence of the facts of the day, the Government could have been induced to enter upon its prevailing arrangements with the various Indian undertakings. His Grace's acquaintance with those affairs is of yesterday, and his ideas of government, naturally are for the future; it might not be unwise, however, not merely in his Grace, but in other statesmen or officials who are destined to rule the country under different circumstances than those in which their predecessors were placed, to instruct themselves in the exact condition of affairs when policies which they now disclaim were entered upon, and when lack of knowledge, alike in respect to agencies and events, was considered reason sufficient for acting with caution on the one hand, and of entering upon alliances with practical men on the other.

There was, it may almost be asserted, no "finance" in India twenty-five years ago. That branch of political economy was as little understood in Londonhall-street as in Calcutta—as little understood as the then surprising theory of railway communication over thousands of miles of uninhabited, certainly of uncivilised, territory. The East India Company—a trading corporation, but one quite as familiar with war and conquest, and their concomitant costs, as with commercial enterprise—positively declined to undertake the supervision of railways, either in construction or management; and hence the origin of the system that has hitherto worked so well for all parties, and which has not (we make the statement with all deference to his Grace of Argyll) resulted all in gain to the subscribers, and in loss to the Government, which, we may hint, is not the originator of the system, but simply the successor of the East India Company in the matter.

Twenty-five years ago the directors of the East India Company could not have raised a million in the market upon the announcement that they intended to expend the sum in railway construction under their own supervision. Even at this day, we question whether the India-office is capable, not of conducting the system of railway extension propounded by

his (trace (for in such capacity it is altogether deficient at present), but of discharging the minor duty of selecting now and proper officers to whom the task could be confided. These functionaries can alone be obtained from the host of officials educated under the present system, and without whose assistance, in some shape or other, Government supervision in India must entirely fail. It is not prudent to deery a system from among the officers of which the whole of the future Government executive must be selected.

It is a fallacy to suppose that the funds for construction of railways in India have been raised under a Government guarantee of five per cent.—a fallacy only surpassed by the supposition that, in consequence of the acknowledged usefulness of railways in India, apart from their revenue results, funds for future construction can be raised at four per cent. The original guarantees from Government in addition to an immediate five per cent., included half surplus profits after that rate had been obtained from earnings. This additional security, twenty five years ago, had perhaps little influence upon the public mind, or at least upon its purely commercial element. A large proportion of the early subscribers to Indian undertakings were superannuated officers, civil, military, and others, practically acquainted with India. These persons were aware that railways, although urgently required in every political and social sense, could not pay interest on their cost of construction for many years; and a mere five per cent. upon Indian enterprise, being much less than what at the time could be safely and speedily secured at home, would not induce *them* to embark their Indian savings in Indian undertakings. It was at the suggestion of these invaluable coadjutors to political and social improvement in India that half surplus profits were embodied in the arrangement; and it was only these persons, and their immediate relatives, who at the first attached value to the consideration. These half surplus profits, however distant, were to Anglo-Indians, and to all whom they could influence, a clear and distinct addition of two-and-a-half per cent. per annum, to be derived by the next generation from the forethought and sagacity of their progenitors. It was by such a process that the Indian invalid, poorly pensioned, contemplated a reasonable and perhaps a respectable provision for his more immediate descendants. Let an attempt be made to raise money, to be expended in India on railway construction, at five per cent. (we doctine to discuss the fallacy of four), without this addition of half

surplus profits, and two events will speedily disclose themselves. In the first place, the great source of subscriptions from individuals personally connected with India will be dried up; Indian officers, civil and military, will cease to embark in schemes in which their families are to have no prospective advantage, knowing as they do that India in the next century will only begin to realise the expectations entertained of it when British supremacy was first implanted on its soil. The second event which cannot fail to touch even the India Office will make its appearance in the vast differences in value which the public will assuredly attach to the old and new investments in Indian railway securities.

Take the case of the larger lines which are approaching completion, and whose half surplus profits are already, like coming events, casting their shadows before them. Will the general public be more or less disposed to purchase the stock of these undertakings on account of there being no further issues—with their capital, in fact, closed?

It is not our purpose to pursue the financial part of the question to its legitimate conclusion. This result will arrive soon enough of itself. We revert therefore to the more practical branch of the subject.

Government is satisfied that there must, within a moderate period, be at least six thousand additional miles of railway constructed in India. It is assumed by the functionaries in the India Office—by the tyros who have been educated under a system which had to be constructed and arranged, and tenderly dealt with, while they were at school—that they are sufficiently competent to undertake duties from which their fathers shrink, and that there need be no misgiving in respect to the management and its consequences which is to issue from their hands. We shall not, at this stage of the proceedings, attempt to controvert the conclusion. Although we have no faith in the practical result, we concede that as a matter of theory railways may *now* be constructed in India, under direct Government supervision, as economically as they have been by companies who had to struggle with difficulties they have overcome, and of the advantage of which, with all other experiences, the Government officials of the day obtain gratuitous possession.

In the first thousand miles which the necessities or peculiarities of India urgently require, the Indus Valley must occupy a prominent position. This line had been handed over to the Scinde company to survey, in consequence of the

chairman of that company having not merely originated the scheme, but proved and enforced its advantages and necessity to a demonstration which the India Office could not resist. The Scinde company has discharged its preliminary functions. It has made the survey, and drawn up the estimates, under the conviction that the line, when sanctioned, would be handed over to the company for construction. The new system is intended to be based on the assumption that construction can *now* be more cheaply carried on under Government supervision than by corporate control. We do not contradict the dogma; but, before placing the slightest reliance upon it, or on the results expected, we should prefer to be informed under what sub-agency Government intends to proceed. Are the Scinde functionaries to be drafted from that company, or is each undertaking in India to incur the liability of having its best men taken from it, so that the India Office may be able to show that Government supervision, by the aid of companies' officers, is better and more economical than corporate supervision which had, in the first instance, to educate its officers in the rudiments of their duty? We shall obtain an answer to this question, no doubt, when Indian budgets of the future come under the annual criticism of the House of Commons.

It matters little, at the present moment, what extent of mileage may be contemplated for construction in India during the next twenty years. Statists and sophists may discourse on what India may become in fifty years after the introduction of railways into the empire. The question for to-day, and late enough it is, assumes the form of an enquiry—When is the Indus Valley, the surveys for which are complete, to be commenced? It is comparatively a minor question to the general public whether or not the Scinde company should be deprived of the concession it has been led to anticipate, and to which it is entitled, notwithstanding the new system to which the Secretary of State for India has given his adhesion. We are satisfied that the concession will not be withheld; we are persuaded that the company will construct the line in a better manner, and in a shorter space of time, than Government supervisors, in the freshness of their task, are likely to undertake. But it is of paramount importance that the Indus Valley should be commenced and finished without delay. We need not repeat, although we revert to, the admirable exposition recently furnished to the highest officials in the State by the Chairman of the Scinde, in respect to the urgency, utility, the social necessity, and the political advantage of an

early completion of this undertaking. It is sufficient to note the fact that every hour's procrastination in this great work involves a pecuniary loss to the shareholders in the Scinde, whose half surplus profits (notwithstanding the readiness with which they provided previous capital, and the exemplary energy which their executive has displayed in discharge of the trust confided to them) are placed beyond their reach until the missing link in the system they have had to supply is provided.

The vast conceptions of the India Office may charm the enthusiast; and the estimate which these officials form of their own capacity may be endorsed by an admiring host of applicants for office; but the new system, like the old, will speedily be broken up into detail. Each separate suggestion will require to be taken on its own merits; every obstacle demand its own means of removal; and there is too much reason to fear that years must pass away before any substantial progress is made, either in raising the money or in expending it, under the new order of affairs.

THE "OVERLAND MAIL," *August 6th, 1860.*

The agreement at which the Secretary of State for India and his Council arrived, that it was their duty, at least, to try the experiment of some less extravagant mode of raising and spending money in developing Indian railways, was reasonable enough. Backed as it was by the independent advice of Lord Lawrence and of the present Governor-General, it is not surprising that something more than the usual official alacrity was displayed, and an answer sent to India which we trust will not bear the result that proverbially clings to things done in haste. The reply that has been sent to India sets on foot an experiment with the object of economising, and the Government of India is now fully empowered to undertake the construction of railways, raising the money on their own credit, and expending it by their own officers. The Government—so believes the Duke of Argyll—can raise money better, and expend it better than the companies; why then, he inquires, should they not be their own contractors, employing their own labour.

There is something specious in what is said, but we must confess to finding too much of the bubble-company sentiment

about this extensive speculation of the India Office for us to place unbounded confidence in the undertaking. The object is most laudable, the energetic action quite exemplary, but we do not believe that simply because the Government undertakes the construction of the lines, and thus establishes single responsibility and single management, it must necessarily be contrary to the nature of things if there is not a considerable reduction in the cost of Indian railways. This is what the Duke of Argyll believes, but we venture to think that he may be wrong both in his estimate of the rate at which the Government can raise all the money requisite to carry out his complete railway scheme, and in the facilities for managing expenditure so as to ensure a saving. If we are disbelieving in the matter we are not to blame, for we can trace our prejudice to well taught lessons by the State; lessons that have been so successfully enforced, that the proposal will be incredulously set aside at once as undesirable by many, not on the merits of the particular case, but on general grounds.

The fact is, the establishing of railways by the State comes upon us like a counter-blast to recent disestablishing. It is not an idea confined to Indian railways; the appropriation of Irish railways by the Government is seriously entertained, and a popular statement of what might be enjoyed in the way of comfort and economy, both of time and money, if all our railways were in the hands of the State, proves in the most cheering way that it is only necessary for Government to buy up all the companies to produce a railway millennium. To complete the installation of the Government as traffic managers, we suppose omnibuses, cars, and steamboats should be made over in addition. Of course there would be the entire saving of law expenses in trying to pass new railway bills. All the money that runs into the pockets of directors, solicitors, and head officials, would run instead, not into shareholders' but passengers' pockets, and with a perfectly harmonious working among all the lines, and a uniform charge of about fourpence for a first-class ticket for a journey of five miles, increasing to, say, five shillings for fifty miles, what pleasure would be experienced during the three hundred million journeys which, allowing for increase, would be about the number taken by railway passengers in Great Britain in a twelvemonth.

We must say the happy sketch Mr. Williams has drawn is what he calls it, "a popular statement," but he founds all his theories on the principle that the State does not want to make

any profit, and that there will be no shareholders crying out for dividends. Passing over the thought which crosses one's mind, that the present stockholders would have to become lenders to the Government, and, consequently, remain dividend receivers, and that even if trains can run without lawyers a good deal of direction and management will be essential anyhow, we notice the contrast between this scheme and that of the Duke of Argyll. The Duke seems to stipulate that the Government of India, if it takes responsibility at all, it is not to do so merely for the advantage of the country, but is to look for profit, so that at least there may be a margin to be applied to the reduction of capital invested.

It must not be overlooked that the case of Indian railways stands upon merits of its own which are altogether dissimilar to any other, and thus it is perhaps beside the mark to cite instances of the expensive working of State railways. The system is to be applied in India, if at all, to supplant a system of Governmentary responsibility that is inconsistent and in many ways unsatisfactory. Otherwise there is much to be brought together from Continental experience on the subject. In Prussia, where the railways are held, in some instances, as private enterprises, in others by public companies, and also to a large extent by the Government, it is, if we mistake not, demonstrated that in the matter of railways, as in so many other enterprises, it is found private management produces the greatest economy; companies come off with a medium position; and the State lines are the most expensively conducted.

THE "OVERLAND MAIL," August 6th, 1860.

Outside Parliament, India has been the subject of the week. The prominent consideration given to the various propositions before the country have been discussed, not only with freedom, but in a remarkably popular fashion, so that the general public has for once had a word to say on our Eastern empire. The principal topic has been the railway scheme, and the Parliamentary utterances, and two official documents to assist with details, have furnished excellent material for newspaper articles, and they in turn have produced an abundance of correspondence.

* *

We have reprinted, as far as our space admits, with extra pages, the news of the week affecting India. One letter, which we reluctantly omit, urges a point or two with peculiar force. To compare the present likely cost of a railway per mile with that of the first experiments in railway making in India is treated as unfair, and it is urged that we must at least, in estimating the Government plan, "bid adieu to the forty two millions of saving." As the *Daily News* remarks, it could scarcely be expected that the departure from a recognised English principle would meet with full concurrence in this country. Mr. Crawford's very modified protest against it unquestionably expresses a feeling which exists rather extensively in the City.

"MONEY, MARKET REVIEW," 7th August, 1869.

The time has not yet arrived for forming an accurate judgment of the new Indian railway policy, as enunciated by the Duke of Argyll. It certainly presents the appearance of some external advantages. It is cheaper, for example, to pay 4 than 5 per cent. for loans—that is, in the abstract; but times have been when the credit of individuals has been greater than that of States; and it is anything but certain that Government railway management, even in India, will be superior in economy to that by private companies. As to the belief that expenditure may be kept more under control when incurred by Government than when incurred by companies, it is sufficient to observe that experience by no means warrants such a supposition, and it may be as well to suspend judgment upon that point for the present. In the meanwhile, we must deal with matters as we find them; and we find that the policy is to be adopted of the Indian Government itself making the future lines of the country, but that certain extensions are to be excepted from the rule on grounds special to themselves. It is certainly only just and reasonable that such exceptions should be made; and there is one which should be especially admitted, not only from a sense of justice towards prior claims, if not rights, but in the general interest on the grounds of public convenience and indispensable combinations with existing lines. We refer to the Indus Valley Railway, which is to connect the lower portion of the Sindo Railway Company's

line at Kotree with the upper portion at Moultan—the “missing link,” so called, because it is a necessary part of the Scinde Company's trunk line—designed to obviate the cost and delays of navigating the Indus between the two points.

To make this question popularly understood, it will be necessary to explain in a few words what the Scinde Railway Company's system is. It is, as a railway system, one of the most important in India. Uniting Delhi and Lahore with the sea at Kurrachee, it opens up to trade not only the whole of the Panjaub, but the countries to the west beyond the mountains; and it brings within its range the capitals of all the Presidencies. The traffic, already large, is so infinitely capable of development that it will, within the next generation, make Kurrachee to the Indian Peninsula what New Orleans is to the valley of the Mississippi; and through Kurrachee and the Scinde and Panjaub system our military power in India will be virtually doubled, because we can transport troops and stores with unprecedented facility. But, as just said, there is a missing link in the system between Kotree and Moultan, which at present the railway company, who virtually hold a concession of the traffic on the entire route from Kurrachee to Delhi, supply by means of steamers, and supply well, all things considered. This missing link is on all sides circumscribed by the railway system of the company. It is not on the north and it is not on the south. Naturally, therefore, the concession for its construction should go to the company, to whose system the missing link undeniably belongs, because they can best adapt the works to the system already existing, and, when constructed, they can best work it in harmony and co-operation with the lines on each side, and so the internal and maritime trade be assured of the utmost accommodation. There has hitherto been the strongest reason to conclude that the concession would be given to the Scinde and Panjaub Company, especially as the company were prepared to meet the views of the Government in respect to superintendence and so on. But the new principle here stopped in; and the idea is now entertained by the Government of working this line for themselves. We have no hesitation in saying that the employment of any other agency than that of the company in this work will, under these circumstances, be injurious to the public, and we cannot believe that the decision is finally taken. A separate agency in the very centre of a combined and independent system could not fail to be inconvenient. If the Government contemplate a scheme for the irrigation of Scinde

in connection with the construction of the lower portion of the Indus Valley line, this may be a reason for deferring the concession of that lower portion; but as to the upper part, between Moultan and Roreo, the concession ought to be granted at once, and the line made as speedily as possible. We say this because there are other grounds for maintaining that this missing link is, or ought to be, one of the exceptions to which the Duke of Argyll pointed the other day, and because it is in this respect peculiarly marked out, by the conditions we have just described, for exceptional treatment from the other eight or nine railway works which the Government appear to be contemplating. "I believe the time has now come," said the Duke—"except with regard to the small extensions of the existing lines which ought to be given to the existing companies—when the Government of India ought to take into its own hands the construction of new lines at its own costs." Now, the Indus Valley line is an extension, or, rather, it is a link in the Sindo and Punjab lines, and, as such, it clearly comes within the rule laid down. Moreover, the whole course of the Government policy towards the company has run in the same current. It was always understood that the company were eventually to make the line in order to complete their system; that the only point regarding which any doubt existed was the precise time when the work should be authorised; and we observe that Mr. Danvers, in his report just issued, after speaking most favourably of the several sections of the system, refers to their amalgamation, adding, "Much advantage, both in the shape of economy and simplicity of management, will be obtained by this arrangement." That is, by the amalgamation. But the system never can be complete unless it includes the missing link; consequently the amalgamation, so advantageous in "economy and simplicity of management," will be but an imperfect arrangement after all unless the Government concede the point for which the company is contending. We should like to see some expression of public opinion upon this subject. To us the case appears to present no doubt at all. Exceptions to the new rule of Government have been admitted, and this is certainly one of them; and we hope that the efforts of the company will be rewarded by their being allowed to complete their own work.

THE "SATURDAY REVIEW," *August 7th, 1869.*

The chief point of present interest regarding India is the rate of progress and the mode of construction of future railways; and on this head we are glad to see that a very considerable change appears to have come over the minds of the India Office authorities between the date of the statement in the Lords and that of the statement in the Commons. Mr. Grant Duff seems to be quite alive to the rather obvious truth, that if unproductive or slowly productive works are to be pushed forward with boundless energy on borrowed capital, the rate at which the money can be borrowed will be something very different from the Duke of Argyll's four per cent., and that the Indian Treasury will be insolvent, in the sense in which States are insolvent which must go on borrowing to keep down the interest of their debt. Mr. Grant Duff laughed at the notion of spending ten millions of borrowed money every year to please the Cotton Supply Association. If the Government only mean to borrow as much as can be borrowed at a low rate, there is an end of all controversy, and we may be perfectly certain they will not go on too fast. They have got an enormous system of future railways sketched out on paper; but paper sketches ruin nobody, and their actual proposals for railway enterprise in the coming year are on the most modest scale. It was quite worth considering whether the railways of India should for the future be made by the Government or by Companies; but Mr. Crawford, who is eminently fit to enter on the subject, abandoned the question of the future, and only tried to defend the policy of the past. He wished to stand up for the Company of which he is the Chairman, and the Companies could not have been better represented, for, besides that he is an exceptionally good Chairman, the East Indian Railway is a perfect model of good management, and is well constructed, well worked, and well administered. As it is conceded that the Government is for the future to make railways, the only question is whether they shall buy up the railways of the existing Companies. We think this would be most undesirable. The existence of these Companies, managed from London by private persons, will tend to counteract some of the great drawbacks attending the direct construction and management of future railways in India. With some of the objections urged against this action of the Government we

cannot agree. Mr. Crawford says that the Government cannot purchase a large quantity of rails as cheaply as a Company can do, for the Government must buy by tender and this will raise the price. But in the first place, there is no necessity for the Government buying by tender, if it will but employ honest and capable officials; and we may rely on this being done, for of the India Office it may be confidently said that the whole atmosphere of the department is hostile to jobbery. And then, if Indian railways are to be constructed on the prudent and humble scale suggested by Mr. Grant Duff, the quantity of rails wanted for India in any one year will be but a drop in the ocean of the iron market. Russia, it must be remembered, is making thousands of miles of railway as fast as it can on the very principles which the Indian Government is but going to adopt. It is borrowing wildly at something between six and seven per cent., without troubling itself about how the interest is to be provided, and no doubt the consequences will be that Russia will in a few years have its power consolidated and its resources developed in an extraordinary degree. But a Government which makes up its mind that it will only borrow at four per cent. and so far as it clearly sees its way to providing the interest, will have a very tiny effect on a market perturbed and controlled by the vast operations of Russia, and of other countries that will imitate Russia if they can. Nor will there be any want of competent persons to construct the Government lines in India, or to lay them out, or to control and work them. There is only too abundant a supply of the kind of skilled labour which the Indian Government will need; and as men will always work for a Government at a less rate than they would demand from private persons or bodies, there is good reason to suppose that the Government can construct its railways henceforth more cheaply than if it were to entrust their construction to companies.

But there are drawbacks to the exclusive management and ownership of the Indian railways by the Government, against which the existence of the present great companies offers a salutary counterpoise. In the first place, the railways belonging to these companies offer a field, limited of course, but not wholly insignificant, to private unofficial Englishmen in India. The Indian Government hates European settlers, and does everything to discourage and worry them; and it does this for very good reasons, because the kind of audacious vagabonds who are most willing to present themselves as European

settlers are exactly the class of people to insult and oppress and ill-treat the natives, and to stir up endless ill-feeling and thwart the benevolent and wise projects of the Government; and, moreover, the Government has no machinery for keeping English evil-doers in order, for they would be always appealing to Cæsar, and laying their griefs before the House of Commons. But still it seems a pity that there should be no outlet for private families in India except through official channels; and the Railway Companies supply one. The inevitable tendency of the Indian Government will be to collect all its railway staff that has to come from England by competition, and to admit in India those only who know how to gain the favour of minor officials. Competition is all very well in its way, but a rival system by its side has great advantages. An able engineer or traffic manager who has had experience, and wants Indian pay, has a chance of employment from one of the companies whose chairman or secretary can see him and attend him, or inquire about him. But he could do nothing at the India Office, where he would be told that when he was ten years younger he ought to have passed an examination. And, in the next place, these companies, with independent boards, and with officials residing in London, afford an excellent means of keeping up the knowledge of India as to what is going on in the railway world here. Mr. Crawford on Tuesday went into an instructive comparison of the working of his line with that of the North Western. It is a matter of personal satisfaction to a man of inquiring and organising mind to go into these comparisons, and a person in Mr. Crawford's position can make them with an ease and completeness which no Indian official could rival. There are also improvements yet to be made in the construction and working of railways which, it is reasonable to believe, will make a revolution in the ideas of men on the subject. Experiments are being made even now, with every appearance of success, which promise to show that railways can be constructed and worked at a cost which would have been impossible a little while ago. India will soon hear of such improvements through companies which have London engineers and directors, and which outsiders can approach; but a staff of purely Indian officials, recruited by lads fresh from an examination, would be sure to disregard and laugh at them as long as possible, simply because they have never had an opportunity of seeing them, and of knowing what is going on in England. The disadvantage which the Government

would be at in this respect, as compared with companies managed in England, is so obvious that it might possibly be wise to place on the Indian Council some person especially competent to counteract it, just as Lord Salisbury has so often contended that the Indian Council will never be what it ought to be until the English mercantile world is represented there.

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PAPER

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ON

THE GAUGE FOR "THE RAILWAYS
OF THE FUTURE,"

BY

B. F. FAIRLIE,

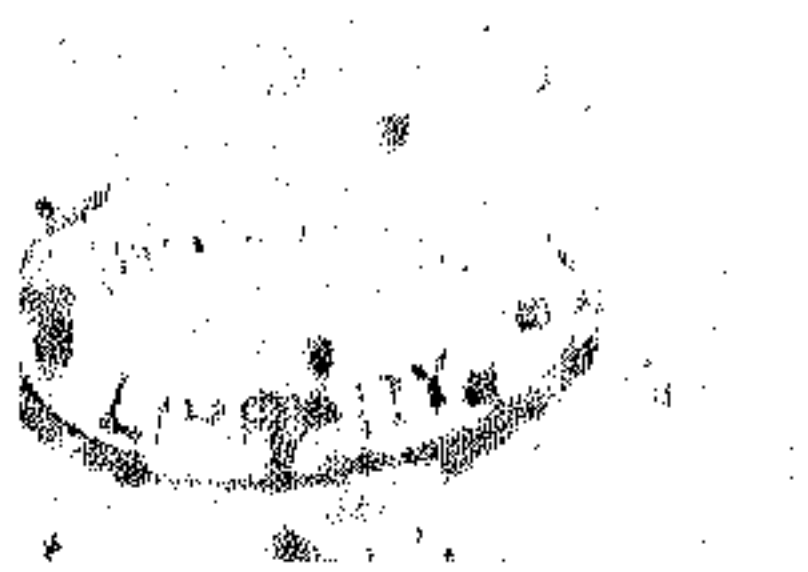
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THE GAUGE

FOR

'THE RAILWAYS OF THE FUTURE.'

The object of this paper is to show in what manner, and to some extent in what degree, the cost of the construction and maintenance of railways is affected by the gauge on which they are built; and by what means it would be possible at once to increase the dividends of shareholders, and to extend the countless advantages railways afford to all parts of the habitable globe, however thinly peopled or unproductive. It will be in the recollection of many that the question of the proper gauge for railways was once a matter of earnest dispute; and that what was called the "Battle of the Gauges," as between broad and narrow, was fought with desperate vigour and with no decided result. Each party of belligerents retired from the contest with heavy pecuniary loss; but neither would allow that the other had been the victor. The result was that the construction of each gauge was pushed forward by those who were interested in it; and thus it befell that a broad gauge line was carried into the northern districts, from which its subsequent removal was the best proof that it ought never to have been taken there.

Although the controversy to which I have referred was conducted with singular ability, and at a very lavish expenditure of the money of confiding shareholders, it is curious to observe that those concerned in it seem never to have taken into account the relative *economy* of the plans that they respectively advocated. The consideration of this most important element in the question could have thrown upon it a totally new light. But the very

word was at that time unknown to the railway world, and the thing which the word signifies has scarcely yet gained its due share of consideration. Had it done so, the present paper would have been unnecessary; for it would have been proved, years ago, that while a narrow gauge is infinitely less costly than a broader one, its capabilities in respect of power and speed are fully equal to the wants of the country. If this had been known, we should not have seen, as at present, large districts deprived of all prospects of railway accommodation; and thousands of shareholders regretting the loss of that return to which their expenditure has fairly entitled them.

Apart from the important question of economy, the carrying capacity of gauges less than 4 foot 8½ inches has never yet been considered in its true light. It has been hastily assumed that a line of narrower gauge than this would be very limited both in its carrying power, and also as regards the speed at which trains could be run; and it has been argued that the saving in cost would be too small to render it desirable to make a change. It is not my purpose to advocate such a change in Great Britain, where a 4 foot 8½ inches gauge is actually established and at work, and where it affords the necessary facilities for the speeds of sixty or seventy miles per hour that are actually run over it; but only to take the conditions of English railway traffic as an illustration of my general arguments. At the same time it must not be forgotten that those conditions could be in some degree modified in the direction of economy by the employment of a new and lighter description of rolling stock. It is known and everywhere admitted that the proportion of non-paying to paying weight in passenger trains is as much as 20 to 1, and in goods trains, exclusive of minerals, as much as 7 to 1. This terrible disproportion is partly due to the system of management pursued; but in a far greater degree to the gauge. The dead-weight of trains conveying either passengers or goods is in direct proportion to the gauge on which they run; or, in other words, the proportion of non-paying to paying weight (as far as this is

independent of management) is increased exactly as the rails are farther apart, because a ton of materials disposed upon a narrow gauge is stronger as regards its carrying power than the same weight when spread out over a wider basis. In proof of this proposition I need only cite the case of the Great Northern Railway, with its gauge of 1 foot 11½ inches. The waggons used upon it for carrying timber weigh only 12 cwt., and they frequently carry a load of over 3½ tons at a speed of twelve miles an hour. In other words, these waggons carry as much as six times their own weight, whilst the best waggons on the ordinary English narrow gauge do not carry as much as twice their own weight.

The good management of the London and Northwestern Railway is so universally admitted, that it will seem almost presumptuous to select this line as an illustration of the faults of the existing system. I have, however, selected it, because its management is such that its shortcomings must be wholly due to its construction; and I shall proceed to show that, if its gauge were three feet instead of four feet eight-and-a-half inches, its goods traffic could be hauled at half the present cost, with half the present motive power, and in such a way as to reduce the present tonnage over the road by one half, and to remove the necessity for the heavy expense that is now being incurred in the construction of a third line of rails. I am perfectly prepared for the incredulity with which these statements will at first be received; but I shall prove their correctness by figures that cannot err. The writer who originally said that a train weight of thirty tons had to be set in motion for every ton of passengers carried was at first ridiculed for his pains; but after a time, and when people came to inquire into the matter, it was found that his statement was absolutely correct, inasmuch that it is now universally received and admitted. In like manner the facts about the goods traffic require only to be investigated; and everyone possessed of common sense will find it easy to understand them.

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The goods and mineral traffic on the London and North-western Railway for a single year amount to about fifteen million tons. I will assume that five out of these fifteen million tons are minerals, consisting chiefly of coal; and I will deal only with the ten million tons of goods which are left as the net residue of the year's carrying. It has been proved that the proportion of non-paying to paying weight is about seven tons to one ton; and this would give seventy million tons of rolling weight employed to carry the ten million tons of paying load. In order to avoid all risk of exaggeration, I will assume the dead weight to be only as 4 tons to 1; which reduces from 70 to 40 million tons the weight of the waggons employed to carry the 10 million tons of paying load. The whole gross weight hauled by the locomotives will then be 50 millions of tons, at an average speed of 25 miles an hour.

The earnings for the goods traffic on this line are 6s. 8d. per train mile; which, at an average rate all round of $1\frac{1}{2}$ d. per ton per mile, would give about fifty tons as the paying weight, and 255 tons as the gross weight hauled per train mile. Dividing this 255 tons into the 50 millions, gives 196,080 trains; which, being divided by the 313 working days of a year, give 626 merchandise trains, over all parts of the North-western Railway, in the twenty-four hours.

The Company's balance-sheet shows that each net ton produces about 4s. 8d., (including minerals, but as the net amount earned per train mile in the merchandise and mineral traffic may be taken as averaging nearly the same, this does not vitiate the argument), which, at $1\frac{1}{2}$ d. per ton per mile, makes the average distance traversed by each ton to be about thirty-eight miles; so that as each ton of the total weight hauled runs thirty-eight miles, and the entire length of line worked is 1,432 miles, it follows that there must be on an average thirty-seven merchandise trains distributed over the total length. This number, divided into the total number of trains per day of ~~seventy-two~~ ~~hauled~~, gives an average of over 17 trains per day.

running on each mile of the line. My object in bringing the figures to this point is to show that, although at first sight the number, 626 trains per day, looks large, yet, when divided over the entire line, it is comparatively small.

Having arrived at this conclusion, we are in a position to see how it would affect the question if the gauge of the line were 3 feet instead of 4 feet 8½ inches. In the first place, the same or a greater speed could be maintained, say up to thirty-five or forty miles an hour. I mention the speed here because I am dealing with goods trains only. Of course when passenger trains are considered the element of speed tells largely in favour of the broad (i.e., 4 feet 8½ inches) gauge; but this has been already admitted. My argument is only intended to show what a 3 feet gauge is capable of accomplishing in the way of duty, up to a speed of forty miles an hour; a speed which on such a gauge can only be obtained by the employment of the double bogie engines.

The speeds in each case being therefore equal, the next point to examine is the result of carrying on the narrow gauge. The proportion of non-paying to paying load has been taken at four to one on the broad gauge, although it has proved largely in excess of this. The waggons employed average four tons in weight, so that on this reckoning each waggon carries one ton for every mile it runs. It would be well to remember here that I am dealing with things as they are, not as they might be.

The waggons for a line of three-foot gauge weigh each one ton, and carry a maximum load of three tons. Supposing that the same number of waggons and trains were run on the narrow gauge as on the broad, it follows that the average one ton of merchandise now carried would easily be taken in a waggon weighing one ton instead of four tons, and that the gross load passing over the line for one year would be only twenty millions of tons instead of fifty millions; whilst the same amount of paying weight would be carried in either case. That is, the small waggons, which are capable of carrying three times the weight of goods now actually carried in a four-ton waggon, would only have to carry one-

third of that quantity, and would produce the same paying load as the heavier waggons; thus, instead of fifty millions of tons travelling over the line, there would only be twenty millions, and, as the haulage cost is precisely the same whether the tons hauled consist of paying or of non-paying load, it follows that this expense would be reduced to two-fifths of what it now is. We must also consider the enormous saving to the permanent way, which would have to bear the friction and weight of only twenty millions of tons in the place of fifty millions. If we assume the same number of trains to run per day, the weight of each would be reduced from 255 tons to 102 tons; or, if the same gross weight of train was employed, the number of trains per day would be reduced from 626 to 250. If there should be sufficient traffic to load the narrow-gauge waggons in such a way as to require the same number and weight of trains that are now worked, the result would be that, without increasing by one penny the cost of haulage and of the permanent way expenses, the three feet gauge would carry a paying load of twenty-five millions of tons as against the ten millions now carried. Here then we have established the fact that, so far as capacity goes, the narrow gauge is superior to the broad one. The former can produce twenty-five millions not out of a gross tonnage of fifty millions; whilst the latter, to produce the same result, if continued to be worked as it now is, would require that one hundred and twenty-five million tons should be hauled, and that at an increased cost in the same proportion of one hundred and twenty-five millions to fifty millions.

It may occur to some of my hearers to ask at this stage whether locomotives can be built to haul large train loads on a 3 feet gauge at the same speeds at which such loads are now taken on the broad gauge—my answer to this is decidedly "Yes."

The Fairlie double bogie engine can not only be made to haul trains fully as heavy and at the same speeds as those now taken on the broad gauge; but it will do this on what is

turned a light railway, with rails that shall not be required to exceed 50 lbs. to the yard, and that shall be fairly worn out, instead of being crushed and ground out as the 84 lbs. rails are under the present system.

It will be seen from this that a very large and important saving could be effected on the London and North-western Railway, if its gauge were 3 feet instead of 4 feet 8½ inches, without changing in the least degree its present system of management; and that this saving, divided between the public and the shareholders, would largely reduce the tariffs to the one, whilst it as largely increased the dividends to the other.

Before entering on another example of the advantages of the narrow gauge, it will perhaps be well to explain why it is that the average paying load now carried on the North-western Railway bears so small a proportion to the weight of the waggons employed in carrying it. The reason is obvious enough. The railway covers a very large area of country, and penetrates into districts from which there is a very unequal traffic; so that there must be a large average of empty waggons passing from one place to another in order to accommodate this traffic. It is impossible to find the same tonnage leaving a station that enters it. There is also great competition for the traffic; since most, if not all, of the large towns touched by this railway are also supplied by one or more lines belonging to other companies, and the inhabitants, having a choice, take care to avail themselves of it by fighting one company against the other. The result is, that each company tries to outbid its neighbour, not only in rates of charge, but also in affording the greatest despatch. This practically amounts to a competition as to which company shall run the greatest number of half filled or empty waggons.

Suppose, for example, that a person delivers a bundle of chairs, or a quantity of any goods, at a station, to be forwarded to some other station. The station-master cannot keep the chairs or other goods until he has a waggon load going to

the same place; but must despatch them forthwith, perhaps alone in a waggon that ought to carry ten times the quantity. But whatever may be the explanation of the small proportion of paying to non-paying load, the fact must in any case tell in favour of the narrow gauge. Suppose even that the waggons always ran empty one-half their time. Take the case of coal waggons, which run full only one way, and return empty. The narrow gauge still has the advantage, for they are only one ton waggons that run empty instead of being four ton waggons. In the case of the bundle of chairs there would only be the actual weight of the chairs added to that of the one ton waggon, instead of to the weight of a four ton waggon; so that, however the matter is looked at, it will always be found that the advantages on the score of economy are enormously in favour of light narrow gauge railways.

In India the competition between companies does not exist, and it is possible to detain goods at stations until a maximum quantity is obtained for transport. Time is there of little importance, and hence it has been urged that under such circumstances a large gauge and large waggons are the best, in order that it may be practicable to run a small number of heavy trains per day.

It is impossible to conceive an argument more fallacious than this; and its employment has saddled India with the commencement of a system of railways extravagantly beyond the requirements of the country for the next hundred years, or even for ever.

I have just shown that a 3 foot gauge-line can carry, without an additional shilling for haulage, $2\frac{1}{2}$ times as many tons as are now carried over the 4 feet $8\frac{1}{2}$ inch gauge of the North-western Railway. Whence then arises the necessity for constructing the Indian Railways on a 5 feet 6 inch gauge? especially when it is remembered that the total goods traffic worked over the whole of them does not amount to a sixth part of that now carried on the Northwestern Line alone.

Taking the case of the East India Railway as being the Northwestern of India, let us see how the absence of competition and the 5 feet 6 inch gauge affect the question of transport. The number of net tons hauled over the line for the year ending 1869, was 938,629, in 32,490 trains; amounting to about 29 tons per train. The average number of waggons composing a train is taken at 25, of 6 tons each; which gives 150 tons of train to 29 tons of freight, or a proportion of over 5 tons of dead to 1 ton of paying load. It will be seen that, notwithstanding the absence of competition, and with everything to favour the working of the line, the actual dead weight is over 5 tons to 1 ton. If, on the other hand, the gauge had been 3 feet instead of 5 feet 6 inches, the dead weight, under the same management, would have been reduced from 5 to 1, to $1\frac{1}{4}$ to 1. Let us imagine the saving that this change would effect in fuel alone; considering that less than one fourth of the tonnage now hauled would afford precisely the same accommodation to the traffic that now exists, and would produce the same paying result. It surely does not require a philosopher to see that the narrow gauge is infinitely superior in every respect even to the 4 feet $8\frac{1}{2}$ inch gauge, and it ought to be engraved on the mind of every engineer that *every inch added to the width of a gauge beyond what is absolutely necessary for the traffic, adds to the cost of construction, increases the proportion of dead weight, increases the cost of working, and in consequence increases the tariffs to the public, and by so much reduces the useful effect of the railway.* Let us suppose for one moment that the conditions of the cost of construction in the two instances were reversed, and that a 3 feet gauge line would cost twice as much to make as a 5 feet 6 inches gauge, even in such a case the difference in the cost of working each ton of goods would be so enormous that the narrow gauge would be by far the cheapest of the two in the end. It is unnecessary to say that the cost of constructing a railway is nearly as the width of its gauge; in very rough countries the narrow gauge will be greatly less

than the proportion to its width, whilst in flat level ground the proportion will be more; but, taking the average, (excluding Rolling stock, fencing, stations, and telegraphs,) the cost will be found to vary as the gauge. The advocates of the 5 feet 6 inches gauge, not content with the burthen which they have imposed upon India, are striving to impose a similar burthen upon our Colonies, and, in too many instances, they have actually succeeded. The Colony of Victoria, for example, has been provided with a system of 5 feet 6 inches gauge railways, which are so magnificent and costly that they charge the Colonial revenue with a trilling deficit of £30,000 per annum.

Tasmania, under the same management, has been saddled with a railway of 5 feet 3 inches gauge. There are other places similarly situated, but to mention them all would prolong this paper beyond its proper limits. I have shown sufficient evidence to prove what I said at the commencement; and, through the medium of this great Association, I desire to inform the inhabitants of countries in which railways are required how these can be obtained cheaply and efficiently. In moderately temperate climates, gauges of 2 feet 6 inches will be found ample for any traffic in any part of the world, and will sustain a speed of thirty miles an hour; while 3 feet is sufficient for either very hot or very cold climates, and will sustain a speed of forty miles an hour.

Railways can be made cheaply, and, at the same time, to be thoroughly efficient; and those who aver to the contrary are, in fact, enemies to progress and to civilization. There is no country too poor to have railways sufficient for its requirements; and railways furnish the cheapest possible mode of transport when they are not borne down by the results of that incompetence and extravagance which we so often see associated together. I regard it as the duty of every man in the old country to assist those of the new by pointing out how they may benefit by our dear-bought experience, and may avoid the

pitfalls into which only too many of our Railway Shareholders have fallen.

The present railways in India, although doubtless valuable for military purposes, have cost about £20,000 per mile. The average rate per ton paid on the East Indian Railway, is 2½d. per ton per mile. It may be fairly questioned how far these lines are boons to the inhabitants, who are called upon to pay taxes to cover the heavy annual interest on the cost, as well as to pay the high tariff of rates mentioned above. In any Indian extensions it should clearly be our aim to satisfy the natives, and to develop traffic at their hands. How different would the results have been, even now, if the lines had cost £5,000 instead of £20,000 per mile, and if the tariff of rates had been ½d. per ton per mile instead of 2½d. Not only would this have been practicable if the narrow gauge had been adopted, but the charge for the conveyance of salt, one of the first necessities of life in the country, need not have exceeded ½d. per ton per mile.

I cannot close this paper without some reference to a matter that is now part of history, and that serves as an admirable illustration of the manner in which self-interest, or even mere conservatism, may render men blind to the most obvious propositions. There are some whose whole desire it seems to be to rest in the path that they have become accustomed to tread; and whose instincts lead them at once to turn and rend any one that proposes a change. In January last my presence was hurriedly required in St. Petersburg by the Russian Minister of Public Works, with reference to the subject of the Fairlie system of railways, to which attention had been called by the very able articles upon the "Railway Problem," which appeared in *The Times* on the 19th, 20th, and 21st October, 1869. (A reprint of these articles will be found on the table.) His Excellency the Minister required me to give a short distinct account of the advantages claimed for my system. I replied, that by the adoption of that system railways could be made

at a cost of little over one-half the sum required to construct them on the ordinary plan ; so that it would be possible to give nearly *two* miles for the sum now expended upon one. That these lines, when finished and equipped, would possess a carrying capacity equal to, if not greater than, that of those on the old system. In other words, they should be capable of carrying as many passengers and tons of goods in twenty-four hours as the best lines now existing ; and that this should be done at a reduced cost, independently of the reduced wear and tear of the permanent way, and of the value of the increased life of the rails. His Excellency observed, that if only a portion of this could be accomplished, it would be a great thing for Russia, and that the matter should be at once inquired into. Not many days elapsed before an Imperial Commission, composed of a number of the most noted scientific men in Russia, and presided over by his Excellency the Count Alexis Bobrinskoy, private Attache to his Imperial Majesty the Emperor, was instructed to come to this country and to investigate the correctness of what I had asserted. Early in February the Commission arrived in London, and after a thorough examination of the question in all its theoretical bearings, it was resolved to put it to some practical tests. The Council of India, the Board of Trade, Norway, France, and other countries sent their representative men to be present on the occasion, as it was felt that what was good for Russia would be equally good for the countries I have mentioned. His Grace the Duke of Sutherland, always anxious to promote any system that will most largely benefit mankind, and having already a large section of railways of his own, built expressly to improve the condition of his tenantry, joined the party, and took a most active interest in all the proceedings. The results of the experiments then made are pretty well known, and any who may not be acquainted with them will find printed records of them on the table.

The Commission returned to Russia, and sent in its report to the effect that I had fully proved the correctness of all my

assertions. This was in March; and in April a railway of fifty versts, on the new system, was ordered by his Majesty the Emperor to be constructed, and to be opened in November next. The locomotives for this railway may be seen any day during the next month at the establishment of Messrs. Sharp, Stewart, and Co., Manchester. The new system has also been adopted for working some of the old lines, and the stock for the Tamboff Saratoff Railway, the Great Russian, and others, may be seen under construction at the same establishment.

The members of the Council of India were so struck with the accounts of the system, that the Home Engineers of the several Indian Railways were requested to report to their respective Boards their opinions on the applicability of a new narrow gauge for India. I have seen several of these reports, the whole of which are unanimous in their opposition to any improvement, or to any interference with the system under which the writers have lived, and moved, and had their being; but in only one of them is there any argument that requires a moment's notice. Mr. Hawkshaw, in his Report to the Directors of the Eastern Bengal Railway, urges that, since those who are in favour of a narrow gauge argue upon the basis of a light rolling stock, the same basis should also be taken by the advocates of a broad gauge. Were it not for this attempt at reasoning, and also for the fact that Mr. Bidder very fiercely attacks both me and my system, I should have left the reports wholly without mention. But I think it is worth while to reply to Mr. Hawkshaw, and also to place on record that Mr. Bidder has evidently never seen my system, although often invited to do so; and that he has based his condemnation of it upon an utterly incorrect description, both as regards principles and details.

The claim to calculate for broad gauge lines on the basis of a lighter rolling stock, is practically an admission that grave errors have been made in designing that which is now in use, and which it is proposed theoretically to not side

while the question of gauge is under discussion. But however Mr. Hawkshaw may build his stock in the future, he cannot possibly build it so light and capable of doing so much duty for the broad as for the narrow gauge. His argument is a complete confession of the mistakes made under the old regime; whilst at the same time it is an attempt to extinguish the general wish to inquire into the merits of the new. It is asking to be forgiven for the past, with a promise to do better in the future,—or to do anything rather than permit clients to go to a new school.

It is a sad incident in the great history of human error when we thus find men led into such mistakes as these by their anxiety to resist innovation. How different would be the course of invention, how smooth the path of improvement, what years of anxious labour would be saved to many of us, if such men would lay aside all rivalries, and would bring their helping hands to the good work of progress.

1874

THE

RIGI-MOUNTAIN RAILWAY

(LAKE LUCERNE).

DESCRIBED

By J. H. KRONAUER, PROFESSOR.

WITH REMARKS BY MAJOR T. F. DOWDEN, R.E.

WITH 3 ILLUSTRATIONS.

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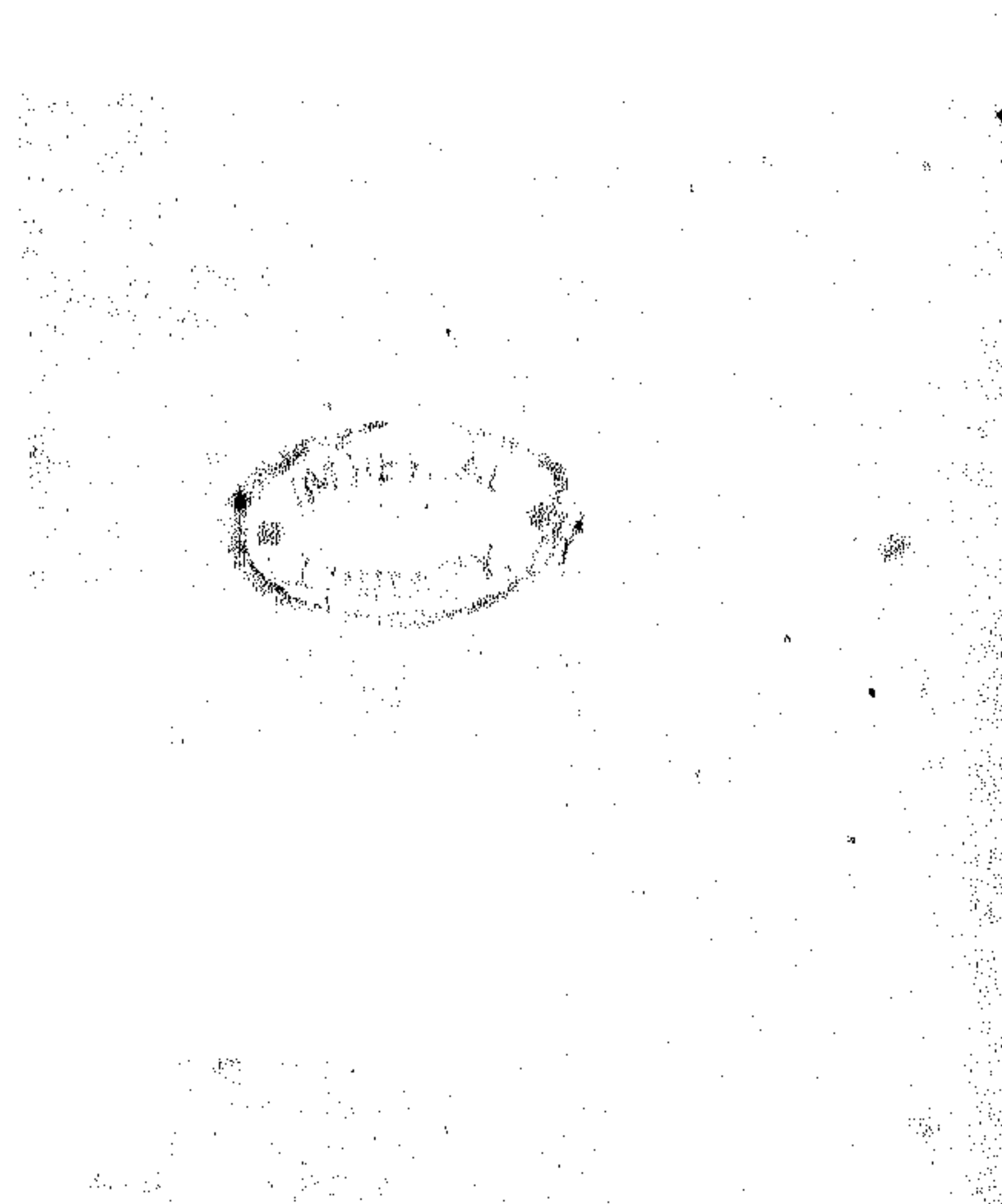
By J. H. KRONAUER, PROFESSOR.

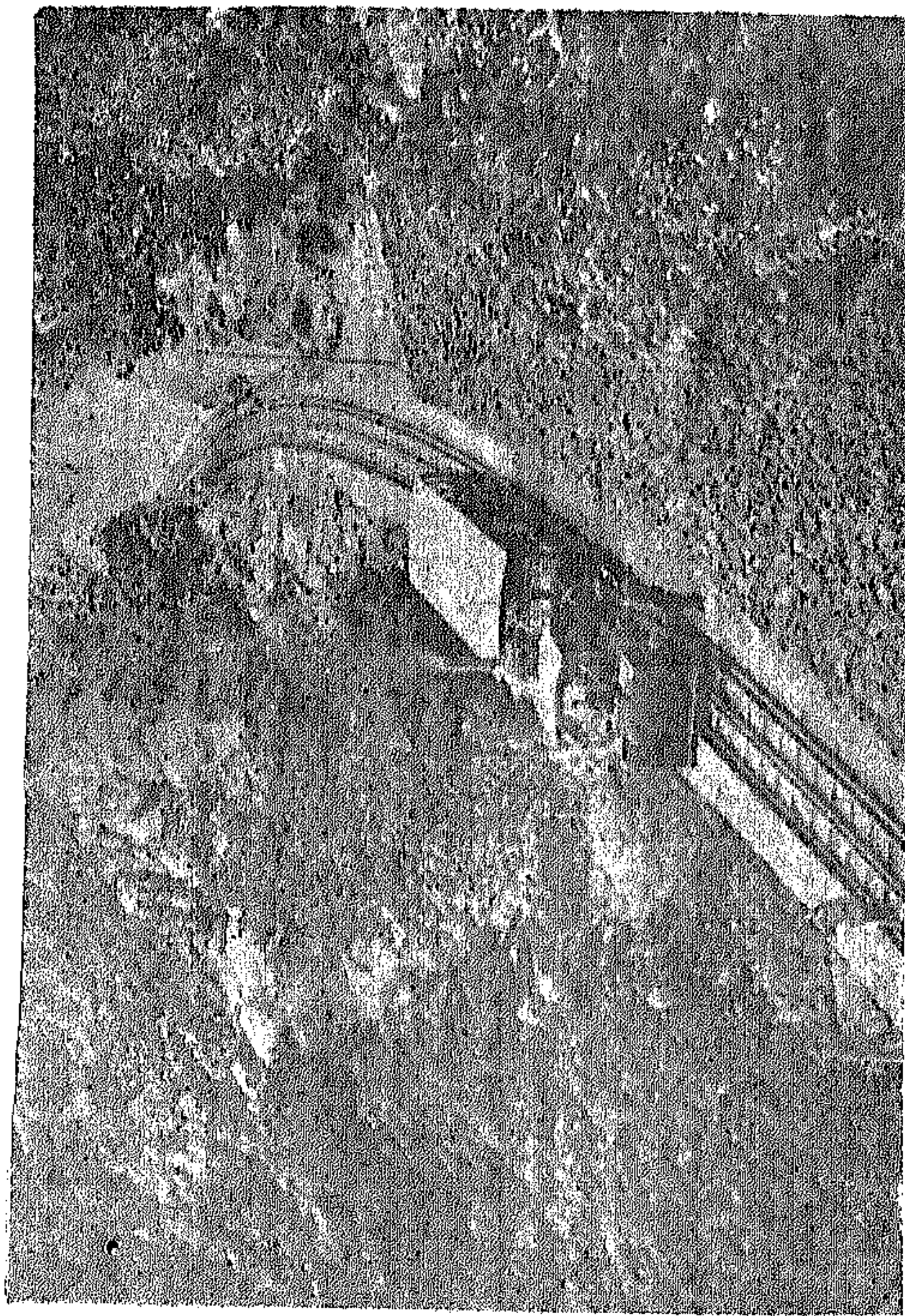
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REMARKS.

The advance of science which every day tends to bring the advantages of refined civilization more and more within the reach of the million, was certainly never more evident than when steam was first applied to locomotion. The journeys which the traveller made with much toil in a day, are now performed with ease and comfort in an hour: the friends we were able to meet once or twice in our lives can dine with us any day they like: countries lying barren and waste have sprung into cultivation, affording support to happy families; and in fact there is hardly a position in modern economies, domestic or political, which does not hinge, directly or indirectly, on locomotion by steam.

Whether these advantages are necessary or not to the ultimate destiny of man is a question which need not be discussed here; but it seems very evident that communities have it in their power, by good government, attention to moral teaching, by industry and energy, to increase their population, and that civilization, which supplies the comforts and blessings which almost inevitably accompany, will, if these attributes be steadily kept in view, not lead, as far as we can see, to anything to prejudice the cause of humanity in the distant future.

Taking things as we find them on this earth, it certainly appears as if the prosperity of countries and the position of the people in the scale of nations was intimately associated with the amount of facilities they have for locomotion. England, covered with a network of railways, is an example of the constant moving of the produce of one district to supply the wants of another, and hurrying of the people to and fro in search of health or wealth. How very different is a neighbouring state, poor Spain, torn by internal dissensions, with no commerce, and, comparatively speaking, no railways. She has a geographical position

in Europe second to none, with mineral wealth untold, to occupy her people, if the country could only be opened up. Turn to France, Belgium, Germany, and the new world of America. The latter, more than any country, exemplifies the progress of a nation pioneered by railway enterprise. Vast deserts, mountains, valleys, and rivers are unable to oppose barriers to the persevering energy and skill with which man has been gifted, apparently to enable him to utilise, to the utmost, the resources of the earth.

The only limit to his progress, humanly speaking, appears to be the one essential, viz., that the undertakings, to use a homely term, should pay.

In order that railways may pay, it appears that two things are requisite: the first is, that economy in construction and working should be exercised; and the second, that the public should desire and be able to avail themselves of the advantages offered to the extent proposed.

The former will be ensured by the careful exclusion of all unremunerative expenditure in construction processes, or such as does not contribute to minimise the power required for working; the latter will be influenced in a large degree by the comfort, safety, and celerity, which may be available at all seasons, the maximum of all of which, with a given outlay, it is the particular business of the engineer to provide. Thus not only does the expected traffic depend on the number of the population and its ability to pay for using a railway, but also on the inducements offered to use it *frequently*. Were railways only to be used for the purposes of trade and the acquisition of wealth, instead of also life and health, they would but half fulfil their objects. Wealth can of itself produce little pleasure to other than misers—and their number is fortunately limited—and most people view riches as a means to comfort and enjoyment. Assuredly no way commends itself to us of getting rid of the surplus rewards of previous labour so much as that which enables us to enjoy other scenes without going through severe bodily fatigue!

Anyhow this view, which has apparently induced the construction of a railway up a mountain with a total rise of 3,900 feet in three miles, solely with the object of providing 40,000 tourists with an easy ascent to the top of the *Rigi* on the Lake of Lucerne, seems justified by the results.

There was no large traffic to count on; there was a good road up which the youth and beauty of Europe and America were wont to spring, with the elasticity of spirit engendered by the charming climate, yet, though the road is no less useful than before, the carriages of the *Rigi* Railway are crowded to an extent that would make an Indian Traffic Manager's heart rejoice. The inducement is entirely the novelty of the sensation, the luxury of seeing, with absolutely no trouble, the most magnificent scenery in Europe.

These are advantages for which the thousands of visitors to Lucerne are ready to pay, and to such good purpose, and with such ability have means been adapted to ends in the construction of the line, that a combination of both circumstances results in a return of twenty per cent. on the capital expended, though the railway is not worked for more than half the year.

These are facts which show that mountain railways are perfectly practicable, and that they may be applied with great success even to a very small traffic.

The principle of the *ladder rail* is to apply direct pressure of the engine through cogs on an iron ladder rail to effect the propulsion of trains instead of by friction of the engine wheels on the rails. There is a limit of steepness beyond which an engine could not retain a grip on an incline by mere friction. It is variously stated by different authorities at from 1 in 4 to 1 in 7. But in practice inclines worked by locomotives are very much flatter than this, for if they were not, the load they could take would be excessively small. But the flattening of gradients which is equivalent to increase of the power of engines is effected only with expense in proportion, while the quantity of traffic may neither be so large as to require great power, or warrant a great expense.

In this way it is expedient to seek for a situation for a mountain railway to take a small traffic, where, though the grade may be as steep as possible, the amount of blasting, tunnelling, and bridging will be a minimum.

This is what has been done on the Rigi Mountain, which, with the exception of a little cutting and a bridge necessary near the foot, presents a surface with an almost continual incline of 1 in 4, on which to lay the permanent way, with a moderate amount of formation and ballast.

The line so laid out has cost £20,000 a mile, and is three miles long, giving a total of £78,000 for the capital. The profits are said to have been last year (1873) 20 per cent., or £15,000.

This amount was received from 100,000 passengers, giving 156£ per passenger, or about 8s. 1½d. As nearly as can be remembered, the fare charged was 7 francs for the ascent and 4 for the descent, or an average of 5½, equal to 4s. 4½d. The expenses may therefore have been about 1s. 8½d., and the total working expenses £6,850. But many persons avail themselves of the railway to go up who prefer the exercise of walking part of the way down, so that it is not easy to deduce accurately the expenses from the data available.

But as regards these expenses, we are able to form a pretty good guess. We know that the expenses of railways are almost invariably in the following proportion: Train Staff, 1; Station Staff, 1; Repair of Rolling Stock, 1; Renewal of Rails, 1; Maintenance of Slopers and packing up the Road, 1; Fuel, 2; Stores and Labour connected with Trains and Stations, 1; Administration, 1; Miscellaneous, 1; Total 10.* These expense proportions are independent of the gradients, but the amount of them will exactly vary with the gradients, and may be measured by the quantity of fuel expended in doing a given quantity of work.

The number of passengers using the line was 100,000, and 54 are contained in 1 train, giving 1,852 train loads, which, distributed over 180 working days, would give about 10 trains,

* See *Notes on Railways* by the author.

which, is probably the number of full ones that were run. The weight of them is made up of 15 tons for engine, 4 for carriage, and about 3 for passengers—total, 22 tons.

On the level it takes about one-seventh of a pound of fuel to take a ton over one mile, which is the same as raising a ton through 28·5 feet, reckoning the resistance at 10 lbs. per ton at a velocity of 15 miles an hour for ordinary trains. For a rise of 1,800 ft. the quantity consumed would be 55 times as much, or 8 lbs. of good coal per ton moved one mile up the Rigi. But in descending no fuel would be required at all, so that per ton mile run, the expenditure would be 4 lbs. on the average of up and down. This would make the cost of working for fuel about $27\frac{1}{2}$ times that of a ton over a mile of ordinary level line; all expenses would be in proportion. In India, a fare of $\frac{1}{4}$ of a penny a mile is one which pays well for 3rd class passengers, the cost being about half that sum; the number of passengers per carriage is not so great as in the Rigi Railway, the dead weight may however be considered constant. $27\frac{1}{2}$ times this amount ($\frac{1}{8}$ d.) would be 5·15d. per mile, or 15·45d. on the average for 'up' and 'down', or 1s. 8½d., which agrees with the expense deduced above; the receipts therefore being 17·58d. per mile, the expenses are about 5·15d.

The large dividends are then clearly traceable to the high fares, which however are cheerfully paid by the tourists, and are, after all, only in keeping with hotel charges at the lakes! It is advantageous to mention these circumstances, because it will show that mountain railways promise well even in situations where a less dividend than 20 per cent. can be counted on.

The economical capability of the single line, which is three miles long, for trains which work at three miles an hour, is 12 trains to the day's work. A train must consume 264 lbs. of fuel on the average per trip,* which would amount to 1·414 tons a day, and for a complete year to 516 tons. The cost of the line was £78,000 complete, and for working expenses, to equal the rate of interest of money,† say 5 per cent., they must be

* $22 \text{ tons} \times 3 \text{ miles} \times 4 \text{ lbs.} = 264 \text{ lbs.}$

† See *Notes on Railways*.

£8,900 a year.* One-fifth of this will be for fuel, £780; it has been shown above that the quantity which can be most economically consumed is 516 tons, which would give the price of coal, including carriage on the Railway, at about £1-6-8 a ton.

The number of passengers with luggage, therefore, capable of being conveyed daily on a single line most economically, would be 324 in each direction, or 648 altogether, making 236,520 per annum.

Owing to the circumstances of the Rigi, which is essentially a sight-seeing line, trains running at every hour up and down would not answer the purpose, for visitors require to go up in the morning and return in the evening, and as they are all actuated by the same motives, the number of daily trains has to be crowded into shorter times towards morning and evening. It will suggest itself to engineers that this necessitates a good deal of 'empty' haulage and a larger stock of engines and vehicles than would otherwise be necessary, and this is in fact the case. Two engines would suffice for a regular traffic, whereas six or seven are to be seen in shed.† The working expenses per passenger are largely increased by these causes.

It also becomes necessary to allow more than one train to be travelling between stations at a time, which appears to be done with little or no danger, when the nature and extent of the brake power available is understood.

As regards the applicability of these railways to India, it may be remarked, that it has at various times been proposed to locate all European troops in the Hills, and there seems no reason to doubt but what they would be specially useful in conveying the troops, followers, supplies, and stores up and down, and that the provision of such railways to approach our hill sanitarium would lead to their being much more resorted to than they now are by both Europeans and the upper class of

* It appears they were £6,350, which shows it was worked beyond its economical maximum.

† This state of things would result in loss to the Company no doubt, but for the cause which proscribes its own cure. That is to say, the demand on the line enables higher rates to be charged to meet it.

natives. The lines could first be used for the transport of building material in the formation of the hill stations, and would not necessitate large outlays to provide a sufficient amount of accommodation for the residents afterwards.

Such a line as the Rigi Railway, affording access to an elevation of 3,900 feet, is shown to be made in Europe for £78,000, or £20 per foot of elevation. The interest and working expenses would not amount to more than £7,800 a year, and would provide for the movement of 648 men, or a reduced number with baggage, heavy stores, or materials, over it daily; the fare charged need not be higher than 10s. 3d. a mile to return 5 per cent. on outlay. Every one knows that this would be an enormous saving in the present cost of ascending our Hill Stations with kit and kin.

It will of course be evident that a less abrupt rise in the gradient would enable more work to be done, but to attain the same elevation, a longer line would have to be constructed, and unless a reduced cost per mile for the less rise occurred, the whole height would be reached with a greater total expenditure. This expenditure might be justified owing to the larger traffic to be expected, and which the greater power resulting from the flatness of the grades would admit of being conveyed; accordingly every case ought to be worked out for itself; the smaller the traffic the steeper the gradients may be left, and *vice versa*.

Not to draw these remarks to a tedious length, the reader is referred to the admirable pamphlet and plates kindly furnished by the Company, which will explain the details of the construction which the author was unable to note on his hurried visit to Lucerne made in September last. To such as have seen the railway up the Rigi and feel interested in engineering works the pamphlet may supply some useful notes, while to such as have not, and who may be contemplating a run home *via* Brindisi on three months' short leave during the summer, it may act as an inducement to take Lucerne on the way, and in doing so, as it is certain such persons will have souls above pay and promo-

tion, they will be fully rewarded by a trip up the Rigi. It must not be omitted to mention that the author's acknowledgments are due to Mr. Maclean of the *Bombay Gazette* for the kind way in which he undertook to have the pamphlet translated from the German; also that the letter from the Company preceding the description of the railway has been printed, first, because it supplies some interesting details, and secondly, because it will enable any one seeking more information to obtain it by addressing the Company direct. *

* Just as the revised proofs of the above are being returned to the press, a description of the Rigi Railway has turned up in the Minutes of Proceedings of the Institution of Civil Engineers, vol. xxxvi., part 2, dated 1873, which enters into fuller details. At page 116 will be found statements confirmatory of the calculations of expense.

The number of trips up and down in 1872 was 2,875, or 16 per day, and number of miles run 8,920, giving 3.1 miles for the length of the line. The number of passengers, both ways included, was 87,000. Gross receipts £15,105, expenses £3,420, not including £3,000 carried to reserve fund. The receipts and expenses per passenger per mile, if they had all travelled the whole length, would be therefore 13.5d., and 3.04d., the latter not including contribution to reserve fund for repairs of way, &c. The receipts are less than shown by the calculations for 1873, and the line appears to be 3.3 per cent. longer than assumed (3 miles). The cost of the line is stated to have been £60,000, and the number of passengers 87,000, the former figures being 77 per cent. and the latter 87 per cent. of those given in the pamphlet. It is probable that Mr. Riggenbach only gave approximate figures in his letter below, but it seems some portion of the Railway is being doubled and the traffic is increasing. The figures given in the Institute Proceedings place the subject in a more favourable light, but considering the enhanced price of iron, and the cost of freight to India, it is probable that the ones appearing in this pamphlet will be more applicable to similar projects in this country. Anyhow they seem to be on the right side. Mr. J. Hawkshaw stated at the meeting that the Rigi Railway seemed, on the whole, to display much constructive cleverness and to do great credit to its engineer.

Aarau, October 10th, 1873.

DEAR SIR,—In reply to your favour of 2nd instant, wishing for details concerning the Rigi Railroad Company, we beg to state the following:—

The Rigi Railroad was constructed in the years 1869 and 1870 by Messrs. Nüeff, Riggenbach and Zschokke, M. Riggenbach, the inventor of the system, being the mechanical engineer, while Messrs. Nüeff and Zschokke constructed the road bed.

Since then, the road has been run constantly during summer seasons, the number of passengers amounting, for this year (1873) to about 100,000, the net profits of the stockholders to about 20 per cent. on the outlay.

The enterprise having met with great approval, a company was started to work the system on other mountains and in other countries, and patents were accordingly taken out where they could be obtained. The company is organized on a capital of 12,500,000f. (£500,000) with Messrs. Riggenbach and Zschokke as its leading engineers, and a large establishment has been constructed under their direction in Aarau for producing all materials, rails, locomotives, &c., necessary for mountain railroads.

Prominent bankers have charge of the financial part.

Six roads in this and other countries are under contract and will be finished in 1874 and 1875; ten others are being surveyed.

The system (ladder-rail) can be applied on inclines of from 6 to 25 per cent. (1 in 20 to 1 in 4).

Replying to your special questions, we may remark:—

1. The locomotive ready for use weighs about 15,000 kilogrammes (15 tons), and costs about 45,000f. (£1,800).
2. A passenger waggon weighs about 4,000 kilogrammes (4 tons), and costs about 8,000f. (£320).
3. Rails weigh 10 kilogrammes (22 lbs.) per yard.
4. Ladder rail weighs 55 kilogrammes (121 lbs.) per yard.
5. Superstructure costs about 110,000f. (£4,400) per mile.

6. Rigi railroad costs 650,000f. (£26,000) per mile.
7. The descent is made simply by compressed air. The brakes are only applied to stop in extraordinary cases, &c.; to stop the trains at once, a train (one waggon and locomotive) can be stopped at one yard's length.
8. The locomotive works with a pressure of ten atmospheres.
9. Only best coals are used.
10. With 25 per cent. incline (1 in 4) the locomotive can only push one waggon with 50 persons and luggage, with only 10 per cent. (1 in 10) the locomotive could push or pull 180 persons with luggage.
11. The rails can be laid on ordinary gauge or narrow gauge. Rigi railroad has the normal gauge of European railroads.
12. The Rigi Railroad was finished last year for three miles with an elevation of 4,500 feet above the level of the sea.
13. On inclines of 5 to 15 per cent. (1 in 20 to 1 in 7) the locomotive can run six miles an hour, at 15 to 25 per cent. (1 in 7 to 1 in 4) four miles an hour.

To acquaint you as much as possible with the whole system, we enclose herewith drawings of locomotives, waggons, ladder-rail, &c., &c., for your inspection.

Should you think it probable that such roads would be useful in your country and could be run profitably, we would put our engineers at your service for the location of lines, the construction of which you could then easily execute by your own engineers according to plans we would hand you.

Our Company would furnish you with locomotives, waggons, rails, ladder-rail, in fact the whole necessary permanent and rolling stock, and we even could send you some experienced engine drivers for working on roads at the beginning and instructing your workmen.

We shall be happy to hear from you, and remain,

Dear Sir,

Yours very sincerely,

IL. RIGOLDENBACH.

THE RIGI RAILWAY

ON THE

LADDER RAIL SYSTEM.

DESCRIBED BY
PROFESSOR J. H. KRONAUER.

(1871.)

With three Illustrative Plates.

The Rigi mountain, whose elevation of 1,800 metres offers one of the most imposing views, and whose elegant hotels give at the same time hospitality to many hundreds of visitors, is visited yearly by about 40,000 persons on an average. Most of them undertake the rather fatiguing ascent on foot, a great number take advantage of somewhat expensive horses, or are carried up. Long ago the desire was expressed for some easier routes, but the accomplishment was always delayed, until at last, to the terror of the guides, carriers, and horsekeepers, the project of a railway was started, and in a short time assumed a definite shape.

As the originator of this bold undertaking, we have to name the engineer, Mr. N. Riggenbach, Director of the Central Railway in Olten, who had already obtained a patent in 1863 in France for a system of Mountain Railways on the principle of the Ladder Rail; but though the model made for the exposition of this working principle served to procure for it many well-wishers, it did not succeed in bringing together the requisite capital to make a trial on a large scale. Only when, in the year 1868, the news came from America that, upon Mount Washington, in the vicinity of Boston, a similar railway, with an ascent of 83 per cent., was in the course of execution, and

after this railway had been carefully examined by a skillful engineer, then only the three engineers—Riggenbach, Nüeff, and Zschokke—associated together to establish such a railroad on the Rigi. They obtained, in the beginning of 1869, from the Luzern Government, a concession for the laying down and working of a railway on the South declivity of the Rigi Mountain, viz., from Vitznau on the Vierwaldstatter Lake to the Luzern-Schwyz canton boundary, above the Kaltbad, with a prospect of a continuation (upon Schwyz territory) to Rigi Kulm. The formation of a company in shares encountered no difficulties, the requisite capital of francs 1,250,000 (50,000/.) was subscribed for at once.

In November of the same year the works began, and the road would, without doubt, have been completed by the autumn of 1870, if, in consequence of the Franco-German war, the delivery, from France, of the rails had not come to a stop.

The length of the railroad is 5,840 metres (3·23 miles) and the difference in level of the termini is 1,200 metres (3,900 ft.). The railroad begins in Vitznau, near the Seegestade, winds through the village with an elevation of 0·037, and passes thence against the precipice of the Rothfluh into the considerable ascent of 0·25 (1 in 4). This ascent varies, however, on the remaining distance between 0·18 (1 in 6) and 0·25 (1 in 4); the maximum of ascent exists for about one-third of the entire railroad. The rest has an incline of 0·21 (1 in 5) on an average. All the curves which occur in the road have a radius of 180 metres (595 ft.).

Above the Rothfluh the railroad goes through a tunnel cut through the Nagelluh, of 75 metres in length, and immediately after goes over a bridge of 76·5 m. (247 ft.) in length, crossing the Schurztobel, which is 23 metres in depth. A little higher up, the road cuts rather deep into a projection of rock, and this place, upon the nature of which there had been some misapprehension, occasioned a considerable delay in the progress of the works. After this, however, the emplacement showed itself exceedingly favourable for the laying down of the railroad.

Superstructure, Plate 1.—The superstructure consists of cross sleepers *a* (Fig. 1—3) 2.40 m. (7.8 ft.) in length, which are totally imbedded in the ballast at a distance of 0.75 m. (2.45 ft.) apart, and forming a ladder, with two longitudinal sleepers *b* bolted thereon; this ladder being intended to take the rails *c* and the iron-toothed cogways *d* *e* lying between these rails.

For the further strengthening of that ladder, masonry foundations are let in at distances of 0.75 m. (2.45 ft.) in the embankment to a depth of 1.50 m. (5 ft.) (upper side). Each of these foundations contains two strong freestones (square stones) which protrude over the masonry at sleeper's height and place themselves against two consecutive sleepers. In this manner it is expected that the foundations are secured against any possible slip.

The abovementioned rails have the universally adopted gauge of 1.435 m. (4 ft. 8½ in.), and are lighter than ordinary railway rails; they weigh, per running metre, only 16½ kilogrammes (33 lbs. to the yard). The cog-rod *d* inserted in the middle serves to catch the cogs of strong cog-wheels of cast steel, which are attached to each axle of the locomotive, as well as on those of the passenger-waggons. It consists of two [shaped rolled rails *d*, through which the wrought iron teeth *e* are passed. The latter are 80 mm. in height, below 55 mm. and above 80 mm. in width; they are pinned together with keys somewhat flattened above and below (Fig. 12, Plate 3) in the walls *d* and are rivetted on the outside. This cog or grip-rod is put together from pieces of 3 mm. each in length, and the ends of two such pieces are fastened by fish-plates inserted below, and well screwed together. As the lowest tooth of each grip-rod piece is the most exposed to a break from the rail in consequence of a break in the latter, trials have been made, what force would be required for the break of such a tooth from the side walls. At the first trial the distances from the plug hole up to the flat ends of the walls was 28 mm., equal to the half of the interstices between two teeth. With a pressure of 20 tons, the wall was torn out from the middle of the rivet hole. Thereupon another grip-rod piece was taken, by which the distance from the

plug-hole up to the ends was 50 mm. The breaking weight here increased to 48 tons. In the first case the so-called *shearing* resisting power was 3.95 tons; in the second case, 3.83 tons per square centimetre. In consequence of this having been established, the strain of two grip-rod pieces was placed, not in the middle of two teeth, but 35 mm. from the uppermost and 26 mm. from the lower tooth, as shown in Fig. 12, plate 13.

Particular difficulties were encountered in making the segments of this grip-rod falling in the curves of 180 metres radius, through which the teeth had to be arranged to go converging.

At the two ends of the railroad are stations, and in the middle of its length there is a place for crossing trains. As the grip-rod makes the applying of usual crossings impossible, the transfer of the train upon the side-track *c' c'* (Figs. 4 and 5) is arranged by means of a turn-table revolving upon the pivot *f*. This apparatus consists of two walls *g*, of double T iron, which bear the rails *c'* and are joined below by the ties *h* to a solid frame. The rollers *i* repose upon rail pieces *k*. The turning of this bridge is done through the windlass *l*, which sets in motion the grip-rod *m* which is joined with it in one link. The length of the bridge is 15 mm. (50 ft.), and is sufficient to take the locomotive and the only passenger-carriage usually attached.

Bridge over the Schurrtobel, Plate 2.—This already previously mentioned bridge stretches in one curve of 180 m. radius, and with an ascent of 25 per cent. (1 in 4) over the Schurrtobel, the profile of which is shown in Fig. 6. It consists of two plate girders *n n* (Fig. 8) which are braced below by horizontal T irons *o* and flat bar irons *p*. The compression beams *q* are 30 cm. in breadth. Upon these girders, the cross beams *r* of double T iron are placed, and upon these again the longitudinal sleepers *t t* for the grip-rail *d e*, and the rails *e e*; two boards *u* forming side walks are also placed thereon. The two edges of the bridge are provided with light iron railings *v* (Figs. 8 and 9).

The lower end of the bridge is supported at *w* in a cut in the solid rock; the other end rests at *x* upon masonry,

and finds here the required play-room for the expansion occasioned by the changes in the temperature. The bridge is further supported by the very light looking piers $a' a'$, which are put together out of double T and angle iron (Figs. 10 and 11), reposing upon stone sockets.

The Locomotive (Plate 3, Fig. 13) was constructed by the Engineer Niggensbach in Olten, and built in the workshops of the Central Railway there. The peculiar construction of the same is adapted to the circumstances under which it is called upon to act. The iron framework b reposes upon two axles d and e , and supports in the middle an upright tubular boiler f , which is so placed that it only comes in a vertical position when the railroad upon which the locomotive travels has attained an ascent of about 19 per cent. The upright position of the boiler had to be selected, because in a horizontal one the difference of the height of water on the fore and hind ends with respect to the tubes, on a considerable ascent, would have been too great, the inclined position of the boiler to the frame makes the differences which arise with an upright boiler less sensible. In consequence of this, the locomotive assumes always a similar position to the direction of the railroad, that is, both on ascending as on descending the same side of the locomotive is directed upwards. Upon the descending side the tender g is placed, consisting of a water and coal-box fastened upon the carriage frame; on the other end there is a compartment h made of trellise work for the reception of luggage.

On each side of the locomotive there is a steam-cylinder i , the piston rod of which is joined in the usual manner to the crank k (Figs. 13 and 15). This contains also the eccentrics l and m for the link motion, but is not, as in other locomotives, also at the same time a wheel axle, but is connected with the actual locomotive axle d' (Fig. 16) through the cog-wheels $n' n'$ and $o' o'$. The machinery pieces n' are 0.2227 m. (8.58 inches) in diameter, and have 14 teeth, whilst the axle wheels are 0.6842 m. (2.223 feet) in diameter and have 43 teeth. As the axle d' does not follow the movements of the running

wheels, but those of the driving-axle k' , the wheels p' are placed loosely upon the journals of the same, and merely kept from gliding off by nuts. Upon the middle of the axle d' lies the grip-wheel q' , which catches in the grip-rail d' s' in the middle of the railroad. Its diameter is 0.8300 m. and it has 20 teeth. The teeth are rounded off and work with the least possible sliding upon the teeth s of the grip-rail, the transverse section of which is seen in Fig. 17. It is through the action of this cog-wheel that the entire load of the steep railroad must be borne; it is therefore manufactured out of first-rate cast-steel. The teeth of it are punched out of the entire piece, and formed with great precision to the required shape.

The other locomotive axle e' carries also two loose running wheels r' , and in the middle a tightly wedged cog-wheel, similar to the one q' upon the other axle. This has however no independent turning motion, but serves exclusively as a brake wheel, when the machine has to be stopped. For this purpose its axle is provided with two brake rods near it upon which the two brake blocks s' can be pressed, through the handle t' , which is attached to the tender, and the various connecting pieces u' , v' , w' , &c. A smaller brake u' is fastened to the driving axle k' (Fig. 18), which can be worked from the crank y' . None of the brake-blocks are smooth upon their broad sides, but indented wedge-shape (this refers also to the brake-blocks mentioned hereafter, attached to the axles of the passenger carriage), and this can be seen in Fig. 15, and conforming to this shape the wooden brake-blocks annex themselves. It is quite apparent that the action of the brakes is considerably enhanced thereby, and in case of need, all possible slipping can be avoided.

The steam issuing from the boiler, by opening of the throttle valves a^s , enters at b^s through the fork-shaped tube c^s branching off towards the two cylinders; the steam going off is carried through the tube d^s to the blast pipe. This is the usual course in locomotives and takes place here in the ascent. It is entirely different in descending; and here the question of the security of the train against an acceleration surpassing the normal velo-

city arises. It must be added that the travelling speed at the ascent as well as at the descent is the same, in fact a comparatively small one, 4,800 metres (3 miles in an hour). During the descent the admission of the steam into the cylinder is completely shut off by means of the valves g^2 . The pistons work backwards and forwards with the motion of the engines, and the main object is only to retard them in such a manner that their reaction upon the cog-wheel q' should regulate the motion of the latter to the required speed. This is done through atmospheric air, which is sucked up by the piston through the lower part of the tube d^2 and again expelled through the tube e^2 . For this purpose there is attached to the latter at e^2 an outlet cock, the opening of which is regulated in such a manner that the air filling the cylinder can only be discharged with considerable resistance (i.e. through a small opening). The space included in the two slide valves and the tube e^2 thus assumes the functions of a wind-boiler, the pressure of the air in them taking the place of the steam pressure in ordinary boilers owing to the resistance to the escape of the air through the small opening. The pressure in these parts must be equal to that in the boiler required for the ascent. A very great increase of pressure takes place in the cylinders from the beginning towards the end of the stroke. The entrance of the air takes place at the box f^2 , in which two valves g^2 and h^2 of 0.12 m. diameter are placed. One of the valves g^2 opens in the upper part of the tube d^2 and allows the passage of escaping steam towards the blow-pipe; the other valve h^2 is placed upon the bottom of the box, opens inwards in the interior of it, and allows atmospheric air to flow in. Both valves are in such a manner connected together through the lever i^2 , that alternately one closes through the opening of the other. At the escaping of the steam g^2 opens and h^2 will be closed; on the exhausting of the cylinder, that is, on the descent, the contrary action takes place. The air-brake acting through these natural means works as strongly as securely, which has been proved by many trips. It remains to be remarked that a small pipe takes water from the tender to the cylinders under the slide-valves

on the descent. Therewith is obtained first a cooling on the one hand, and, on the other hand, the drying up of the piston packing, &c., is prevented.

Finally, a further very important contrivance has to be mentioned, which prevents the locomotive from running off the rails in case a foreign substance were to come between the teeth. This is shown in Fig. 14, and consists of strong angle irons r^a , of 18 centimetres in width, which are fastened in front and behind to the locomotive and catch under the upper flanges of the ladder rail sides d with horizontal and vertical play-room of 15 mm. each. The weight of the machine with loaded tender is 12,500 kilogrammes (12.5 tons).

Passenger Carriage (Plate 3, Figs. 18 and 19).—The construction of these carriages is clearly shown in the drawings. Low entrance doors afford the passengers an unobstructed view of the lovely scenery. Nine benches, affording six places each, are placed in the interior of the carriage. The peculiar shape of the same (Fig. 18) allows a comfortable seat in all positions that the carriage may have to assume upon the inclines. The benches consist of 5 light wrought iron frames each, upon which wooden ribbands are screwed for the seat and the back to be fixed to.

Each of the two carriage axles h^a (Fig. 19) are provided with two tightly wedged running wheels l^a , with two indented brake-blocks m^a , with a cog rod wheel n^a , and with two brake contrivances o^a, p^a, q^a . With the help of these latter the conductor is able to stop the carriage suddenly at any place he likes, as by the drawing on of the brakes, the axles, and with them the wheels n^a , are brought to a stand and then held fast in the ladder rail d *c*.

Finally, it must be remarked that there is no coupling between the locomotive and the passenger carriage; the latter simply leans against the former, and when travelling in either direction, is naturally on the upward or ascent side of the locomotive.

By careful examination of all the arrangements one must confess that not only is the class of design particularly well adapt-

ed for mountain railways, but also that all the arrangements are so carefully contrived that the working is perfectly safe and free from all danger. The future will teach us how the railroad, for the laying down of which the utmost endurance and solidity have been sought, will resist the action of changes in the temperature, displacements of the ground, &c. As however the line will only be worked during the dry season—at the utmost six months of the year—there will be ample time to repair all possible damage which may occur. The greatest security to the working can however be found in the fact of the very small travelling speed, and that the train and also the passenger carriage alone can be stopped immediately, when necessary.

Fig. 1. Transverse Section of the Railroad Yee

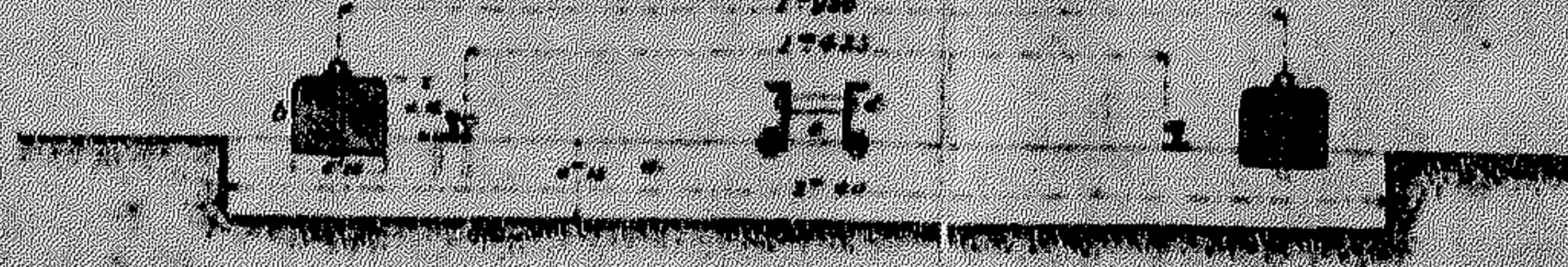
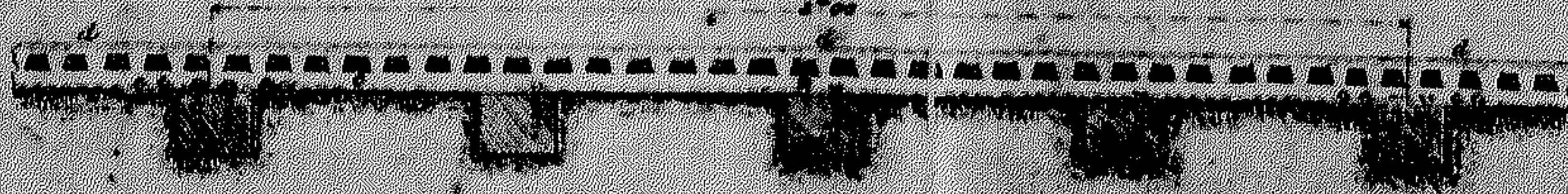


Fig. 2. Longitudinal Section of the Railroad Yee



Ground Plan of the Railroad Yee

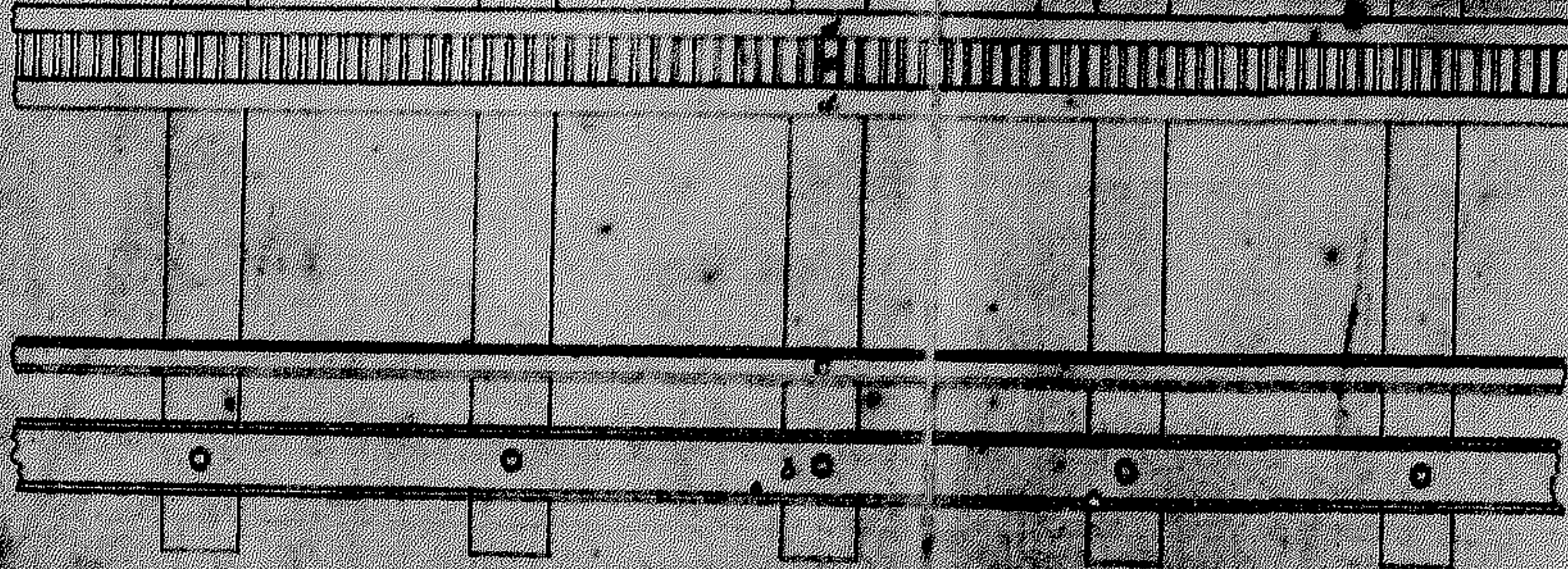


Fig. 4. Side Elevation Yee



Turntable

Fig. 5. Ground Plan

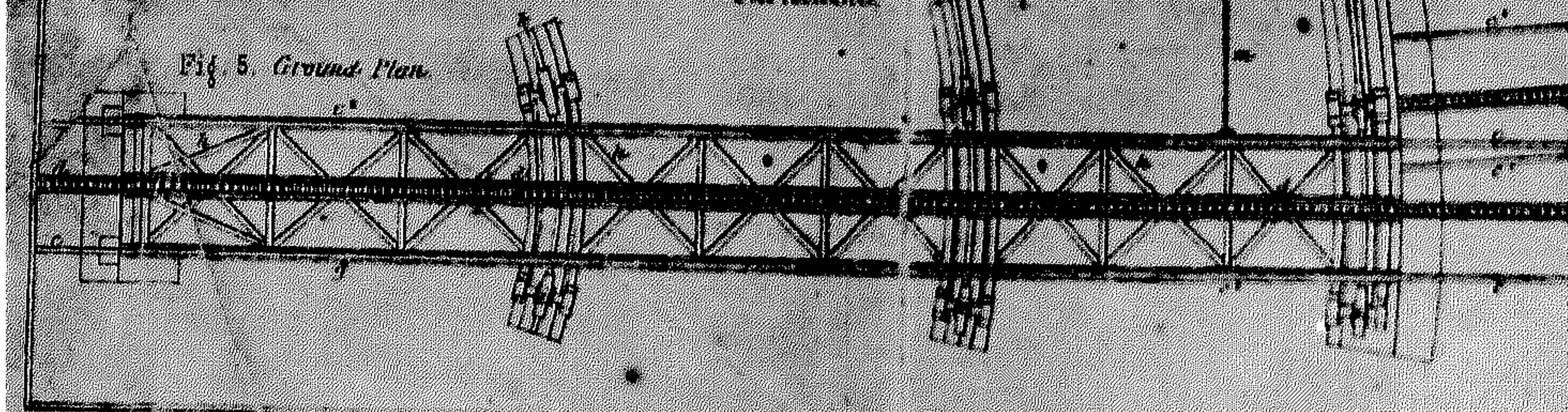


Fig. 8. Transverse Section of the Bridge $\frac{1}{80}$

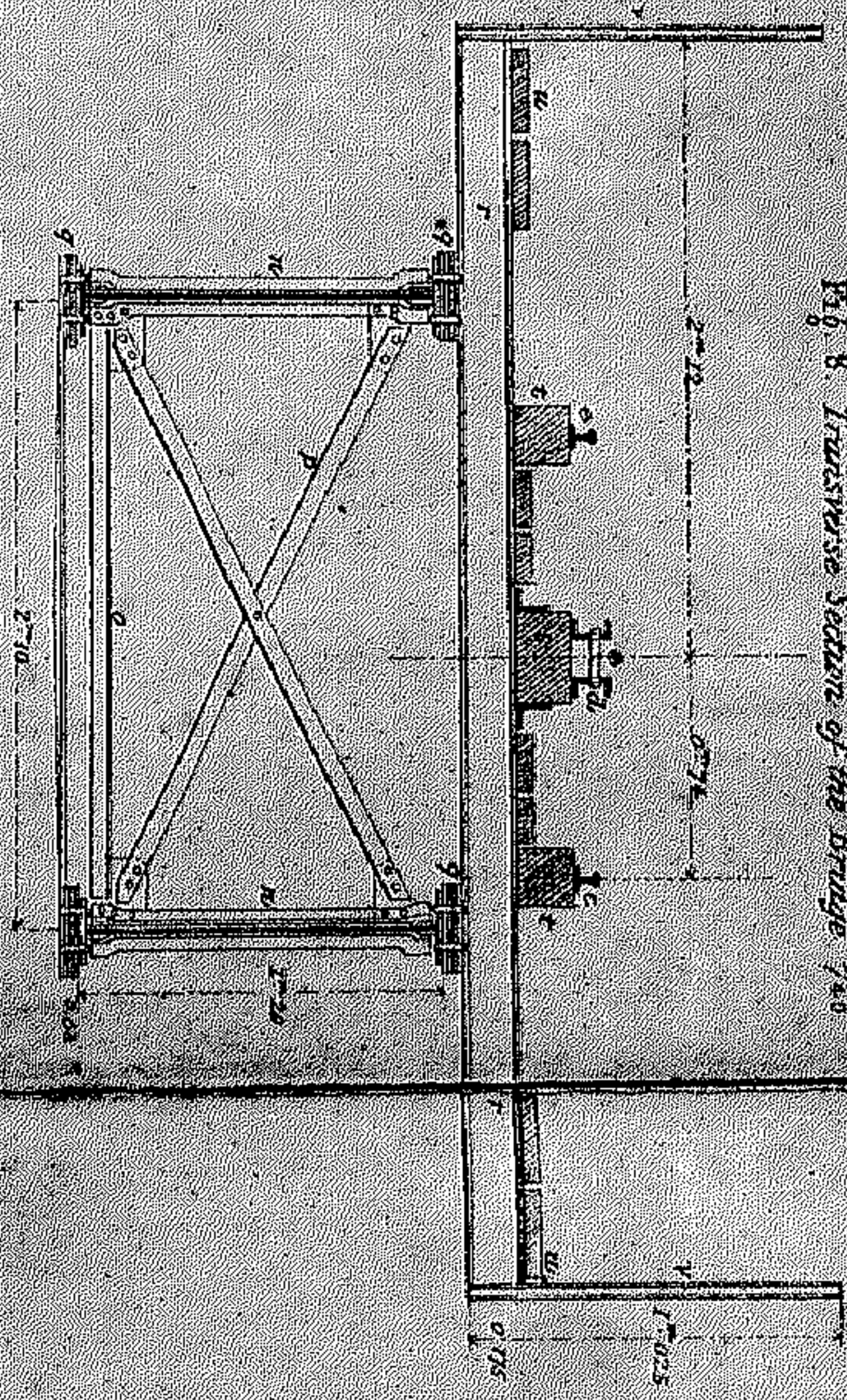


Fig. 9. Longitudinal Section of the Bridge $\frac{1}{100}$

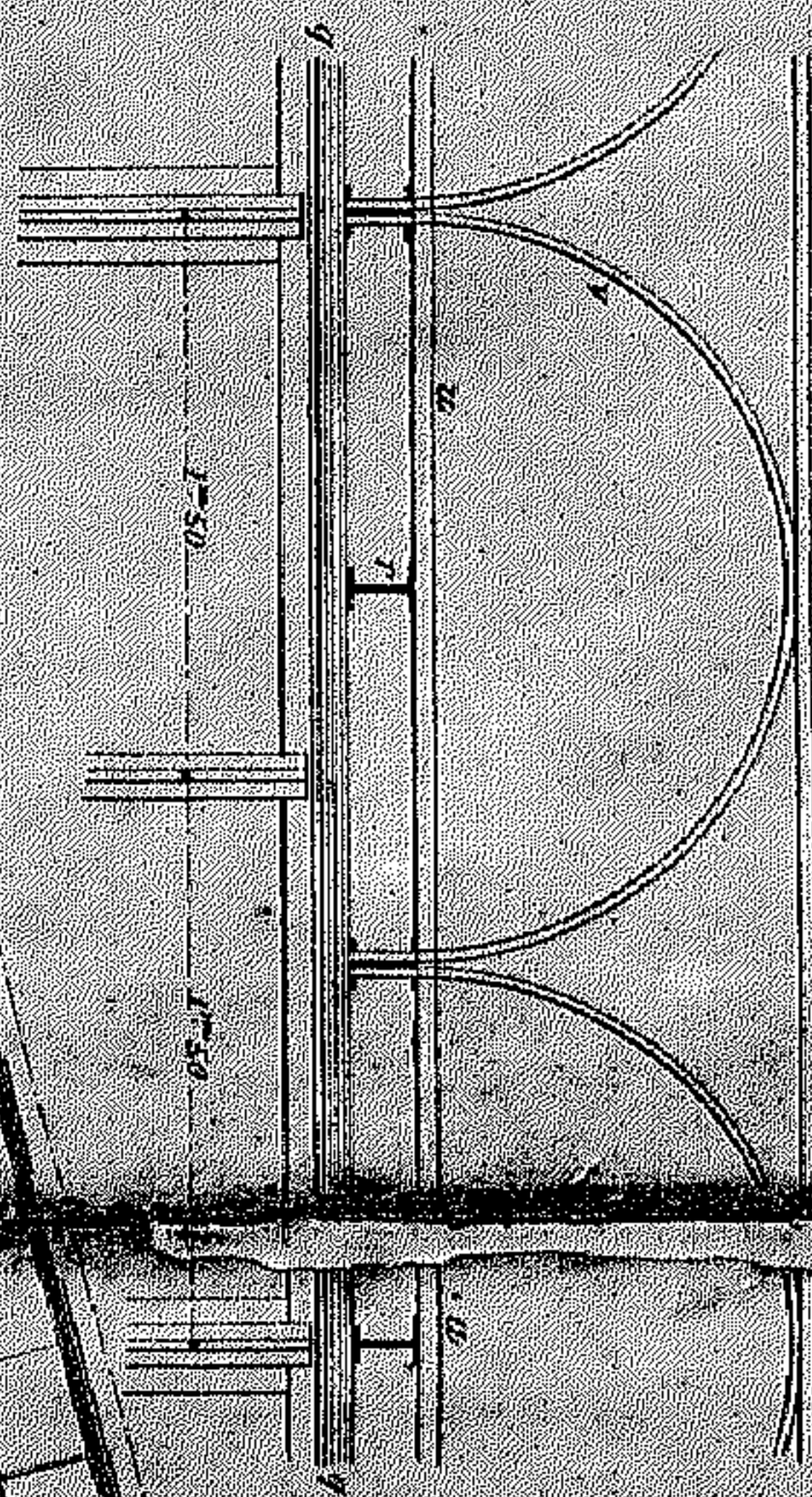


Fig. 6. Side Elevation of the Bridge $\frac{1}{100}$

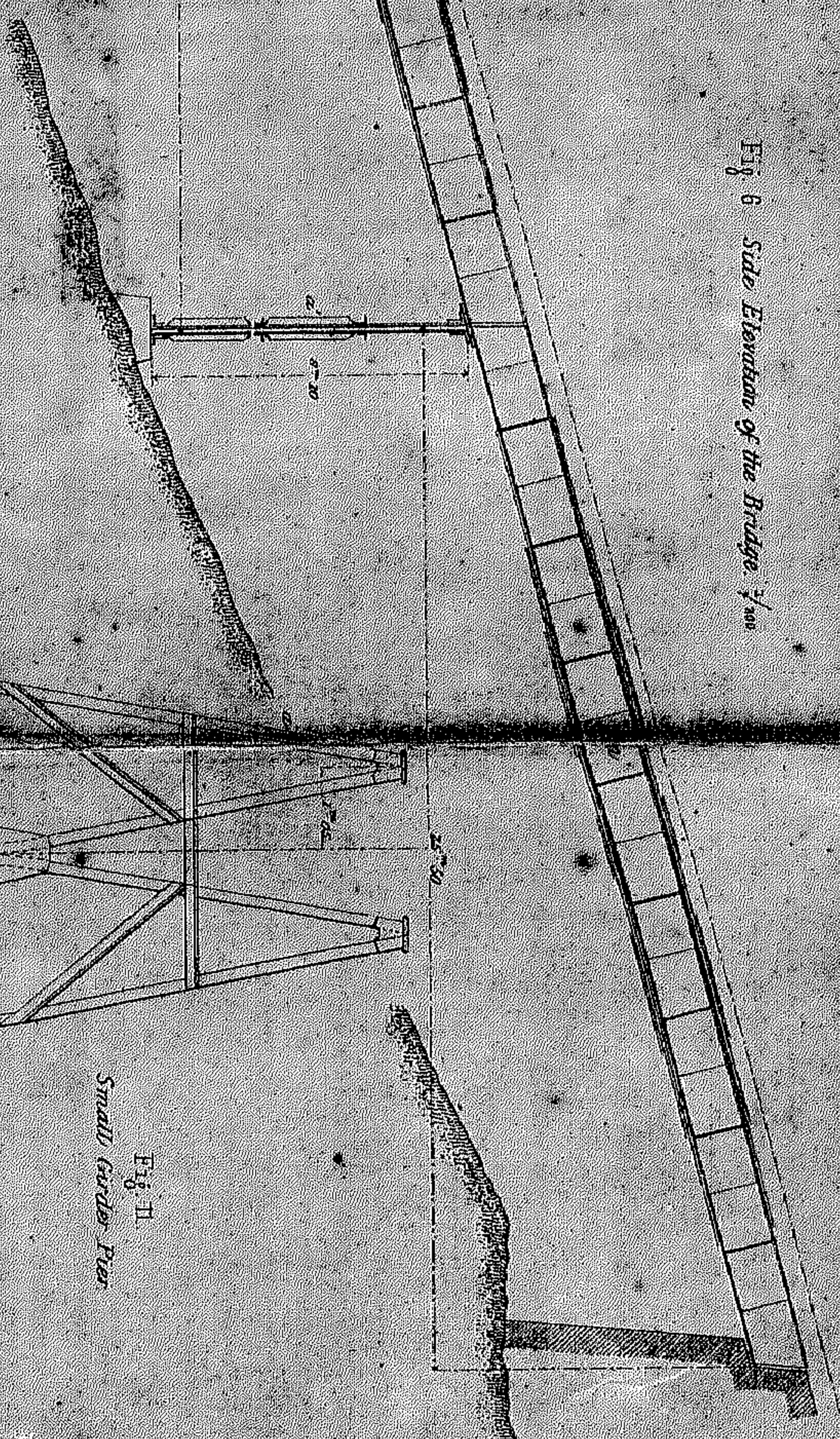


Fig. 10. Large Guide Pier Plan

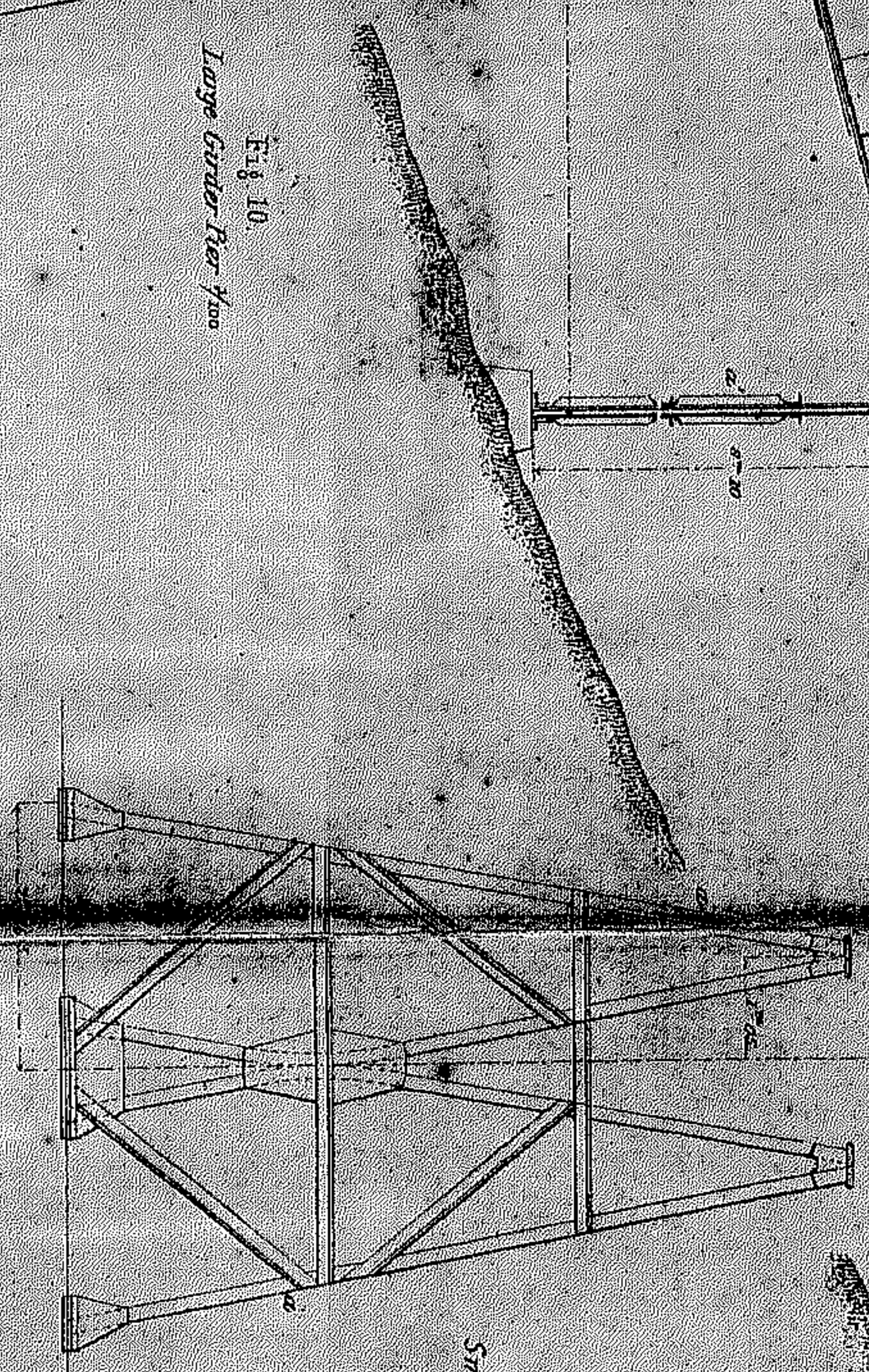


Fig. 11. Small Guide Pier

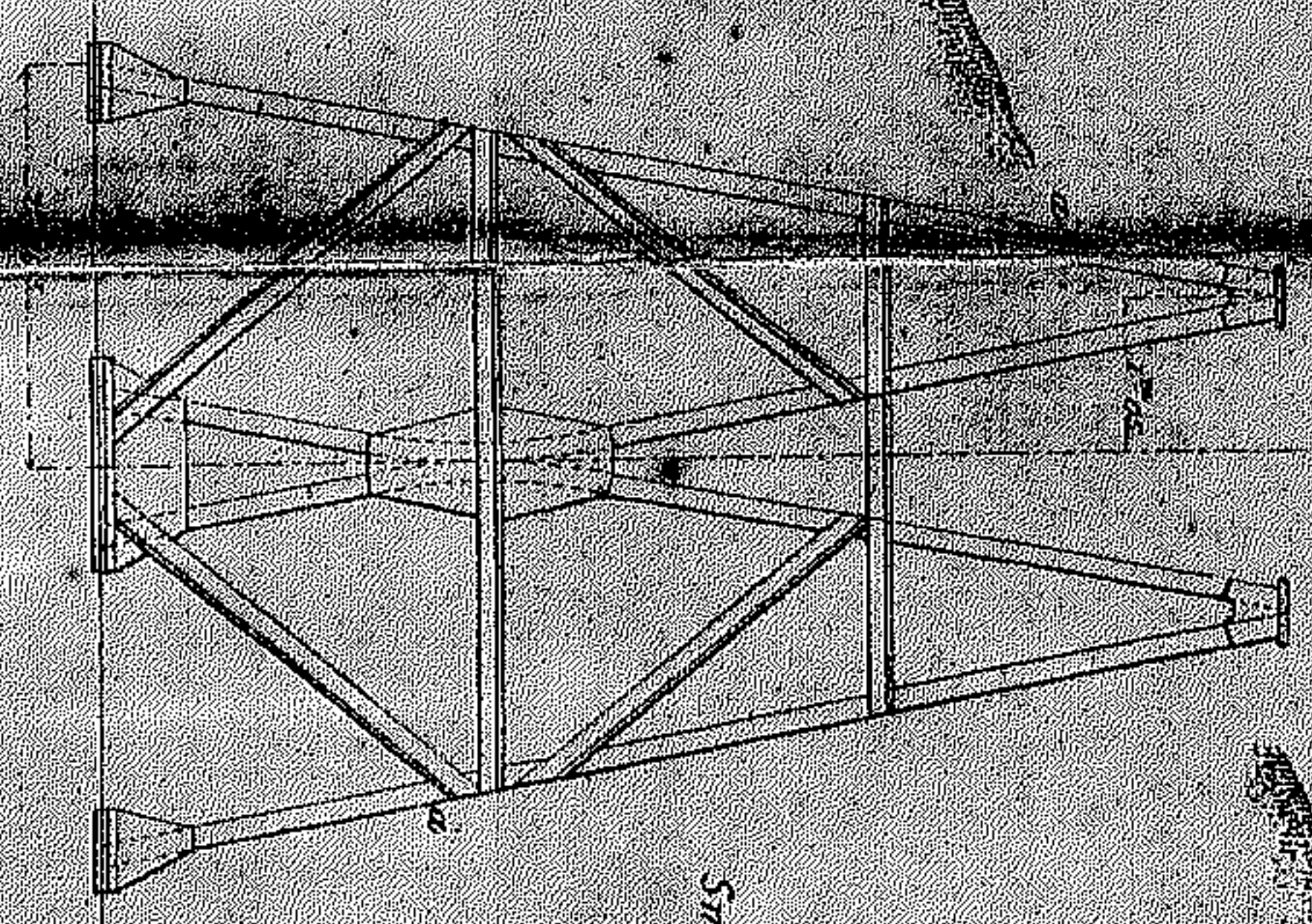
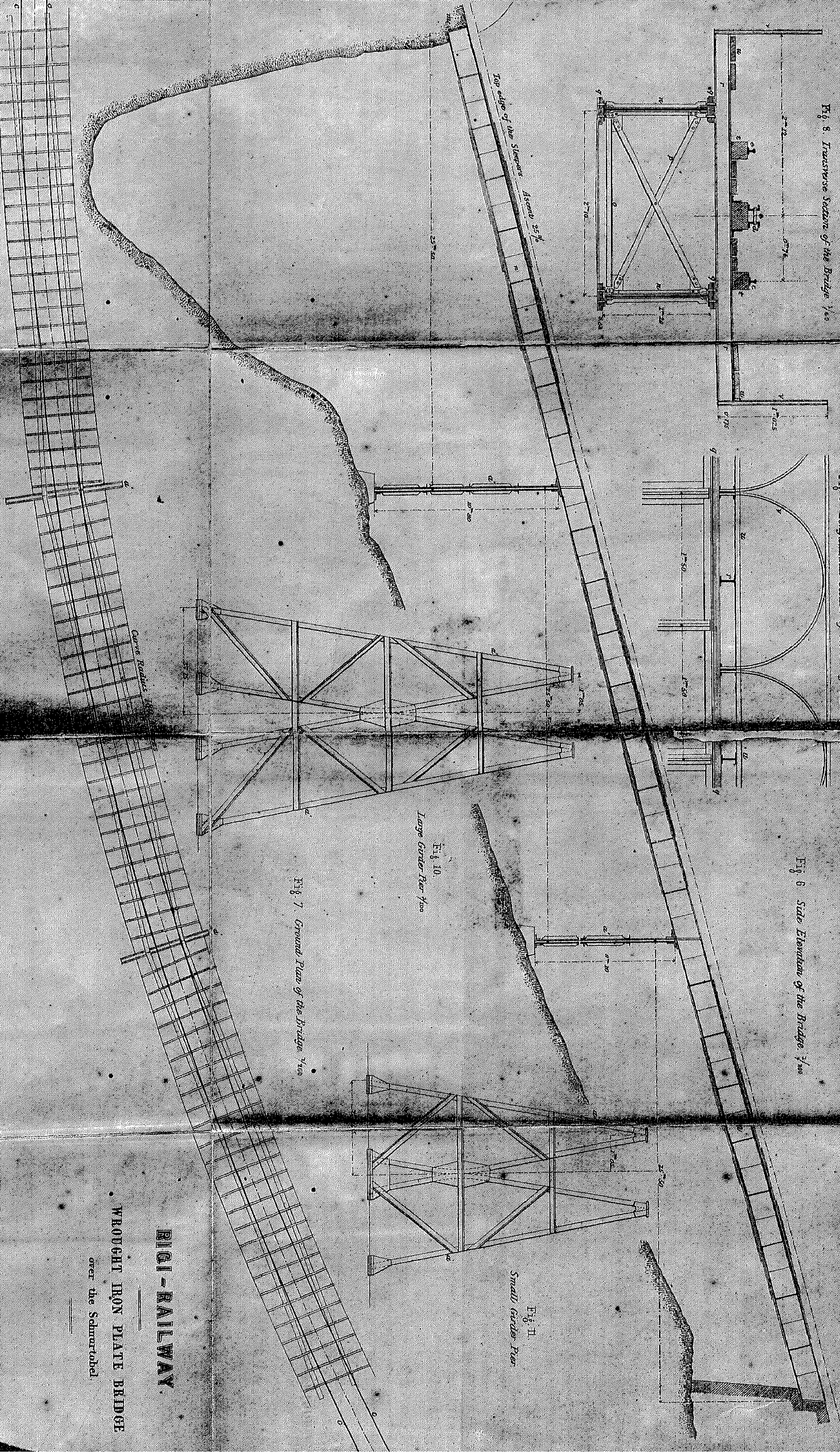


Fig. 7. Ground Plan of the Bridge $\frac{1}{100}$



RIGI-RAILWAY.
WROUGHT IRON PLATE BRIDGE
over the Schurdtobel.

RULES

OF THE

New Amalgamated Society

OF

RAILWAY SERVANTS IN INDIA.

REGISTERED UNDER ACT XXI OF 1860.

CALCUTTA:

PRINTED BY I. C. BORE & Co., STANHOPE PRESS, 240, BOW-BAZAR
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Price four annas only.

RIGI-BAHN

Fig. 13. Locomotive $\frac{1}{25}$

Chief Dimensions of the Locomotive.

Diameter of the Cylinders	10.63 inches
Stroke	15.75
Expansion Proportion	1 to 3
Wheel base	2.87 feet
Gauge	4.37
Weight of the Machine with Water and Coals	12 tons
Steam pressure	150 lbs.

Diameter of the Driving Wheels n'	8.75 inches
" of the Axle Wheels. o'	26.75 "
" of the Cogrod Wheels q'	25.06 "

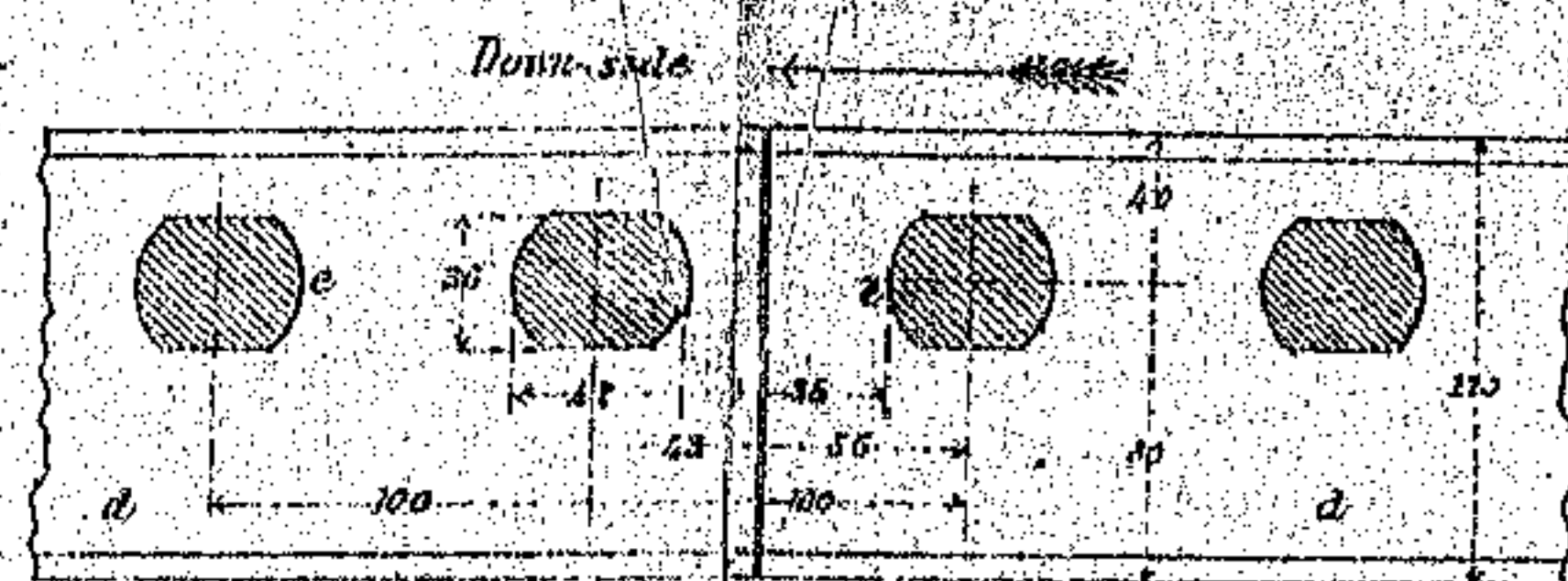


Fig. 14. Transverse Section of Ladder Rail

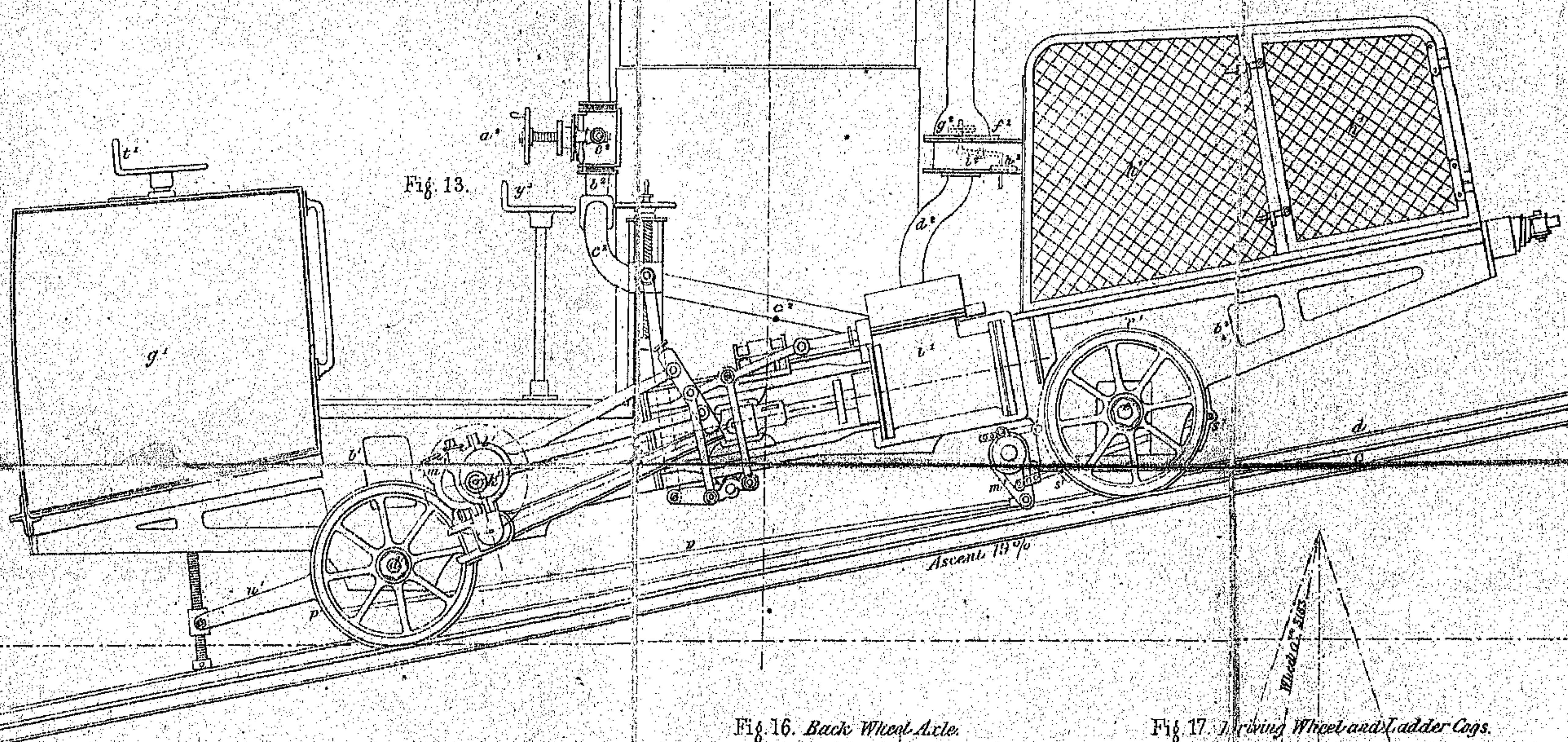
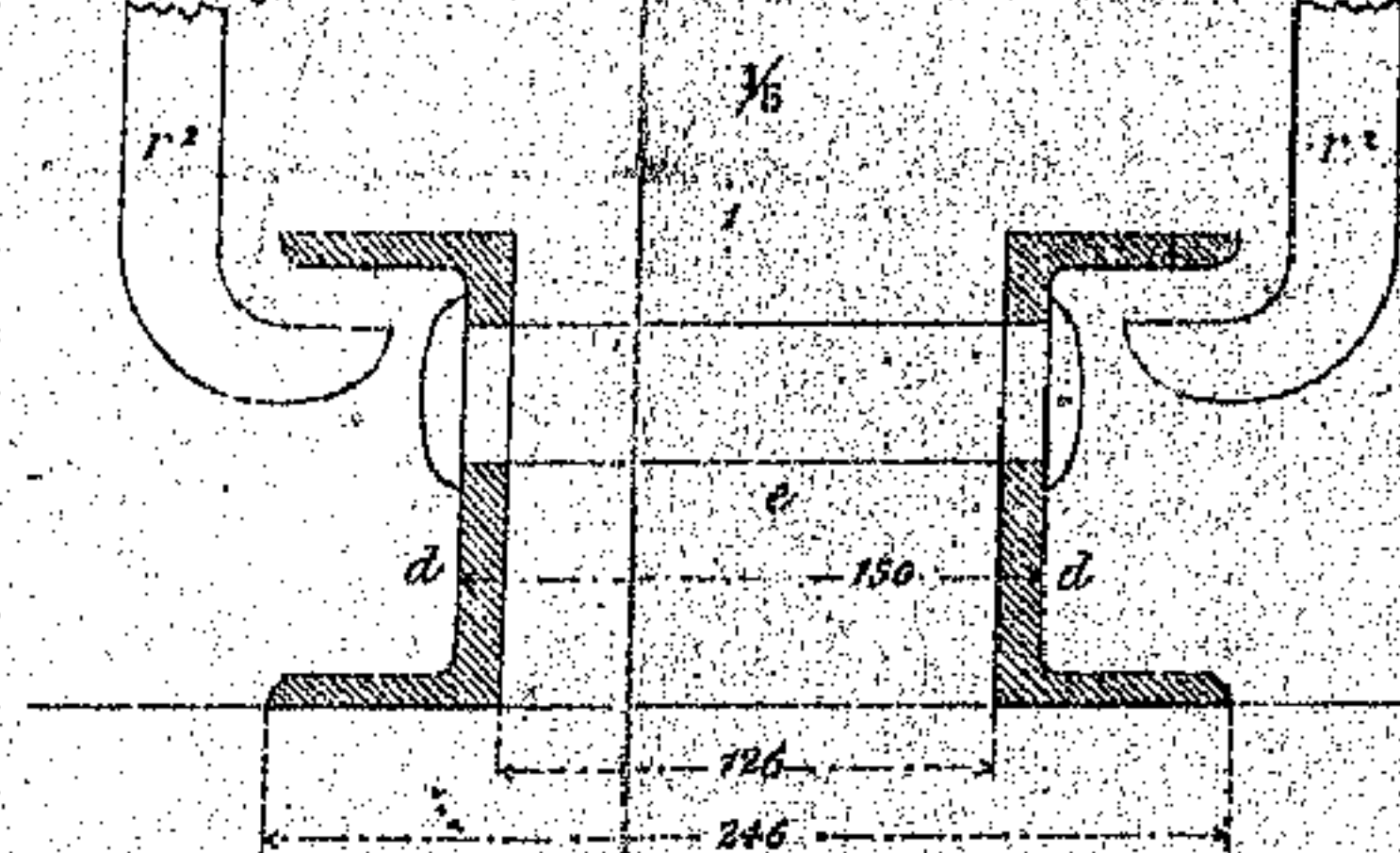


Fig. 15. *Driving Axle.*

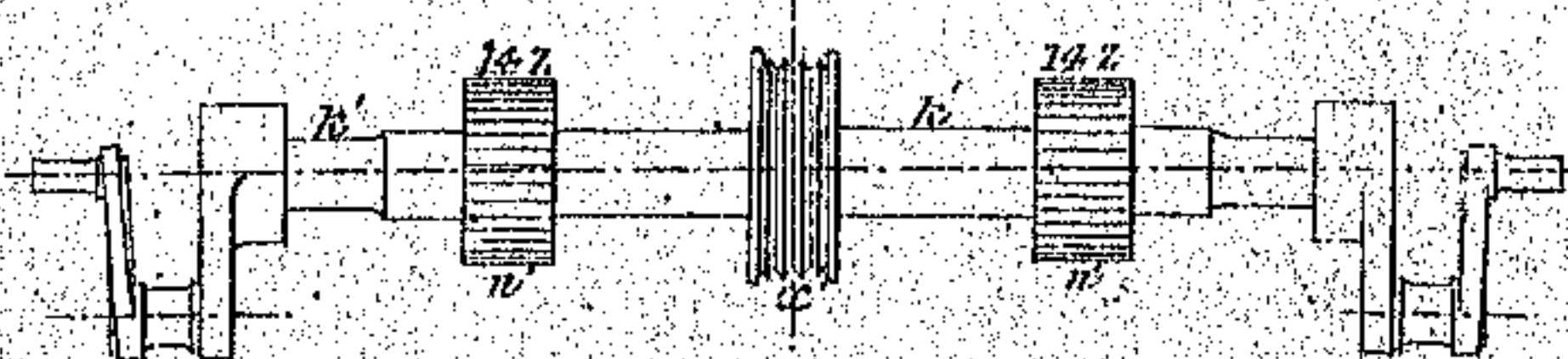


Fig. 16. *Back Wheel Axle.*

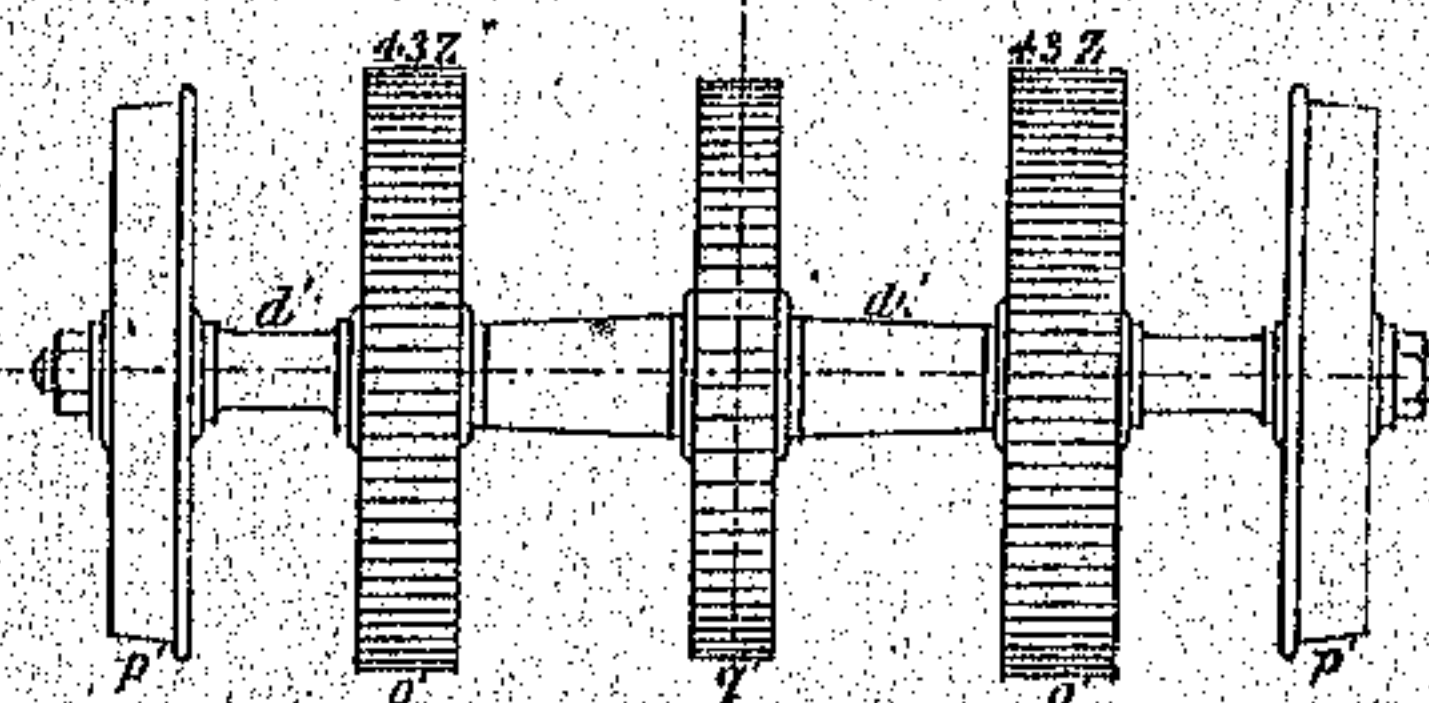
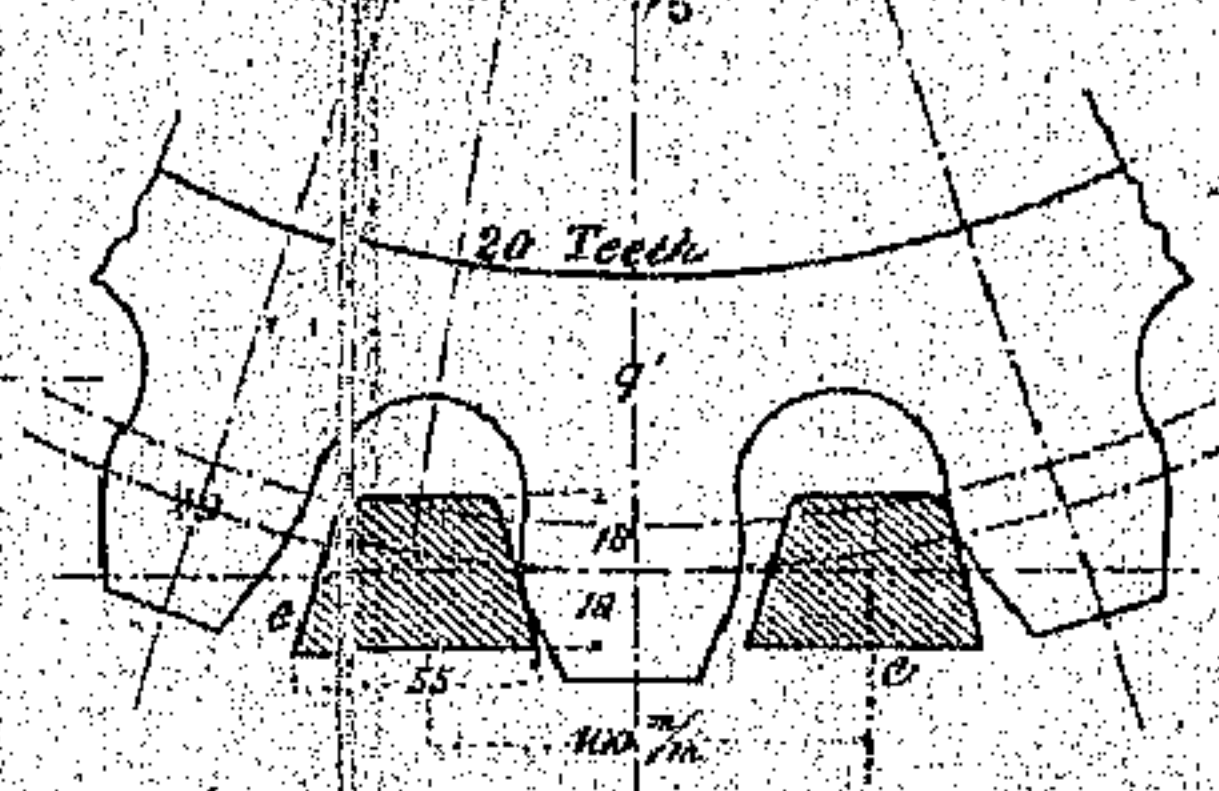


Fig. 17. Driving Wheel and Ladder Cogs.



Passenger Carriage. $\frac{1}{25}$

Fig. 18. *Longitudinal Section & Side Elevation.*

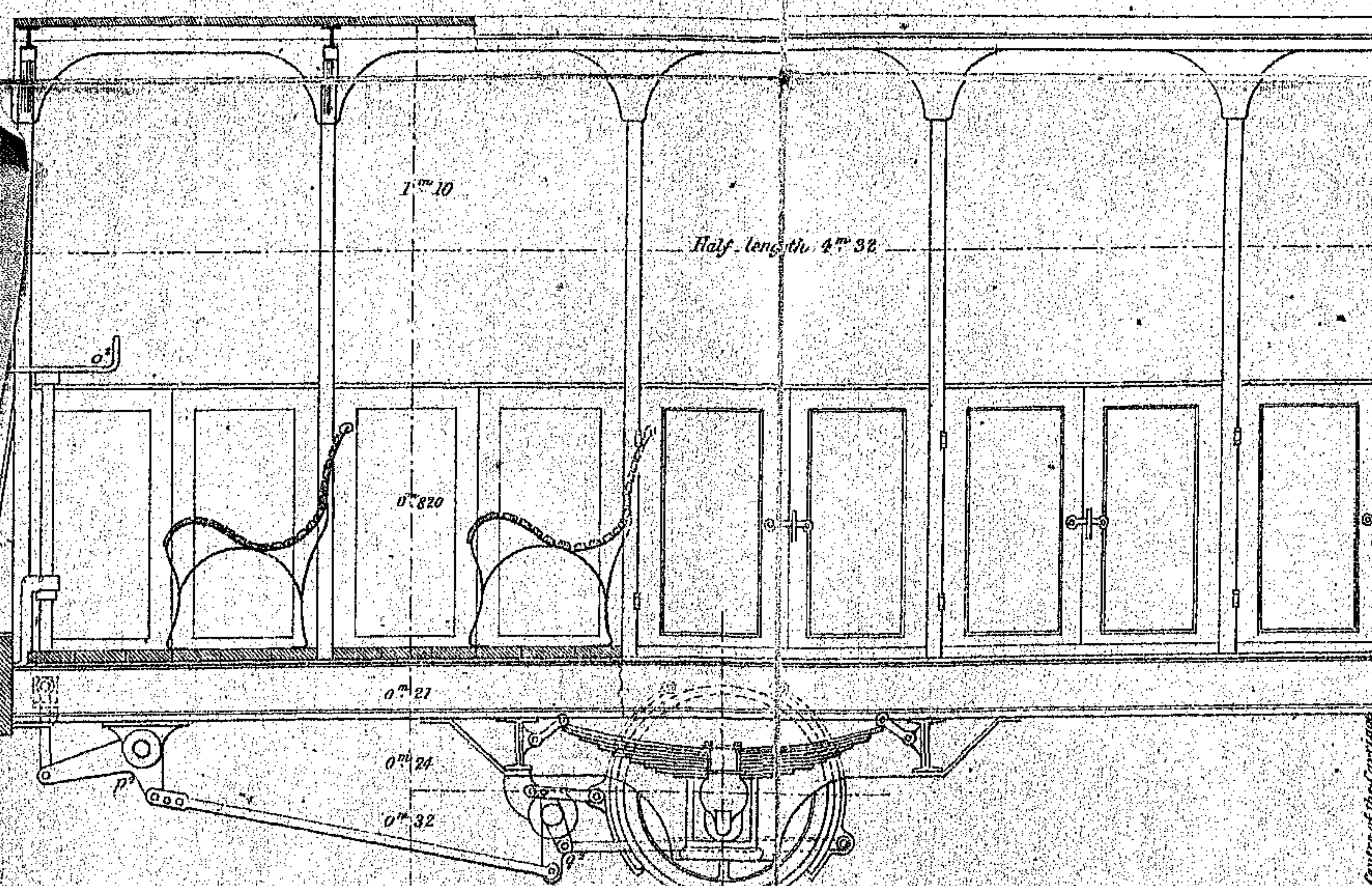
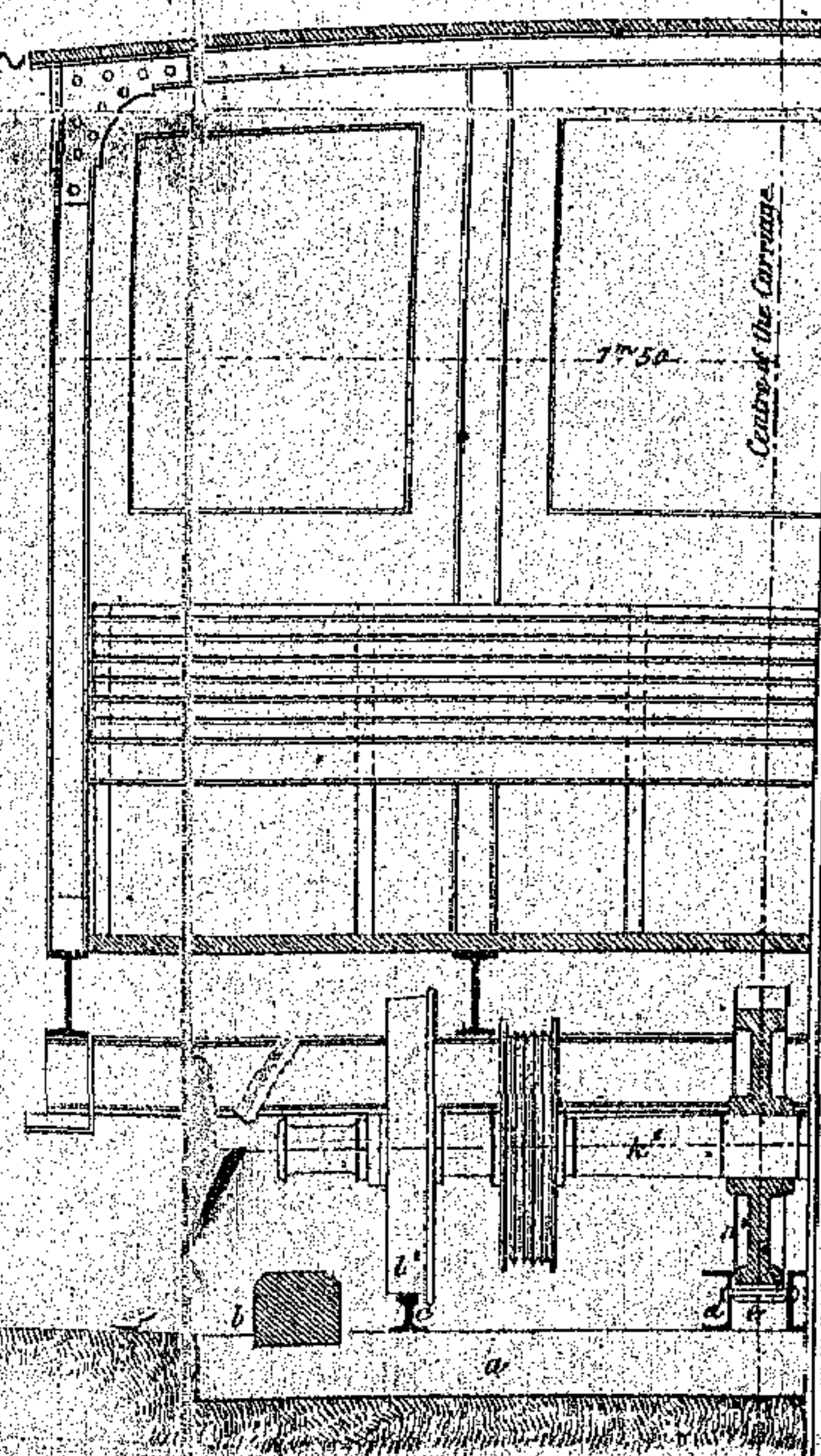


Fig. 19. *Transverse Section.*



III. Names and addresses of the General Secretary, General Treasurer and Executive Council of the Society at the formation of the Society.

General Treasurer.

General Secretary.

SECTION I.

GENERAL RULES.

IV. The Head Office of the Society shall be at Allahabad until the year 1881, when it may be removed elsewhere according to the Rules of the Society.

Head Office.

V. After the 31st of December 1880, the Head Office of the Society may be removed in the manner hereinafter mentioned, once in every third year on the 31st December, but it shall not be removed oftener than once every three years unless recommended by the Executive Council.

Removal of Head Office.

VI. The Head Office of the Society shall not be at any time removed from the Branch in which it is located, unless the votes of not less than three-fourths of the members entitled to vote, have been given in the manner hereinafter described, in favor of such removal to one particular Branch of the Society. All written votes for, or against the removal of the Head office shall be in the hands of the General Secretary of the Society not later than three months before the time required for the removal to be effected, and the votes shall state where the Head Office shall be located for the next three years. All votes that are not received at the appointed time shall be considered and taken to be null and void.

Votes necessary to effect the removal of the Head Office.

VII. Should a sufficient number of votes be received at the Head Office three months before the expiration of the time for removal of the Head Office, the President, or General Secretary shall, within seven days, call a General Meeting of the members to be held at the Head Office of the Society: at which the number of votes for, and against the removal of the Head Office shall be read, and the result declared; but should an insufficient number of votes have been received at the Head Office, it shall not be compulsory on the President, or General Secretary to call a meeting for the removal of the Head Office for another three years.

Meeting for removal of the Head Office.

VIII. The general management and administration of the Society's affairs shall, with such exception hereinafter mentioned be in the hands of a President, General Secretary, General Treasurer, and an Executive Council, assisted by District, and Branch Officers, and if necessary Organizing Officers elected or appointed in the manner hereinafter mentioned.

General management.

The appointment of a President shall not take place, until by the extension of the Society's business such a step shall seem advisable to a majority of the members of the Society, who shall send their votes to the General Secretary to be read at a General Meeting of the members convened at the Head Office of the Society. Districts shall be formed, and District Officers appointed when the Executive Council deem such a step advisable.

IX. The candidates for the appointments of President, General Secretary, and General Treasurer shall be nominated by the Executive Council; but any Branch desirous of nominating any qualified person as candidate for these appointments, shall submit their names to the Head Office within one month from the time they are made acquainted with the necessity for electing any, or all of these officers, when if there is more than three persons nominated by the various Branches for each appointment, the Executive Council shall decide whose names shall be submitted to the members for election. The names shall then be sent to each Branch, and one month shall be allowed for the members at the Branches to send their votes to the Head Office. All votes arriving after the expiration of the time allowed will be declared null and void. Those candidates who receive the greatest number of votes shall be elected to the vacant appointment.

X. The President of the Society shall possess a thorough knowledge of Railway work, and shall have been connected with the Society for three years prior to his nomination. He shall have been at least eight years a resident of India. He shall understand the working of the Society, and of Railways, and be fitted to act as referee in cases of dispute.

XI. The President (when one has been elected) shall possess control over the affairs of the Society at the Head Office, Districts, and Branches, and shall have power to call any meeting of the Society whenever he may consider it expedient, or necessary to do so. He shall preside at all delegate and Executive Council meetings at which he is present; and shall possess the right of presiding at all other meetings of the Society. He shall satisfy himself that the business of the Society is conducted in a proper manner, and shall decide on all urgent cases referred to him for settlement. He shall have power to suspend any member of the Society who endeavours to create dissension among the members, or who places the rules of the Society at defiance, but shall report the cir-

circumstance at the next Executive Council Meeting. He shall not have power to expel any member from the Society without first obtaining the sanction of the Executive Council. Should he become aware of any misappropriation of the Society's Funds, he shall immediately take steps, or cause steps to be taken against the guilty person, or persons. He shall in conjunction with the General Secretary and General Treasurer visit every Branch of the Society once every year and issue a general report concerning them. He shall check the General Treasurer's cash book, or cause it to be checked. He shall sign all receipts for remittances made to the Head Office from Branches, and no receipt for remittances shall be considered legal unless it bears his signature. He shall do such things as may be necessary to promote the objects of the Society, and shall be responsible to the entire body of the members of the Society through their representatives on the Executive Council. He shall receive a salary of Rs. 300 per month, and when travelling on the Society's business, second-class train fare, and Rs. 5 per day travelling allowance; but he shall not be entitled to any other allowances. He shall hold office so long as he possesses the confidence of the members.

XII. Until such time as a President is appointed, the Executive Council for the time being shall, immediately after their own election, elect a Chairman from among themselves, whose duty it shall be to preside over all Executive Council Meetings, sign receipts in conjunction with the General Treasurer, and General Secretary, for remittances made to the Head Office; and satisfy himself that the Rules of the Society are strictly carried out.

XIII. The General Secretary shall possess a thorough knowledge of Railway work, and also of the requirements of the Society. He shall possess a knowledge of political and social economy, understand keeping accounts, be able to address a meeting, and transact the duties that may be assigned to him by the rules of the Society. He shall have been connected with some Indian Railway for not less than eight years prior to becoming a candidate for the appointment.

XIV. He shall conduct all necessary correspondence retaining copies of all important letters despatched. He shall prepare a quarterly report of the condition of the Society, a copy of which shall be issued to every Branch of the Society. He shall prepare a report every half year, showing the number of members who have joined since the last report was issued, and also the members

who have been expelled, the general condition of the Society, and any particular that may be likely to affect its future welfare. He shall keep a correct record of all proceedings of the Executive Council Meetings, and send, or cause to be sent a summary of the proceedings of each Council Meeting to the *Railway Service Gazette* for publication. He shall be permitted to speak on any subject at any Meeting, but shall not be allowed to vote at Executive Council Meetings. He shall, excepting in special cases, issue the agenda of business for the Executive Council Meeting one month before the date appointed for the Meeting. He shall receive all votes, and should there be a President hand them over to that officer before the time appointed for the Meeting at which they are to be brought forward. When a President has been appointed, the General Secretary shall obey all instructions he may receive from that officer, so long as they shall not be opposed to, or at variance with the Rules of the Society. He shall visit the Branches of the Society once every year if the duties of the Head Office will permit him to do so. He shall have power to call General Meetings whenever and wherever he may deem it expedient for the promotion of the Society's welfare, but shall send, or cause to be sent a summary of the proceedings of such meetings to the *Railway Service Gazette*. He shall attach his signature to all receipts granted from the Head Office for remittances. Should any contracts or agreements of any description be entered into by the Society and any other person, or persons, the General Secretary shall, unless otherwise determined by the Executive Council, be the representative of the Society; and so also in any legal suit, or suits, or actions in which the Society may be either prosecutor, or defendant, the General Secretary shall represent the Society as their Attorney, and if unable to attend himself at the prosecution of any legal suits, or actions, he shall have power and authority to appoint an approved person as his Attorney to appear and act for the Society in his stead.

XV. The General Secretary shall, so long as he remains in that appointment, receive Rs. 200 per month, ^{Salary and term of office.} second-class train fare when travelling on the Society's business, and whenever 50 miles distant from the Head Office Rs. 5 per day travelling allowance. The General Secretary shall always notify his arrival at, and departure from the Head Office to the President, (if one has been appointed,) otherwise to the chairman of the Executive Council.

The General Secretary shall retain office so long as he give general satisfaction in the performance of his duties. He

shall find security for Rs. 2,000 through a Guaranteed Association, and shall be subject to such fines for neglect of duty as the Executive Council shall impose.

XVI. The General Treasurer shall thoroughly understand accounts, and book-keeping in all its Branches; he shall be able to prepare an analytical financial report of the Society in a plain and simple form, and be able to audit complex accounts.

XVII. The General Treasurer shall, from the returns submitted to the Head Office, keep a correct record of the payments made by each member of the Society in the register provided for that purpose, also a record of the benefits paid to each member of the Society; he shall receive all remittances from the Districts, Branches, and members of the Society, and grant receipts for the same signed by himself the President, (or if a President has not been appointed, by the Chairman of the Executive Council,) and General Secretary.

XVIII. The General Treasurer shall not make any remittance to any Branch excepting on an order signed by the General Secretary, and bearing the Society's seal.

XIX. The Treasurer shall prepare a monthly report on the condition of the Society's Funds for the Executive Council.

XX. The General Treasurer shall prepare a Balance Sheet every half year, on, or before the 14th January and the 14th July, which he shall submit along with his vouchers and the Bank Book to the Auditors for them to check and attest its accuracy. He shall also prepare a financial report respecting the Society every half year at the same time as the Balance Sheet, which he shall submit to the Executive Council at their next Meeting.

XXI. The General Treasurer shall produce his books and receipts when called upon to do so by the Executive Council, President, or General Secretary of the Society. The General Treasurer shall attend all Meetings of the Executive Council and may give an opinion but shall not be allowed to vote.

XXII. The General Treasurer shall deposit all money received by him in the Bank along with the remainder of the Society's money, in the name of the Society within 24 hours after receiving it, unless the Bank should be closed, when he shall be required to deposit the amount immediately the Bank re-opens: should he fail to

comply with this Rule he shall be dealt with at the discretion of the Executive Council.

XXIII. As the funds of the Society at the Head Office shall constitute a reserve which shall not be drawn upon unless the balance at any District or Branch shall fall so low as to compel them to call for a remittance, it shall be the duty of the General Treasurer to keep a separate and correct account of the amount in the Bank derived from each class of subscribers, under the various headings of superannuation, accident, death, benefit, non employed, sick benefit and general management.

XXIV. The General Treasurer shall hold office so long as he gives satisfaction to the Executive Council.

XXV. The General Treasurer shall receive a salary not exceeding Rs. 120 per month so long as he remains in his appointment, and should he be required to visit any of the Districts, or Branches to inspect their books and accounts (which he shall be empowered to do on an order from the Executive Council) he shall receive second-class train fare, and if over 50 miles from the Head Office, Rs. 3 per day allowance. He shall find security for Rs. 2,000 through a Guarantee Association.

XXVI. The Executive Council of the Society shall, until the Society is divided into Districts, consist of 30 members—15 Europeans and 15 Natives belonging to the various departments—exclusive of the President (if one), General Secretary, and General Treasurer, elected by ballot from among the members residing in the station or town where the Head Office is located; but when three Districts shall have been established then at the next election following the establishment of such Districts, the ballot shall be for an Executive Council consisting of twenty-one members, (termed resident members,) residing in the same station, or town as that in which the Head Office of the Society is situated,—one-third of whom shall retire from office each year,—and of one member appointed by the Committee of each District. For every additional District above three, that is established, the number of Executive Council members residing in the station where the Head Office is located, shall be reduced by three at the next election following the establishment of such Districts. Every District Chairman shall by virtue of his office be an ex-officio member of the Executive Council so long as he continues in office as District Chairman. The Executive Council shall fill any vacancy that may occur among the resident members of the Executive Council, but

the person they appoint shall retain office, so long only, as the member in whose room he shall have been appointed would have retained office, had he continued a member of the Executive Council.

XXVII. There shall be a General Meeting at the Head Office of the Society one month before the Election of first Executive Council, at which meeting all the members of the Provisional Executive Council shall retire from office, but shall be eligible for re-election. At this Meeting an Executive Council shall be elected by the votes of the members who are present at the Meeting, and by those votes which have been received at the Head Office by the General Secretary from the Districts, or Branches 72 hours before the time appointed for the Meeting.

XXVIII. All elections of the Executive Council after the first election shall be by the votes of the Subsequent elections, members at the various Branches of the Society which shall be sent to the General Secretary before the 1st of November in every year. The votes shall be examined by scrutineers appointed by the Executive Council, and there shall be a General Meeting of the members of the Society once every year in the month of November at the Head Office, when the result of the voting shall be declared, and the names of the newly elected Executive Council made known. Any member elected on to the Executive Council and refusing to accept office, or any member resigning his seat on the Executive Council before his term of office has expired, without furnishing a satisfactory reason for so doing, shall with such exception hereinafter mentioned, be fined Rs. 10. Members who have served their term of office on the Executive Council may, if they desire it, claim exemption from election for twelve months.

29. Unless the resident members of the Executive Council can agree among themselves who shall retire in the first and second year, they shall decide the question by ballot.

XXX. There shall be a General Meeting of the members at the Head Office of the Society in the month of January, in whose presence the retiring Executive Council shall hand over their insignia of office, and the Executive Council elect shall be invested.

Every Executive Councilman shall, before he is permitted to take part in any Executive Council Meeting, take an oath of fidelity to the Society, and should he refuse to do so his election shall be considered null and void.

XXXI. The Executive Council shall meet once every three months, or oftener should the President of the Society, or if there be no President, the Chairman of the Executive Council, or General Secretary consider it expedient, or should either of these officers receive a requisition duly signed by not less than one-third of the members of the Executive Council, for the time being, requesting a meeting to be convened, it shall be the duty of the officer receiving such requisition to summon an Executive Council Meeting, or cause one to be summoned within fourteen days from the date he receives the requisition, and should he fail to comply with the request after acknowledging receipt of the requisition, the requisitionists shall make the circumstance known to the members through the *Railway Service Gazette*.

XXXII. Notice of the business to be brought forward at each Executive Council Meeting shall, unless in very special cases, such as emergent Executive Council Meetings summoned by the President, or General Secretary, be issued for the information of the members of the Council not less than one month before the date appointed for the Meeting, and no other business but that which has been notified shall be brought forward; but any Executive Councilman can at an Executive Council Meeting give notice of any motion he intends bringing forward at a subsequent meeting, and it shall be placed in the notice of business for the next meeting. The Executive Council shall at every regular quarterly Meeting determine the amount to be expended by the Head Office for management until the next regular Executive Council meeting is held. During the period between the Executive Council Meetings the business of the Society shall be managed, and conducted by the President (if one), the General Secretary, and General Treasurer, or if no President by the Chairman of the Executive Council, the General Secretary, and the General Treasurer of the Society.

XXXIII. Seven members of the Executive Council exclusive of the General Secretary, and General Treasurer, shall form a quorum, with power to act, and all business transacted by them if in accordance with the Rules and the Bye-Laws of the Executive Council, shall be binding on all members of the Executive Council.

XXXIV. The Executive Council may prepare bye-laws for their own government, and after such bye-laws have been approved of by a majority of the members of the Executive Council, they shall not be al-

tered, amended or rescinded, without the sanction, and approval of three-fourth of the members belonging to the Executive Council.

XXXV. Until such time as the Society is divided into Districts every member of the Executive Council shall have one vote, but the Chairman of any Executive Council Meeting shall have, in addition to his own vote, the casting vote, which he shall only be permitted to record should the votes for, and against any motion be equal. When the Society is divided into Districts it shall be competent for the Executive Council to make such arrangements respecting voting at Executive Council Meetings as may seem to them desirable.

XXXVI. Every Executive Council member representing a District shall, when present at Executive Council Meetings, receive Rs. 5 per day allowance, and he shall unless travelling on pass also receive second-class train fare to and from the Head Office: these expenses and allowance to be paid by the District he represents. Resident members of the Executive Council shall receive Rs. 2 for every Executive Council Meeting they attend. Any Executive Council member who is ten minutes late in attendance at an Executive Council Meeting shall be fined Rs. 3, and if absent altogether from the Meeting he shall be fined Rs. 5, unless a satisfactory explanation for his absence is submitted at the Meeting from which he is absent.

XXXVII. The Executive Council shall, immediately after taking office, elect 15 members from among themselves to constitute a Permanent Committee.

XXXVIII. It shall be the duty of the Permanent Committee to satisfy themselves that the Funds of the Society at the Head Office are securely and profitably invested, to examine all bills in connection with the expenditure at the Head Office, and see they are in accordance with the rules before passing them for payment. The Permanent Committee shall satisfy themselves that the auditors audit the accounts of the Society at the Head Office every six months. They shall meet every month, or oftener if necessary, and shall at the monthly meeting satisfy themselves as to the cash balance at the Head Office, and have submitted for their approval a financial statement of the Society's affairs.

They shall not sanction any disbursement from the Society's Funds at the Head Office except such disbursement be in ac-

accordance with the Rules, or it is to defray the cost of management previously sanctioned by the Executive Council, or necessary remittances to Branches or Districts. *No benefit shall be disbursed to individual members from the funds at the Head Office of the Society.*

XXXIX. Three members shall form a quorum with power to act. They shall receive Rs. 1 for every meeting they attend, and shall be fined Rs. 3 if absent unless they send a satisfactory excuse in time to be read when the meeting opens.

Quorum and allowances.

XL. The Permanent Committee may make Bye-Laws for their own government, but before such Bye-Laws can be acted upon they shall receive the sanction and approval of the Executive Council, after which they shall be binding upon all members of the Permanent Committee, and shall not be altered, amended, or rescinded without the consent of a majority of two-thirds of the members of the said Committee.

Bye-Laws.

XLI. The auditors shall be elected by the Executive Council and shall retain office for twelve months only, but shall be eligible for re-election. They shall each receive Rs. 20 every half year for their services. The President (if one), the Chairman of the Executive Council, the General Treasurer, the General Secretary, and the District and Organizing Secretaries, shall not be eligible for election as auditors.

Auditors.

Organizing Secretaries.

XLII. The Executive Council shall have power to engage one or more organizing Secretaries should they consider such officers necessary, but in no case shall the salary and allowances conjointly, of any organizing Secretary, exceed Rs. 150 per month, nor shall any other expenses beyond second-class train fare be permitted when he is travelling on the Society's business.

XLIII. An organizing Secretary shall, when instructed by the General Secretary, or by an order from the Executive Council in Meeting, visit any Branch or Branches of the Society. He shall inspect the books, receipts, and vouchers, at each Branch and send a monthly report of his transactions to the General Secretary for the information of the Executive Council. He shall when necessary instruct the officers of any Branch in the method of conducting the Society's affairs. At every

Duties of organizing Secretaries.

Branch he visits he shall convene one or more meetings for the purpose of making the members acquainted with the condition of their Branch, and also for the purpose of making the objects and progress of the Society known. He shall, when required, organize new Branches, and when not otherwise engaged on Society's business, he shall, if required, attend the Head Office, and place himself under the instructions and orders of the General Secretary. He shall be subject to such fines for neglect of duty as the Executive Council shall impose.

*Chief Marshalls, Chief Banner Bearers, and
Chief Warders.*

XLIV. The President or if there is no President then the Chairman of the Executive Council shall, once in each year appoint members of the Executive Council to fill the offices of Chief Marshalls, Chief Banner Bearers, and Chief Warders, and the members so appointed shall retain office for one year only unless re-appointed.

XLV. These appointments shall be made at the first general meeting of the members held at the Head Office in the month of January in each year, immediately after the newly elected Executive Council have taken the oath of fidelity to the Society.

Term of appointment.

XLVI. The Executive Council shall have power to decide all questions and cases on which the Rules are silent, and should any doubts arise respecting the interpretation of any Rule, or Rules, the question shall be decided by the Executive Council whose decision shall be final until the next Delegate Meeting. The Executive Council shall have power once every year to sanction the disbursement of Rs. 500 from the management fund to be devoted to rewarding deserving officers, and members of the Society.

Power of the Executive Council.

XLVII. Should any dispute arise between any of the members, and their employers, and it is decided to refer the matter to arbitration, the Executive Council shall have power to appoint one, or more arbitrators on the part of the members.

Appointment of Arbitrators.

XLVIII. None of these rules shall be altered, amended, rescinded, or added to until three years have expired from the date of the registration of the Society; unless the Executive Council shall recommend such alterations, amendment or addition.

Alteration of rules.

XLIX. No alteration, amendment, or addition shall be made to or in these Rules unless such alteration, amendment, or addition shall have been previously circulated among the various Branches of the Society not less than two months before such alteration is to be effected.

Proposed alteration of Rule to be circulated among the Branches.

L. Any or all of these Rules may be altered, amended, rescinded, or added to by the Delegate assembled at a Delegate Meeting providing the alteration, amendment, or addition shall have been circulated among the Branches of the Society two months previous to the day appointed for the Delegate Meeting—and such alterations shall be binding on all members.

How Rules can be altered.

Should the Executive Council of the Society at any time determine it is expedient that any of these Rules should be altered, amended, or rescinded, or that any new Rule should be added to them, they shall issue a circular, or cause one to be issued to every Branch of the Society, pointing out the reasons in full for the step that is recommended, and requesting the votes of the members belonging to the Branches both for and against the proposed alteration, to be sent to the General Secretary within two months from the day on which the circular is issued, when a meeting of the Executive Council shall be held, and after the votes have been scrutinized the result shall be made known to all the Branches of the Society.

LI. Should a majority of the members assembled at a regular meeting of any Branch desire any particular Rule to be altered, amended, or rescinded, they shall forward their views in the form of a proposition to the General Secretary, requesting him to lay it before the Executive Council of the Society at their next meeting. Should a majority of the Executive Council assembled in Meeting consider the alteration a judicious one, the General Secretary shall be instructed to circulate it among the various Districts and Branches for the opinions and votes of the members of the Society. The votes from the Branches both for and against the alteration, must be in the hands of the General Secretary not less than fourteen days before the next regular Executive Council Meeting, and all arriving after that time shall be declared null and void. The General Secretary shall lay all votes before the Executive Council describing which are legal and which are illegal votes, when they shall be examined, and the result made known.

Branches desiring Rules to be altered.

LII. Should the decision be unfavorable, the Branch that proposed the alteration may request the General Secretary to again circulate their proposed alteration three months before the next Delegate Meeting takes place, and lay the votes received before the Delegates in Meeting assembled: and it shall be the duty of the General Secretary to comply with the request. The decision of the Delegates shall be final.

Referring alteration of Rules to Delegate Meeting.

Funds.

LIII. No money shall be withdrawn from the Funds of the Society deposited in the Bank at the Head Office of the Society, excepting by cheque which must be signed by the General Secretary, General Treasurer, and the President (if one), or Chairman of the Executive Council for the time being.

Withdrawal.

SECTION II.

DELEGATES.

I. Every Branch that contains not less than fifty *free* members shall be entitled to appoint one Delegate to represent their Branch at all Delegate Meetings of the Society. Any Branch that contains more than one hundred *free* members, shall be entitled to appoint one Delegate for every fifty *free* members the Branch contains, and to ensure representation as far as practicable for those Branches that do not contain fifty *free* members, it shall be the duty of the District Committee, or if the Branches are not under the jurisdiction of a District Committee of the Executive Council to so arrange, that the smaller Branches which are nearest to each other shall unite together and appoint a Delegate of their own choosing. But when two or more Branches unite together for the purpose of electing a Delegate, the combined number of their *free* members must not be less than fifty. No one Delegate shall represent more than ninety-nine *free* members.

Appointment of Delegates.

II. A Delegate shall hold office for twelve months only, but shall be eligible for re-election.

Term of Office.

III. Every Delegate attending a Delegate Meeting must, before leaving the Branch, or Branches he represents, provide himself with proper credentials, and no Delegate shall be allowed to take any part in a

Delegate's credentials.

Delegate Meeting unless he previously makes over his credentials to the Secretary of the Meeting. The credentials of every Delegate must bear the signatures of the Chairman, Secretary, and three of the members of the Committee of the Branch he represents, or he shall not be allowed to take any part in the proceedings of the Delegate Meeting, nor will he be allowed any expenses or allowance whatever.

IV. Every Delegate, when attending any regular or special Delegate Meeting, shall, with such exception hereinafter mentioned, receive so long as he is engaged on the Society's business Rs. 7 per day, and if he has not been supplied with a *free* pass he shall receive second-class Railway fare from the Branch he represents to the station at which the Delegate Meeting is held, and back again to his own Branch, and no greater amount than the sum mentioned herein shall be allowed to any Delegate for his attendance. Any Delegate who is in the receipt of pay from the Railway, or service he belongs to, during the time he is attending the Meeting, shall only receive Rs. 5 per day, and not Rs. 7. Any Delegate residing in the Station where the Delegate Meeting is held, shall only be allowed Rs. 3 per day while attending the Delegate Meeting, if he is in receipt of pay from the Railway Company, or employer he is serving.

V. The Rules and Byo-Laws to control the Delegates, when assembled at any Delegate Meeting, shall be prepared by the Executive Council only. The decision of a Delegate Meeting on all matters submitted to it shall be final, and no question decided by them can be re-opened until the next Delegate Meeting.

VI. All Delegate Meetings shall be summoned by the President of the Executive Council, or by a Resolution of the Executive Council, or by the General Secretary at the written request of not less than one-third of the *free* members belonging to the Society at the time the requisition shall be received at the Head Office, and no other officer, or officers, member, or members shall have power, or authority to convene a Delegate Meeting. Should one-third or more of the *free* members of the Society send in a written request, or application for a Delegate Meeting to be called, they shall accompany their application with a sufficient sum of money from their private resources, and not from the Society's funds, to defray the cost of the meeting: should they fail to send the necessary amount, their application shall not be attended to: should the Meeting be called and

the question they bring forward be decided in their favor, their money shall be refunded to them.

VII. There shall be a Regular Delegate Meeting held once every four years reckoning from the date the Society was registered.

Regular Delegate Meetings.

SECTION III.

RULES THAT SHALL GOVERN DISTRICTS WHEN ESTABLISHED.

I. Every district shall be formed of Branches, but no District shall contain more than five thousand members, and when it exceeds that number of members the District shall be again divided. The limits of each District shall be clearly defined by the Executive Council. Each District shall control the Branches within its jurisdiction according to the Rules, and Bye-Laws of the Society, and the District management shall take such steps, with the approval of the Executive Council, as may be deemed advisable for promoting unity among the members, and strengthening the Society.

Limit to number of members in a district.

II. Every District shall, on being formed, obtain a Charter from the Executive Council of the Society, and no District shall be considered perfect, nor shall its acts be considered legal, although in conformity with the Rules of the Society, unless it possesses a proper Charter.

District Charter.

III. No application for a District Charter shall be entertained unless the Branches who purpose forming the District contain altogether not less than 1,500 *free* members. Every application for a District Charter must contain the names of each Branch that will belong to the District, with the number of *free* members in each Branch the place where the Head Quarters of the District are to be established; the names of the District Officers, and Committee elect. The application must be signed by the Chairman and Secretary of every Branch that desires to belong to the District, and must also bear the signature of the proposed District Officers and Committee.

Application to obtain District Charter.

IV. Should any member or members establish a District without first obtaining a Charter from the Executive Council, all and every such member, or members shall forfeit all claims to every benefit, and privilege of the Society that he or they may have become entitled to, and shall in addi-

Penalty of establishing a District without obtaining a Charter.

tion cease to belong to the Society. Any District failing to send in its returns to the Head Office for six months shall have its charter cancelled.

V. At the formation of the District, the members belonging to the various Branches of which it shall be formed, shall decide where the Head Quarter of the District shall be, but in no case shall the Head Quarters ever be at a station that contains less than twice the number of the members that there are Branches in the District.

VI. At the expiration of every five years, commencing from the time the District was first established, the Removal of the Head Quarters of a District may be removed to some other suitable station for five years, should three-fourths of the members in the District, who are entitled to vote, consider such a step advisable. But the Head Quarters of the District shall not be moved oftener than once every five years, unless the sanction of the Executive Council has been previously obtained.

District Management.

VII. The affairs of the District shall be conducted by a District Chairman, a District Secretary, a District Treasurer, and a Committee formed of eight members, four of whom shall be Europeans and four Natives residing in the station at which the Head Quarters of the Districts are located, and also in addition, one member belonging to each Branch in the District that does not contain less than twenty *free* members.

VIII. The Chairman, Treasurer, and the eight members of the Committee residing at the Head Quarters of the district shall be elected by all the members in the District, who are entitled to vote. Election and term of office. Each District Committee man, who represents a Branch on the District Committee, shall be elected by the members of the Branch in which he resides. The District Chairman, Treasurer and Committee shall, with such exception hereinafter mentioned, so long as they conduct the Society's affairs, according to the Society's rules hold office for one year, and shall be eligible for re-election. Half the members of the Committee who reside at the Head Quarters of the District shall, with such exception hereinafter mentioned, retire by rotation from office every year, but shall be eligible for re-election. Half the members of the first Committee shall retain office for eighteen months. The names of the first half of the Committee who retire shall be decided by ballot. The result of all elections shall be sent without delay to the Head Office of the Society.

IX. There shall be six additional officers in each District, namely, two District Marshalls, two District Warders, and two District Standard Bearers. The appointment of these officers shall lay in the hands of the District Chairman after his election, and he can confer them upon any District Committee man he chooses, but they shall not be given to any other but members of the District Committee.

District Chairman.

X. The District Chairman must have been a regular subscribing member of this Society or some Railway Society for a period of two years prior to his election as District Chairman. He shall during his term of office possess the right of presiding over all meetings of the Society (unless the President of the Society be present) that are held in the District to which he belongs, and shall be an ex-officio member of the Executive Council of the Society, whose meetings he shall when possible attend once in each half-year.

He shall see that all meetings over which he presides are conducted with propriety, and according to the Rules of the Society, and such Bye-Laws as may be hereafter issued by, or with the sanction of the Executive Council of the Society. He shall see that the District Committee meet at least once in every month, and he shall satisfy himself that the minutes of the previous meeting are correctly recorded before having them confirmed, or attaching his signature to them. He shall not knowingly permit any infringement of the Rules, or Bye-Laws of the Society and shall see that all fines are duly inflicted upon those members, who break the Rules; should he break any rule or bye-law himself, or knowingly permit one to be broken he shall be fined Rs. 20 and removed from office, and one of the District Committee shall be appointed to officiate as District Chairman until the next election of officers. He shall see that auditors are elected once every year by the members residing at the Head-Quarters of the District, and that the District accounts are audited once every half-year, namely, in the months of January and July. He shall also see that the District Secretary prepares a Report upon the condition of the Society in the District every half-year, and this Report together with the auditor's Report and the half-yearly Balance Sheet shall be laid before a Meeting of the District Committee not later than the 5th of January and the 5th of July in every year, and immediately after the Meeting forwarded to the General Secretary of the Society. He shall satisfy himself that the District Secretary and District Treasurer per-

form their duties in a proper manner, and that the funds of the Society in the District are securely invested; should anything come to his notice likely to prove injurious to the welfare of the Society, or the interests of the members, he shall immediately acquaint the District Committee, and President, or General Secretary of the Society with the circumstance. He shall, in conjunction with the District Secretary, and District Treasurer, sign receipts for all money received at the District Head-quarters, and shall satisfy himself that the remittances to the Head Office are regularly and properly made.

District Secretary.

XI. The District Secretary must possess a thorough knowledge of railway work, and must have been in the service of some railway company for at least eight years previous to offering himself as a candidate for the appointment. He must understand the nature, and the working of the Society, be able to address a public meeting, understand how to keep accounts, and if the Executive Council, or the President of the Society deem it necessary, shall be required to pass an examination before being nominated as a candidate.

XII. The District Secretary shall be elected by those members in the District who are entitled to vote. If more persons than one offer themselves as candidates for the appointment of District Secretary, the person who obtains the greatest number of votes shall be elected, and retain office so long as he gives satisfaction. If it should be necessary to dismiss the District Secretary, he shall (excepting when proved guilty of negligence or gross misconduct) receive one month's notice, or one month's pay; should he wish to resign, he must give one month's notice, or forfeit one month's salary.

XIII. He shall receive the reports and monthly statement from the Branches from which he shall prepare a monthly statement showing,—

1st.—The number of members in the District.

2nd.—The amount of money at each Branch in the District, and also at the Head-quarters of the District specifying the sums placed to the credit of the various funds.

3rd.—The expenses of management at the Branches and at the District Head-quarters during the month.

4th.—The amount paid away in benefit to members during the month.

5th.—The names, and numbers of all members who have received benefits in the District during the month.

6th.—The number of members who have joined, and the number who have been expelled during the month.

7th.—The number of members out of employment in the District at the end of the month.

8th.—A general report on the condition of the labor market in the District. The report shall be despatched by the District Secretary to the General Secretary of the Society at the Head Office not later than the 10th of every month.

The District Secretary shall keep the register of members in his District, in which he shall credit each member in the District with the amount he has paid into the Society, and also enter the benefits every member receives. He shall conduct and keep a copy of all necessary correspondence, record the proceedings of all District Committee Meetings in a minute book kept for that purpose, and supply the Branches in the Districts with stationery and copies of the reports that are received from the Head Office. He shall make out his bill for whatever expenditure he may incur once monthly, and lay it before the District Committee to be passed before receiving payment from the District Treasurer. He shall visit the Branches in his District not less frequently than once every three months, and oftener if required, but he shall not visit any other District without having been previously invited to do so by the Chairman of the said District, or by order of the General Secretary, or President of the Society. (For expenses of visiting Branches more than once every three months see Rule 35 Section 4.) He shall send a report of all meetings he holds to the *Railway Service Gazette* for publication. Should he be called away from the Head-quarters of the District, he shall previously notify his departure with the cause thereof to the District Chairman. He shall also on his return to the Head-quarters make his arrival known to the District Chairman. He shall when possible, attend all Executive Council Meetings, at which he will be permitted to speak on any subject that may be brought forward, but he shall not possess the right of voting. He shall obey the orders of the Executive Council, and carry out the orders and instructions of the District Chairman when such orders and instructions are not at variance with those received from the Executive Council, or with the general Rules of the Society.

XIV. The salary of the District Secretary shall be Rs. 150 per month. He shall receive when travelling in the District on Society's business second-class train fare, and when the distance shall exceed 20 miles from Head-quarters Rs. 2 per day allowance; when visiting another District, or attending Executive Council

Meetings he shall receive Rs. 8 per day allowance, he shall, when visiting a District, or Branch by request, be paid his expenses, and allowance by the District, or Branch that requested his visit. When attending Executive Council Meetings his expenses and allowances shall be defrayed by the District he belongs to.

XV. The District Secretary shall find security for Rs. 2,000 through a guarantee Association.

Security.

District Treasurer.

XVI. The District Treasurer shall be elected annually at the

Duties.

same time as the Chairman, and members of the Committee. He shall receive all remittances for which he shall, in conjunction with the District Chairman and District Secretary grant receipts. He shall within 24 hours after receiving any money on account of the Society, deposit it in the name of the Society in such Bank, or Banks as the District Committee shall have provisionally decided upon, unless the Bank is closed when he shall make the deposit as soon as it re-opens. Should he retain any money in his possession more than 24 hours after receiving it, he shall, unless the Bank, or Banks have been closed as aforementioned, be fined such amount as the District Committee shall decide upon. He shall, with the exception of the proper remittances to the Head Office, not make any disbursements whatever unless he receives a written authority to do so, signed by the District Chairman, one Committee man, and the District Secretary, or by order of the Executive Council; with such exceptions hereinafter mentioned he shall not disburse on account of the District expenses a greater amount monthly than is allowed by the Rules, and Byo-Laws of the Society.

Should any *special* circumstance necessitate the expenditure

Exception.

of a larger sum than is allowed by the Rules of the Society for the monthly expenses of the District Head-quarters, the District Committee may pass a Resolution at a Committee Meeting sanctioning such disbursement, and a copy of such Resolution signed by those Committee men present at the Meeting, shall be sufficient authority for the District Treasurer to make the disbursement, but a copy of such Resolution shall be forwarded to the Executive Council. The District Treasurer shall make no payment whatever unless he receive a proper receipt for the same, and should he be unable to produce a proper voucher for any payment said to have been made by him, he shall make good the amount. He

shall make the remittances to the Head Office of the Society clearly specifying on what account they are made. He shall keep the accounts for each fund separate, and distinct. He shall produce his books at every Committee Meeting, and before the Meeting closes specify what amount there is to the credit of the District in the Bank. The District Treasurer shall attend Committee Meetings, but shall not be allowed to vote on any subject.

XVII. The District Treasurer shall receive Rs. 20 per month, and shall find security for Rs. 1,000 through a Guarantee Association. Should he be proved incompetent to perform the duties entrusted to him, he shall be removed from office, and another member appointed to officiate until the next election of officers.

Salary.

Auditors.

XVIII. Two auditors shall be elected annually at the same time as the District Chairman, Treasurer, and Committee. They shall audit the accounts of the District Treasurer every half-year, and shall each receive Rs. 10 per annum for their services. They shall not attend District Committee Meetings (except when their report and audit is brought forward), unless they shall have been elected members of the District Committee at the annual election. The District Chairman, Secretary and Treasurer, shall not be eligible for election as auditors.

District Committee.

XIX. The members of the District Committee shall be required to attend all District Committee Meetings, and for every Meetings they attend they shall each receive one rupee, but if any member is absent from any meeting, and it shall be proved he was able to attend he shall be fined Rs. 2, and his name shall be forwarded to the General Secretary for record. Any member arriving 15 minutes after the time appointed for opening the meeting shall be fined Rs. 1, and forfeit his fee for attendance. Any member refusing to take office who has been elected on to the District Committee shall be fined Rs. 10, unless he is a retiring member of the Committee, when he shall if he wishes, be exempt from holding office. If the District Chairman is 15 minutes late in attendance at a District Committee Meeting, he shall be fined Rs. 2; and if absent without a satisfactory cause being assigned, he shall be fined Rs. 5. In the event of the District Chairman being absent at the time appointed for the Meeting, the members shall, if there is a quorum present, elect their own Chairman

for the evening, and proceed with the business on the agenda-paper. If the Chairman presiding does not maintain order by enforcing the Rules, he shall be fined Rs. 5. A summary of the proceedings of all District Committee Meeting shall be sent to the *Railway Service Gazette* for publication.

XX. Every District Committee shall possess the right of framing Bye-Laws for its own government (so long as such Laws are not opposed to the General Rules), but before they can be acted upon they must receive the approval of the Executive Council.

XXI. There shall be one regular District Committee meeting every month, but Special Meetings may be held whenever the District Chairman, or Secretary may deem it necessary, or any seven members of the Committee may append their signatures to a requisition in writing addressed to the District Chairman, or District Secretary to call a Special Meeting, and should their request not be complied with, they shall report the circumstance at once to the President, or General Secretary of the Society. No smoking, or drinking shall be permitted at any meeting, and any member infringing this rule, or creating a disturbance, or refusing to obey a call to order shall be expelled the meeting, and dealt with as the Committee shall decide. After the meeting has been opened, no member shall retire until it is closed without first asking permission of the Chairman to do so.

XXII. Five members independent of the District Secretary, and District Treasurer shall form a quorum with power to act.

District Marshals, Standard Bearers and Warders.

XXIII. The duties of the District Marshals shall be to organize and arrange all processions and assemblies, so as to prevent confusion or disorder.

XXIV. Every District shall be at liberty to have a standard of its own, with such device thereon as the members in the District may think fit to adopt, but the cost thereof must be defrayed by the members themselves, and not out of the Society's funds. When a District possesses a standard it shall be carried in all processions by the District Standard Bearer who shall be responsible for its safe keeping.

XXV. The District Warders shall guard the door of the Committee room when the meetings are being held, and prevent the intrusion of any non-members who have not been invited.

District Funds.

XXVI. No portion of the District Funds shall be withdrawn from the Bank in which they are deposited except on a cheque signed by the District Chairman, District Secretary and District Treasurer for the time being, or by some person or persons duly authorised by the Executive Council of the Society for the time being, to make such withdrawal.

XXVII. Should the funds in the District ever fall below Rs. 1,000 the District Committee shall be immediately informed of the circumstance; and should they deem it advisable, application shall be made without delay to the Executive Council of the Society for a remittance; such application shall be accompanied with a statement of the accounts in the District since the last Financial report was issued, which shall be signed by the District Chairman, District Treasurer, and District Secretary, and shall show for what particular fund or classes the necessary money is required. No District shall retain in its possession at the District Head Quarters more than Rs. 2,000 without permission of the Executive Council. All money in excess of Rs. ~~5,000~~ ²⁰⁰⁰ shall be remitted monthly to the Head Office of the Society.

Abolition of Districts.

XXVIII. Should a majority of the members in the District desire the District management to be abolished and the District dissolved, or should the expenditure for management at the District Head Quarters exceed 10 per cent of the money received from the Branches by the District Treasurer, or should the District officers prove extravagant, or neglectful of their duties, or should they individually or collectively take any step themselves, or permit any member or members in the District to take any step whatever that may cause dissatisfaction or ill-feeling among a majority of the members of the Society, it shall be lawful and legal, and shall be in the power of the Executive Council to take away, or order to be taken away, the charter from the District, and to abolish the District and either incorporate the Branches in the District with some other District or Districts, or place them under the immediate control of the Head Office, and it shall be lawful and legal for the Executive Council of the Society to remove or order to be removed all books, papers, documents and monies from the District Head Quarters to the Head Office of the Society, and place all the Branches in the Districts in direct communication with the Head Office of the Society.

If the District charter is cancelled through no proper returns having been sent in to the Head Office for six months, the District shall be abolished and dissolved by an order from the Executive Council.

XXIX. No Officer or member of the District Committee shall discuss the proceedings of the District Committee at any Branch Meeting, unless the sanction of the District Chairman has been previously obtained, or to defend themselves from any charge brought forward against them in their capacity as members of the Committee. Any infringement of this rule shall render the member so offending liable to expulsion from the District Committee.

General Rules applicable to District Officers and Committee men.

SECTION IV.

BRANCHES.

I. No Branch shall consist of less than eight members, or more than two hundred, and its affairs shall be conducted and managed by a Chairman, Secretary, Treasurer, and a Committee who shall be elected annually by the members in the Branch. The limits of each Branch shall be clearly defined by the District it belongs to, or should it not belong to a District the limit shall be defined by the Executive Council.

When a Branch contains over two hundred members it shall be divided into two or more Branches.

II. Should eight Railway employes residing in one station be desirous of opening a new Branch, they shall forward an application containing their names, addresses, and occupation to the nearest Branch of the Society, in the form Appendix D, and if such Branch considers them fit and proper persons, the Chairman shall order the Secretary to forward the application to the Executive Council, with a recommendation that the applicant be permitted to open a Branch of the Society at the station they reside at.

III. Any member, or members opening a Branch of the Society without first obtaining the sanction of the Executive Council to do so, shall, each and every one of them, be fined Rs. 50, and shall be suspended from all benefit and privilege until the fine is paid. If the fine should remain unpaid for a period of two months by any member on whom it has been inflicted, such member shall

Penalty for opening a Branch without obtaining sanction of the Executive Council.

cease to belong to the Society, and the money shall be recovered as laid down in Rule 8, Sec. VI.

IV. When the Executive Council sanction the opening of a new Branch, they shall grant it a Charter of warrant of constitution, and such charter shall be produced at every Branch Meeting.

Should any Branch lose its Charter, it shall not be legal for it to work until a new one is obtained, or should the Charter not be produced at any Meeting of the Branch, all acts done at any such Meeting shall be *illegal*. Should a Charter be lost the application for a new one must contain all particulars concerning the loss.

V. Should any Branch containing eight or more members fail to send in the required Returns to the Head Office, or the District Office, whichever it may be working under for three months, the Charter of the Branch shall be cancelled, the Branch shall be put in abeyance, and the Officers and Committee residing at the Branch shall forfeit all claim to any benefit whatever from the Society until such time as the Branch is revived and obtains a new Charter.

VI. Each Branch of the Society shall be under the management of a Chairman, Secretary, Treasurer, two Wardens, two Marshalls and a Standard Bearer, and when the number of members in the Branch permit a Committee of not less than five members, all Branch Officers, except the Branch Secretary and Branch Treasurer, shall be ex-officio Committee-men.

Branch Committee.

VII. When the Committee consists of five members only inclusive of officers, three shall form a quorum with power to act; but when the members of the Committee shall be more than five, for every two members above five, there shall be one more member added to the members necessary to form a quorum, until the number to form a quorum amounts to ten which number shall not be exceeded.

VIII. The Branch Committee shall consider all urgent cases, and decide thereon. They shall meet regularly once in every month, before the first Branch meeting takes place, to transact such business as may be brought forward. They shall have power to frame Byo-laws for the Branch but such Byo-laws must be approved of by the members of the Branch in

open meeting, and subsequently by the Executive Council before being put into operation; every member of the Branch Committee shall receive eight annas for every Committee Meeting he attends. If absent from a Meeting after being summoned, and not sending any satisfactory explanation for non-attendance, he shall be fined one rupee.

IX. No member in arrears is eligible for election on to any Committee, and any Committee-man allowing his monthly subscription to the Society to fall in arrears, shall not be allowed to attend any Committee Meeting, and shall notwithstanding be liable to the fines for non-attendance.

Committee-men in
arrears with subscrip-
tions.

Sub-Committee.

X. Sub-Committee may be appointed for the examination of candidates before they are admitted as members of the Society, and such Sub-committee shall be elected by the members at a regular Branch Meeting. If no Sub-Committee is appointed, the duty of ascertaining the fitness of candidates to become members of the Society shall devolve upon the Branch Committee.

How appointed.

Admission of Candidate into the Society.

XI. No Branch shall admit any candidate as a member of this Society unless such candidate shall have been regularly proposed and seconded in writing (by two members not in arrears) and he shall have agreed to conform to, and abide by the Rules and By-laws of the Society, at a Branch meeting, nor until he shall have passed such examination as will satisfy the Committee of his competency and character.

Examination ne-
cessary.

XII. No Branch shall accept any verbal statement respecting the fitness of a candidate to become a member of the Society, but shall require a printed or written Certificate of his competency and qualifications signed by the Chairman and also not less than three of the members of the Committee by whom he was examined, before his admission shall be permitted.

Production of
Certificate of Exam-
ination necessary.

XIII. Should the members of any Branch infringe the two preceding Rules by admitting a candidate without the production of the necessary Certificate duly signed vouching for his fitness, every member present at the meeting at which the candidate was admitted shall be fined a sum not exceeding Rs. 10.

Penalty of in-
fringement of the
two foregoing Rules.

XIV. Should any Committee, appointed to examine into the fitness of a candidate, submit a false statement respecting such candidate's qualifications, each, and every member of such Committee shall be fined a sum not exceeding Rs. 50.

Penalty on Committee of examination for false Certificate

XV. The Certificate of the Committee who examined the candidate shall be forwarded by the Branch Secretary along with the members' Proposition Form, and other papers to the Head Office, when a Certificate of Competency will be granted by the Executive Council.

Certificate of Competency.

Election of Branch Officers, Committee, and Term of Office.

XVI. The Branch Officers, and Committee shall be elected annually at the first Meeting in December, and should any member refuse to take office after being duly elected, he shall be fined Rs. 5, unless he can obtain a substitute, who shall be approved of by a majority of members present at the Meeting. The Branch Officers, and Committee-men shall hold office for a period of twelve months, and shall be eligible for re-election. No officer of the Branch, or member of the Branch Committee, who has been duly elected and appointed, shall be permitted to resign his office without producing full and satisfactory cause and reason to the Branch Committee for his conduct. Should he fail to give a satisfactory reason, and resign the appointment to which he has been elected, he shall be fined Rs. 5.

With such exceptions mentioned in Rules 17 and 52, and as are hereinafter mentioned, no member of the Society shall be elected by the members of a Branch to hold two offices in the Society.

Number of appointments that may be held by one member.

XVII. The members in any Branch which does not contain more than thirty members, may elect one member to fill both the appointments of Branch Treasurer and Secretary, but it shall not be compulsory on the member so elected to take up both appointments; and should he do so, he shall receive the salary attached to both offices and shall also become liable to the fines connected with the appointments.

Exceptions.

When the number of members in the Branch shall exceed thirty, the appointments shall be separated at the next election of Officers.

Chairman, Branch Officers and their Duties.

XVIII. The Chairman shall conduct all Branch Meetings at which he is present in an orderly manner, and according to

these Rules and the Bye-laws of the Branch. He shall appoint two Warders, two Marshals, and one Standard Bearer, immediately after his election has been confirmed. He shall satisfy himself that all important correspondence sent to, or despatched, from the Branch is read at the Branch Meeting for the information of the members. He shall see that the Meetings of the Branch are regularly held, and that the fines for non-attendance are inflicted on all members who cannot give a satisfactory reason for their absence from the Meeting. He shall convene, or cause to be convened, Committee, and Special General Meetings of the Branch whenever he may consider it expedient, or when required to do so by one-third of the free members in the Branch. He shall appoint scrutineers when necessary for the purpose of counting the votes at General Meetings, and shall declare the result before the Meeting closes. He shall read, or cause to be read, the Bye-laws of his Branch at each half yearly Meeting, and shall see that the monthly Returns are regularly sent into the District, or the Head Office, whichever the Branch may be working under, signing them before they are despatched. He shall satisfy himself that every Branch Officer performs his duty in a proper manner, and should any of them neglect their duties, he shall report them to the members of the Branch who shall decide upon the punishment to be inflicted. The Chairman is the most important officer in a Branch. If he does his duty the Branch will flourish; should he neglect it the Branch must suffer; therefore members should exercise great care in their selection of a Chairman. The Branch Chairman shall, so long as he retains office, be an ex-officio member of the District Committee, should his Branch be working under a District. Should the Branch Chairman be absent at the time appointed for the Meeting, the members shall appoint one to officiate for him.

Branch Secretary.

XIX. The duties of the Branch Secretary shall be to keep all documents, books and papers belonging to his office in such form, and for such use as the Rules of the Society, and the Bye-laws of the Branch require. He shall conduct all correspondence except such as relate to money matters. He shall attend every Branch and Committee Meeting, and correctly record the proceedings. He shall forward the result of the annual election of the Branch officers to the District and Head Office of the Society.

XX. The Secretary shall read such Reports as have been received since the last Meeting at the next Branch Meeting after receiving the report.

Reading Reports.

He shall also read all correspondence that has been received or despatched since the last Meeting. He shall prepare all voting papers, and carefully record the number of votes for, and against any question or subject voted on.

XXI. The Secretary shall convene all regular Meetings of the Branch he belongs to by advertisement, or circular, as specified in the By-laws of the Branch, or if the By-laws are silent on the subject, as the members in Meeting may decide.

He shall convene Special Meetings whenever ordered, to do so by the Chairman, or on receiving a requisition signed by one-third of the free members belonging to the Branch. Should any Branch Officer leave the Station, the Secretary shall at once convene a Special Committee Meeting for the purpose of enabling the retiring officers to make over his office, and also to enable the Committee to appoint another member to officiate until the next election of officers. A summary of all Branch Meetings shall, with the approval of the Meeting, be sent to the Society's journal for publication.

XXII. The Secretary shall acquaint the Head Office with the removal of any officer or member from the Branch giving their register number, and date of removal, and where removed to.

XXIII. The Secretary shall carefully preserve the Branch records, and see that all documents and papers are filed for reference. He shall always keep a sufficient supply of stationery and application forms in stock. He shall, when applied to, supply application forms for members requiring benefit, and if requested shall fill in the application form, but shall exercise his own discretion about signing it.

XXIV. The Secretary shall make out and send into the District or Head Office, whichever the Branch may be working under, a monthly Report which shall be made up to, and include the last day in the month: it shall give the number of members working in the Branch, and the number transferred during the month; the names, registered number, and occupations of any members who have been relieved during the month. It shall give the condition of the labor market, and the state of wages, it shall also give the names, and the residence of the Branch Chairman and the Branch Secretary.

XXV. The Branch Secretary shall once each half-year forward to the Head Office a Report properly verified by the Chairman, and Treasurer, showing the total number of members en-

rolled in the Branch during the half-year. It shall also show the condition of the Branch, and shall contain the register number, and name of *each member* belonging to *each class* in the Branch: likewise the name, and register number of every member who has been expelled during the half-year, giving the cause of expulsion, and shall contain a statement of the property in the Branch belonging to the Society, and its value, also the address of the Society's Meeting-room.

XXVI. The Secretary shall forward his monthly Report to the Head Office, or District to whichever the Branch is attached by the fourth of each month, and his half-yearly Report shall be despatched to the Head Office by the 8th of July, and 8th of January in each year, and for neglecting to forward the reports as required he shall be fined two rupees.

XXVII. The Secretary shall, on receiving information from the Branch Treasurer, warn all members in the Branch who are three months in arrears by circular, or letter, three days before the Branch Meeting is held.

XXVIII. The Secretary shall not have authority to collect, or acknowledge the subscriptions of members.

XXIX. The Secretary of every Branch shall receive per quarter the following salary: for every *free* member at the end of the quarter belonging to Class A that is entered in the books of the Branch, he shall receive three annas per quarter only; for every *free* members at the end of the quarter belonging to Class B, that is entered on the books of the Branch, he shall receive one anna six pie per quarter only; and for every *free* members at the end of the quarter belonging to class C that is entered on the book of the Branch he shall receive nine pie per quarter only.

XXX. The Branch Secretary shall be allowed to speak on any subject, but shall not be allowed to vote at any meeting.

Branch Treasurer.

XXXI. The Branch Treasurer shall keep the Register of the Branch, in which he shall write the names of all members belonging to the Branch, and he shall enter to each member's credit such sums of money as they may pay to him as their subscriptions to the Society. He shall notify in the Register the removal of any member who may leave the Branch, also the date when any member in the Branch ceases to belong to the Society, specifying the cause

of the cessation of membership. He shall keep a separate account of all fines that may be paid to him.

XXXII. The Branch Treasurer shall be the only person in the Branch who shall be authorized to receive and acknowledge subscriptions, or any other monies that may be paid into the Fund of the Society at the Branch. He shall enter all money he may receive in a cash-book clearly specifying from whom, and on what account it was received. When receiving monthly subscriptions from members he shall acknowledge the amount in their pass-book, and also give a distinct and separate receipt for each month's payment that is made, such receipt shall bear the date of payment, the amount paid, the register number of the member, and the letter of the class he belongs to, and be signed by the Branch Treasurer. The Branch Treasurer shall not (unless permission is given by the Byo-laws of the Branch to act otherwise), receive any joining fees, or monthly contributions except at a Branch Meeting.

XXXIII. The Branch Treasurer shall either give warning himself to members who are three months in arrears three days before the next Branch Meeting, or he shall forward their names to the Branch Secretary for him to do so. The Branch Treasurer shall once a month at a regular Branch Meeting read out the names of all members in the Branch who are over one month in arrears with their subscriptions, and shall state the amount they are in arrears. He shall, unless prohibited by a Resolution passed by a majority of the members at a Branch meeting, post up the names of all members who are in arrears with the amount due by them to the Society, in the Branch Meeting-room.

XXXIV All lawful disbursement from the funds in the Branch shall be made by the Branch Treasurer only, but he shall not make any such disbursement unless by a written order signed by the Branch Chairman, and two members of the Branch Committee, or by a Resolution passed by a majority of the members present at a Branch, or Committee Meeting, or by the written order of the Committee of the District to which the Branch is attached, signed by the District Chairman, Secretary, and Treasurer, or by an order of the Executive Council signed by the General Treasurer, and the General Secretary. The Treasurer shall enter all disbursements in the same Cash Book with his receipts, but on the opposite page to that containing the receipts. When entering disbursements he shall always mention the authority for making them.

XXXV. The salaries allowed by the Rules for the Branch Officers, the fees for attendance of Committee-men at Committee Meeting, the contingent expenses allowed for each Branch Fees to District Committee-men for attending District Committee Meeting, cost of any special visits of the District or General Secretary made by request of the Branch, remittances to the District or Head Office, and the benefit allowed to members by the Rules of the Society, shall be the only disbursements deemed and considered lawful disbursements.

XXXVI. No Branch shall, unless the sanction of the Executive Council has been previously obtained, disburse a larger sum per month than Rs. 5 for contingencies out of the Society's funds at the Branch.

XXXVII. Should the members in the Branch desire to make any special disbursement, over and above the amount sanctioned by the Rules, the written sanction of the District Committee or Executive Council must be first obtained.

XXXVIII. The Branch Treasurer shall keep the following books:—The Register Book, Cash Book, Remittance Book, printed Receipt Book, containing receipts for members' subscriptions, Register of Members Relieved, Bank Book, and such other books as may be considered necessary for the good working of the Branch. The books shall be produced once a month at the regular Branch Meeting. When they shall be laid on the table for inspection, they shall be submitted to the Auditors of the Branch, or of any of the principal officers of the Society when required. The Branch Treasurer shall, when applied to by any member who is leaving the Branch, supply such member with a Clearance Certificate which he shall have signed by the Branch Chairman and Branch Secretary, and shall also sign the same himself before handing it to the applicant.

XXXIX. This book shall always be used when remitting money from the Branch to the District, or Head Office of the Society; the book contains four counterfoils, the first counterfoil specifying the amount remitted, shall be sent along with the money under registered cover to the District, or General Treasurer as the case may be; the second foil shall be despatched to the District Chairman, or the Chairman of the Executive Council advising him of the amount despatched to the Treasurer; the third foil shall be des-

patched to the Secretary of the Branch from which the remittance is made, who shall produce and read it at the next Branch Meeting, after which it shall be filed; the fourth foil shall remain in the book for reference; every counterfoil shall be signed by the Branch Chairman, and Branch Treasurer. Should any sums of money be remitted to the Head, or District Office and the system herein laid down is not carried out, and the money not be received by the Head, or District Office within one month from the date on which it was despatched, the Branch Treasurer shall make good the entire amount of the remittance.

XL. Every Branch Treasurer shall receive the printed Receipt Book from the *Head Office direct*, and shall give one receipt therefrom for every month's subscription that may be paid to him by members of the Society, *taking care to fill in the counterfoil correctly*; when all the receipts in the book have been issued, he shall send the counterfoil to the *Head Office direct* when a fresh book shall be sent to him.

XLI. The Branch Treasurer shall, at the end of every month, fill in, and despatch before the 8th of the following month to the District Office, if the Branch is working under a District, otherwise to the Head Office, a *Monthly Return* which shall contain the registered number of every member from whom he has received money during the month specifying the amount received from each member. The total amount of money in the Branch on the first of the month shall be shown in the Return, and added to the amount received during the month. The Return shall also contain a statement of the disbursements made in the Branch during the month, and show the balance in the Branch, and also the number of free members in the Branch, and the members in arrears. The monthly Return shall be signed by the Branch Chairman and the Branch Treasurer before being despatched to the District, or Head Office.

XLII. The Treasurer shall every half-year in the month of July, and January, prepare a *Half-yearly Balance Sheet and Statement*, Balance Sheet in the form Appendix A, or as near thereto as circumstance will permit, showing the total receipts, and disbursement of the Branch during the half-year. This Balance Sheet shall be duly examined and audited by the Auditors of the Branch, and laid before the members of the Branch at the first Branch Meeting in July, and January in each year, and after being signed by the Branch Chairman two copies shall be made out by the Branch

Treasurer. These copies shall be signed by the Branch Chairman, and Branch Treasurer, and one shall be forwarded direct to the Head Office of the Society, while the other shall be posted in the Branch Meeting room for general information. The original Balance Sheet shall be made over to the Branch Secretary to file along with the records of the Branch. At the same time as the Branch Treasurer prepares the Balance Sheet, he shall prepare a statement showing—

1st.—The number of members enrolled into the Society at the Branch during the half-year specifying what classes they have joined.

2nd.—The number of members who have joined from other Branches.

3rd.—The number of members who have left the Branch without notice.

4th.—The number of members deceased.

5th.—The number of members left the Society.

6th.—The number of members in the Branch who have been expelled the Society.

7th.—The names, and registered number of members in arrears in the Branch at the end of the half-year, with the amount due by them.

8th.—The number of free members in the Branch at the end of the half-year. Copies of this statement shall be prepared in the same manner as the Balance Sheet to which they shall be attached.

XLIII. The Branch Treasurer shall find security for Rupees 300, or such larger sum and in such manner as the members in the Branch decide upon. Should the Branch Committee fail to see that the Treasurer finds security, they shall individually, and collectively be responsible for any loss that the Society may sustain through him.

XLIV. The Branch Treasurer shall attend all Meetings of the Branch unless unavoidably prevented, and shall receive the same salary as the Branch Secretary.

The Branch Treasurer may speak on any subject, but shall not be allowed to vote.

Funds.

XLV. Each Branch of the Society may retain in its possession a sum of money not exceeding Rs. 250 which shall be deposited for safe keeping in such manner as the Branch Committee shall resolve upon. When the funds in the Branch exceeds Rs. 250 the surplus shall be remitted to the District or Head Office

whichever the Branch may be working under. When the funds in a Branch fall below Rs. 100, the Branch Treasurer shall at once inform the Branch Committee of the circumstance. Should the Branch Committee deem it expedient to augment the amount, they shall pass a Resolution empowering the Treasurer to obtain a remittance from the funds at the Head, or District Office; a copy of such Resolution shall be signed by the Branch Chairman, and Secretary and shall be forwarded by the Branch Treasurer to the Office from which the remittance is desired. It shall be accompanied by a statement of the condition of the Branch.

XLVI. All applications from Branches shall, unless otherwise specified, be addressed to the General Secretary, or if the Branch is working under a District to the Secretary of the District it belongs to.

Marshals, Warders and Standard Bearers.

XLVII. The officers shall be appointed by the Branch Chairman after he has regularly taken over charge of the Branch.

XLVIII. It shall be the Marshal's duty to conduct all ceremonies, and arrange processions so as to avoid confusion and disorder.

XLIX. The Warders shall take charge of the door of the Meeting room to prevent the entrance of all uninvited persons and intruders.

L. The Standard Bearer shall carry the banner of his Branch in all processions and will be responsible for its safe custody. Branches can have whatever description of Banners they choose but the cost thereof must be defrayed by the members at the Branch, and no portion of the Society's fund shall be devoted to the purchase.

LI. At the first Branch Meeting in January in each year two Auditors shall be elected by ballot, whose duty it shall be to examine the Treasurer's Balance Sheet every half-year, and specify at the foot thereof whether it is a correct statement or not, attaching their respective signatures. The Auditors shall receive Rs. 5 per year for their services, they need not be members of the Society. The Branch Chairman, Secretary, and Treasurer shall not be eligible for election as Auditors.

Branch Meetings.

LII. There shall be two regular General Meetings in each Branch in every year, one in the first week of July, and

one in the first week of January; at these meetings the half-yearly Balance Sheet, and Statement shall be laid before the members for approval. Every Branch that is working under a District shall, at the General Meeting in January, elect by ballot the member who is to represent the Branch at the District Committee Meetings; at the same meeting, a Delegate shall also be elected to represent the Branch at Delegate Meetings. Any officers except the Branch Treasurer may be elected Delegate, or District Committee-man. If the Branch Secretary holds the appointment of Branch Treasurer as well as Secretary, he shall not be eligible for election to the appointment of Delegate, or District Committee-man. The Delegate and District Committee-man shall hold office for twelve months only, but shall be eligible for re-election.

LIII. Special General Meetings may be convened by order of the Chairman, or by the Branch Secretary, on a requisition signed by one-third of the free members belonging to the Branch. Seven days' notice by circular, or advertisement of any General, or Special General Meeting shall be ample and sufficient notice.

LIV. There shall be not less than one regular Branch Meeting in every month, the date of which, and time of meeting shall be notified by circular or by advertisement, and no further notice shall be deemed necessary for information of the members of the Branch.

LV. Any member who has been a member twelve months, or more, neglecting to attend a General Meeting, Special General, or regular Branch Meeting (after being duly summoned) shall be fined four annas if he attends half-an-hour after the time of Meeting, and if not present at all he shall be fined eight annas unless a satisfactory reason for such absence be given at the Meeting.

LVI. A free member shall be a member who has belonged to the Society for twelve months, who is not in arrears with his payment to the Society, and who is entitled to vote.

LVII. Members who have paid their third contribution shall with such exception hereinafter mentioned have the right of speaking, and voting in their own Branch only, on any business of the Society, and at the election of officers. No member under suspension or two months in arrears shall be allowed to vote; nor shall any member who has previously belonged to another Branch of the Society be allowed to vote, unless he produces a clearance certificate from the last Branch he

paid into. This Rule shall be binding on any new Branch, after it has been established three months, but not before. Every member in the Society shall possess one vote.

LVIII. All members over the age of fifty shall be exempted from attending the meetings of their Branch should they wish to claim exemption. Being at work until one hour before the meeting takes place shall exempt a member from the fine, but an apology shall be sent to that effect, and should it be proved that the apology is false he shall be fined one rupee. Branches shall have a discretionary power to exempt the following members from attendance at general meeting, those that are sick or are suffering from constitutional weakness, family affliction or bereavement, also any person in the capacity of an employer, or foreman shall be exempt from holding office, or attending any meeting unless specially summoned; but each Branch shall be empowered to define who are foreman, and who are not; members on the funds shall be exempt.

LIX. When any motion has been decided upon no member shall be allowed to speak again on that subject during the meeting.

LX. No member shall be allowed to leave any meeting without the sanction of the Chairman.

LXI. All business transacted at any meeting when duly summoned shall be binding on all members of the Branch, providing such business is in accordance with the General Rules.

LXII. There shall be no liquor, or smoking allowed in the meeting room during the transaction of business.

LXIII. When a member addresses the Chairman that may be presiding he shall be standing or be fined rupee one, any member interrupting another member whilst addressing the meeting shall be fined rupee 1.

LXIV. Five questions shall be asked each club night namely (A) If any applications have been made for benefit (B) The number of members out of employment (C) If all applications have been attended to (D) If there are any new members to propose (E) Whether any member has any thing to propose for the good of the Society or of his own Branch.

LXV. Every officer belonging to a Branch shall be protected by these Rules, and such subsequent Rules and Bye-laws as may be framed; and when any member is appointed to officiate during the absence of the Branch Chairman, at any meeting of the

Branch, the same good order shall be kept as if the Chairman was present, and the same fines imposed, and as the object the Society aims at are promoting the welfare of its members, to effect which it is necessary the utmost harmony, good-will and unity should exist among them, it has been resolved that if any member should insult, or abuse any other member, or by discourteous language, cause, or try to cause a breach of the peace in any way, at any Meeting, he shall be expelled the Meeting, and fined a sum not exceeding Rs. 20, and for a repetition of the offence shall, in addition to the former punishment, be suspended from all benefit of the Society for the space of twelve months, and if he repeat the offence he shall be expelled the Society, and forfeit all claims to benefit of any description. The foregoing penalty will also be inflicted on any member who shall endeavour to intimidate any other member, and cause or try to cause such member to speak, vote, or act in the affairs of the Society other than he shall desire to do of his own accord. This rule shall be read once every quarter.

LXVI. Should the Executive Council abolish any Branch, or should the members at any Branch dissolve the Branch, or should a Branch fall into abeyance, the Charter of the Branch together with all the books, records, things and money belonging to the Society, shall be despatched to the Head Office of the Society without delay, and should this not be done, it shall be legal for the Executive Council to enter a suit, or action in a Court of Law for the purpose of obtaining, and recovering the aforementioned Charter, books, property, things, and monies from the person or persons who retains possession of them.

LXVII. Any Branch whose returns have not been sent in to the District, (if the Branch is attached to a District) or Head Office for six months, shall be placed in abeyance.

LXVIII. It shall be in the power of the Executive Council of the Society to abolish any Branch of the Society, at which the members infringe or violate any of these Rules, or conduct their business under any Rules, or Bye-laws not sanctioned by the Executive Council.

LXIX. No District, or Branch, or any member or members belonging thereto shall be allowed to send any address, or circular relative to the Society in General to any other Branch, or District of the Society without first obtaining the sanction of the Executive Council to do so, and should any District or Branch violate this Rule, it shall be in the power of the Executive Council to

abolish such offending District, or Branch, and demand that all books, papers, property, things, and monies whatsoever belonging to the Society, be despatched to the Head Office of the Society within a specified time, and it shall be the duty of the District, or Branch to comply with this demand, and if the demand is not complied with, it shall then be legal for the Executive Council to institute such proceedings through a Court of Law as will enable them to recover possession of the aforesaid books, papers, monies, and things belonging to the Society.

LXX. If any member, or members shall attempt, either publicly or privately, to break up the Society, or perform, or cause to be performed any act, or acts that might, in the opinion of the Executive Council, injure the Society, such member, or members so offending shall be fined a sum not less than Rs. 100, and in addition shall be expelled the Society by the Executive Council, and never be re-admitted, forfeiting all benefits of any description from the Society, and any member being aware that this Rule is ignored, or that any attempt is even contemplated which may tend to injure the Society in any way whatever, and shall fail to inform the Executive Council of the same, he shall be expelled the Society, forfeit all benefits he may have been entitled to, and never be allowed to rejoin.

SECTION V.

PUNISHMENT.

I. Any officer or member, with such exceptions hereinafter mentioned, infringing any existing or future Rule or Bye-law of this Society to which no special penalty is attached, shall be punished according as a majority of the members of the Branch to which he belongs assembled in Regular Meeting shall decide, but no Branch shall have the power to inflict a greater fine upon any individual member for one offence than Rs. 100. Branches shall also have the power of suspending and expelling members belonging to their Branch, for the infringement of such Rules as those punishments apply to.

II. No Branch shall have power to punish the Chairman of the Branch without first sending a statement of his offence to the District Committee, (if the Branch is attached to a District, or if not to the Executive Council) but a Branch shall have power to temporarily suspend the Branch Chairman from office.

District Committee. III. The District Committee shall have power to punish, fine, suspend, or expel any member in the District (except the District Chairman) who shall infringe any existing, or future Rule or Bye-law of the Society to which no special penalty is attached.

Executive Council. IV. The Executive Council shall have power to fine, suspend, or expel any member in the Society (except the President) who shall infringe any existing or future Rule or Bye-law of the Society to which any special penalty is, or is not attached.

Impeachment of President. V. The Executive Council, if they have what they consider sufficient evidence to prove the President is injuring, or has injured the Society, may suspend him from office, and may draw up a deed of impeachment against him, which shall be circulated among the Branches of the Society for the information of the members. A Special Committee, comprised of six members, shall be elected by the members of the Branches throughout the Society. Such Committee shall investigate the charges against the President, and decide according to the evidence received.

Branch Chairman and District Chairman. VI. Branch Chairman shall be tried by the District Committee, and District Chairman by the Executive Council only.

Rules to be observed before members are punished for special offences. VII. With such exception as hereinafter mentioned, before any member can be punished, the following Rules shall be strictly observed:—
(A) Every offending member shall be made acquainted with the charge or charges that are preferred against him, by a letter despatched to his address under registered cover through the post office ten days before the day appointed for the meeting at which the case is to be brought forward.

(B) Two-thirds of the votes of the members present shall be necessary to prove the accused member guilty.

(C) Should the offending member fail to attend the meeting to which he is summoned, the case shall be decided in his absence.

Exception. VIII. The foregoing rule shall not affect, or cancel, or alter the Rules respecting arrears of contribution or non-payment of dues, nor shall it affect, cancel, or alter any other Rule which admits of a member being summarily dealt with.

IX. Any member who considers he has been unjustly punished by the Branch to which he belongs, may, any time within one month from the date the punishment was inflicted, appeal to the District Committee to have his case investigated by them, and should the District Committee uphold the decision, he may appeal to the Executive Council through the District Office for them to investigate his case, and their decision shall be final unless the member appeal to the next Delegate Meeting.

X. Any member who considers he has been unjustly punished by the Committee of the District within whose jurisdiction he resides, may, within one month from the date the punishment was inflicted, appeal to the Executive Council for a fresh investigation of his case, and should the Executive Council uphold the decision of the District Committee, he shall be at liberty to appeal through the Executive Council of the Society to the next Meeting of Delegates for them to investigate his case and the decision of the Delegates shall be final.

XI. Should the Executive Council themselves punish any member of the Society by fine, suspension, or expulsion from membership in the Society, and such member feel himself aggrieved, he may request the Executive Council to convene a Special Committee Meeting at the Head Office to investigate and decide upon his case; such Special Committee shall be comprised of one member from each District Committee in the Society and to meet the expenses they would incur through attending the Meeting to which they were summoned; the appellant, when making the appeal, shall deposit such a sum of money with the General Treasurer as shall defray the cost of their attendance. If the decision of such Special Committee is in favor of the appellant, the money deposited shall be returned to him, but should it justify the conduct of the Executive Council he shall forfeit such portion of the money as shall be necessary to defray all expenses; should no deposit be made, or should an insufficient sum to meet the expenses be deposited by the appellant, the Executive Council shall decline to convene a Special Committee Meeting.

XII. All fines duly imposed shall be reckoned as arrears of contributions, and shall be considered as money due to the Society, and which shall be recoverable through a Court of Law.

XIII. Any member suspended from benefit shall be required to continue paying his contribution during his term of suspension, and should he fall into arrears he shall cease to be a member of the Society, and shall forfeit all payments he may have made to it. A suspended member shall not be allowed to vote, or speak at any Meeting of the Society.

XIV. Any member who shall have been expelled shall forfeit all monies he may have paid into the Society, or any of the Funds attached thereto. He shall also forfeit all rights and privileges he may have previously enjoyed as a member of the Society, and shall cease to be a member.

XV. Any member who shall be prosecuted by the Society, shall, if convicted, cease to be a member and shall forfeit all monies he shall have paid into the Society or of any of the Funds attached thereto.

APPENDIX.

XVI. The General Secretary shall, on application from any Branch of the Society, supply it with one copy of Bye-laws suitable for a Branch, which the members at the Branch may adopt in their entirety, or before adopting them they may alter, expunge from, or add to them, but all such alterations, or additions must not be at variance with any of the established Rules of the Society, and the Bye-laws must be approved of by the members in the Branch, and subsequently be submitted to the Executive Council for their approval before being put in operation.

SECTION VI.

Fees, CONTRIBUTIONS, BENEFITS, &c.

I. Any employed in any way connected with any Railway in India, Burmah, Ceylon, the Straits Settlement, or any Island in the Indian Ocean, shall be eligible for admission into the Society on the following condition:—
1st.—He shall be able to read and write.

2nd.—He shall be in employment at the time his name is submitted for admission into the Society.

3rd.—He shall agree to conform, and submit to the Rules and Byo-laws of the Society that may be in force when he joins, and also to any additions or alterations that may be made to or in them at any future period in the manner herein mentioned.

II. With such exceptions, hereinafter mentioned, no person shall be admitted as a Member into this Society after it has been duly registered until he has been proposed, and seconded, and approved of by three-fourths of the members present at a Branch Meeting, and his joining fees, and one month's subscription to the General Fund of the Society have been paid, and in addition it shall be necessary for him to pass an examination to test his knowledge of the duties pertaining to the appointment he occupies in the Railway he belongs to prior to being admitted a member. Should he pass a satisfactory examination and be admitted a member of the Society, he shall receive a Certificate of Competency from the Executive Council of the Society. Failing to pass the examination he shall not be admitted into the Society, but he may renew his application should he succeed in passing any subsequent examination before duly authorized members of the Society. Any candidate for admission into the Society who has been in the service of his employer for six years, and whose competency and character are vouched for by his proposer and seconder shall be exempt from passing any examination.

Any person subscribing Rs. 20 annually to any Fund connected with the Society, shall, so long as he continues subscribing, be borne on the books of the Society as a Governor, any person making a donation of Rs. 100 to any of the Funds of the Society shall be borne on the books as a Vice-Patron. Vice-Patrons and Governors shall possess the right of attending any Meeting of the Society, and of speaking thereat, but shall not be entitled to vote on any subject, nor shall they be entitled to any benefits from the Society, nor shall they be required to pass any examination.

III. There shall be three classes of members in the Society, namely Class A, Class B, and Class C, with separate fees, subscriptions, and payments, pertaining to each class, which members of the various classes shall pay at, and after their admittance to the Society so long as they continue members of the Society. Such fees shall be as follows:—

Joining fees including 1st month's subscription and cost of Rule Book to be paid before the member is proposed.

Monthly subscription in advance.

	Rs.	A.	P.	Rs.	A.	P.
Class A	12	4	0	2	0	0
„ B	7	4	0	1	0	0
„ C	3	12	0	0	8	0

And an annual assessment payable in January for all classes, of eight annas per member to revert exclusively to a Delegate Meeting Fund.

IV. Should the Funds of the Society be at any time insufficient to meet the demands for benefits, it shall be in the power of the Executive Council to put a levy on all members of the Society, and such levy, if not paid by any member, shall count as arrears of contribution.

V. Should a member belonging to Class B, wish to become a member of Class A, or should a member belonging to Class C, wish to become a member of class B, he shall be allowed to do so with the sanction of the Executive Council only, providing he complies with either of the following conditions:—*First*, By paying up the difference between the amount he has paid into the Society and the amount he would have paid in had he belonged to the Class he wishes to become a member of. Example—A member has belonged to Class B for two years, and has paid into the Society Rs. 80-4, and wishes to join class A. By paying another Rs. 30 in a lump sum he can belong to Class A, and his membership in that Class will count from the date he joined the Society. Again, if a member has belonged to Class C for two years, and has paid into the Society Rs. 15-4, and wishes to join Class B; he can do so by paying in Rs. 15 in a lump sum, and his membership in Class B shall count from the date he joined the Society. *Secondly*, A member can be admitted into a higher Class than the one he belongs to by forfeiting portion of his term of membership. Example—A member has belonged to Class B for two years, and has paid into the Society Rs. 80-4, which amount would cover ten months' membership in Class A. If the member is willing to forfeit fourteen months' membership, he shall be admitted into Class A without making any extra payment. Again, a member has belonged to Class C for two years, and paid into the Society Rs. 15-4 which amount would cover nine months' membership in Class B. If the member is willing to forfeit fifteen months' membership he shall be admitted into Class B without making any further payments; the privilege of changing from a lower class to a higher class shall only be permitted

once a year. Any member belonging to classes A, or B, who, from reduced circumstances may desire to become a member of classes B, or C, shall be allowed to do so providing he obtain the sanction of the Executive Council first, but he shall not be entitled to a refund of any of the money he may have paid while a member of the higher class he belonged to. The privilege of changing from a higher to a lower class shall only be permitted *once* to any member.

VI. Any Railway employé who has been admitted in conformity with these Rules, shall, so long as he pays regularly the contributions and monies required of him, and does not violate or infringe any of the Rules, continue a member of this Society, and should he leave the service of the Railway Company he may be employed by and obtain any other kind of employment, he shall still continue a member so long as he pays his contributions and complies with the Rules of the Society. All subscriptions should be paid in advance. Thus for example:—The subscription for the month of February is due on the 31st January. Every member shall receive a Pass Book, or Pass Card which he shall be required to present when paying his subscriptions to the Officer of the Society appointed to receive the same, and he shall satisfy himself that the payment he has made is correctly entered, and acknowledged in his book, or on his card. He shall also receive a distinct and separate receipt for the payment he has made. Every member should take great care of his Pass Book, or Pass Card, and the separate receipt he receives for each payment, as should he require benefit hereafter, it would be necessary for him to produce both the book, or card, and the last receipt he received, before he can obtain the desired benefit. Except in cases where members are not attached to any Branch, no payment of subscription, or dues shall be made by them save at a Branch Meeting. If a member is unable to attend the Branch Meeting, he may send the money along with his book, or card to the Meeting stating his reason for non-attendance. Should a member lose his Pass Book he can procure another one from the Head Office on payment of 8 annas.

VII. When the money due from any member amounts to the sum of two months' subscription, or when any member is two months in arrears with his subscription, he shall be suspended from all benefit. When the money due from any member amounts to the sum of his subscriptions for six months, or when any member is six months in arrears with his subscriptions, he shall, with such exception hereinafter mentioned in Rule 8 cease to be a member

of the Society, and shall forfeit all money he may have paid into the Society, and also all claim he may have upon the Society: but he may be re-admitted, if duly proposed, as a new member. All fines, and money owing by a member and not paid when due shall be considered as arrears of contribution. Members in arrears shall not be permitted to make or second any proposition for the admission of candidates.

VIII. The Executive Council may, at their discretion, pass a resolution empowering any Officer of the Society to recover arrears, or money due by any member of the Society according to the provisions mentioned in Clauses 9 and 10 of the Act under which this Society is registered, and after the sums due have been recovered from such member they may at their discretion expel him from membership by passing a resolution to that effect, when he shall forfeit all claim of any description he may have on the Society, and cease to be a member.

Should any member, who is six months or more in arrears with his subscription, prove to the satisfaction of the Executive Council that he has fallen into arrears through circumstances beyond his own control, they, at their discretion, shall permit him to pay up his arrears, but he shall not be entitled to any benefit until the total amount of such arrears shall be paid up.

No member who has allowed his subscription, or payment to fall twelve months in arrears shall be allowed this privilege.

IX. The following shall be the scale of benefit for those members entitled to receive benefit according to these Rules and the general conditions herein specified:—

	Class A.	Class B.	Class C.
When out of employment, for three months, per month	Rs. 20	Rs. 10	Rs. 5
If permanently disabled through an accident while in the performance of duty, for-life, per month	Rs. 15	Rs. 7	Rs. 3
After 12 years membership if permanently disabled through blindness or paralysis for life per month	Rs. 15	Rs. 7	Rs. 3

Class A. Class B. Class C.

During sickness (when
no sick pay is allowed
by employer) for three
months, per month, at
the rate of

... Rs. 15 Rs. 7 Rs. 3

After 20 years' member-
ship, if over 50 years of
age, superannuation al-
lowance for remainder
of existence, per
month

... „ 20 „ 10 „ 5

At death—to members
nominee or nominees

... „ 250 „ 150 „ 75

Legal support

... „ 125 „ 75 „ 0

X. No member shall be entitled to any benefit from the

General condition
attached to benefit.

Society who has got into trouble, or been
dismissed through drunkenness, incompe-
tency, neglect of duty, or gross misconduct,
and when the arrears of any member amount to two months
of his subscription to the Society, he shall forfeit all claim to
benefit of any description whatever. No member, two months
or more in arrears, shall be entitled to any benefit or assist-
ance from the Society for any circumstances that may happen
to him while so in arrears, although he may subsequently pay
up his arrears. No member shall be entitled to two descrip-
tion of benefits at one time without the sanction of the Exe-
cutive Council.

Every member shall, when applying for benefit, produce his
Pass Book, together with the last receipt for payment of his
contribution and shall not receive any benefit unless he does
produce them. His application must be made to the Branch
he last paid into.

XI. Should any member be dismissed for incompetency he

Non-employment
Benefit.

shall not, with such exception hereinafter
mentioned, receive non-employment benefit
unless he hold a proper Certificate of Com-
petency from the Society proving he was qualified for the
appointment he held, any member resigning his situation with-
out first proving to the Executive Council that it is advisable
he should do so, and he shall have obtained their sanction to
such a stop, shall not be entitled to any benefit, after a member
has received non-employment donation he must be employed
in some situation for three consecutive months, and not be in
arrears before he shall have any claim to donation again.

Should a member hold a proper Certificate of Competency from the Society, or should a member be only officiating in the appointment from which he has been dismissed for incompetency, he shall receive non-employment benefit, or should it be proved that a member from circumstance beyond his own control has not had an opportunity of passing the examination required by the Society, he shall be allowed non-employment benefit providing he pass his examination immediately after being dismissed. The applicant must pass the examination before he receives the benefit allowed.

XII. No member shall be entitled to sick benefit who is in receipt of any salary from the company he is employed by, or if the malady, or disease he suffers from has been brought on through his own misconduct or neglect, nor in any case shall he receive sick benefit unless he produce when applying for benefit a certificate signed by a medical practitioner specifying the nature, and cause of his illness.

XIII. No member shall be entitled to accident benefit unless permanently disabled, and no member shall be entitled to this benefit who shall have caused the injuries he may suffer from by his own carelessness or neglect, or incompetency to execute the duty he was performing at the time of the accident. Accidents caused while on duty through fits, or ill-health or a visitation of Providence shall not be recognised. Free members of twelve years' membership who may be permanently disabled through blindness or paralysis shall be entitled to superannuation allowance according to scale.

XIV. Any member making a false statement of his age on joining the Society, shall forfeit all claim to superannuation. Superannuation benefit will be payable in any part of the civilized world exclusive of the current rate of exchange, if the superannuated member forward a quarterly statement signed by a Justice of the Peace, and a clergyman proving that he is alive. The Executive Council can, at their option and with the consent of a superannuated member, purchase his allowance for Rs. 600 if the member belongs to Class A, for Rs. 800 if he belongs to Class B, for Rs. 150 if he belongs to Class C, and after that payment such member shall have no further claim upon the General Fund of the Society whatever.

XV. Every member should, on joining the Society, nominate in writing in the presence of the Secretary of the Branch he belongs to, and one other witness, the name and address of the person, or persons he may wish to receive this benefit at his death, and should he fail to do so, or should the nomination form he has filled in, not be produced within one month after his death, the Officers of the Branch to which the deceased member belonged, shall pay the benefit to such person, or persons deemed, and considered by them to be the person entitled to receive the same, and the receipt of such person, or persons for such payments shall absolve the Society from any further claim that may be made upon it on account of the deceased member. The receipt of the person, or persons who present the nomination form, whether such person or persons are, or are not the actual nominee, or nominees shall be evidence of the payment having been made, and the Society shall not be liable for any further demands that may be made upon it in respect of the deceased member.

XVI. Legal assistance shall only be granted to a member who is prosecuted for an alleged offence while on actual duty. No member guilty of drunkenness, gross misconduct, or incompetency shall receive legal assistance. All cases in which legal support is granted to a member should be immediately reported to the Head Office.

XVII. With such exceptions hereinafter mentioned a member must have belonged to the Society.

Six calendar months before he shall be entitled to Non-employment Benefit.

Twelve calendar months before he shall be entitled to Death Benefit.

Twelve calendar months before he shall be entitled to Sick Benefit.

Twelve calendar months before he shall be entitled to Legal Support.

Two years before he shall be entitled to Accident Benefit.

Twelve years before he shall be entitled to any Superannuation allowance.

Any member or members of any other Society, or Association amalgamating with this Society, shall, with the approval of the members of this Society on the recommendation of the Executive Council be entitled according to their term of membership in

Exception to the above Rule.

their own Society, to the benefits enumerated in these Rules, so long as they conform to the Rules and By-laws of this Society.

XVIII. All applications for benefit shall be made in writing, and shall be signed by the applicant himself, and two free members who are able to support the statement made by the applicant. The application shall, with such exception hereinafter mentioned, be presented by the person who claims the benefit, and not by any other person, or the benefit shall not be paid; application forms will be supplied by the Branch Secretary.

Exception to above Rule. Should the person; or persons entitled by the Rules of the Society to the Death benefit, be residing at a distance of over one hundred miles from any Branch of the Society, it shall not be necessary for him, or them to attend in person to receive the benefit, but their application must be signed by two clergymen, or a justice of peace, (and accompanied by a doctor's certificate of cause of death) or other persons whom the officers of the Branch which has to disburse the benefit may approve of; otherwise the benefit shall not be paid.

XIX. All benefits, with each exceptions hereinafter mentioned shall be paid by the Treasures of the Branch to which the applicant belongs, on the written order of the Chairman who presided at the meeting which sanctioned the payment; but should a member be removed from the Branch he belongs to before the benefit can be paid to him he shall inform the Treasurer what his future address will be and the Treasurer shall then at his earliest convenience remit the benefit to the Treasurer at the Branch where the member has gone requesting him to pay it to the member and obtain a receipt from him.

Urgent cases **XX.** In cases of great urgency a Special Committee Meeting may be convened at the Branch to which the applicant belongs, to decide upon any application for benefit. All cases where a member is dismissed for imputed neglect of duty, shall be very carefully enquired into by the Branch Committee.

False statement and declaration **XXI.** Any member supporting a false statement, or making a false declaration for the purpose of obtaining any benefit from the Society for any other member, shall make good any loss the Society shall sustain, be fined Rs. 20, and on a second offence of a similar nature be expelled the Society.

XXII. Any member who shall have defrauded the Society by obtaining money from the Society's Fund through false pretences, or by making a false statement shall be expelled the Society, and in addition thereto shall be prosecuted in a Court of Law, unless he restore to the Society on demand the amount of money he obtained from it.

XXIII. Should any member misappropriate or disburse any of the Funds of the Society except in such manner as is stated in these Rules, he shall be required to refund the amount to the Society and shall be fined Rs. 20, be deprived of any office he may be holding in the Society, and shall be suspended from all benefits for 12 months, and for a second offence shall be expelled the Society.

XXIV. Any member or officer belonging to the Society, who refuses on demand from proper authority to deliver up any money, or property which he may have, or ought to have in his possession, or for which he is accountable, shall be prosecuted in a Court of Law and shall subsequently be expelled the Society.

XXV. All fines recovered from members shall be remitted to the Head Office direct. They shall be devoted to forming the nucleus of a Fund for the establishment of an orphanage, or school in connexion with the Society.

XXVI. Should any member of the Society be proved guilty of accepting a bribe from another member, or should any member be proved guilty of giving a bribe to another member, or should a member be proved guilty of bribery by the Railway Company he belongs to, he shall for the first offence be suspended from all benefits for a period of twelve months, and the Executive Council shall be justified in circulating his name among all the Branches of the Society. For a second offence of a similar nature he shall be expelled the Society.

XXVII. Any member of the Society who shall be proved guilty of drunkenness, or of being under the influence of intoxicating liquor, or drugs when on duty, shall be suspended from all benefits for twelve months, and for a second offence of a similar description he shall be expelled the Society, and on each occasion the Executive Council shall be justified in circulating his name among all the Branches of the Society for general information.

BALANCE SHEET of the

Branch for the Half-year ending

RECEIPTS.		DISBURSEMENTS.	
Joining Fees from 25 members belonging to Class A	250 0 0	Remitted to Head Office on account of members belonging to Class A	
Joining Fees from 100 members belonging to Class B	500 0 0	Remitted to Head Office on account of members belonging to Class B	
Joining Fees from 100 members belonging to Class C	300 0 0	Remitted to Head Office on account of members belonging to Class C	
Monthly contribution from members belonging to Class A	600 0 0	Remitted to Head Office on account of Sale of Rule Books	
Monthly contribution from members belonging to Class B	600 0 0	Remitted to Head Office on account of Donations	
Monthly contribution from members belonging to Class C	600 0 0		
Sale of Rule Books	100 0 0		
FINE RECOVERED FROM MEMBERS VIZ.		BENEFITS DISBURSED TO CLASS A	
Class A, Reg. No. 40, J. Brown infringing Rule 16, Sec. 4	5 0 0	Registered No. 120, K. N. Banerjee, (death)	
Class A, Reg. No. 67, C. Jones infringing Rule 55, Sec. 4	0 0 0	Ditto " 460, Mr. F. Smith, non-employment	
Class B, Reg. No. 104, J. Boxe infringing Rule 55, Sec. 4	2 0 0		
Class B, Reg. No. 700 J. Green, infringing Rule 16, Sec. 4	0 0 0	CLASS B.	
		Registered No. 800, Member B. Chatterjee, sick	
		Registered No. 550, Member Mr. Dey, legal	
		CLASS C.	
		Registered No. 600, Member Mr. W. Williams, non-employment	
		Registered No. 175, Member Madho, agent	
DONATIONS.		Stationery for the use of the Branch	
From Vice-Patrons		Postage	
O. T. Milton, Esq	100 0 0	Secretary's Salary from January to June 1880	
A. C. Banerjee...	100 0 0	Treasurer's ditto	
From Honorary Members		Contingencies	
J. Smith, Esq. ...	20 0 0		
K. M. O. Mookerjee...	20 0 0		
		BALANCE IN THE GRANGE	
		TO CLASS A	

20

GENTLEMEN,

Witness my signature this _____ day of _____ 18__.

Witness { Proposer
 { Secondor

Proposer's Signature
Residence

Register No.

I beg to second the above proposition.

Seconders's Signature.

Register No.

Residence

Dated 18

To

THE CHAIRMAN, OFFICERS AND MEMBERS,

Branch,

DEAR SIRS AND BROTHERN,

We have examined Mr. _____
and find him competent to perform the duties of his present
appointment. He is also able to read and write. We recom-
mend that he be admitted a member of the Society, and be
granted a Certificate of Competency by the Executive Council.

We are Gentlemen,

Yours obediently and fraternally,

Chairman Examining Committee Register No.

Member of Committee Register No.

Ditto

Do. "

Ditto

Do. "

Date

187 .

APPENDIX C.

NEW AMALGAMATED SOCIETY OF RAILWAY SERVANTS IN INDIA,

Branch
187 .

To

SIR,

Your application for admission together with the Report
of the Committee of Examination was laid before the mem-
bers at a Meeting on the _____ and
the result being favorable _____ you
will please attend a Meeting that will be held at the _____
on the _____ when you will be duly enrolled.

Yours Faithfully

Branch, Secretary.

APPENDIX D.

FORM OF APPLICATION TO OPEN A BRANCH

TO
THE CHAIRMAN, OFFICERS AND MEMBERS,

*Branch of the New Amalgamated Society
of Railway Servants in India.*

GENTLEMEN,

We, the undersigned employes, are desirous of having a Branch of the New Amalgamated Society of Railway Servants in India opened at _____ to be called the _____ Branch. We believe that the establishment of such a Branch would promote the welfare of the Railway employes residing at _____, and conduce to the prosperity of the Society by increasing the number of its members. We also believe that it would strengthen the bonds of union, and add to the power and influence of the Association. We therefore respectfully beg you will forward this application to the Executive Council of the Society, supporting it with a recommendation that we be granted a Charter to enable us to open a Branch at the place, and under the title before mentioned. If our request be granted, we promise faithfully to conform to and abide by the Rules of the Society.

Names	Address	Occupations	If a member state Class and Register No.

RECOMMENDATION TO OPEN A BRANCH.

Branch
187 .

TO
THE EXECUTIVE COUNCIL OF THE NEW AMALGAMATED SOCIETY OF RAILWAY SERVANTS IN INDIA.

DEAR SIRS AND BRETHREN,

I have the honor to inform you that at a Meeting of the members belonging to this Branch held on the _____, an application (herein attached) from Messrs.

requesting permission to open a Branch of the Society at
to be called the Branch was read,
and after due consideration it was resolved that this Branch
should recommend their application for a charter to be granted
and that they be permitted to open a Branch of the Society at
as requested by them.

By order,
Yours fraternally,

Branch Secretary.

APPENDIX E.

APPLICATION FOR A DISTRICT CHARTER.

To

THE EXECUTIVE COUNCIL OF THE NEW AMALGAMATED
SOCIETY OF RAILWAY SERVANTS IN INDIA.

*The application of the undersigned
Branch officers of the New Amal-
gamated Society of Railway Ser-
vants in India,*

RESPECTFULLY SUBMIT,

That your applicants having the welfare
to the Society at heart are desirous of rendering the
organization more perfect and of strengthening the combina-
tion by uniting the members of the Society more closely to
gather which in their opinion would be assisted in a great
measure if the Branches to which your applicants belong were
permitted to form themselves into a District having its Head
Quarters at , with the following members to hold
the appointments specified against their signatures.

Name	When	Reg. No.	Present Residence.	Occupation.	Appointment a District Chair- man, District Secretary, Dis- trict Treasurer, Committee man.

The free members in the Branches which your applicants belong to exceed the number required by the Rules, they therefore respectfully beg that you will grant them a Charter or Warrant constituting the Branches they belong to into a District under the title of the District.

Should our request be granted we promise faithfully to abide by and conform to the Rules and the Bye-laws of the Society.

Applicants' signature	Class	Reg. No.	Name of the Branch at- tached to,	Official Position in this Branch,	Number of free Members in the Branch.

PLATELAYER'S GUIDE;

A BOOK OF INSTRUCTION

FOR
PLATELAYERS AND INSPECTOR'S ASSISTANTS

IN THE
ENGINEERING DEPARTMENT

OF
INDIAN RAILWAYS

PURGE No. 2-8.

ALLAHABAD :

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Road, for the Author and Publisher.

New Amalgamated Society of Railway Serv in India.

Head Office, 7, South Road, Allahabad, N.-W. P.

This Society is divided into 32 Branches, established in following places: -

East Indian Railway. Lucknow, Cawn
Allahabad, Buxar, Dinapore, Sahibganj, Rampore Har, New
Muldapore, Assensole, Baneeganj, Kanoo Junction, Howrah

Eastern Bengal Railway. Kanchrapur
Northern Bengal State Railwa
Saidpur, Sam.

Rajpootana State Railway. Agra, B
kui, Ajmere, Delhi.

Madras Railway. Chiklapah, Jodhpur, Pe
bore, Secramangalam.

South Indian. Branches are being formed at
Chinopoly, Negapatam, and Madurai.

Holkar State Railway. Khandwa.

Sind Punjab and Delhi Railway
Lahore.

Punjab Northern State Railway
Shudra.

Indus Valley State Railway. - A
wahan, Mooltan.

The Society has a Press of its own, at which three Journals are published: one is the *Indian Railway Service Gazette*, in columns of which are published the reports of Branches, and the proceedings of the periodical Executive Council Meetings, other general and interesting matters.

The Society has paid 18 Dividends to its Members, the sum **Rs. 15,000**, and now possesses cash and property to the value of **Rs. 22,000**.

Any further information can be obtained on application to any of the Branch Secretaries, or from.

F. T. ATKINS,

General Secretary,
7, South Road, Allahabad

THE
PLATELAYER'S GUIDE;
A BOOK OF INSTRUCTION
FOR
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~~~~~  
A L L A N H A L L I D :

Printed By E. T. ATKINS, at the "Indian Railway Service Press," 7, South  
Road, for the Author and Publisher.

6577(7)

ERRATA.

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- t Page 3, third line, the sign should be “+”, not “X” as given.
- , Page 32, ninth line, *read* in small crooks it is “folt” by a lateral, &c.
- , Page 54, fifteenth line, *read* consist of one “part,” not one “pail.”
- , Page 73, fifth line, laid “with” their edges turned down.





## PREFACE.



IN offering this book to Inspectors' Assistants in the Engineering Department of Railways, I must say that there is very little original matter in it; it has simply been compiled from different sources, and will be found to contain information relating to all subjects an Inspector should have some knowledge of in connection with the duties he is expected to perform.

I have avoided crowding the pages with references, and I will mention here a few of the books I obtained material for this work, are the following:—Pardo's Notes, Roorkee College Papers, Railway Construction by Stephenson, Text Book of Science, Well Boring, and several other works. I have also to thank many friends for the cordial help given me, and by means of which I have been able to add to my limited stock of knowledge, and which I am desirous to communicate for the benefit of others. I beg to add that this work is not being published from any lucrative motive, but from a desire to benefit, and its price will be within the reach of the Inspectors' Assistants, who it is hoped will find it useful as a book of reference.

There is something new to be learnt nearly every day, and I trust to make this book replete with information relating to our work as I gain more experience; any mistakes that may appear, will be rectified in a second edition of this work, which will be published should sufficient encouragement be given, and readers are therefore requested kindly to communicate to the compiler any mistakes they may find, or additions which they think would add to the usefulness of this work.



## CONTENTS.

- CHAPTER I.—Definitions, Weights, Measures, Areas, Cubic Contents, &c.
- CHAPTER II.—Fixing, Ranging and Laying out of Line.
- CHAPTER III.—Earthwork, Embankments, Cuttings, Construction of Bank, Drainage of Roadbed, Slopes and Local Surface—Ballast.
- CHAPTER IV.—Laying of Permanent Way, Permanent Way on Curves, Expansion, Elasticity, Permanent Way Materials, Points and Crossings, Turn Tables, Watering Tanks, Gradient Boards, Fences, Mile Posts.
- CHAPTER V.—Materials used in Building, Moulding and Burning of Bricks, Tiles, Brickwork, Masonry, Cut Stone, Rubble Stone.
- CHAPTER VI.—Quarrying and Blasting.
- CHAPTER VII.—Mortar, Cements, Concrete, Asphalt, &c.
- CHAPTER VIII.—Foundations, on Hard Soil, on Soft Soil, Piles, Wells or Cylinders, Footings.
- CHAPTER IX.—Bridges, Arched, Site, Piers and Abutments, Outwaters, Spandrels, Wing Walls, Parapet or Ballast Walls, Flooring, Construction of Arches, Centring, Oblique Arches, Revetments, Girder Bridges, Culverts.
- CHAPTER X.—Tunnels.
- CHAPTER XI.—Roofs, Square or Pot Cylinder, Terrace Roofs, Sloping Terrace, Couple Roofs with Flat and Pan Tiles, Shed Roofs, Thatched, Tiled, Iron Roofs.
- CHAPTER XII.—Tools and Machines.
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## CHAPTER I.

### Definitions, Weights, Measures, Areas, Cubic Contents, &c.

All the angles that can be made round one point amount to 360 degrees, that is, all the angles that could be made by straight lines terminating at the same point amount to 360 degrees.

An angle less than 90 degrees is called an acute angle, more than 90 degrees an obtuse angle, and exactly 90 degrees a right angle.

A circle is a figure bounded by a curve called the circumference, which is equally distant from a point within called the centre. The circumference is supposed to be divided into 360 equal parts, called degrees.

An arc of a circle is any part of the circumference.

A chord is a right line joining the two extremities of an arc.

A segment is any part of a circle bounded by an arc and its chord.

A tangent is a line that touches a figure without cutting it.

The radius of a circle is a straight line drawn from the centre to the circumference.

The diameter of a circle is a straight line passing through the centre and terminating at the circumference.

A sector is any part of a circle bounded by an arc and two radii drawn to its extremities.

A triangle is a figure of three sides and three angles.

A square has four equal sides and four right angles.

Lines are parallel when they have no inclination to one another.

A rectangle is a parallelogram having four right angles, but the opposite sides are only equal.

A rhomboid is an oblique-angled parallelogram.

A



A rhombus is an equilateral rhomboid having all its sides equal, but its angles oblique.

A diagonal is a right line crossing a figure, and terminating at its two opposite angles.

A trapezium is a four-sided figure having none of its opposite sides parallel.

A trapezoid has only a pair of its opposite sides parallel.

-----0-----

#### LONG MEASURE.

| Inches. | Feet. | Yard. | Rod. | Furlong | Mile. |
|---------|-------|-------|------|---------|-------|
| 12      | 1     |       |      |         |       |
| 36      | 3     | 1     |      |         |       |
| 108     | 16½   | 5½    | 1    |         |       |
| 7920    | 660   | 220   | 40   | 1       |       |
| 63360   | 5280  | 1760  | 320  | 8       | 1     |

#### SQUARE MEASURE.

| Sq. inches. | Sq. feet. | Sq. yard. | Pole. | Road. | Acre. |
|-------------|-----------|-----------|-------|-------|-------|
| 144         | 1         |           |       |       |       |
| 1296        | 9         | 1         |       |       |       |
| 39204       | 272¼      | 30¼       | 1     |       |       |
| 1568160     | 10390     | 1210      | 10    | 1     |       |
| 6272640     | 43560     | 1310      | 160   | 4     | 1     |

#### SOLID MEASURE.

| Cubic inches | C. ft. | C. yard |
|--------------|--------|---------|
| 1728         | 1      |         |
| 46656        | 27     | 1       |

A prism is a solid or body, whose ends are any plane figures, which are parallel, equal and similar, and its sides are parallelograms.

A cone is a round pyramid having a circular base.

|                   |           | Cubic feet. |
|-------------------|-----------|-------------|
| 1 candy of rhinam | 360 acres | 16.63       |
| 1 parah           | 50 "      | 2.30        |
| 7.23 paraha       | 1 candy   | 500 lbs.    |



Explanation of certain characters that will be found in this work :—

|                                   |                             |
|-----------------------------------|-----------------------------|
| $\backslash$                      | Signifies plus or addition. |
| $-$                               | minus or subtraction.       |
| $\times$                          | multiplication.             |
| $\cdot$ or a line above and below | } signifies division.       |
| $\therefore$                      |                             |
| $\propto$                         | proportion.                 |
| $=$                               | equality.                   |
| $\sqrt{\quad}$                    | square root,                |
| $\sqrt[3]{\quad}$                 | cube root.                  |

#### AREA.

Triangle  $= \frac{\text{base} \times \text{perpendicular}}{2}$

Do. if equilateral, square of any side  $\times \cdot 433$ .

When three sides are given, add the three sides together, take half the the sum ; from the half sum, subtract each side separately, multiply the half sum and the three remainders continually together, the square root of the last product will be the area of the triangle.

Trapezoid  $= \frac{2 \text{ parallel sides} \times \text{perpendicular}}{2}$

Trapezium  $= \text{diagonal} \times \frac{1}{2} \text{ sum of perpendicular.}$

Circle  $= \text{diameter}^2 \times \cdot 7854.$

or

Circumference  $\times \cdot 07958.$

Parabola  $= \frac{1}{2} \text{ of base} \times \text{altitude.}$

Ellipso (transverse axis  $\times$  conjugate axis)  $\times \cdot 7854.$

*To find the area of a circular ring, or the space included between two concentric circles:—*

Multiply the sum of the radii by their difference, and multiply the product by 3.1416 for the area.

### Circle Contents.

|          |   |              |   |         |
|----------|---|--------------|---|---------|
| Prism    | × | area of base | × | height. |
| Cylinder | × | or           | × | do.     |
| Cone     | × | or           | × | height  |

To find the hypotenuse of a right-angled triangle, add the squares of the two legs together and extract the square root of the sum. To find one leg, subtract the square of the other leg from the hypotenuse and extract the square root of the difference.

To find the diameter and circumference of a circle, the one from the other.

As 7 : 22 :: diameter to the circumference.

As 22 : 7 :: circumference to diameter.

### CONTENTS OF EMBANKMENTS.

There are three methods of calculating contents of embankments:—

1. By averaging and areas.
2. By the middle area.
3. By the prismoidal formula.

The first gives an amount which exceeds the correct amount, the second falls short of the true amount, but the prismoidal formula gives the correct amount. The rule for finding the solidity of a prismoid is, — add into one sum the areas of the two ends and four times the middle section, parallel to them, then one-sixth of this sum multiplied by the length will be the contents.

### TO MEASURE PIPES, TANKS, &c.

The following is a rough and ready way to find contents of circular tanks, wells, &c.:—

Square the diameter in inches and cut off the right-hand figure as a decimal, the result will be gallons in each 3 feet (yard) of depth. Thus:—

| Diameter in inches. | Inches. | Square inches. | Gallons and yards. |
|---------------------|---------|----------------|--------------------|
| 6                   | 6 × 6   | 36             | or 3.6             |

### TO FIND THE CONTENTS OF A BARREL.

If the diameter is equal everywhere.

Multiply the square of the diameter in inches by the depth and divide the product by 359.

If the centre or bung diameter is larger than the ends. Square the centre diameter in inches, multiply it by 2, to which add the square of the diameter of the end, then multiply this by the length of the cask and divide by 1077.

### TO FORM A RIGHT ANGLE WITH A CHAIN OR MEASURING TAPE.

Take 40 on the line, 30 for the perpendicular, and 50 for the hypotenuse.

*Velocity in the middle of a stream* is found by observing the distance a floating body goes over in a given time.

The discharge of a river is found by multiplying the sectional area by the mean velocity.

*Velocity of Light.*—Light travels at the rate of 192000 miles per second nearly.

*Velocity of Sound.*—It has been found that sound travels at the rate of about 1142 feet per second or a mile in 4½ seconds; and therefore by proportion any distance may be found corresponding to any given time, viz. multiply the given time in seconds by 1142 for the corresponding distance in feet, or take  $\frac{3}{11}$  of the given time for the distance in given miles.

### TO FIND THE NUMBER OF GALLONS ANY RECTILINEAL VESSEL HOLDS.

Multiply length in inches by breadth in inches, and by depth in inches and divide the total by 277.274, the quotient will give the number of gallons in the vessel.



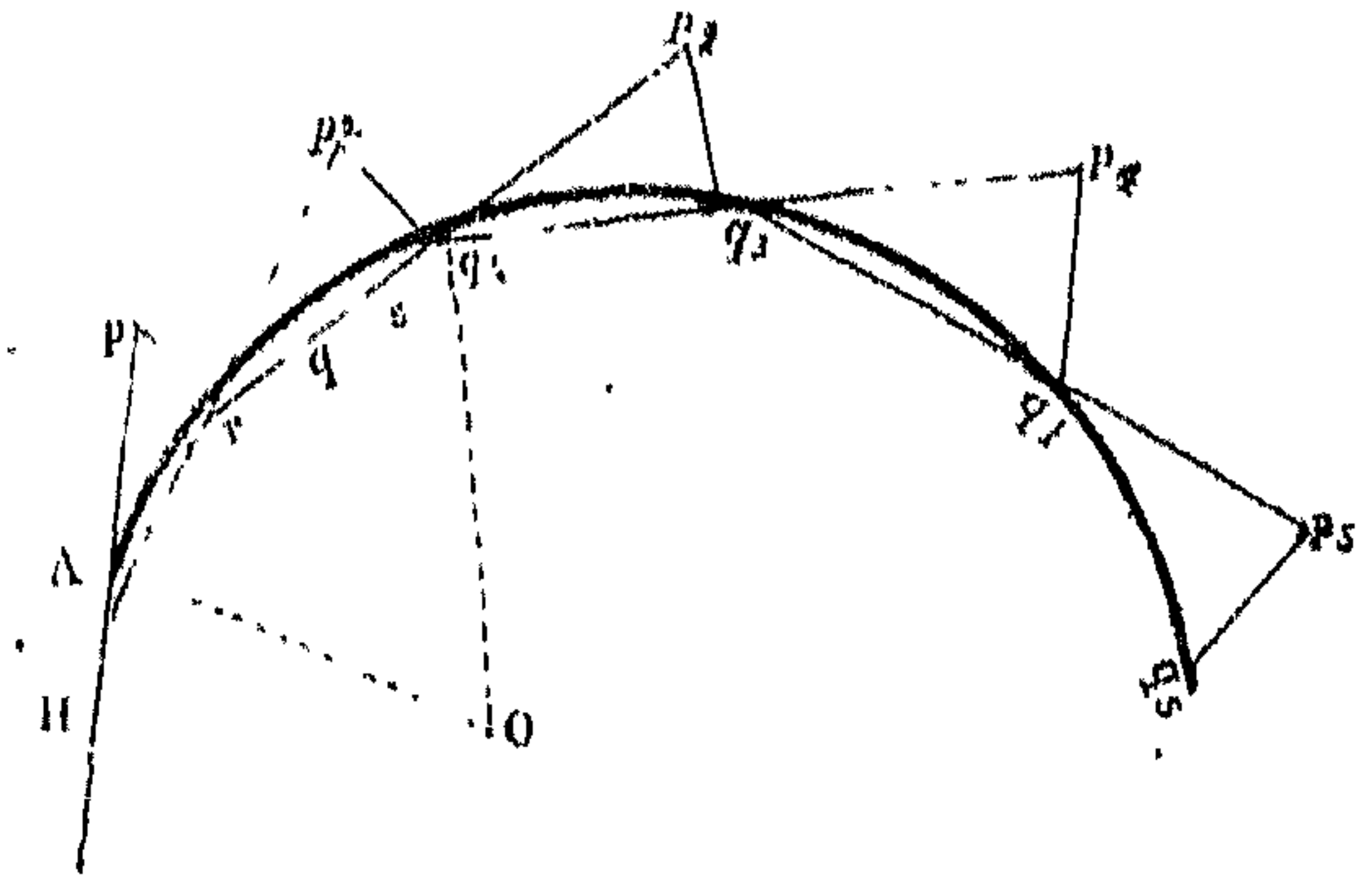
## CHAPTER II.

**Fixing, ranging and laying out of line.**

*Determination of Route.*—In the laying out of Railways the most important point to be considered is the determination of its route, or general course. The primary object is usually the connection of two distant towns, it is desirable to obtain the most direct and shortest means of communication, but many difficulties on account of the nature of the country, &c., present themselves to an Engineer, who with much care and consideration has to examine the district, ascertain the courses of the valleys and hills; and makes general enquiries as to the nature of the strata, the position, population and trade of the neighbouring towns, and all other points which may affect his election. He then sketches out one or more lines on a map which appear to him to be most advantageous: these he has carefully surveyed and levelled over, having cross levels taken by which he may be able to ascertain whether any benefit may be obtained by deviating from the line at first laid down. Being thus in possession of all the necessary information, he finally determines the course of the line, which is then laid down upon a plan and also marked on the ground by pegs driven at proper intervals (generally 66 feet apart); very careful levels are then taken over the line thus marked out, every undulation in the surface of the ground being taken notice of, the width of every stream, river, canal, road, &c., is measured, as also the level of its surface, and the exact angle (called the angle of skew) which its direction makes with that of the line. From these levels, a section is formed representing on paper, the undulations of the ground, which at once denotes the route to be adopted and will show the required embankments, cuttings, &c. It is a matter of great importance, that the line of rails should deviate as little as possible from a perfectly straight and level line. Theoretically the best is that which is perfectly straight and level throughout its course. In practice such a line is unattainable, owing to the large outlay which such a step must entail, and the obligation to construct branches to serve those towns, lying to the right or left of the straight line, which towns a line with moderate curves might perhaps have been made to pass through.



## RADIUS OF A CURVE.



FOR DESCRIPTION see 11th Page.

*Curves.* The natural unevenness of the earth's surface makes the use of curves in railways absolutely necessary, that the nearest practicable level may be attained by avoiding hills, and other elevations, by winding round their bases by means of curves, which are also equally necessary in avoiding other natural and artificial obstructions, such as rivers, lakes, swamps, &c., also towns, parks, pleasure grounds, &c., thus a great saving is made in the expenses of construction. Sharp curves where unavoidable should be brought as near as possible to a station, and on no account on steep inclines. Curves should, if possible, be made on the portions of the line which are either on the surface or embanked, and not in deep cutting, where the curving would prevent a clear view of the line for any distance being obtained. In Railway practice the curves adopted are arcs of circles, and when the curve is composed of two or more having a common tangent, and their concavities turned in opposite directions, it is called a Serpentine or S. curve. As it is desirable that one should have an idea how a curve is laid out, a simple way of ranging curves by offsets in equal chords is given in annexed sketch.

Offsets at the end of the first chain from Tangent point of Railway curves is given in a table to be found in the Appendix. The straight portions of the railway are always first laid out, and are in all cases tangents to the curves at the termini.

*Gradients.* Gradients are evenly ascending or descending portions of Railway. When practicable they should rise each way towards a station, so that the train may lessen speed when approaching the Station, and attain speed in leaving it. In long inclines it is desirable to form occasionally short level portions, which while they check the speed of descending trains materially assist those ascending.

After the route has been determined upon, the centre line is marked out by the Engineer by stakes driven in at proper intervals, giving both the line and level of the rails, after which pegs for the top and slopes are given and the bank, road, or cutting is proceeded with.

## CHAPTER III.

## Earthwork.

The earthwork is the foundation and support of the whole superstructure, and as such must be uniformly firm. The embankments of the Madras Railway consist of a base of 20 feet wide for a single line, and 32 feet for a double line of Railway with slopes on each side. In single lines 16 feet of the base lie to the south and the remaining 4 feet to the north of the centre line. The annexed sections represent an embankment and cutting, fully formed, with slopes, &c., for a single line of Railway.

The breadth of Formation of the depends upon the gauge, or clear distance between the rails of a track, the numbers of tracks and the clear space between the rails of each track, the space left outside of them for projection of carriages, and for men on foot, and the additional space for slopes of ballast, &c. The following are examples :

|                             | Single Line. |            | Double Line.                |            |
|-----------------------------|--------------|------------|-----------------------------|------------|
|                             | <i>ft.</i>   | <i>in.</i> | <i>ft.</i>                  | <i>in.</i> |
| Clear space outside of rail | 4            | 0          | 4                           | 0          |
| Head of rail                | 3½           |            | 2½                          |            |
| Gauge ...                   | 5            | 6          | 5                           | 6          |
| Head of rail                | 3½           |            | 2½                          |            |
| Clear space outside of rail | 4            | 0          | middle space                | 6—         |
|                             |              |            | Head of rail                | 2½         |
|                             |              |            | Gauge                       | 5—6        |
|                             |              |            | Head of rail                | 2½         |
|                             |              |            | Clear space outside of rail | 4—         |

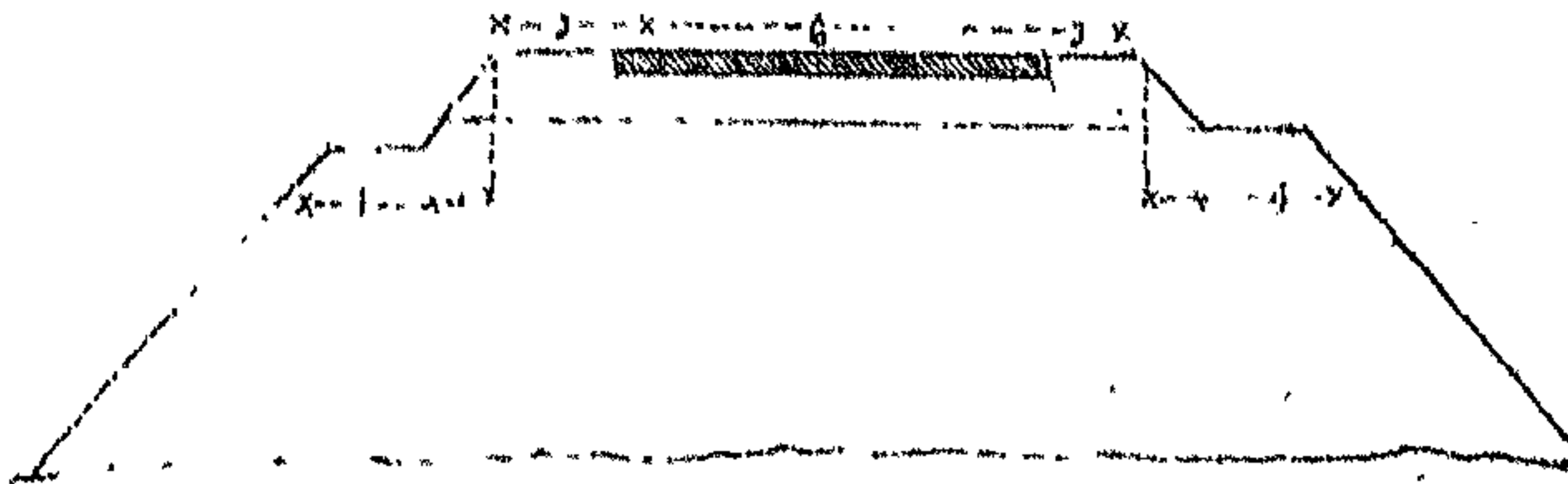
## CONSTRUCTION OF BANKS.

Banks of very bad soils, like clay or loam, are sometimes raised in lifts or layers of 3 or 4 feet each, each layer being well rammed or settled, so as to be concave on top. This is an expensive mode. The best plan is to carry out the bank, in two parallel rows or ridges, forming together the full intended width and to fill in the intermediate space by subsequent tipping. This is largely practised for bad soil. Correct allowance is made for the settling of the material of the bank, and time is given for this settling to

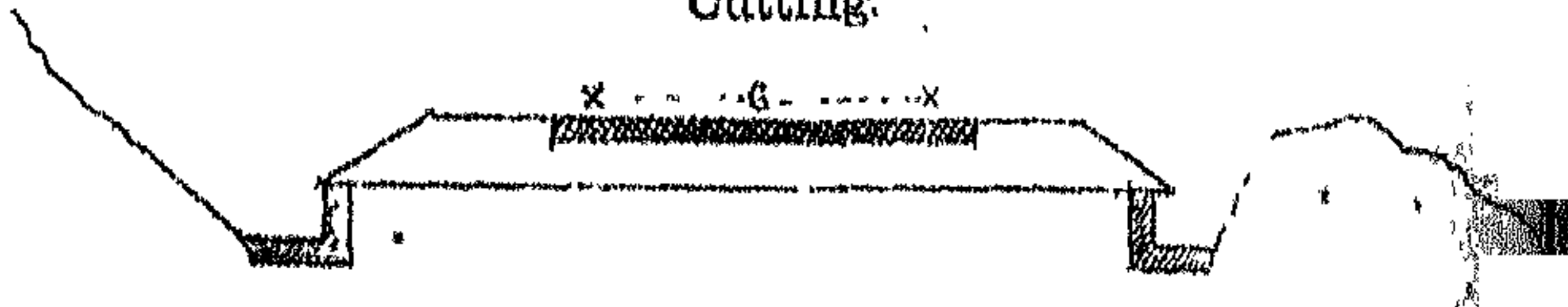


# SKETCH OF SECTION OF Embankment and Cutting.

Section of Embankment.



SECTION  
OF A  
Cutting.





occur before the ballast is put on or the rails and sleepers laid. Where level crossings are employed it is usual to pave between the lines of rails, and to some distance on either side, to prevent the sinking of the track, abrasion of the iron, and straining of the fastenings, from the passage of heavy wagons. In all cases, during the formation of embankments, the greatest care is taken to exclude water, until the surfaces are finished and the drains completed.

*Slopes.*—It is desirable, as far as expence is concerned, that the slopes of the sides of embankments, and cuttings, should be formed as steep as the strata of which they are composed will allow. No general rule, however, can be given for the slope at which the sides of banks and cuttings will stand, even when the description of soil is given, because there are such a variety of circumstances by which they are affected in cuttings: most kinds of stone will stand vertically, chalk  $\frac{1}{2}$  to 1, sand and gravel  $1\frac{1}{2}$  to 1, and clay at about 2 to 1. Many methods have been adopted to prevent slips from taking place. But one of the simplest means is thorough drainage, without which the best description of ground will in time be acted upon by the combined action of land springs and the weather. The embankments demand the use of every possible precaution to ensure their solidity, not only on account of their size, but because the vibration imparted to them by the passing trains greatly increases their tendency to slip. The expence and time required to form them in layers often forbid the adoption of that method. They are usually constructed by raising them to their full height at one end, and so carrying them onward. The tops of embankments and the bottoms of excavations are brought to a height called the "Formation Level" about 2 feet below the intended level of the rails, and then shaped with a fall from the middle to each side, in order to drain off the water which falls upon them.

*Drainage.*—The thorough drainage of excavations by ditches, cross drains, &c., is of the highest importance. Their sides often require to be supported by retaining walls. Water is a great destroying element, and its removal from the road bed is very necessary. The action and effects of water, although daily exhibited,

may be briefly recapitulated. Water running on the surface dissolves and washes the earth, soaking the road bed and choking the ditches. When soaked the road bed loses its firmness, and the ballast sinks irregularly; this displaces the track, thus increasing the resistance, and adding greatly to the wear and tear of both track and machinery. When the ballast sinks, many of the sleepers will be left clear and hanging by the rails. These on the passage of a train deflect deeply, thus opposing a heavy grade against the wheels. Water standing close to earthwork is sometimes injurious. No matter what may be the height of an embankment of clay or sand, water will rise to the top, being carried by absorption and will produce all the effects just stated. Water not only destroys the cohesion of the material of the road bed, but swells its bulk. In cuttings, water will convert the whole road bed into mud. Whenever this dries in the sun it is partly dissipated in dust, while clayey soils will shrink and crack in every direction. Partial saturation, and occasional washing of banks, are sufficient to disturb the track, although perhaps not to an inconvenient extent, and in such case the iron is more or less bruised, the fastenings strained, the chairs broken, the resistance augmented, and thereby the consumption of fuel increased and the whole wear and tear greatly enhanced. Though drainage must provide for the immediate removal of falling water from the surface of the earthwork, it must cut off the communication of water from the tops of slopes, and at a point below the rails; and it must reduce the force, and conduct away the discharge of descending currents on slopes. Drainage may therefore be considered under three heads: that of the road bed, that of slopes, and local surface drainage by ballast, the last will be considered under the head of ballast.

*Drainage of road bed.*—The formation level is made sufficiently wide to give a good interval between the rail and the ditch, a level space being left between the bottom of the ballast and the edge of ditch, on which any wash carried from the road bed may rest without choking the drainage; a similar space is usually left outside of the ditch in cuttings. Much attention is paid to cutting the ditches straight and at an equal distance from the track at all points in their length, so that whatever the road bed may expand

from water, the swelling would be equal at all points. The inclination of the ditch is carefully attended to, so that they shall not serve as reservoirs for stagnant water, the nearest outlets being sought into every neighbouring watercourse of sufficient extent and activity to support the required discharge.

*Drainage of slopes.*—At the top of cuttings through ground which is level in transverse section ditches are made on both sides, to prevent the surface water of the adjacent fields from washing down the slopes. These ditches are generally set well back from the edge of the cuttings, so that the water shall not break through and cause slips. In cuttings in siding ground the top ditch is made on the upper side only. These crest ditches are carried out and have their outfall at the ends of the cuttings. The bottom ditches have only to receive the drainage of the slopes. The surface of the slope may be intersected by numerous shallow open drains (spade drains as they are called) running either straight down from the top to the bottom, or diagonally each way so as to form a continual like *WV* on the face of the work. The slopes of embankments require occasional surface or spade drains for the descent of rain water. They are generally provided also with bottom drains. These not only prevent the base from being torn away by the water, but they prevent also the soaking of the bank by the standing water, which might otherwise collect around it. The most prominent plan for draining slopes of cuttings are underground perforated earthen pipes, gravel or other porous substances in the face of the slope, also dry wells sunk perpendicularly in the slopes and drained by underground pipes. To the solidity and thorough drainage of the earthwork of railways must be attributed a large part of their economy of maintenance and much of the economy of fuel with which they are run. The support being firm and the fastenings ample, the track remains smooth and the trains run quietly.

Side channels in cuttings should be kept at a good depth below level of the rails; they should be sunk below formation level, which is 2 feet below rail level. In cuttings where rock is near or



above formation, it would be well if possible to remove the rock down to a depth that will prevent the line from jarring.

*Ballast.*—Ballast is employed on the top of the formation surface in which the sleepers are embedded which carry the chairs and rails, a great variety of materials are used as ballast on English Railways. These are broken stone, burned clay, cinder, sand, shells, broken bricks, and culm or small coal. The preference turns between broken stone and gravel, and where the latter has a natural mixture of clean sand, it is probably preferred in most cases. The ballast has four distinct offices to perform. It must *first* of all distribute the bearing of the track over the surface of the earthwork; *second*, it must confine the track in place; *third*, it must secure the drainage of the surface, and lastly it must, by its character give a certain elasticity to the road—uniformly intermediate between the rigidity of rock, or the hard bottoms of cuttings, and the weakness and softness of common earth. The depth of ballast is generally 2 feet, 1 foot of which is entirely under the sleepers, the rest around and above them. In India we find that Kunkor, broken stone, broken brick and sand are usually employed for ballasting. The primary object of ballast is to distribute the weight of the track and applied load over the surface of the earthwork beneath, hence in ballasting this object should especially be kept in view. The earthwork is in no case fitted to sustain any load until it is thoroughly drained, as ballast best fulfils its purpose when it is provided of good quality, and in sufficient quantity it may be concluded that about two feet depth of clean ballast will secure all the following conditions. *First* distribution of the bearing of the applied load. This prevents the crushing of the road bed. *Second*, by enclosing the sleepers on all sides, the track is held steadily in place, and the trains run quietly. The sleepers are also protected from decay when thus enclosed. *Third*, drainage is secured, the surface water running through to the edges. No depth nor excellence of ballast, however, can compensate for insufficient drainage of the earthwork. The ballast is not water-proof itself, while if the ditches are not well opened the road bed beneath will be constantly saturated by absorption of water from



the slopes. *Fourth*, with the usual materials a certain elasticity is interposed between the track and earthbed. *Fifth*, ballast to be good must be clean, and must be such that does not rise, as sometimes sand by rising does great injury to the engine machinery and by its presence on the tread of the rail greatly increases the resistance and thereby greatly augments the work of the Locomotive.



#### RULES TO BE OBSERVED IN BALLASTING.

On the completion of the working of a ballast train a report should be sent to the Engineer, stating whether the whole of the ballast stacked by contractor has been removed, so that if any remain it should be measured before the contractor be allowed to stack again.

All ballast wagons should be kept in lay-byes, and secured so that they cannot be taken by other Departments, and should not be removed without notice being given to the Engineer.

Ballast should not be allowed close to the inner side of the rails, as it facilitates the throwing up of the ballast by the flanges of the wheels of vehicles, and this is liable to injure the gearing in engines as well as increasing the friction and is liable to make the bearings of the vehicles run hot. It should be kept in the inner side as low as the head of the top of the fishplates and on the outside low enough to show all the keys, and it should be deposited clear of the line at a distance of 5 feet at least, and must not block up side ditches and prevent free drainage. It should be deposited on flat places, so that accurate measurements could be taken.

Ballast pits should not be within 30 feet of Government Telegraph posts.

Grease for ballast trains is procurable at greasing stations, on applying to the Station Master and granting him a receipt for the same.

## RANGING CURVES BY OFFSETS IN EQUAL CHORDS.

Let  $II$ ,  $A$ ,  $q^4 q^6$  be the tangential portions of a railway, the extremities  $A$  and  $q^4$  of which are required to be united by the circular curve  $A q^4$  to which  $II$ ,  $A$ ,  $q^6 q^4$  shall be tangents, the radius of the curve being given.

Let the radius in this case be 80 chains, or one mile; prolong the tangent  $II A$  a distance  $A P = 1$  chain; then opposite 80 in the table No. 1 at the end of the book is found 4.95 inches  $= p q$ , which set off at right angles to  $A P$ , thus giving the first point in the curve. In the direction  $A q$  measure  $q p = 1$  chain, and set off  $p^2 q^2 =$  twice  $p q = 1.95 \times 2 = 3.9$  inches, at right angles to  $q p^2$  then  $q^2$  is the second point in the curve. This last operation must be repeated till the curve shall have been set out to the point  $q^4$ . Lastly  $q^4 p^6$  being measured 1 chain, in the direction  $q^3 q^4$  the offset  $p^6 q^6$  will be found  $= 4.95$  inches the first offset  $p q$ , thus proving the accuracy of the work. In this manner the operation is conducted, whatever may be the length of the curve.



## CHAPTER IV.

## Permanent Way.

*Laying out of Permanent Way.*—We will now proceed to describe the manner in which the iron road is laid on the bank, or cutting already formed. On an embankment or soft road the posts are first arranged, as nearly as possible in the required line, the tie-bars are then put in, and fixed by the gibs and cotters; the rail is put into the chairs, and after another two rails have been dealt with in the same manner, they are joined together by two fish-plates, which are laid sideways, and fixed to both rails, by four screws and nuts, the keys being put in between the rail and the outer-side of the chair, and struck with a hammer. Previous to this being done, it is very desirable that a washer of  $\frac{1}{2}$  inch or  $\frac{3}{4}$  of

an inch be introduced between the ends of the rails, so as to allow for expansion. Seven pots are generally used under a 20 foot 85lb. rail, their distances apart as follows:—

|                    |        |          |            |
|--------------------|--------|----------|------------|
| From joint of rail | 1 foot | 3 inches | first pot. |
|                    | 3 "    | —        | second "   |
|                    | 3 "    | 9 "      | third "    |
|                    | 4 "    | —        | fourth "   |
|                    | 3 "    | 9 "      | fifth "    |
|                    | 3 "    | —        | sixth "    |
|                    | 1 "    | 3 "      | seventh,   |

After the rails have been laid as previously described, they are brought to the required position by sluicing, or in other words men with crowbars, one end in their hands, and the other end under the rail, and backs turned to the side on which the rails have to be moved, give the rails simultaneous jerks which bring them into the required position. After this has been done the rails should be lifted if required, so as to preserve an even position lengthways, and this is done by a lever, which lifts the rails while the pots are being packed. The packing of the pots is done by crowbars inserted into the holes at the top of the pots, while with the feet ballast is pushed into it, and it thus gets filled. The system generally adopted of laying the Permanent Way on hard or rocky roads, is generally that of fixing the rails on iron chairs, spiked by trenails, and supported upon wooden sleepers, placed at intervals, the same as that previously described for the pots, the keys put in between the rail and outer-side of chair; the chairs have to be placed on the sleepers at a distance to suit the proper gauge of the Railway, the sleepers should be carefully hand packed both under and around them. On a girder bridge the wooden sleepers are put on the girders, the chairs come on them, and the rails are fixed in them. The sleepers are fixed on to the girders by screws and nuts called Dog-bolts, the head of the bolt being tightly fixed under the flange of the girders, four dog-bolts are used for each sleeper, two for the outer and two for the inner flanges of the girder; the girders again are fixed on the masonry by oil bolts,



which are introduced through the bed plates of the girders, into the oil stones, which have holes punched in them, and molten lead is poured into them to keep the bolts firm.

*Permanent Way on Curves.*—In order to diminish the danger of carriages leaving the rails, it is usual, in order to counteract the centrifugal force, to give a transverse slope to the surface of the rails of a curve technically termed the *cant*. The wheels of a railway carriage are made slightly conical, so that the diameter of the wheel, on the outer side is about half an inch less than its diameter on its inner side near the flange. The effect of this difference is to keep the carriage in its proper position, in the centre of the railway, and to prevent the flanges of the wheels from coming into contact with the rails. The wheels, being made conical, they have a self-adjusting action, which is found sufficient to preserve the carriages in their proper position upon the rails, on those portions of the line which are straight; but on a curve, a new force, the centrifugal force is called into play, by which the carriage is solicited to move in a straight line, the mere action of the conical wheels is not sufficient to counteract the tendency of the carriage to move in a straight direction, and to cause them to follow the course of the required curve. To effect this, therefore, and prevent, as much as possible, contact between the flanges of the wheels and the rail, another means has been devised of throwing the carriage over to the opposite side to that on which the centrifugal force tends to keep them. This means consists in raising the rail on the outer side of the curve to a certain height above that on the inner side, by which the curve has a tendency given it to slide towards the inner side, the height, or, as it is termed, *super-elevation of the outer rail* being so adjusted, that this tendency, with the combined effect of the conical wheels, is just sufficient to balance the centrifugal force. The following is a simple rule for calculating the required lift of the outer rail. Let  $v$  be the speed in miles an hour. The cant for centrifugal force is equal to gauge  $\times \frac{v^2}{16 \times \text{radius}}$ . One-half of the cant should be given by raising the outer rail above the



level of the centre line, the other by depressing the inner rail. Another rule, stretch a thin line 66 feet long on the curve for which you want to find the super-elevation, measure the versed sine, and to this add one and a half inch, which would be the cant required. The versed sine in this case would be the measured distance from 33 feet on the stretched line to the curve.

*Expansion.*—In laying Permanent Way, allowance should be made for the contraction and expansion of the metal. The holes in the fishplates are  $\frac{3}{4}$ ths of an inch in diameter, and the bolts by which the fishes are fastened to the rails, have a diameter of  $\frac{3}{4}$ ths of an inch, a fourth of an inch is therefore allowed for expansion, but in some places the rails are squeezed together so tightly, that the blade of a penknife could hardly be inserted between them; this arises from the fact that when keys are driven in, each knook of the hammer pushes up the rail against the adjacent one, and they are jammed tight; thin plates of iron, say an ordinary washer  $\frac{3}{4}$ th or  $\frac{1}{2}$  of an inch thick, if used between the rails, before they are keyed in, would prevent their being jammed together so tight. When no allowance is made for expansion, the rails are very liable to buckle.

*Elasticity of Permanent Way* is a compromise between smoothness and hardness. Were roads perfectly smooth, elasticity would not only be unnecessary, since there would be no shocks nor jars for it to relieve, but it would be positively injurious, as it would disturb the perfect level. On the other hand, where roads are most rough, there are more shocks, and concussions, and the greatest amount of elasticity is required to counteract them, to enable the wheels to make the track yield to nearly a level line than would be if it were absolutely unyielding: since no roads can be made, much less kept perfectly level, elasticity in the track, just in proportion to the roughness, is an indispensable element of economical traction and repairs.

The general qualifications required in Permanent Way are, *First*,—that it should be fixed so firmly, that the gauge shall be preserved, otherwise the carriages would be thrown off the line. *Second*,—That it should preserve a horizontal position across the

line (except in cases of curves). *Third*,—That it should preserve an even position lengthways, otherwise the carriages would proceed in a succession of bumps or jerks, which would cause a loss of power from increase of friction, and be dangerous to springs and axles. *Fourth*,—There should be a certain elasticity in the roadway, whereby the rigidity of impact between rails and wheels will be avoided, such rigidity being dangerous to the axles, and causing much wear and tear. *Fifth*,—that the rails should be strong enough, between the points of support, to bear, without changing form, the greatest weight liable to come upon them.

—————( )—————

#### PERMANENT WAY MATERIALS.

*Sleepers* are generally made of wood and iron, the former are usually rectangular in section 6 or 7 inches thick, and long enough for both rails to rest on, with something over on each side. The sleepers are placed from  $2\frac{1}{2}$  to 4 feet apart, the distance being lessened as the gauge and weight of engines increase, or the strength of the rail diminishes. They should be laid carefully in the ballast, which should be packed under and around them, and which generally covers the upper surface of the sleeper. The timber used for sleepers should be heavy, tough, and impervious to heat and damp. Sleepers should be straight, and of uniform sizes. A crooked sleeper gives a very poor bearing, and often by its rolling tendency, acts to disturb the track, even when the bearing is otherwise sufficient. To prevent the sleepers from decay, they are sometimes preserved. The preserving liquids usually employed are as follows:—Coal oil, which is the common coal tar of gas works, with its ammoniacal liquor expelled by boiling. The process is called *Creosoting*. Solution of bi-chloride of mercury (corrosive sublimate) one pound to 15 gallons of water, this process is called *Kyanizing*. Solution of chloride of zinc 1 pound to 84 gallons of water or  $1\frac{1}{2}$  to 100 by weight, this is *Murnettizing*.

Large, well-formed sleepers are a part, in the series of provisions, by which good and economical tracks are secured. The earthwork being made firm by its own ample width, and by good drainage, the ballast being deep, clean, and moderately binding, and the sleepers resting uniformly over a broad surface, we have

a strong and permanent foundation, on which if the rails are well fastened, the whole must inevitably be smooth and quiet. It is by permanent smoothness in a track that we avoid constant crushing, and churning of the ballast, avoid crushing and rotting the sleepers, and breaking the chairs or other joint fastenings, prevent crushing and breaking rails, and that we also reduce the great increase of resistance, and the largely increased wear and tear of machinery always accompanying a bad track.

Wooden sleepers should not be removed unless they are absolutely decayed. Sleepers on arched bridges should be only used for spans over six feet, for three feet and under culverts, the arch being at a great depth from formation it is unnecessary. An accident happened from wooden sleepers being bored too many times for trenails, the sleeper becomes weak, the trenail forced out, and the gauge of course becomes wider. Not more than one set of holes should be made. Oak bridge sleepers should have their ends bound with hoop iron.

*Pot sleepers.*—Iron or pot sleepers consist of a combined cast iron hollow block and chair in a single casting, the hollow block has holes on top of it for packing. Their bearing is concentrated, the diameter of those now in use on the Madras Railway being 1 foot and 20 inches, and their weight about 85 lbs. The cast iron sleepers are more advantageous in form, and in durability of material, than the wooden sleepers. They are found to pack better, and lie more quietly. They do not spring out of the ballast, and hammer back into their beds, on the passage of a train, as a long elastic beam with a partial bearing would do. In short they are beams, and not levers, and they utilize all their surface, by transferring the load directly to the road bed.

The gauge of two pot sleepers and a tie-bar with the gib inside, and cotter outside, originally intended, is tighter than that of the timber sleeper; this does not make so much difference on the main line on straight portions, it does more so on curves in proportion to their sharpness, and makes the most difference of all in sharp curves leading from points. To remedy this, and give more play it is desirable to make the gibs and cotters to change places. On siding curves of 1 in 7½ lead of crossing, both the



gibs being transposed will not be found to give too much play. On other curves of small radius the gib should be transposed only on one side.

*Tie-bars.*—The rails are fixed in the usual manner on the chairs of the pots and keyed; and the gauge preserved by ties passing through each set of sleepers: these ties are called tie-bars, they are 7 feet 8 inches in length, with holes in them for receiving the gibs and cotters.

*Gibs and Cotters.*—The gibs and cotters are used in fixing the pots to the tie-bars. The cotter is a piece of flat wedge-shaped iron four inches long, used on the outside of rails, and the gib about two inches long with a niche in it, on the inside. On a curve a gib is placed on the outside of the outer rail, and another on the inner side of the inner rail, or in other words a gib and a cotter are placed alternately.

*Chairs.*—The common chair is made of iron, and weighs about 30 lbs. The chair receives the rail, which is fixed tightly to it by means of *keys* or wedges, the wooden keys are made of hard wood. By striking these keys with a hammer the line is kept in proper gauge.

*Trenails.*—The chairs are fixed on the wooden sleepers by means of two iron spikes, otherwise called trenails, which are driven vertically through the sleeper, each of which carries two chairs one for each rail. Other kinds of chairs are used for points and crossings, and will be noticed under that head.

Keys should be marked when put in to ascertain how long they last, they should be carefully driven in, so as not to split, they do not split when of the proper size. It will invariably be found that whenever there is a loose key, the pot under it has generally pulverized sand or dust over it; this is caused by the ballast getting in between the rail and pot, and being ground into powder by the pressing of the rail on the pot. The pot will also be found to have sunk.

*Rails.*—These are made usually in lengths of about 20 feet, and are fitted on to the chairs in the manner previously described. The lighter the rail the more bearing it should have on chairs or



pots. The weight per lineal yard of a rail depends on the nature and amount of traffic which they are to carry. Those in use on the Madras Railway are double-headed, and of the following lengths and weight:—

|         |            |          |         |
|---------|------------|----------|---------|
| 20 feet | Heavy Rail | per yard | 84 lbs. |
| 20 "    | "          | "        | 75 "    |
| 17 "    | "          | "        | 75 "    |
| 20 feet | Light Rail | per yard | 65 "    |
| 16 "    | "          | "        | 65 "    |

The double-headed rail is adopted for convenience of fastening, as well as for changing the wearing surface, when one becomes worn. Rails are subject to abrasion of the upper surface from the wear and tear of the traffic, and from lamination, that is a tendency to split off in layers from the continual pressure of the wheels. A rail is merely an elastic beam, and that it deflects is proved by the oozing out of mud from under the sleepers in wet weather, and the continual product of dust in the same places in dry weather. The allowance for the expansion of joints is the same in all countries, with equal variations of climate. The necessary allowance for a 20 foot rail is as follows:—

| At 100 Degree | place the rail in | contact    |
|---------------|-------------------|------------|
| " 90          | at a distance of  | ·016 inch. |
| " 80          | "                 | ·032 "     |
| " 70          | "                 | ·049 "     |
| " 60          | "                 | ·065 "     |
| " 50          | "                 | ·082 "     |
| " 40          | "                 | ·098 "     |
| " 30          | "                 | ·014 "     |
| " 20          | "                 | ·131 "     |
| " 10          | "                 | ·147 "     |

Some of the rails used on the Madras Railway are made of steel, and are usually laid on the approaches to a station, where there is much wear and tear, owing to the starting and stopping of trains. The steel differs from the wrought iron rail by the sound, which is clear and high in steel, and dull in iron; there is also another difference by which they could be picked out from iron ones, namely that they have a bulge in the entire length of their web.

When renewing rails, a number indicating month and year when it was put in should be made in the middle web, with a steel punch, just sufficient to make a lasting impression, thus, J. R. and 66 for January and so on.

F. February  
M. C. March  
A. L. April  
M. Y. May  
J. N. June  
J. L. July

A. T. August.  
S. T. September.  
O. T. October.  
N. M. November.  
D. R. December.

When new rails are put in to replace defective ones, full allowance should be made for expansion in the new rail: one-eighth of an inch in the morn, and one-sixteenth of an inch at noon should be allowed.

Steel rails are intended to be used on either side of station from the Main Line East and West points, to a distance of  $\frac{1}{4}$  to  $\frac{1}{2}$  a mile, according to the necessity for them is apparent, by the greater or less wear and tear, consequent on application of the brakes and this depends on the inclines on either side of the station. The steel rails should only be put in when there is a necessity for the renewal of the present iron ones, and not before. It has been estimated that the wear and tear, or waste of the rail is about one-tenth of a lb. per yard per annum, or that one-eighty-fourth of an inch in depth is annually worn away, but this depends much on the quality of the iron used, and many other attendant circumstances.

Some tracks in the United States, America, were laid with close joints in cold weather, and the result was that the track was raised vertically one foot, and thrown laterally two or three feet by expansion.

*Joints.*—No track is complete excepting with thoroughly spliced joints, making the rails practically continuous. No more chair nor seat can be sufficient since the foundation upon which the whole rests—the earthwork,—cannot be depended upon for its permanent support. For a deep rail, the fish-joint is probably the most simple and durable. No excellence of joint fastenings can

compensate for defective earthwork or drainage, bad ballast, small irregular and decayed sleepers, or for weak unsound rails. Before we can have good smooth roads, admitting of easy traction at high speeds with a low rate of maintenance, each detail must be perfected so far as the means have been indicated, conjointly by science and experience.

*Fish-Plates.*—When two rails unite, what is called a fish-plate is used to connect them; which is simply a piece of bar iron 1 foot 6 inches long, laid sideways, and fixed to both rails by four screws and nuts called *fish-bolts*. The excellence of the fish-joints in deep rails is obvious. The tensile strength of the web of the rail itself resists the downward pressure of the wheels, that pressure being transferred through simple plates of iron, standing on edge. All that is required of the fastenings of the splice is to hold it laterally in place, and if the rail is nearly square under the load, only slight fastenings are required, in fact, the splice would remain in place without fastening while the weight was upon it.

*Dog-bolts* consist of a screw and nut about 9 inches long, and are used in fixing the sleepers to girders; one end of it catches under the flange of the girder, while the other has a nut on it, which should be screwed down tight; but before the nut is put on, a washer (a thin flat piece of iron) either circular or square, should be put in so as to prevent the nuts from being imbedded in the sleepers.

*Chill-bolts* are used for fixing girders to the sill stones, the bottom of the bolt is broader than that at top, and is imbedded into the stone which has a hole made in it to receive it; it is made fast with molten lead, which keeps it in its place, and a nut is screwed on to the top of it.



### POINTS AND CROSSINGS.

*Grade of the Crossing.*—The “load” means the proportion at which the siding rails part from the main line, measured from the nose (for example) in a crossing of 1 in 10, if a perpendicular one foot long be raised from 10 feet, measured on the main line and from the nose, it will mark the distance of the siding rail from it,



and this is called the lead of the crossing. Crossings chiefly in use are 1 in 10; 1 in 9; and 1 in  $7\frac{1}{2}$ .

The "lead" also means the distance from point to crossing. The following two rules are used for finding the leads of crossings:—

1. Twice the angle of crossing multiplied by gauge, minus one and three quarter of the angle will give the lead.
2.  $9\frac{1}{2}$  times angle of crossing gives lead.

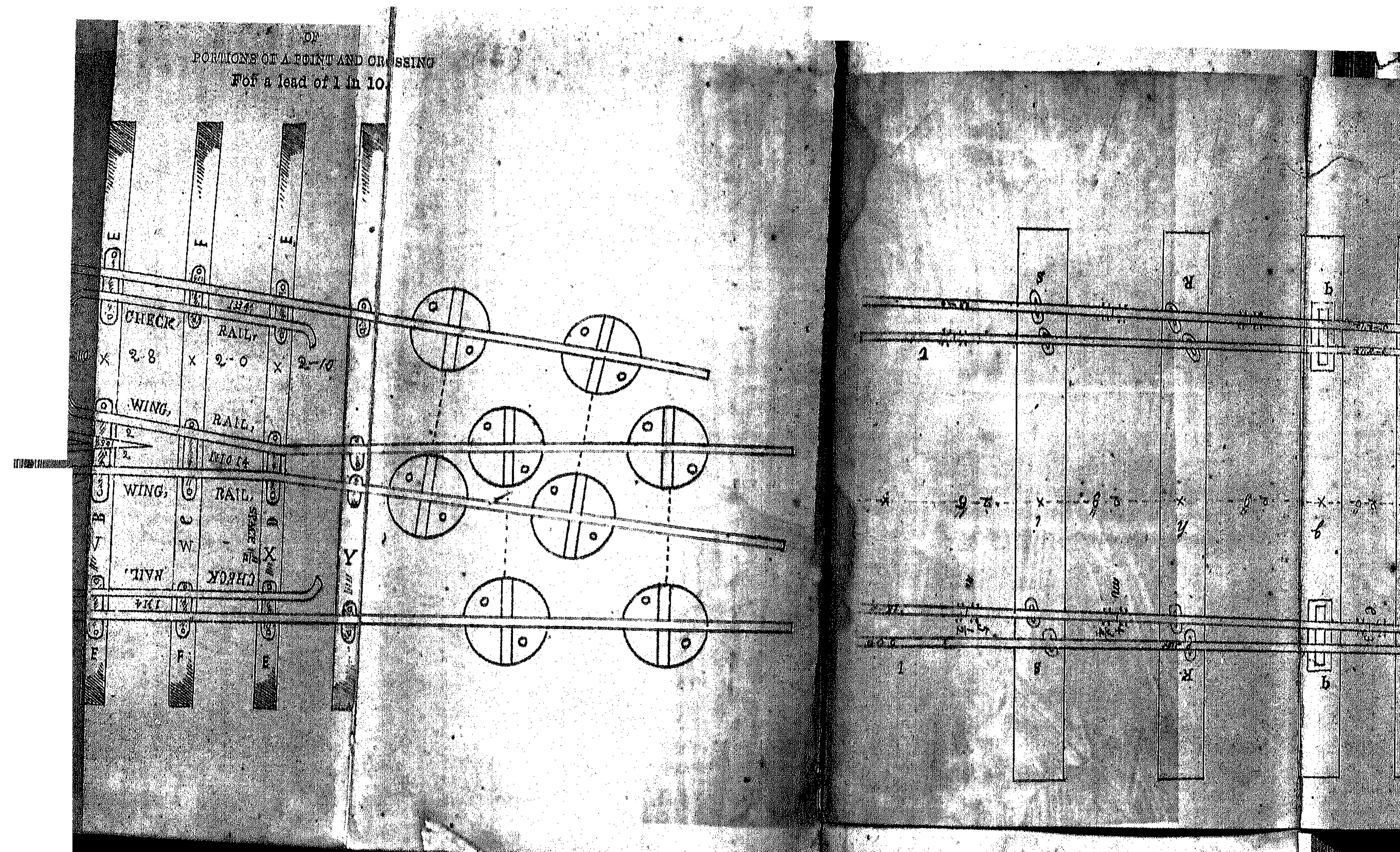
*Switches.*—By these trains can be transferred from one line to another while in motion. The apparatus consists of two parts known as the switch and points, the former consisting of a moveable rail, or tongue, tapered at the end so as to be close to the main rail, or to move sufficiently far to enable the flange of wheel to go in between.

To move the switches, and render them also self-acting, a lever is employed with a counterpoise arranged to act within the switch-box, which is placed at the side of the line, and from which the handle of the lever protrudes. The switches are so arranged, that the main line is always kept open when the lever is not touched.

*Points.*—The point of the crossing referred is not the actual point of the crossing, but the point where the centre lines of the rails which compose the crossing intersect, if it consist of two of the ordinary main road rails meeting at the proper angle. In order to mark its position on the crossing, a straight edge or string must be held close to the inner edge of the rails, the points where the line of the inner edge of either rails cut the outer edge of the other, being marked in this way on the crossing, a line joining these two marks will pass through the point of intersection of the centre lines of the two rails. If the crossing be a solid box, lines must be marked on it parallel to each face of the **V** at a distance from the face equal to half the thickness of the rails. The point where these lines intersect is the point required.

The *Noan* may be defined as a fixed tapered termination, when two lines of rails cross each other, and which are made of extra hard iron or steel to prevent their being injured. Opposite the







also, guard or check rails are provided to keep the wheels from swerving out of the intended course.

The different parts of the points and crossings will be better understood than explained from the accompanying sketch. The materials used in them are as follows:—

(See attached drawing.)

*Tongue Rails.*—Switches or tongue rails are usually 12 feet long; for strength's sake the fine end of the switch is made greater than the indent on the stock rail usually allows, it will therefore project a little in front of the rail.

*Stock Rails* are 15 feet long; they have indents on their inner sides for receiving the tongue rails.

*Wing Rails* are those at the termination of the switch rails near nose.

*Guard or Check Rails* are used on both sides of the line of railway, parallel to wing rails; they are used to prevent the flange of the wheels from striking against the point where the two lines intersect each other.

The chairs used in a point or crossing are as follows:—

*Sliding chairs.*

*Double sliding chairs.*

*Block chair.*

} Used for tongue rails to move on.

Chairs in the crossing (in the drawing) are figured A., B., C., D., E., F.,

A. chair connects the two lines of rails of crossing.

B. chair connects the crossing and wing rails.

C. chair at the point of crossing, connects nose and the wing rails.

D. chair, just above C. chair connects wing rails.

E. and F. chairs, with the last one, are used under the guard or check rails.

*Joint Chairs* serve the purpose of fishing plates, when rails have no holes in them for fish-bolts.

*Heel and Nose Chairs* connect stock rails with the rails of

*Girder Chairs* are used for bridges, when rails are used as girders, they are generally single block chains.

Eye-bolts at points are sometimes broken by the striking of the engine and carriage wheels, the eye-bolt being perpendicular, they should be horizontal.

All facing points should have locks and keys, the Station Master being held responsible for them.

The inner side of the switch box should be at least 5 feet from the rail; when this distance is not obtainable, it should be worked by a crank action of the lever, being placed parallel to the rails.

Switch lever handles, if loose, should be fastened securely with a small rivet. All switches should have their numbers painted on them.

All switch boxes should be examined occasionally, for sand getting in sometimes impedes the action of the counter-weight and the switches do not close properly; also if the counter-weight is not heavy enough it will not close the points, when this is the case, additional weights should be added.

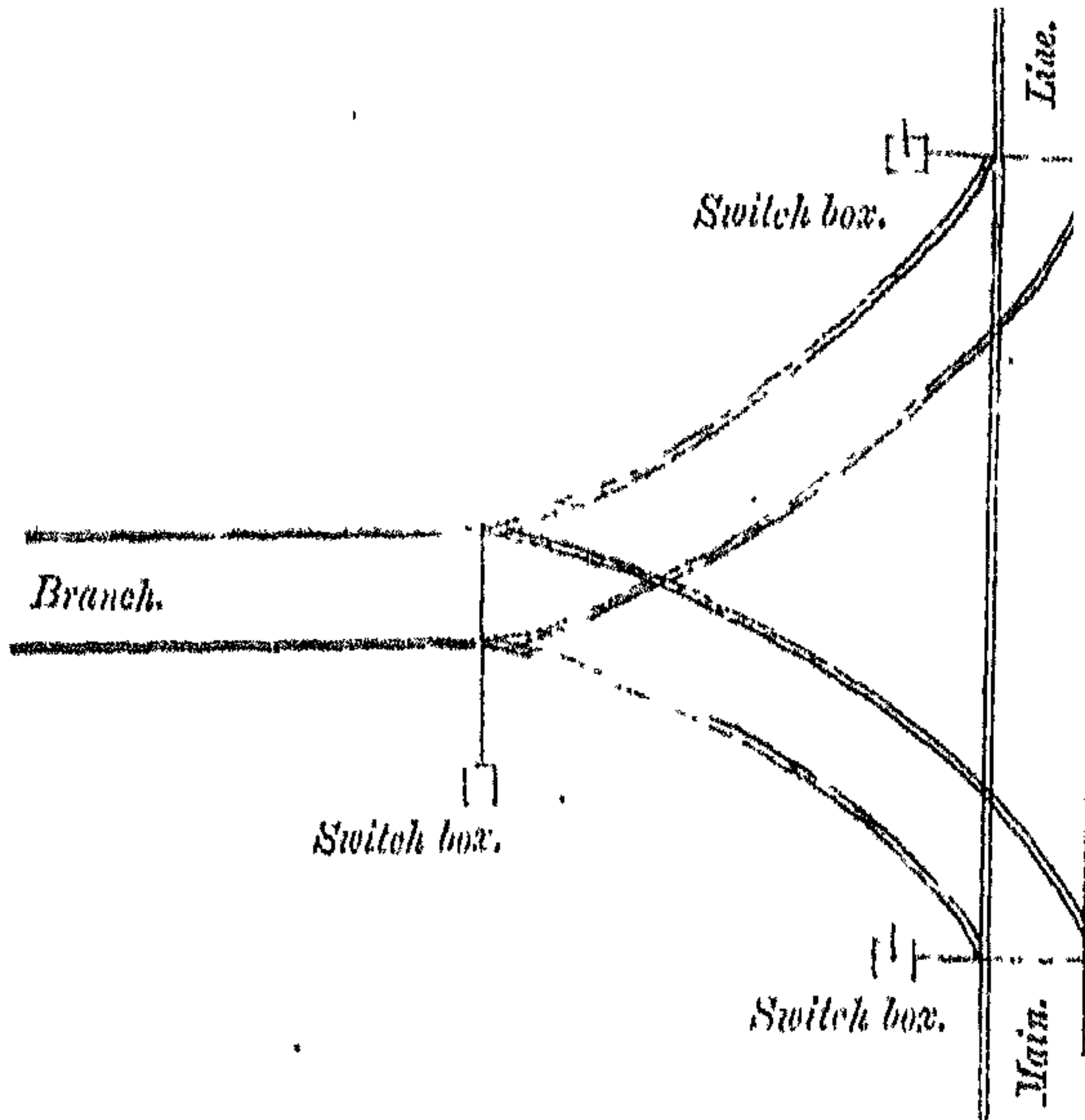
*Mixed Gauge.*—In order to remedy the inconvenience caused by transshipment of goods and passengers, resulting from the difference in gauges of different railways, it has been suggested to join those lines of Railway which communicate with broad and narrow gauge lines by a mixed gauge, which may be done in two different ways. To lay the narrow gauge line, in the centre of the broad, each having its own distinct lines of rails, or to lay a third rail outside the narrow gauge line at such a distance from it, that while two rails form the narrow gauge track the two extreme ones form the broad gauge.

*Turntables.* To enable carriages to be transferred from one line to another, two methods are used

*First.* Turntables, these enable carriages, or engines to be turned round, on the same line, or by being worked in pairs, and by the help of two short connecting rails to be moved from one line of rails to the other. A Turntable is a large circular disc turning on



SKETCH OF A LINE LAID  
FOR  
Reversing a train of carriages.





a pivot, and of a sufficient size either to receive a carriage or tender and engine. The turntables generally in use are of cast iron, with wrought iron ties, bolts, and revolving gearing, they are also made of wood and iron, or wrought iron alone. Some time the whole table is supported on a girder, so nicely balanced on its pivot, as to be easily turned by the strength of two men. Large turn tables are about 21 feet in diameter, small ones 12 to 15 feet. Those for an engine and tender 10 feet in diameter. A turntable consists of the following parts, a foundation of masonry or concrete, a circular cast iron base having a pivot in the centre, and a track for rollers around the circumference. A set of conical rollers carried in a frame, which turns about the pivot, a platform supported on the pivot at its centre, and on the rollers at its circumference, carrying one or more lines of rails, and provided with catches to fix it in different positions. Turntables are generally moved by direct manual force, but those of the largest size require the aid of wheel-work. *Second.* If it is desired to reverse the direction of a train and thus avoid the expense of a turntable, or to serve its purpose temporarily, and if there is sufficient space a branch line is formed at right angles with the main line, and communicating with it by two curves as per the following sketch (see drawing). The train has only to be run off the main line by the curve, into the branch until the last carriage has cleared the point when the switches are altered, and the trains are returned to the main line by the other curve, by which the whole train will have been reversed.

*Watering Tanks.*—At certain stations tanks are required to supply the tenders of the engine at proper intervals. These tanks are built in convenient places, close to the station siding, and are provided with a syphon and hose. At certain places wells have to be provided, and bullock runs are used for drawing the water, others manual labour is used for this purpose, also steam pumping engines.

*Gradient Boards* are put at the foot and top of the inclines to the road, they are marked on both sides, to guide the Engineer as to the nature of the road over which he is travelling.

*Fences.*—The best fence is undoubtedly a quickset hedge or her overgreen. The *Aloe fence* is used largely on the Madras railway. All old aloes which have flowered should be rolled away,

and removed, as they prevent the rest from growing properly, besides are unsightly; these should be planted in the gaps; the existence of gaps in fencing allow cattle to stray on the line, which is the cause of accidents, and the state of the fence is therefore of as much importance as the maintenance of the rails themselves. High weeds and grass, for about a yard or five feet from the fence, should be cut, and the remaining grass set fire to, if this is not done sparks from the engine are likely to ignite the grass and injure the fence. All trees and bushes three feet upwards encroaching on the edge of banks, along the line should be cut down; those at the foot of the bank should be left standing, as the roots tend to strengthen the bank.

Fences in tanks should be above the highest water mark.

*Corrieopillay fence.* Corrieopillay makes a good fence, as soon as it grows any height, it should be cut down half through, and bent down so as to interlace.

Aloes, &c., should be planted about the beginning of wet weather; *Prickly pear* makes a very good fence, but spreads a great deal, its use has been condemned. *Wire fences.* The posts may be of wood, connected with four or five wires, about the same thickness as telegraph wires, or the standards themselves may be made of iron. At intervals a straining post is used, by which the wires can be tightened or slackened. This fence is very expensive, and apt to be stolen, it has been recommended that a wire fencing on standards consisting of live trees, planted at proper intervals apart, would make a very good one in time.

*Scotch Clapnet.* On rock, hedges cannot be made to grow, so in such places where it is met with, a wall about three feet high, 1½ foot broad at bottom, and tapering to 9 inches, is built, on top of this sharp stones on edge are embedded in chunam.

*Mail Posts* are generally five feet in length, of which three feet are buried in the ground. The face should be smooth, and the distance marked in figures, deeply cut and painted, or only painted.

*Gates and Level Crossings.* Level crossing gates should be self-closing, the posts, or if stones are procurable, should be put in,

to prevent gates swinging back. The posts should not have too much of a cant, but should just be canted enough to allow the gates to swing back easily without slamming violently. Some do not close from an accumulation of earth at the foot of them; this should be removed. Gate posts should be charred and tarred before being buried. The level crossings should be kept free from earth between the rails and the guard rail. In cases where stones have been placed against self-closing gates, those who have done it should be discovered and prosecuted. At level crossings some hedges run in from the gate towards the rails: these should be removed to prevent accidents, as passengers cannot have a clear view of the line before crossing.

#### GANGS.

*Gangs.*—The gang coolies should be always present on the line from 6 A. M. to 6 P. M., their meals should be brought to them. The gang maistry with his coolies should stand on the right hand side of an approaching train, the maistry should give the all right signal to the coming train, or in his absence one of the coolies should do so. The whole of the road should be opened out by them; any ballast which has caked in the pots, should be taken out, and replaced, unless better ballast is available at hand. Each gang should work at this, at least two days every week, and should commence at the end of their length, and work straight through. The best plan will be to open out, and repack every other pot for a length of four telegraph posts, and then to go back and do the same with the intermediate pots and so on. The gangs should have brooms to sweep off all ballast from rails before a train passes.

Tie-bars and chairs should be square with the line, and 1 foot 6 inches from the joint. When joints of rails do not butt evenly they must be brought square on one side, and the other will fall into its proper place. The gangs should not be allowed to use any of the formation surface for packing sleepers, for when it rains the whole becomes a puddle.

For clearing the cess, a line should be always used to mark the boundary of the cess, giving 30 feet width of bank at



top. If the turf is above the level of the cess, this should be chopped away, so as to allow free drainage of the surface water all along over the edge of the cess. The cess should be kept parallel to the rail level (*i. e.*) without undulations, and when the height of the ballast above the cess becomes greater or less, a up or down in the cess is to be made. No weeding should be done outside the boundary line, and no ballast ought to be wasted by being thrown over the slope, or outside the line.

Gang maistries should be held responsible for the gaps on their lengths.

All gangs should assist in cases when trains are on fire.

A list of tools which each gang should be supplied will be found in the Appendix.

#### WATCHMEN, BEAT BOOK, &c.

In appointing watchmen, preference should be given to those who can read. Watchmen should see to the properly driving home of keys, replace decayed ones, and also look to the screwing up of fish bolts. They should be provided with two fog signals. They should keep the ballast and cess clear of grass, and should not be allowed to burn trees except next the fence, on the side further removed from the rail. Watchmen at stations should devote a short period of each day to cleaning weeds; once properly cleared, it will seldom require clearing again.

Badges are issued with the names of the stations between which they are used. Two badges are used between every two stations numbered 1 and 2 respectively. The beat book is kept by the Station Master, this should be constantly examined by Inspectors, and returned to the Engineer's Office at the end of each month.

Watchmen should not hurry over their lengths, but do whatever work is laid out for them on their way. The object is to insure the men going through their lengths a certain number of times daily. Inspectors should arrange that the watchmen leave two contiguous stations about the same time so that the badges are exchanged half way.



When a train is passing, the badge should be held up so that it can be seen from the engine, and sloped in the direction the watchman is proceeding. No watchman should leave the line, until he is properly relieved, and has handed over his pouch, belt, &c., to the man who relieves him. Night watchmen should flash the light of their lanterns on their numbers, and when in possession of a badge to hold it close to and over their number plates.

#### DUTIES OF AN INSPECTOR.

One of the chief duties of an Inspector is to carry out all the instructions received from the Engineer, as soon as possible. He should be punctual, and exercise forethought and patience. Inspectors should satisfy themselves that their gangs do their proper quantity of work, and this they can only do by constantly moving about in trolleys. Every Inspector should keep notes in his pocket-book; it should be an accurate and faithful record of all the acts done, and orders given by them; it should specify concisely, but in detail, all duty performed, inspections made, and every occurrence and information coming to their notice. The note book should be kept with regularity and method: first the date should be entered, then particulars to follow, and last of all a line to be drawn before the next day's date and entries are made. Facts apparently trivial when they occur, frequently will be found of importance afterwards, so that the note-book will be a record of these circumstances.

Inspectors should occasionally inspect the night watchmen, they should examine points frequently, at least once a week, and see if they are kept oiled, and in good order, by the pointsman. They should examine the bridges on their lengths once a month, also personally examine level crossing gates, and see that the latches, if any are provided, catch properly. The station fittings should also be inspected once a month. They should examine watchmen once a quarter, to see if they know and understand their duties.

Inspectors should annually personally examine, and report number of rails which will require renewal; and should personally

superintend the renewing or inverting of rails. Gang tools should be inspected once a quarter to see if they are kept in good order.

The Inspection book should be taken while riding on the engine, and slacks gaps, &c., should be marked in it.

*Slacks* are caused by unevenness, the rails are depressed, and the wheels of the engine or carriage dip over such portions. Such dips are felt perpendicularly.

A *Rough* is caused by the road being out of line, which is in small crooks, it is by a lateral movement of the engine; a rough may also be caused by a hard road.

*Loose joints.*—Loose joints are better and more clearly heard in a carriage, the bolts of the fish-joints are loose, and the sound caused by them is a click, click, click, or cluck, cluck, cluck. Riding several times on an engine will teach one the feeling on bad places. In all cases of accidents a report should be made to the Engineer by telegram immediately, stating so, and giving such information as possible, a full report by letter should follow. The locality of accidents, or detentions, should be indicated by the numbers on the nearest Telegraph post.

All employes are bound to seize and impound cattle.

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#### RELATING TO OFFICE, STORES, &c.

All Official letters should be numbered consecutively, and begin from 1st January in every year, each letter should only contain one subject.

All accounts, &c., should be sent in punctually on the 20th of every month; if the 20th falls on a Sunday then on the 25th. Diaries should have details entered in column of Remarks, they should contain all names of night watchmen absent or present on night of inspection. On the back of diaries the following should be entered:—No. of Convictions this week, and No. of Ballast trains worked this week. A separate form for these is unnecessary. The depth of wells should also be entered in diaries once a month.

Extra work should not be undertaken without sanction. When sanction is asked an estimate of the probable cost must be sent; anything emergent, however, should be done at once, and a report

sent with probable cost. No contract work should be commenced without sanction, and completion of particular works should be reported. For materials purchased or supplied by contractor, a bill should be made out on a common sheet of paper, and sent in once a fortnight. Notice of the working of trollies should be given to Station Masters of nearest stations. Conicopillay sheets for repairs to Bridges, Rungulows, Fences, &c., should contain in the body the nature and extent of repairs.

Earth and Masonry in Cubic yards.

White-washing, &c., Squares of 100 ft.

Fencing, by Chains 100 ft. long.

Inspectors should always have at hand a list of Bridges, not floored, and which have no curtains, and those having curtains and no flooring. They should also have hung up in their offices a list showing all forms, statements, accounts, &c., which should be sent to the Resident Engineer (periodically, occasionally, weekly, monthly, quarterly, half-yearly and annually), also the day of the week and month on which they are to be despatched to the Engineer's Office. A list of returns, &c., to be forwarded is appended.

When cattle are run over, notice should be taken, and a report made if the engine has a cowcatcher or not.

Tie-bars when forwarded to be fastened in bundles of 25 or 50 each.

All indents should be sent about the 22nd of each month, for supplies for the following month. The indents for materials should state for what purpose they are required. Indents for stationery should be sent once a quarter.

Empty gunny bags, and packing cases, should be returned to Divisional Stores.

#### LIST OF RETURNS, &c.

##### WEEKLY.

Trolley notices to Station Masters (*on Saturdays*).

Tradesmen's report and receipt of orders for extra work (*on Monday*.)

Permanent Way Inspector's diaries



Quantity of road opened and packed by Permanent  
Way gangs (on Monday.)  
Progress report of Protective Works (if any) „  
Milango return of ballast train (if any) „  
Register of convictions (if any) „  
Report of work done by ballast train „  
Inspection report of night watchman (to be entered in diary) „

MONTHLY, ON THE 2-ETH OF EVERY MONTH.

Indent for oil, &c.  
Office and watchmen's pay sheet.  
Permanent Way gangs' pay sheet.  
Pay sheet of all extra labour.  
Memo. of vouchers forwarded.  
Statement of tools with gangs and miscellaneous stores.  
Contractor's bills with measurements and details.  
List of Permanent Way materials.  
Statement of broken pots.  
Do. defective rails.  
Do. rails inverted.  
Do. wooden sleepers renewed.  
Receipts and consumption of coconut oil.  
List of subscribers to the Provident Fund.  
Do. of Pines.  
Do. of Bridges on the section.  
Condition of Buildings at stations.  
List of stores unaccounted for.  
Register of depth of wells at stations (to be entered in diary.)

QUARTERLY.

Statement of trees at station compounds.  
Indent for stationery.

HALF-YEARLY, ON THE 2-ETH OF THE MONTH.

Statement of Bungalows.  
Table B. I. Maintenance of Way (rails).  
Do. B. II. Do. Do. (sleepers)



Length of sleepers and rails on section.  
 Estimate of works on section.  
 Statement of crossings in line on section.

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YEARLY, ON THE 24TH OF THE MONTH.

Return of casualties (*every September.*)

Officers and native servants employed in the maintenance of the way and works (*every December.*)

On a Station Master leaving a Station a list of fittings missing should be sent to the Engineer.

A list of cuttings on each section should be made out, and kept at each office, showing mileage, and information whether they are on rock, gravel or earth.

Indents for points and crossings, or parts of the above, should mention mustor, and load of crossing, also weight of rail; and for trenails, screws, blocks, or any other of which there are different sizes, a mustor should be sent, or the size given.

When materials are sent to Divisional stores, or transferred to another section, advice notes should be sent to the Storekeeper, or Inspector, also to the Resident Engineer. A fortnight's supply of oil should be kept in stock.

Mile and Telegraph numbers, when invisible, should be sent to stores.

Every assistance should be afforded to the Police when making enquiries referring to Railway cases.

In cases of robberies of goods, &c., a report should be sent to the Police, and every facility given them to prosecute their enquiries, and a report made to the Engineer. Police constables should not be interfered with when walking on the line in uniform. When any men are dismissed for disobedience or any other cause, a letter should be sent to the Engineer informing him of the circumstances.

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TROLRIES AND TRUCKS.

Inspectors should grant permission to subordinates for working trollies, and issue notices to stations regarding the working of them.

Trucks are vehicles used for conveyance of stores, rails, pots and other heavy materials, &c.

Trolly is the name applied to all covered vehicles used by Inspectors in travelling along the line. Trucks and trollies should be provided with good brakes, and should have the number of Division and Section, also net weight of the body, painted on each. They should have a flag pole with the number of the truck or trolly to which it belongs branded or painted on it. The flags to be 4 foot  $\times$  8 foot. All trucks to have a rod of iron not less than  $3\frac{1}{2}$  foot high with a frame on top to support a lamp, the rod must be a fixture. The lamp must show a red light in opposite directions, and to have the number of trolly.

No truck or trolly should be put on the line without having a red flag or lamp, as directed, attached to it. A lamp is always to be carried with oil, and trimmed. Trollies should be kept neat and clean, with an oil feeder for oiling bearings. They should be protected up and down the line by red signals 1000 feet on either side, or 12 telegraph posts when on the level, and at a greater distance on a gradient; on starting from a station they should be protected by a watchman from the adjoining section, until the watchman goes ahead, returns and shows his all right signal.

Every truck should have a sufficient number of men, and every watchman when protecting a trolly should carry a fog signal, and use it promptly when he observes that the approaching train has not seen his danger signal. Fog signals should also be put down when a line is obstructed, or rails are being removed, &c. Trollies and trucks should not run at a greater speed than six miles an hour. Inspectors should be strict with mistries, writers and their assistants, and see that these rules are adhered to, especially on sharp curves round hills and where the gradients are steep and sharp. Watches should be regularly compared with station clocks.

#### TELEGRAMS.

In case of accidents, where obstructions occur, making the presence of the Engineer desirable before trains can pass, telegrams informing him of this should be marked B. M. When such a prefix is used Inspectors should report the fact of having done so to the Resident Engineer by letter.

Telegrams should only be sent in case of necessity, to save time, when a letter cannot reach quick enough, and they should be as short as possible.

### SIGNALS, SEMAPHORES, &c.

Signals are either movable or fixed, the former consists of a flag by day, and lamps by night of different colours. Red meaning "danger," green "caution," and white "safety."

Fixed signals consists of semaphores, with arms of different colours, and which can be raised or lowered, or fixed in different positions by levers, worked on the spot, or by means of wires from the station a short distance off. There are also fog or detonating signals, to be used when the weather is foggy or in dark rainy nights, or in case of danger.

The signal to "stop," will be given by a red flag or light, or by the left hand side arm of the semaphore being raised to a horizontal position.

The signal to "go slowly" will be given by a green flag or light, or by the left arm of the semaphore being raised half-way up.

The signal to "go on" is a white flag or light, or by the left arm of the semaphore being within the post.

When both arms of the semaphore are raised, both lines are obstructed.

In the absence of regular signals, anything moved violently up and down,\* or a man holding both hands up, is a signal to stop.

A man holding one arm up is a signal to go slowly.

A man holding his right arm in a horizontal position is, to go on.

The semaphore signal is invariably made from the left hand side of the post as soon by the approaching Engine Driver.

Semaphore arms should be placed horizontally, and not let them drop. In re-painting them, the old paint should be scraped off. In painting boards the colour is better put on by painting them white first, before putting on the vermillion. Danger signals at gates, and semaphores, should be painted on the white side of the semaphore.



When sufficient notice has not been given of special trains, the Assistant or others should proceed by first train, and signal to gang industries, they should hold up both their hands as in "danger," and point out the direction in which the train will run.

No workman should wear red clothes.

#### STATION, BUILDINGS, &c.

Urgent repairs at stations should be carried out at once, on any doubts arising application to be made to the Engineer; alterations in original design not to be made until sanctioned. Flooring of rooms and thresholds in stations not to be of bricks, but of flags, slabs or stone.

The walls of all passages where natives go through to purchase tickets should be tarred four feet from ground level.

When steps are let into the platform, trapdoors are to be put over them, with a hinge, so that they be covered on approach of a train.

In arimale coal tar should be used once a month, the wall being tarred from three feet above ground level; the flooring should be asphalted.

Care should be taken of trees at stations, and new ones be planted there, as well as along the line, when the rains set in.

Privies attached to Bungalows to have outlets at the rear, with a flooring of asphalt.

Signboards to native arimale should be placed above the wall on a post close to the wall, and should not project from the wall itself.

Locks at stations to be kept in good order, and receipts obtained from Station Masters. They are to be held responsible for the fittings. Transfer of Station Masters to be reported to the Engineer.

Station compounds should be kept free from grass. High and dry grass to be cut periodically. Grass at station compounds should be let by auction.



No thatched buildings are to be allowed in station compounds.

The nails securing palings in stations should be clamped, to prevent their being stolen or broken.

In paving, the Nirjee slabs should be well packed underneath with sand, to prevent the likelihood of their breaking from any weight being thrown upon them.

Near goods' sheds, pillars with unserviceable rails built in them, should be erected, for bandy men to tie their cattle to, and prevent them straying.

Every station to have a cinorator, to burn refuse in; it should be three feet high, the top diameter 3 feet and the bottom 5 feet, the thickness of wall being one foot. These should be occasionally inspected, and report made if not used.

Sentry boxes to have a peg driven in at each corner, and the box fastened to them with bolts, to prevent their falling during high winds.

A pit should be dug in an obscure corner of the Station compound, for throwing in the contents of the urinal buckets.

Cross platform fencing to be 3 feet from edge of platform, to prevent accidents to Firemen and Guards while signalling.

All buildings should be whitewashed once a quarter.

Coupling racks to be placed, under roof against Station walls to consist of plank 9' X 6' X 2" to be bolted to the wall by lewis bolts and loaded into the stone or brick work.

Racks to have 12 hooks 9" apart, 4½" from either end.

Notice boards at Stations to be hung square.

All earth-boxes in urinals to be supplied with cocoanut ladles.

Wells should be provided with gauges, and a register of the depth of the wells to be kept at each office, and entries made in them monthly as to the quantity of water.

Repairs to water columns, turntables, both engine and carriage travellers, are executed by the Locomotive Department.

## MISCELLANEOUS.

One of the chief duties of a Section Maistry is to examine and report on the state of Bridges on his Section.

All measuring tapes should be kept in good order, and of the proper length.

No portions of the scotch blocks to be nearer to the rail than 1 foot 2 inches, and tops of the main and other bolts should not be higher than 8 inches above rail level.

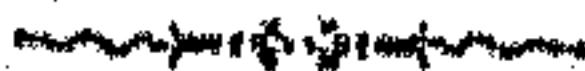
*Loading of Timber Trucks.*—Whenever long materials are loaded on two timber trucks, both trucks must be single bolster ones. If more than two trucks are used, the trucks at each extreme end must be single bolster ones. Double bolster trucks must only be used when the length of the materials is such as to allow of their being carried only upon one truck, or they may be used as stated above, as support wagons, between two single bolster trucks, in the case of very long materials; provided that the single bolster trucks carry their fair share of the load, and that the materials are allowed sufficient lateral play, on all the bolsters of the double bolster trucks.

The earthwork for repairing pipes buried in the ground should be carried out on a requisition from the Loco. Foreman.

Watches sent for repairs must be properly packed.

In the top side pocket of a double-breasted coat, an inner pocket or fob, for the watch, and opening inside, should be made to carry the Company's watch in, this will prevent it from falling out when stooping or jumping.

In all cases where Rail Girders for 6 foot openings are put in, the sleepers over them need only be of the smaller size, that is 10 foot x 8 inches, the girders being placed 6 feet apart.



## CHAPTER V.

**Materials used in Building.**

*Bricks.*—The qualities to be aimed at in making bricks are soundness, hardness, regularity of shape, and uniformity of size. A good brick should give a clear ringing sound when struck, and should not much increase in weight after being immersed in water, and does not absorb more than a fifth of its weight in water.

The best brick earth consists of a mixture of pure clay and sand, free from pebbles of every kind. Bricks made of pure clay warp and crack in burning, and those made of soil containing sand in excess have but little strength, and are easily crushed. About five parts of clay to one of sand form the best brick earth. Tempering is performed by men treading the clay, mixed with water, under their feet. The object of the tempering is to bring the earth into a homogeneous paste, for the use of the moulder. The quantity of the water will depend on the quality of the earth, but no more should be used than will suffice to make the clay so plastic that it can be moulded easily.

Bricks are made both on tables and the ground; when on the latter, the ground should be level, and made as smooth as possible by the removal of grass, stones, &c. A chunam terrace may be formed on the ground, and the bricks moulded on it. The bottom of the mould should be covered with a thin strip of iron, as wood wears away very quickly.

Great attention should be paid to drying the bricks. Before they are burned, they should be protected from the direct action of the sun and wind, so that one part may not dry more rapidly than another, otherwise the brick will crack from unequal shrinking.

*Burning.*—The bricks are generally burnt in kilns, which have open spaces or flues that run through the kiln. Between the flues bricks are laid in alternate courses (header and stretcher) until they are the required height, the upper three courses meeting gradually over the flues, over this the bricks are laid on edge; in



the walls of the flue, the bricks are kept a little apart, but above the other portions they are packed quite close, not only at right angles parallel to the sides, but also to have courses running alternately oblique, lastly all the sides are plastered with mud.

*Firewood.*—The best kind is logs five feet long or less, and from eight to sixteen inches in diameter; each log to be split into three or four pieces.

The kiln is lighted to windward. Should a strong wind be blowing, a screen is placed on the windward side of the kiln to lessen the draught; for if the fire gets too violent, many of the bricks will become distorted by partial fusion, or fuse and adhere together. A slow fire should be kept up for twelve hours after lighting, then the heat should be increased by keeping up a smart fire for about thirty-six hours. When the flues should be closed, and the fire allowed to die out.

About 800lbs. weight of wood are sufficient to burn a thousand bricks.

*Tiles.*—Those in use are the pot tile, the pan tile and the flat tile, gutter and ridge tiles being merely a larger description of the two first. The pot tile is formed on the potter's wheel, the pan and flat tiles are moulded. The clay used is of a blackish colour and very stiff, it is put into a tempering pit (the bottom of which is paved with bricks) and is covered entirely with water for twenty-four hours; the clay is then trodden by men's feet, and heaped up, and with a circular iron cutter the slices are pared down from top to bottom. This process is repeated three or four times until the hard pieces and stones have been broken down and cleared. It is then kneaded into a stiff paste, when it is in a fit state for the potter or moulder.

The burning is effected entirely with wood which is mostly green, as it is seldom cut before it is required. The kiln is circular, the burning generally takes seventy-two hours, being maintained night and day.

Flat tiles, the clay getting and tempering is precisely the same as for pan tile, and need no further description.



*Brickwork.*—With good brick and mortar this description of work offers great strength and durability. In using bricks for building purposes, an even surface or foundation is first prepared, which should be truly level in every direction. The first course of bricks is usually laid without mortar, the bricks being placed with their broadest surfaces upwards and downwards. This course being finished mortar is laid over its upper surface, to bed the bricks of the next course, which must have their vertical joints also filled in with mortar, and in this manner the work proceeds upward till finished. Straight walls are built up by first setting out the quoins, or angles of the building on the ground, and then straining a line from one point to the other, which of course will be straight. The line is fastened at its two ends to wooden pegs, which are stuck in the soft mortar joints. In order to be able to fix this line in its proper place, two quoins of the building must be carried up three or four courses higher than the intermediate work, and the lower courses must be made truly level by the application of the bricklayer's level. The work may now proceed with any required rapidity; all that is necessary being to examine that the faces of the wall are truly perpendicular, which is done by the application of a plumb rule at every course, and an occasional examination of the level state of the courses, which ought to be made at every fifth or sixth course. When walls are to be built circular, they must be carried up by moulds, which are thin boards three or four feet long, one edge of which is cut into the curved form the wall is intended to have, and they are used in the manner of a rule, being applied upon the upper surface of every course, and the bricks are placed in exact coincidence with the curved edge. When the first two or three courses are laid, the mould will only need occasional application if the walls are perpendicular, because the plumb rule used in the ordinary way will be sufficient to carry up the work correctly from the bottom courses if properly laid. When curved work is of small radius, it will require the bricks to be cut into wedge shapes, or must be moulded for the purpose. Round pillars are usually built with quadrant-shaped bricks, and when they are of considerable height, circular slabs of stone, of the same diameter as the pillars, and about three inches thick, are introduced at every four or six feet.

As a general rule the brickwork or masonry of a building ought to be carried up, as nearly as possible, at one uniform height all around, as it is desirable that an equal weight should be thrown upon every portion of the foundation, and lower work, and no part will have a greater tendency to sink or settle than another.

As brick has a great avidity for water, it should be soaked before being used. By taking this precaution the mortar between the joints will set more firmly than when it imparts its water to the dry brick, which it frequently does so rapidly as to render the mortar pulverulent when it has dried. Another reason for the brick being dipped in water is that they are generally covered with dust, which intervenes between them and the mortar, and prevents adhesion.

*Brickbond.*—The bond used in brickwork, deserves a great deal of attention. English bond is a continuation of one kind throughout the same course, and consists of alternate courses of headers and stretchers, the headers serving to bind the walls together transversely and the stretchers longitudinally. Broad masses of masonry, such as the piers of bridges, may be carried up in alternate courses of headers and stretchers, taking care that no two vertical joints occur in the same line over each other in two contiguous courses, and the bricks should not be placed with their whole length along the side of another, but so that the end of one may reach to the middle of the others which lie contiguous to it, and two rows laid diagonally or a herring-bone bond may occasionally be introduced. The thickness of the joints should not exceed quarter of an inch. Flemish bond consists in laying alternately headers and stretchers.

*Masonry.*—In masonry the term "face" is usually applied to the front of the wall, and the term "back" to the inside; the stone which forms the front is termed the facing, that of the back the backing, and of the interior the filling or hearting. The term "course" is applied to each horizontal layer of stone or brick in the wall. The divisions between the stones in the courses are termed joints. The upper surface of each course is called the bed; the arrangement of the different stones or bricks in each course is



termed the "bond." Bricks or stones having their lengths the thickness of the walls are termed *headers*, and those which have their lengths in the length of the wall are called *stretchers*.

*Out Stone*.—Masonry of out stone is stronger, and more solid than that of any other class, but owing to the labour required in dressing the stone it is very expensive. Out stone is sometimes used as a facing or covering to brick or rubble work, and it is then called "ashlar masonry." All the stones of a course should be of exactly the same height, but it is not necessary that the height of every course should be the same. All vertical joints should be at right angles to the face. The upper and lower beds should be square with the face, and consequently parallel with each other. It is not necessary to dress the back of the stones. The vertical joints of a course should fall on the middle of the stones in the course below. Bond stones of a length to reach at least one foot into the backing should be introduced into every course. Every bond stone should, if possible, be placed in the middle between those in the course below, and the quantity of these stones should not be less than a sixth of the face of the wall.

*Rubble Stone Work*.—This description of masonry is extensively used in this country, and if carefully executed possesses all the strength and durability required in a structure of an ordinary character. The stones used for this purpose are prepared by knocking off the sharp weak angles of the block, it is then cleaned from dirt and wetted before being placed on its bed. The bed is prepared by spreading over the top of the lower course an ample quantity of good ordinary tempered mortar into which the stone is firmly imbedded, the interstices being filled up with smaller pieces and chippings into the mortar. The best stones should be selected for the edges, and more particularly for the corners. Slab stones, or those which divide naturally into plates, will produce stronger and better work than boulders or stones that present a round surface.



## CHAPTER VI

### Quarrying and Blasting.

*Stones.*—*Laterite*\* may be described as a clay stone more or less impregnated with iron in the form of red and yellow ochres, with a perforated and cellular structure. *Laterite* is said to harden on exposure to the air.

*Granite.*—This is one of the most common rocks in Southern India, and is met with both in strata and unstratified. True granite is a compound of quartz, felspar and mica, not chemically united together, but so closely aggregated, that when the grain is fine it is difficult to distinguish one from the other, but if coarse, the three materials appear almost distinct. Instead of the mica another substance called hornblende is found in some varieties, which are then called *sionite*. *Sionite* is harder and more difficult to work than real granite, and is one of the best stones for building purposes.

*Quarrying stone.* The first point is to select as clear and extensive a surface of rock as possible, on which heavy logs of wood are laid, and kept in a state of ignition for two hours. The rock is then struck with a crowbar, to ascertain from the sound if a crack has been made, and when this is found to be the case, a large heap of light fuel, such as thorny branches, &c., is burned for the same period or less, when the upper laminae become partially detached will separate from the rock, its delamination being marked by a sound which guides the workmen in removing the ashes. They then insert wedges into the crevices, driving them as far as possible, and throwing heavy weights on the surface break the stones into pieces of the required size. When flags for flooring or other purposes are required, the rock is first heated and partially separated, a line of holes a few inches apart is then chiselled according to the intended dimensions, and the flags are separated by steel wedges being inserted in these holes, and struck forcibly by a hammer. Rock may often be removed by lighting large fires upon it, and extinguishing them with cold water, which causes it to crack. When granite is of a grey colour, with white sparks, resembling the grains on a plank, it will generally be easily split in this manner.



*Blasting.*—The implements used in blasting, consist of the jumper with which the holes are made, the scraper or spoon for clearing the holes of the chips produced, the needle which is driven into the charge, and remains while the hole is filled, so that when ultimately withdrawn a channel is preserved communicating with the powder; this arrangement, however, has been superseded by the fuse, which is put in after the powder, into the hole, and the space around is filled up by means of the tamping bar with clay, &c. The operations which constitute the process of blasting are boring the holes, loading, and firing. The jumper is an iron bar of variable length, according to the depth required for the blast. Its two ends are tipped with steel formed like knife edges, their length across depending on the diameter of the hole for which they are to be used. In using the jumper one man sits down on the rock, in a convenient position, and holding the lower part near the bit, he guides it that it may strike fair in the hole, while another stands upright, and raising the jumper drives it forcibly home. At intervals a little water is poured in by which the rock is to a certain extent softened, and the dust is thereby converted into a pasty consistency, and thus more easily removed by a metal spoon. After the hole has been sunk to its proper depth, and the charge deposited, it must be tamped or filled in again, so that a due resistance may be offered to the explosive force of the powder, and that this force be directed through the line of least resistance, which is measured from the centre of the charge, to the nearest surface of the rock. The best material for tamping is small fragments of the rock in which the blasts are being prepared, but it is never free from giving fire and causing accidents. Ant-hill earth is the next best, then clay. The tamping bar is a heavy brass rod, of a diameter a little less than that of the hole in which it is to be used, and slightly tapering at the extremities. At each end an open groove is formed along the side, to admit of the bar being used with facility, while the needle or fuse is placed in the hole. Brass is selected for tamping bars to avoid risk of accidents, from the charge being ignited by sparks which would be struck were iron or steel employed. The tamping material is put into the hole, in small quantities at a time, say enough to fill an inch or

inch and a half at a time, and each is well and firmly rammed home by successive blows. In using the needle it is necessary to grease it well before the tamping is begun, and turn it often during the process.

The charges of the powder should be as the cubes of the line of least resistance. Thus if four ounces of powder have a given effect, on a solid piece of rock two feet thick to the surface, it ought to require thirteen and a half ounces to produce the same effect upon a similar rock three feet thick; for 4 (the cube of 2) is to 27 (the cube of 3) as 4 is to 13½. The effect produced will depend on the nature of the rock, the quality of the powder and tamping. The results of the first two or three blasts should be carefully noted, and the charges can be regulated according to the rule that has been given (*vide* table given in Appendix). The space occupied by the needle, when the needle is used, is filled with fine powder, and is fired by means of a slow match, made of paper or linen, soaked in a solution of nitre or gunpowder, and this must be so arranged as to give the person firing it time to retire before the powder explodes. Great caution, and care, must be used by the person in charge of the blasting.

#### *Precautions to be used in Blasting.*

1st. No charge is to be fired, if possible, without a patent fuse.

2nd. Stone tamping is never to be used. The best description is burnt brick, or unburnt when the clay is stiff; the clay of paddy fields where procurable, and well kneaded, is good. Some soft material such as dry grass, paper, or cotton, should be put in over the powder before the tamping is commenced.

3rd. The ministry in charge should himself count the number of charges before they are fired, and carefully count the number of explosions, so that he may be sure none of the holes have missed fire.

4th. The time of firing blasts should be always when the least number of people are on the ground, either early in the morning, 12 o'clock (provided the coolies go to dinner then), or

six in the evening. Before firing, a horn should be blown, or a drum beaten, to warn people. Men should also be detached with red flags on either side, at a distance of about 150 paces, with strict orders to allow no one to pass, until the shots go off, and to use force if necessary to prevent them.

5th. In case of a mis-fire, the person in charge should be very careful, as many fatal accidents have occurred from re-boring; the safest plan, when practicable, is to clear out the remains of the old fuze with a copper or brass noodle, and introduce a fresh portion of fuze, having first put a little fresh powder down as priming. Should it, however, be found absolutely necessary to re-bore a hole, it must be deluged with water, and the tamping worked gradually out in a thin paste. Copper or brass tools should be used in re-boring.

6th. Tamping bars of iron, are not on any account to be used, but only those entirely of brass, or with a foot of brass at either end.

In cases of fatal accidents, those in charge of blasting operations will be severely punished by the Magistracy if found culpably negligent.





## CHAPTER VII

## Mortar, Cements, Plaster, &amp;c.

*Mortar or Chaux.*—Mortar is usually composed of slaked lime, and sand, to which sufficient water is added to bring the mixture to a proper consistence before it is used. When limestones or shells are subjected to a high temperature, all the water and carbonic acid which enter into their composition are driven off, and the result is quicklime. This substance shows a strong avidity for water, and for carbonic acid, which it absorbs from the atmosphere; when water is poured over the stone, it swells and cracks, evolving a considerable degree of heat, and finally falls into a fine white powder, in which state it is called slaked lime, also hydrate of lime. Pure limes slake perfectly, but the impure limes do not do so, and are often the best for building purposes. Lime is divided into two classes: Common lime, and Hydraulic or water lime. The mortar of common lime will not harden under water, or in very moist places; hydraulic lime yields a mortar which sets readily, and becomes hard in moist and dry places. The following is a simple method of ascertaining the properties of a lime stone. A small portion of the stone should be calcined over a common fire, on a plate of iron, and after being slaked should be kneaded into a thick paste, and made into a ball, which being placed at the bottom of a glass vessel, and covered with water will in a short time give evidence of the quality of the stone. If it does not set it would be called the common lime; but if it hardens, it would be classed under the hydraulic variety.

*Lime-kilns.*—The kiln in which the operation of burning is performed are of various shapes and sizes. A small arch, one and a quarter foot in height, and the same breadth, raised five feet from the ground, runs longitudinally through the kiln; the top of the arch has a grating of brick on edge, which is partially covered with broken tile, so that nothing drops through them. Over this bed a layer of charcoal is placed and fire applied, when sufficiently kindled, the mixed shells, or lime stone and charcoal, are to be laid in small heaps a foot and a half apart; when the fire has been communicated to them, the intermediate space must be filled to a



level with more shells or lime stone and charcoal, and when the fire has extended to these, another layer to be put on as was done in the first instance. It takes about twelve hours for the stones or shells to be calcined, and twenty-four more for cooling. A moderate breeze hastens the burning.

*Sand.*—The sand used in mortar should be clean and sharp. Sea sand should be avoided on account of the salt in it, but that found in the beds of rivers or streams may be used.

*Mortar.*—Two parts of sand are generally mixed with one of lime to form mortar; the lime and sand are ground in a circular trough made of stone, by a stone wheel turned by a pair of bullocks. The mortar when thoroughly ground, is taken out of the trough, and collected in conical heaps where it remains till required. The best mortar is produced from recently burnt lime. Mortar made with hydraulic lime should be used with as little delay as possible.

*Cement* is made with a mixture of one part of powdered brick, one of lime, and one of sand. A mixture of brickdust, lime and oil is sometimes used, as a lining to cisterns.

*Portland Cement* is composed of a clayey mud, and chalk ground together, and afterwards calcined at a high temperature. After calcining it is ground to a fine powder, and used in all damp or wet foundations, as it is a good hydraulic cement.

*Concrete.*—Is composed of equal quantities of lime, sand, and burnt clay, or broken bricks nicely pulverized, all three of which are well ground, and well mixed with two parts of broken brick, and two of broken stone or gravel, or four of any one kind; the proportions, however, vary as they depend upon the purpose for which it is intended to be used. Sometimes the proportion of one of lime to two of sand, and four of gravel is used, or one of lime, two of brickdust and four of broken stone. When the lime is used without being made into mortar, it is usual the lime used should be unslaked, all the proportions are well mixed together, first when dry, and then mixed again while water is being poured on it; the mixing should continue until every broken brick or broken stone is well covered over with lime, &c., and should always be thrown from a considerable height, by which its solidity is greatly

increased. In filling deep wells, where the water cannot be pumped out, a good plan is to lower the concrete in bags, which have four long strings attached to four of its corners, so that while the two strings at its mouth are used for lowering it, those at the ends are intended for emptying and drawing up the bag. The concrete should be put in about two feet at a time, and well rammed or beaten down.

*Plastering.*—For plastering, the mortar should be of the following proportions, one of lime to one and a half river sand, well beaten up and mixed with water, and applied to the surface of the wall with a trowel.

*Whitewash* is made with slaked lime and water. It should be of such consistence, that it will not immediately drop from a brush that has been dipped into it. Gum, or rice water, added to it, makes it adhere to the wall, and prevents it from soiling anything that touches it.

*Blue and Yellow wash* are laid on just as whitewash: the former derives its colour from coconut shell charcoal, and the latter from yellow ochre ground up with chunam. Before whitewashing an old wall, all the former coat of whitewash should be scraped off, else the new coat will not adhere properly. In white or blue washing smooth plastered walls, the following gums mixed with the wash will cause it to adhere: the babool tree (Tamil, *karnuvalam*), the velutree, and the wood-apple tree (Tamil, *vilumuram*) are those which produce the gums in use.

*Asphalt.*—Asphalt flooring should be laid on a good concrete foundation, six inches deep, and should be laid quite even. The concrete should be thoroughly set and dry before the asphalt is laid, otherwise the asphalt will blow. Dry ashes should be swept on the surface of the concrete, to remove moisture. The asphalt should be heated with wood, the mineral tar should be first put into the cauldron, and the asphalt broken thin gradually mixed, stirring well. When the asphalt is ready for use, it should give off light puffs of smoke, and drop freely from the stirrer. The surface while hot should be sprinkled with chalk powder or fine sand, and stamped

well. The asphalt should be laid in widths of three feet, the joints kept clean and free from dust, and heated before laying the next width.

|                                 |     |     |          |
|---------------------------------|-----|-----|----------|
| Thickness for goods' warehouses | ... | ... | 1½ inch. |
| Railway platforms               | ... | ... | ¾ "      |
| Arches, &c., &c.                | ... | ... | ½ "      |

Asphalt should not be used where it is likely to be saturated with oil or grease. For repairs, pour hot asphalt over the spot, and allow it to remain until the part to be removed is softened. Not more than 686 lbs. of asphalt will be required for a square ¾ inch thick.  $10' \times 10' \times \frac{3}{4}'' = 686 \text{ lbs.}$ , or 110 lbs. to a cubic foot. Asphalt pavings should be cut across diagonally, with the edge of a hot trowel, to prevent people from slipping and falling.

*Plastering.*—The following is the method of plastering walls:—

*For one coat*—the plaster is composed of one part of lime, and one and a half of river sand, thoroughly mixed and well beaten up with water. Before applying the plaster, the wall should be trimmed with a trowel, and swept perfectly clean, and then sprinkled with water. The wall being ready the plaster is mixed and brought to the required consistency. It is then laid on with a trowel, about half an inch thick, and levelled with a flat wooden rule, being afterwards smoothed with a wooden rubber till it acquires an even surface. During the process of rubbing the plaster is occasionally sprinkled with a little pure lime mixed with water, to give it a hard and even surface.

*For two coats*—the first coat is applied as already described, with the exception that the surface is left rough, and no pure lime is applied during the process of rubbing. A day or two after the first coat is put on, and while it is moist, the second coat is applied. The plaster used for the second coat consists of three parts of lime and one of white sand. These are mixed as before, and afterwards ground by women on a flat stone with a small stone roller, till they are reduced to a fine paste. The plaster thus prepared is laid on a wooden rubber, and applied with care over the first coat about the eighth of an inch thick. It is then rubbed down perfectly smooth with a small trowel, and afterwards polished with a crystal, or

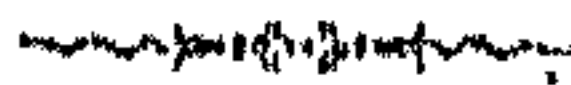


smooth stone rubber, and as soon as it has acquired a polish, a little very fine ballapan (soap-stone) powder is sprinkled on it, to increase the whiteness and polish of the plaster, and the polishing continued. The second coat ought to be applied and finished in one day, for it usually hardens too much during the night to be polished the following day, unless in damp weather. The practice is to continue polishing the plaster until it is quite dry, and a number of bricklayers are employed in order that it may be well polished the first day. Moisture continues to exude from the plaster for some days after it is completed, this ought to be carefully wiped off with a fine cloth, and the wall kept perfectly dry till the moisture ceases.

*For three coats*—the first is laid on as already described, but it is left a fortnight or three weeks to dry before the second coat is applied. The plaster for the second coat consists of one pail of lime and one of fine river sand freed from the coarser particles, and from clay by sifting. It is well mixed and beaten up in a clean trough and applied over the first coat, about a quarter of an inch in thickness, the first coat being moistened with a little water. It is next rubbed down in the same manner as in the first coat, but acquires a much smoother surface the plaster being of a finer quality. A day or two afterwards, before it has time to dry, the third coat is applied. It consists of four parts of lime and one of fine sand. These after being well mixed, and reduced by grinding to a very fine paste, quite free from grittiness, are put into a large earthen jar, and mixed with the whites of eggs and tyre or milk curds, in the proportion of 12 eggs and  $1\frac{1}{2}$  measure of tyre to every parak of plaster. These are all mixed and rubbed between the hands till the ingredients are thoroughly incorporated, and the composition reduced to a uniform consistent paste, a little thicker than cream, and perfectly free from grittiness. The plaster is now fit for use, and is put on with a wooden rubber, about a tenth of an inch thick and gently rubbed till it becomes perfectly smooth. Immediately after this another coat of still finer plaster is applied, consisting of pure lime ground to a very fine paste, and afterwards mixed with water in a clean tub till it is the consistency of cream. This is put on about a sixteenth of an inch thick with a brush, and rubbed gently



with a small trowel till it acquires a slight degree of hardness. It is then rubbed with the crystal or stone rubber till a beautiful polish is produced, not forgetting to sprinkle the wall with fine ballapam powder during the process of polishing. If the plaster is not entirely dry on the second morning the operation of polishing ought to be continued until it is quite dry. The moisture as above directed must be carefully wiped off, and the wall kept quite dry till all appearance of moisture ceases. The stone used in polishing is a crystal or white pebble, or piece of soap-stone, about three inches long and one and a quarter broad with a perfectly smooth face.



## CHAPTER VIII.

## Foundations.

*Foundations.*—The formation of a firm and secure foundation, upon which to build a structure, is frequently one of the most difficult operations which the Engineer has to perform. When the ground is firm, and sufficient to support the structure to be placed upon it, it is only necessary to make its surface level; when however, the ground has a slope, it will not be necessary to bring it all to one level, but it may be cut into a series of level benches or steps. When the ground is not sufficiently firm to be trusted, it is found necessary to adopt some artificial means of increasing its resistance: one of the most common methods of doing this is to drive long pieces of timber termed "piles" vertically into the ground, until the resistance they offer is sufficient; they are all sawn off to the same level, and a platform of timber is formed on top of them, upon which platform the intended structure is built. The piles are usually 12 inches square, pointed at their lower extremity and shod with iron, to enable them to penetrate the ground more easily, they are driven into the ground by repeated blows of a heavy weight, allowed to fall under the influence of gravity, on their upper extremity, which should be surrounded with a hoop or ring of iron to prevent the pile being split by the blows.

Another method is to throw the base of the structure over a large superficial area, which is sometimes done by spreading large masses of concrete over the ground, and spreading out the wall with footings, or by laying large flat stones over the ground as a foundation course upon which to commence building.

In compressible soils, such as some kinds of clay, sand may be used to form a bed for the foundation; it should be wotted and spread in layers of six inches, and each layer firmly rammed before the next is laid. In very soft ground, however, this could not be adopted, as the sand would gradually work itself down.

\* *Foundations on Wells.*—When works are to be constructed in the beds of rivers, or in other situations, where the soil is sand, or of a silty nature, and when water is met with in such quantities that

excavation in the ordinary manner would be very troublesome, the foundation is laid upon wells. The least size for foundation wells is three feet inside diameter, and the thickness of rings from 9 inches to 14 inches. The wells should be placed not less than six inches from each other. Before the wells are commenced, the ground should be levelled, which is easily done, by removing the sand from the whole site of the intended work, until the water is reached. The bricks should be cut expressly for the purpose, somewhat narrower at one end than the other. The first course of bricks is laid on the well ring, which is made of three pieces of plank. Banyan and mango planks are commonly used for well rings, but the wood of the country gooseberry is best, being less perishable under water; sometimes basket work is used instead of planks below. The curbs should be formed of rings, the lowest one about three inches broad, and those on top increasing in breadth, so that the topmost one would be the required thickness of the brickwork. The bricks should be laid in chunam, and when the well is finished time should be given it to dry, but while drying it should be constantly kept wet. The mortar used should be of a kind that will set under water. The well is now ready for sinking, which operation is performed by well sinkers, who, by removing the sand from within the well, cause it gradually to sink.

Wells are also sunk by a patent invention: "Bull's Patent Dredger," which, being let into the well, and drawn up, will bring up much more sand at each time than what a man would bring up, and the well could be sunk by this means to a greater depth than it could be done by well sinkers. A derrick with blocks, &c., will be required to work this dredger. The chief points to be attended to is, that the dredger should be carefully let into the centre of the well, and never on to the side, as too much of sand being taken out from one side, will tend to make the well lose its perpendicular.

Another patent, Engineer Stonoy's Excavator, is useful when clay has to be taken out from under the well. The excavator is let into a rod of iron placed in the centre of the well, and is worked by a handle fixed on to the rod.

Wobb's Excavator is also another used for taking out soil from within wells.



Wells have occasionally been made of a rectangular shape, they are more difficult to sink than round wells, and require more care.

*Footings.*—The bottom courses of the masonry of the foundations are usually extended beyond the face of the superincumbent work, the object of these spread courses, or footings, is to distribute the weight of the structure over a larger area of bearing surface, by which a liability to settlement from compression of the ground is much diminished.

*Temporary dams.*—Before a work is commenced in the bed of a river or stream, it will often be necessary to construct a temporary dam. Dams made with sand can never be water-tight, but they will often serve a good purpose. In order to protect them from the action of the waves, stakes should be driven in front, behind which date mats or branches of trees may be placed; at the part where the stream is running, which should be left till the last, stout stakes are placed across the stream, to the front of which fascines made of clay rolled up in branches of trees, and bound round with straw ropes, are rolled, and the bank is rapidly filled.

*Stone facing or Revetment.*—The object of stone facing is to protect the bank from the action of water, when agitated by high winds, and from injury from rain. The stones are usually laid in a single layer, and vary in size according to the height of the bank. The largest stones are placed at the bottom, and should be sunk 9 or 12 inches in the solid earth. After the first course is laid the earth should be filled in behind to the height of the stones, and well rammed, the next and following courses should be laid in the same manner. The stones should be well fitted together, and the crevices stopped with smaller pieces. The usual slope is  $1\frac{1}{2}$  to 1, but a slope of at least 2 to 1 would be better.





## CHAPTER IX.

## Bridges, Arches, &amp;c.

*Bridges.*—The two kinds of bridges chiefly used on the railway are arched and girder.

*Definitions.*—The extreme supports of a bridge by which it is joined to the line of railway are termed the *abutments*, and the intermediate ones, *piers*. The walls which sustain the embankments where they join the bridge are termed the *wings*. The square termination at each of the wings are the *abuts*. The projection of the piers beyond the faces are termed the *cutwaters*. The lowest extremities of an arch are called its springings or *springing lines*. The top of the arch is the *crown*, and the portion of the arch over the springing lines the *haunches*.

*Site.*—As a general rule a straight reach of the river or stream is to be selected and a place where the bank is high on both sides. The axis, or centre line of the bridge, should be placed perpendicular to the thread of the stream, when the locality admits of its being done, when this cannot be effected, the bridge is termed askew or oblique, because the sides or faces of the piers, which must be parallel to the thread of the stream, in order that they may not be exposed to the effects of the water striking them obliquely, or oblique to the axis.

*Arches.*—The forms usually given to the arches of bridges are those of a semi-circle, of the segment of a circle less than a semi-circle, and of a semi-ellipse. The semi-circular arch is easy of construction, presents great stability, and springing from a horizontal surface, the load acts perpendicularly, and therefore the arch has little tendency to spread or exert lateral pressure against the abutments. It cannot be often adopted, when the side banks of the river are elevated above the surface of the water, for the rise being equal to half the span the road on top of it would be inconveniently raised. The segmental arch, if made with a great rise, is open to the same objection as the semi-circular, and if made very flat presents less strength, and causes a great pressure or horizontal thrust against the abutments; but with the span and rise

duly proportioned, it is the form which is mostly adopted. The semi-elliptical arch gives more waterway than a segment of a circle for the same span and rise.

*Span and rise of Arches.* — The crown of the arches should be three feet above the highest flood, in order to allow space for floating bodies. It is of great importance to give a bridge sufficient height, as a considerable diminution of waterway is compensated by a little additional height. As to the number of arches, if possible streams should be crossed in a single span, especially impetuous torrents among hills. As a general rule bridges should consist of an odd number of arches, in order that a pier should not be built exactly in the centre of a stream. When the span of a bridge does not exceed 12 or 15 feet the arch should be segmental with a rise of one-seventh of span, and it will then be an arc of 60 degrees nearly. The rise should increase with the span, and when that exceeds 30 feet one fourth this proportion will combine solidity with a handsome appearance.

*Piers and Abutments.* — The foundations of piers and abutments must be according to the nature of the ground on which they are built. As the horizontal thrust of two half arches, on each side of a pier counteract each other, the only effect that the pier will have to sustain will be that arising from the weight of the two half arches, with the weight that may be placed over them on the road surface. The abutments having to sustain the thrust from the arch on one side, must be of greater thickness than the pier; the rule of one-sixth of the span for piers, and one-fourth for the abutments, will be found a very safe rule, but it will in most cases give a greater thickness than necessary.

*Outwaters.* — The projections of the ends of the piers, or outwaters are sometimes made in the form of semi-circle or semi-ellipse, but it will be best to make the faces of the pier form a right angle, the length of the outwater is then equal to half the breadth of the pier.

*Spandrels.* — The spandrels between the face walls are usually built up to a height of about one fourth of the rise of arches.

*Wing walls.* The wing walls may be built either at right angles with the abutment, or with a curved splay outwards. The length of wing walls should be one and a half times the height of roadway, above the bed of river. Their thickness at bottom should be one-third of their height, and they should be built with offsets or steps on the inside, so as to reduce the thickness at top. Wing walls are known to have cracked to such an extent that it has been necessary to rebuild them, this has been caused by the earth having been thrown in loose between them swelling after becoming saturated with water. This accident would never happen if the earth was gradually filled in as the walls are being raised, it is then trodden on daily, and cannot be easily penetrated by water.

*Ballast or parapet walls* are built up on both sides of the bridge, and are intended to keep the ballast in its place.

*Flooring.* When there is a likelihood of the bed of the river or stream between the piers and abutments being scooped out or scoured, by the force of the current, it becomes necessary to protect it by means of retaining or curtain walls, running the length of the bridge, both on the up and down stream side. The top of the curtain should be about two feet thick, over this stones or bricks on edge with mortar are set, forming the flooring. The flooring should be about two or three feet below the bed of stream. The curtain walls will have to be built over wells or otherwise according to the soil.

*Construction of Arches.*—Arches are constructed of both bricks and stone. In all arches the joints should be prolongations of the radii of curvature. When arches are built with the ordinary rectangular bricks, laid so that the joints are continuous from the soffit, to the back of the arch, it is evident that however close the joints might be at the soffit, they would be very open at the back, and the strength of the arch would depend on the mortar in the joints; to remedy this defect it is usual to build arches upon concentric rings. The great sinking of some arches on removal of the centring is almost entirely due to the thickness of the joints. The two sides of an arch should be begun and carried on



simultaneously, otherwise the centring will be subjected to an unequal pressure, and change its form. After both the sides of the arch have been brought to near the crown, space is left for the key bricks or key stones, which are driven in tight, after which the centring should be shakened.

*Oblique Arches.*—In a skew or oblique arch, it is not possible to lay the courses parallel to the abutments, for were this done, the thrust being at right angles to the direction of the courses, there would be a great portion of the arch on each side that would have nothing to keep it from falling. In order to bring the thrust into this direction, the courses must be laid as nearly as possible at right angles to the front of the arch, and at an angle with the abutment, and it is this which produces the peculiarity of the skew arch. When such arches are built of stone much nicety is required in shaping the voussoirs, but with brick they may be built with nearly as much facility as the ordinary arches.

*Centring.*—From the nature of an arch it is clear that it could not be placed in the position they are intended to maintain, without artificial support for them to rest upon, until the arch is capable of supporting itself; and when this is done the artificial support has to be removed, in order to throw open the space, that has been arched over, without any impediment. The artificial support thus made use of is called the centre or centring of the arch. In all centring the two chief points to be attended to, are that its upper bearing surface should be very correctly formed to the figure assigned to it, and that it shall be sufficiently strong to bear the weight of the materials the arch is to be composed of, together with the workmen, tools, &c., without sinking or changing its form.

A centring is usually composed of timbers constructed on horizontal tie-beams, supported in several places by pillars, the frame being connected transversely by braces and struts, and at top by other timbers fashioned to the curve of the intrados. Between the pillars and the tie-beams there should be placed single or double wedges, or blocks with wedge-formed steps cut in them. When these centrings are to be lowered, if single wedges have



been used, with the smaller ends projecting, the wedges are struck back by blows from a hammer, which tends to lower the centering; when double wedges have been used, the upper one which has its smaller end projecting out should be struck. Sand boxes, consisting of a round box and a round solid plug fitting loosely into it, are sometimes used for lowering centerings. The box has a small hole in it, at the bottom, which is also fitted with a small plug, the box is filled with fine dry sand up to half its depth, then the round plug is put on, and the beams and centering come on top of it. After the arch has been turned and keyed, the small plugs from the holes in the box are removed, when the sand runs out, and the centering gradually lowers itself. From four to six boxes, or more according to the size of the arch, are used, and the plugs from these should all be drawn out simultaneously, also in the case of wedges they should all be struck at one and the same time.

Stones falling out of arches should, in being replaced, be wedged up tightly with iron wedges dipped in melted asphalt. Wedges of sizes, and asphalt, should always be kept in stock.

*Girder Bridges.*—The principle usually adopted in the construction of bridges of cast iron is to support the roadway upon girders having top and bottom flanges, securely fastened together by bracing frames, which are rivetted to the girders. The bottom flange of the girder has a plate of iron called the bed-plate rivetted to it, this plate fixes the girder to the masonry, having holes in it which tally with the holes in the sill stone, into which a bolt called the sill-bolt is introduced. The girders have side webs which impart considerable lateral stiffness to the girders, which prevent any tendency to bend laterally or sideways. The girders are in the place of arches, and stretched across the required span, they have to rest upon abutments and piers, as in the case of arches, which are not required to be so thick as that of those for arches, but just sufficient to give the girders a good bearing. Spans up to 6 feet may be spanned by two sets of rails fixed firmly on chairs, over this the Permanent Way is laid. But in spans above 6 feet cast iron girders are used. The girders are usually kept 8 feet apart. In girder bridges those to span 20 feet are 25 feet long, having a bearing of one and a half feet on each pier and abutment.

Those for 30 feet are 35 feet long, having a bearing of two and a half feet, and so in proportion according to the length of girders the bearing increases. The height of a 20 foot girder is  $1\frac{1}{2}$  foot high, while for a 30 foot one it is three feet high. The girders should have the bed-plates first rivetted on, then laid across the required span, a derrick, chain and ropes, being worked by a crabwinch, the bracing frames are then fixed and rivetted on, and the girders are brought to their proper places, usually by traversing screw-jacks, and let down on the sill stones which have been placed in their proper position. A sheet of lead is usually introduced between the bed-plates and sill stones, the sill stones should be set in Roman Cement. Girders are sometimes also braced together and rolled on to their places.

Boiling tar should be applied to the surface of all iron girders requiring a preservation coat, care being taken that the iron is very thoroughly scraped before the tar is applied.

*Culverts.* These are constructed to allow the free passage of water under the raised road, wherever it crosses irrigated fields. It will not be necessary to make a tunnel or culvert for every field channel that crosses the proposed line. Some of them may be turned and made to run parallel to the road, until a convenient place for passing them under the road is met with. Small fields crossed by the road may need only one tunnel, but larger portions of irrigated land will require two or three at least, and an additional one on an average for every quarter of a mile of raised road. However small the quantity of the water that has to pass, it is not advisable to make any tunnel less than a yard wide, and in order that there may be uniformity, all tunnel vents should be either one yard or one and a half yards in span, and so on. The culverts have abutments and piers similar to those already described for bridges; they may be arched, or have girders to carry the permanent way on top of them, or if consisting of one small vent may be covered over with thick and strong slabs.

*Temporary Bridge.* may be made of sleepers 10 or 12 feet long. Two holes should be bored in them 8 feet apart,\*the sleepers should be placed in a square, first, two are put down parallel and

8 feet from one another, then long iron bolts, 5 feet or more, are fixed into these, then two more sleepers at right angles to the first set are fixed through the bolts, then again the next two like the first, and so on until the required height is obtained. Cross sleepers, in the centre should be added to bind them together, and the whole should be well secured with spikes. Into the four small squares formed by these sleepers, bricks or stone should be thrown in to weight and keep the whole down. It is well, when practicable, to brace the sides with pieces of long wood spiked to it, also to make a small excavation, as a foundation for it before putting down the first set of sleepers. Over an abutment or pier of this kind, girders may be placed and the line laid on them, if no girders are available, on small spans 6 to 8 feet rails may be made to take their place. First two sets of rails are fixed firmly on chairs, and over this the permanent way is laid in the usual manner.

*Arches in dwellings* are of different kinds, but are so generally known, that probably one or two examples will suffice. Gauged arches are arches generally used over openings to door and windows where the bricks are gauged. Inverted arches are mostly used in the basement stories of large buildings. Relieving arches are those placed over the openings in the walls after the lintel or bressummer, as the case may be, is fixed, and relieves the woodwork of the superincumbent weight. An impost is that part of a wall or pier from which the arch springs, or the springing line. These arches are turned in a similar manner to that already described for bridges, but in the case of inverted arches, the surface of the ground on which the invert is to come must be moulded of the required shape, and this generally is done with concrete.





## CHAPTER X.

### Tunnels.

*Tunnels.*—Before any decision can be arrived at by the Engineer, as to the course, levels, dimensions and mode of construction to be adopted, careful surveys and examination of the geological strata are requisite, together with soundings, from which a section of the surface of the ground to be passed under may be made. The character of the strata is ascertained by borings, by sinking trial shafts or pits, on the line of the intended tunnel, or by small drifts nearly following its course. The trial shafts serve afterwards as working shafts, through which the earth from the tunnel can be raised during its progress, and by working either way from them, enabling the work to be carried with great rapidity; by breaking up the tunnel in short lengths; and on the completion of the work, affording means of light and ventilation. A drift-way has the advantage of perfectly draining the ground, through which the tunnel is to be formed, and its insuring the certainty of the tunnel being formed in the required line. After the nature of the strata to be passed through is ascertained, the Engineer determines the best form of transverse section, and upon the thickness of masonry requisite to securely support the sides and roof.

There are two methods in ordinary use for sinking the shafts, the first can only be followed when the ground is tolerably firm and free from water. It consists in making an open excavation of the form and dimensions of the shaft, and to such a depth as the nature of the ground may indicate to be safe; a curb or ring is then laid, and the wall or lining of the shaft is proceeded with, care being taken to ram in the ground firmly on the outer side, so as to leave no space or vacancy. As soon as the brickwork forming the lining has been carried up to the level of the ground, and the earth behind it securely rammed or punned, the second length of excavation is proceeded with; this must be done with caution, so as not to endanger the stability of the portion already built; the excavation of soil in the centre of the interior of the shaft is proceeded with leaving particles to support the curb; in the spaces thus excavated shores or props are introduced as a

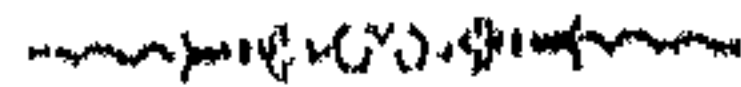


temporary support of the curb while the remainder of the ground is being removed. These props are placed in an inclined position, the remainder of the ground removed and a second curb laid at the bottom of the excavation, and the lining of the brickwork proceeded with in the spaces between the struts until it reaches the curb at top, so that the curb may have a firm and secure bed upon the brickwork below it, care should be taken to perfectly fill up every space between the curb and brickwork. The props are then removed, and the brickwork completed in the spaces which they occupied. The excavation is again proceeded with, and the various operations already described repeated until the shaft has attained the required depth. This mode of building shafts is technically termed *underpinning*.

The second method is frequently employed in sinking wells, and is adopted when the soil is too loose or full of water to allow of an open excavation being made with safety. The curb is laid on the intended site of the shaft, and the well built up, the excavation within the shaft is then proceeded with, the whole of the ground being removed in this case from under the curb, which, being thus left without support, and being loaded with the weight of brickwork upon it, will gradually descend, and thus as the excavation is carried down, the curb will follow, and as it sinks the well must be carried up, so as to maintain its level with the surface of the ground; care should be taken in sinking these shafts, and to avoid one side of the curb descending more rapidly than the opposite one, by which the shaft would be thrown out of its perpendicular, by a little management in the removal of the ground this may usually be avoided.

The brick shaft having been carried down to a few feet of the top of the intended tunnel, the excavation should be proceeded with cautiously, and the sides secured with timber frames and planks, until carried below the level of the bottom of tunnel. A small drift-way should now be commenced, about the level of the bottom of the tunnel, to drain out any water met with in the bottom of the shaft, which thus becomes a well from which it could be easily removed. The excavation of the tunnel is then proceeded with. After this has been done, or rather while this is being done, the

brickwork for the tunnel, usually consisting of an invert, side walls, and arch is proceeded with. Over this invert earth and ballast is put, and the permanent way laid on top of it. It will be found necessary to have a drain running through the length of the tunnel, to remove all water from the roadway.



## CHAPTER XI.

## Roofs, &amp;c.

*Arched Roofs* are chiefly used for tanks, baths, &c., but in other buildings they are very seldom used, the construction of these are similar to those used for bridges made of bricks.

*Syrian or Pot Cylinder Roofs.*—These roofs are formed with hollow earthenware cylinders instead of bricks, and are much lighter. The cylinders are made on the potter's wheel, are about 9 inches in length, and from 3 to 6 inches in diameter at the larger ends and from 2 to  $3\frac{1}{2}$  at the smaller, they are partially closed at top and bottom. The construction of this roof is as follows: After the walls have been raised the required height, a centring must be prepared, similarly to those used in bridge-building, except that it need not be strong. The first three feet of the arch is commenced with brick and chunam, on the two side walls of the room, the cylinders are then laid side by side in chunam along the length of the room, with their small ends downwards; the second row is placed in the intervals between every two of the first, and so on. Both sides of the arch rise equally till the last row, which of course is vertical, is forced in on the top and completes the whole. Two courses of flat tiles in chunam are afterwards placed over the arch, and the exterior plastered, and well rubbed down. The water during heavy rains lodges in the cylinders, and keeps the roof damp for a long time; hence this description of roof is not recommended.

*Terraced Roofs.*—The terraced roof renders the rooms underneath cooler than a tiled roof. Joists are laid across  $1\frac{1}{2}$  foot from centre to centre, if the space between the walls of a room does not exceed 14 feet; but if greater, the length is generally divided, into two or more portions, by large beams of wood, and the joists are laid across at right angles, connecting them with the end walls and with each other. Over the joists come a course of brick on edge in chunam, the bricks being of small size (usually  $6" \times 9" \times 1"$  and placed diagonally), then a thickness of three inches of jolly or broken brick in chunam, and lastly three coats of



plastering. The joints are some times boarded over, the brick on edge is then dispensed with, but the jolly with flat tiles, and plastering come as before. The slope for the water to run down should be about a quarter of an inch to a foot, and great pains should be taken to lay out the slope with regularity so that the water may run off easily. Joists need not exceed 3" in thickness, and never less than two inches. The girders or beams should not be placed more than 10 feet apart, but the precise distance will depend on the length of the room, and position of the doors and windows, they should rest on wooden wall-plates, or granite stones, about 4 feet in length, and 6 to 9 inches thick, so that the pressure may be equally distributed over a greater extent of wall; girders should be laid from a foot to a foot and a quarter into the wall, and joists six inches.

*Sloping Terrace.*—In this description of roof, the rafters should be placed 1½ feet apart from centre to centre, and the reapers which are nailed to their upper surface at right angles, should be one-fourth of an inch thick and two inches wide, and placed six inches apart from centre to centre, so that the flat tiles, which are usually six inches long, may have at each end an inch of support. The covering usually consists of three courses of tiles, the first laid on the reapers, with mortar between the joints; the second or third courses are set in mortar, and covered with three coats of plastering. The tiles should always be dipped in water before being used. Cracks in the last two kinds of roofs are repaired by pouring tar and pitch into them. Cracks are usually caused by the sinking or sagging of the rafters, the cracks are also repaired by setting a row of three bricks or tiles over the crack, either in mortar, or in a mixture of tar, brickdust and lime.

*Couple Roofs with flat or pantiles.*—The most simple roof is that which has only one row of timbers arranged in an inclined plane; this is called a shed roof, or a lean-to. For rectangular buildings, the roof consists of two rectangular planes equally inclined, this is called a pent roof, or also the four sides are formed by inclined planes, when it is said to be a hipped roof, and the inclined ridges the hip. The useful framework of tiled roofs consists of a series of couples each formed of two rafters meeting



at an angle, and joined by one or two pieces of wood termed "collar-beams." The couples are placed  $1\frac{1}{2}$  feet apart from centre to centre, and in hipped roofs the distance of the extreme couples from the ends must be equal to half the breadth of the room; the rafters from the corners of the ridge or highest part of the roof are called hip rafters, and the shorter ones which meet the hips the jack rafters. Over the couples come the reapers, which are nailed to them; the covering over this consists of either flat and pantiles, or only of the latter. When both are used, one course of flat tiles are laid on the reapers with mortar between the joints, the pantiles are then laid over them in rows touching each other from top to bottom; the pantiles should uniformly overlap each other, to the extent of not less than one-fourth of their length, a second course is then laid with the convex side upwards, and overlapping each other, these tiles are so placed as to cover the intervals between the rows in the first course. The ridges and hips are covered with tiles of a larger kind, overlapping each other, and are set in mortar. The ridge and hips are plastered, and the sides also in stripes 6 or 9 inches wide, these stripes are called *chunam borders*, and their object is to bind the tiles together. The slope of a pantiled roof should be one-third the span or breadth of the building, anything above this will make the tiles slip.

*Thatched Roofs.*—The framework of thatched roofs may consist of a series of couples, but they need not be placed so close together as when they are intended to support tiles. Reeds, jungle grass, straw, palmyra and coconut leaves, are usually used as thatch; a thatched roof of jungle grass has a very neat appearance. The slope must be half the span, or the sides must be inclined at an angle of 45 degrees with the horizon, and the angle formed by them at the ridge will be a right angle.

*Trusses.*—When the span of a building is over 20 feet, trusses should be used. A king-post truss fulfils every condition of strength and stiffness that can be required in a roof, provided the size of the timbers are well-proportioned, and the joints well and securely made, the rafters are tied together and prevented from

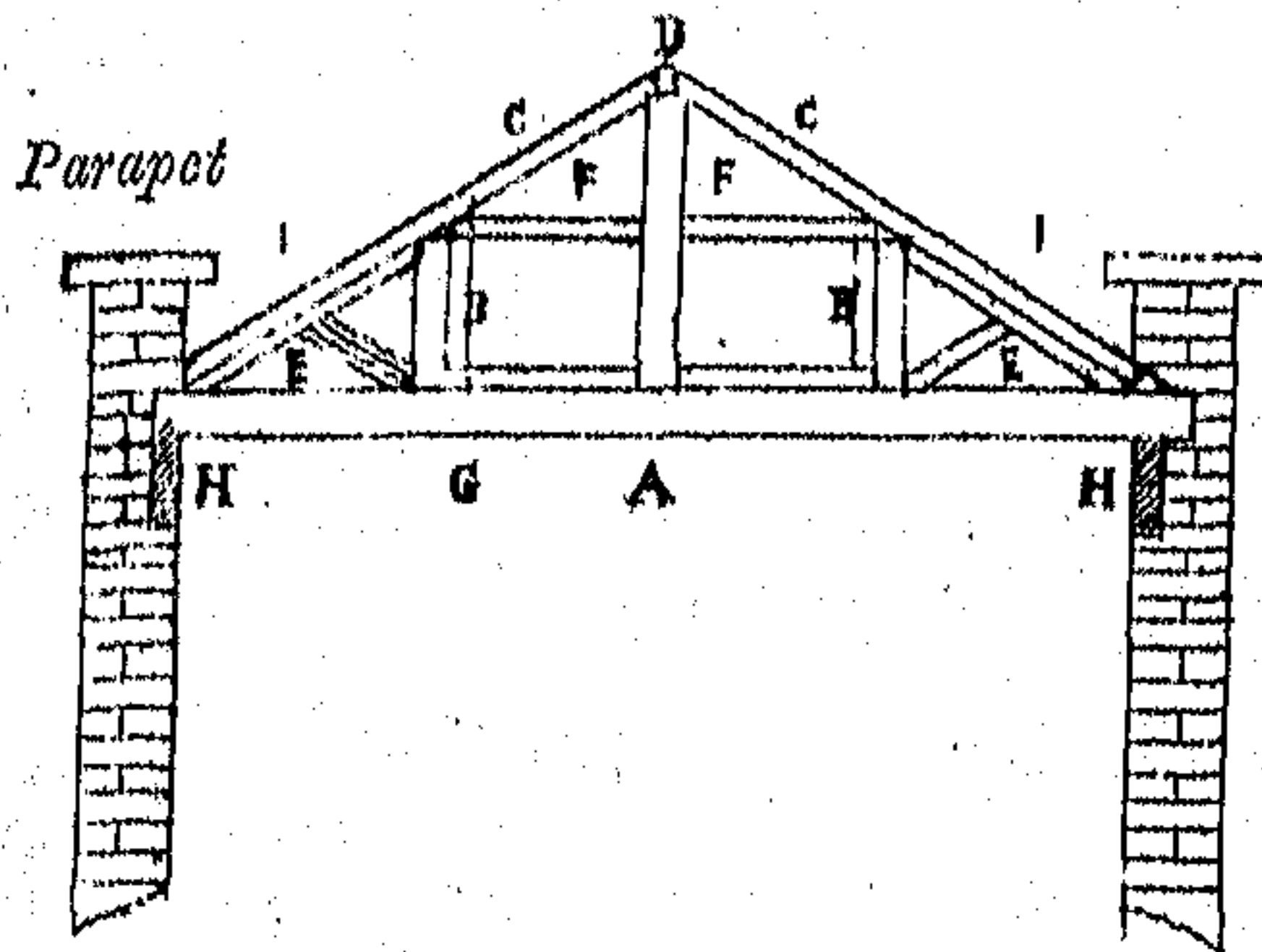
spreading by a piece of timber extending from one wall to the other, called a "tie-beam" the feet of the rafters being fastened to it. These rafters are called "principal" rafters; to prevent the tie-beam from sagging it is suspended to the top of the rafters by the "king-post"; and to prevent the rafters bending, they are supported in the middle by struts or braces from near the bottom of the king-post, placed so as to be nearly perpendicular to the rafters. Trusses are usually placed 8 or 10 feet apart, and the roof is built upon them by "purlins" or long pieces of square timber placed in horizontal directions, at equal distances apart. The common rafters come over these, and have reapers. When the span is over thirty feet the tie-beam is usually supported at additional points by suspension pieces called "queen-posts," from the bottom of which spring additional struts.

From the accompanying sketch will be seen the various description of roofs, which will convey to the mind of the reader the meaning of the technical terms used; as much information as possible has been given relating to this one sketch. A roof constructed like it would be an unnecessary expense, but it has been drawn in order to illustrate the difference of the various parts, having reference to the terms generally used.

(See Drawing.)

*Iron Roofs.*—From its strength, durability, and incombustible nature, iron is a material eminently suitable for the construction of roof principals and purlins for railway stations, &c., and moreover it admits of being arranged in such forms as will occupy a minimum space. These roofs admit of being classified under four distinct heads: First,—Roofs supported by triangular trusses or principals. Second,—Roofs supported by straight girder trusses or principals. Third,—Roofs supported by arched trusses or principals. Fourth,—Roofs supported by dome-shaped framework. Over the framework sheets of corrugated iron or zinc are placed. In such positions that are much exposed to wind care must be taken to prevent the covering being blown off by the wind getting underneath. Through the ridge of every alternate corrugation, where reapers are not closer than 2 feet apart

# ROOFS.



A. is the king post.  
 B. B. the queen post.  
 C. Rafter.  
 D. Ridge.

I. Purlin.

E. Struts.  
 F. Collar.  
 G. Tie beam.  
 H. Wall plates.



for zinc or galvanized iron; screw a  $2\frac{1}{2}$ " or 3" galvanized iron screw, using a 4 or 5 lb sheet lead washer one inch square dabbed or dipped in lead-coloured paint (thick) then over the lead washer (as in use for rivets). The top upper sheets should be laid their edges turned down. Where roopers are more numerous than stated above, the screw need not be put through every rooper. The screws should be screwed, and not hammered in; nails in no case should be used.

*Iron Roofs.*

Rise =  $\frac{\text{Span}}{5}$  The principals to be 6 feet 8 inches apart.

*Tiled Roofs.*

Rise =  $\frac{\text{Span}}{3}$

*Thatched Roofs.*

Rise =  $\frac{\text{Span}}{2}$  or even two-thirds of it.





## CHAPTER XII.

## Tools, Machines, &amp;c.

*The Bricklayer's Level.*—This instrument consists of a board from 1 to  $1\frac{1}{2}$  inches thick, which should be well seasoned, that it may not crack nor warp, another board is morticed or otherwise firmly attached at right angles to the middle of the first, in such manner that their surfaces may be flush. A true perpendicular line to the under edge (which must be perfectly flat and smooth) is now laid off, from the centre of the under side, upon the surface and is there strongly marked, a saw cut is made at the top, in the direction of this line, from which a plumb line is supported, its weight or bob hanging in a hole, cut through the bottom board, and large enough to give the bob some play in every direction without contact. The bottom board should be exactly 2, 3 or 4 yards long from end to end, in order to give results of deviation from level, in yards of length without calculation. If this instrument is correctly made it will be evident that on setting its bottom edge on a wall, or other surface that is perfectly level, the string of the plummet should accord exactly with the line scratched throughout its whole length; while, on the contrary, if not level the string will be thrown to one or other side of the line. To prove the correctness of the implement place it as above on a surface that it shows to be perfectly level, and such a one may always be made by driving wedges under one end of a thick plank. After finding that the plummet hangs in the proper vertical direction, reverse the level by turning the two ends of the bottom planks into the opposite positions they before held; when if the plummet retains its same parallel position to the line, the instrument is correct. If otherwise half the error must be corrected by raising one end of the plank, and the other half by altering the position of the line drawn. By several reversions of this kind, the true position of the perpendicular line will be obtained, and then the instrument may be used with confidence. The difference of level between two points may be obtained with this instrument in the following way. Drive a picket down to the surface of the ground, and another distant a few inches less than the length of the level; then set the level to rest on the two

pickets, and the plumb line will show where their heads are truly level. A third picket is then driven in, also a fourth and so on, to the heads of which the level is successively applied, and the length of the last picket is the difference of level required; the heads of all the pickets will then be on the same level.

*Platolayer's or Mason's Levels*, are small spirit levels, made of glass and mounted on brass tubes. In this description of level, when the bubble is in the middle of the glass tube it is said to be level. A ten foot rod or plank of lesser length is generally used with it by platolayers when chocking the levels of the rails, or on curves the super-elevation of the outer rail. By masons also it is used to set out or check their work.

*Blocks or Pulleys* are used for raising weights. The common pulley consists of a wheel with a groove made on edge or circumference, which confines the rope, this wheel is put into an iron or wooden frame called a block, where it turns with a metal pin. The single block has one wheel in it, the double two and a triple three. A system of pulleys, or a number combined together, is called a muffle. There are several arrangements made in the pulleys used to raise weights, in some single-wheeled pulleys, there are means provided to release the rope, a part of the sheave opens at the edge sufficiently to pass the rope over it, or to disengage it, these are called snatch-blocks. The power of pulleys admits of being almost indefinitely increased by combination. Systems of pulleys are of two classes, those in which a single rope is used, and those which consist of several ropes. In both cases the weight is attached to a moveable block, in which are fixed two or more wheels, and whatever the system is, every wheel has a separate axle, and there is a distinct wheel for every turn of the rope at each block. It matters not how these several wheels are arranged, they may be combined in a variety of ways so as to gain an advantage, or as it is termed a purchase, which is more or less according to the number of the pulleys, and their mode of construction. There are many systems of pulleys worked by a single rope, in all of this kind there is one moveable block, over which the rope runs, and to which the weight is attached; the

weight here is raised by the lower block, and the rope instead of being finally attached to the fixed block at top passes over a second wheel in that block, and then under a second in the lower.

When there is a great strain upon machinery, ropes cannot be used with any degree of safety; chains being more advantageous are employed, they are of a variety of forms, and are used with pulleys made expressly for them, each chain carries a tooth which passes into a notch made on the edge of the pulley.

*Derricks.*—The most simple method is by the use of tackle, attached to the top of a mast or two poles lashed together at a height sufficient to enable the object to be lodged, where required. The derrick is raised and kept in position by guys or ropes from its head, and fixed to piles firmly fixed in the ground. In lifting girders, &c., a triple block is fixed at the head of the derrick, and another double one is fixed to the girder, one end of a single rope is fixed in the triple block hook, passes through the double, then to the triple, and so on until it passes down to a single one placed at the base of the derrick, in a line level with a crabwinch around the barrel of which the rope is wound; by working the winch the girder is lifted, and placed in the required position.

*Lever.*—The lever is the most simple and the most generally used for raising weights to a small height. Sometimes two pins are fixed in the lever at a short distance from each other, which slide in two pairs of vertical grooves provided with ratchets, so that when the long arm of the lever is pulled by means of a rope, the nearer pin serves as a fulcrum, and the more distant one is elevated, at the same time with the weight, and detained in its place by a click, when the rope is slackened, the weight sinks a little and raises the pin which first served as a fulcrum, to a higher place in its groove.

*Capstan.*—The capstan consists of an upright barrel or drum, turning on a vertical axis, the upper part has a head with holes in it, for the insertion of levers or bars, by means of which it is turned, and the rope coils around the capstan.



*Crahwinch.*—The crahwinch is employed for raising weights, it has a winch and barrel, and is worked by a wheel and pinion, the whole is fixed on a strong frame, a double handle enables two men to lift considerable weights.

The *Hand Jack* is a portable contrivance used for elevating the end of a block of stone or piece of timber or girders, or to hold up a wall that requires underpinning, and will be found very useful in the hands of the builder. The power of the jack is obtained by a rack and pinion placed in a block of wood about 30 inches long, 10 inches broad and 6 inches wide, the rack has a double claw at its upper end, and a small pinion which engages in the tooth, the axis of the pinion is supported in two iron plates bolted to each side of the block, and one axis passing the side plate to which is attached the winch or handle, the turning round elevates the rack, and with it the claw which is applied to the load to be raised.

*Screw Jacks.*—In screw jacks the block of wood or iron has a hole through the entire length of its axis, to allow the screw to move up and down without touching, at the top of the block is a nut through which the screw passes when turned round, at the bottom it has a flat bed-plate. This kind is called a bottle jack. Some jacks are placed on a tripod or three-legged stand.

*Traversing Screw Jacks.*—This is a similar contrivance to the above, but has a horizontal screw passing through the upright iron, by means of which and a handle termed the ratchet the whole weight resting on the jack may be moved to or from one position to another, as required.

*Cranes* are generally employed for raising or lowering heavy weights, and large bodies. The wheels accompanying it are usually set in motion by turning a winch.

*Pumps* are generally used for drawing water from foundations. Picottahs and baling baskets are the simplest kinds used in foundations, where not much water has to be contended with, but can only conveniently raise or lift the water to about 10 feet, and when there is a great difference of level, two sets must be



used, one taking the water from the foundation pit to a ridge formed in the ground half way, and the other throwing it on to the surface of ground, where by a drain it may be led off.

*Chain Pump.*—The chain pump is formed of a long chain or strip of canvas, with a number of small buckets or planks fixed upon them at regular distances, and which pass over two wheels one at top and one at bottom of a wooden tube; to the upper wheel are attached handles, by turning which the buckets or planks, as they mount, raise the water on the ascending side, which flows off by a trough placed on the surface of the ground. This description of the pump is very useful for short lifts, and with great difficulty it could be worked at an inclination over 60 degrees.

*Forcing and Suction Pumps.*—The suction pump consists of a vertical pipe immersed in water, at the lower end is attached a drum which has a check valve, within this pipe sometimes is fixed a piston with a valve attached to it. By the piston being worked up and down, the air becomes rarified, and the water ascends. Pumps of this kind are variously constructed, and different positions given to the pipes. In some machines, right over the suction pipe, a fan-like contrivance in a case (from which a bent elbow pipe leads the water off this fan) is fixed which is brought to motion by means of a barrel, which is fixed on to the same axis as that of the fan, this barrel is moved by a leather belt encircling it, and the fly-wheel of the stationary steam engine by means of which it is worked.

There are other again similar to the one already described, but which may be worked by manual labour.

*Piles* are made use of in foundations, &c., they are long pieces of timber which are vertically driven into the ground, they are made sufficiently long to enter firmly into the soil, the lower extremity of a pile is pointed, and shod with iron to penetrate the ground more easily; the upper end is surrounded with a hoop or ring of iron to prevent the pile from splitting when driven into the ground by the repeated blows of a heavy weight allowed to fall on it.

*Pile Driving.*—The simplest is that of using a sloop, one end resting on the ground, the other on the head of the pile, and is raised and dropped by men standing opposite each other.

*Pile Driving Engines, &c.*—The three-hand maul, made of a block of wood hooped with iron, having two long handles radiating from its centre, put at such a distance that it can be worked by two men. Assisted by another in lifting it who holds by a short handle opposite to them, and is used when the piles are not of great length. The pile engine varies in size and construction, when small, and the block which is let fall does not exceed two or three hundredweight, it is worked by a single rope passing over a large pulley attached to a derrick, one end of the rope being attached to the weight, the other is divided into as many small ropes as may be required, at each of which a man works, and when the weight is raised, the whole let go together. This kind of machine can only be used for driving short piles, as the weight cannot be lifted beyond the height to which the men's arms can reach, but it has the advantage of being easily and rapidly worked. For larger operations a ram of from 8 to 10 cwt. is used set in a frame of woodwork placed on a base formed by four timbers framed and bolted together, at right angles to which is screwed or securely attached a crabwinch worked by four or six men. On this framing is placed on one side two upright pieces of timber, on the other an inclined ladder, the whole accurately braced together; at the top a wheel is fixed, over which the chain worked by the crab passes, and is attached to the monkey (or weight) which has a plate in front and at back, so that it is confined to work up and down the perpendicular pieces of timber which are protected by plates of iron. The ram is usually made of cast iron. After the ram has been raised to the required elevation, it is released by pulling a rope, that opens the nippers attached at the top of it, when it falls with considerable weight on top of the pile.

*Screw Piles* are usually employed in situations where the depth of water is great, and where a soil composed of loose and unstable sand is incapable of supporting any kind of structure, or where the waves of the sea have the power of undermining

any work within its influence. Screw piles consist of a large spiral flange or screw of iron, making about one turn and a half; it has a square spindle upon which the pile is fixed, and it is secured in the ground by screwing it down to any depth that may be found requisite, which is easily effected by turning round the pile, to which an handle should be fixed.

*Boring Rods.*—The operation of boring is resorted to when it is necessary to examine several beds of earth, and to discover their nature. When the soil to be examined is under water, a hollow cylindrical pile is usually driven down, within which the boring rods can with facility turn. The tools vary in form according to the material to be pierced, all have a screw at the upper end tapped to one thread and easily fit into the rods. A hollow conical instrument, with a spiral worm around it, is useful in sandy soil; a cylindrical auger, with a valve in it, in mud. The boring rods are in long pieces, which could be screwed into each other when it is necessary to go down deeper.

*Jim Crow* is a contrivance made use of in straightening rails: it consists of two arms with a claw each, in the centre of the arms is a hole, into which a screw runs, the end of the screw has also a claw; the bent part of the rail is put in between the arms and the screw claw fixed to its bend, when by turning the top of the screw with a large spanner the rail gets straightened.



## CHAPTER XIII.

## Paints and Varnishes.

*Paints and Varnishes.*—The material chiefly used in painting is white lead, and when ground up with linseed oil forms the common white lead paint of commerce. To produce different tints, various colours are added to the white lead. The following are the colours generally used:—white, black, lead colour, red and green. White paint is produced by grinding up white lead with the linseed oil. Black is produced by lamp-black, which is soot collected from the burning of resinous substances. Lead colour is produced by mixing a small quantity of lamp-black with white lead. Red paint is made with red ochre. Green paint is composed of indigo and yellow ochre, or chalk and copperas.

All work should be perfectly dry before being painted, for if damp or moist the paint will not adhere properly, but when dry will peel off, leaving the work to be destroyed by the action of the weather and climate.

Instead of being painted, doors, windows, and roof timbers are often varnished with wood oil. It is prepared for use by being boiled with a little white dammar (resin), which gives it a polish and causes it to dry quicker.

Girders and sleepers, also timbers of roofs much exposed, are usually tarred; the tar should be boiled before being applied.

For the preservation of woodwork at stations, doors, &c., in the interior should be brushed with oil, while on the exterior they should be painted green. In positions where they are likely to be soiled or exposed to rough usage, they should be tarred.





## CHAPTER XIV.

## Boring.

IN addition to its use in operations of well work, boring is of service in a variety of ways; for mining purposes, railway works, examination of ground for foundations, &c. Though boring practically requires skill and care, yet in principle it is extremely simple. The operation consists, as its name would imply, in working a hole, in this case made in the crust of the earth, of a diameter varying according to circumstances, and in a vortical direction generally. Many systems have been, and now are, practised in carrying on this kind of work. The ordinary plan is to attach the borer, which differs according to the nature of work to be done, to iron rods screwed together in lengths of from ten to twenty feet; a circular motion being given to the borer by the workmen above, assisted when required by a vortical jumping motion, causes the boring tool to work for itself a hole in the ground. For boring it is necessary to work upon a stage. The stage consists of a stout plank floor resting on strong putlocks. The flooring is well braced together by planks nailed transversely across the same. In the centre of this floor is a square hole, a little larger than the boring rods, which therefore can pass through it, but not large enough to allow a small hook apparatus, which, having the power of holding the rods suspended while they are screwed and unscrewed, will prevent their falling through the stage. Over the staging is placed a pair of shears or a triangle, to which is attached a windlass and ropes by which means the rods are suspended, lowered or raised. Under the boring stage, wooden trunks, strongly but temporarily screwed, are fixed as guides, for the boring tools, permanent pipes, &c. These trunks may be made square, and are fitted by sockets over into each other. Sometimes temporary iron pipes are used instead of these wooden trunks. Thus having, we will suppose, bored through the mottled clay, the sooner the pipes follow the better, as the sand underneath is liable to blow up into the bore-hole, or the clay itself, when not dense and stiff, may fall, and to a certain extent choke up the hole. The pipes used are either of cast or wrought iron,

the latter are generally used for small distances, and the former being thicker, for very deep work where much driving will be required. The pipes are joined together, sometimes by screws, rivets, or by solder. The boring rods are usually made of wrought iron, in lengths of from 10 to 20 feet; it is, however, convenient to employ them of only one length, and to number the rods, in order at any time to have an approximate guide to the depth of the boring. The head of the first rod is made with a hook by means of which it is suspended to the lever communicating the percussive motion; and below this hook it has an eye formed to receive a transverse bar, which, being turned by the workmen, communicates the rotary motion. The bottom of each rod has a socket tapped with a female screw, to receive the head of the succeeding rod, which is formed by a male screw fitting into the socket. Under the screwed head there is a swelling out of the rod, for the purpose of suspending it, during the operation of withdrawal, the projection rests upon the sides of the crow's foot, whilst the upper rod is being detached, and the crow's foot itself is supported by the stage upon which the men work; a small hook apparatus before referred to is the crow's foot now named.

In borings of small depth the rotary and percussive motions are produced by manual labour; when the depth becomes exceedingly great, horse power or the steam engine, has to be employed. The rotary motion is usually communicated by means of levers traversing the eye; and in tolerably yielding materials such as clay, sand, soft chalk, &c., no other motion is required to secure the descent of the boring tool; but in harder materials it is necessary to comminute the rock before the tool can make any progress. The simplest manner of effecting this object, consists in suspending the rods by a rope coiled two or three times round the barrel of a windlass, and adjusting the rope in such a manner that if a workman hold one end of the coil tight the friction will be sufficient to raise the rods on the windlass being set in motion. Should the end of the rope the workman holds now be slackened, the coil becomes loose and the rods descend with a force proportionate to their own weight, and the distance they have travelled through. A regular percussive motion is therefore gained by

keeping the windlass constantly in motion in one direction, the attending workman alternately allowing the rods to be drawn up a certain distance, and then by relaxing his hold, to fall. As the boring tool is in all these operations the acting part, its form varies, according to the resistance of the ground to be traversed; the first condition being, that it corresponds with the diameter of the bore. Each tool is shut upon a rod carrying a joint, the joint being usually a screw, with the female screw downwards. The boring tools may be divided into four classes, according to the object they are intended to effect: 1st, tools for cutting rocks by percussion; 2nd, tools for extracting soft or disintegrated materials; 3rd, tools for cleansing and enlarging or equalizing the bore-hole; 4th, tools for extracting any broken rods, or for accidental works, or for raising or lowering the tubes.

The tools for percussion consist of an infinite number of chisels. In hard rocks, a plain chisel with a diameter equal to the hole to be bored, and with a cutting edge is sufficient. Other modifications of the chisel, giving it a divided action are used for harder rocks. The twisted chisel is adopted for softer rocks.

Boring tools are usually made upon the same principle as wood augers; that is to say, they consist of a point which disintegrates the rock by its rotary motion; of a species of tongue, or of a clack, to support the loosened materials; and of the body of the auger which contains these materials, at the same time that it serves to enlarge the hole. It must be evident that these augers can only be used in soft ground, for they would not exercise any action upon hard rocks. Their forms differ according to the nature of the strata traversed, being open and cylindrical, for clayey or calcareous lands possessing a certain degree of cohesion. They are closed, and sometimes conical, in running sands; and in this case it is also necessary occasionally to use closed augers with clacks, or even a moveable bullet, to prevent the accumulated materials from falling back into the bore. The tools for the purpose of withdrawing any broken rods, consist of three principal descriptions: a species of hook, which is made to fit under the projecting parts of the rod; a screw tap, the mouth of which is larger than the end of the rod to be raised; and a spring clutch, so arranged



that the rod will allow the catches to descend, but in the upward motion they are pressed upon the rod by means of stool springs. Should these means fail, no resource is left but to thrust the rod aside, into the bore, and continue the work beyond it. A tool called a "scotch" is used for the purpose of allowing the rods to rest on the wooden stage, or for that of unscrewing the different lengths.

It must not be understood that the above description comprehends every tool used by borers. The nature of the ground to be operated upon varies so much in one locality from what it is in another, that every case requires to be treated, as it were, upon its own merits.





## APPENDIX.

The jambs in brickwork are the upright parts of an opening, either in brickwork or masonry. The reveals of a window are that portion of the opening described as a jamb in doorways.

The walls constructed to support the joists on ground floor, or basement floor, are called sleeper walls.

Sailing courses in brickwork are those courses that project beyond the face of the wall. The parts of brickwork or masonry, stopped short and left in a rough state for the purpose of the building being continued at some future time, are called toothings.

Concrete foundations are estimated by the cubic yard.

Grouting to granite and other paving by the superficial yard.

Concrete floors are taken by the superficial yard, giving thickness.

Clay and any description of gravel, &c., by the yard cube.

Both pan and plain tiling, plastering and whitewashing, &c., are measured by the square of 100 feet superficial.

About 52 bricks laid on edge will pave 1 superficial yard. 58 bricks laid flat 1 superficial yard. 15 tiles (10 inches) will pave 1 superficial yard. 10 tiles (12 inches) will pave 1 superficial yard. About 73 paving bricks on edge will pave 1 superficial yard. A paving brick is usually 9 inches long,  $4\frac{1}{2}$  inches in width and  $1\frac{1}{2}$  in thickness.

770 plain tiles 6 inches gango will cover 1 square.

663        „        7        „        „        1        „

578        „        8        „        „        1        „

182 pan tiles 10        „        „        1        „

152        „        12        „        „        1        „

Plain tiles are about  $10\frac{1}{4}$  inches in length,  $6\frac{1}{2}$  in width and  $\frac{1}{4}$ ths of an inch in thickness, and weigh about 2lbs. 6 ozs.

Pan tiles are each about  $13\frac{3}{4}$  inches in length,  $9\frac{1}{4}$  inches in width, and about  $\frac{1}{2}$  an inch in thickness, and weigh about 4lbs. 10 ozs. each.

A square of plain tiles contains about 765, and weighs about  $14\frac{1}{2}$  cwt.

A square of pan tiles contains about 180, and weighs  $7\frac{3}{4}$  cwt.

A corbel is a piece of stone used to support any weight above.

A pediment is the triangular cornice used in the decoration of windows.

The soffit is the under surface of any part of a building that is left open to the view.

Blocking course is usually a heavy piece of stone in good work, which gives stability to the cornice and brickwork under.

The distance from wall to wall is called the bearing; this term is applied in the case of timbers placed horizontally.

The terms binding rafters and purlins mean the same, and refer to that part of a roof forming a support to the rafters.

Timbers placed in walls are called bond timbers.

Clamping implies fixing a piece of wood to the end of a board.

Pieces of timber framed in a horizontal direction in a roof are called collars.

The different portions of a door are: bottom rail, middle rail, top rail, and the sides are called the styles, and the part on which the hinges are fixed is called the hanging style. The panels underneath the shutters of a window are called elbows; any boards thicker on one side than the other are termed feather-edged.

The upright portion of the wood-work in an opening in a wall is called the jamb, and the wood-work over the same is called the jamb linings.

The upright bar of a window is called the mullion.

Measures of capacity (Mudras) —

|            |                   |                |
|------------|-------------------|----------------|
| 8 ollucks  | 1 measure         | 100 c. inches. |
| 8 measures | 1 morcal          | 800 "          |
| 6 morcals  | 1 parck of chunam | 1,000 "        |



Land is measured by Gunter's chain, which is as follows:—

|             |                |            |              |
|-------------|----------------|------------|--------------|
| 7·92 inches | ..             | ...        | = 1 link.    |
| 12 inches,  | or 1·515 links | = 1 foot.  |              |
| 36 "        | or 4·545 "     | = 1 yard.  |              |
| 198 "       | or 35 "        | = 1 pole.  |              |
| 66 feet     | or 100 "       | = 1 chain. |              |
| 10 chains   | ...            | ...        | = 1 furlong. |
| 80 "        | ...            | ...        | = 1 mile.    |

|                              |                                    |
|------------------------------|------------------------------------|
| 1 Rupee's weight or one tola | = 180 grains.                      |
| 1 Pagoda                     | ... .. = $54\frac{11}{16}$ grains. |
| 1 Pollum                     | ... .. = 546 $\frac{1}{2}$ "       |
| 1 Vin                        | ... .. = 3lbs. — 2 oz.             |
| 1 Maud                       | ... .. = 25lbs.                    |
| 1 Chaudy                     | ... .. = 500lbs.                   |

*To find the area of a long irregular figure.*—Take any number of offsets, at equal distances along its length. Add all the offsets together; divide the sum by the number of offsets plus one, and multiply the quotient by the length.

#### DECIMAL EQUIVALENTS.

|                    |        |
|--------------------|--------|
| $\frac{1}{4}$ foot | = .25. |
| $\frac{1}{2}$ "    | = .5.  |
| $\frac{3}{4}$ "    | = .75. |

| Inches.   | Inches.     |
|-----------|-------------|
| 1 = .0833 | 7 = .5833.  |
| 2 = .1666 | 8 = .666.   |
| 3 = .25   | 9 = .75.    |
| 4 = .333  | 10 = .833.  |
| 5 = .4166 | 11 = .9166. |
| 6 = .5    | 12 = 1·000. |

## VELOCITY OF SOUND.

By various experiments it has been found that sound travels through the air uniformly at the rate of about 1142 feet per second, or a mile in 47 seconds, and therefore, by proportion, any distance may be found corresponding to any given time, namely—multiply the given time in seconds by 1142 for the corresponding distance in feet, or take 3.14ths of the given time for the distance in miles. *Ex. 1.* After observing a flash of lightning it was 12 seconds before I heard the thunder; required the distance of the cloud from whence it came. Here  $12 \times 3.14 = 36.14$ ths = 2 4.7th miles.



## TABLE.

GIVING DISTANCES FOR FIXING POSITIONS OF SLEEPERS, &amp;c.

FOR

DIFFERENT LEADS OF CROSSINGS.

Switches.

| PARTICULARS.                                  | LEADS OF CROSSINGS. |         |           |         |          |         |
|-----------------------------------------------|---------------------|---------|-----------|---------|----------|---------|
|                                               | 1 in 10             |         | 1 in 9    |         | 1 in 7½  |         |
|                                               | Feet.               | Inches. | Feet.     | Inches. | Feet.    | Inches. |
| From crossing point to end of curve           | 15                  | 2½      | 11        | 7       | 8        | 6       |
| From end of curve to intersection of tangents | 52                  | 0       | 46        | 5       | 37       | 6       |
| From crossing to point                        | 92                  | 5       | 84        | 6       | 69       | 9       |
| From beginning of switch, 1st set of rails    | 12 & 15             | 0       | 12 & 15   | 0       | 12 & 15  | 0       |
| From beginning of switch, 2nd set of rails    | 9-5½ & 5-2½         |         | 9-0 & 5-3 |         | 9        | 8½      |
| From beginning of switch, 3rd set of rails    | 18 & 20             | 0       | 18 & 20   | 0       | 18 & 20  | 0       |
| Distance between sleepers a to b              | 2                   | 8       | 2         | 8       | 2        | 8       |
| " b to c                                      | 2                   | 9       | 2         | 9       | 2        | 9       |
| " c to d                                      | 2                   | 9       | 2         | 9       | 2        | 9       |
| " d to e                                      | 2                   | 9       | 2         | 9       | 2        | 9       |
| " e to f                                      | 2                   | 0       | 2         | 0       | 2        | 0       |
| " f to g                                      | 2                   | 0       | 2         | 0       | 2        | 0       |
| " g to h                                      | 2                   | 0       | 2         | 0       | 2        | 0       |
| " h to i                                      | 2                   | 0       | 2         | 0       | 2        | 0       |
| Space between rails at k                      | 0                   | 2       | 0         | 2       | 0        | 2       |
| " l                                           | 0                   | 3       | 0         | 2½      | 0        | 3       |
| " m                                           | 0                   | 4½      | 0         | 5½      | 0        | 6       |
| " n                                           | 0                   | 6½      | 0         | 6       | 0        | 7½      |
| Chairs at o                                   | Sliding             |         | Sliding   |         | Sliding. |         |
| " p                                           | Double              |         | Double    |         | Double.  |         |
| " q                                           | Block               |         | Block     |         | Block.   |         |
| " r & s                                       | Common              |         | Common    |         | Common.  |         |
| " t                                           | Pots                |         | Pots      |         | Pots.    |         |

**TABLE.**  
**GIVING DISTANCES FOR FIXING PORTIONS OF SLEEPERS, &c.**

100

*DISTANCE OF PORTIONS OF CROSSINGS*

**Points and Crossings.**

| PARTICULARS                                      | LEADS OF CROSSINGS. |         |         |         |         |          |
|--------------------------------------------------|---------------------|---------|---------|---------|---------|----------|
|                                                  | 1 in 10             |         | 1 in 9  |         | 1 in 7½ |          |
|                                                  | Feet.               | Inches. | Feet.   | Inches. | Feet.   | Inches.  |
| Distance between sleepers u to v.                | 2                   | 10      | 3       | 2½      | 3       | 1        |
| "                    v to w                      | 2                   |         | 3       | 1       | 2       | 10½      |
| "                    w to x                      | 0                   | 0       | 0       | 1       | 1       | 10½      |
| "                    x to y                      | 0                   | 10      | 3       | 0       | 2       | 3½       |
| From nose to point                               | 1                   | 10      | 1       | 7½      | 1       | 0½<br>12 |
| Space between point and mouth of                 | 0                   | 1       | 0       | 1½      | 0       | 1½       |
| Space between nose and wing; and                 | 0                   | 3       | 0       | 2       | 0       | 2        |
| Different kind of chairs to be laid on sleepers. |                     |         |         |         |         |          |
| On sleepers u                                    | Common              |         | Common  |         | Common. |          |
| "          v                                     | B D & L             |         | B D & E |         | B D & E |          |
| "          w                                     | P C & F             |         | P C & F |         | P C & F |          |
| "          x                                     | B H & E             |         | B H & E |         | B H & E |          |
| "          y                                     | Common              |         | Common  |         | Common  |          |

FLUXES FOR SOLDERING AND WELDING.

Iron or Steel — Borax or Sal Ammoniac.

Tinned Iron — Resin or Chloride of Zinc.

Copper and Brass — Sal Ammoniac or Chloride of Zinc.

Zinc — Chloride of Zinc.

Lead — Tallow or Resin.

Lead and Tin pipes — Resin and Sweet oil.

PROPORTION OF STEPS IN STAIRCASES.

The rise should not be more than 7 inches nor less than  $5\frac{1}{2}$  inches. The tread should not be more than 12 inches nor less than 9 inches. A good proportion is Rise in inches =  $\frac{no}{Tread\ in\ inches.}$

SAIL WORKING LOAD FOR HEMP ROPE'S, &c.

| Circumference of Rope. | LOAD. |       |      | Diameter in inches of Chain. | LOAD. |       |      |
|------------------------|-------|-------|------|------------------------------|-------|-------|------|
|                        | Tons. | Cwts. | Qrs. |                              | Tons. | Cwts. | Qrs. |
| Inches 1               | 0     | 1     | 3    | $\frac{1}{8}$                | 1     |       |      |
| " 1 $\frac{1}{4}$      | 0     | 2     | 3    | $\frac{1}{4}$                | 1.7   |       |      |
| " 1 $\frac{1}{2}$      | 0     | 4     | 0    | $\frac{3}{8}$                | 2.2   |       |      |
| " 2                    | 0     | 7     | 0    | 9-10                         | 2.8   |       |      |
| " 2 $\frac{1}{4}$      | 0     | 9     | 0    | 11-12                        | 3.3   |       |      |
| " 2 $\frac{1}{2}$      | 0     | 11    | 0    | $\frac{1}{2}$                | 4     |       |      |
| " 3                    | 0     | 13    | 0    | 13-14                        | 4.6   |       |      |
| " 3 $\frac{1}{4}$      | 0     | 16    | 0    | $\frac{5}{8}$                | 5.5   |       |      |
| " 3 $\frac{1}{2}$      | 0     | 18    | 13   | 15-16                        | 6.2   |       |      |
| " 4                    | 1     | 1     | 0    | 1 inch.                      | 7     |       |      |
| " 4 $\frac{1}{4}$      | 1     | 5     | 0    | 1, 1-16                      | 8     |       |      |
| " 4 $\frac{1}{2}$      | 1     | 8     | 2    | $\frac{1}{2}$                | 9     |       |      |
| " 5                    | 1     | 12    | 1    | 1, 3-16                      | 10    |       |      |
| " 5 $\frac{1}{4}$      | 1     | 16    | 0    | $\frac{3}{4}$                | 11    |       |      |
| " 5 $\frac{1}{2}$      | 2     | 1     | 2    | 1, 5-16                      | 12    |       |      |
| " 6                    | 2     | 9     | 1    | 1, 3-8                       | 13.5  |       |      |
| " 6 $\frac{1}{4}$      | 3     | 1     | 0    |                              |       |       |      |
| " 6 $\frac{1}{2}$      | 3     | 15    | 2    |                              |       |       |      |

SIGNS OF THE WEATHER.

A few of the more marked signs of weather are the following : Whether clear or cloudy, a rosy sky at sunset presages fine weather. A red sky in the morning bad weather, or much wind (perhaps rain), a gray sky in the morning fine weather ; soft looking or do-



light clouds foretell fine weather, with moderate or fine breezes; hard edged oily looking clouds, wind. A dark gloomy sky is windy, but a light bright-blue sky indicates fine weather. A bright yellow sky at sunset presages wind, and a pale yellow wet. Dew is an indication of fine weather, and so is fog.

The following building data will serve as a guide in preparing similar statements, but no one is recommended to pin his faith too closely to the details, but rather to observe carefully for himself. As prices must necessarily vary in every district, they are only given in the first two items, to make the form complete.

#### BUILDING DATA.

| Quality.                      | Workmen and materials.    | Rate. | For | Price. |
|-------------------------------|---------------------------|-------|-----|--------|
| <i>Excavating Foundation.</i> |                           |       |     |        |
|                               |                           | Ra.   | A.  | P.     |
| 2                             | Men Coolies ... ..        | 0     | 2   | 0      |
| 1½                            | Women ... ..              | 0     | 1   | 0      |
|                               | Sundries ... ..           | 0     | 0   | 0      |
|                               | For 150 cubic feet ... .. | 0     | 0   | 3      |
|                               | For 1 cubic foot ... ..   | 0     | 0   | 1      |
| <i>Brick Work in Chuanam.</i> |                           |       |     |        |
| 1,000                         | Bricks including Car.     | 2     | 4   | 0      |
|                               | Flugs.                    | 0     | 5   | 0      |
| 7                             | Parahs Chuanam ... ..     | 0     | 1   | 0      |
| 10½                           | Parahs Sand ... ..        | 0     | 6   | 0      |
| 2½                            | Bricklayers ... ..        | 0     | 2   | 0      |
| 1½                            | Men Coolies ... ..        | 0     | 1   | 0      |
| 0                             | Women ... ..              | 0     | 2   | 0      |
| 2½                            | Carts of water ... ..     | 0     | 0   | 0      |
|                               | Sundries ... ..           | 0     | 0   | 0      |
|                               | For 60 cubic feet ... ..  | 7     | 0   | 0      |
|                               | For 1 cubic foot ... ..   | 1     | 0   | 0      |

#### BRICKWORK IN CHUANAM, 60 CUBIC FEET.

1,000 Walls bricks.      2½ Bricklayers.  
 7 Parahs of chuanam.      5 Women.  
 1½ Parahs of sand.      1 Man.  
 2 Boys.



### FLAT ARCH WORK IN CHUNAM, 30 CUBIC FEET,

|                     |                |
|---------------------|----------------|
| 600 Wall bricks.    | 4 Bricklayers. |
| 5 Parahs chunam.    | 1 Man.         |
| 7½ „ sand.          | 6 Women.       |
| 1½ Cart-load water. |                |
| Contingencies.      |                |

### CIRCULAR ARCH WORK IN CHUNAM, 80 CUBIC FEET.

|                        |                 |
|------------------------|-----------------|
| 610 Wall bricks.       | 4½ Bricklayers. |
| 5 Parahs chunam.       | 1½ Man.         |
| 7½ „ sand.             | 8 Women.        |
| 2 Carts load of water. |                 |
| Sundries.              |                 |

### PLASTERING WITH ONE COAT OF CHUNAM, 1 SQUARE.

|                  |                  |
|------------------|------------------|
| 4 Parahs chunam. | ½ Man cooloy.    |
| 3 „ sand.        | 8 Women.         |
| 1½ Bricklayers.  | 1 Cart of water. |

### PLASTERING WITH TWO COATS, 1 SQUARE.

|                  |                   |
|------------------|-------------------|
| 5 Parahs chunam. | ¾ Man.            |
| 4½ „ sand.       | 5 Women.          |
| 3½ Bricklayers.  | 1½ Cart of water. |

### PLASTERING WITH THREE COATS, 1 SQUARE.

|                  |                   |
|------------------|-------------------|
| 6 Parahs chunam. | 1 Man.            |
| 5 „ sand.        | 7 Women.          |
| 5 Bricklayers.   | 2 Carts of water. |

### WHITEWASHING 10 SQUARES, 1 COAT.

|                       |          |
|-----------------------|----------|
| ¾ Parah of chunam     | ½ Man.   |
| 1½ Bricklayers.       | 2 Women. |
| 1 Cart load of water. |          |

### WHITEWASHING 10 SQUARES; 2 COATS.

|                    |           |
|--------------------|-----------|
| 1 Parah of chunam. | 1 Man.    |
| 2 Bricklayers.     | 3½ Women. |
| 3 Carts of water.  |           |

### PAVING WITH BRICK ON EDGE IN CHUNAM, 1 SQUARE.

|                    |                 |
|--------------------|-----------------|
| 700 Wall bricks    | 2½ Bricklayers. |
| 5 Parahs chunam.   | ½ Man.          |
| 7½ „ sand.         | 5 Women.        |
| 2½ Carts of water. |                 |

## LIST OF GANG TOOLS.

| Name and Description          | No. | Name and Description.                         | No. |
|-------------------------------|-----|-----------------------------------------------|-----|
| Angers, 5-8th inch ... ..     | 1   | Hook, Hedge ... ..                            | 1   |
| " 4 " ... ..                  | 1   | Spirit Lamp ... ..                            | 1   |
| " 1 1/2 " ... ..              | 1   | Spirit Level ... ..                           | 1   |
| Adzes ... ..                  | 1   | Mallet ... ..                                 | 1   |
| Beaters, Iron ... ..          | 2   | Pickaxe ... ..                                | 2   |
| Boards, Slight ... ..         | 1   | Padlock, with Key ... ..                      | 2   |
| Books, Rule ... ..            | 1   | Track Rule ... ..                             | 1   |
| Bill Hooks ... ..             | 2   | Lamp Screen ... ..                            | 1   |
| Chisels, Cold ... ..          | 2   | Schute ... ..                                 | 2   |
| Chisel, Carpenter's ... ..    | 1   | Shovel ... ..                                 | 8   |
| Crowbars, Flatblades ... ..   | 2   | Spinner ... ..                                | 6   |
| Files ... ..                  | 1   | Square, Wooden ... ..                         | 1   |
| Feeders, Oil Line ... ..      | 1   | Strait-bit Edge ... ..                        | 1   |
| Flags, Red ... ..             | 2   | Wrenches, Monkey ... ..                       | 1   |
| Fog Signals ... ..            | 6   | Tin Can ... ..                                | 1   |
| Gauges, Iron or Wooden ... .. | 1   | Ink Bottle ... ..                             | 1   |
| Key Hammers ... ..            | 2   | Leather Pouches, with belts and plates ... .. | 1   |
| Sledge ... ..                 | 1   | Road examine boards ... ..                    | 1   |
| Hand Hammers ... ..           | 1   | Clags, Green ... ..                           | 2   |



**TABLE**  
**OF OFFSETS FOR RAILWAY CURVES.**

OFFSETS AT THE END OF THE FIRST CHAIN FROM TANGENT POINT OF RAIL-  
WAY CURVES.

| Radius of<br>curve in<br>chains. | Offsets in inches and<br>decimals. | Radius of<br>curve in<br>chains. | Offsets in inches and<br>decimals. |
|----------------------------------|------------------------------------|----------------------------------|------------------------------------|
| 5                                | 70.2000                            | 155                              | 2.5548                             |
| 10                               | 30.6000                            | 160                              | 2.4750                             |
| 15                               | 26.4000                            | 165                              | 2.4000                             |
| 20                               | 19.8000                            | 170                              | 2.3204                             |
| 25                               | 15.8100                            | 175                              | 2.2628                             |
| 30                               | 13.2000                            | 180                              | 2.2000                             |
| 35                               | 11.3142                            | 185                              | 2.1405                             |
| 40                               | 9.9000                             | 190                              | 2.0842                             |
| 45                               | 8.8000                             | 195                              | 2.0307                             |
| 50                               | 7.9200                             | 200                              | 1.9800                             |
| 55                               | 7.2000                             | 210                              | 1.8857                             |
| 60                               | 6.6000                             | 220                              | 1.8000                             |
| 65                               | 6.0923                             | 230                              | 1.7217                             |
| 70                               | 5.6571                             | 240                              | 1.6500                             |
| 75                               | 5.2800                             | 250                              | 1.5840                             |
| 80                               | 4.9500                             | 260                              | 1.5231                             |
| 85                               | 4.6588                             | 270                              | 1.4667                             |
| 90                               | 4.4000                             | 280                              | 1.4143                             |
| 95                               | 4.1684                             | 290                              | 1.3655                             |
| 100                              | 3.9600                             | 300                              | 1.3200                             |
| 105                              | 3.7714                             | 310                              | 1.2774                             |
| 110                              | 3.6000                             | 320                              | 1.2375                             |
| 115                              | 3.4435                             | 330                              | 1.2000                             |
| 120                              | 3.3000                             | 340                              | 1.1647                             |
| 125                              | 3.1680                             | 350                              | 1.1314                             |
| 130                              | 3.0461                             | 360                              | 1.1000                             |
| 135                              | 2.9333                             | 370                              | 1.0708                             |
| 140                              | 2.8285                             | 380                              | 1.0421                             |
| 145                              | 2.7310                             | 390                              | 1.0154                             |
| 150                              | 2.6400                             | 400                              | .9900                              |

TABLE

SHOWING HEIGHTS WHICH THE OUTER RAIL OF A CURVE SHOULD BE RAISED.

| Radius of the Curve. |          |     |    |  | Broad Gauge.                             |         |         |
|----------------------|----------|-----|----|--|------------------------------------------|---------|---------|
|                      |          |     |    |  | Velocity of the train in miles per hour. |         |         |
|                      |          |     |    |  | 15.                                      | 30.     | 60.     |
|                      |          |     |    |  | Inches.                                  | Inches. | Inches. |
| 5 Chains             | 330 feet | ... | .. |  | ...                                      | ...     | ...     |
| 10 "                 | 660 "    | ... | .. |  | 1' 13                                    | 5' 71   | ...     |
| 15 "                 | 990 "    | ... | .. |  | ' 80                                     | 3' 23   | 12' 86  |
| 20 "                 | 1320 "   | ... | .. |  | ' 49                                     | 1' 07   | 7' 88   |
| 25 "                 | 1650 "   | ... | .. |  | ' 31                                     | 1' 23   | 4' 00   |
| 30 "                 | 1980 "   | ... | .. |  | ' 18                                     | ' 73    | 2' 92   |
| 35 "                 | 2310 "   | ... | .. |  | ' 09                                     | ' 37    | 1' 40   |
| 40 "                 | 2640 "   | ... | .. |  | ' 03                                     | ' 11    | ' 44    |

TABLE

SHOWING THE CHARGES OF POWDER TO BE USED FOR LINES OF LEAST RESISTANCE

| Line of Least Resistance. |         | Charge of Powder. |      | Line of Least Resistance. |         | Charge of Powder. |      |
|---------------------------|---------|-------------------|------|---------------------------|---------|-------------------|------|
| Feet.                     | Inches. | lbs.              | ozs. | Feet.                     | Inches. | lbs.              | ozs. |
| 1                         | 0       | 0                 | 0    | 4                         | 0       | 2                 | 0    |
| 1                         | 6       | 0                 | 1    | 4                         | 6       | 2                 | 13   |
| 2                         | 0       | 0                 | 4    | 5                         | 0       | 3                 | 14   |
| 2                         | 6       | 0                 | 7    | 6                         | 0       | 6                 | 12   |
| 3                         | 0       | 0                 | 10   | 7                         | 0       | 10                | 11   |
| 3                         | 6       | 1                 | 5    | 8                         | 0       | 16                | 0    |



The following Table will give the means of calculating the space occupied by any given quantity of powder, in round holes of different sizes from 1 to 3 inches,

| Diameter of the Hole. | Powder in one inch of Hole. | Powder in one foot of Hole. | Depth of Hole to contain one pound of Powder. |
|-----------------------|-----------------------------|-----------------------------|-----------------------------------------------|
| Inches.               | lbs.      ozs.              | lbs.      ozs.              | Inches.                                       |
| 1                     | 0      0.410                | 0      5.028                | 38.197                                        |
| 1½                    | 0      0.942                | 0      11.304               | 16.976                                        |
| 2                     | 0      1.676                | 1      4.112                | 9.549                                         |
| 2½                    | 0      2.618                | 1      15.416               | 6.112                                         |
| 3                     | 0      3.770                | 2      13.240               | 4.244                                         |

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1846

STEAM-TRAMWAYS

FOR

INDIA.

AN INTRODUCTORY PAMPHLET

BY

CLAUDE VINCENT, AMICE,

ENGINEER IN CHARGE

OF THE IRRIGATION BRANCH.

Published under Official Sanction.

MADRAS:

HIGGINBOTHAM AND CO.

By Appointment to Her Majesty the Queen of England, and to the Madras University.

1881.

Price eight annas.

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STEAM-TRAMWAYS FOR INDIA.

CHAPTER I.

INTRODUCTION.

THE great famine in Bombay and Madras of 1876 to 1878 took every one somewhat by surprise and attracted very serious and very general attention. The loss of life was so great that pity opened widely the purse-strings of private benevolence; and the cost to the State was so enormous, that politicians eagerly inquired whether it might not have been materially diminished by the exercise of a little previous foresight. It was felt that the frequent repetition of such expenditure—and there is no particular reason why it should not have to be repeated somewhere at any moment—would precipitate the prophesied ultimate collapse of the Indian finances. So suggestions were freely offered as to the causes of famines, the proper way of meeting them, and their possible prevention in the future. An influential Royal Commission was also appointed who have issued a most exhaustive report on all the bearings of the question.

Speaking generally, remedial measures that have been proposed are divided into two classes: (1)

Measures that contemplate the extensive creation of irrigation works ; (2) Measures that contemplate a considerable development of the system of inland communication.

Advocates of the first system have a good deal of solid argument on their side, for they say, and very justly, that irrigation works confer permanent benefit on the country, and enable the individual cultivator to lay up a store of food against a dry day ; whereas improved communications confer but little real benefit to the individual, and seldom pay a reasonable interest on the outlay upon them. Unfortunately, irrigation works fail most conspicuously when their assistance is needed most urgently. In a dry year, and still more in a succession of dry years, even the largest irrigation systems produce a reduced supply, and, moreover, the area protected by them can, at the best, bear but a ridiculously small proportion to the total area affected by an extensive famine. Only great rivers have any supply in dry years—small rivers, and of course all tanks, being perfectly innocent of water at such times—and the great rivers of India are limited in number. Moreover, even though food-grain may be stored in favoured regions in good years, and though it may be also produced in excess of the local demand in bad years, yet it is quite one thing to have the grain at the place of production, and quite another to get it, in the middle of a crisis, to outlying famine-stricken localities. A recommendation of some members of the Famine Commission is that large store-houses should be built for grain in important centres, so that a reserve may exist in times of scarcity. But it is unlikely that this idea will be carried into execution for it presents difficulties that need not be discussed here, and, in any case, the reserve would not constitute a sufficient supply dur-

ing the recurrence of a period such as that of 1876-78.

Any one who had practical experience of famine-work during that time will know that one of the chief difficulties arose, not from the scarcity of grain, but from the impossibility of sending it forward with sufficient rapidity or in sufficient quantity from the ports, or stations of delivery, to the interior of the country. The block at the Madras port, or at Raichoor Railway Station where Bombay territory ends and that of Madras begins, in 1877, must have been seen to be believed. The grain was there and in abundance; it came from Burmah, from Calcutta, from the Central Provinces, from the Punjab, but it lay there for days owing to the hopeless block on the lines of rail. Merchants up-country had plenty of demand for grain, but they could only obtain it with great difficulty and at enormous expense, so the price when it reached the consumer was raised very much beyond what it would have been, had the ready demand met with an equally ready supply. And the lines of price and the lines of mortality rise and fall with unerring synchronism in famine tables. Neither when the grain reached the up-country railway station were the difficulties ended. Bullocks had died in thousands, and the means of transport were thus rendered scanty,* so that it may be said that people died of hunger with the food at their very doors. The remedy for this state of things, say the advocates of the second of the abovementioned systems, lies in the development of

*In time of drought and famine the substitution of mechanical for animal power for purposes of transport is another very important advantage which it is not possible to reckon by any money standard. (Chapter V, Section 4, para. 8 of Part II of Famine Commission Report.)

The cost of transport by cart is estimated at five times that by rail in ordinary times, but it will increase to ten times as much during famine. (para. 4 of same.)

internal communication. The battle between the two systems has been hotly contested enough, but victory may be said to rest finally now with the latter, the expenditure on large irrigation works having been strictly limited by the Secretary of State, while the railways of the country are about to be largely developed. For example, in the current year, out of the £2,500,000 to which the total yearly expenditure on Productive Public Works is now limited, £1,780,000 are to be spent on railways and only £758,000 on Irrigation Works. Moreover, it is believed that by far the larger share of the £750,000 which are to be yearly devoted to Protective Works will also go to the further development of internal communications.

Great encouragement has also been held out to private capitalists to embark in Indian ventures, which are understood to mean principally, railways. Para. 179 of Part I of the Report of the Famine Commission runs:—

“The future power of the country to resist”
 “the pressure that arises from drought is so”
 “immediately dependant on the improvement of the”
 “means of internal communication, that it is, in our”
 “opinion, impossible to exaggerate the importance”
 “of striving to accomplish this in every practicable”
 “way.”

The railway-system of India is fairly complete so far as the great trunk-lines are concerned, but this is about all that can be said. The real function of railways is to bring about the closest possible alliance between the producer and the consumer, and this can never really be attained until all the principal tracts of country are within easy reach of a line of rail. There are still many important pro-

ducing centres in India, which are situated miles and miles from any ready means of communication with the outer world; and the food-produce, which is there in excess, does not really benefit the consumer, the expense of carriage making any reduction in price to him impossible.

Remedy this state of affairs, it is said; run light and inexpensive lines of rail from the trunk-lines into these districts, their surplus produce will then be rendered available, one of the great famine difficulties will be solved, and the resulting development of trade will increase incalculably the wealth of the country in ordinary years. But the fatal objection is at once raised. "Where is the money to come from?" The Government of India have not got it at their disposal; private enterprise will not step in unless a substantial guarantee is promised; and Government have almost renounced the principle of guarantees. Why? Because it has been shown by experience that but few of the trunk-lines will ever work up to their guarantee, and that it is quite certain that feeder lines, as they are called, will never do better, if so well, as the trunk-lines. It is scarcely probable that even a light line of railway in India will ever be constructed for much less than from £6,000 to £7,000 a mile; and, at this rate, and with the expenses of working and management as high as they must necessarily be, it is impossible, on any reasonable estimate of traffic, to show any satisfactory percentage on the expenditure. India is a poor country; so much is at last happily acknowledged; and the inhabitants of India have their travelling idiosyncracies, which ought to be recognised, but often are not. So that in the first place travelling, for people as well as for goods, must be cheap, and in the second place its methods must coincide with the wishes of the people.

Nothing makes travelling so popular as making it easy. A man living 10 miles from a railway remains contentedly at home. Bring the railway to his door and he will think that a journey is the one thing he has always needed to complete his happiness. So also with goods. A producer has a surplus stock, but carriage being difficult, he sells it to the nearest middleman at the local rate. The latter, who does things largely, sends it off to a trade-centre and makes a handsome profit. Improve the means of carriage, the producer then sends his stock direct to the trade-centre, and he benefits, even though prices there fall to the advantage of the consumer.

We thus come to this—that improved communications, or, let me say once for all, railway feeders, are highly desirable, but that even light lines of rail are, in most cases, too expensive to be practicable. Is there any alternative? I think there is, and that it is to be found in steam-tramways. The reasons for this opinion will be indicated in the next chapter.

CHAPTER II.

HISTORICAL AND DESCRIPTIVE.

TRAMWAYS generally are of quite modern origin, and steam-tramways in particular may be said to be still in the earliest stage of development.

To America belongs the credit of being the pioneer of this new mode of locomotion. They were adopted there long before they became popularised in Europe, and in large American cities tramways have now replaced almost all other means of conveyance. For instance, in some streets of New-York there are four lines of rail, along each of which cars pass at intervals of two minutes. But in England, vested interests and the dislike to novelties long prevented the introduction of the system, and it was not till 1860 that the first tramway was established at Birkenhead. It was not till 1869 that the vestries of the suburban parishes of London were forced, by the pressure of public opinion, to grant concessions to Tramway Companies, and even now their operations are confined to the suburbs, no tramway running into the heart of London. In Paris the first important tramway was not established till 1875, but a start having been once made the after-growth has been very rapid. This indeed is true generally. At first the public were suspicious, and Municipalities and Corporations imposed hopeless conditions on would-be concessionaires. But the system was too good not to be successful. A few examples sufficed to show that a method of quick, pleasant, and cheap travelling had been secured,

and one town after another became so eager to obtain these advantages for itself, that now there is scarcely a place of importance that has not got its tramways completed, in progress, or projected.

Horses were at first solely used for traction on tramways, but their prime cost is so great, and their employment involves such difficulties of upkeep and management, that numerous attempts have been made to replace them by some method of steam traction. These attempts have not been very successful hitherto, as the use of steam-power on public roads is subject to such stringent regulations, that it has not been found possible to comply with their conditions. The smoke, the noise of the engines, and the difficulty of controlling them, are all exaggerated, and are supposed to present so many annoyances to the general road-traffic, that a form of locomotive power which will successfully meet all these objections has hitherto been considered a *sine qua non*. Compressed air engines have been tried on numerous occasions, but with only a moderate measure of success, and there can be little doubt that eventually public opinion will change, the objectors will have to yield to the force of example, and that steam will triumph.

As a matter of fact, the anticipated dangers resulting from the use of steam are purely chimerical. Steam-cars are in use now in many cities of Europe and America, and not the slightest difficulty or danger is found to result from their employment. Any Anglo-Indian may verify the truth of this assertion for himself without much trouble. He probably knows Turin. The next time that he halts there on his way to or from England, he may see steam tram-cars running up the Via di Po, the principal street in the town, and into the Piazza

di Castello. In this case scarcely any precautions are used to lessen the noise or the smoke of the locomotive. The train of passenger-cars is drawn by a separate locomotive, which would certainly look a strange object to a horse the first time he saw it, but which, in Turin, all horses now pass with the utmost indifference. Horses in towns but rarely shy at objects; so many things are strange that they merge all into a general indifference. Noises they do mind, but the noise made by a steam-tramway going at a slow speed is almost inaudible.

So far reference has been made only to tramways in towns, but with the example of steam traction engines before them, and with the principle of steam-tramways admittedly successful, it was evident that the pioneers of the new enterprise would soon turn their attention to the possibility of successfully serving country districts. It was the logical sequence of suburban tramways—first to bring the outlying portions of a city into easy communication with its centre, and then to bring the means of locomotion to the environs and outlying villages. They were obvious difficulties in this extension, for tramways to be successful must be cheaply constructed, *i.e.*, they must be able to utilise the existing roads, which, in turn, involves the absence of any steep gradients on the latter. Also, being at first designed solely for passenger traffic, it was necessary that the flow of passengers should be fairly continuous and their numbers constant.

The first country tramways that have been introduced into Europe on a large scale are accordingly in a country where all these conditions are fulfilled,—the north of Italy.

The plain of Lombardy, with Milan as its centre,

formed the place of all others for such an experiment. The country for miles around Milan is almost perfectly level; the roads are numerous and good; there are many surrounding villages all filled with a large and busy population; and lastly, and this is a point of no small importance, the country is very little intersected by railways. The first Milanese tramway was only laid down, to the best of my knowledge, about 4 or 5 years ago, but, at the present moment, there are 200 miles of rail branching out from Milan on every side along fifteen of the principal roads, and running in some cases as far as 30 miles into the country. Steam-tramways exist of course in considerable numbers in other countries, especially in America, Germany, and France, but they have nowhere reached as yet the same stage of development as in Lombardy. I recently had a very advantageous opportunity of studying the working of the Italian system. I made Milan my head-quarters for several days while I was making an official inspection of the important Irrigation works in the neighbourhood, and every day I went to the head-works, or to some point of interest on the various canals, by means of one or other of these lines of tramway. I also had what may perhaps be called exceptional advantages for studying the details of the working of one of the Companies; and, as any system of steam-tramways in India would certainly be based to a considerable extent on the results of these Milanese lines, I will proceed to indicate some of their more important features.

The line that I will take as typical was opened in June 1878, has a length of 18.64* miles, and runs along a fine straight road about 20 feet broad with a slight and steady ascent out of Milan. There is only one dif-

*It has in addition a branch of 0.3 miles opened last year.

fault point in the whole line, where the road ascends sharply over an arched bridge across a navigation canal. The use of the portion of the road required by the tramway was granted gratis by the Provincial authorities to whom the road belongs. In some other cases however an indemnity has been claimed by the proprietors of the road. The Company is only obliged to keep in order that portion of the road which is occupied by the tram, and as the gauge is 4', 8" $\frac{1}{2}$, which is the same as that of the Government railroads, about 7 feet is about the width for which the Company is responsible, allowing a small margin outside the rails on each side.

Government sanction has nominally to be obtained before a tramway concession can be taken up, and Government surveillance is exercised when the line is working, but neither of these points are very strictly enforced up to the present. The Italian Government has shown itself to be very unselfish and very discriminating in the matter. Unselfish, because as proprietor of the railroads, the tramways enter into direct and, I may add, successful competition with it; and discriminating, because it has recognised the importance of securing to the province the utmost possible development of the system, and has therefore declined to strangle its birth by any vexatious regulations or stringent control. As a matter of fact, the rails of some of the new trams have been laid down before the sanction of Government to the concession has even been asked for, and the Bye-Laws framed by the Companies are not interfered with, except so far as to see that the public safety is duly considered. This latter point is secured principally by limiting the maximum speed of the steam-trams to 11 miles an hour. This point brings out well the perfunctory nature of the Government control, as, on every line, the trains run to a speed

of certainly 15 miles an hour and probably more. In fact their printed time-tables are boldly based on a higher rate of speed than is allowed by regulation. It is known however that it is the intention of Government, as soon as the trams are as fully developed as is reasonably required by the needs of the province, to bring in a law strictly defining the right of tramways, which will be rigidly enforced. The Companies at present are therefore only in the state of "making hay while the sun shines."

As a matter of convenience the Company does the repairs to the whole breadth of the road, receiving an annual subsidy from the Provincial authorities for the up-keep of their portion of it.

The capital of the Company to which I am more particularly referring, consists of £40,000 worth of fully paid up shares, and of £10,000 worth of debentures. There are 4,000 shares of £10 each, and the market value of each is now £16, which sufficiently indicates the prosperity of the Company. A large amount of foreign capital is invested in the Milanese lines.

The cost of the main line was about £2,300 per mile including rolling stock and all incidental expenses, divided as follows :—

<i>Preliminary Expenses.</i>					£	£
Inauguration	..	..	...	...	219	} 1,740
Indemnity to Concessionaires	...	...	...	...	880	
Sundries	...	...	...	...	641	
<i>Buildings, &c.</i>						
Station at Milan	...	..	...	...	5,517	} 7,886
Terminal Station	...	..	...	...	616	
Other buildings	...	...	...	...	60	
Legal expenses	...	...	...	...	1,693	
Permanent way	...	...	...	...		21,121
Carriages and Trucks	...	...	...	...		5,901
Locomotives	...	...	...	...		5,897
Office Expenses	...	..	...	...		282
Tools, &c.	...	...	...	...		266
Sundries	...	...	...	...		208
					Total...	<u>£48,801</u>

The buildings at Milan comprise workshops for the repair of the rolling-stock, and sheds in which it can be housed; also a small station, but regular station-buildings are not required, tickets being taken *en route*. At the other end there is a housing shed; but at other places, the train simply draws up in the principal street of the village, opposite the "Alborgo di Tramway," which suffices as a rallying point for passengers.

The permanent way is supposed to be laid down flush with the road, and is so through towns and villages, but in the country there is a drop of nearly an inch between the rails, from the top of the rail to the roadway, which makes it very unpleasant, if not impossible, to utilize the between-rail portion for ordinary traffic. No doubt the Companies have made their permanent way like this intentionally,

so as to keep road-traffic off their lines and so to save wear and tear, but when the Government Regulations are framed, this omission will have to be rectified. The rails are of Vignoles section, made of Bessemer steel weighing 36·28lbs. per yard, clamped on to cross-sleepers of wood. In towns and villages there is a longitudinal sleeper above the cross-sleeper, and the rail is then clamped on to that, a guard rail being also employed. There is also a guard rail round all curves, the minimum radius of which is 131 ft. The steel rails cost £9 16s. a ton. The cost of up-keep of the permanent way varies from £16 to £19½ per mile per annum, but the details of receipts and expenditure during one year will be shown in a copy of the balance-sheet later on. The line is only single—there is no double line of steam-tram yet established anywhere in Italy—but there are shunting stations at the principal villages, where trains can pass each other.

There are three classes of passenger carriages, besides goods-trucks and goods-vans. The passenger carriages are divided into ;

1st class, which weigh 51·18 cwt., are 19·7 ft. long, 8·86 ft. high, and carry 16 inside passengers, besides from 12 to 16 passengers on the platforms at each end ;

2nd class, which weigh 49 cwt. are of about the same dimensions as the 1st class, and carry 22 inside passengers and about the same number of platform passengers ;

open-side carriages for summer use, which weigh 43 cwt. are 22·3 ft. long, and carry 32 seated passengers.

The carriages cost on an average £200 each, and there are altogether 40 at work on the line at

the present moment, some having been purchased since the Company was first started, on the construction of the branch line abovementioned. One or two American carriages were imported and were much liked, but the Belgian make is well spoken of, and Grondona of Milan also turns out good ones.

There are altogether 8 luggage trucks and vans on the line, but the goods-traffic is small at present, consisting chiefly of milk and garden produce for the markets of Milan.

The locomotives are mostly of Swiss or German manufacture coming from Zurich or Cassel. They have very much the appearance of a high box on wheels, being covered in as much as possible so as not to frighten horses. They are of the ordinary direct-acting outside-cylinder type, weigh from 6 to 10 tons, develop from 20 to 30 H. P., and work at a nominal maximum pressure of 118 lbs. on the square inch. As a matter of fact this is exceeded, and I saw several working up to 10 atmospheres, or 147 lbs. on the square inch. They cost from £640 to £800 each, and there are 12 now at work on the line. They all burn coke, patent-fuel being said to give out too much smoke. Coke costs about 36s. a ton at Milan.

The total number of miles run in 1880 was 128,889, and the total cost of running was £4,283, or nearly 7·9*d.* per train-mile, which includes the lighting of carriages, wages of servants, &c.

As regards the locomotives alone, the average consumption of fuel in each for each mile run, is 10 lbs. of coke, 1·1 lb. of wood, and ·18 lbs. of oil. The fares are 1·13*d.* per mile 1st class, and ·64*d.* per mile 2nd class. The goods rates are fixed so as to be between the express and slow-train rates on the neighbouring lines of rail. There are 6 trains each way every day, extra trains being run on Sun-

days and holidays. There are 7 stopping stations between Milan and the Terminus, and, at intervals between these stopping stations, poles are placed, at which people who wish to be taken up may take their stand. The tram will stop for them there, but not at other places, as it is well known that frequent stoppages cause a great loss of power, equal, it is estimated, to half a mile of running for each stoppage. These intermediate stopping-places appear, however, to be very rarely used. The engines can stop the trains dead in about 25 yards.

The trains consist of the locomotive, which has an engine-driver and a boy to look after it, and generally of one 1st class, one 2nd class, and one open carriage, with perhaps a goods-van. One conductor and one check-taker look after these. There are in all 38 subordinate employes on the line. The ticket-system is as follows; all tickets are given in the cars, the conductor being provided with two rolls of narrow paper which are marked off into divisions, each representing $2\frac{1}{4}d.$ for the 1st class, and $1\frac{1}{4}d.$ for the 2nd class. All fares are in multiples of these, and he gives each passenger the number of divisions his fare represents. The check-taker follows the conductor, and to him each passenger gives his slips which he tears in half and throws away. At the end of each trip, the number of divisions issued by the conductor is counted by the cashier, and he hands over the equivalent sum. Season tickets are given, but there were no return tickets on the line in question till September last. The above system is said to answer well and there is but little fraud. I may mention, by the way, that the most successful means of checking fraud yet discovered is on the Bombay horse tramways, that are the property, I believe, of an American firm. There is a monthly drawing of prizes, in which each ticket taken has a

chance of several very handsome sums of money, so that naturally every passenger insists on having a ticket.

The principal traffic on the Milanese lines is between October and May, and there is steady influx of country people into Milan on market-days, (3 a week), and many also come in to see their friends in the famous free hospital at Milan which contains 2,500 beds.

The maximum gradient on the line is 1 in 20, which is about as steep as an ordinary locomotive can manage with an average train. On the Tivoli tramway at Rome there is a steady continuous ascent of about 1 in 33 with a reversing station. It is supposed by the Milanese authorities that a tramway would not be likely to pay for a short distance, say under 10 miles, unless there was a very large passenger traffic, such as that to some pleasure resort. This is well exemplified by the Turin tramways, which do not run far out into the country, but only through and round the town, and out to a country resort 7 miles from Turin. They only run about 7 miles an hour, but do not differ materially in other respects from those of Milan. They use the ordinary horse-tram rails in Turin.

The country tramways are said to draw all the traffic to them for a distance of at least 2 miles on either side of the line. This distance sounds small, but the richness of the country and the multiplicity of its roads must be carefully borne in mind. It has already been said that where they run parallel to, or near the railways, the latter suffer much from the competition. An instance was given me of a horse-tram that was established 10 years ago to a place called Moriza, 12 miles from Milan, which has caused a total loss to the railway running to the same place of £24,000.

The following is an abstract of the balance-sheet of the Tramway Company I have been describing. It will be observed that the taxes form an exceptionally heavy charge, there being an income tax of 18 per cent., besides taxes on carriages, sheds (house-tax), and Railway Traffic tax. The total taxation is about 20 per cent. on the net income. No one who knows Italy needs to be told of how heavily the burden of taxation weighs there, many landed proprietors having to pay in all nearly 50 per cent. of their income in taxes. However it is the penalty a poor country has to pay for being great, but, in spite of it all, there are plenty of Italians who raise the cry of "Italia Irredenta," and who wish to go to war with France about Tunis.

BALANCE SHEET OF A MILANSE STEAM-TRAMWAY COMPANY FOR 1880.

	Receipts.	£.	£.
Passengers		12,300	
Goods		304	
			12,703
Interest			81
Contribution from three hamlets ...			104
Compensation for damage to Cars ...			14
Postal Service			81
Discount and Rebate			115
Sundry Receipts			126
	Gross Receipts...	£13,344	
	Gross expenditure...	£10,784	
	Net Receipts...	£2,560	

That is the gross expenditure is equal to
80·8 per cent. of the gross receipts.

Total length of tramway, 27·94 miles.

Train mileage, 128,880.

Receipts per train mile, 25·6d.

Expenditure do. 20d.

EXPENSES.					£	£
Rolling-Stock						
Depreciation.	{	Locomotives ...	...	608		
		Carriages ...	...	578		
		Buildings ...	...	48		
Consumption.	{	Coke ...	...	1,188		
		Wood... ..	...	102		
		Oil and grease ...	...	510		
		Leathers ...	...	26		
		Varnish, &c ...	...	53		
		Tools ...	...	46		
						3,104
Maintenance and Repair of Locomotives,		}	790			
Carriages, and Roads ...						
Depreciation of Permanent Way			1,786			
Workshops, &c.			16			
Cost of inauguration, &c.			131			
Assurances.	{	Fire ...	9			
		Accidents ...	28			
						2,760
Cost of Administration.	{	Direction ...	729			
		Office ...	18			
		Stamps... ..	7			
		Publishing ...	98			
						852
Taxes	...	...	...	586		
Lighting	...	...	...	28		
Rents	...	...	...	12		
Interest on Debentures	...	...	...	250		
Salaries	...	...	...	2,708		
Legal, &c., expenses	...	...	...	45		
Rewards	...	...	...	33		
Sundry losses	...	...	...	17		
Sundry expenses	...	...	...	389		
						4,068
Gross expenditure...						£10,784

It will be observed that a fixed sum is paid to an Insurance Office which takes all risks as regards compensation to passengers for accidents on the line. The accidents have been but few and un-

important hitherto, being confined to cars running off the rails round curves, &c. There are no night trains, by which much risk is avoided. The net profit is equivalent to a dividend of about 6 per cent., which is considered small in Italy. A certain amount has been put on one side to constitute a Reserve fund. Analysing the figures given in the above balance-sheet, we find that the passenger receipts were made up as follows:

	No.	Receipts.		
		£.	s.	d.
1st Class Passengers ..	299,490	3,031	7	1
2nd do. ...	1,453,052	9,004	8	4
Return Tickets ...	..	102	9	7
Season do. ...	...	81		
Special Trains ...	...	64		
Reserved Carriages ..	.	20		
		£12,809 0 0		

This gives the result that each 1st class passenger pays on an average $2\frac{1}{4}d.$, which is equivalent to a journey of 2.21 miles; and that each 2nd class passenger pays on an average $1\frac{5}{8}d.$, equivalent to a journey of 2.44 miles.

The mean daily receipts, from passengers and goods combined, is £10 8s. 8.6d. Moreover, the train mileage during the year having been as above stated 128,889, it follows that the passenger receipts per train-mile were $23\cdot03d.$ and the goods receipts, $\cdot677d.$, or a total receipt of $23\cdot707d.$ for each mile run; sundry receipts of $1\cdot893d.$ bringing up the total to $25\cdot6d.$, as stated in the balance-sheet. Such are the principal details of the Italian steam-tramway system. It will be seen that they are virtually light railways running along the high-roads, and, in fact, an Engineer said as much to

me, "For all practical purposes we consider them as railways." But whether they are called rail or tramways does not much matter; they confer an enormous benefit on the district they traverse, and there can be no doubt that the system is capable of very large and profitable development in European countries, where the conditions are similar to those obtaining in the neighbourhood of Milan. The principal opposition to them arises from popular prejudice, but any one who has seen them at work in Italy must confess, that 6 or 7 feet of the roadway may very well be given up to a tramway at the side of most important roads, and that the tramway traffic, and the ordinary road-traffic of the country, are perfectly capable of being carried on side by side, without the very slightest difficulty or danger.

The following are some particulars of a steam-tramway between Cassel and Wilhelmshöhe in Germany, extracted from volume 52 of the Minutes of Proceedings of the Institution of Civil Engineers.

The line is $3\frac{1}{2}$ miles long, on an incline of 1 in 16.6, and on a curve of 164 ft. radius. The rails are of steel weighing 36 lbs. to the yard.

There are two locomotives on the line of 20 H. P. each, weighing, with 2 tons of water, 9 tons. They burn 88 lbs. of coke for a double journey of 6.6 miles, running $7\frac{1}{2}$ miles an hour. Each engine can draw two fully loaded cars up the incline, and in twenty-two days the two made 302 trips carrying 34,000 passengers. There had been, at the time the paper was written, no stoppages or accidents, and no cases of alarm to horses. The author considers that—"experience enough has been gained to allow not only the relaxation of the legal restrictions to the use of steam-power on tramways, and to sweep away horse traction altogether, but also

" of a large extension of the system for light con-
" structing lines of railway to be laid at a small cost on
" common roads; the speed of these lines not to
" exceed 12 miles an hour, and the engines to be such
" as will require only a single attendant. The track
" should be of the best description with steel rails
" and iron sleepers; such a track can be laid com-
" plete at a cost per mile of £1,200 for material, and
" £300 for laying. Rolling-stock, such as used at
" Cassel, can be bought at the following prices;
" Locomotive, £500; covered car, £200; open car
" £125; and open goods waggon £75."

Let us now consider how far and with what modi-
fications the system is applicable to India.

CHAPTER III.

STEAM-TRAMWAYS FOR INDIA.

TRAMWAYS in Europe have hitherto been designed almost solely for passenger-traffic, the goods traffic even on those that were treated of in the last chapter being very inconsiderable, though capable of development. In India, on the other hand, it is fairly certain that if a country tramway is to be successful, it must traverse a line where the goods traffic is considerable, and succeed in drawing to itself the major share of the carrying trade.

The native of India is not a great traveller, and for short journeys between village and village he has his own means of conveyance, and prefers to make his journey at his own time, so that a tramway might not attract a very large proportion of passenger traffic. Even in Indian cities, tramways have not always proved successful, as we in Madras know to our cost. True, the Madras Company failed chiefly on account of faulty management, and there is the example of the Bombay Company to prove that town tramways, if well managed, may yield handsome profits even in India, but a country tramway here would never return a profit from passenger traffic alone. It has already been said that travelling facilities engenders travelling desire, and so no doubt the passenger traffic on a country tramway would go on increasing, if the line was judiciously chosen.

And there would not be much ground for hesitation as regards the choice of the best lines. There are many towns lying at a moderate distance from the lines of rail, between which and the nearest station a very large traffic exists, which is urgently in need of some more expeditious mode of conveyance than that provided by the cumbrous bullock cart. In the Madras Presidency, every one can call to mind numerous such instances. The South-West line of the Madras Railway took expressly, as is well known, a line running some distance from the principal towns of the districts it traverses, and consequently Arcot, Vellore, Salem, &c., which are all centres of a considerable trade, are quite disconnected from the railway. Nellore and Kurnool on the Bombay line are also far distant from railway facilities, though each is the centre of a large producing region. Again, in connection with the South Indian Railway, the road between Madura and Ramnad has already been subject to the proposal of a light railway line, though the project has been temporarily shelved on account of the cost. The connection of Tranquebar with Mayaveram is another instance. In Lower Bengal too, where the country is so thickly populated, a very great need is felt for some better method of carriage than at present exists. It is not unlike Lombardy in its flatness, its richness, and in the large proportion of its inhabitants to its area, so that if steam-tramways ever become successfully established in India, it will probably be here, as in Lombardy in Europe, that they will be most largely utilized and most profitably worked.

However, it is too early yet to discuss the question as to where tramways might be established, for we have first to show that they are capable of being established at all with a reasonable prospect of success. I shall have to deal with figures to a certain

extent, when discussing the movement of passengers and merchandise in the country, and I shall take for my purpose the published returns of traffic on some of the principal Indian railways. This will be disadvantageous to the tramways in some measure, for it is very generally admitted that, most Indian railways have not yet succeeded in drawing to themselves so large a proportion of the general traffic of the country, as had been anticipated. Perhaps the native has not quite realised yet the advantages offered by a railway, or perhaps the Railway Companies have not, in some cases, consulted sufficiently the peculiarities of the native character. Anyhow the fact remains. In tramway management, on the other hand, the system would be on such a very much smaller scale, that fares, time-tables, &c., might be altered constantly without much difficulty, till the convenience of the majority of the travelling public had been satisfied, with the result of a better chance of relative success than has as yet fallen to the fortune of railways.

The first question to be considered is the position that Government would assume towards the new enterprise, should any proposals for its trial be brought forward. The principal points are ;

(1.) Would permission be given to the local authorities to grant the use of their roads ?

(2.) Would a reasonable rate of speed be authorized ?

(3.) Would interbooking between tramway and Railway Companies for passengers and goods be adopted on State, and encouraged on guaranteed railways ?

(4.) Would Local Fund Boards and Municipalities be encouraged to guarantee a moderate rate of interest to the undertakings?

Let us briefly consider each of these points.

(1.) Would the use of the roads be granted?

It would be scarcely worth while to consider the feasibility of making a tramway a paying concern, if this concession were not made; for it would burden the Company hopelessly at the outset, if it had to purchase land and to make all its own embankments, cuttings, and bridges. I will therefore assume that the use of the roads would be granted under certain conditions, and turn to,

(2.) The rate of speed allowed.

The conditions here would necessarily be somewhat different to those existing in Europe. There, foot-passengers are comparatively rare on the roads, nor is there anything approaching the same amount of cart-traffic as in India. Also the existing cart-traffic is better organised, and you do not, for instance, come across the long interminable lines of carts, often hopelessly intermingled, that are so common here. In Europe the road-traffic looks out for the tramway; in India the tramway would have to look out for the road-traffic. That is about the difference. The best way to conduct the traffic safely at a moderate rate of speed would be to allow the Company to fence off that portion of the road occupied by its line, but it is highly improbable that this concession would be granted in many instances, or, indeed, that the existing width of road would render it possible to grant it. On the other hand, a fair rate of speed is an essential condition of success, for to secure the passenger-traffic, the tramway

would have, at any rate in Southern India, to compare favourably as regards fares and speed with the little two-wheeled vehicles, locally called "jutkas." These run at about 8 miles an hour, so that a speed of at least 10 miles an hour would have to be maintained. No doubt at first the running would have to be conducted with much caution, but as, at this rate of speed, the cars could be stopped dead in a distance of 70 feet, there should be no danger about it. Moreover, when the hours of passing of the tramway became known, the native bullock-drivers would soon learn to be on the look-out for it. The Italian locomotives are provided, some with a powerful steam-whistle, and others with a horn blown by the driver, to warn carts of the approach of the tram. I may also add that the driver sits at the front of the locomotive, where are placed the brake-handle, and that for shutting off steam, so that he has his train absolutely under control.

(3.) Would interbooking between tramway and Railway Companies be adopted?

This again I consider as an essential feature of success. It has been said that in most cases—at first certainly in all cases—tramway lines would serve as railway feeders, and unless they were really treated as such, the commercial and travelling public would never take to them. If at the railway station, rebooking, reweighing, and all the other formalities had to be gone through a second time; the trouble, the delay, and the general friction, would be so many impossible barriers to success. It may even be said that to be really successful it ought to be possible to pass railway waggons in case of need over the tramway lines. This involves however the difficult question of gauge which will be referred to presently, and, in the meantime, I will only assume

that the above-mentioned facilities would be readily accorded, as being of as much advantage to the railway as to the tramway.

(4.) Would a moderate guarantee be authorized?

This is really the kernel of the whole affair. Naturally, in writing of tramways, I am not putting a purely hypothetical case of possibly successful enterprise. There are capitalists in Europe who have already been profitably connected with Tramway Companies, and who would be willing, if a favourable opening could be shown to them, to put themselves at the head of similar enterprises in India. "But," they will certainly say, "India is an uncor-"
"tain country at the best, and in the case of a new"
"class of undertaking it is quite an unreliable"
"country. Tramways may prove a success, or they"
"may not. We are willing to make a trial, if we"
"are guaranteed against total loss."

The present policy of the Government of India, as announced in the Hon'ble Evelyn Baring's Financial Statement of March 25th last, is opposed to guarantees in principle, but still admitting them to a limited extent in practice, should it be found that private enterprise, which is to be encouraged by every legitimate means, is so timid as not to venture forwards without this helping hand. And private enterprise is timid; justly timid, I may add. But without a guarantee it is improbable that there will be any tramways. The position is certainly a difficult one, for there are very few Municipalities that will be in condition to offer any guarantee to a Tramway Company, which will affect their incomes enormously by largely reducing their toll-fees. I may safely take half of the total income as being the proportion which many Municipalities derive from tolls; and, if the effect of a tramway is to reduce the tolls by half, each

Municipality will look to the Company for an equivalent compensation, and will not hear of a guarantee, much as they may desire to see their communications improved. The only plan would be to introduce octroi duties, which are levied in almost every continental city, but to which the Indian Governments have always been steadily opposed. But suppose octroi duties were sanctioned, and the Municipal finances balanced in this way, the difficulties of a guarantee would almost disappear.

Take the case of a line 5 miles long connecting a Municipal town of 20,000 inhabitants with a railway station, and suppose the income of the Municipality to be Rs. 20,000, and that of the Local Fund Board of the circle to be Rs. 50,000. The line of tramway might require a capital of £20,000, to put an extreme case, on which interest at 3 per cent. would amount to £600 a year, which might be jointly guaranteed by the two Boards.

It will be seen that the introduction of tramways is not by any means a simple affair, and would involve many concessions on the part of Government. Let me also add, that they would require very judicious treatment. Capitalists are frightened, not only at the uncertainty of enterprise in India, but at the vexatious control to which it is subject. No doubt zeal for the public interests and for the public safety are admirable qualities in a Government Officer; but they may be carried too far. Men, who have dealt with important concerns in western countries, come here, and sometimes find that they are treated with a suspicion that they resent, or are hampered by a control which they find unendurable. If a tramway concession is given, let the official regulations for it be drawn up most carefully, though in a liberal spirit, in the first

instance; and let them then be left unchanged, as far as possible, so that concessionaries may know exactly the conditions they are bound to conform to, and not have to depend on the continuity of purpose of successive supervising officers.

I cannot do better than quote here the remarks on the subject of encouragement of private enterprise made by the Hon'ble Evelyn Baring in paras. 84 to 91 of his Financial Statement.

84. It is, however, manifest that a capital expenditure of £2,500,000 a year is inadequate to meet the present wants of India. Are we therefore to abandon all hope of constructing canals and railways with the rapidity which the exigencies of the country demand? I hope not. It has always appeared to me a remarkable fact that India,—with all its magnificent and, as yet, only half-developed resources, and with all the security to life and property resulting from a Government, which, whatever be its defects, is at all events strong, honest, and well-intentioned,—should up to the present time have been obliged to pledge the full security of the State in order to attract any considerable portion of the surplus capital of England. I hope that some railways afford sufficient attraction to induce private individuals to undertake their construction without the aid of Government, or, at all events, with a minimum amount of such aid. I do not question the wisdom of the policy which would permit private capitalists to embark in this field. It was therefore with pleasure that I read the following instructions which have been received from the Secretary of State:—

“In the case of railways, I do not doubt that Your Excellency will bear constantly in mind the importance, whenever possible, of ensuring their construction by private capital, either local or European. It is true that up to the present time no Companies have been found willing to undertake the construction of railways without a Government guarantee; but I would, nevertheless strongly urge upon Your Excellency that, when any reasonable prospect of success presents itself, an endeavour should be made to encourage the raising of capital through private agency, on the exclusive security of the success of the undertaking. Any step in this direction will meet with my most cordial support and co-operation. In the event of its becoming apparent that the due execution of this policy is impracticable, it may become

desirable to consider whether a modified system of guarantee might not advantageously be adopted. By a modified system I mean one so restricted in respect to time and to the rate of interest guaranteed as to give the subscribers a real interest in the efficient and economical administration of the railway."

85. It is sometimes urged that a railway is a monopoly, and, for that reason, should be in the hands of the State, and not of any private interests. Further, that to concede the right of building a railway is to part with one of our most productive resources.

86. It is true that a railway is generally a practical monopoly. The State, therefore should exercise so much supervision over its working as will prevent the monopoly being exercised in a manner detrimental to the public interests. Thus the State should possess a right of inspection, in order that the line may be certified by competent authority to be safe for the transport of goods and passengers. It should regulate the maximum tariff and fix the gauge on which the line is to be constructed. It is especially necessary that a conditional right of purchase after the lapse of a certain period should be reserved. But when provision has been made for these and some other points, which I will not now enumerate, the necessity for State interference ceases. The interests of the public do not necessarily demand that the State should create an artificial monopoly in its own favour in respect to the construction of all railways.

87. As regards the loss of revenue, it may be urged that if the profits of the railway be left to fructify in the pockets of the people they will be more advantageously employed than would be the case were they paid to the State, with a great chance of their being employed on unproductive expenditure. Moreover it is to be observed that the indirect benefits to the State and to the country resulting from the extension of railway communication are obtained equally well whether the railways are constructed by Government or by private agency. The value of land is enhanced; new markets are opened; an impetus is given to the export trade, and the greater power of transport and concentration affords a hope that military expenditure may be reduced.

88. Even if the general arguments in favour of constructing railways solely through the agency of the State were more valid than I conceive them to be, I should still hold that those arguments did not apply in India. The first economic requirement of India is that her resources should be developed without delay,

and that means of communication should be so improved as to facilitate migration from districts which are over-populated to those in which labour is scarce. I doubt whether Government agency alone can adequately perform this task, and I hold that in any case it is not desirable that it should do so if private agency can be found to undertake the work. I am not without hope that, if an impulse can be given to railway construction by British enterprise, Native capitalists will enter the field, either alone or in conjunction with Englishmen. I should regard such a movement as an important factor in the practical education of the people, inasmuch as it would tend to wean the Natives of India from that dependence upon Government which is intensified by concentrating in the hands of the State all the organised skill which the construction and management of a railway requires. If over the Natives of this country are to be schooled in the first rudiments of self-government, it is desirable that they should be encouraged to act for themselves in such matters, rather than that they should rely always upon that coercive philanthropy which insists upon doing everything for them.

91. I am unable as yet to say anything definite as to the conditions under which concessions may be made to private capitalists. Possibly these conditions may vary according to the exigencies of each particular case. It appears to me, however, that the Government may legitimately help in a variety of ways short of giving a guarantee. Government officers may make surveys and estimates, and supply all necessary information with a view to enabling private individuals to judge for themselves whether they care to invest their money in any particular scheme. The land on which the line is constructed may sometimes be given free of cost. Possibly, in some cases, grants of waste land in the vicinity of a new line may be given. On the other hand, certain conditions, to some of which I have already alluded, must be imposed, and it will be important only to give concessions to such persons as can afford good security that they have at their command a sufficient amount of capital to carry out the undertaking to a successful issue.

It will be observed that the Finance Minister refers almost solely to railways, but, as has been previously mentioned, steam-tramways are still quite in their infancy, and possibly he had not thought of them as being a method of inter-communication in India, more suitable perhaps than even light rail-

ways. The views of the Government of India thus authoritatively enunciated give every possible encouragement to private enterprise, and, as has been already implied, I have not contemplated a Government guarantee to the undertakings, at any rate at the commencement. I would rather let the enterprise depend on the support of local authorities, who have the best means of judging, and who are the most interested in judging rightly.

This brings us to the construction of tramways.

They might either be laid down by the local authorities themselves, or else a concession might be given to independent capitalists for their construction and maintenance. The latter case is the only one worthy of consideration, but the position of the local authorities in the matter has so far to be considered, that they will certainly have to invite the attention of the capitalist to the opportunity that may exist for a profitable undertaking within their jurisdiction, and they will also have to decide on the terms they are prepared to offer him, and the reservations they may determine to make in their own favour.

The possibility of making a tramway a paying concern will depend:

- (1) on the original cost of its construction.
- (2) on the traffic returns.

The estimated cost of construction must be based on the cost of similar concerns in Europe, with such additions as the freight, &c., of the plant will entail. This additional cost may be calculated with sufficient exactness from the corresponding figures for the Indian railways. The use of the roads is as-

sumed, subject to such conditions as are specified hereafter, and it is also assumed that the road is bridged throughout, and that the bridges will be capable of carrying the train as they are, or with but such additions as may be made at a moderate cost. Finally there is the question of gauge.

I have said above that there would be certain obvious advantages could the railway trucks be run, in case of necessity, over the tramway lines. Conversely there would be many advantages could the tramway rolling-stock pass over the railway lines. The locomotives, carriages, and waggons could then be set up at a moderate rate in the railway workshops at the sea-port, and could be run directly on to the tramway; repairs could, on occasion, be done in the same way; and the tramway trucks could load and unload in the railway sheds and sidings.

A special form of rail, and perhaps also a wheel flange differing somewhat from that usually employed for tramway-cars, might have to be adopted to render these desiderata possible, as experiments made in Glasgow have shown that, to allow railway waggons to pass easily over ordinary tramway lines, the gauge of the latter should be $\cdot 787$ inches less than that of the former.

On the other hand there would be many disadvantages attendant on the adoption of the standard gauge of Indian railways for tramway lines.

The gauge of almost all European lines is $4' 8\frac{1}{2}"$, the same as that of the railways, and scarcely any lines have been constructed of a broader gauge, with the one exception of the Dublin tramways which are of the Irish railway gauge of $5' 3"$. If one had to select the gauge the most suitable for India on the grounds of efficiency and economy, it is probable

that one would choose the metre gauge, which would, I may remark, be adopted in any case for all tramways running in connection with narrow gauge railways. The 5' 6" gauge would entail a large additional cost of up-keep, on account of the additional width of roadway to be maintained; the prime cost of the rolling-stock would be enhanced, as designs and patterns would have to be specially prepared for it; and, lastly, it is probable that on many roads the necessary breadths of road and bridges could with difficulty be spared. On *prima-facie* grounds therefore, it would appear that the disadvantages of the 5' 6" gauge exceed its advantages, and that Tramway Companies would decline to adopt it. On the grounds of general convenience however, and on those of public policy, no other gauge could be admitted on the lines running in connection with broad-gauge railways, and it is likely therefore to be one of the principal conditions of the proposed guarantee, that the standard gauge shall be adopted.

The last chapter gave with sufficient detail the approximate initial cost of Steam-tramway Lines in Europe, and, in the following table, I have made out approximate estimates based on those details for lines of 5, 10, and 15 miles in length, for India. It is improbable that any line would be established shorter than the first, or, at the commencement, much longer than the last of these. All calculations have been made in £. s. d. for convenience of comparison with European and Indian Railway returns.

I.—Approximate Cost of 5 miles of Tramway, 5' 6" gauge.

	<i>Permanent Way.</i>	£	£	£
1	Cost of re-formation of road, including strengthening of bridges where necessary, at £300 per mile (5 miles) ...		1,500	
	Bessemer-steel rails, weighing 35lbs. a yard, 56 tons per mile, at £7 per ton ...	385		
	Iron sleepers, 70 tons per mile at £3 per ton ...	210		
	Add 40 p/c for freight, &c. ...	238		
	Laying Permanent Way at 2s. per yard, per mile ...	176		
	per mile £	1,000		
	For 5 miles, to include sidings, and circular sweep for reversing locomotives at each end, and extra curves ...		6,054	7,554
	<i>Locomotives.</i>			
2	Three locomotives, each of 30 H.P., weighing 10 tons each, at £700 ...		2,100	
	Add 40 p/c for freight and fitting up ...		840	2,940
	<i>Carriages and Trucks.</i>			
3	One combined 1st and 2nd class car ...		240	
	Four open cars at £150 ...		600	
	Two closed vans at £120 ...		240	
	Twelve open trucks at £100 ...		1,200	
			2,280	
	Add 40 p/c for freight, &c. ...		912	3,192
	Carry forward ...	...	...	18,686

I.—*Approximate Cost of 5 miles of Tramway, 5' 6" gauge.*

		£	£	£
	Brought Forward. ..			13,686
4	Sheds for rolling stock at one end, repairing shop, necessary offices, &c. ...			750
5	Payment to Concessionaires ...		250	
	Compensation ...		500	
	Legal, &c. expenses ...		250	
				1,000
6	Fitting up offices ...			100
7	Tools, &c. ...			100
8	Sundry expenses ...			364
			Total £...	16,000
				or
				£ 3,200 per mile.

II.—*Do—for 10 miles.*

		£	£	£
1	Formation of Road ...		8,000	
	Rails, sleepers, &c., for 11½ miles ...		11,009	
				14,009
2	Three locomotives ...			2,640
	<i>Carriages.</i>			
3	Two composites, six open cars, two vans, and 18 goods-trucks.			4,788
4	Sheds, &c. ...			1,250
5	Compensation, &c. ...			1,500
6	Fitting up offices ...			150
7	Tools, &c. ...			200
8	Sundry expenses ...			378
			Total £...	25,000
				or
				£ 2,500 per mile.

III.—Do—for 15 miles.

		£	£	£
1	Formation of Road ...		4,500	
	Rails, sleepers, &c., for 18 miles.		18,162	
				22,602
2	Four locomotives ...			3,520
	<i>Carriages.</i>			
3	Two compositors, 9 open cars, 3 closed vans, and 21 trucks ...			6,846
4	Sheds, &c. ...			1,750
5	Compensation, &c. ...			1,750
6	Fitting up offices ...			200
7	Tools, &c. .			300
8	Sundry expenses ...			472
Total £ 37,500				
				or
				£ 2,500 per mile.

N.B. No special form of sleeper is referred to, but it is believed that a suitable one can be obtained not weighing more than 70 tons per mile.

The prices of rolling stock have been taken higher than European prices on account of the increased width, and 40 per cent. has been added throughout for freight, insurance, &c., which it is considered is ample, the corresponding increase on Indian Railways not exceeding 25 per cent.

The rolling-stock allowed would be amply sufficient for the commencement of working. The same number of locomotives will be required for the 5 mile as for the 10 mile line. The prices of iron and steel are taken slightly in excess of current English prices.

A portion of the cost of laying is included in the £300 per mile estimate for the re-formation of the road.

IV.—Approximate cost of 5 miles of tramway, metre
(3'. 3 $\frac{1}{8}$ " gauge.

	<i>Permanent Way.</i>	£	£	£
1	Formation of Road.		1,500	
	Bessemer-steel rails, weighing 80 lbs. a yard... ..	830		
	Iron sleepers, 65 tons per mile.	195		
	Add 40 p/o for freight	210		
	Laying Permanent Way	176		
	per mile for 6 miles	911	5,466	6,966
	<i>Locomotives.</i>			
2	Three at £500 each		1,500	
	Freight, &c... ..		600	2,100
	<i>Carriages and Trucks.</i>			
3	One composite car		200	
	Four open cars at £125		500	
	Two closed vans at £100		200	
	Twelve open trucks at £75		900	
	Freight, &c... ..		1,800	
			720	2,520
4	Sheds, &c.			750
5	Compensation, &c.			1,000
6	Fitting up offices			100
7	Tools, &c.			100
8	Sundry expenses			464
		Total £...	14,000	
			or	
			£ 2,800 per mile.	

V.—*Do*—for 10 miles.

		£	£
1	Formation of road	3,000	
	Rail and sleepers (11½ miles) ..	10,477	13,477
2	Three locomotives		2,100
3	Carriages as in II		3,780
4	Sheds, &c.		1,000
5	Compensation		1,500
6	Offices		150
7	Tools		200
8	Sundries		793
Total £...			23,000
			or
			£ 2,300 per mile.

VI.—*Do*—for 15 miles.

1	Formation of road	4,500	
	Rails and sleepers, (18 miles)...	16,308	20,808
2	Four locomotives		2,800
3	Carriages as in III		5,075
4	Sheds, &c.		1,500
5	Compensation		1,750
6	Offices		200
7	Tools, &c.		300
8	Sundries		372
Total £...			33,000
			or
			£ 2,200 per mile.

N.B.—The cost per mile is sensibly less than on standard gauge. Continental prices have been taken rolling-stock.

The above tables give what is considered a fair estimate of the cost of construction of a line of steam-tramway, and I will now turn to the second of the propositions I have already laid down as requiring to be determined before a line can be undertaken, *i.e.*, the traffic returns. On English railways the gross expenditure and the net receipts are about equal; *i.e.*, taking a rough average, they are each about 50 per cent. of the gross receipts. On Indian railways however the figures for different lines show such enormous variation that any general average must be received with caution. For instance, for 1879 the following extremes are observable:—

Lines.	Proportion of expenditure to Gross Receipts.	Net Receipts.
<i>Guaranteed Lines.</i>		
East-Indian Main Line ...	31.85 p/c.	68.15 p/c.
Madras	68.68 „	31.32 „
Average for all Lines ...	48.16 „	51.84 „
<i>State Railways.</i>		
Sindia	134.96 p/c.	34.96 p/c.
Muttra-Bathras	54.96 „	55.04 „
Average	78.82 „	21.18 „
General average	52.16 p/c.	47.84 p/c.

As regards tramway lines we have seen that on those round Milan the expenditure has been 80 per cent. of the receipts, (but a very much better average is expected), and in England, and on the continent generally, the expenses on horse tramways amount

to from 90 to 75 per cent. of the receipts. There are no reliable figures from which a general average for steam-tramways can be obtained, but it is admitted that they will be much cheaper to work than the former, so that if I take from 70 to 75 per cent. as the proportion that the expenditure will bear to the gross receipts, I shall probably be on the safe side.

To attract capital to a line the probable net percentage on the outlay should not be less than 5 per cent. with a reasonable prospect of increase.

Taking now line No. I, which is the most unfavourable in the above tables, we find that 5 per cent. on the capital of £16,000 involves a net receipt of £800 per annum, which, as above stated, is probably about 25 per cent. of the gross receipts. These should therefore amount to £3,200 which gives £2,400 as the gross expenditure. The length of the line is 5 miles; so supposing 10 trains to run each way every day we get a daily mileage of 100 miles, and a yearly mileage of 36,500 miles. From these figures again we get 26·3*d.* as the gross receipts, and 19·37*d.* as the gross expenditure, per train-mile.

On Indian Railways in 1879 the corresponding figures are as follows, the extremes being given in each case as before.

Lines.	Gross Receipts per train-mile (goods and pas- senger.)	Gross Expon- diture per train-mile.
<i>Guaranteed Lines.</i>		
Eastern Bengal	133· 68 <i>d.</i>	
South Indian	66· 6 <i>d.</i>	
Average	96· 96 <i>d.</i>	46· 82 <i>d.</i>

Lines.	Gross Receipts per train-mile (goods and pas- sengers.)	Gross Expen- diture per train-mile.
<i>State Lines.*</i>		
Punjab, northern	118·16d.	
Sindia	48·56d.	
Average	70·44d.	55·44d.
General average	92·64d.	48·44d.

On English railways, the receipts per train-mile average 69·3d. and the expenses 33·78d. On English horse-tramways, the receipts per mile run average 16d. and the expenses 12d. On the Italian tramway, the receipts per train-mile were 25·6d. and the expenses 20d. but it must be remembered that it carried next to no goods traffic, which in India would, it is expected, form a large portion of the receipts.

This expectation is based on the receipts of Indian railways where the goods traffic brings in about twice as much as the passenger traffic. The figures for 1879 are

	Passengers £	Goods £
All railways		
Gross receipts...	3,418,910	7,274,408

The receipts on the 5-mile line of tramway may be taken in a somewhat smaller proportion, and I will allow a higher ratio of passengers, say 14·8d. per train-mile from passengers and 12d. per train-mile

* Excluding coal-lines and Khamgaon Railway.

from goods. On Indian railways the corresponding receipts average 72·36*d.* and 102·96*d.* The proportion of 3rd and 4th class passengers on Indian railways is 97·432 per cent. of the whole number carried, and it is stated also that 97 per cent. of the goods traffic belongs to the cheapest category. I will therefore, to be on the right side, take the whole of the above-mentioned tramway receipts at the lowest rates in each case. The lowest railway rates are $\frac{1}{2}$ *d.* (2 pies), per mile for passenger, and 1*d.* (8 pies) per ton per mile for goods. Adopting these figures, we got an average of 57·2 passengers and 12 tons of goods per train-mile, which would be about a maximum train-load; or, assuming all the passengers and goods to go through from the town to the railway station, and *vice versa*, we have a yearly total of 337,562 passengers and 87,600 tons of goods, or a daily average of 1,144 of the former and of 240 of the latter, or 572 passengers and 120 tons of goods passing each way every day.

Would this high rate of traffic be obtainable? It would certainly seem doubtful to any one acquainted with the movement to and from Indian Mofussil towns, but with a smaller traffic the line could not be made to pay on account of its high capital cost. In fact, even with the returns quoted, the interest would soon fall into arrears, unless a development of traffic took place, and unless 150 or 200 train-miles a day could be run with full loads. The cost of running cannot be taken safely at less than 12*d.* a mile, though in Italy, with coke at almost its Indian price, the cost is only 7·9*d.* This would absorb £1,825 per annum leaving only £575 for depreciation, renewals, and sundries. As a matter of fact, at least £1,000 a year would be required for depreciation alone, which makes the deficiency very apparent.

Taking on the other hand the 15-mile line, the capital of which is £37,500, the interest charges at 5 per cent. would be £1,875 making £6,250 the gross receipts, assuming on the larger concern that the expenditure is 70, and the profit 30 per cent. of the total. Supposing 6 trains to run each way every day we get a daily mileage of 180 and a yearly mileage of 65,700 miles, so that the gross receipts per train-mile are 22·83*d.* and the expenditure 15·981*d.* This would be provided by 10 tons of goods and 49·82 passengers per train-mile, in other words by 60 tons of goods and by 296 passenger passing each way every day.

The total yearly expenditure would be £4,375, and the running expenses, at 12*d.* a mile, £3,285, leaving £1,090 for renewals, &c. Or if the running expenses could be brought down to 10*d.* a mile, as they ought to be, we should have £2,738 to provide under this head, leaving £1,637 for other items. As a beginning, this would be fair enough, for it would only be rational to suppose that the traffic would largely develop, and that the country cart would be soon beaten in the competition for the carrying trade. If the town situated 15 miles from the railway, could double the assumed traffic in a year or two, all the figures given above would be also doubled, and the Company would obtain a 10 per cent. dividend, and be able to put by a very handsome surplus to form a sinking fund.

But it is time to bring this long chapter to a conclusion. The calculations for any of other line may be worked out in the same way, but enough has been said to show the relative advantages and feasibility of the undertakings. It will be seen that it would be difficult to make a short line a paying concern, unless there was an exceptionally heavy

traffic, and any town so situated, that wished to possess the luxury of a tramway, would probably have to pay for it, by contributing a fixed yearly sum to the Company's receipts. A yearly contribution of £1,000 would probably enable the 5-mile tramway to pay its way, including renewals, &c., if the traffic were only as heavy as has been assumed.

For longer lines than those that have been taken, the cost of construction per mile might be a trifle less, and a proportionately smaller through traffic would leave a margin for profit.

CHAPTER IV.

CONCLUSION.

It may be objected to the principle of reasoning adopted in the calculations of the last chapter that I have argued from results to premises, that I have first assumed the interest, deduced therefrom the net receipts, and thence the traffic. But in treating of the question generally no other alternative is possible, for it would not do to assume a traffic which might perhaps be higher than would be applicable to an actual case, and be therefore valueless. The method adopted too has this advantage, that it presents the question in the form the most adverse to the tramways. I have said that the receipts cannot be assumed less than a certain amount, and that the traffic must therefore amount to at least a certain total, if any line is to be thought of as a paying concern. It is within the compass of every one's powers to ascertain the total amount of passing traffic, and the only other requirement, before comparing it with the figures I have given, is to calculate the proportion of it that the tramway would attract. It is not an easy question and scarcely any data exist on which to frame an answer. But if the principal merchants of a busy town could be induced to become part proprietors in the Company, they would have a direct interest in sending their goods by its agency, and in promoting, by their example, the development of the passenger traffic. This, and fixing low rates, would furnish the best chances of

success, and naturally no line would be undertaken except under reasonable prospect of support from those whom it was intended to serve..

The advantage of assuming the most adverse conditions is that, if the gross receipts may be taken higher than those obtained by the method of calculation adopted, so much the better for the chances of the tramway, but I would urge on every one who may be tempted to bring forward a scheme not to be over-sanguine. As has been already said, the distinguishing feature of enterprises in India is their timidity, and nothing encourages this timidity so much as failure in their beginnings. If the first lines are carefully chosen, cheaply constructed, and well worked, there is no reason why tramway enterprise should not develop, and result in the profitable employment of a good deal of capital, in a very rapid development of the internal trade of the country, and of a partial solution of one of the great Indian problems,—a successful famine campaign. But if blasted in its beginnings it will have a short life, and a poor one.

But, it may be urged by some into whose hands this pamphlet may fall, who is going to undertake these enterprises for which such a magnificent future is predicted? Even granting that we have, or that we can point to, a line which fulfils in some measure the stated conditions, we know of no expert to whom we can turn to seek for a reliable opinion on the prospects of our scheme. There is, at any rate in this part of India, no independent Engineering enterprise, and none but a very large concern could stand the cost of bringing out an Engineer specially from England to undertake the preliminary investigations.

The data necessary to be collected are not how-

ever very elaborate, and the following list comprises every information that need be obtained before the actual proposals for the formation of a Company to construct a line are brought forward.

1. A map of the town, and of the country lying between it and the railway station, showing the road on which it is proposed to lay the tramway, other roads, and neighbouring villages.

2. The population of the town and villages.

3. A return of the traffic between the town and railway, and in the neighbourhood generally, detailing what it principally consists of, how carried, the approximate number of passengers and weight of goods, with rates of present conveyances.

4. A longitudinal section of the road, with cross sections at all important points, and a description of the bridges, culverts, &c. Also information as to the price and quality of the material of which the road is formed; distance of gravel and stone-quarries; prices of labour in the neighbourhood; depth and minute description of formation of road.

5. Cost of bringing machinery, or railway material to locality; cost of concrete work in ditto; and, generally, the cost of fuel and of such materials and labour as would be employed on a tramway. (These details for any neighbouring railway should specially be quoted.)

6. Particulars as regards the climate, rainfall, &c.

7. The conditions of the concession in detail;* noticing obligations as regards up-keep of road; liability to tolls, taxes, &c.; probability of guar-

* In Italy, tramway concessions are for a period of 50 years.

antee; estimate of proportion of traffic tramway will secure, with reasons.

A combination of Local Fund and Municipal estab-

* Though the steps taken by the Government with a view to offering facilities for the extension of railways where a proportion of the necessary capital have not been effectual, great advantages could be gained by interesting local communities and capitalists in making investments of local public utility, and we trust that the plan may be further considered, and, if possible, brought into practical operation. (Chapter V, Section 4, para. 11 of P. O. R.)

lishments would generally suffice for the preparation of all this information, and even if it did not, perhaps Government might, in the furtherance of the policy, announced in the Financial Statement (page 80) be induced to assist the Local authorities* by granting

to them the services temporarily of one of their own officers.

There is one point on which I would remark before I conclude, and that is as regards the management of the tramways. I have said that in all probability a moderate guarantee would be required, but there is this objection to a guarantee, that the irresponsible management of a small concern, (and it must be irresponsible in a great measure if the capital is not locally subscribed), is apt to be lax when there is an assured income.

But all tramways, and especially new tramways in a country new to them, require the best and most careful control, and I would therefore urge as a *sine qua non* of management, either a stake in the Company, or a payment by results.

And here, I think, I may conclude. I do not pretend to have exhausted the subject, or even to have done more than to treat of it in the most elementary fashion. There are numbers of details,—such as the best form of road, of rail, of sleeper, of locomotive,

of car, of truck, to adopt; the ticket system; the fares, and so on—which all have to be considered. But if the perusal of these pages carries with it the conviction that what has proved successful in Europe, may be as successful in, as it is undoubtedly suitable to, India, their purpose will have been fulfilled, and the above-mentioned details may safely be left for subsequent treatment.

I may add that, so far as the Madras Presidency is concerned, I shall be glad to answer any further questions on the subject that I am able, or to furnish any assistance that is in my power.

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ELECTRICAL INTERCOMMUNICATION ON RAILWAY TRAINS IN MOTION.

BY

W. H. FLOYD, M. S. T. E.,

SUPERINTENDENT OF TELEGRAPHS, GREAT INDIAN PENINSULA RAILWAY.

1882.

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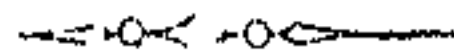
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ELECTRICAL INTERCOMMUNICATION ON RAILWAY TRAINS IN MOTION.

Although twenty-seven years have passed since the first attempt was made in England to establish an electrical intercommunication on Railway Trains in motion, and several plans have been brought forward with that object from time to time, it can scarcely be said that any electrical system has been so thoroughly tried under varied conditions, as to give complete assurance that it may be relied upon to satisfactorily afford communication between passengers, guards, and engine drivers on Railway trains in India. The first practical system of electrical intercommunication brought forward in England was introduced by Mr. W. H. Preece in 1864, but, although it was successfully tried on the London and South-Western and other lines of Railway, it was prevented from coming into extended use by the preference of Railway authorities for the mechanical arrangement known as the "cord" system, that was conditionally sanctioned by the Board of Trade in 1867.

In 1865, the South-Eastern Railway Company adopted an electrical system of intercommunication, introduced by the Company's Telegraph Engineer, Mr. C. V. Walker, and that system has, it is believed, worked satisfactorily ever since under Mr. Walker's supervision.

In the same year Messrs. Varley and Martin patented an electrical system of intercommunication, and the Royal Train on the London and North-Western Railway line was fitted with it.

A train running daily between London and Wolverhampton was also fitted with this system, which is said to have worked regularly and well for nearly two years. At the end of that time the train was called in for repairs, and its successor was fitted upon the "cord" system.

In 1872 an electrical system was introduced by Colonel Binney on the Great Eastern Railway.

Between 1872 and 1878 no fresh plans were brought forward, and, in the latter year, it was said that only two systems of the four mentioned remained in practical use—viz., Walker's on the South-Eastern Railway, and Preece's on the London and South-Western.

Since 1878, however, some of the London, Chatham, and Dover Railway Company's mail trains have been fitted with Varley and Martin's system.

The Preece, the Walker, and the Varley-Martin systems resemble each other in the particular that with each of them only one insulated wire is employed; the railway metals and screw-coupling drawbars being relied upon to provide a return wire, or earth connection; and they are all worked on the electrical principle that was first applied to this kind of communication by Preece in 1864; but each has a different method

of coupling the insulated wire between vehicles, and a different kind of alarm communicator for the use of passengers.

The Preece coupling rope is formed of three stranded copper wires, insulated with india-rubber, and covered with a thick plaiting of hemp. This rope is brought from the insulated line wire through the buffer beam of one vehicle, and has at its free end a galvanised iron eye that engages with a gun-metal hook fixed on the buffer beam of the opposite vehicle, and is pressed firmly to it by a strong flat spring.

Each buffer beam has a coupling rope at one end, and a gun-metal hook at the other, both connected to the insulated line wire, so that a double electrical connection is made between vehicles, and the couplings are always ready for joining, no matter which end of a vehicle is presented.

The Walker coupling is a hard brass wire spiral enclosed in a vulcanised india-rubber tube. The spiral has a brass ring at each end, and a brass hook to receive the rings is connected with the insulated line wire and fixed at the centre of each end of a vehicle near its roof. These couplings are removed at the end of a journey and transferred to another train, or stored.

The Varley-Martin coupling rope is made by wrapping seven wires round seven hempen cords, each wire round its separate cord, and making them into a rope bound together by two servings of hemp soaked in an insulating compound. Malleable cast-iron eyes are attached at the ends of the connecting ropes, where the couplings are made, and these pass over and are firmly grasped by strong malleable iron hooks actuated by powerful springs placed in cast-iron boxes attached to the carriages. The eyes are coated with copper,

and the hooks with brass, at the points of electrical connection.

With this coupling, as with the Preece coupling, a double connection is made between each vehicle.

None of the three couplings described will give any signal in case a portion of a train is separated on a journey, but each inventor has a plan for providing such a signalling arrangement where it is required.

Colonel Binney employed two wires for his system of intercommunication as it was tried on the Great Eastern Railway in 1872. The wires were led over the roofs of the vehicles and connected by a hook and eye and flat spring between them.

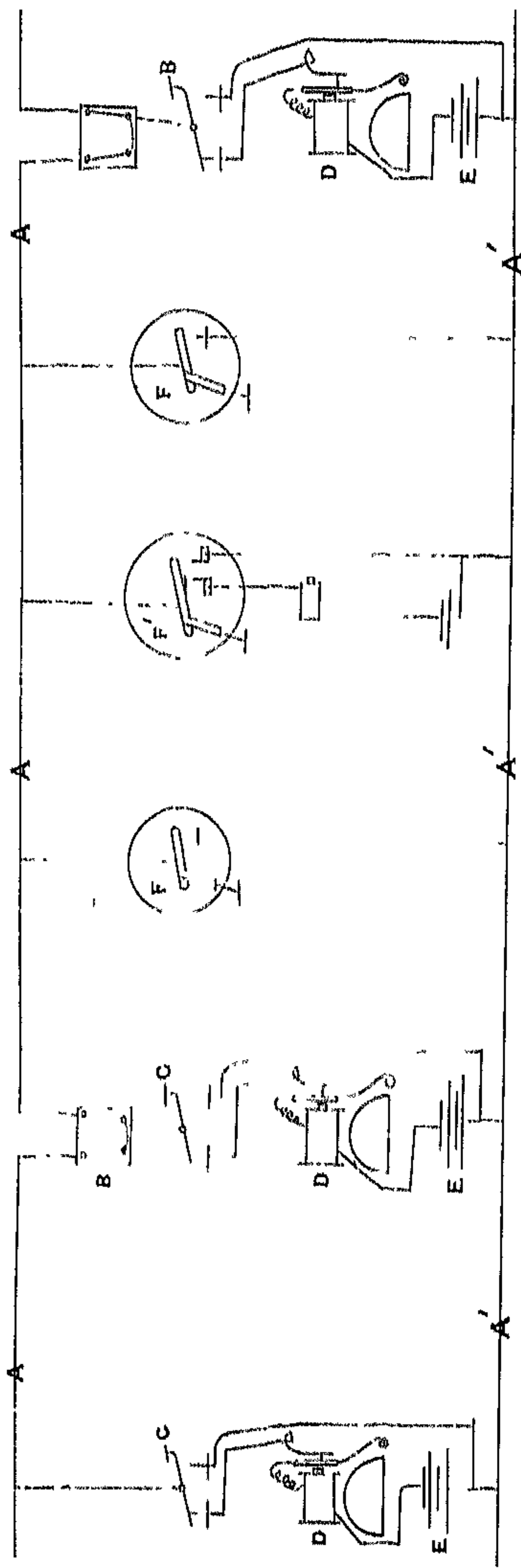
Description has been confined to the various kinds of coupling employed by inventors of electrical systems of intercommunication, because the coupling is the only really difficult part of any such system. Once a simple and effective coupling for the insulated wire is secured, it is only necessary, for the establishment of satisfactory intercommunication in a Railway train, to have strongly made bell and battery arrangements that will stand the shaking given to them by the moving train, and to keep the apparatus under efficient supervision.

The method of making the electrical connections to the bells and batteries employed will depend upon what facilities for intercommunication are required.

If it is sought only to provide that passengers and guards may ring to the engine driver, an electric bell, without battery or contact maker, will be required on the engine, a battery and contact maker in the front brake van, a contact maker only in the rear brake van, and an "alarm communicator" in each compartment of the carriages whence it is intended that passengers may ring to the engine driver.

FIG. 1

Diagram showing Electrical Connections in a Train composed of one Engine, two Brake Vans, and three Carriages. Centre carriage fitted with local bell and battery to indicate where alarm originated.



A Line wire. A' Return, or Earth wire. B Switch. C Contact maker. D Electric bell. E Battery. F Alarm communicator for carriage, *not* fitted with local indicating bell and battery. F' Alarm communicator fitted with local indicating-bell and battery.

But, if it is intended that passengers shall be able to ring to the guards as well as to the engine driver, that guard may ring to guard, or driver, and that the driver may ring to the guards, it will be necessary to have an electric bell battery and contact maker on the engine and in each guard's brake van, as well as an "alarm communicator" in any compartment of a carriage whence passengers are to be allowed to ring the bells.

This plan is illustrated on the opposite page, together with a method proposed by the writer for connecting an indicating bell to direct the guards to the compartment of a carriage whence an alarm has originated. A train composed of an engine, thirteen passenger coaches, and two brake vans has been fitted up on the Great Indian Peninsula Railway in the manner shown by the diagram, and is running daily on the local service between Bombay and Kalyan, in order to ascertain by experiment whether an electrical system of intercommunication will meet the requirements of Indian Railway traffic; and to practically test a form of coupling for connecting the necessary insulated wire between carriages, and an "alarm communicator" that have been recently designed and patented by the writer.

The coupling now under trial upon the Great Indian Peninsula Railway was designed especially with a view to suit trains that have their composition varied many times during a journey, as is the case with the mail and other through trains upon that line. With such trains the risk that a shunting porter may forget to unhitch anything that will not prevent vehicles from separating, is repeated so often during the run of a train, that it is very important to have the electrical coupling for intercommunication purposes so arranged that if the shunter should forget to cast it loose, it will

become uncoupled immediately one vehicle moves away from another, and will not become damaged in the process.

The coupling (Fig. 2) is formed by two pieces of metal tube, each 3 inches in length and $1\frac{1}{8}$ inch in diameter, and closed at one end. A strong flat spring, fixed at the closed end of each piece of tube, projects half an inch beyond the open end, and carries at its free extremity a wedge-shaped piece of metal.

When two pieces of tube are brought together, and one wedge-shaped piece is forced over the other, as shown in Fig. 2, a good electrical contact is made and the coupling is complete.

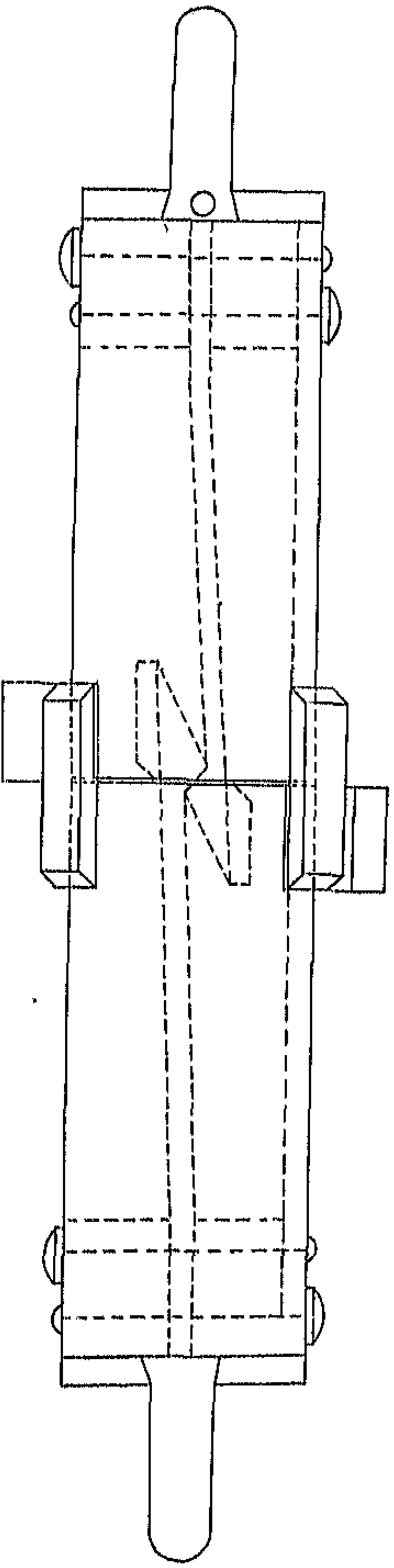
There is a slotted piece on one side, and a stud on the other, of each piece of tube to act as guides and to prevent any circular movement of the parts after they have been connected.

The insulated line wire is fastened to a ring at each end of the complete coupling, and is carried thence to the centre of the width of the carriages at such a height as to be well clear of the screw couplings and side chains of the vehicles. The coupling hangs in the centre of the space between two vehicles, and can only be separated by a direct strain. The amount of the strain required may be regulated by the strength of the springs in the tubes, and the shape of the wedge piece. The couplings employed on the Great Indian Peninsula train separate at a direct pull of 20 lbs.

For the return, or earth, wire the writer prefers to use the permanent way rails connected *via* the wheels of the vehicles of the train, and supplemented by the screw coupling drawbars joined together underneath each carriage by wire spirals, but if such an arrangement should prove to be unreliable in India, as has been suggested—

FIG. 2

FLOYD'S SYSTEM OF ELECTRICAL INTERCOMMUNICATION IN RAILWAY TRAINS.



Coupling to connect insulated line wire between vehicles.

although it has been found perfectly reliable in England for the past 16 years—the coupling under description may be readily made to couple up a return wire as well as the insulated line wire. For this purpose it will only be necessary to fasten the fixed end of the flat spring of each piece of tube in a block of ebonite instead of in metal, thus insulating the spring from the tube. Then the spring will couple the insulated line wire; and the metal case, slotted pieces, and studs of the tubing will couple the return wire; thus the rails of the permanent way will no longer be required to complete the electrical circuit. In connection with most of the electrical systems that have been brought forward provision has been made for giving a signal in case any part of a train should become separated, but, so far as the writer is aware, none of the plans for that purpose have been brought into practical use upon Railways. It is an objection to such a signal that unless some more or less complicated machinery is added to the ordinary electrical apparatus employed in intercommunication systems, the signal given when part of a train breaks away must of necessity appear to engine drivers and guards exactly like the signal given by a passenger whose “alarm communicator” is intended to give a peremptory order to stop the train; therefore there would be risk that the train might be stopped by a break-away-signal being mistaken for a passenger’s signal, and a collision might result from the hinder part of the train that had separated running into the foremost part. Such liability to mistake, and consequent danger, might perhaps be prevented by some such arrangement as the following:—

In each carriage have a train of clock to drive a small wheel that has parts of its periphery insulated,

and parts making rubbing contact with a flat spring, every time the wheel revolves. Connect the wheel and spring in the intercommunication circuit.

Arrange passenger's "alarm communicators" in each carriage, so that any one of them will start the train of clock work when a passenger gives an alarm signal. Then the ringing of the bells on the engine, and in the guards' brake vans, instead of being continuous will be interrupted at regular intervals, and thus clearly show that the alarm signal has been given by a passenger.

Each carriage may have the periphery of its clock-work wheel differently insulated from the others, so that signals given by passengers will not only be identified as such, but the particular carriage that a signal comes from will also be told to driver and guards.

But such a plan would be somewhat expensive, and would introduce complication where extreme simplicity is much to be desired. As, however, Railway authorities who regard a break-away-signal as an important requirement of an electrical intercommunication system in trains, may see some way of overcoming the difficulty proceeding from similarity of signals without incurring serious expense, or introducing complications, the writer has devised an adaptation of his coupling that provides for a continuous signal, identical with that given by a passenger, being given if any part of a train should become separated on a journey.

In this adaptation of the coupling the springs are insulated from the tubes, as described in page 9 so that neither the permanent-way rails nor the screw couplings are brought into use to complete the electrical circuit for the intercommunication, and a small lever is so arranged in each piece of tube that it is insulated from the wedge-shaped piece on the flat spring as

long as the coupling remains connected up, but immediately the coupling is separated, the small lever is forced hard on to the wedge piece, and makes full contact between the insulated flat spring connected to the line wire, and the metal case, slotted pieces, and studs connected with the return wire. Thus the bells on the engine, and in both guard's brake vans, will ring continuously, precisely as they would do if a passenger had given an alarm. It is claimed for the coupling described above that it is simple in construction and very strong, that it may be made of inexpensive materials—the cases may be of iron gas-pipe if desired,—that it assures perfectly safe electrical contacts which are cleaned by the separation, or re-connection, of the coupling,—that it may be used either with or without employing the rails of the permanent way for a return wire, and that it may be readily adapted to giving an alarm in case part of a train should become separated on its journey.

Also that, by means of spare lengths of insulated wire rope having a half coupling at each end, any number of vehicles not fitted with the electrical inter-communication system may be bridged over, so that they will not interfere with signals passing through the electrically fitted portion of the train: and that any description of rolling stock may be fitted with the electric rope and couplings as quickly as it could be fitted with the "cord," so that Railway companies employing the writer's system need only have electric ropes permanently fixed to stock that is constantly running, or that is required to be provided with alarm communicators for the use of passengers; vehicles only occasionally running remaining unfitted with electric ropes and couplings, except when they are actually in work.

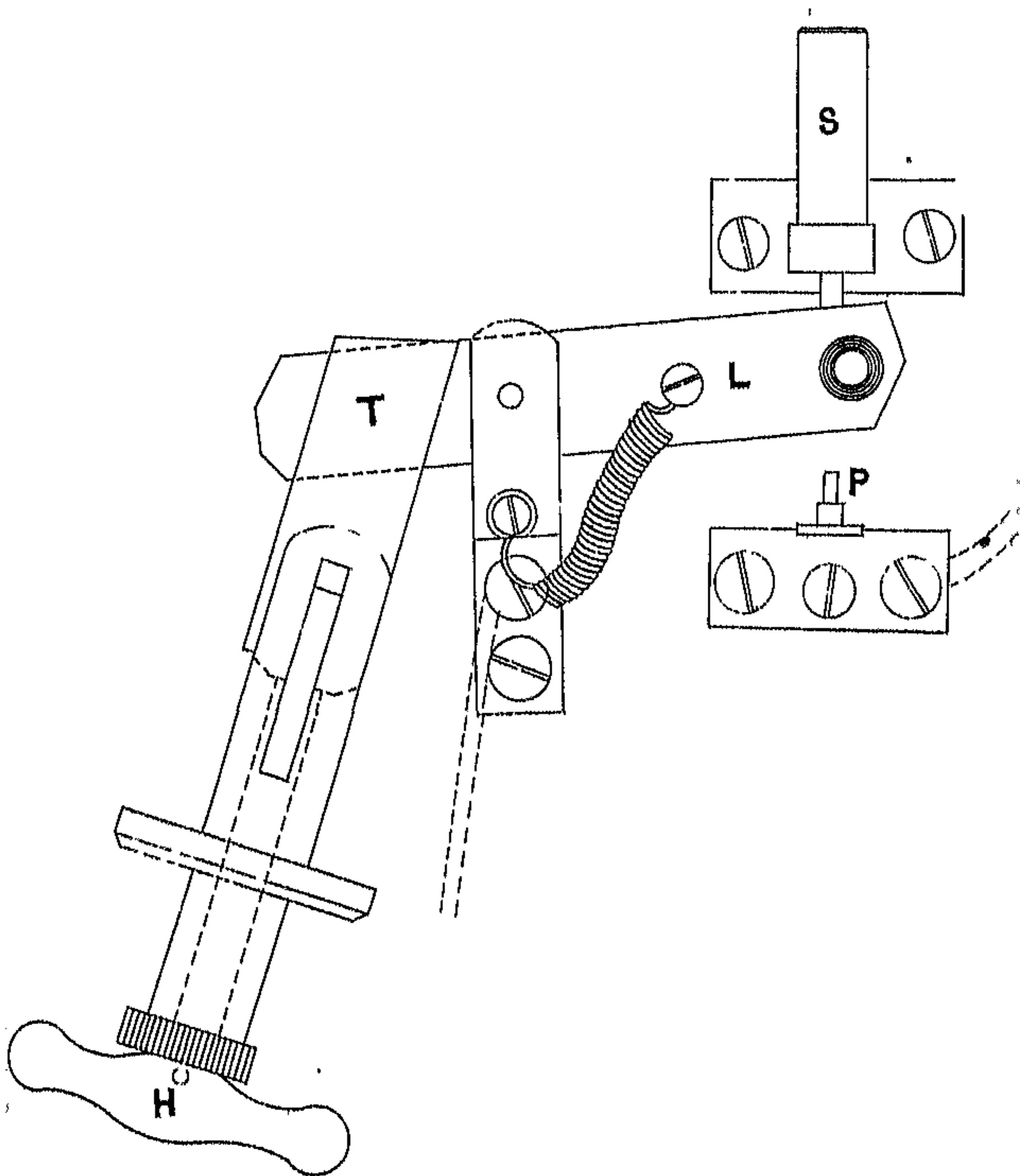
The "alarm communicator," Fig. 3, to be fixed in railway carriages for the use of passengers, has a neat teakwood case,—not shown in the figure—from which only the cross-piece **E** projects. A passenger having pulled this cross-piece downwards once, the tongue **T** is removed from a slot on the lever **L**, and the latter, being released, falls upon the contact point **P**, assisted thereto by the helical spring enclosed in the tube **S**, thus connecting the line wire with the return wire or earth (see Fig. 1) and causing the bells on the engine and in the brake vans to ring continuously until the guard unlocks the teakwood case and restores the lever and handle to their normal positions. The passenger cannot put the handle back until the case has been unlocked, because the tongue **T** cannot enter the slot on the lever **L** until the latter has been lifted clear of **P**.

In case it is required to have an indicator to direct the guards to the particular carriage whence an alarm has been given, the "alarm communicator" lever **L** is slightly lengthened, and an additional contact point is placed alongside **P**, but insulated from it—this extra contact point connects with a small electric bell, and thence with a battery that is connected with **P** (see Fig. 1). Then, when a passenger releases the lever **L**, it falls on both contact points, thus establishing its own circuit as already described, and also completing a local circuit that causes the small bell in the carriage to ring out a direction to a guard passing alongside the train as to where he should look for the originator of the alarm signal.

The switch shown in each brake van (Fig. 1) is to enable the front guard to communicate with the engine driver only, without ringing the rear brake van

FIG. 3

FLOYD'S SYSTEM OF ELECTRICAL INTERCOMMUNICATION
IN RAILWAY TRAINS.



Alarm Communicator.

bell, or to communicate with the rear guard only, without ringing the engine bell. For the former purpose he disconnects the bar nearest to the rear of the train from its lower terminal, and keeps the bar nearest to the engine connected up as shown in the diagram, and for the latter purpose he disconnects the bar nearest to the engine, and keeps the bar nearest to the rear of the train connected up. The switch is only required in the front brake van, but as any brake van may be placed in front of a train, it is necessary to fit every vehicle of that class with a switch.



EAST INDIAN RAILWAY COMPANY.

A D D R E S S

OF THE DEPUTY-CHAIRMAN,

BAZETT WITTENHALL COLVIN, ESQ.,

AT THE

**FORTY-SEVENTH HALF-YEARLY GENERAL
MEETING OF PROPRIETORS,**

HELD ON THE 19TH DECEMBER, 1894, AT THE

**CANNON STREET HOTEL, CANNON STREET,
LONDON.**

London :

PRINTED FOR THE COMPANY.

EAST INDIAN RAILWAY COMPANY.

ADDRESS

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The SECRETARY having read the notice convening the meeting,

The CHAIRMAN said—Before entering on the matters which we have to consider to-day, I must begin by saying that to our great regret, and I am sure to yours also, General Strachey is prevented by indisposition from taking his usual place in the chair. He has not been well for the last week, and though he is now recovering I am glad to say, his medical advisor will not at present allow him to venture out of doors. The duty devolves upon me, therefore, on the present occasion, of giving you the account of our proceedings which you are accustomed to receive at these Half-yearly Meetings; and though I can ill supply your Chairman's place, I will to the best of my ability lay before you the results, and notice the principal points in the working of the half-year which ended on June 30th last.

In doing so, I will commence with a comparison of the actual figures for the half-year under review, with the estimate of them which was previously made.

The gross receipts for the half-year of which I am speaking were in round figures (I will not burden your memory with the smaller ones) 292 lakhs of rupees,—they were estimated at a little over 290 lakhs. The working expenses were 88 lakhs,—and were estimated at 85½ lakhs. The net receipts were 204 lakhs of rupees, which is just the amount that was anticipated. (“Hear, hear.”) I do not know that there is any point in

connection with these figures to which I need specially advert, except that of the increase of rather more than 10 lakhs of rupees in the working expenses about one-half, or a sum, roughly speaking, of 5 lakhs is due to the increase in our traffic. As the work to be done increases it will be readily understood that the expenses of doing it must increase. The 5 lakhs of rupees, which make the other half of the sum, are accounted for by increased charges on account of the permanent way. In order to maintain this properly we have in every year to relay rails and replace sleepers. This work goes on continually. But in some half-years, when the materials are on the spot and the circumstances are favourable, a larger amount of it is done; in other half-years, under less favourable circumstances, the progress of renewal is slower: but the excess of this half-year, although it may appear large, is balanced by a smaller expenditure in other half-years.

I turn now to the actual and estimated dividend of the half-year.

The amount anticipated by the Chairman at our last meeting, when he took the exchange at 13d., was £1 1s., in addition, of course, to the 2 per cent. of guaranteed interest, and he hoped it might be £1 2s. if certain claims against the Government on account of telegraph charges were paid to us during this half-year. These claims, however, have not yet been paid, and the consequence is that the Company's share of the net profits, which were brought home at a rate slightly more favourable than we had anticipated, has yielded exactly the £1 1s. (in addition to the guaranteed 2 per cent.) which was estimated. In comparing this figure of £1 1s. with the dividend of £1 3s. 6d. which was paid in the corresponding half-year of 1893, it must be remembered that the profits of that half-year were increased by a refund to revenue of a sum

of about $10\frac{1}{2}$ lakhs, which had been charged to revenue improperly, and which, on being transferred to capital and credited to revenue, of course swelled the dividend of that half-year. Now, the Company's share of that refund of $10\frac{1}{2}$ lakhs was a little more than 2 lakhs, which is equivalent to a dividend of 3s. 6d. In order to make a fair comparison between the dividends of the half-year which I am reviewing and of the corresponding half of 1893, it is necessary to deduct this extraordinary addition of 3s. 6d. to the income of the latter period. Making that abatement, the dividend for the first half of last year would only have been .£1, and we have therefore actually made about 1s. more during this half-year than we did then.

I now come to the estimate of the probable results of the working of the current half-year which will end on 31st of this month, and will give a forecast, so far as one can be made, of the probable dividend to be paid in July next. The figures for the half-year come out as follows: Our gross receipts have been in round figures 253 lakhs, against 242 lakhs in the corresponding period of 1893, that is to say, there has been an increase of 11 lakhs, or about $4\frac{1}{2}$ per cent., and our net receipts have been 174 lakhs, against 168 lakhs in 1893, or, less the payment which we have to make to the Delhi-Umballa-Kalka railway, 171 lakhs, against 165 lakhs in 1893. From this sum must be deducted what are known as the fixed charges, that is, the annuities, and the charges on account of interest on capital advanced by the Secretary of State, &c.; the amount of these charges will be $154\frac{1}{2}$ lakhs, leaving a total surplus of about $16\frac{1}{2}$ lakhs. Of this last figure the Company's share of one-fifth will amount, less Indian income-tax, to very nearly Rs. 3,10,000. What dividend this sum in round figures of Rs. 3,10,000 will yield depends of course on the rate of exchange at which the Board may be able

to bring the money home. For some time past the exchange, as we all know, has been pretty steady at about 13d., and some good judges, I understand, think that it has now fallen as low as it is likely to go. Upon this point it is hardly safe to venture upon prophecy, but assuming that the exchange falls no lower than it is now, the surplus to be distributed to the Company in July next should yield nearly 5s. in addition to the guaranteed 2 per cent. If exchange should fall to, say, 1s., our dividend will fall to nearly 4s. 6d., and will be proportionately less of course with any greater fall, or higher if by any unexpected good fortune the downward movement of exchange should be reversed. It must be borne in mind that it really is this question of exchange upon which the amount of our profits in any given half-year, in spite of our fast increasing traffic, largely depends; and against the loss by exchange at present I fear we have no remedy. The increase in our fixed charges during the half-year which will end on the 31st of the present month, that is caused by a fall in the rate of exchange from 1s. 2½d. to 1s. 1½d. per rupee, amounts, approximately, to 1½ lakhs of rupees; that is to say, put in round figures, to £75,000. These 1½ lakhs, and an increase of 5 lakhs in working expenses, make a total of 10½ lakhs in excess of the corresponding charges of 1893, and these 10½ lakhs of extra charges are equivalent to a reduction of say 6s. in the dividend, of which reduction nearly 4s. 6d. are wholly and solely due to the fall in exchange. Nevertheless, although our dividend in July next will probably be less by 3s. or 3s. 6d. than the dividend paid last July, this is not likely to be more than a temporary fluctuation in the amount of our profits. From the returns of former years it will be seen that our traffic is so surely and so rapidly increasing that we can look to the future with perfect confidence. In the end the growth of our traffic should more than compensate any future

fall of exchange which we can reasonably anticipate, and in the meantime, if we look to the dividend paid and estimated for the whole of the current year 1894, we see that it will amount approximately to $5\frac{1}{2}$ per cent.—a return which at the present rate of interest on investments would not, I think, be very easy to procure elsewhere.

I pass now to the general results of the working of the half-year which I am reviewing. The gross receipts, the figures of which are given in the report, exceed those of the corresponding half-year of 1893 by more than 21 lakhs, and are higher by 14 lakhs than those of any previous half-year. This increase is both in passengers and in goods. The passenger traffic shows an increase of very nearly 10 lakhs of rupees, and an increase in the number of passengers carried of about one million. The rapid increase in the passenger traffic is remarkable. The passengers during the first half-year of 1894 were not only more numerous than those of the corresponding half-year of 1893 by a million, as I have said, or 12 per cent.; but their total for the half-year that we are considering exceeds the total number of travellers who passed over the line during the whole twelve months of 1880, which was the first year of our existing contract. The goods traffic, as you will see, carried in the half-year was rather over $3\frac{1}{4}$ millions of tons, against rather less than 3 millions of tons in the corresponding half-year. The receipts on this account were in round figures 189 lakhs, against 178. Turning to the details of the goods traffic, the only article that calls for notice is coal. The quantity of this which has been carried for other than our own purposes (I exclude what we carry for the use of our line) shows an increase of about 130,000 tons. This increase is due almost entirely to the coal shipped from Calcutta. The State and other railways which got their coal from us have not materially altered their consumption. The

increase is in the quantity carried to Calcutta, where large exports have been taking place; principally to Bombay, Rangoon, and especially during the last half-year to Ceylon. *As regards the charge for carrying this coal, great reductions, which have been referred to in former reports, have been made in the rate with a view of facilitating and stimulating the coal trade.* A ton of coal is now carried over one mile on the East Indian railway for a charge which may be approximately stated as ½d. In addition to this low rate, reductions of charge are made for large quantities and long loads, and also upon coal consigned to Calcutta for export by sea. The increase of 100,000 tons in the quantity of coal carried for the public during the past half-year is good proof of the appreciation by the public of the advantages which have been offered them, and of the success of our endeavours to assist the business. Indeed, a considerable export has already been established at the docks. We should be glad if it were possible to go further in the direction of reduction, but for the present the limits of what can be safely done by us towards cheapening the transport of coal have probably been approached. Some margin of profit is necessary, and with the great fall of exchange, and the consequent heavy increase which I have noticed in our fixed charges, we must be careful not to go too far.

As regards general merchandises, I do not propose to occupy the time of this meeting with much comment on details. The variations in the different items are very inconsiderable, and what little there is to be said about them has been said in the report. I have only one general remark to make, which is, that in spite of the absence of activity in the export trade of Calcutta during the past half-year, our gross receipts have continued to increase, and that by 21 lakhs, or 7·7 per cent. This continuous growth is very satisfactory, because

it shows that we have a large, steady, and increasing volume of internal traffic, upon which we may safely depend for our income, irrespective of any fluctuations of the external trade.

I will now leave the figures of the report, and proceed to one or two other points which I think will interest you.

You will have noticed that an application is being made to Parliament for an Act. The object of this application appears fully from the notice which has been printed *in extenso* in the report, and as the proposal will hereafter be submitted to the approval of the Company at a Special Meeting of the Annuitants, and full explanations will then be given, I do not propose to detain the present meeting with any detailed account of what is in contemplation. This much, however, it may be as well to say now, that the advantage which we seek to gain by the measure in question is the important one of enabling us to raise capital. We have long needed capital for constructing branches and feeder lines, for which, however desirable and however promising in point of profit, no money has been hitherto available. The Company is at present dependent, under the contract, upon the Secretary of State for the supply of any capital it needs. For causes with which we are not at this moment concerned, there have always been great difficulties—difficulties to which your attention has been called on previous occasions—in obtaining funds for the extension of our line. Under the Bill which we desire to promote we shall be given power, if it becomes law, to borrow for this purpose upon the security of the general Undertaking, somewhat in the same manner that municipalities borrow upon the security of their rates. If invested with such power, we shall be in a position to obtain money without going to the Indian Treasury for it—(“hear, hear”)—and we have good reason to hope that we shall be able to obtain it upon more favourable terms. For all capital sup-

plied by the Secretary of State we are charged under our contract 4 per cent. With the security that we shall be able to offer we ought to be able to borrow it at 3, or very little more than 3, per cent., and in proportion to the reduction of that interest the charge upon the Undertaking will be reduced. On the other hand, with the experience which has now been gained of railway results in India, it may safely be predicted that any auxiliary line with which we should be likely to concern ourselves, when constructed in the busy and populous districts of Bengal and the North West through which our main line passes, would hardly pay less than the 3 per cent. estimated for interest, and we may fairly anticipate that it would pay a good deal more. Lastly, it will be seen from the notice to which I have referred in the report, that the powers which the Company are seeking to obtain will, like all its proceedings, be dependent on the consent and subject to the control of the Secretary of State, who is of course our principal partner in the Undertaking.

To put the matter in a few words, the proposal that we are making may be described as one for enabling the Company to raise money at less than 4 per cent. interest, and to do that without incurring any risks beyond those to which it is already liable, or overruling any of the safeguards which now exist. It may be added that the powers sought are also intended to be made use of in facilitating the construction of auxiliary railways, for which the necessary capital would be found by the persons interested in them, whilst our concern in the business would be limited to working the lines, when made.

There is a summary at the end of the report in paragraph 56 of certain improvements in the working of the line introduced during the last half-year. I need not refer to them all, but may draw attention to the fact that we are adding to

the number of our passenger and goods vehicles, and providing special wagons for the transport of mineral oils. For this purpose we are sending out 104 passenger carriages of all classes, 730 goods wagons, and twelve oil-tank wagons, which are almost all in addition to the rolling stock that we already have.

EAST INDIAN RAILWAY.

STATEMENT SHOWING RESULT OF WORKING.

(Including Lines worked by the Undertaking.)

1878-1894.

Half-year ended	Passenger Unit Mileage.	Coaching Receipts.	Goods Unit Mileage.	Goods Receipts.	Miscellaneous Receipts.	Total Receipts from all sources.	Working Expenses.	Percentage of Working Expenses on Gross Receipts.	Net Receipts.	Fixed Charges.	Contract rate of Exchange.	Interest on Stores.	Interest on Capital advanced by Secretary of State.	Provident Institution.	Surplus Profits.	Company's Share.	Exchange at which brought home.	Dividend with Guaranteed Interest.
1878-30th June	No.	Rs.	No.	Rs.	Rs.	Rs.	Rs.		Rs.	Rs.	1 10	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
31st December	285,958,091	54,41,499	884,153,227	1,51,42,806	7,81,206	2,35,66,511	72,52,090	33-94	1,41,13,421	81,54,893	...	...	39,666	1,30,680	58,16,444	29,03,222	1 7-125	3 7 6
1879-30th June	309,962,555	58,22,871	436,317,452	1,63,07,012	9,61,928	2,35,91,811	78,81,970	37-65	1,57,09,841	81,70,909	...	...	47,105	1,53,124	73,37,738	36,68,869	1 8-312	3 13 9
31st December	273,463,820	53,54,973	343,732,284	1,34,12,413	9,57,024	1,97,24,410	63,53,322	32-20	1,33,71,088	81,70,909	...	...	51,742	1,30,645	49,14,022	24,37,011	1 8-250	3 7 4
1880-30th June	303,002,937	57,79,050	484,370,158	1,61,21,507	8,12,451	2,27,13,008	74,00,011	32-88	1,53,12,997	95,93,257	1 8½	1,79,952	...	1,53,130	58,86,658	10,77,352	1 7-812	3 7 0
31st December	307,184,227	58,94,218	363,703,242	1,37,11,359	6,26,505	2,02,32,082	67,90,687	33-56	1,34,41,395	95,95,129	...	2,15,411	19,650	1,34,414	84,76,791	6,95,558	1 7-580	2 17 6
1881-30th June	322,680,375	61,22,814	454,518,425	1,60,00,582	6,83,906	2,28,07,254	67,48,105	29-59	1,60,59,149	98,48,518	1 8	2,59,649	31,036	1,60,591	57,59,355	11,51,871	1 7-850	3 9 0
31st December	308,584,428	57,69,319	509,670,833	1,62,37,963	5,96,906	2,26,04,218	77,15,057	34-13	1,48,89,161	98,48,518	...	2,68,844	62,926	1,48,891	45,59,982	9,11,996	1 8	3 3 4
1882-30th June	415,714,393	71,21,607	521,382,496	1,74,62,134	6,21,436	2,52,06,227	85,76,092	34-02	1,66,30,135	98,48,518	...	2,51,067	1,13,937	1,66,301	62,50,311	12,50,062	1 7-622	3 11 0
31st December	368,274,266	60,70,702	482,046,581	1,63,04,342	5,36,523	2,19,11,367	88,28,991	40-29	1,30,82,376	98,85,732	...	2,12,542	1,63,235	1,30,324	26,90,053	5,38,011	1 7-344	2 13 6
1883-30th June	424,329,718	65,98,074	624,013,080	1,94,49,481	5,74,529	2,66,22,384	94,24,215	35-40	1,71,98,169	1,00,17,379	1 7½	2,09,526	2,02,729	1,71,982	65,96,553	13,19,311	1 7-531	3 12 6
31st December	403,286,795	64,89,742	580,218,812	1,68,45,843	5,74,522	2,37,10,113	91,78,738	38-71	1,45,31,374	1,00,23,093	...	1,94,560	2,31,752	1,39,914	39,42,055	7,88,411	1 7-750	3 0 0
1884-30th June	443,089,778	70,24,192	588,854,835	1,75,93,785	4,16,087	2,50,84,064	96,60,760	38-58	1,53,73,304	1,01,40,599	1 7½	1,79,512	2,63,216	1,50,522	46,34,454	9,26,891	1 7-250	3 2 8
31st December	419,177,663	66,33,693	384,116,823	1,27,81,354	3,81,378	1,97,96,925	73,06,092	36-40	1,25,80,833	1,01,40,599	...	1,92,387	2,92,826	1,34,088	18,30,433	3,66,096	1 7	2 8 9
1885-30th June	454,438,952	73,98,374	558,186,701	1,76,02,079	4,93,775	2,54,94,203	85,90,289	33-69	1,69,03,914	1,02,61,159	1 7½	1,62,307	3,48,876	1,69,039	59,62,533	11,92,507	1 6-187	3 7 6
31st December	411,306,848	66,52,875	490,414,789	1,50,69,374	3,99,625	2,21,21,874	82,18,436	37-15	1,39,03,488	1,02,61,159	...	1,67,289	3,87,087	1,39,034	29,48,989	5,89,788	1 5-469	2 12 6
1886-30th June	467,824,984	75,12,063	578,714,181	1,77,80,290	5,31,938	2,58,24,291	88,94,557	34-44	1,69,29,734	1,07,76,426	1 6½	1,41,520	4,27,890	1,69,297	54,14,600	10,57,771	1 5-687	3 4 6
31st December	446,389,809	71,89,421	482,515,613	1,45,16,284	3,73,798	2,20,81,503	76,98,860	34-36	1,43,82,643	1,07,76,426	...	1,65,237	4,47,083	1,43,826	23,50,070	5,33,163	1 4-844	2 11 5
1887-30th June	492,317,803	77,35,733	593,069,616	1,76,26,797	4,30,518	2,57,93,048	79,96,700	31-00	1,77,96,343	1,09,14,189	1 6	1,40,551	4,61,685	3,27,963	59,51,961	11,81,252	1 4-786	3 5 6
31st December	453,258,037	71,96,834	456,450,255	1,40,12,468	3,61,618	2,15,71,000	70,38,698	32-62	1,45,32,302	1,09,14,189	...	1,59,734	4,71,872	1,45,323	23,41,184	5,53,517	1 4-031	2 11 6
1888-30th June	513,474,563	80,68,123	583,587,708	1,70,30,792	3,85,125	2,54,85,040	84,98,240	33-34	1,69,36,300	1,15,05,758	1 5	1,39,360	4,55,934	1,69,368	47,15,881	9,19,904	1 4-594	2 19 0
31st December	463,028,312	73,07,031	449,467,529	1,34,90,658	3,49,673	2,11,47,362	70,25,748	33-22	1,41,21,614	1,15,05,758	...	1,23,603	4,67,993	1,41,216	18,78,045	3,58,439	1 4-312	2 7 6
1889-30th June	514,145,561	79,54,460	560,280,916	1,63,23,549	3,61,096	2,48,39,105	81,67,018	33-15	1,64,72,087	1,13,28,431	1 4½	1,43,864	4,94,132	1,64,720	38,40,933	7,51,188	1 4-906	2 16 6
31st December	475,820,556	75,64,190	443,938,553	1,33,61,352	3,12,322	2,12,37,864	77,13,441	36-34	1,35,19,423	1,13,28,431	...	1,61,964	5,01,415	1,34,945	8,67,718	1,64,152	1 6-437	2 4 0
1890-30th June	499,645,092	78,58,941	525,933,015	1,56,50,594	4,46,715	2,39,56,250	77,10,153	32-60	1,62,46,097	1,15,05,757	1 5	1,54,332	5,05,707	1,61,450	33,17,716	7,63,040	1 6-340	2 17 6
31st December	454,729,509	72,93,679	409,724,124	1,23,97,359	4,31,853	2,06,72,891	63,28,912	30-61	1,43,43,979	1,15,05,757	...	1,62,497	5,05,397	1,42,136	18,97,859	3,79,541	1 4-812	2 8 6
1891-30th June	575,160,962	90,45,804	621,359,306	1,82,15,043	4,17,511	2,76,78,358	75,15,930	27-15	2,01,62,428	1,06,42,387	1 6½	1,42,304	5,11,649	2,97,190	80,89,458	16,31,357	1 4-971	3 15 3
31st December	498,281,369	80,13,654	512,079,014	1,56,88,881	3,34,883	2,40,37,428	66,84,360	27-31	1,73,53,068	1,06,42,387	...	1,24,394	4,59,010	1,70,785	57,76,702	11,18,357	1 3-875	3 2 0
1892-30th June	533,441,871	84,64,229	676,197,888	1,87,79,786	4,64,910	2,77,08,945	76,73,608	27-69	2,00,35,337	1,15,69,406	1 4½	1,04,502	4,65,647	1,97,479	74,10,873	14,45,691	1 2-923	3 7 6
31st December	490,512,532	79,08,539	519,636,491	1,44,91,564	4,07,944	2,28,08,097	67,10,620	29-42	1,60,97,477	1,15,69,406	...	93,729	5,70,227	1,58,224	34,30,802	6,86,160	1 2-594	2 12 0
1893-30th June	547,396,432	87,57,644	656,788,048	1,79,67,904	3,54,534	2,70,80,072	76,94,763	28-42	1,93,85,309	1,30,34,784	1 2½	99,510	6,16,409	2,01,234	61,76,449	12,35,290	1 3-225	3 3 6
31st December	555,263,569	88,70,811	542,075,811	1,60,02,535	3,23,668	2,41,97,014	73,59,420	30-41	1,68,37,594	1,30,34,784	...	1,20,740	6,57,442	1,65,204	25,32,199	5,06,440	1 0-937	2 8 0
1894-30th June	626,203,722	97,34,701	729,084,648	1,90,33,755	4,14,762	2,91,53,218	87,73,329	30-06	2,04,00,889	1,26,32,406	1 3½	1,08,157	7,14,546	2,00,454	63,89,867	12,77,973	1 1-156	3 1 0

the number of our passenger and goods vehicles, and providing special wagons for the transport of mineral oils. For this purpose we are sending out 104 passenger carriages of all classes, 730 goods wagons, and twelve oil-tank wagons, which are almost all in addition to the rolling stock that we already have.