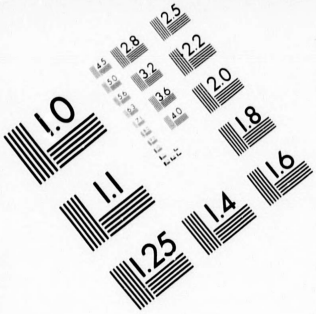

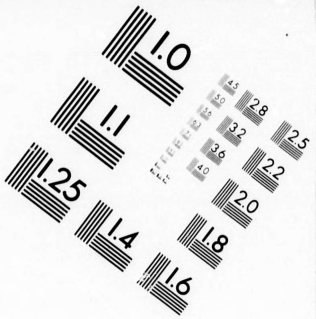

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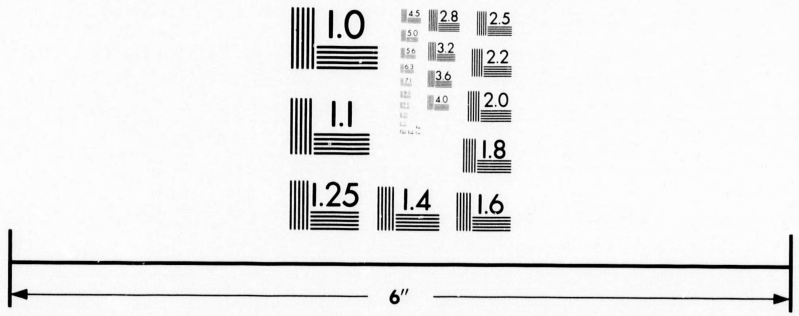

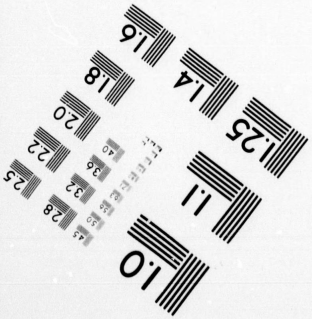

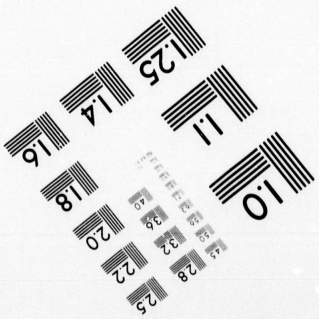

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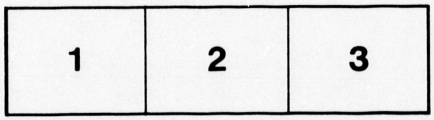

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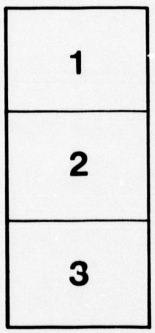

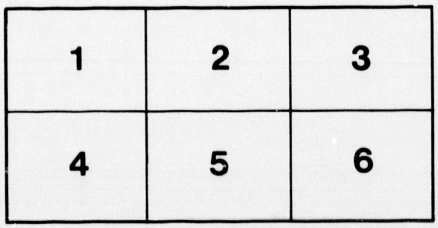

REPORT

ON THE

System of Electric Street Cars

FOR THE

CITY OF TORONTO

BY

GRANVILLE C. CUNINGHAM, M.I.C.E.,
CITY ENGINEER.

NOVEMBER 1891.

4938

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REPORT ON THE SYSTEM OF ELECTRIC STREET CARS FOR THE CITY OF TORONTO.

To the Mayor and Council of the City of Toronto:

GENTLEMEN,—In compliance with the instructions conveyed to me by resolution of the Committee appointed to deal with street railway matters, I recently visited various cities and electricial manufacturing establishments in the United States, with a view to determining from actual observation what was the best system of street car propulsion at present in use, so that, from the experience of other places, we in Toronto might be enabled to choose and adopt that which is the best. The places which I visited were: Buffalo, N. Y.; Cleveland, O.; Pittsburg and Allegheny, Penn.; Washington, D. C.; New York; Newark, N. J.; Albany, N. Y.; and Boston, Springfield and Milford, Mass. I also visited and examined the electrical manufacturing establishments of the Short and the Brush Companies, at Cleveland; the Westinghouse Company, at Pittsburg; the Edison Company, at Schnectady, N. Y.; the Thompson-Houston Company, at Lyn, Mass., and the laboratory and experimental works of Mr. Edison, at Orange, N. J. In the fortnight that I had at my disposal I have endeavored to make myself acquainted with all the latest improvements that have taken place in street car traction or propulsion.

Of the systems other than horse traction that present themselves for adoption in the street car service of Toronto, there are cable traction and electrical propulsion, for we may put aside, at once, steam motors as being unsuitable to our streets.

Cable traction in large and thickly populated cities is undoubtedly a great improvement over horse traction, and its introduction conferred a vast benefit on those cities requiring rapid transit for large numbers of passengers. It is, however, in many respects inferior to electrical propulsion, and is unsuitable for the thinly peopled districts surrounding a large city, where the numbers to be carried are small, and the cars run at considerable time intervals. I may, perhaps. briefly indicate to the Council some of the points in which cable traction is inferior to electricity as a motive power. At the outset there is a much heavier cost of construction in preparing the streets for cable traction than for electricity. Then, in working the system, a very large proportion (about thirty per cent.) of the power generated in the power house is absorbed in simply moving the dead weight of cable; and this dead weight must be moved whether one or one hundred cars are attached to the cable; with electricity the power absorbed is directly in proportion to the number of cars running.

Curves, switches and turnouts are difficult to manage with the cable; with electricity they are no more trouble than with any surface system.

For extensions to the suburbs, where traffic is light, the cable is unsuited. The large, dead weight of cable has to be moved constantly to provide for the conveyance of only a few cars, though it would be adequate for the conveyance of a large number, and the same heavy construction works have to be undertaken for these few as for the many. With electricity, the cars running in the

suburbs absorb only the amount of power required for their propulsion, and this power can be furnished from the power house by the addition of the requisite generators.

With the cable system the cars can move no faster than the cable; they can run slower only at the expense of great wear to the cable, and they cannot reverse their motion at all. With electricity the cars can run fast or slow, as desired; they can be stopped or run back by simply turning a handle, and are much more controllable and manageable in this respect than even are cars drawn by horses. The speed of the cable cars is limited by the rate at which the cable moves; the speed of electric cars, up to 15 or 18 miles an hour, is limited by the conditions of the roadbed on which they are travelling and the exigencies of the traffic amongst which they are moving. There are few cities that need and demand rapid transit in the suburbs more than does Toronto, and there are few cities to which an electrical system is better suited.

Passing by the cable system as being undesirable for adoption here, I go on to consider the electrical systems at present before the public.

They are three: the storage battery, the underground or surface conduit, and the overhead wire.

There is something very attractive about the idea of the storage battery system: that each car should carry with it the store of electricity required for the performance of its work, and that this store should be drawn upon at will, to run fast or slow as occasion required, without the intervention of any accessories in the shape of conduits or poles or wires. This would be the perfection of electrical locomotion, and the advent of such a perfect electrical system would be hailed with delight by all street car companies and electrical engineers. But this day has not yet dawned. The great difficulty that has to be contended with is the enormous weight of battery that has to be carried in order to supply even a moderate amount of power to the car. This weight of battery aggregates two and three-quarter tons for a car sixteen feet long that is capable of carrying, when some passengers are standing, about forty people. And even with this weight of battery the voltage obtained is little more than one-half that conveyed to cars running by other systems. To increase the voltage would mean adding more cells to, and increasing the weight of, the battery, and this again would require a larger car for its conveyance, and more power to propel it. The Council will readily understand that with a power so limited, and so heavy a weight to be propelled, it is impossible to have anything but a most moderate rate of speed, that is not superior to that obtained from horses.

I examined two storage battery systems, one at Washington, D.C., and the other at Milford, Mass. At Washington four cars are running on a line that is two and one-third miles in length. The batteries are placed under the seats of the car and occupy the whole length of each side. At Milford there are five cars fitted with storage battery, but only two are running at any one time on the track, which extends altogether about six miles. The cars are used to relieve each other, and each car after making its trip is run into the power house to be re-charged. At Washington the storage battery is used only in that part of the

city where Congress has forbidden the erection of poles and wires. Outside this limit the Street Railway Company run electric cars on the overhead wire system. These are the only storage battery systems at work within the limits embraced by my tour of examination. There was one formerly running in Brooklyn, N. Y., but it has recently been abandoned. The Council will readily see that what is being done in storage battery work is small indeed as compared with that being done with overhead wire cars, in almost every city and small town in the States. From one of the power houses alone of the Boston West End Railway Company there are at present running 160 cars every day for nineteen hours a day, and the Company is constructing an immense power house at the present time that will operate 660 cars

None of the electrical companies that I visited are doing anything at all in the line of developing the storage battery system. Mr. Edison himself, who is the leader in electrical invention, has apparently dropped the matter. The system seems now to have reached a point at which it rests until some further discoveries in electrical science shall be made. The improvement in the system that is required before it can be a practical success and generally adopted as a motive power on a large scale, is the discovery of some metal much lighter than lead that may take the place of the heavy lead plates now used in the battery, and a metal that may at the same time be capable of carrying as much or more electrical current than the lead plates now hold; or, the discovery of some means by which the lead plates now in use may be able to carry a much heavier charge of electricity than they now hold, and thus enable the weight of battery to be largely reduced, while its power shall be increased. On some such lines as these the improvement of the storage battery system must proceed before it can be applicable to the running of the number of cars (at present about 150) required in this City at the speed necessary to give satisfaction. An electrical system would be of no value to Toronto unless it could afford rapid transit.

The underground or surface conduit system for conveying the current of electricity from the power house to the car running on the track, presents itself as a possible means of avoiding the use of poles. The difficulty that surrounds this system is in properly insulating the conductor so that the electricity may not be lost in continuous leakages. For street railway work this conductor must either be sunk below the ground or it must be on the surface; it cannot be raised above the surface as it would then form an obstruction to the vehicular traffic. In either of the conditions – below ground or on the surface—the conductor is subject to constant loss of electricity from imperfect insulation when subject to the changes of our climate. It seems impossible to guard against the losses that will take place from mud, rain and snow causing short circuits. In all the places that I visited I saw no example of this system at work, or even being attempted. I visited Mr. Edison's experimental works at Orange, N.J., and learned that he is at present working at a scheme by which the current shall be transmitted on one rail of a street railway system, taken up by the wheels of the car, passed through the motor, and returned by the other rail. Mr. Edison is endeavoring to insulate the rail, which shall be used as the conductor. But even if this insulation should be completely effected, it seems to me that the system would be open to strong objections for use in street traffic.

If a horse should happen to place his fore hoof on one rail while his hind hoof was on the other, he would form a "short circuit" which would draw through his body the whole current of electricity, with very astonishing results; or if a wagon should travel along the street with the wheels on both rails at the same time, as we frequently see done, a "short circuit" would be completed and the continuous current destroyed. But whatever may be the future of this system, or however difficulties that at present seem insuperable may be overcome, there is not at present any system of underground or surface conductor that is practically successful for use in street railway work, or any such system whose adoption I would recommend by the Council.

The third system that I have mentioned is that by which the electrical current is conveyed by an overhead wire, and drawn down to each car by a trolley pole making contact with the wire by means of the trolley wheel. This is the system which is now so largely used throughout the United States. With the exception of New York, where no electrical system is used, there is scarcely a city or town in the United States but now has its street cars propelled by electricity supplied on this system. In two of the places that I visited—Albany, N.Y., and Springfield, Mass.—the electric cars have already entirely displaced horse traction, and the street car horse is no longer seen on the streets of those cities. The wonderful rapidity with which electricity is establishing itself as the motive power for street railways may be learned from the following figures. At the beginning of 1888 there were throughout the United States about twenty electrical roads in operation, having a total of eighty miles of track, and working ninety motor cars. Early in 1890 this had grown to 1,670 miles of track and 2,650 motor cars. But, by the middle of September of the present year—that is, little more than three years from the practical application of the system—the figures show 412 electrical companies in operation, on 3,009 miles of track, and using 6,732 motor cars. The following concise statement of the present extent of street railways in the United States and Canada is taken from the address of Mr. H. M. Watson, President of the Street Railway Association, delivered at the Pittsburg Convention, in October last:

Number of miles operated by animal power	5,443
" " electricity	3,009
" " steam motors	1,918
" " cable	660
	11,030
Number of cars operated by animal power	25,424
" " electricity	6,732
" " cable	3,317
" " steam motors	1,044
	36,517
Number of companies operating street railway lines by animal power.	537
" " " " electricity....	412
" " " " cable	54

This shows a remarkably rapid growth of the electrical system, and when we know that, with the exception of about twenty miles, all the above electrical mileage is worked by the overhead wire system, we are justified in saying that that is the only practical system at present available for operating street railway cars on an extended scale. The storage battery might be used on small level systems where only very few cars are run, at very considerable time intervals, and where no high speed is required, but it is unsuited to the large traffic of such a City as Toronto; the only system that is at present suitable and available is that of the overhead trolley wire.

This trolley wire is suspended at a height of eighteen or twenty feet above the ground, over the centre of each line of railway. When the streets are not too wide—that is where they do not exceed fifty or sixty feet between the kerbs—the trolley wire is carried by a suspending wire that is attached to poles placed at the kerb or either side and stretched across. These poles are, in the central parts of the City, most frequently made of iron; three sections of iron gas pipe are used, the lower section is usually about six inches in diameter and the upper sections somewhat smaller. The height of the poles is about twenty feet above ground, and, when neatly made and painted, they are no more unsightly or injurious to the appearance of the streets than are ordinary gas lamps. They are placed about 120 feet apart and usually carry the feed wire for the trolley wire. All the objectionable cross arms and vast net work of wires with which we are painfully familiar in connection with telephone and telegraph poles is absent on these electric railway poles. In streets that are too wide to place the poles at the kerb—such as our Spadina Avenue—they are placed in the centre of the devil-strip, and a bracket projecting on either side carries the trolley wire over the centre of each track. In those parts of the City where the trolley wire is crossed by numerous telephone wires it is customary to erect light guard wires about a foot above the trolley wire, so that in case of a telephone wire breaking it will be prevented from making contact with the trolley wire. This is a good precaution, and should be observed where the telephone wires come in proximity to the trolley wire. Considerable misapprehension exists in regard to the danger arising from these trolley wires. They are much less dangerous than electric light wires, as the voltage of the trolley wire is only 500, while that of the electric light wire is more than four times as great. A shock from a trolley wire, though giving a smart blow, is by no means fatal, and has been received by many men working about a car system without serious results. In case of the trolley wire breaking and falling to the ground, a simple "cut out," that works automatically in the power house, immediately renders it dead and harmless. The electricity is drawn from the wire to the motor car by the trolley pole in the manner that is doubtless familiar to the Council. Cars running on this system are wonderfully manageable and easily controlled. They can run fast or slow as desired; stop, when running at high speed, in about two car lengths; and can be reversed and run back at will. They are more easily handled and controlled than are cars drawn by horses.

In view of the facts which I have briefly laid before the Council, and of the experience which I have gained on my recent tour of examination, and from careful study of the question, I have to recommend to the Council that the motive power which shall be forthwith adopted by the Toronto Railway Company and applied to the running of all street cars throughout the City of Toronto, in accordance with the terms and conditions of the lease of the Street Railway franchise from the Corporation of the City of Toronto to the said Toronto Railway Company, shall be that commonly known and designated as the overhead-single-trolley-wire electric-system, and that the details of the erection, construction and maintenance of this system shall be subject at all times and in all particulars to the approval of the City Engineer of the City of Toronto: Provided (and this proviso is part of the recommendation that I make) that if at any time during the currency of the aforesaid lease or any extension or extensions thereof, the development of electrical invention shall be such, that some other system of electrical propulsion better than that known as the overhead-single trolley-wire electric-system shall be invented and made practically workable for street railway traffic (and the City Engineer shall be the judge of this), that it shall be competent for the Council of the City of Toronto, on the recommendation of the City Engineer, to order and direct that this other system of electrical propulsion shall be used in place of that above described as the overhead-single-trolley-wire-electric-system, and this other system of electrical propulsion shall then in that case forthwith be adopted and used by the said Toronto Railway Company, for the propelling and working of street cars on their railway system throughout the City of Toronto, subject to the terms and conditions of the said lease as aforesaid.

Before closing this report it is necessary that I should say something in regard to the width of the strip between the double tracks, commonly called the devil-strip. In the various places that I visited I found that there was great variation in regard to the gauge of the track and the width of the devil-strip. The gauge varied from four feet eight and a half inches to five feet two and a half inches, and the devil-strip from three feet to six feet. The usual width of the strip is from four to four and a half feet. In Pittsburg and Alleghany, however, the strip is only three feet wide, and in these cities the streets are narrower than in Toronto, and the vehicular traffic very much greater and more congested. On a street in Pittsburg (Smithfield Street) there is only thirty-four feet between the kerbs, a double line of tracks in the centre of the street, with a three-foot devil-strip, and on this street numerous electric cars travel backwards and forwards, crossing cable systems and other electric systems, while there is a vehicular traffic in excess of anything we have in Toronto, and yet accidents do not seem to take place. There can be no doubt, however, that, though not absolutely necessary, it would be expedient to widen this strip to four feet when laying down new lines or relaying existing lines in Toronto. The electric cars should not be wider than seven feet six inches from out to out, and with this there would be just nine inches clearance on a three-foot devil-strip when the cars were passing each other. I think it would be expedient to increase this width when relaying the tracks by widening the strip to four feet. But I am

of the opinion that in the central parts of the City, on King, Queen and Yonge Streets, it would be greatly for the general good of the community to lay only single tracks on these streets, using Adelaide and Richmond Streets between Sherbourne Street and Spadina Avenue, and Victoria Street as far north as Gerrard Street, for the return traffic. Having before me the example of Pittsburg, I feel very strongly that it would be in the interests of this City to avoid such a condition of things here if any reasonable means can be found for so doing. In future years the vehicular traffic on our main streets may be expected largely to increase. The expense of widening our streets would be enormous, but the adoption of single tracks would be practically a widening of the street by giving up so much more of the space to vehicles. I discussed this question with the President of one of the electric railways of Pittsburg, and he was clearly of the opinion, from the experience of his own city, that it would be a great benefit both to the railway company and the community to have single lines on the crowded streets when parallel streets can be had close at hand for the return traffic. The car traffic can be handled so much more expeditiously and safely among a crowd of vehicles and pedestrians when there is only only one track. This, however, is not a question of pure engineering: there are complicated questions of general municipal policy that arise or suggest themselves on this subject on which the Council is better able to express an opinion than I am. I would therefore not make any definite recommendation on the subject of single lines as indicated, only pointing out that from an Engineer's standpoint I would consider it the best plan to adopt, and requesting that the Council will consider the whole question and instruct me as to its opinion on the subject.

As this part of my report may possibly not be adopted until after some time has been allowed for discussion, I would respectfully suggest that the Council should as soon as possible adopt or reject that part of the report recommending the electrical system to be used by the Railway Company, in order that the Company may be able to proceed at once in making preparations for the introduction of electricity.

All of which is respectfully submitted.

GRANVILLE C. CUNINGHAM,
City Engineer.

TORONTO, 23rd November, 1891.