PLATE II.—MACHINERY PALACE OF THE PARIS EXHIBITION OF 1889.

the price of which is scarcely any higher now than that of iron, we are reaching much more economical results.

The Machinery Palace will consist of the main gallery, of which we have just spoken, and of annex galleries fifty-six feet in width, with the first story connected by broad stairs. It will be connected with the galleries of the various sections, in the principal axis of the Champ de Mars, by a central pavilion 98×98 feet.

The covering of the aisles and lower parts of the main gallery will be zinc. The remainder of the central portion will be covered with striated glass $\frac{1}{4}$ inch in thickness.

Notwithstanding the difficulties in the way of construction, especially in the way of laying the foundations, the estimated cost is but about three dollars per superficial foot.

The general decoration will be very simple. The architect will endeavor to give the structure a utilitarian character that does not exclude originality, and without any loss of artistic appearance.

The accompanying engraving (Plate II.) gives a perspective view of the main and lateral galleries.

The use of steel in the construction of this imposing building will be the first application of that material in a work of so great an importance. We doubt not that this proof of confidence accorded by our great engineers to a metal which, even to-day, is admitted with a certain fear by many of our builders, will happily contribute to increase the application of steel in our structures, and consequently to give a desirable impulse to its manufacture in our metallurgical works.

The 362 $\frac{3}{4}$ foot truss, like all bold works, has met with numerous partisans who have understood the true end of it; and it has also found many, and among them some of our most eminent architects and engineers, who have opposed the idea of erecting an immense hall with a span of 362 $\frac{3}{4}$ feet and a height of 148 feet for the reception of machines, which, as a general thing, have quite small vertical dimensions.

To meet this objection, it may be answered that the Machinery Palace is not only designed to contain all the marvels of mechanical construction due to modern science, but also (and this is not its least worthy aim) to show the entire world the power of the present French industry and the progress that has been made in the art of building with metal—a progress due in the main to our engineers of the Central School.

The main gallery of the Machinery Palace will form an immense rectangle 1,378 feet in length by 374 in width. Along two of the sides of this will extend the lateral galleries, that are very distinctly shown in the engraving.

The lattice girder that will support the flooring of these galleries, and which will surround the entire main hall, will produce a decorative effect of the happiest kind.

The entire space beneath the upper galleries will be free, the only points of support being taken upon the trusses themselves.

The general decoration will be a consequence of the construction itself, that is to say, it will be of the simplest character, without any false artifice, and will allow the spectator to clearly read the *motif* of every part.

The mounting of the trusses will begin on the 1st of July. On this occasion there is some talk of getting up a fete to replace the one designed to celebrate the breaking of the ground, and which was to have occurred when the work was begun.

Numerous studies are now being made of the system of lighting to be adopted. The magnificent electric light plants that have been established in recent times, and the progress that is being made every day, give reason for the belief that our engineers will emulate one another, and will in a large measure co-operate in the success of one of the most remarkable works of the Exhibition of 1889.—*Le Genie Civil*.

ON DEATH BY ELECTRICITY.

By M. D'ARSONVAL.

I HAVE just been performing a number of experiments with such electrical machines as are employed in the industries, with the view of determining under what conditions *intensities* and *potentials* may become dangerous. In a preceding communication I have already established the fact that what is truly dangerous when these machines are used is the *extra current* that occurs at the moment the current is broken, and in order to annul this extra current, I proposed to interpose a series of volta-meters containing acidulated water along the conducting wire.

The new arrangement that I now employ is at once more simple and efficient. It consists of a V-shaped tube made of an insulating substance. This tube, after being filled with mercury, is interposed in the main current. In order to close the latter, it is only necessary to turn a cock which is maneuvered like the cock of a gas pipe. In this way the machine is unprimed without its being able to give an extra current spark.

I also make use of another arrangement, and that is a glass tube filled with mercury and dipping into a reservoir containing the same substance. This tube is provided with a ground stopper that not only permits of suppressing the extra current, but also of interposing any sort of resistance in the circuit.

The practical conclusion to be drawn from these experiments is that the dangerous potentials of continuous currents do not begin till after 500 volts.

With alternating current machines it is the abrupt variations in the potentials that constitute the danger and give the paralyzing shock. It must not be forgotten, besides, that it is only necessary to touch one of the wires to get a discharge. The electromotive force of these machines should not exceed 60 volts.

It is of interest to state that the mechanism of death varies with the nature of the electricity employed. Thus, with the extra current or with alternating currents, there is no anatomical lesion, and the patient can usually be brought back to life through the practice of artificial respiration. The discharges of static electricity from batteries, on the contrary, cause a disorganization of the tissues that renders fruitless all attempts to restore life.—*Revue Internat. de l'Electricité*.

A CATALOGUE containing brief notices of many important scientific papers heretofore published in the SUPPLEMENT may be had gratis at this office.

PROGRESS OF ELECTRIC RAILROADS.

To the Editor of the Railroad Gazette:

With electricity there is a remarkable flexibility of application and range of choice as to method. The car can carry its own power in storage batteries; the current conductors may be put out of sight in conduits; a third rail can be placed on any existing track; or the car may depend for current upon an overhead wire with contact trolley or brush; and all of these can be used together, if necessary, on one road. I have been on street railways where each of these plans is exemplified, and have found all practicable and operative. The motor can be put anywhere, even on the roof, and can be geared up in a dozen different ways. The average recovery of power is easily 60 to 65 per cent., and in every case the current required is exactly proportionate, at the minute, to the work being done. A first class horse car costing \$1,200 will, with an electric motor, cost from \$2,000 to \$2,250, but the horse car road has from 6 to 12 horses per car, the horses costing about \$125 to \$150 apiece. The cost of the electric conductors is more than offset by the wear and tear of a horse track. The central station electric plant will, in many cases, be more than paid for by the economy in real estate, and it can be put anywhere along the line or near it. It can also, as it does now, supply electric light and power for general purposes.

Coming to the work actually done, it will be best to speak of the performances of the various motor companies, *seriatim*. The Daft Electric Light Co., of this city, has now had running at Baltimore for about two years a road using the third rail system, but now adopting the overhead wire. With an annual increase of passengers of over 75,000, the cost of electric power per car per day has been \$4, as compared with the former cost for horses of \$6.50 per car per day. The speed has been increased from 4 miles per hour with horses to 8 miles with motors. This road is 2 miles long, with grades up to 350 ft. per mile, and undulating throughout. The road has 3 motor cars and 3 passenger cars. Another road built on the Daft system is now in operation at Los Angeles, Cal., using the overhead wire. It runs 3 miles and is to be 2 miles longer. It has 4 motors and 4 cars, each of which has a carrying capacity of 40 persons, but has often carried twice that number. The road carried 14,982 passengers during February, and has taken as many as 1,500 in a single afternoon. The speed maintained is usually from 10 to 12 miles an hour. The Daft overhead system is also being employed on the Orange, N. J., Crosstown Railroad, where one motor car has been placed on the completed section of track. Another Daft road is being built at Pittsburg, by the Safety Electric Railway and Power Co., of New York. It is to cost \$120,000, will have both overhead and conduit conductors, presents the slight difficulty of a 14 per cent. grade, and will go into operation this summer with 5 motor cars. The Daft system is also under contract for Mansfield, O., and Ithaca, N. Y.

The Van Depoele Electric Manufacturing Co., of Chicago, has a number of electric street railways in operation, presenting some novel features. The road of the Port Huron, Mich., Electric Street Railway Co. has 3 miles of track, one 15 h. p. motor running 3 cars, and two 10 h. p. motors, each running an independent car. The road crosses a swing bridge, but the overhead wire is so arranged that while the circuit is not broken when the bridge is open, the contact for the car is remade automatically as the bridge closes. The road is undergoing extension and increase of rolling stock. At Windsor, Ont.—a suburb of Detroit—a short road with 2 cars runs along the bank of the Detroit River. At Detroit is a road $1\frac{3}{4}$ miles long, with one motor car which, with its train, has traveled at the rate of over 25 miles an hour. The service is being increased. At Appleton, Wis., the Appleton street railway put the Van Depoele system in operation last year. The motive power is obtained from a 60 h. p. dynamo driven by a water wheel, and a double overhead conductor is in use. The initial rolling stock consisted of 5 cars with motors, but the plant is growing very rapidly. The road is $4\frac{1}{2}$ miles long, including 9 per cent. grades, some on sharp curves. The total cost for power for the 5 car service figures out at \$1.50 per car per day.

At Scranton, Pa., the Scranton Suburban Railway Co. has over 2 miles of Van Depoele road running with great success. The rolling stock was 3 cars at the start, but is being largely increased. Overhead conductors are used, with little contact trolleys. Speed ranges from 6 to 15 miles an hour. Grades are up to 6 per cent. As on the Appleton road, handsome Pullman cars are in use. The power is furnished by the electric light station, where a 60 h. p. dynamo is installed. The total charge for power is \$9 per day of 16 to 17 hours, but as the dynamo can easily operate from 8 to 10 cars, the item of \$3 per day per car is excessive. It will, in almost every case of electric railways with current conductors, be safe to estimate from \$2.50 to \$3 per day per car as the total cost of power, that being a liberal basis of calculation.

At Montgomery, Ala., the Van Depoele system was tried on a road $1\frac{1}{2}$ miles long, and is now being applied to the whole network, with overhead conductors throughout. The total length of track thus equipped is over 11 miles, consisting of a main trunk road with four branches. Brill cars are to be used, with 18 motors. One of the owners of the road told me recently that he had found a saving with electricity of from 30 to 40 per cent., and he expected much better results over the whole system.

The Van Depoele Co. has contracts now being executed for roads at Lima, O., and Binghamton, N. Y. The latter road, $4\frac{1}{2}$ miles long, will be equipped with 3 cars with 10 h. p. motors, 4 cars with 15 h. p. motors and 1 car with a 20 h. p. motor. The Lima road is 3 miles long and will have 6 cars.

The Denver, Col., Tramway Co. has $3\frac{1}{2}$ miles of road equipped with the Short-Nesmith system, and has 7 cars in operation, making an average speed of 6 miles an hour. The conduit in use has a $\frac{5}{8}$ in. slot. The track crosses five steam railway tracks, eight horse car tracks, and a bridge 200 ft. long. The current lights the cars and rings the gongs.

At Detroit, Mich., the Detroit Electrical Works are operating on the Highland Park road 2 cars, 13 hours per day, using not to exceed 900 lb. of coal, at \$1.60 a ton, bringing the cost of fuel somewhat under 80 cents, or 40 cents per day per car. The Fisher system is in

use. A speed is maintained of about 15 miles an hour with a load of 30 passengers to the car. The motors, weighing 1,100 lb., are suspended between the trucks. The road is 3 miles in length, but is now being extended half a mile further. It is operated by two engineers and a motor man, who also acts as conductor, for each car. A simple conduit system is in use, a light rail, over which a phosphor-bronze contact wheel travels, being sunken between the rails under grooved planks. The system is now to be applied in Pittsburg, where it is under contract for a road about one mile long, beginning with 2 cars.

The Henry Electric Railway Co., Kansas City, has equipped with overhead conductor a double track road starting from East Fifth Street, and proposes to run two-car trains on it. The same company reports that it is also equipping a 9 mile road in the suburbs of San Diego, Cal., where very high speed will be attained.

The Union Electric Co., of Philadelphia, has a 2 mile road on the Schlesinger system, with conduit, on Ridge Avenue, Philadelphia. Just at present, however, the company is busy on the construction of mining roads. It is now executing a contract for a large mining company, the road, wholly in the mine, being 6,000 ft. long. The electric locomotive will haul from 15 to 20 loaded cars. Similar equipment is being contracted for on two other mine roads, and in one of these cases, by the way, an electric power transmission of 400 h. p. over three-quarters of a mile is contemplated.

The Sprague Electric Railway and Motor Co., of New York, has built a road for the East Boston Sugar Refinery Co., running from the water front up into the refinery, to convey sugar in bulk. An overhead conductor is used, with contact trolley and flexible connector. The cars will have a carrying capacity of $4\frac{1}{2}$ tons each. The dynamo supplying current for the road during the day will feed incandescent lamps at night. The Sprague system has also been adopted by the Union Street Railroad of St. Joseph, Mo. At least 20 cars will constitute the preliminary equipment. Current from the electric mains will also light the cars, and speed up to 12 miles an hour is to be reached. The Sprague Co. has also been making some important tests with storage batteries on street cars, with remarkably good results, under the supervision of one of the best known firms of street railway engineers in the world. One such car has been ordered for a Boston road, and though the experiments have but recently been finished, the company has had applications from well nigh a hundred roads for estimates looking to the use of the storage system. A very large number of estimates have also been requested and made for roads with the direct current system, using overhead conductors or shallow conduits. I have had an opportunity of looking through the estimates and find them to cover roads all over the Union, sometimes two or three in one city.

The Bentley-Knight Electric Railway Co.'s conduit system is to be used in New York City by the North and East River Railway Co., whose tracks will run through Fulton Street, across the city, to Wall and Pavonia ferries. The Bentley-Knight system, which has been specially worked out with a view to use in large cities, was demonstrated first on a road in Cleveland, O., and is now to be seen on a track at the Rhode Island Locomotive Works, Providence. Its introduction into New York renders its details very interesting, but they cannot all be given. The nature of the thoroughfare and the heavy traffic on it calls for the best construction. The grades run up to 1 in 10. The conduit to be used is only $13\frac{1}{2}$ inches deep, and $25\frac{1}{2}$ inches wide, over all, and the contact plows are so devised that in any case of necessity they can be pulled clean out of the slot at a second's notice. The road will go into operation with 20 motor cars, and the work of preparation is now going on busily, all the contracts having been made. As the franchise expressly stipulates the use of this system, there is no reason to doubt that it will go into operation this summer, probably by August 1.

The Bentley-Knight Co. has also closed a contract this month with the Observatory Hill Passenger Railway Co., Allegheny City, Pa., and hopes to fill it by the end of July. In this road it supplies about 1,200 ft. of double track conduit, and about the same length of single track conduit; and then the conductors go overhead and run out some three miles in the suburbs. As soon as the conduit proves satisfactory, this road will be extended across the river into Pittsburg. It is a really tough job, as there is a maximum grade of 10 per cent. to climb carrying a full load, Broadway cars, at a rate on that stretch of not less than four miles an hour.

I ought not to omit mention here of the fact that this is the system in view for the New York Underground Railway, which, if the plans are carried out, will be a magnificent piece of engineering all round. The motors intended for this are of 400 h. p., capable of making 50 miles an hour, and weighing 48,000 lb.

The Julien Electric Co., of New York, has made a demonstration with its storage battery and motor on the Eighth Avenue road in this city. I have, myself, had the pleasure of trying the car, which was very smooth, steady, and rapid in operation. The system is now also being tried in St. Louis, and bids fair to be adopted in a great many places. With the storage batteries of the Electrical Accumulator Co., of New York, driving such motors as the Sprague, some excellent results have also been attained. As far as can now be learned, running street cars by electric storage will not cost more than \$4 to \$5 per day, on regular city schedule and traffic, as compared with \$6.50 to \$7.50 for horses. The cost of the cells is still high, but comes within the cost of horses—from 6 to 12 per car—and will, in my opinion, be materially reduced by improvements in the batteries inside of a twelvemonth. With the storage system, no conductors or conduits are needed.

There are some new systems awaiting trial, such as the Ries, Bidwell, Edgerton, Field, and others, embodying some very notable points of excellence, but it would take too much space to discuss them now, as it would the experiments made, and yet to be made, on the New York elevated roads, or the various roads shown at exhibitions and other like resorts during the last four or five years, and having to their credit about 500,000 passengers carried in safety and comfort. I must also pass by such special systems, dependent on electricity, as the Enos suspended car road, which is to be adopted at Los Angeles, Cal., and the Chandler

aerial transportation road. I must close simply with an enumeration of the roads and places about to adopt electricity. At Ansonia, Conn., an electric road, $3\frac{1}{2}$ miles long, from Derby to Birmingham and Ansonia, using overhead wire, has been contracted for. It will be used for both freight and passengers, and power to drive the dynamo will be taken from the Housatonic dam. At Newton, Mass., a road is to be built by a company already formed; one is proposed for Worcester, Mass. At Brookline, Mass., two will soon be in operation, and one each is in view at Bangor and Biddeford, Me. Two roads are contemplated in Brooklyn, one at Coney Island, and one at Rockaway. Pelham Park, N. Y., is to have a road this summer, and Asbury Park, N. J., is advertising for bids on another. Franchises are asked for a road in Jersey City and Bayonne; and Plainfield, N. J., is also wanting a road. In Pennsylvania, Scranton, with one successful road, is to have another, and probably two. A road is to be built from Carbondale to Jermyn, 4 miles. In Reading, the Perkiomen Avenue Company proposes to adopt electricity. Harrisburg is to have a road, and it looks as though before the end of the year Pittsburg will have half a dozen. Down South steps have been taken to construct new electric roads, or adopt the system on old roads in Jacksonville, Fla.; Pensacola, Fla.; Birmingham, Ala.; Selma, Ala.; Atlanta, Ga.; and Fort Smith, Ark. Among roads spoken of in Ohio are several at Cincinnati, Cleveland, Tiffin, and other places. Wichita, Kan., is proposing to adopt electricity for its street cars. Lincoln, Neb., has formed a company to operate an electric railway from the business part of the town to the stock yards. In San Francisco a road is to be built on Fillmore Street hill, and roads are also wanted at San Jose and Riverside, San Bernardino County. If I were at liberty to do so, I could add to the above list about fifty names of places where, from present indications and movements, it is safe to say that electric roads will be running within a year.—*T. C. Martin, in Railroad Gazette.*

SURFACE TENSION OF LIQUIDS UNDER THE INFLUENCE OF THE ELECTRIC CURRENT.

By EDWARD BLAKENEY.

WHILE experimenting some time ago on the mechanical effects of an electrical current, I constructed an instrument which exhibited a very curious and interesting phenomenon. I have never seen anything of the kind elsewhere, and although I was much interested, I have never had the time to fully investigate it.

I shall be glad to describe the experiment to the readers of the *Electrical World*, in the hope that it will be of interest. Perhaps some of your readers may find a useful application for the principle.

In the bottom of a small glass tumbler (see accompanying sketch) is placed about $\frac{1}{8}$ inch of mercury. A

SURFACE TENSION OF LIQUIDS.

glass tube of $\frac{1}{8}$ inch internal diameter is suspended vertically in the center of the tumbler, with its lower end dipping into the mercury, but not quite touching the bottom of the tumbler.

A punctured copper disk is slid down over the tube. This disk serves as one of the electrodes, the mercury serves as the other. The tumbler is then filled with water.

When, now, a battery of two or three cells is connected to the terminals, the mercury is seen to be somewhat agitated, and at the same time the water begins to rise in the tube. If the latter be not too high, the water at last overflows and the action continues; but if the tube be over two or three inches high, there is a point reached where the water will rise no higher. This, undoubtedly, is the point of equilibrium between the weight of the water and the force which is acting upon it.

It will be noticed that, in order to ascend the tube, the water must first find its way under the mercury. So far as I investigated the matter, it appeared to me that the mercury took on a sort of vortex motion, drawing the water down at the sides and expelling it in the center, thus filling the tube.

When the action is continuous, the instrument might properly be called a vortex electrical pump.—*Elec. World.*

REGENERATING LECLANCHE CELLS.—M. Eugene Alliot, of Chateaufort, employs a battery of eight Leclanche elements, with which he occasionally lights up a couple of small glow lamps for a few minutes at a time. Owing to the rapid polarization of the battery, it is, of course, impossible to get a full light for more than a few minutes. It, however, occurred to M. Alliot to try "to regenerate the zinc and the dioxide of manganese" by means of a reversed current. By sending the current from a small dynamo through the cells once a week, for only a few minutes at a time, it was found that the Leclanches did not tend to polarize when feeding the lamps nearly as quickly as before. It will, however, scarcely be admitted that the zinc has been "regenerated" by this process, although, no doubt, the depolarizing effect of the reverse current re-