Seventh. Empty the tub into the box and set the latter in motion.

Eighth. After ten or twelve revolutions, occupying about one minute, stop the motion, open the trap-door and empty the mixed concrete into the tub, so that it can be deposited by the crane in some convenient spot within its sweep, and thus be out of the way of the succeeding batch.

It will generally be found convenient to convey the concrete to its allotted place in wheel-barrows. It should be compacted with rammers, in horizontal layers 5 to 6 inches in thickness, until all the coarse materials are driven below or flush with the general surface.

As a rule concrete should be compacted in place before the cement has had time to take its initial set. Where the cement contains quicklime, a delay of a few hours is sometimes necessary to allow the lime to become thoroughly slaked.

CHAPTER VII.

TRAMWAYS, AND STREET RAILWAYS.

A horse can draw, upon a good stone tramway, a load 11 times as great as he can move with the same effort and at the same speed upon an ordinary gravel road, the force of draught being only $\frac{1}{170}$ of the load in the first instance while in the second it is $\frac{1}{15}$. Even upon a very dry and smooth broken stone road—*i. e.* a macadamized road in its best condition—the tractive force is $3\frac{1}{2}$ to 4 times as great as upon a good stone tramway.

The marked advantages of a hard smooth surface for the wheels of heavy vehicles to move upon on the one hand, and the comparatively great expense of providing such surfaces on the other, has led to the practice in some localities of restricting the width of the wheel tracks to what will simply suffice for the convenient use of the several kinds of vehicles upon which the traffic is conducted, while the rest of the roadway is finished with a less costly covering.

A construction of this kind is called a tramway, which consists of two parallel tracks of suitably smooth and hard material to receive the wheels, while the spaces between them on which the animals travel, as well as the road surface on either side, is paved with a different material.

The wheel tracks are usually of stone; occasionally of wood or iron.

As tramways are intended for the equal and common use of all classes of vehicles, and not, like street railways, for the exclusive benefit of specially constructed cars restricted to one kind of traffic, their construction and maintenance properly belong like street paving to the municipality, rather than to private corporations. They possess certain advantages over street railways in being adapted to every variety of traffic and vehicles, with entire freedom to leave the tram when needful without becoming helpless or inefficient, and return to it as occasion or convenience may suggest. Stone tramways are in general use in Southern Europe, particularly in Turin, Milan, Verona, and many of the smaller cities and towns of Northern Italy.

The Italian Tramways.

The Italian stone tramways consist of two parallel lines of granite blocks or slabs, each slab being usually about 2 feet in width transversely, 8 inches in thickness, and 4 to 6 feet in length. The blocks are laid end to end with close joints. The clear distance between the two lines is about 2 feet 4 inches, making the width between the two axes or center lines 4 feet 4 inches, which is about the average width between the carriage wheels. The roadway is usually formed with a slight inclination from the sides toward the centre, the tramway blocks being laid to the same inclination, with their upper surfaces flush with the road surface on both sides.

The horse track between the blocks is therefore the lowest part of the road. It is paved with cobble stones from the neighboring streams, forming a shallow concave channel along which the surface water flows away into suitable cross drains.

The wings of the road may be paved, Macadamized, graveled, or left as earth roads.

The foundation for these Italian trams usually consists of a bed of screened gravel 5½ to 6 inches in depth, surmounted with a 2 inch layer of sand in which the granite blocks are set.

The road bed is well compacted by ramming or rolling before the gravel is spread, and this is also watered and rolled or rammed in the usual manner. Sub-drainage is provided in soils which require it.

The surface drainage is discharged by the central gutter between the trams, into sub-drains, through vertical shafts covered with stone gratings. The gratings are formed from a single piece of granite, cut concave on the top to correspond to the surface between the trams, and usually provided with three slots, each about 12 inches long, 1½ inches wide, and 8 to 10 inches apart.

The cost of constructing one mile of the tramway above described, with wages varying from 3 to 3½ francs per day for stone cutters, 1½ to 2 francs for common laborers, and 2 francs for pavers, amounts to about $8,600, gold. This includes the paving between the trams, the subdrains, and the openings in the central gutter leading thereto covered with granite gratings, and surface grooving the blocks to give horses a foothold on the trams when turning out on steep grades. It does not, however, include the cost of paving the roadway outside the trams.

Although the first cost of a good stone tramway is comparatively large, it possesses a long life, and the necessary annual expense upon it for repairs is but a mere trifle. It is an error to assume that they are out of date, although their usefulness and their general adaptation to the necessities and conveniences of traffic, have been greatly restricted by the introduction of steam and street railways. They are certainly not adapted to the most crowded streets of a city, and as a connecting route between neighboring towns, a railroad, although costing three to four times as much, might in most cases be preferable ; but upon wide streets and over short suburban lines with a large traffic, and in special cases in manufacturing and mining districts, and in large cities, as a connecting link between the termini of railroads, where steam cars are inadmissible, they are able to supply a convenient and inexpensive method of carriage, while the current outlay for maintenance, which amounts to a heavy tax upon all other kinds of roads, is only nominal.

Where the haulage is heavy both ways the tramway should have a double track, the centre line of blocks being common to both, and wide enough to allow the vehicles to meet and pass each other without leaving the trams.

To insure a greater degree of permanence and stability, the blocks should be bedded in hydraulic mortar, upon a concrete foundation 6 inches thick. This would allow a reduction in their thickness to about 6 inches.

The horse track should be paved with stone blocks as greatly preferable to cobble stones.

An excellent substitute for a stone tramway is a stone block pavement of carefully selected blocks laid in mortar upon a concrete foundation. Its width for the vehicles in common use need not exceed 13½ to 14 feet to enable them to meet and pass each other without collision. It should be along the middle of the roadway, and slope each way from

the crown at the rate of about 1 in 40, the wings being finished with any covering suitable for the neighborhood.

Tramways should of course be laid on the grade of the street as usually constructed, and there can be no advantage in having the middle of the street lower than the sides.

Street Railways (Called also Tramways).

On a well built railroad, the force required to move a car upon the level rail, at a speed of 5 miles per hour is not far from $\frac{1}{230}$ to $\frac{1}{250}$ of the total weight of car and load, varying within these limits with the state of the rail with respect to moisture and dryness.

The following rule is the one in common use for obtaining this resistance:

1. Multiply the weight in gross tons by 6. The product regarded as pounds will be the friction.

2. Multiply the weight by the velocity in miles per hour and divide by 3. The quotient will be the allowance to be made for concussion, in pounds.

3. Square the velocity in miles per hour, and multiply the square by the frontage in feet, and divide the product by 400 for the resistance of the atmosphere in pounds.

4. The sum of these three results is the total resistance in pounds.

Upon street railway lines, in consequence of the presence at all times of more or less dust and stiff mud upon the rails, the tractive force is comparatively large. In the average condition of the road it may be set down as fully $\frac{1}{120}$ of the loaded car, so that a car weighing 4,000 lbs. carrying 28 passengers, each weighing 150 lbs—total 8,200 lbs—would require the exertion of a force of 68⅓ lbs ($\frac{8200}{120}$) to move it on a level rail at a low speed. Upon descending grades of 1 in 68½ the brakes would not therefore have to be applied.

In practice the grades must conform to those of the street, and for short lengths may be even steeper than would be suitable for ordinary vehicles upon a good street surface. The question of grades, therefore, for street railways, except in special cases, resolves itself into the adoption of those already existing.

Upon the Bleecker street and Fulton Ferry line, in New York city, there are two very steep grades, one with an aggregate rise of 10.3 feet in 225.25 feet, equal to a mean of 1 in 21.8, and the other with an aggregate rise of 10.3 feet in 248.8 feet, equal to a mean of 1 in 24. The point of highest grade upon each ascent is very considerably steeper than the average rise, which includes those portions with a gentle grade near the foot and the crest of each stretch.

Drainage.

Upon streets suitably provided with paved carriage ways and sidewalks, and with sewers, there is no occasion to make any special or additional provision for the drainage of street railways, but for lines located upon country or suburban roads, the same precautions must be taken to secure thorough surface and sub-drainage that have already been described as necessary for ordinary roads. There is no occasion to repeat them here.

Construction.

A street railway, as almost universally constructed in the United States and elsewhere, consists of rolled-iron rails, laid upon longitudinal timbers or stringers, resting upon

timber cross ties. The top of the rails should set flush with the surface of the street, and they should, preferably, be of such patterns and laid to such gauge as will least incommode the ordinary traffic conducted with the vehicles of the neighborhood, for it will rarely occur that the interests of the railway, and those of the truck, cart, and express wagon will be other than identical. Upon crowded streets in particular, and generally in the business portions of cities and large towns, every device calculated to keep the current of traffic moving, and prevent blockades, is a benefit alike to all.

Rails.

It is desirable that the car wheels should bear upon the rail directly over the centre line of the stringers, or as nearly so as possible, in order to obviate any tendency of the rail to cant to one side, when the wood begins to become soft and weak from decay. This condition however would exclude the rail with the single rib, raised on one side only (See Figs. 68 and 69) and having a broad flat surface occupying the rest of its width, which is really the form offering the least interference with the traffic conducted on ordinary carriages; for the broader the surface upon which such carriages can track, the less will be the difficulty, and the less the wrench upon the wheels, as well as upon the rails, in taking and leaving it.

In some cities the pattern of the rail, as well as gauge of the track, is prescribed by municipal authority, with special reference to obtaining such a railway as will not only reduce to a minimum the annoyance occasioned by the rails to promiscuous traffic, but will enable them even to contribute to its promotion and convenience.

A grooved rail, as a general rule, is not the most desirable either for the railway company, or the ordinary vehicles upon the street. It collects the dust and mud, and, in cold weather, gets filled with ice and snow, thus greatly augmenting the tractive force of the car; while the wheels of wagons and hacks, and especially of all of the lighter and frailer classes of carriages, having once entered the grooves, experience a severe strain, and are not unfrequently twisted off, in leaving them, while the rails themselves are thereby more or less disturbed and in time loosened at their fastenings. In Fig. 65, serviceable and convenient forms are shown at **b**,

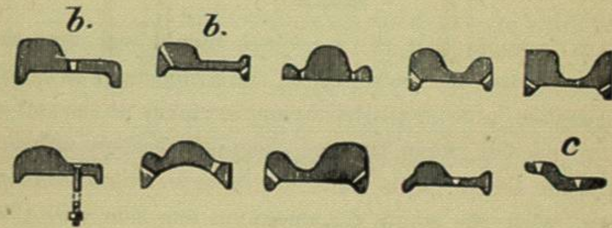

FIG. 65.

which if made of 55 pounds weight per yard will answer for heavy traffic. For light traffic form **c** of 30 to 35 pounds weight has been found to be suitable. Rails are sometimes made of 70 and even 75 pounds weight to the yard. Cast iron rails have been tried without giving satisfaction.

Stringers, or Sleepers.

The purpose of the stringers is two-fold: to secure a uniform bearing for the rails, and to raise them to the level of the street surface. They may be of southern or of ordinary white pine, preferably the former, on account of its superior stiffness and hardness. Any other kind of durable

wood possessing these qualities, may of course be used, provided its price be such as not to exclude it. The sleepers are sawed, the usual dimensions being 7 to 8 inches

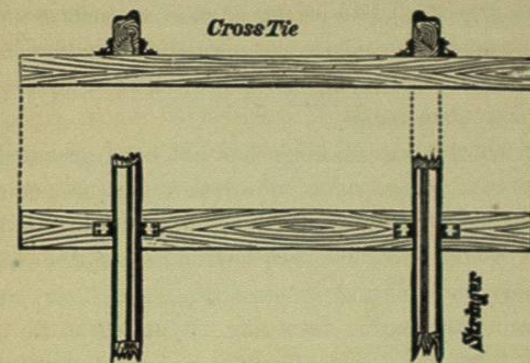

FIG. 66.

in depth, with a width equal to that of the rail, and a length varying from 25 to 40 feet. (See Figs. 66 and 67.)

Cross Ties.

The cross ties (Fig. 66) may be of any durable wood, either white or yellow pine, chestnut, or white oak, hewn or sawed, 6 to 7 inches wide, 5 to 6 inches deep, and of such

FIG. 67.

length as to reach about 12 inches beyond the stringers on either side. They may be faced on the top and bottom only, the bark alone being taken from the sides.

Upon streets suitably sub-drained, the cross ties are simply laid in trenches excavated to receive them, care being taken not to loosen up the soil to a greater depth than is requisite to give them a firm and level bearing throughout their entire length, with their top surfaces parallel with the line of the grade. The earth should be packed around them and under their edges by tamping with a crow-bar or other suitable implement, to guard against subsequent settlement or disturbance.

When suitable sub-drainage has not been provided, as will often be the case upon suburban streets and country roads, and especially where the railway is to rest upon clayey or spongy soils, the bed should be sub-drained, in substantially the same manner prescribed for ordinary roads, by excavating to a width exceeding the length of the cross ties by at least some inches, and to a depth of 6 inches below them. The trench thus formed, after suitable cross drains have been constructed, is then to be filled in with a ballast of broken stone, gravel, coarse sand, or a mixture of them all, which should be thoroughly compacted by ramming in layers, to guard against further settlement or shrinkage. When the filling has reached the requisite height to receive the cross ties these are placed in position, the material under their edges further compacted by tamping, and the filling continued to the level of their top surfaces.

The cross blind-drains should be at least 12 to 18 inches in depth, below the bottom of the filling or ballast, and should extend out on either side to the side ditches.

To preserve them from early decay, the stringers and cross ties should be creosoted, in the manner described on page 162 which, if thoroughly done, will add at least ten years to their life.

Fastenings.

No little difficulty has been experienced in firmly securing the rails to the stringers, and the stringers to the cross

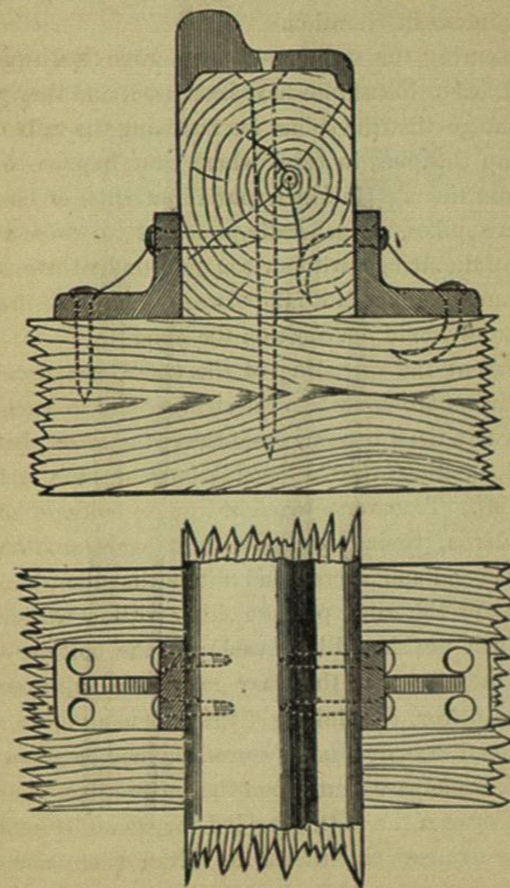

FIG. 68.

ties, and no system or method of fastenings has yet been devised, possessing so few objectionable features as to command general adoption. It has been found impossible to do away with the use of spikes, bolts, or pins, and these become loose from the gradual enlargement of the holes occasioned by incessant vibration.

For securing the stringers to the cross ties, square or octagonal oak or locust pins have been used, and they possess the advantage that the spikes for fastening the rails can be driven into the pins, in cases where they happen to come directly over them. Half inch round iron bolts, or long half inch square spikes, are generally preferred to wooden pins. The ends of the stringer with an iron plate under them, should rest on a cross tie, and not fall between them, but those on opposite sides should not meet on the same tie.

To prevent the spreading of the track, cast iron knees or angle irons are spiked to the stringer and to each tie or each alternate tie. In some cases these knees are placed on both sides, in others on the outside only of each stringer. (see Fig. 68). Transverse wrought iron tie bolts, of about ½ inch round iron, passing through both stringers, and having a head on one end and a screw and nut on the other, have also been used for the same purpose either with or without the knees. Such ties should be placed near the bottom of the stringers, in order that they may receive no injurious tension or strain from the sinking of the pavement above them.

Additional security against spreading may be given by a good block stone pavement, upon the entire street, including the space between the rails, provided the stones be set firmly against the stringers on either side. Even where a cheaper kind of pavement is used for both horse track and street, it is desirable that one row at least of stone blocks should be

set on each side of each stringer, and these should be composed of alternately long and short blocks (as shown in Fig. 69), so as to tooth into the contiguous pavement, and thus avoid a continuous joint which would wear into a rut.

The best pavement between the rails, and upon which the animals appear to travel with greater confidence and less fatigue than upon any other possessing the requisite firmness

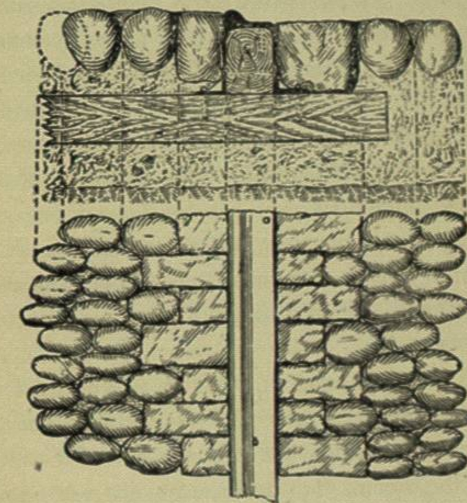

FIG. 69.

and durability, is one of rather small cobble stones, laid with a very slight inclination from the centre toward the rails.

The top of the pavement should be at the same height as the top of the adjacent edge of the rail. With a rail therefore, having a single rib on one side and a single horizontal flange on the other, the pavement next the rib will be as much higher than that next the flange as the rib projects above the flange. If the rib be on the inside of the rail the horse track will be higher than the rest of the street, and if on the outside, it will be lower.

Many methods of fastening the rails to the stringers have been practiced, among which that of clinch spikes with countersunk heads, driven vertically through the bed or thin portion of the rail, well into the sleeper, is about the best. When the width of the bed will admit of it, the spikes should be placed two to three feet apart, alternately near its inner and its outer edges, so as to give the rail a firmer seat, and counteract its tendency to cant to one side or the other. Sometimes the spikes pass through the edge of the rail diagonally, and sometimes screws are used diagonally or vertically. When rails with vertical webs at the sides, reaching some distance down the faces of the stringer, are used, the fastenings may be spikes, screws, or staples passing through the rail into the timber horizontally. The ends of the rails should meet as far as possible from the ends of the stringers.

The perishable nature of wood is a source of serious expense in the maintenance of street railways, and efforts have been made to substitute iron and stone for the timber cross ties and sleepers, but no trial of this method of construction has extended over a sufficient period of time to fully test its practical value.

Many experimental attempts have been made to replace horses by mechanical motive power, for the propulsion of street cars; and gas, hot air, electricity, as well as steam, have been suggested and some of them tried as motors, but never with entirely satisfactory results. In the present condition of the problem, the great desideratum appears to be a small, noiseless, spark-and-smoke-consuming steam engine.

Car Starters.

The frequent haltings and startings which are necessary for the accommodation of passengers using street cars, operate as a most serious tax upon the endurance of the horses, and within the last few years many mechanical devices have been tried, mostly as matter of experiment, with the object of removing or lessening this evil.

The prevailing idea appears to have been to store up the power necessarily exerted by the brakes in bringing the car to a state of rest, by the compression of some form of spring, and then to expend it in turning the car wheels, so as to assist the horses at the moment they are required to start forward.

It is to be regretted, however, that no car starter has yet been invented, possessing sufficient practical merit to command general approval. They have all failed in a greater or less degree, to render with reasonable certainty, and at the proper moment, the measure of aid required of them. In order to be efficient, they should be under the easy and quick control of the driver, and possess enough initial power to move the car within 1 to 1½ seconds after the signal to start is given, and before the horses have taken the draught upon their collars.

The principle upon which the Crozier car brake and starter operates will be understood from Fig. 70. The upper portion of the figure represents the apparatus in plan, while an end view is given in the middle, and a side view in the bottom cut.

A is a bevel wheel keyed fast to the car axle, and B is another wheel facing it but fitted so as to turn and slide on the axles and having a rose clutch, C, for connecting to the axle so as to turn it when desired; it also has a sleeve D, extending nearly to wheel A, and coupled by a crotched arm E, with a rock shaft below (seen at F in the bottom cut) by which the driver, by means of a lever at W, shifts the gears as required for stopping and starting.

The sleeve D, is also the bearing for one end of the shaft G, on which is a wheel I, for gearing with wheel A, also a wheel H, for gearing with wheel B, and also a drum K, for winding up a spring or springs L, and which has its other bearing in the arm J, of the rock shaft F, so that by the oscillation of the rock shaft through the medium of the lever at W, the shifting is effected.

When the car is moving forward, if the driver by a movement of the lever at W, gears the shaft G, with the wheel A, by means of the wheel I, the drum K winds up a chain which compresses the spring L until the car stops, the wheel B being at this time disconnected with the clutch C, and free to move around. At the signal to start, the shaft G is thrown out of gear with the wheel A, and the wheel B at the same movement engages with its clutch at C. The spring then reacts, and in unwinding the chain from the drum K, starts the car through the medium of the wheels H and B. The wheel B, being larger than wheel A, affords a greater leverage to the power of the spring in starting, than that applied in compressing it when stopping.

The Fireless Locomotive.

Upon the subject of mechanical motive power for street cars, to which reference was made on page 240, it seems proper to mention an invention of Dr. Lamme of New Orleans, consisting of a small locomotive with a boiler of

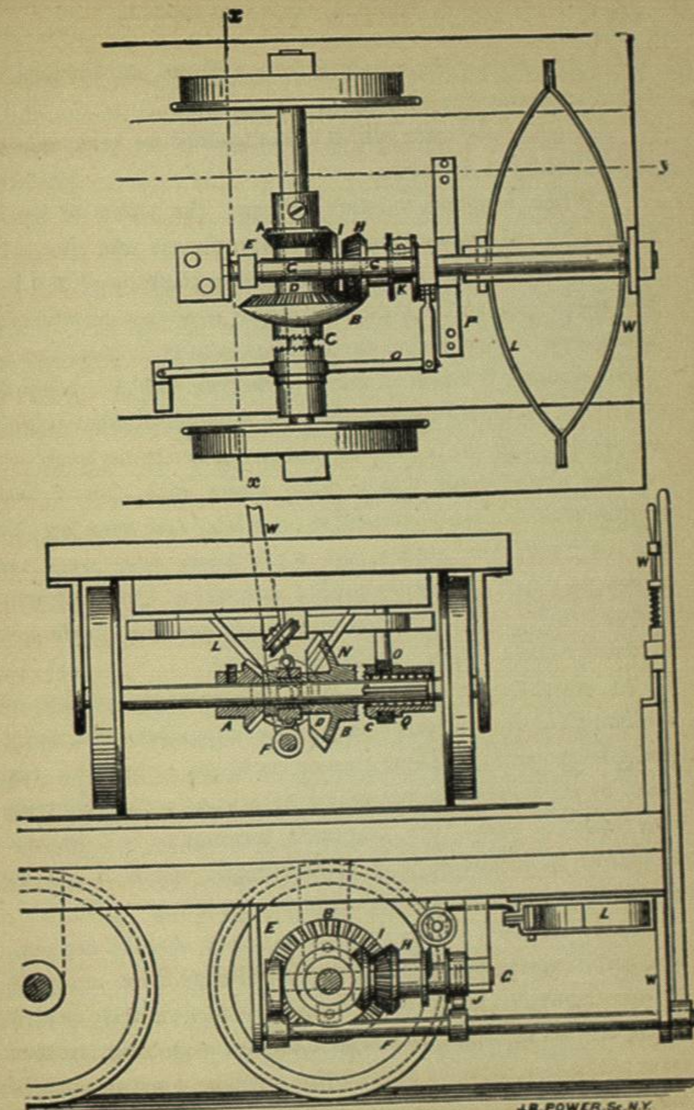

Fig. 70.

about 60 cubic feet capacity, but without any furnace or other appliance for heating it.

The principle upon which it is expected to work may be stated briefly as follows:

"When required to start the car, the boiler is nearly filled with cold water, and the locomotive is run alongside of a large stationary boiler, working at a pressure of 200 lbs. The steam pipe of the stationary boiler is connected with the locomotive boiler, steam then rushes into the latter, and in a few minutes it raises in the cold fireless boiler a pressure of 180 lbs. The connection with the stationary boiler is then uncoupled, and the fireless locomotive is ready for work."

The experiments which were made with this fireless engine were tolerably successful on roads that were level or nad only very low grades, and while there were very few stoppages; but upon steep grades and when operating with frequent halts, its limited power was soon rendered inefficient by the constant loss of heat by radiation.

As street railways must adopt the ordinary grades established for other vehicles, and as the stoppages must necessarily be frequent to allow passengers to get in and out, and must be made, even upon ascending grades, unless they are exceptionally steep, Dr. Lamme's locomotive will require extensive modification and improvement before it can be accepted as a practical solution of this question.

There are such strong prejudices in the mind of the general public against placing a steam boiler in a car occupied by passengers, even although it may be kept entirely out of sight, and so arranged as not to interfere with their comfort or convenience, that it is doubtful whether a self-contained steam car can ever commend itself to popular favor.

It is to be hoped, for the benefit of all, that the inventors who do not share this view, will be able by mechanical contrivance and skill, to remove the objections on which it is founded.

Statistics of Street Railroads.

The following tables, giving the chief particulars of certain horse railway companies, have been arranged at the request of the author, by Mr. Isaac Newton, Engineer, of New York city, from the annual reports of the Massachusetts Railway Commissioners, and the State Engineer and Surveyor of the State of New York for 1873. The examples have been selected so as to give information respecting the operation of such railways in the crowded streets of cities, as well as on ordinary country roads or turnpikes.

The particulars given may be divided in two classes: *first* those regarding the cost of the construction of the roads: *second*, those referring to the cost of maintenance, including all operating expenses, and the amount and source of the revenue. In the case of the New York railways, the figures respecting the cost of construction are not in all cases reliable, but those regarding the operating expenses are, in the opinion of the writer, correct: the latter are obviously of the most importance. Engineers can estimate with all needful accuracy the cost of constructing and equipping a proposed horse railway; but respecting the cost of operation, the facts obtained from experience with existing roads are the only safe guides to a close estimate.

Regarding the Massachusetts Roads, both classes of figures may be taken with confidence, as accurate statements of the facts.

TABLE I.—*Particulars of Horse Railroads in State of New York,*

	Second Avenue Railroad.	Third Avenue Railroad.	Sixth Avenue Railroad.	B'way and 7th Av. R. R.	Eighth Avenue Railroad.	Dry Dock and East B'way Railroad.
I. Description of Road.						
1 Length laid........	10 miles.	8 miles.	4 miles.	8 miles.	9,50 m.	10.73 m.
2. Length of double track, incl. sidings.	11 miles.	10 "	4.375 "	16.25 m.	....	.. ..
3. Weight of rails, pounds per yard...	60 lbs....	56 to 68lbs	60 lbs.	52,62,65 lbs	60to65 lbs	48,52,62 lbs
II. Revenue.						
1. From passengers..	$678,547	$1,512,396	$737,357	$894,188	$757,152	$776,80[illegible]
2. Horses, manure, old material, advertising in cars, and miscellaneous......	$2,637	$628,429	$201,077	$25,977	$40.887	{ Bonds—$490.900 Mis., $7,915
3. Total revenue.....	$681,185	$2,140,826	$938,434	$920,158	$798,040	$1,275,623
III. Operating particulars.						
1. Number of passengers carried........	13,570,955	26,950,000	14,747,141	17,883,776	15,143,048	15,536,160
2. Rate of fare.......	{ 6c. thro. 5c. way.	{ 6c. thro. 5c. way.	{ 5 cents.	5 cents.	5 cents.	5 cents.
3. Rate of speed, including stops......	1 h. 20 m.	1 h. 20 m.	6 m. p. h.	46 min.	90 min.	....
IV. Equipment.						
1. No. horses or mules	1022	1841	1,097	1,146	1,000	835
2. Number of cars...	154	{ 251 Pas. 11 Frt.	} 100	141	110	131
V. Cost of Road and Equipment.						
1. Road-bed superstructure, incl. iron,	$1,816,412	$1,500,000	$857,444	$2,841,270	$844,459	$340,241
2. Land, buildings, & fixtures, incl. land damages	$410,593	$1,817,365	$827,590	$657,360	$599,211	$471,830
3. Horses & harness.	$173,187	$250,000	$385,817	$191,050	$102,390	$141,775
4. Cars..............	$111,550	$190,000	$111,108	$157,478	$137,513	$134,000

compiled from Report of N. Y. State Engineer and Surveyor for 1873.

	42d and Grand St. Ferry Railroad.	Bleecker St. and Fulton F. Railroad.	Ninth Avenue Railroad.	Brooklyn Bath and Coney Is. Railroad.	Brooklyn City Railroad.	Brooklyn City and Newtown Railroad.	Coney Is. and Brooklyn Railroad.	Buffalo Street Railroad Company
I.								
1.	5.13 miles	9 miles.	6.10 miles	7 miles.	40.50 m.	15 miles.	10.29 m.	8.81 m
2.	5.13 miles	13 miles.	....	3,000 ft.	41 miles.	7½ miles.	4.63 m.	8.81 m.
3.	64 lbs.	56 lbs.	62to95 lbs	45to70 lbs	45to64 lbs	45&52 lbs.	45 lbs.	50 lbs.
II.								
1.	$340,637	$252,859	$89,217	$50,577	$1,461,308	$191,955	$179,924	$200,920
2.	{ Bonds, $236,000 Mis., $10,119 }	$4,864	$6,486	$15,322	$34,990	$5,231	$41.967	$123,349
3.	$586,757	$257,704	$95,704	$65.900	$1,496,294	$197,186	$221,891	$324,[illegible]
III.								
1	6,812,759	5,057,191	1,784,346	386,234	29,500,000	3,886,314	3,506,117	3,442,768
2	5 cents.	5 cents.	5 cents.	....	{ Adults, 5, 8, 10. Ch. 3 & 4	} Adlts. 5 Ch. 3 cts	{ Thro. 25 Way, propor.	} 8 cents.
3.	57 min.	40 min.	47 min.	50 min.	....	....	1 h. 46 m.	45 min.
IV.								
1.	444	400	190	{ 1 horse, 9 dum. cars	} 1,895	301	....	281
2.	58	40	20	{ 24 Pass. 2 Frt.	} 412	68	....	{ 58 cars. 14 sleighs
V.								
1.	$729,754	$1,749,554	$515,786	$69,890	$1,090,855			$216,814
2.	$171,510	$28,523	$443,122	$48,164	$600,543	} $813,273 (items 1–4)	} $698,806 (items 1–4)	$160,464
3.	$93,959	Extens'n, $23,595	$22,600	$127,993	} $733,401 (items 3–4)			$71,216
4.	$59,455	....	$17,600	....				$80,4[illegible]

	Second Avenue Railroad.	Third Avenue Railroad.	Sixth Avenue Railroad.	B'way and 7th Av. R. R.	Eighth Avenue Railroad.	Dry Dock and East B'way Railroad.
VI. Operating Expenses.						
1. Repairs to road-bed rlw., incl. iron, rep. of bldings, fixtures,	$22,497	{ $131,975 Rl. Est. $220,281 }	$110,255	$41,469	$47,390	$49,691
2. Taxes on real est..	$3,900	$25,128	$22,781	$14,875	$22,852	$8,839
3. Superintend., office exp., clerks, etc....	$22,209	$44,675	$12,476	$18,850	$20,261	$22,359
4. Conductors & driv.	$146,089	$341,116	$170,136	$194,052	$162,111	}
5. Watchmen, starters, switchmen, and roadmen..........	$29,160	$224,983	$49,320	$18,875	$15,274	} $239,993
6. Repairs of cars....	$22,608	$49,633	$23,616	{ Snow— $8,157 $30,516 }	$46,524	{ Engine, $1,508 Cars, $45,795
7. Repairs of harness,	$3,764	$8,885	$5,749	$4,989	$6,709	$4,994
8. Horseshoeing	$24,500	$60,768	$39,727	$28,020	$29,096	$22,674
9. Horses or mules...	$28,302	$131,628	$106,337	$48,600	$63,200	$49,114
10. Stable expenses..	$59,362	$8,493	$71,539	$63,501	$57,376	$3,202
11. Feed, hay, etc....	$119,820	$267,144	$150,780	$154,404	$137,298	$138,611
12. Fuel, gas, & lights	$6,149	$18,747	$6,732	$8,577	$7,080	$5,556
13. Oil and waste....	$501	$2,750	$818	$1,311	$755	$859
14. Water tax, ins'ce.	{ $915 $3,438 }	$4,762	$8,253	$4,856	$5,220	{ $1,094 $7,607
15. Law expenses....	$2,476	$22,746	$2,150	$4,954	$6,997	$2,442
16. Damages to persons and property.	$5,118	$2,294	$1,763	$6,264	$2,220	$7,41
17. Rents	$1,899	$19,150	$4,000	....	$9,927	$9,81
18. Car licenses......	....	....	$3,500	....	$5,250	....
19. Advert. and print.	....	$4,751	$328	$67	$375	$174
20. Taxes on divid'ds.	....	....	....	$487	....	....
21. Contingencies....	$7,358	$1,600	$4,216	$3,364	$2 550	{ Snow— $10,218 $3,021
22. Total operating expenses..........	$511,073	$1,591,516	$794,484	$655,709	$648,476	$634,990

	42d and Grand St. Ferry Railroad.	Bleecker St. and Fulton F. Railroad.	Ninth Avenue Railroad.	Brooklyn Bath and Coney Is. Railroad.	Brooklyn City Railroad.	Brooklyn City and Newtown Railroad.	Coney Is. and Brooklyn Railroad.	Buffalo Street Railroad Company
VI.								
1.	$9,019	$4,121	$6,956	$15,101	$61,879 }	$4,648	$15,141	$21,941
2.	$14,770	....	$4,657	$382	$49,433 }		$1,346	$457
3.	$15,511	$7,427	$3,762	$4,486	$38,869	$5,250	{ $3,000 $2,901 }	$10,706
4.	$67,359	$49,549	$28,109	$3,065	$387,120 }	$62,727 }	$54,286	$47,959
5.	$20,116	$7,053	$3,691	$3,427	$69,383 }			....
6.	$17,419	$20,119	$3,320	$2,939	$53,816 }	$7,852	$12,790	$13,784
7.	$2,302	$2,551	$795 }		$11,306 }		$1,560	$2,720
8.	$10,656	$10,991	$4,182 }		$50,600 }		$5,683	$7,684
9.	$20,300	$44,471	$1,300 }	$365	$45,874	$9,448	$10,322	$18.935
10.	$30,622	$22,415	$8,874 }		$104,027	....	$13,784	$27,836
11.	$50,097	$35,838	$22,752 }		$245,313	$36,033	$34,338	$23,881
12.	$2,838	$1,541	$739	$2,753	$8,360	$935	$1,158	$1.879
13.	$43	$484	$104	$661	$627	$103	$279	$261
14.	$1,583	$1,932	$1.352	$1,139	$9,365	$1,526	$3,11	$2,794
15.	$4,250	$390	$330	....	$3,000	$50	$654	$1,456
16.	$1,388	$633	$448	....	$16,781	$318	$600	$528
17.	$1,500	$6,022	....	$150	$2,328	$401	$237	....
18.	....	....	$400	....	....	....	....	....
19.	$20	$9	$55	$34	$2,389	....	$624	$3,019
20	....	....	....	....	....	....	....	....
21.	$24,410	$4,453	$108	$834	$29,620	$1,769	$4,034	$9,016
22.	$293,709	$220,007	$91,942	$35,340	$1,190,098	$131,064	$155,862	$194,86

TABLE II.—*Giving particulars of the horse railways named below compiled from the report of the Board of Railway Commissioners of the State of Massachusetts for* 1873.

	Highland St. R'lwy Boston.	Lynn and Boston Railway.	Lowell Horse Railway.	Merimac Valley Hse. R'lwy Co.	Metropolitan Street R.'lway Co.
I. Description of Road					
1. Length, miles	5.42	11.75	3.815	5	43.608
2. Length of double track.	1.985	.13	......	......	8.734
3. Length of single track operated in one direction, miles	1.17	......	......	......	5.097
4. Length of single track in both directions, miles.	.28	11.61	3.815	5	21.043
5. Length of switches, sidings, etc., miles	.25	.87	.216	1600 feet	3.981
6. Length measured as single track, miles	5.67	12.61	4.031	5.303	47.589
7. Weight of rail per yard, pounds	.48	¼ – 45 ¾ – 25	28½ to 33	1600 ft.—19 10400 ft.—30	30 to 55½
II. Equipment.					
1. No. of horses or mules	252	239	50	55	1269
2. Number of cars	36	35	12	15	201
III. Cost of Construction.					
1. Grading and Paving	$124,591	......	$14,006	$2,000	......
2. Track, including timber, rails, and laying	......	......	37,211	35,784	......
3. Engineering and other exp. during construction,	14,950	......	238	....	....
4 Total cost of construct'n	139,541	$181,960	51,455	37,784	*1,100,437
5. Average per mile of sin. track, not incl. sidings	25,745	15,485	13,487	7,556	25,231
IV. Cost of Equipment					
1. Horses or mules	38,870	32,265	8,002	9,327	165,819
2. Cars	41,605	30,300	12,002	16,618	189,956
3. Other vehicles and articles of equipment	16,686	16,698	4,757	5,165	112,429

	Highland St. R'lwy, Boston.	Lynn and Boston Railway.	Lowell Horse Railway.	Merrimac Valley Hse. R'lwy Co.	Metropolitan Street R'lwy Co.
V. Operating Expenses.					
1. Reps. of rd.-bed & tracks	......	$15,767	$1,845	$2,507	$47,915
2. Reps. of cars and other vehicles, harness, horse-shoeing	$6,175	19,164	3,751	5,419	39,732
3. Repairs of buildings	......	1,588	70	338	6,940
4. Keeping good the stock of horses	1,950	9,439	......	439	29,464
5. Wages of all employees, excepting Pres., Treas., Sup't. and clerks	60,893	55,716	11,677	11,853	431,225
6. Provender	25,896	31,397	10,066	8,485	158,338
7. Taxes and insurance	2,312	1,729	865	900	24,900
8. Damages for injuries to person and property	32	11.562	782	....	31,970
9. Rents & tolls paid other companies	......	18.402	......	....	3,017
10. Salaries, office exp., etc.	5,960	12,013	3,068	4,245	117,671
11. Interest	......	5,051	......	....	....
12. Total exp. of operating.	103,920	181,823	32,127	34,188	891,220
VI. Revenue.					
1. Received from pass'gers.	127,399	162,713	33,555	34,002	945,585
2. Rec. from sale of manure	609	1,301	638	520	2,219
3. Inc. from other sources.	......	255	531	332	26,048
4. Total income	128,008	164,269	34,724	34,845	982,853
5. Pr. ct. of exp. to income,	92.5	110.68	92.5	98.	90.676
VII. Operating Particulars.					
1. No. miles run by cars	397,432	447,068	122,953	176,280	2,470,214
2. Aver. cost per mile, cts.	26.12	40.67	26.1	19.4	36,078
3. No. of pass'gers carried.	2,511,180	2,150,652	592,716	453,673	18,211,026
4. Rate of speed, incl. stops. Miles per hour	6	6	5	5	5 to 6
5. No. of persons regularly employed by Company	149	102	25	24	640
6. Rate of fare—cents	6ct. ticket 5	4 to 25	4, 5, and 6	3	5 to 15

* This is the total cost to the Company of road built and purchased; the cash cost is estimated to be $1,046,473.79.

The Brooklyn City Railroad Company operates 41 miles of double track, radiating from the Fulton and Hamilton Avenue ferries through the city to its suburbs in various directions. The returns for the year 1875, show that the company owns 1,950 horses. Each working horse travels, upon an average, $16\frac{1}{2}$ miles daily, which somewhat exceeds the average daily distance traveled on the New York city lines. The monthly feed bill amounts to about $19,000.

During the year 1875 the company lost 334 horses, and the yearly depreciation in the value of the live-stock was about 28 per cent., the average annual depreciation for a term of years being about 25 per cent. The number of men employed is 1,000.

The company carried during the year 29,000,000 passengers, at an average cost per passenger of $4\frac{21}{100}$ cents, or an aggregate cost of $1,221,592.

The gross receipts from passengers were $1,446,537.

Mr. Sullivan, the President, states that among the various pavements in use between the rails, upon the ten roads operated by his company, the one which is the easiest upon the horses, and therefore the best, is formed of small cobble stones, laid with only a slight fall from the centre to the sides; and that the horses should always be shod with flat shoes, rather broad at the heel and without calks, and without cutting away any of the frog, so that a portion of the weight shall come upon the frog, whenever the animal treads upon an even surface. It is a rare occurrence for any of the horses to become disabled by contracted feet.

THE END.

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