RAILROAD GAZETTE

FRIDAY, APRIL 24.

CONTENTS.

Contributions.

Coupler Unlocking Devices.

TROY, N. Y., April 20, 1891.

TO THE EDITOR OF THE RAILROAD GAZETTE:

The last paragraph of the contribution to your issue of April 17, 1891, entitled "Coupler Unlocking Devices," is liable to misconstruction. While agreeing generally, as every one must, with the statements made in the article that nearly all of the M. C. B. couplers in general use do not conform to the law, from the fact that the brakemen must go in between the cars to open the knuckle for coupling [See Laws of the State of New York 1886, Chap. 439, Sec. 4, which says that "unless the same (refering to coupler) can be coupled and uncoupled automatically without the necessity of having a person go between the ends of the cars," (to open the knuckle)]. It is not a fact that all devices of the M. C. B. type have this failing.

The Trojan Automatic Coupler, manufactured by us, is operated from the side by a rod, under the protection of the dead blocks; and it may be either brought up on the end of the car, or may be hung completely under the end sill. This rod connects directly with the lock of the coupler, which may be unlocked and the knuckle thrown open by its use. The coupler is thus truly automatic, and fulfills all the requirements of the law. Not only in tests has it been shown to be the strongest coupler yet made, but in actual use it has given satisfaction to all railroads which have used it, and no complaints of broken parts have yet been heard.

BURDEN, RENSHAW & CO.

Mr. Howard Again on Two-Shoe Brakes.

APRIL 6, 1891.

TO THE EDITOR OF THE RAILROAD GAZETTE :

Your article in the *Railroad Gazette*, of March 27, referring to my communication on "One Shoe vs. Two Shoe Brakes" is written under a misapprehension of my argument which you state to be "based upon the astonishing theory that journal friction tends to stop the rotation of the wheel, but does not retard the motion of the vehicle." As I am quite unconscious of having propounded such an astonishing theory, I hope you will give me space for this reply. . . . The journal friction of a one-shoe brake seemed sufficient to account for the difference in the length of the stop (always in favor of the two-shoe) as this journal friction makes it impossible to use the same amount of shoe pressure as can freely be used on a two-shoe brake without sliding the wheels. I have not asserted that "journal friction tends to stop the rotation of the wheel, but does not retard the motion of the vehicle," but I did say that journal friction is not *effective* in stopping the motion of the vehicle. The retardation caused by the pressure on the journal is very much less effective than it would be if the journal were free and the momentum that is absorbed by journal friction was converted into rotation of the wheel and there taken up by the brake shoe, as it would then yield about ten times the retarding force. Hence the reason why a two-shoe brake can use higher percentages of pressure, without sliding the wheels than a one-shoe brake, there being no interference with the free conversion of momentum into rotation of the wheel, while a one-shoe brake reaches the point of wheel, sliding very quickly as the speed decreases and the length of the stop is proportionally increased.

You say "Mr. Howard assumes that he can use greater resistance to the rotation of the wheels than long experience indicates to be desirable." All our squeeze brakes are constructed to use 80 per cent. of the wheel weight, and that they do so I know to be a fact from actual test with pressure gauge upon the brake cylinder. I also know that we have never had a complaint of sliding wheels with this pressure. I, therefore, "assume" nothing when I say that a brake is not efficient that cannot use this pressure. . . . Captain Galton's experiments show that no brake is effective that does not use 80 per cent. of the wheel weight, and he expressly states that the most effective braking is done with a pressure of three times the wheel weight at high speeds, with a gradual reduction to a stop.

I am glad to note your approval of two shoe-brakes upon cars, especially passenger cars, and your enumeration of the advantages they possess over the one-shoe brakes, pointing out that these advantages fully justified the use of the additional mechanism required to operate them; but I am quite at a loss to understand why all these advantages should disappear when two-shoe brakes are applied to locomotives. JAS. HOWARD.

[Our readers will be glad to know that this is positively the "last word."—EDITOR.]

Starting Gear for Compound Locomotives.

53 STATE STREET, BOSTON, Mass., April 3, 1891.

TO THE EDITOR OF THE RAILROAD GAZETTE :

It is rather surprising that the various letters which have appeared in the *Gazette* from Herr von Bories and Messrs. Hope & Co. relating to the relative advantages of the intercepting valve and Linder systems of starting gear for compound locomotives have not called out any discussion from railroad men. At the present time, when the compound locomotive is just appearing on American soil, this is to be regretted.

I take it that nothing is better proved than that the intercepting valve system is perfectly successful and satisfactory. Moreover, I take it that the reason for existence of the various Linder devices is their cheapness, and if an intercepting valve can be devised that is as cheap as a Linder device, the victory is more than won by the intercepting valve system.

The fact that one Linder device is only created to be followed by another, each one being the long-sought specific for the diseases of the compound locomotives, shows that they are not satisfactory. They are exceedingly ingenious, without doubt, as well as cheap, but I should be loth to advocate a perforated high pressure slide valve which is almost constantly leaking steam into the receiver. Steam is a rapid traveler, and the leakage through these holes must amount to considerable, especially at slow speeds. It is no argument to say that the indicator doesn't show it, as there are many hurtful phenomena which the indicator isn't delicate enough to show. We all know how leaky valves affect the economy of engines, and surely no one would think of running a locomotive with the cylinder cocks open. Will Messrs. Hope & Co. explain how they would expect an indicator diagram to look that shows leakage through the Linder equalizing ports.

In Messrs. Hope & Co.'s pamphlet on the Linder starting valve they assert that all intercepting valves close whenever there is a back flow of air or steam from the low to the high pressure cylinders, and thus endanger the receiver by too great pressure whenever the engine is reversed before stopping. This is by no means a necessary quality of intercepting valves, and even if it were, the safety valve, which should be on the receiver, would take care of the pressure. I fail to see that this differs at all from the effect of reversing an ordinary simple engine before stopping, and keeping the throttle valve closed.

Coming now to the general question of the compound locomotive from the economical standpoint, it is almost a platitude to say that the compound locomotive has no business to exist if it is not more economical in the consumption of steam and fuel than the simple locomotive, for the very obvious reasons that it is the more costly and ponderous. Nothing is better proved than that it is more economical than its predecessor to a paying extent. If its existence is due to its ecomony, how much more desirable is it when that economy reaches a maximum. Any probable extra cost of an intercepting valve over the Linder system will be surely more than justified. It is, in fact, very certain that an intercepting value can be made which will cost fully as little and be as durable as either of the Linder devices, and if this is so why should the Linder device be used?

I wish to say a few words concerning types of compound locomotives. The type that has come to stay is without doubt the two-cylinder type, for several reasons: 1. It is the simplest and cheapest. 2. It is the most economical. 3. Its working parts are the same in number and kind as those of the simple engine, and therefore more acceptable.

As to the question of economy, the compound engine saves steam because (*a*) for any given amount of expansion condensation is diminished, and it therefore (*b*) permits greater expansion, and thus (*c*) better utilizes high-pressures, which in themselves are to some extent more economical than low-pressure. The two-cylinder type of engine has less cylinder (that is condensing) surface per cubic inch of piston displacement than the four-cylinder type, and is therefore more economical than the latter. It permits the use of a re-heating receiver in the smoke-box, which the four-cylinder type as built does not, and is therefore again more economical than the latter. It is almost incredible that any designer of compound locomotives should sacrifice this valuable feature of re-heating steam in the middle of its expansion when it is free to all and so easily accomplished.

Among the lesser reasons for the economy of the compound locomotive may be mentioned the fact that if the high pressure valve leaks, the steam instead of either being wholly lost or not working expansively in that cylinder, finds its way to the low pressure cylinder which may have a tight valve, and thus work to some extent expansively. Another is that steam which is initially condensed in the high pressure and re-evaporates and thus does not work expansively in the high pressure cylinders, will work expansively in the low, and any water formed in the high will stand some chance of being re-evaporated in the receiver, and so work expansively in the low. F. W. DEAN.

The Rapid Transit Problem in New York.

BY W. HOWARD WHITE.

The question of rapid transit in New York practically resolves itself into three methods :

First—The occupation of another north and south avenue or street by a structure similar to that of the present elevated railroads.

Second—The use of a tunnel under a street or through the blocks.

Third—The use of an overhead structure high above the street surface and through the blocks.

The first method would undoubtedly be profitable and the franchise could probably be let for a handsome figure, but public feeling is so strong against this method, that it seems tolerably certain that the commission will not authorize it, though it appears that they are empowered to do so.

A tunnel through the blocks at any distance under the streets less than 30 ft. may be practically thrown out, because it requires as much expense for right of way as the high level schemes, and would involve nearly as much construction cost as the deep tunnel schemes, apart from the alteration of buildings on the line. It would involve all the well-known disadvantages of the underground systems, to wit, artificial light and ventilation, and rather poor air at best; excessive noise; absence of outlook and sunlight; greatly increased liability to accident, and much more serious results when such take place. It is sometimes assumed that artificial ventilation will make a tunnel equally as satisfactory as an open air road, but this point seems to need a little discussion. In the first place, even if such a road is to be operated by cable or electric power, there seems to be a generation from the damp surfaces of a tunnel of gas or fungi which the most perfect ventilation will probably never remove sufficiently to render the air as good as the air of a thoroughly well ventilated building above ground, and that is about 50 per cent. more impure than the ordinary outside air of a great city. If, now, the constantly vitiating air in the cars is to be replaced from this already inferior air, its condition can never be more than indifferent. Add to this the fact that the draughts into car windows or ventilators will be intensified by the confinement of the air passed through by the train, it will obviously lead to greater unwillingness on the part of the average passenger to the opening of ventilators. The result must be a high degree of vitiation of the train air as compared with overhead roads. So far as testimony on this subject exists, it refers to imperfectly ventilated tunnels, but such as does exist is conflicting. Mr. Harold Frederic, in the New York *Times* of Feb. 24 last, tells us that the new London Subway is perfectly fresh, while an apparently unbiased contributor to the *Railroad Gazette* of Jan. 16 last, says: "I do not think the ventilation good. Indeed, I believe it is purely fortuitous! There was a smell of damp cellar, suggestive of mycelium, a sort of old beer-cellar flavor not yet fully developed, and reminding one somewhat of the return air-ways of a coal mine. My head aches yet from the foul air;" and again: "It is likely, however, that much better provision must be made for ventilation. Undoubtedly to day the air was much vitiated, and probably it does not become changed at the shafts and staircases, but is merely churned to and fro in the tubes by the trains, and so is gradually accumulating carbonic acid from passengers, burning gas-lamps and tobacco. I am not alone in this opinion, and so mention it."

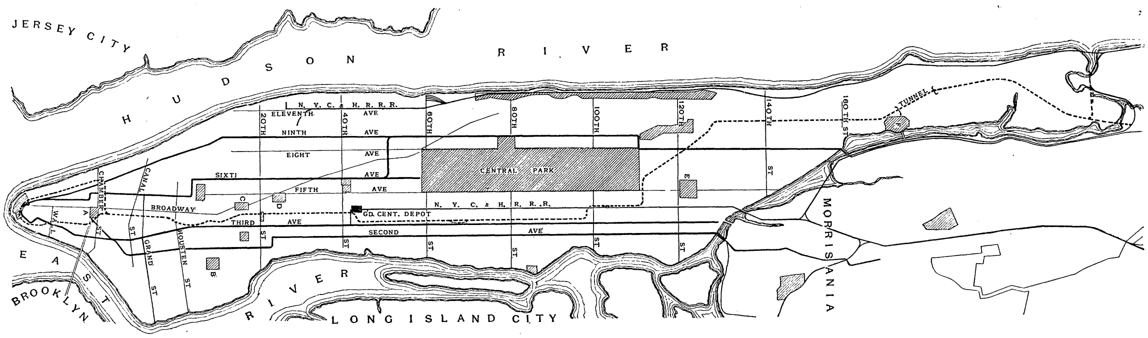
It will be borne in mind, too, that one of the functions which should belong to the ideal rapid transit scheme is the carriage of suburban trains from the connecting roads outside directly into the heart of the city without change of cars or engine. The tunnel ventilation problem, with this limitation added, under present motive power conditions, is practically hopeless.

The increased liability to accident under any tunnel scheme is unquestionable, being less under the deep tunnel schemes than under the others, because these admit a more direct alignment. It is obvious that in a tunnel—even a well-lighted and smokeless one—the main dependence for avoiding collisions must be the block system in some form. The automatic block is too liable to cause prolonged delay when something goes wrong to seem well adapted to a traffic of this character; and all hand block systems are liable, through the imperfection of the human intelligence or character, to cause accident under certain circumstances. Where the driver of a train is able to see trains in his way, even when on curves, as on an open prairie, he works under much more secure conditions and will be able to proceed at some sneed even when the signals that are expected to guide him are known to be out of order. It will always be more difficult, also, even in a well-lighted tunnel and on straight lines, to estimate the distance of a train ahead, and to make out whether it is standing or moving, than where a number of different objects alongside the track enable the runner to better estimate the distance and movements of a train in his way. Anyone who will try the experiment of watching a train from one of the New York elevated platforms at some little distance off, will probably be convinced of the utility of neighboring objects in assisting his judgment as to its movements and distance. The additional horror of underground accidents probably needs no demonstration—at least to a person with vivid imagination.

Taken altogether it will be generally conceded that an underground road will operate at a disadvantage in competition with an elevated one. It will be shown further on that this element of traffic is really the most mportant one in the situation. The result must be to provision in the law that sufficient deposit should be made with some trust company to cover the claimed value of the property in each case, and maintain such an income for the owner as might be shown by him as derived from the property taken, until the case could be permanently settled.

The plans on file with the Commission do not show in much detail just how such a scheme is to be worked as to the buildings, except that the People's Company has filed a reasonably specific plan and profile of their route, embracing a line extending (so far as Manhattan Island is concerned) from Spuyten Duyvil, at the Harlem, along the ridge overlooking the Hudson to 183d street, thence by tunnel under the Kingsbridge road to the east side of Tenth avenue at 170th street, thence southward on a line some distance west of the Central Park; and below it west of Seventh avenue to below Fortieth street; thence centrally on the island to a point north of Chambers street and east of Broadway, where the line forks. The east branch crosses the Brooklyn Bridge station, and the west one, running parallel and near to the North River, unites with the eastern one at the Battery and forms a loop. This line is a good one in the main, but seems open to criticism on the following points: It does not give connection with ner of the present elevated roads, and by their connection with the Ninth avenue road at Twenty-ninth street, if the Gould and Vanderbilt interests could be sufficiently reconciled to effect this. It would seem to be to the mutual advantage of the parties to make such an arrangement, as it would lead to an increase, both in the Ninth avenue business by the additional passengers delivered to it, and to the Hudson River by the impetus given to local development along its line. The present grade tracks of the Hudson River are too great a barbarism to be tolerated indefinitely, and the raising of them in this way, would be a practical compromise between complete abandonment and retention where they now are.

In estimating on the cost of a masonry structure through the blocks, a plan has been worked out for arches over the streets, resting on cellular piers capped by transverse arches in such a way as to divide the space below as profitably as possible for business or dwelling purposes, particularly with reference to getting thin front and rear walls, in order not to interfere with the lighting of the buildings. The station platforms have been assumed between each pair of tracks, the outer tracks being looped out around the platforms, and used for the local business.



PROPOSED RAPID TRANSIT ROUTE FOR NEW YORK CITY.

Proposed Route in broken line; Existing Railroads in heavy full lines.

eliminate from consideration shallow tunnels through the blocks.

As to similar tunnels under streets it is to be said, first, that the expense of construction will probably be nearly as great as for deep tunnels, owing to the expense of removing pipes, sewers and other obstructions; second, the element of possible damages will be great and uncertain; third, these tunnels would, in the lower part of the city, limit, in the streets where most needed, the spread of present facilities in the way of the pipes, wires, tubes and no one knows what kinds of future facilities, which cannot so well afford to pay for right of way as can a railroad.

It seems tolerably certain, therefore, that the deep tunnel schemes are the only underground ones worthy of consideration, noting that a road in open cut, as has been proposed for part of a rapid transit line, seems the worst possible means of rapid transit. It is liable, in addition to other difficulties which it has in common with tunnels, to blockade by snow.

Coming now to elevated roads, among the schemes offered to the notice of the commission there seem to be but three really practicable ones.

First, the Boynton bicycle, which is dependent on making a deal with the present elevated road, and is really merely an enlargement of their plant, with further interference with the light room of the street.

Second, the proposition to place an open work pier in each street with a pair of legs on each curb line, with truss bridges spanning the entire blocks between. The truss is placed with the lower chord at 110 ft. above street level, carrying four tracks, on two levels. This plan, as will be shown below, has the merit of accomplishing the object aimed at with much less capital than any other scheme of comparable advantages, and could be carried out with great rapidity and without being hampered much, if any, by obstructions in the way, and consequently with less and easier curvature. In view of the excellent foundation to be had almost everywhere in New York, there is hardly an element of conjecture in such a scheme. The cost could, therefore, be calculated with great accuracy in advance. The figures given for this scheme, as for all others, are based on building a bridge much beyond the requirements of any rolling stock now in use, in order to provide a structure, if not for all time, at least for as much time as it is possible to forecast the needs of.

The last class of schemes is that of a masonry viaduct through the blocks, the existing buildings being rebuilt to serve at once as supports for the structure, and as modern fireproof buildings, to be used for apartments, hotels, offices, or warehouses, according to the part of the city in which they might be. The difficulty with this scheme is the great cost and the more or less tedious nature of the proceedings necessary for obtaining possession of the right of way. It would seem, however, that the latter difficulty might be met by an additional the Grand Central Station; it gives up the Harlem business, which is the best part of the island at that end; it leaves the thickly settled region east of the Park, which, with the Harlem business, enables the Third Avenue Railroad to carry 40 per cent. of the whole elevated traffic, and goes west of the Eighth Avenue line, where the business is comparatively thin. Now, if any one thing is certain in this matter, it is that the proposed line must go through the best paying region that exists to have any chance at all of paying.

Hence, the line estimated on below for this kind of elevated road, and also for the bridge structure, is that shown by the map herewith, which gives a line from the Battery to Kingsbridge on the east side of Central Park without interfering with a modern fireproof building, or with any building of serious importance, with the exception of Amberg's Theatre, south of Sixty-seventh street. Between Sixty-seventh and Sixty-ninth streets there is such a mass of important buildings on very high ground that it would probably be better to make a detour into Third avenue over the elevated line or east of the avenue, in order to avoid these buildings. The line is thenceforward clear of important buildings (except at 126th and 127th streets, where they could be crossed high up), clear to the Harlem. The route proposed would cross Tenth avenue at 170th street just over the street, run in tunnel from 173d to 183d street west of the Kingsbridge Road, thence follow the hollow along that road to the Harlem, connecting, as indicated, with the Hudson River Railroad just west of the new Harlem River cut-off.

The Peoples' Company has selected the above described line for a tunnel with excellent judgment, but they have laid down their route from the tunnel end to the Harlem more to the westward, and occupying more valuable ground. This appears undesirable, both on account of the greater right-of-way cost and because less central to the upper part of the island.

The line shown on the map has been selected to make connection between all down town ferries, the Brooklyn Bridge and the Grand Central Depot; to get as large a slice of the business between Third and Sixth avenues, below the Central Park, and between the Park and Second avenue as practicable, while incurring a minimum of expense for right of way. Above 110th street, by carrying an elevated structure directly over the Fourth avenue railroad tracks, the Harlem local business could be served and connection made at the Harlem River with the New Haven tracks, enabling their local trains to go down town. The branch to the west would build up and serve the undeveloped upper portion of the island and bring in the local trains of the Hudson River road. The only part of the island not relieved by this system is that west of Central Park. The traffic on this line would be considerably relieved by the competition of the proposed system above the park. Further relief might be given by raising the Hudson River tracks below Riverside Park above the grade of the street, after the man-

The "straight" right-of-way, so to speak, has been taken at 50 ft., providing for four tracks on the same level, and at 11 ft. centres, and with the outside track centres not less than 6 ft. from all structures. This width and clearance, except on curves, is sufficient for all rolling stock which is in general use in the United States, and the reduction from 12 ft., the more usual centre distance, gives an opportunity for light shafts on the sides of the buildings below, and allows somewhat for failure of lot lines to match on opposite side of a block or street, and for extra right of way on curves and diagonal crossings of blocks.

As there would be a good deal of this failure to match, however, in any event, it has been assumed in the calculation that an average of two and a half lots in width would be required, and that three additional 25×100 ft. lots would be taken for each station. Any masonry plan with the tracks on two levels would involve almost entire destruction of the space below by the size of the piers required and their concentration.

An attractive feature of this scheme would be a public passage through the blocks under the road, which, with the protection afforded by the arches over the streets, would offer a covered approach to the stations of the road from any intermediate street. The spaces on the ground floor along this passage work out very well into bazaar shops and stands of a great variety of sizes. Access to the road would be had, of course, by elevators, and in order to avoid multiplying these at any station, the elevator shafts could be massed in one group, passing up through one of the platforms and run sufficiently above the platforms to enable the passengers taking a train to get to either up or down trains by crossing a bridge and going *down* a flight of stairs, or by the latter only. In leaving the train, descent would be again made by a flight of stairs to take the elevator. The course or itinerary of the latter would be from the ground directly to the upper-level bridge, above the tracks, then down to the level below the tracks and then back to street level. Such an arrangement would entail at any minor station only one ticket seller at the street and two elevator attendants, who would control the ticket boxes, instead of the four men now generally required for these duties.

By a longitudinal cellular construction for the support of the tracks the space under them would be left available for a variety of pipes, conduits, cables, etc., so that rental of the spaces might prove a considerable source of revenue.

A structure in iron, with the spaces below filled with buildings, would be more economical, but it would be much more noisy for the occupants of the buildings as well as for the passengers over the road; would be more expensive for maintenance, and would give rise to troublesome problems as to the connection between the iron and masonry portions in the matter of tightness against weather.

In estimating on the tunnel scheme a tunnel 60 ft. wide at the spring of arch, by 30 ft. in height at the centre, has been assumed, any smaller size for the purpose being worthy of the opprobrious title of rathole, bestowed upon such by Mr. Richard Deeves in his communication to the *New York Times* of Jan. 11 of this year.

The estimate follows Mr. Deeves' figures with one important difference. Mr. Deeves has apparently estimated the tunnel excavation at $7 per yard. As the Aqueduct tunnel cost $6.67 per yard, the larger tunnel would certainly not show a better rate, in spite of the advantage of the larger section, for the reason that the conditions are much more unfavorable. In the first place the drainage conditions are much less favorable, all water having to be hoisted from shafts. The amount of water is likely to be greater at the greater depth with reference to tide water at which the tunnel would be, and with the close proximity of rivers on either hand. Secondly, the excavation from such a tunnel would be the most tedious in its character of any work on record. Every yard of rock must be hoisted up a shaft, loaded upon wagons, and the vast majority of it carried an average of a mile or thereabouts to tide-water, and then scowed to an indefinite distance, to be finally dumped. It will be borne in mind that the quantity of material from the tunnel would be so large as to make disposal on the island in its present conditions perfectly impracticable, unless with such haul as to be more expensive than the other plan.

On the other hand, Mr. Deeves allows only $638,000 per mile for brick lining and backing. Such lining could hardly be made safely less than 4 ft. thick for a 60-ft. span, and at 50 cents per cubic foot—a very moderate allowance for this work—this would amount to $1,267,200 per mile, which figure is therefore adopted. Mr. Deeves has allowed rather largely for rolling stock, but has omitted shops. His assumed length is 12 miles, but as it is 13¼ miles in a bee line from the Battery to Kingsbridge, this distance has been substituted for his. With these alterations, and an allowance for the general expenses of such an enterprise, and interest on the money invested while still unproductive, the account stands as given below.

No allowance has been made for freight stations in the tunnel or bridge scheme, the conditions being somewhat unfavorable for getting the necessary side track room without interfering with the streets.

In the case of the masonry viaduct, by connecting the loops between two quarter-mile stations by extra tracks on an additional lot width on each side, ample switching room could be had overhead. The buildings below, connected by car lifts with the tracks above, would afford ample facilities for unloading and storage, wagons being driven in on the ground floor and loaded and unloaded by suitable shoots and lifts.

CONSTRUCTION COST.

The line is from the Battery to Kingsbridge, with loop to ferries, and the estimate is based on spans of 240 ft., with piers 160 ft. from street to upper chord.

Cost per span with tower	$97,160	
Cost " of foundations	4,240	
Total cost per 260 ft. block	$101,400	

Cost per mile.

20.2 blocks of structure at $101,400	$2,048,280	
4 stations, lifts and platforms, including land, at $120,000	480,000	
Land damages, 20 blocks, at $20,000	400,000	
Rails, ties and fastenings	30,000	
14.6 miles bridge at	$2,958,280	$43,190,889
* 0.65 " trestle at $678,000		440,700
* 0.64 " tunnel at $3,198,000		2,046,720
15.89 "		$45,678,309
Rolling stock		$5,600,000
Shops, block system, water supply and miscellaneous		1,000,000
		$52,278,309
Legal expenses, interest, superintendence and commissions, 12½ per cent		6,534,789
Total cost of bridge structure		$58,813,089

ESTIMATED COST OF MASONRY STRUCTURE.

The estimate is with right of way bought and fully built upon.

Battery to Ninety-seventh Street, with Loop, per Mile.

5 lots per block. 100 per mile			
Extra for four stations....... 12 " "			
112 lots at $35,000	$3,920,000		
Cost per lot of 6 story fire-proof building at 27c. per cu. ft., $37,857			
112 at $37,857	4,240,000		
		$8,160,000	
Extra for supports and arching of railroad	$1,060,000		
4 stations per mile at $30,000	120,000		
Permanent way complete	30,000	1,210,000	
		$9,370,000	per mile.

Ninety-seventh to 110th Street, Trestle Structure over Fourth Avenue, per Mile.

Iron trestle at $100 per ft	$528,000	
Permanent way	30,000	
Stations	120,000	
	$678,000	per mile.

110th to 170th Streets, per Mile.

Land, 112 lots at $20,000	$2,240,000		
Buildings	4,240,000		
		$6,480,000	
Construction, permanent way and stations		1,210,000	
		$7,690,000	per mile.

170th Street to 183d Street, Tunnel and Approaches, per Mile.

Tunnel and lining	$3,000,000		
Permanent way	30,000		
Land damage	48,000		
Stations	120,000		
		$3,198,000	per mile.

*See estimate for masonry viaduct.

183d Street to Kingsbridge, per Mile.

Land, 112 lots at $8,000	$896,000		
Buildings	4,240,000		
		$5,136,000	
Construction, permanent way and stations		1,210,000	
		$6,346,000	per mile.

Cost of Total System, Battery to Kingsbridge.

Battery to Ninety-seventh street	8.5	miles, at $9,370,000		$79,645,000
Ninety-seventh street to 110th street	0.65	"	678,000	440,700
110th street to 170th street	3.6	"	7,690,000	27,684,000
170th street to 183d street	0.64	"	3,198,000	2,046,720
183d street to Kingsbridge	2.5	"	6,346,000	15,865,000
	15.89 miles.			$125,681,420
Connection with New York Central				50,000
Two freight stations, with heat and light plant for system				1,680,000
Rolling stock				5,600,000
Shops, block system and miscellaneous				1,000,000
				$134,011,420
Legal expenses, interest superintendence and commissions, 12½ per cent				16,751,428
Total cost of masonry structure				$150,762,848

COST OF DEEP TUNNEL LINE, BATTERY TO KINGSBRIDGE DIRECT.

Excavation, per mile	$2,860,000	
Lining, per mile	1,267,000	
Permanent way, per mile	30,000	
Stations, per mile	120,000	
Land for stations, per mile	420,000	
13¼ miles, at	$4,697,000	$62,235,250
Rolling stock		5,600,000
Shops, block system, and miscellaneous		1,000,000
		68,835,250
Legal expenses, interest, superintendence and commissions, 12½ per cent		8,604,406
Total cost of tunnel scheme		77,439,656

The income derivable from the different schemes is stated below, on the basis of a single five-cent fare from the Battery to Kingsbridge. On this basis any of the schemes is seriously handicapped in comparison with the present elevated system, whose longest five-cent ride is less than 10 miles in length against about 15 on the proposed Battery-Kingsbridge elevated lines. This difficulty would also make it hard to operate through trains from the suburbs into the city without change. If, however, proper authority were conferred to collect extra fares, say, above 155th street, it is probable that some satisfactory ticket-collecting arrangement could be devised without change of cars.

INCOME.

Bridge Structure.—The income account of the bridge scheme may be estimated as follows: If the passenger business be estimated at three-quarters of the present elevated railroad income from the Third and Sixth avenue lines, or, say, equal one-half of the whole income of the Manhattan, it would at present amount to about $2,000,000 net. It seems fair to assume as much as this in spite of somewhat greater operating expense, in view of the section of the city traversed and of the greater length of line, and also in view of the greater agreeability of a line without stairs to climb, freer from noise and with more agreeable outlook. This $2,000,000 would give less than 3½ per cent. on the estimated cost of $58,000,000. If, now, we turn to the possible maximum business of such a road in order to get a figuring basis, assume the trains fully occupied, that is, all seats taken for 14 hours per day. If the trains are one minute apart on each track of the four, and each train of eight cars seats 400, the annual capacity is $365 \times 400 \times 60 \times 4 \times 14 = 490,560,000$ passengers at 5c. = $24,528,000, or perhaps $12,000,000 net. This would give a return on the capital outlay of 20.7 per cent.

Masonry Structure.—In the case of the masonry structure the income would be made up of: 1st. Rents of buildings; 2d. Passenger income; 3d. Freight income, and 4th. Rental of conduit space (disregarding in all cases income from carriage of mails and express matter). Referring to the estimate we have:

Building investment.

Battery to 97th street, 8.5 miles	@ 8,160,000 =	69,360,000
110th street to 170th street, 3.6 miles.	@ 6,480,000 =	23,328,000
183d street to Kingsbridge, 2.5 miles	@ 5,136,000 =	12,840,000
		105,528,000
Income from this at 4 per cent., to take a conservative figure, is		4,221,120

2d. The passenger income would be same as from the bridge structure.

3d. The freight business practicable seems exceedingly difficult to guess at; 400 cars per day with a rate of 15 cents per ton, including terminal charges, a low rate for the character of freight to be expected, namely, jobbing goods, would be as little as would make it pay to make the estimated outlay for freight stations. This would give a net return of, say, $120,000, after deducting 50 per cent. for expenses.

4th. Allow for rental of conduits, 16 miles at 4,000, $64,000, we then have:

Income Account.

Building rental	$4,221,120
Passenger income	2,0 0,000
Freight "	120,000
Conduit rental	64,000
Total	$6,405,120

or 4.3 per cent. on $150,000,000.

The maximum in this case figures out as follows, the freight income and conduit rental being pure guess work, but kept low enough to be apparently quite safe:

Building rental as before	$4,221,120
Passenger income	12,000,000
Freight "	300,000
Conduit rental	100,000
	$16,621,120

or 11 per cent. on the capital invested.

Tunnel.—On the tunnel scheme, if the same passenger income be assumed, we have minimum and maximum returns of 2.6 per cent. and 15.6 per cent. The prospect of even the smaller figure being realized at once seems small in view of the unattractive character of the method of transit.

So many estimates of a general character have been given on the cost of a tunnel system under New York, showing a much smaller cost than the above, that it seems necessary to call attention again to the fact, that, so far as known to the writer, none of these except that of Mr. Deeves, above referred to, have gone into any detail that could be analyzed.

It seems to have been assumed that the driving of a tunnel under New York was one of the simplest and most inexpensive things in the way of tunneling that could be found. The facts as pointed out above are these: The tunnel would have to be driven through a rock generally hard, and almost always treacherous. The use of a shield in view of the blasting required would be impracticable. The quantity of water to be expected would be enormous, judging by the results of wells in different parts of the city. The cost of handling the material, as pointed out above, would exceed that of any known tunnel, so far as can be judged in advance.

An iron lining would be impracticable for a four track tunnel on account of the expense for so great a span with probable irregular and uncertain loading. If four small tunnels were driven the expense of driving them would be enormously increased. The flanges of the iron lining add to the noise inseparable from a tunnel with any known rolling stock and permanent way, except possibly the "glissade" track exhibited at the last Paris exhibition.

The result of this investigation is to confirm the conclusion reached by the very original and entirely different method of Mr. Cooper in your recent issue, that the franchise for building a rapid transit railroad in New York (other than by an elevated structure in a street), in competition with the present elevated system, is one requiring subsidy and not one for which capitalists will pay money or which they will undertake without assistance.

The most feasible method would seem to be by guarantee, on the part of the city, of a limited interest on the investment, viz., that it would make up any shortage below the rate fixed upon, with release of the property from taxation for a limited period. The commission having determined the most practicable route and method, might ask the legislature for power to make such an arrangement with the party who would bid for the franchise at the shortest term of tax release.

April 6, 1891.

Block Signaling.*

[Mr. Paine's paper dealt with many things with which our readers are already familiar; therefore we reproduce but a small part of it. It will probably be published in full by the club.]

Permissive blocking does not strike me as being blocking at all. Its success depends on the combined action of two persons who must both obey their rules promptly and correctly. In order that the system may prove a success, the flagman must run back a long distance as soon as the train slackens speed, no matter what the weather may be, no matter how tired or sleepy or lazy he may be, and the engineman must be on the lookout for the flag at every moment. He must not be attending to any of the multifarious duties devolving on him, but must give his whole attention to the track in front of him, so far as his eyes are concerned. The engineman must, first and foremost, make his schedule time, or, if late, something more than schedule time; he must also run carefully under the permissive signal.

Does any one doubt what the result will be? He always has and always will argue when placed in a similar position, either that the train against which he has been cautioned has got out of the way or else that the flagman of that train has been sent out to protect it. On the other hand, the flagman, knowing that he has the protection of the signal behind him, reasons that the engineman of the following train has been cautioned against the train in advance and that he is running carefully under a green signal. Then the inevitable happens The engineman is in a hurry, the flagman is either tired or careless or lazy, and there is a collision with the usual results, which your are all familiar with, in the way of wrecked cars, and burned, mutilated and suffering human beings. In view of the above facts, I suggest in all sincerity that the term "permissive blocking" be abandoned, to be replaced by the more appropriate expression "pernicious blocking." . . .

At the present time the question of night signals is agitating the minds of railroad officials in general, and signal engineers in particular, and very justly so, for our present standard, or rather want of standard, is most unsatisfactory in every way.

There are many different arrangements of the lights for indicating the positions of signals at night. The most common plan is a green light for caution, a red light for danger and a white light for safety. This plan, although advantageous for its simplicity, may well become, from the breaking of a red or green glass, a source of the greatest danger. I know of several well-authenticated instances where this has occurred. The signal engineer of a well-known road told me not long ago of a case in his knowledge where a serious collision through this cause was averted only by the presence of mind of the engineman, who brought his train to a stop in the face of a white signal, because he knew or suspected that the signal was wrong. The multiplication of lights is a common resource for avoiding the before-mentioned danger, and is practised on many roads. It, however, has many disadvantages, the principal ones being excessive cost of manufacture and maintenance, and the possible confusion of having so many lights. The ideal semaphore would, without reference to color, show at night a brilliantly illuminated arm of approximately the same size and shape as the arm appears by daylight. A very close approach has been made to this semaphore, which, how-

* A paper read by Mr. G. H. Paine, Signal Engineer, before the New York Railroad Club, April 16, 1891.