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THE LAWRENCE UNDERGROUND CONDUIT ELECTRIC TROLLEY RAILROAD.

The cable traction system for street cars has received, certainly, very great development, and examples of its most modern form, with the latest improvements, are to be found in this city, where the Broadway and the Third Avenue lines are both operated by it. Its defects are many and important; the original cost of the plant is very great, and whether many or few cars are in operation the cable has to be kept going at a standard speed, so that considerable power may be uselessly expended during the night hours. Seventy-three per cent is wasted on the Philadelphia cable lines. Naturally, its operation is more economical as more cars are running. On curves a car cannot be stopped, and on at least one curve in this city there has been a great deal of difficulty in conducting the traffic, the cars being perpetually interrupted in their progress.

In our present issue we illustrate the Lawrence system of underground trolley, the invention of Mr. William Lawrence, of this city.

Accepting the fact that the trolley, so far, has proved itself the most available mechanism for car traction, Mr. Lawrence has invented an underground system in which the inherent difficulties, which have made all electric conduit systems heretofore useless, are so thoroughly overcome that, with the conduit filled with water and the track completely flooded, the car is driven as easily through the water as on the dry track. The leading feature of the Lawrence road is the use of circuit breakers, which, as the car passes, bring into circuit 32 foot sections of a girder or trolley rail. As each section is passed by, it goes out of circuit. A single feed wire is carried along the track and connects with each of the 32 foot sections of the trolley rail to the switches. As at present constructed, the regular rails are used for the return.

Several constructions of the road are shown in section in our cuts. In one of the engravings may be seen a cross section of the single and double track road, and at the bottom of the page we give a longitudinal section showing the trolley rail in place in the conduit. On page 311 we show a new form of rolled steel conduit, which will probably be adopted, as it occupies a space of but 4½ by 9 inches.

The general construction resembles the cable conduit but is much simpler. Through and along the conduit formed under the slot passes a small girder or trolley rail in 32 foot sections, fastened together by

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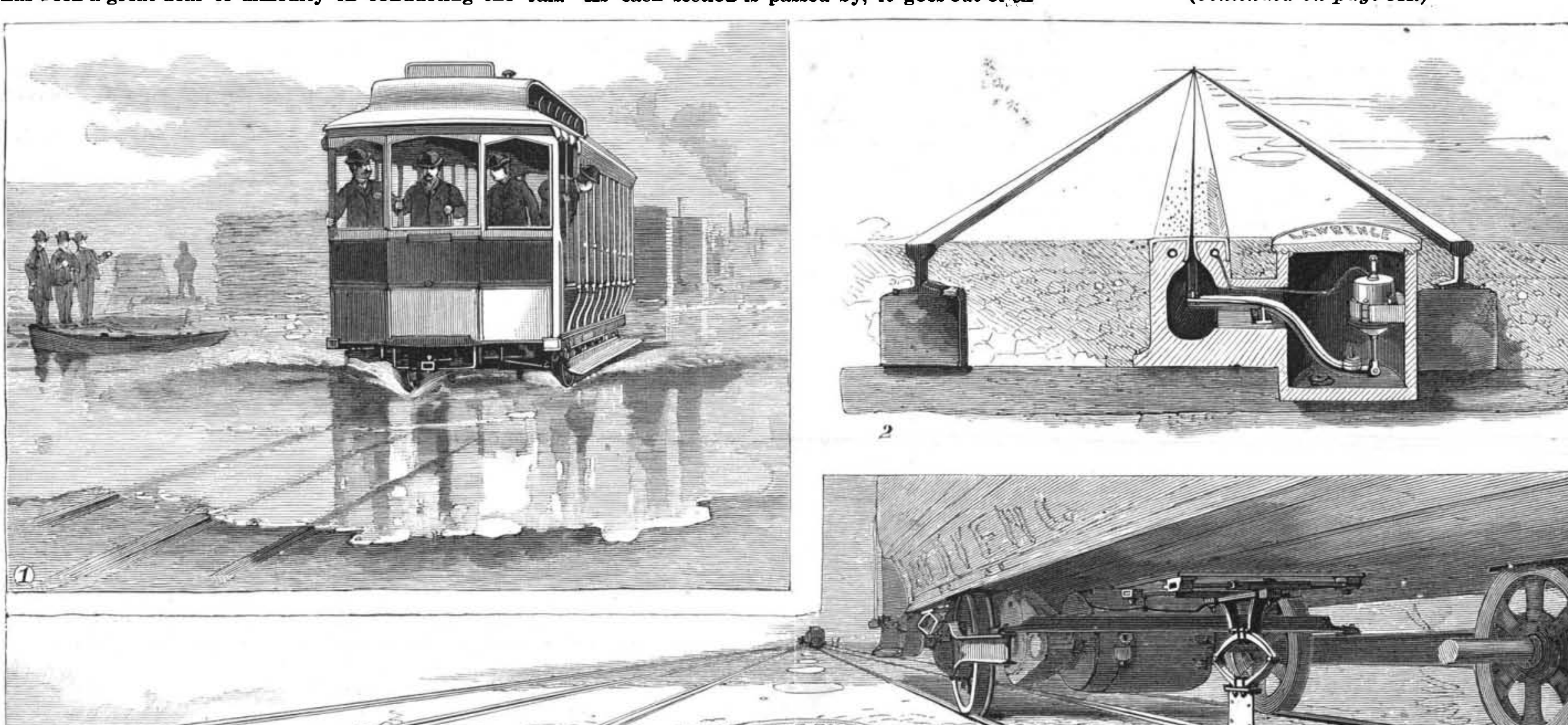

1. Running the car through water. 2. Single track construction. 3. Double track construction, with single feed wire. 4. Longitudinal section of road.

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fiber pieces, so as to insulate the different lengths. Each rail is carried by levers which run out at right angles thereto. On the outer end of the levers are weights which overbalance the girder, no springs being employed. The other end of each lever is connected to a circuit breaker which connects by vertical connection with a feed wire in the junction box. When the weights raise the trolley rail, as they normally do, the circuit is open and the trolley rail receives no current.

When the car is above any given section it depresses the trolley rail a little, forcing up the other end of the lever and closing the circuit so as to bring the depressed section of the trolley rail into electrical contact with the feed wire. As the car passes from the section of rail, the rail is raised by the weights on the lever and the circuit is broken by gravity.

The car carries a special trolley device 2 feet 6 inches long, with a wheel at each end, which is a radical feature of the system inasmuch as it prevents sparking. Between the trolley and the car is an elliptical spring, so that the shoe is always forced downward. It is the pressure of this spring that directly depresses the section of trolley rail. Another object of the two rollers is to enable the car to force down the rail in advance, before it leaves the rail it is just passing over; this prevents jarring as the rail junctions are passed. From the trolley the current is taken by ordinary connections to the motor, passes through the same, and then returns to dynamo house through the rails, or can be returned by wire, the system being admirably adapted to the use of the latter. Whether a single or double line of track be laid there is required only the one feed wire, and only the one set of circuit breakers with one or with two sets of levers. This feature is brought out very clearly in our illustration of the double track system.

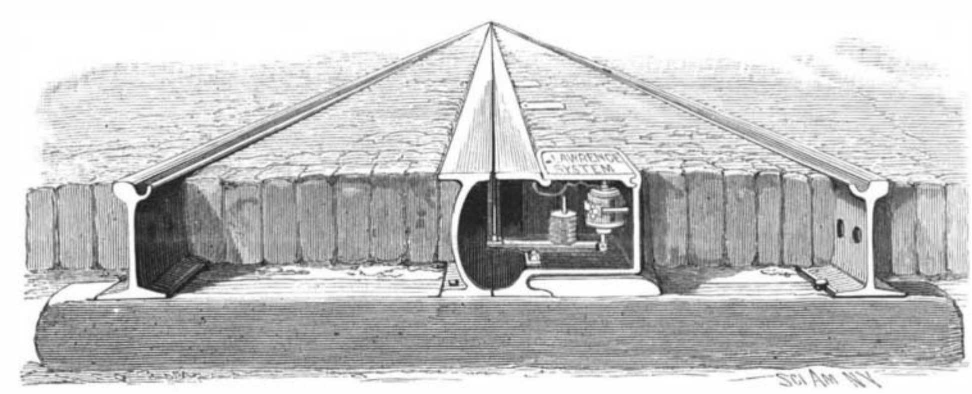
Another important feature remains to be spoken of It is assumed that the conduit will naturally accumulate dirt. To dispose of such, a brush pressing against the bottom of the conduit may be attached to the trolley shoe which will sweep all dirt before it. Every 1,000 feet or so a special pit and dirt chute, shown in one of the cuts, is provided, down which the dirt accumulated in front of the brush falls, thus keeping the conduit clean.

The experiment of running the car through water is the subject of another of the cuts, which is no fancy sketch, but is the exact representation of an actual experiment conducted on the working track now erected in the yard of the Harlan & Hollingsworth Company, at Wilmington, Del. On this occasion the ground had been so deeply submerged by the breaking down of a dike, that the car had to be reached by a boat, yet on boarding it the electrician started without the least trouble. Heretofore there have been endless difficulties with underground electrical car traction conduits, the presence of dampness, the drifting in of snow, mud, dirt, and water, have all operated to short circuit any exposed conductor placed therein, and to occasion very heavy leakage, complete disaster to the system, or to prove its impracticability. In the Lawrence system the leakage is exceedingly slight, and will not equal that in the overhead trolley system.

The original cheapness of installation is also in its favor. The very small size of the conduit necessary will permit of its being built in steel entirely above the ties, and of the 9 inches of depth, only 5½ inches are used. When no car is on the line, the dynamos simply keep the perfectly insulated cable charged. There is absolutely no draught on them for current, as the leakage is virtually zero; if a single car is sent over the line, the system is only subject to the trifling leakage which may be incurred by the depression of a single section of the trolley rail all the time and of two sections for a very small fraction of the period. It is actually proposed, as a matter of cleanliness, to periodically flush out the conduits with water, a process which, in the case of the ordinary underground electric systems, would involve a certainty of disaster. It is not easy to see how any accident can happen to the system. If one of the circuit breakers or junction boxes, as they are called, gets out of order, the utmost harm it can do is either to keep a 32 foot section alive—involving, perhaps, a trifling leakage—or to throw the section totally out of circuit, a matter also of the least possible importance, as the car, by its inertia, would readily pass the place. A junction box can be replaced in five minutes. If any accident should happen to one or more sections of the trolley rail, the system would be still in a condition to be used, and would not have to lie idle.

The ground at Wilmington in which the conduit is laid is made ground, saturated with water and subject to continual overflow. The place is of a nature to give the road the severest possible test.

At the office of the Lawrence Electric Company, 59 Wall Street, New York, N. Y., the company which controls this invention, further interesting details may be obtained.



STEEL GIRDER CONSTRUCTION OF LAWRENCE ELECTRIC RAILROAD.

Windmill Electric Plant.

The employment of windmills for the charging of electric storage batteries has heretofore been illustrated in the SCIENTIFIC AMERICAN. The installation of this class of devices is now being done in England by the Rollason Wind Motor Company. The motor consists of a set of five curved vanes fixed to a vertical shaft. These vanes measure 7 feet by 20 feet, the longer length being placed vertically. A shield is arranged so as to allow the wind to strike only such vanes as present their concave sides to it, a vane being fixed to move the shield automatically into the proper position. The horizontal diameter of the mill is 20 feet, and it is fixed on top of an iron frame 30 feet high. The weight of all the working parts, as well as the side thrust due to wind pressure, is taken up on friction rollers running in oil baths. Owing to the reduction of friction thus effected the mill will start in very light breezes, and in one of eight miles per hour is rated at two horse power. At Willesden the motor drives a five horse power dynamo, to which it is connected by belt gearing. The dynamo is used to charge accumulators, and the latter supply a current which may be used for lighting or power purposes. The details of the electric plant have been worked out by Messrs. Edmundsons, of London. A magnetic cut-out is supplied, which breaks the circuit when the speed of the motor, and consequently the voltage of the dynamo, falls too low. An automatic switchboard has been devised, which, as the speed of the dynamo rises, alters the arrangement of the cells from parallel to series, and thus avoids the risk of buckling the plates. To cut out the dynamo when the batteries are fully charged, advantage is taken of the change in the specific gravity of the electrolyte of a cell. An hydrometer is placed in one of the cells, and as it rises, the stalk closes a light contact which brings a magnetic belt shifter into play, and thus stops the dynamo. A similar device is made use of to bring back the belt when current has been taken from the batteries.

Artificial Coloring of Fruits.

The *Bulletin d'Arboriculture*, of Belgium, points out the following sophistications to which fruits are at present submitted in Europe.

Acetate and sulphate of copper have for a long time been employed for coloring plums that are too green. The color of lemons is "improved" with citronine and naphthol yellow, and the green spots are imitated by means of diamond green.

A pleasing color is given to strawberries by sprinkling them with sulpho-fuchsine or rhodamine, or else a mixture of rhodamine and azo-red is used.

Nothing is easier than to give peaches a beautiful color. To this effect there is employed a mixture of rhodamine, azo-red and citronine, which is applied by means of a brush and a perforated plate of zinc.

The melon itself is not spared. Atropeodine or azo-orange is introduced into the interior by means of a tube, and care is taken to add a little essence of melon.

Apples and pears come in their turn, and pretty varieties of them are obtained by means of aniline colors, which attack the flesh as well as the epidermis.

At a recent dinner Dr. Villon offered his guests some pears whose exterior seemed to be intact, but which internally exhibited the colors of the French flag. The blue was obtained with Victoria blue and the red with a mixture of rhodamine and azo-red.

REMARKABLE CANNON VELOCITIES.—At the arsenal of Rochfort a 6·3 inch gun was made up to the extraordinary length of 52·5 feet by screwing additional tubes to the muzzle so as to make it up to 90 calibers in length. With a projectile of 99·2 pounds weight the unprecedented muzzle velocity of 3 983 foot seconds was obtained.

Sugar to Produce Muscular Work.

The subject of sugar as a food producing muscular power was discussed last winter before an English society by Dr. Vaughan Harley. From a brief summary of his paper, given in *Nature*, we make the following extracts:

During a twenty-four hours' fast, on one day, water alone was drunk; on another, 500 grammes of sugar was taken in an equal quantity of water. It was thus found that the sugar not only prolonged the time before fatigue occurred, but caused an increase of 61 to 76 per cent in the muscular work done.

In the next place, the effect of sugar added to the meals was investigated.

The muscle energy producing effect of sugar was found to be so great that 200 grammes added to a small meal increased the total amount of work done from 6 to 39 per cent.

Sugar (250 grammes, about 8 ounces) was now added to a large mixed meal, when it was found not only to increase the amount of work done from 8 to 16 per cent, but increased the resistance against fatigue.

As a concluding experiment, 250 grammes of sugar was added to the meals of a full diet day; causing the work done during the period of eight hours to be increased 22 to 36 per cent.

The Theory of Hail.

O. Marangoni, writing in the *Transactions of the Royal Lincean Academy* and in the *Nuovo Cimento*, has discussed the genesis, the structure, and the morphology of hail a phenomenon in which electricity plays an important part.

After criticising the theory of Volta, he expounds his own views. A hail cloud is drawn out by the wind in the form of a horizontal tongue. By its rapid evaporation there is produced an intense cold. Thus there are formed flecks of dry snow which, by friction against the minute drops of water, become, according to Faraday, charged with negative electricity, and are then attracted by the positive electricity of the drops of water. The snow flakes behind the cloud, *i. e.*, to the windward, are covered with a layer of ice, at first dry and then moistened. At the same time, according to recent researches of Lenard, which have appeared in Wiedemann's *Annalen* (vol. xlvi., 1892), they are charged with positive electricity, and are driven in an outward direction by the positive electricity of the rain drops. Thus being cooled below zero and breaking through the cloudy stratum, they become charged anew with negative electricity, are coated with a new snowy layer and are again attracted by the cloud. Each hailstone, taking a wavy line, becomes enlarged by coating itself with alternate layers of opaque and transparent matter, and is ultimately thrown to the right or the left, occasioning thus the roaring noise which precedes the fall of hail, which then takes place in two parallel bands, separated from each other by a region of rain. These views agree well with the structure of hailstones as often observed, and with narrow linear extension of the hail over belts of country, and with the generally short duration of the storm.

As regards the structure of the hailstones, the author notices the existences of a gradual passage from snow to hail. He does not, however, seem to consider the fact that hail often accompanies a westerly or southwesterly wind (equatorial current), while snow rarely, if ever, occurs except along with a northerly or easterly wind (polar current).

Some of the forms of hail studied fall without lightning, but with a strong negative potential, while the others are accompanied, in proportion to their size, with lightning and thunder.

It may be permissible to regret that the awkward word "lightning" has now become definitely established in our language in place of the good old terms "levin" and "laite."

Fire in a Historic Building.

The roof of the old Speedwell Iron Works, at Morristown, N. J., caught fire April 19, and the firemen had much difficulty in saving the building. The structure has a history. It was erected just at the close of the revolution by Judge Steven Vail. On the second floor of the building Prof. Samuel F. B. Morse and young Alfred Vail worked for years to perfect the electro-magnetic telegraph instrument. On the same floor, in 1836, the first successful tests were made, and the nails used to support the wires are still sticking in the beams and joists. In the same building the machinery for the steamship Savannah, the first to cross the Atlantic, was built, and the wheels of the first American-built locomotive were made there. The bell in the belfry was cast before the revolution. It was cracked in the fire and will be recast.