A DINING ROOM ELECTRIC RAILWAY.

ALTHOUGH lighting is, no doubt, the most important application of the distribution of electric energy, it is not the only one, and we wish no better example of this than the little railway established by Mr. Gaston Menier in his dining room. A car, passing and stopping in front of each guest, rapidly performs, under the direction of the master of the house, all the essential maneuvers of a punctual and well ordered service. The device consists of two essential parts—the track and the car. The track consists of four parallel rails, mounted upon oak stringers, placed end to end. The two external rails receive the wheels of the car, are insulated from each other, and communicate with the inductor of a dynamo-electric motor. The two internal rails upon which the contact rollers run put the electric source (a battery of twenty accumulators) in communication with the armature of the motor, through the intermedium of a commutator to the right of the master of the house. This commutator permits of stopping the train or of changing the direction of its running through a change in the direction of the current in the armature.

The oak stringers rest upon supports that raise the track about four inches above the level of the table, and in the space thus left are placed such table objects as salt cellars, covers, etc. Although the eight wheels that support the car form two bogies placed at its extremities, it would be difficult, since the length of the platform is thirty inches, to make the car describe a semicircle at the end of the table, as the radius of such a curve would be scarcely more than sixteen inches. This difficulty has been overcome by substituting an automatic switch for the curve. The track, starting from the pantry, where the dishes are placed upon the car, traverses a small tunnel and reaches the dining room. At the end of the table, the car meets a switch from which the track branches off to the right and left and passes before the guests sitting on each side. At the other end, the tracks unite again so as to form a single road.

The two switches are held in a given position by springs, and are set by the car itself. After the car has crossed the first switch, it runs from left to right till it reaches the opposite switch, and then runs back from right to left along the other side of the table.

It is unnecessary to say that the car can run in either direction on the same track, but, in order to make it pass from one track to the other, it must necessarily cross the switch to the right that is most distant from the pantry.

The gauge of the track is four and a half inches—a width sufficient to assure a satisfactory stability to the rolling stock without encumbering the table.

The car consists of a platform thirty inches in length by eight and a half in width that pivots upon two bogies, one of which carries the motor, while the other is but a two-axled truck, serving as a support. The dynamo-electric motor consists of a Siemens double T bobbin. The use of two bobbins, keyed at right angles, prevents dead points, and permits of starting the car from any position. The four wheels of the bogies are connected by coupling rods in order to increase the adhesion, and are actuated by a gearing that reduces their velocity in the ratio of 1 to 9. The expenditure of electric energy is insignificant, since the current does not exceed 0.5 or 0.6 ampere, with an electromotive force of 36 volts. The car weighs sixteen pounds when empty, and is capable of carrying one hundred and thirty pounds. By interposing resistances in the circuit, it is possible to vary the normal speed between four inches and three feet per second.

The stopping and starting are done very quickly, and a simple reversal of the current permits of sending the car from one point to another

very speedily. It is wonderful to see how perfectly the car at once obeys the master's orders through the skillful maneuver of a commutator within his reach.—*La Nature*.

ELECTRICITY AS A MOTIVE POWER.*

By WM. WHARTON, JR.

SINCE the last annual meeting of this association the subject of using electricity as a substitute for horse power on street railways has received much attention,

applications, and capabilities, has been hitherto a subject the knowledge of which has been confined mainly to scientific circles, but it is evident that the time has come when it will be put in harness in place of the horse to draw cars and to perform many other duties which a few years ago would have been considered entirely chimerical and visionary. So long as the oxidation of metals or other chemical action was the only available method by which electricity could be produced, the expense attendant upon such means limited its use to a very narrow sphere. Since, however, steam

power and water power have been so successfully employed to generate electricity, and to do it so cheaply, the range of its usefulness and application has been wonderfully enlarged from year to year. It is not intended in this paper to make use of scientific terms, or to discuss the question from any standpoint but that of practical observation and experience, nor is it intended that any comparisons shall be drawn between electric motors and steam locomotives, but there is a wide field for work in which neither the locomotive nor the horse is able to satisfactorily accomplish the duty called for.

The systems at present in use for electrical propulsion of cars are divided into two classes.

First, that in which the electricity is conducted from one or more active generating sources along a suitable conductor or conductors to be used in the cars, with proper return connections; and secondly, that system in which the electrical power is obtained from accumulators or secondary batteries carried along with or within the body of the car. Of the first there are several methods, namely: That in which the electricity is carried along a conductor

above the ground, considerably above the car, either directly over it or toward one side.

That in which the electrical conductor is situated at the side of the railroad and elevated a few feet only above the ground.

That in which the electricity is carried upon the surface, either by a third rail or other conductor running on the level of the ground or pavement.

That in which the electricity is carried beneath the surface by a conductor placed within a suitable conduit for its protection, access being had to said conductor through a slot in the top of the conduit, so as to allow of electrical connection with the motor on the car.

The plans of having the conductor along the surface or at the side of the railroad not much above the surface have so many evident and practical disadvantages that they need not be taken into consideration in this paper. Therefore, the question is reduced to the three methods of overhead conduction, underground conduction, and storage batteries.

It is evident that better service must be furnished at the same cost, the same service furnished at a cheaper rate, or that both objects combined shall be attained by the use of electricity before it takes the place claimed for it.

The writer believes fully that the last proposition of both better and cheaper service has already been proved by actual service and daily use, but in the nature of things improvements upon the present methods will be discovered, and "the survival of the fittest," which applies as well to mechanical appliances as to animated life, will by its inexorable laws weed out and discard those which are deficient or incompetent.

There are so many intelligent, persevering, and scientific minds engaged in active experiments and researches into the mysteries of nature's powers, and more especially those relating to electricity, that discoveries are constantly being made, human knowledge in this age extending more rapidly than at any previous time. The subject is fascinating and the prizes sought after are brilliant and valuable. The increased cheapness in production of

FIG. 1.—A DINING TABLE ELECTRIC RAILWAY.

and great advances have been made in the practical application of it to that purpose, so that it may now be stated broadly there is no longer any doubt or uncertainty that electricity can be successfully and economically employed in a great many places, if not most places, as a substitute for animal power. Quite a number of electric railways are in operation in the United States, running satisfactorily under all the requirements of public service, so that there is much greater familiarity with and a more general knowledge of electricity among railroad men and the public than ever before. There is so much confidence in the practicability of electrical propulsion of cars being well established, that the subject is no longer treated with doubt or disdain; on the contrary, great interest and respectful attention are at once manifested whenever the subject is brought up.

Although some parties, interested perhaps in pushing forward their own special inventions, may claim too much, the actual facts as presented daily in the regular work of the cars are good enough to warrant this belief and confidence. Electricity, in its manifestations,

* A paper read before the Philadelphia Street Railway Convention, Oct. 19, 1887.

FIG. 2.—ELECTRIC CAR FOR DINING TABLE.

electricity which may fairly be assumed for the future will of course add to the advantages, and enlarge the scope, of its use. At present there are many places where electricity can be generated at a nominal cost by the use of water power, and this energy can be carried a number of miles without any loss or leakage of practical consequence.

Where this can be done, of course the parties have special advantages. So also there are many towns and cities in coal regions, or natural gas regions, where the same result of cheapness in production can be obtained, although by different means. As a case in point it may be mentioned that the electrical railway in Scranton, Pa., has its power station located about midway of the route, and immediately at the foot of a large hill or great mass of hundreds of thousands of tons of culm, which is principally composed of the small, fine particles of coal produced in mining or left after the screening and preparation of the commercial sizes of coal for the market. This has been accumulating for many years, is still accumulating, and has hitherto been considered only an inevitable nuisance, which the mining proprietors would gladly have given away for nothing to get rid of it, and not have it occupy their land.

The price which the railroad company pays for this culm is but ten cents per ton, and as it only has to be wheeled through the door of the engine house, the whole distance from the culm hill to the furnace under the boilers not being over fifty feet; and as the whole consumption per day is on the average but five tons, or in money value but fifty cents per day, it is evident that the cost of electricity in this case is exceedingly small indeed, that sum being sufficient for the fuel to produce the steam power which generates electricity enough to run four and sometimes five cars, carrying at times seventy-five passengers each over a railroad track about four and a half miles in length, having long grades, a number of which are five or six feet to the hundred, and the steepest of which is seven and a quarter feet per hundred. The tractive power required upon some of these grades is still further increased by curves or switches occurring on them. It may be well to mention some other points about this railroad in Scranton, which has been running about one year, with great success, and exhibits in many respects a favorable example of an electrical railway with overhead conductors. The cars have four wheels; two of them are open cars, each carrying one motor of 20 horse power. The motor is placed in the body of the car midway of its length, and all four of the wheels are driving wheels, the connections between the motor and the wheel axles being made by means of chains and sprocket wheels. Three of the cars are closed cars, each with one motor of 15 horse power, which is placed on a closed platform at the forward end of the car. In these the forward wheels only are driving wheels, and their connection with the motor is made in the same way as on the open cars, with chains and sprocket wheels. The company will shortly place four more cars upon the line, each with a motor of 25 horse power.

These larger cars are intended not only to propel themselves, but to be able each to haul in addition two other cars loaded with passengers up all the grades. The running time of the round trip on the main line, being in all eight miles, is one hour, which includes all stoppages and the waiting at each end of the route, so that the average speed attained is more than eight miles per hour. There is no difficulty in going much faster; in fact, the men in control of the cars have to be watched to prevent their running at excessively high speed, particularly on the return trip to the city, where the grades allow the car to be run for most of the distance by gravity alone. At the generating station there are two stationary engines of 180 horse power each, two dynamos of 100 horse power each, and four boilers of 100 horse power each. Only one engine and dynamo, however, and two of the boilers are in use at any one time. The railway company expects also to furnish in the future electricity for the lighting of the town of Dunmore, situated at one end of the line, by which the income of the company will be materially increased. The duplicate engine and dynamo and the duplicate set of two boilers are for the purpose of providing against contingencies of accident to those in use, and also to allow of alternations in service, thus giving opportunities of frequent examination and inspection.

Upon this railway, as before stated, the overhead system of conduction is employed, having flexible connection between the motor on the car and the carrier traversing the conductor, which is a solid copper wire of five-sixteenths inch diameter, suspended on a part of the route from transverse wires attached to wooden poles placed on both sides of the street about one hundred feet apart lineally, about twenty feet high and about six inches in diameter at the surface of the ground, and on the rest of the line suspended from arms projecting sideways from wooden poles at the side of the railway about twenty feet above the ground. The line is a single track railroad with several turnouts or passing places, at which points the electric overhead conductor branches off over the side track also; and an ingenious system is in use by which the carrier, running upon the overhead wire, with two grooved wheels of about two and a half inches diameter, automatically shifts the connections at the points of divergence from the main line, so that the carrier always follows that one of the overhead conductors which is above the track upon which the car is traveling.

It is contemplated, however, to use two separate and independent overhead conducting wires throughout the whole length of the route, so as to avoid the possibility of any difficulty with the carriers at the points of intersection at the turnouts, although this has not happened often. The return current of electricity is taken by the rails. The electrical current has a tension of about six hundred volts, which, while sufficient to give a shock, could not produce any dangerous effect on man in case the current should by any means be diverted. Part of the road is laid with tram rails and the rest with T rails, and a part is paved and the rest unpaved, so that these different conditions, in connection with the many grades and the curves and the turnouts, give ample opportunity to thoroughly test the working of the system. Although the overhead wires in this case do not present any more unsightly appearance than the numerous telegraph cables and wires to which we are so accustomed, it is, however, evident that the use of the overhead system will be

prohibited in most cities and towns, especially since the general determination to place all electrical wires through cities underground. The noise of the carriers running on the conductors is not much, although it can be readily noticed; but the noise produced by the motors and the chain and sprocket connections is quite considerable. This latter could be entirely avoided by the use of a noiseless motor and a better method of connection, of which motors and connections there are several kinds easily obtainable. Noiseless, efficient, and durable electric motors suitable for use on cars can be had in which the weight per horse power does not exceed sixty pounds.

In a paper of the length to which this must necessarily be limited, it will be impossible to do much more than treat of the subject in a general manner, but it can be stated specifically and certainly that electric railways with overhead conduction have demonstrated beyond a doubt their capability to propel a few cars, even if heavily loaded, at less cost and much greater speed than could be obtainable on railways operated by horse power. This is true in places where the coal required must be bought at usual rates and the exceptional advantage of fuel at merely nominal cost does not exist, as at Scranton, and likewise at Wilkesbarre, where an electrical railway is under construction, upon which the cost of coal used will not exceed sixty or seventy cents per day for five cars.

In the case of electrical railways with underground conduction the effort has been made to give all the advantages of the overhead system and at the same time remove the objection which in most places is absolutely prohibitive of having the conductors and poles or other supports obstructing the streets. In doing this, however, great difficulties arise, some of them of a very serious character. The costly conduit, with the needful arrangements for drainage and for cleaning out, together with the increased care necessary to provide against the considerable loss or leakage of electricity, which nevertheless generally takes place in spite of all precautions, detract greatly from the apparent advantages of the plan. Many inventions have been patented and numberless devices contrived to overcome the many objections of this method, but there is great room for doubt whether practical success has yet been obtained.

Neither by overhead nor underground conduction have more than a few cars as yet been moved simultaneously upon railways, although many ingenious arrangements are offered by various parties who confidently assert they can run any required number of cars. This, however, yet remains to be proved. Both plans, also, are open to another serious objection in the entire stoppage of travel on the whole line in the case of breakage or derangement of any part of the conducting apparatus or the generating machinery. In this respect they are under the same disability that the cable system of car traction is hampered with. Possibly, by suitable arrangements of duplicate engines, boilers and dynamos, duplicate conductors, and auxiliary, sectional, or relay systems of conduction, this disability, threatening as it appears to be, may be so reduced as to be of no great detriment. This, however, also remains to be demonstrated.

Taken altogether, underground conduction does not compare favorably with overhead conduction up to this time. One great trouble with the latter plan, however, is that although it can be used to great advantage and economy on lines running a few cars in towns, or in suburban districts outlying large cities, it will probably never be allowed by the municipal authorities in large cities, which of course are the very places where the advantages of electrical propulsion are needed the most. To move a large number of cars, as for instance upon the Third Avenue or Broadway lines in New York City, the electrical conductor, whether overhead or underground, must be of great size if the current is of low tension; while on the other hand, if a small or moderate sized conductor be used, the current must then be of dangerously high tension, and of course it would then be very difficult to avoid great loss of electricity from leakage.

There remains to be considered the accumulator or secondary battery system. In this each car carries its own supply of energy, and is entirely independent of any method of continuous electrical conduction. No change of track or roadway is required, nor any costly conduit or unsightly poles or other supports, while the cars can run anywhere that a car can be taken by horses. These points are of immense advantage, and are the chief merits advanced by its advocates, independent of its economy over horse power.

In practice, cars of the size of the usual two-horse cars are provided with about 80 accumulators, weighing when filled with fluid and ready for use about 40 pounds each. These cells are placed under the seats, one half being on each side of the car. Their combined weight is 3,200 pounds, and the weight of two motors each of five horse power should not, together with their connections to the car axles, exceed 800 pounds, so that the additional weight imposed upon the car is say 4,200 pounds, which allows 200 pounds for the apparatus to control the current and for other electrical appliances. This added weight, if placed upon a four-wheel car, may be of disadvantage to the car or to the track. If this should be the case, the difficulty is removed by the use of eight wheels on two swinging trucks, which support the car much better, and distribute the weight upon the track. Both these kinds of storage battery cars are in service with entire success. The charging of the cells is done by a dynamo driven by steam power or any other desirable means, and it takes four hours to charge cells which are able to perform four hours' work. To remove from the car the cells which have done their work and to replace them by freshly charged cells takes no more time than the time required to change horses. It requires 10 horse power exerted for four hours to charge the batteries or cells of each car, so that 40 horse power hours are needed to accomplish it.

The cost of running large stationary steam engines of, say, 200 to 400 horse power, constructed with the modern improved cut-off appliances and other economical devices, has been found, after extensive investigations, not to exceed two-thirds of one cent per horse power hour.

This allowance is a liberal one, and is above, rather than below, the actual average cost, including fuel at average market prices, attendance, repairs to engine and boilers, oil, etc. We will, however, take it at 1 cent per horse power hour. Forty horse power hours

at 1 cent costs 40 cents, which is the cost of 4 hours' car service; and as the day's work of a car should be taken as 16 hours, we have as the whole cost of a day's supply of electricity four times 40 cents, or \$1.60.

Since four teams of two horses are required to draw a car for 16 hours, and as one additional horse per car is the usual allowance for sick or disabled horses, nine horses per car are needed for a day's work, which, at 50 cents per horse for feed, bedding, attendance, shoeing, etc., is \$4.50, against \$1.60 for the storage battery electricity. Making extraordinary allowance for possible errors in this comparison, the difference is still astonishing to those who have not looked into the matter critically. With motors properly constructed, a speed of eight or nine miles per hour is readily accomplished—in fact, eight miles per hour may be taken as the speed at which such motors will work to the best advantage, and return the greatest percentage of mechanical efficiency. The requirements of street car service demand variable rates of speed, as for instance in crowded streets, behind other vehicles, or in turning curves and entering switches it is necessary to go slowly and cautiously; and the weight of the load carried at different times will vary from an almost empty car to one overloaded. These conditions, together with increased power needed to ascend grades and to start loaded cars, especially on up grades, call for electric motors which will under such greatly varying circumstances respond at all times almost equally well.

There are motors which while engaged in performing an equitable work and running at an equitable speed, for both of which purposes the motor was specially made, will return 90 or possibly 95 per cent. of efficiency, while the same motor when run at some different speed or under some different load may return but 30 or 35 per cent. So that the average performance of such motors in street car service would probably give only 50 per cent. return of efficiency. Motors can, however, be obtained which will under all the variations of street car work constantly return 75 per cent. of efficiency.

The durability of storage batteries is a point which those interested in other systems are very prone to doubt, but it has been proved in actual use in cars that they will continue in good, serviceable condition for eighteen months or two years. Makers of these batteries offer to guarantee them good for two years of street car service. The lead-lined wooden containing boxes will last for many years. The negative plates are good for more than two years, while the positive plates are certainly good for eighteen months, if not more.

The plates being of lead and lead oxide are still of value when they become unserviceable, for the metal can be recast into new plates, and the lead can be recovered from the oxide. The first cost of storage battery cars and the engine and dynamos is at present prices considerably more than the first cost of cars provided with suitable complement of horses and harness; but when the saving in first cost obtained by dispensing with the ground and the stables required for horses is taken into account, the balance will in many cases be in favor of storage battery cars. This is of course applicable more particularly to large cities where ground is very valuable. By methods now being introduced into the manufacture of storage batteries, their production will shortly be made at a reduced cost, and their durability increased at the same time.

It should be remembered that the increased speed at which electric cars can travel is so much greater than horses could draw them that two cars can readily do the work of three horse cars, especially as the electric cars requires no time for resting at the ends of the route; but although they can easily do this, so much increase of speed would not be allowed or be practicable through the streets of most cities or towns. It could be done with safety and advantage through wide streets or avenues and in suburban districts. It will, however, be perfectly safe to say that three electric cars can do the work of four horse cars, and, if desired, they can at the same time be of greater capacity than horse cars, for while the horses can do no more, no such difficulty exists with electricity. Without referring to the excessive first cost required for the expensive cable traction system, and comparing the first cost of the entire plant and equipment needed for a storage battery electric railway on which three cars will perform the service of four horse cars with the first cost of the entire plant and equipment of a railway using horse power, it will be found that the advantage will in most cases be in favor of storage electricity. Let us now compare the operating expenses.

Running expenses of four two-horse cars for one year, to wit:

Conductors, 365 days at \$3.00 each car per day of 16 hours	\$4,380
Drivers, " " " " " " " " " " " "	3,650
36 horses, " " " " " " " " " " " "	6,570
	\$14,600
One year's deterioration and repair of four cars at \$300 each	800
" " " " " " " " " " " "	1,440
	\$16,840

Running expenses of three storage battery cars for one year, to wit:

Conductors, 365 days at \$3.00 each car per day of 16 hours	\$3,285.00
Drivers, " " " " " " " " " " " "	2,737.50
Electricity, " " " " " " " " " " " "	2,190.00
	\$8,212.50
One year's deterioration and repair of three cars, including dynamos, storage batteries, and motors, \$1,600 each	4,800.00
	\$13,012.50

This leaves a balance to the credit of the storage battery cars of \$3,827.50.

The fact of each storage battery car carrying within itself its own energy gives to the individual cars an independence of action which neither the cable traction plan nor the overhead or underground system of electrical propulsion possesses, for all of these depend upon central sources of power, which may at any time be interrupted, so that breakage or accident to any part involves the stoppage of the whole line.

In a sanitary and cleanly point of view, the withdrawal of the car horses from our streets would be of great benefit, and this would be accomplished without having, as in the case of the cable railway, an open drain, which, although supposed to be kept clean, in fact nearly always contains a deposit of street refuse to a greater or less extent.

The leakage of electricity in storage batteries, charged but not in use, need not be taken into account for

any length of time that cars would probably stand idle. In fact, the leakage from batteries in good condition would not exceed ten per cent. in three months.

The percentage of mechanical energy given by the steam engine which is recovered in actual work under the variable conditions of street car service on the driving axles, with storage battery cars properly equipped, is at least forty per cent., and with electricity by direct conduction at least fifty per cent. In cable traction, after deducting the power needed to move the cable and to revolve the wheels guiding and carrying the cable, not over twenty-five per cent. is left for drawing the cars, and on some cable railways even less.

The increased speed so easily and advantageously obtained on electric railways as a class not only enables three cars to do the work of at least four horse cars, and effect the great annual saving shown above, but it has a tendency to invite travel and thereby increase receipts, also to give street railways the opportunity to extend their lines advantageously further into outlying districts and to compete on better terms with elevated roads and steam railroads than would be possible with horse power.

The rapid deterioration and destruction of street car horses shows the exacting and terrible nature of their work, although it is for only four hours per day. Their powers are already overtaxed, and they can do nothing more either in speed or in load carried.

Electric cars, by dispensing with horses, allow more room in the streets for other vehicles, and this advantage in crowded streets is of moment. Take, for instance, Washington Street, Boston, or Broadway, New York, and it will be readily seen that this relief to the clogged traffic would be great.

Electric cars can go backward or forward with equal facility, they are under perfect control, can stop and start more quickly than horse cars, and in case of delay can make up lost time. They never get sick with epizooty or other disease, and during strikes or other periods of enforced idleness do not require to be fed. On down grades they will run by gravity without the expenditure of other force, and on level or nearly level

be much more efficient than horse power could effect. Street car electric motors of fifty horse power or more, if required, can be as easily made, and are as easily controlled, as motors of five or ten horse power, so that electricity has ample ability to keep the tracks clear from accumulations of snow. As with locomotives, sand boxes should be placed upon electric cars, so that if any slipping of the wheels should be observed, either from the greasy, slippery condition of the track, sometimes seen in damp weather when the streets are not properly cleaned, or from snow or ice upon the track, the driver, by opening a suitable valve, can let out a little sand upon the rail, and at once overcome the difficulty.

It is sometimes asked why two motors of five horse power each should be needed upon a car usually drawn by two horses. In explanation of this it may be stated that a car horse can, and very often does, exert for a short time in starting a car or upon steep grades a force of five or even more horse power. A mechanical horse power is the measure of the moderate duty which a horse can constantly and regularly exert day after day in a regular day's work without injury; but car horses are constantly temporarily called upon to exert unusual and unreasonable power, which is the reason they are so rapidly destroyed in street car service. It is evident therefore that the electric motors must be able, when called upon, to exert the same power that the horses under pressure can be made to perform temporarily, so that a maximum of five horse power in

people stating they felt nothing at all, and the others no more than a slight tingling sensation.

The term "storage batteries," so generally in use, is apt to give a wrong impression, no electricity whatever being stored or contained within them, for in charging the batteries a chemical action is forced to take place, and when this chemical action is allowed to reverse itself, electricity is generated thereby. The car motor immediately uses this, and when the motor is stopped the chemical action and, therefore, the generation of electricity cease.

In this report care has been taken not to refer by name to any patented inventions or to recommend any particular make of electrical appliances. As to these matters, those proposing to use electricity, whether by overhead or underground conduction or by storage batteries, should of course be careful to select such methods as are the most reliable, efficient and durable, and to deal with parties not only responsible as to the validity of their patents, but capable of doing what they undertake to perform.

Any one who peruses the railway journals and notices the number of electric railways now in operation, and the still greater number of those in course of actual construction or projected, has cause for surprise, if he has not closely been following the course of events.

That electricity, by some of the present methods of its use, or by better ones yet to be invented, will entirely supersede the use of horses and cable traction

SENDING AND RECEIVING MESSAGES.

TRAIN OPERATOR'S EQUIPMENT, WITH BATTERY.

SENDING AND RECEIVING INSTRUMENTS.

stretches a very little electric energy continues their motion when once they are started.

The electricity, besides running the motors, will supply the car with incandescent electric lights, actuate an electric signal gong, and operate electric bells for the use of the conductor and passengers in stopping or starting the car. It is usual to have the regular hand brake for stopping the cars, but the motors can be instantly reversed by electricity if desired. This method, however, should only be employed when it is necessary to stop the car very quickly to avoid accident or for some other imperative reason. By this means the car can be stopped in much less distance than is possible by the hand brake, which, of course, operates with the same efficiency whether upon electric cars or horse cars.

It has been questioned whether in winter, when the tracks are liable to be obstructed with snow or ice, the electric cars will be able to propel themselves, owing to the fact that they obtain their power of propulsion from the adhesion of the wheels upon the rails, so that if the wheels are prevented from reaching the track there would be a great liability of their slipping and turning around without giving any forward motion to the car itself. In answer to this, it may be stated that during last winter on the electric railway in Scranton, having the overhead conduction system, and from experiments made in Philadelphia with a storage battery car, it was found that there was no unusual difficulty presented in snow storms, the wheels, owing to the added weight, settling more readily through the snow, and thus reaching the rails. Upon roads properly equipped with snow plows, or snow sweepers with revolving brushes, propelled by powerful electric motors, the clearing of snow from the tracks would no doubt

each of the two motors will develop only such force as the requirements of street car service are constantly demanding during short periods of time.

It is not intended in this report to indicate that cable railways for use on steep hills or high grades will be superseded by electric railways, for the latter are limited to such grades as the adhesion of their wheels upon the rails will enable them to surmount, just as in the case of the steam locomotive, so that there is a suitable and proper sphere of usefulness for cable railways in the many places for which they are particularly adapted.

It has been proposed to increase the tractive power of electric cars upon inclines by causing magnetic attraction to be developed between the wheels and the rails, and also by the use of other devices. All these methods present complications which probably will more than outweigh the advantages sought to be attained.

In developing the best construction and management of electric cars and railways, careful attention to details, some of which at first sight may appear trivial, should be exercised, in order to obtain the best results, no matter which of the three plans be adopted. It should, however, be said that in practice at the present time the running of electric cars requires no more intelligence or skill than the running of horse cars, and also that the electric current with continuous conduction on lines using a few cars need not be of such tension as to endanger human life, 500 volts being sufficient. With the storage battery system the tension of the current is so low, 160 volts being sufficient, that no shock whatever could be experienced by a man taking through his body the whole current required to propel the car. This has been repeatedly done, some of the

upon all street railways, excepting under the special conditions for which cable traction is occasionally applicable, is a question that admits of very little doubt.

TELEGRAPHING TO AND FROM TRAINS IN MOTION.

THIS new system of telegraphy, by which messages may be sent from and received on the cars when in motion, is now in regular operation on the Lehigh Valley Railway. An interesting exhibition of the system was given by the Consolidated Railway Telegraph Company, of this city, on the 6th of October. A special train of six cars was run from Jersey City to Easton, carrying the apparatus for transmitting and receiving. The train contained the guests of the Consolidated Company, and the party was the outcome of an invitation extended by Mr. Charles A. Cheever, the president of the company, to the New York Electric Club. The trip occupied about five hours. During the running of the train, the operator was kept busy sending and receiving messages. Although the speed of the train has no relation to the practical working of the apparatus, yet a greater measure of public appreciation may be looked for from the fact that the cars ran at very high speed, exceeding sometimes sixty miles an hour.

The method is a simplification in some respects of the Edison system, already very fully described by us. The tin roofs of the cars are utilized as one leaf of a condenser that is charged and discharged by the action of a "buzzer" many hundred times a second. The other leaf of a condenser is represented by a line of wire strung on low poles carried along the track as nearly as possible at an even distance from the track,