

so short that the first of the two reactions passes unperceived in the calorimeters.

The fact should likewise be borne in mind that, in presence of water in large excess, the nitrogen peroxide is changed into nitric acid and bioxide; while, if the proportion of water is not considerable, a mixture of nitric and nitrous acids is obtained. The latter afterward absorbs the oxygen slowly, and is finally converted into nitric acid. From this we see that circumstances apparently slight may cause a considerable variation in the combination of nitrogen and its compounds with oxygen.

THE PALACES OF NATIONS AT THE PARIS EXPOSITION.

THE visitor to the Paris Exposition, after he has taken a general survey of the grounds, is very apt to wander into the pavilions of the various countries which form the "Street of Nations." These buildings occupy the left bank of the Seine. The first building which is encountered is the Pavilion of Italy, whose

by the newspapers of the country. The construction is original and represents a farm house in Jutland. The front with its carved wood is very attractive. The interior is fitted up like the Danish villa.—For our engravings we are indebted to *Le Monde Illustré*.

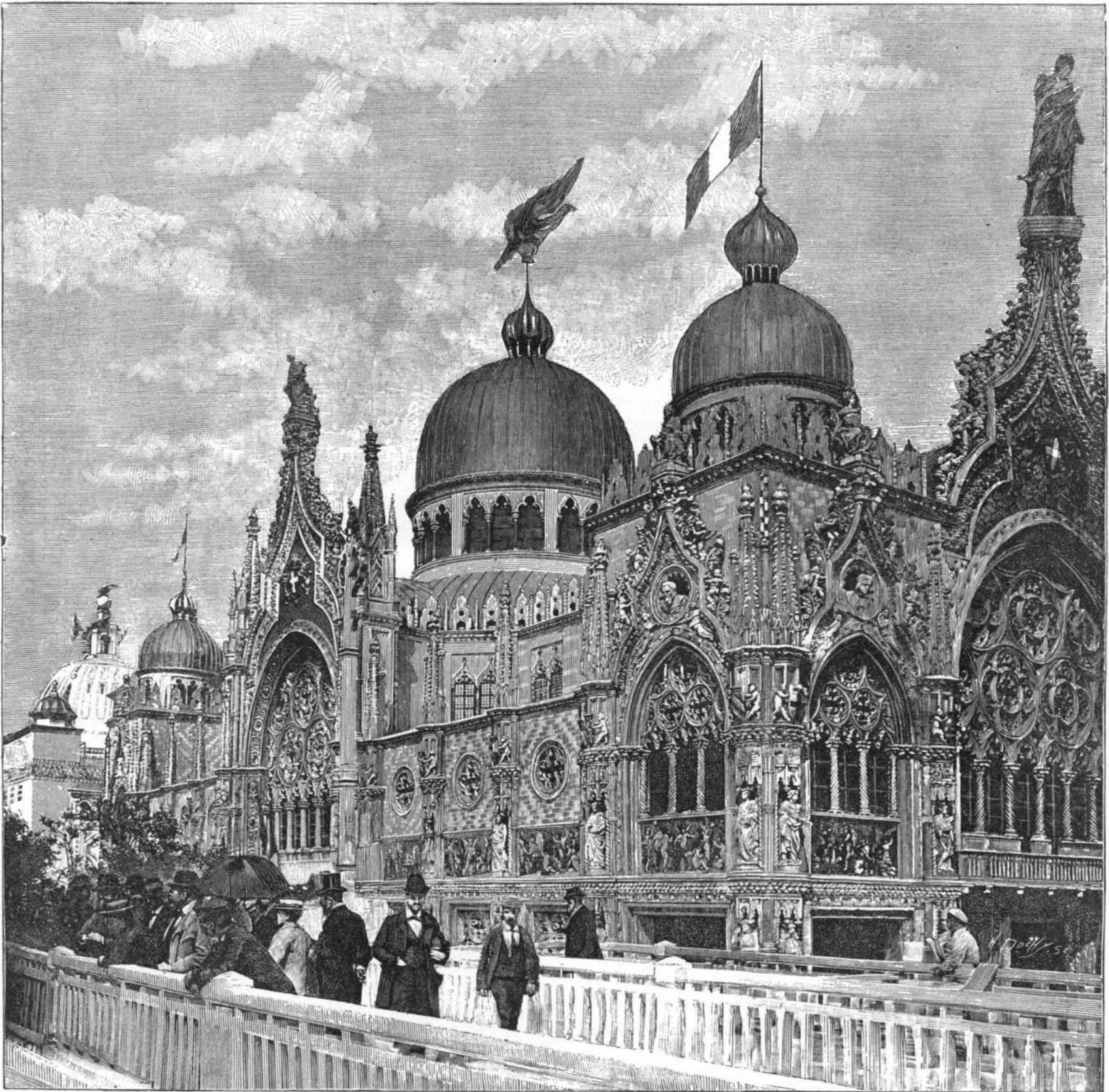
THE ELECTRIC AUTOMOBILE.*

By A. L. RIKER.

IN presenting this paper on the electric automobile for your consideration and discussion to-night, I will endeavor to clear up a few of the mysteries surrounding this type of vehicle, and demonstrate the advantages it possesses over all other forms of motor vehicles. In purchasing a vehicle—an automobile—for pleasure driving, one is naturally anxious to procure a vehicle that will require the least possible attention from the operator, which condition is met alone by the electric automobile. This may seem to be a very positive statement, but I shall prove it to be correct. To begin with, we must have a basis of comparison, and for this we must turn to that most widely used and popular

or to climb a grade, but accomplish this electrically by a series of switches, so grouped as to be operated by one handle, and which I shall designate hereafter as the controller. From this controller wires lead to four groups of batteries, and to the motor or motors as the case may be. At this point I will state that there are a number of different arrangements for varying the speed of electric automobiles, but I think that this one is the best, and most commonly used, and a description of this method of speed regulation will be of more interest and value to you. As the speed of an electric motor depends upon the pressure of the current supplied, you will at once see that change of pressure means also change of speed. This pressure, in technical language, is called voltage.

As it is necessary when re-charging the batteries to connect them to a direct current, each cell requiring about 2.5 volts, and as the prevailing pressure is in the neighborhood of 110 volts, it is necessary, if we desire to charge economically, to use from 40 to 44 cells of battery. These are placed in four crates or boxes, each holding ten cells. The cells in each crate are connected



THE PARIS EXPOSITION—THE PAVILION OF ITALY.

large gilded domes suggest to such a remarkable degree San Marco at Venice; the style is Venetian Gothic of the sixteenth century, and the architect has embraced in it some of the most beautiful bits of the Doge's Palace at Venice. Ogival architecture is rare in Italy, but it has always been celebrated among artists on account of its beauty. The center of the building is crowned by a large dome and each of the two wings has a smaller dome. The façades are elaborately ornamented with statues and mosaics. The interior which has a gallery is largely given up to exhibition purposes. Some of the most important objects of the exhibition are furnished by the manufacturers of Italy, especial attention being paid to the art industries for which Italy is so famous. The chandeliers with their crystal lustres are specially noticeable. The Palace of Italy was called by the workmen who were helping to construct the various buildings "The Cathedral."

The Palace of Denmark forms part of a series of buildings of the second rank which are installed among the trees of Quai d'Orsay. This building owes its existence to public subscription, which was opened

method of vehicle propulsion, the hay motor, commonly known as the horse. My reasons for referring to him are as follows:

You are all probably more familiar with this "motor" than any other and know how he automatically overcomes changes in his work. For instance, driving along a road, and arriving at the foot of a hill, your horse puts forth the extra effort necessary to accomplish the additional work without any attention on your part, and this is true only of the horse and the electric motor. All other motors require some manipulation, however slight, on the part of the operator. Another feature that they possess in common is the ability to exert the greatest traction effort at the lowest speed. Again, the fact that you can greatly overload them both for short periods, is common only to these two powers.

Under these conditions we do not require any changes of gearing in the electric automobile to alter the speed

in series, that is to say, the positive terminal of one is fastened to the negative terminal of the next. As the pressure of a cell on this charge is about two volts, and there are ten in a crate, the pressure at the terminals of each crate is approximately 20 volts. Now it is possible to so connect the four boxes that we obtain three pressures, namely, 20 volts, 40 volts and 80 volts.

The controller changes the connections of the four sets of crates, and enables the various pressures to be supplied to the motor. In the first position the four crates are connected so that the motor receives a pressure of 20 volts. As they are now connected in multiple, each crate furnishes one-fourth the total current; for example, if the motor takes 20 amperes, each box is furnishing five. This arrangement allows all of the cells to discharge at the same time. This method of control has another very advantageous feature. If one of the crates should show signs of being discharged before the others, by leaving the controller in the first position for a short time, the other crates will charge the weak one, and save those cells from over-discharge and possible injury.

* A paper read at the 204th meeting of the New York Electrical Society, New York city, March 22, 1900.

In the second position of the controller, the crates numbers 1 and 2 are connected in series, as are also crates 3 and 4. These two sets are then grouped in multiple and furnish a pressure of 40 volts to the motor. In this second arrangement only one-half of the total current is supplied from each crate; therefore if the discharge is as before, 20 amperes, each crate or box is furnishing ten. In the third position we have the greatest pressure we are able to produce. In this position all the crates are connected in series, and the pressure supplied to the motor is 80 volts, and the total current of 20 amperes is furnished by each crate.

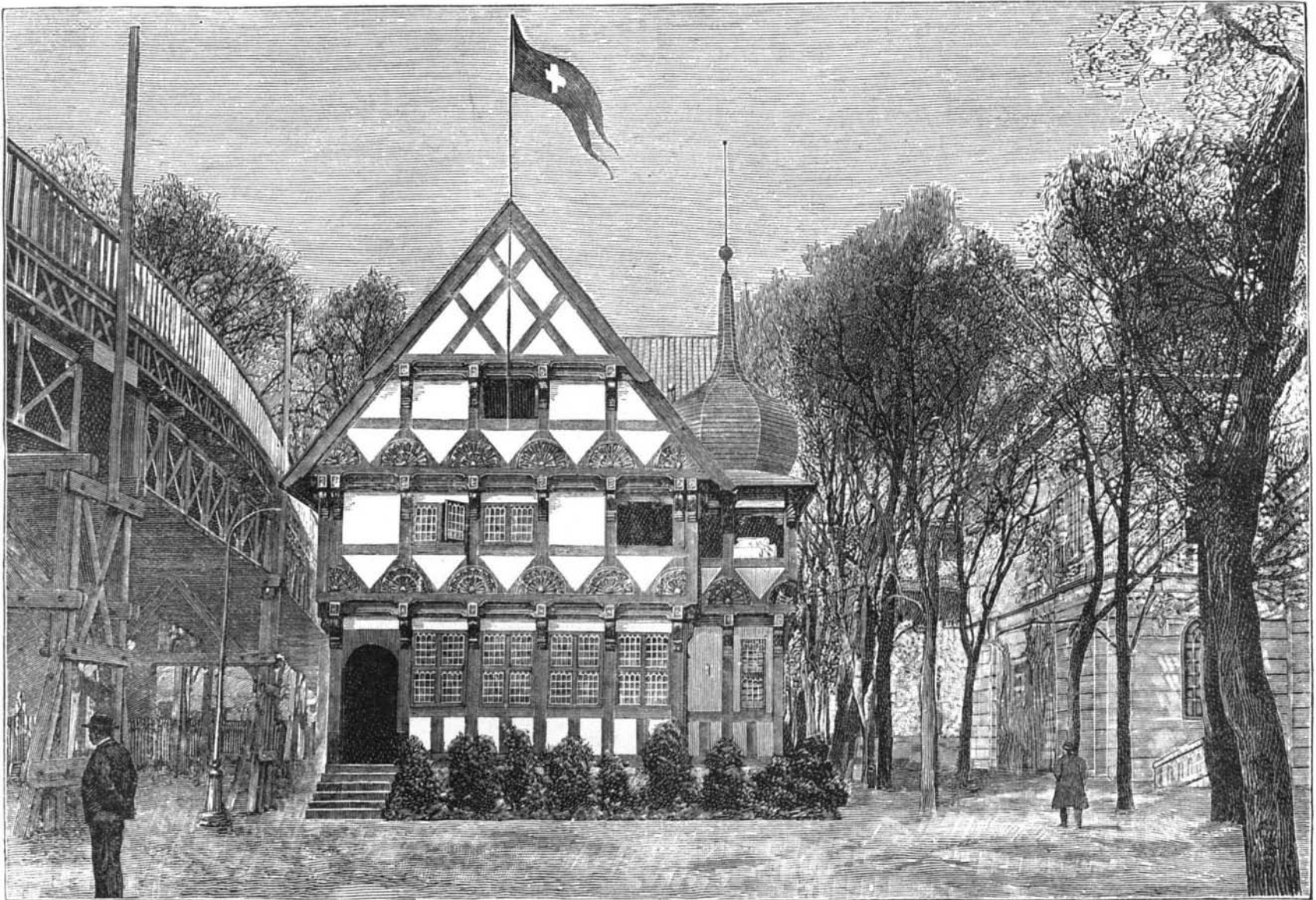
You see that by the above combinations we are able to produce three pressures, which correspond to three different speeds of the carriage. Of course, it is possible to increase the number of speeds by using more than four crates. For instance, six crates will give four speeds. But experience has shown that three speeds are sufficient and have been adopted as a standard arrangement for electric vehicles. These speeds are about as follows: First position, from 0 to $3\frac{1}{2}$ miles per hour; second, from $3\frac{1}{2}$ to 7 miles per hour; third, from 7 to 14 miles per hour. It is also possible to have these three speeds for backing, but practice has shown that two are sufficient.

I now show you the complete controller and the lever for operating it. When you remember that the forward and reverse speeds, as well as the shutting off of the supply of power to the motor, are all done by this one lever, you can see how easy it is to operate an electric carriage. For instance, you take your seat, placing one hand on the steering bar and the other upon the controlling lever. The most natural thing to do is to

When a storage battery is connected to a source of current to be recharged, the back pressure of a cell is about 2.1 volts, making the 40 cells require 84 volts to recharge them. As they absorb the charge, their pressure gradually rises to 2.5 volts per cell, or 100 volts for the 40 cells, at which pressure the charging should be stopped, as the battery is full. The meter also indicates this condition. As it is also necessary to know at what rate to recharge the cells, the other half of the instrument is graded in amperes. This portion of the meter has a double scale, reading either the amount of current going into or out of the battery, enabling us to charge at the proper rate for the best results to the battery, and when running, shows the amount of power being used. It is therefore possible with an electric carriage and one of these meters to know at any time just what horse power you are developing.

As it is absolutely necessary in recharging a battery to connect the positive terminal of the battery to the positive charging wire, and the negative battery terminal to the negative wire, some means must be devised making it impossible to connect them incorrectly. This can be accomplished in a number of ways. The one that has been most generally adopted consists of two parts, the socket, which in practice is fastened to the carriage and the positive and negative battery wires being attached to the two rings, the outer of which is positive and the inner negative. Fitting this socket is the plug, which is connected by a flexible cable to the source of current for charging. This plug consists of two concentric tubes which encircle and make contact with the rings in the socket. You will therefore see that to recharge, it is only necessary to

obtained as from the differential gear, that is, if one wheel and motor have to go faster than the other, it can do so. This double motor equipment is used mostly for the heavier types of vehicles. Having shown that the electric possesses advantages over all other types of vehicles, why is it that any others exist? It is for this reason, and this alone, that the radius of the electric vehicle at present is limited to about 30 miles. If we could increase this radius of action to 90 or 100 miles, what one of you would think for one moment of any other motor? Even the competitors of the electric vehicle admit that its advantages far outweigh its disadvantages. Now let us look at the latter from the standpoint of the gasoline or steam vehicle manufacturer. First, the limited radius of action; second, the excessive weight; thirdly, the short life of the batteries; and finally, the great cost per mile. To refute these statements I have facts which were compiled from actual data. In regard to the radius of action, I will say that there are on the market to-day electric vehicles capable of making 50 to 75 miles on each charge of the battery, and I have a report of a carriage in France that has covered 108 miles on a single charge. This carriage weighed complete about 2,200 pounds. Further, I believe that inside of six months a light electric vehicle will be produced, not exceeding 1,000 pounds in weight, that will be capable of carrying two passengers fifty miles on one charge. This disposes of the first two statements. The last two can be brought under one head, as in the cost per mile the life of the battery must be taken into consideration. It has been published by competitors of the electric carriage that the cost of operation was five cents per mile. This is



THE PARIS EXPOSITION—THE PAVILION OF DENMARK.

push the lever in the direction you wish to go. If you desire to go ahead, the lever is pushed in that direction, and the carriage immediately responds, without jerk, jar or noise. Wishing to increase the speed, you push the handle further and the carriage responds. When you wish to stop, what more natural than to pull the lever back and apply the brake. Now, you may wish to back your vehicle. By pressure of your thumb, you release a catch that prevents accidental reversal and pull the handle back. The carriage immediately goes backward. Nothing could be more simple or easier to operate, and I think that in this you will agree with me.

As it is necessary to know how much electricity we have stored up, and how fast this is being consumed, we use a combined volt and ampere meter. I think at this point it would be well to explain that the difference in pressure between a fully charged storage cell and the same discharged is about three-tenths of a volt, being two volts at the beginning and 1.7 volts at the end of the discharge. With 40 cells, the pressure at the start is 80 volts, which falls gradually to 68 at the finish. These meters are therefore marked in this manner—opposite 80 volts the word charged is written, and discharged against 68. You can therefore spin along at ease until, while running on a level stretch of road at a normal discharge, your meter reads 75 volts. You know then that you have used half your charge, and that you must either return or find some means of recharging. This device has been in constant use for over three years, and I have never known any one to run out of a charge if they went by the reading of the meter. I have so far explained only one side of the meter, and how it operates on discharge or the running of the carriage. It has still another function.

insert the plug in the socket, and close a switch, it being impossible to connect the charging wires incorrectly.

A crate of batteries, four of which constitute the equipment, are provided with handles, so that they can be easily removed from the vehicle, and making it possible, by having two sets of batteries, to keep the carriage in constant service. The wires from the controller connect to these crates and are clamped by the thumb-screws at the end of the crate, making it possible to take out an exhausted battery and replace it with a fresh one inside of five minutes. A motor, the apparatus that transforms electric into mechanical energy and propels the carriage, is probably the most perfect of any power transforming device, having an average efficiency of 80 per cent. and especially adapted to vehicle propulsion, exerting a continuous rotary effort, capable of being overloaded from 100 to 300 per cent., and responding to every call made upon it. Noiseless and without vibration, it is and always will be the ideal motor for automobiles.

As you all know, when turning a corner, one wheel of the carriage must travel faster than the other. This can be accomplished in several ways with the electric automobile. This is what is called the single motor running gear, and the differential action of the wheels is accomplished by the well known method of making the driving axle in two parts, each half being keyed to a wheel and connected to each other by a system of gears. This arrangement is generally used for light carriages. Here is an entirely different method of obtaining the same effect. In this arrangement, the differential and single motor is replaced by two motors, each directly geared to a driving wheel. The motors are so connected electrically that the same results are

delightfully vague, as they do not state whether this is simply the cost of current for recharging or if they include in their figure the depreciation of the batteries. However, they have certainly put their estimate at a remarkably high figure. To offset these erroneous statements, I will give you a few facts as to the cost of operating electric vehicles, which data is not theoretical, but compiled from actual running expenses of a pleasure carriage. The vehicle that I have reference to, and from which this data was obtained, has been in almost constant use since 1897. During this period it has covered over 20,000 miles. The cost for battery maintenance has been \$150, or $\frac{3}{4}$ of a cent per mile. The current, as supplied with the regular Edison Company's rate of ten cents per horse power hour, adds $1\frac{1}{4}$ cents per mile, making the total cost $2\frac{1}{2}$ cents actual as against the theoretical statement of the gasoline manufacturer, 5 cents per mile.

As these figures just given are based on the present weight and capacity of the storage battery, let us indulge in a little speculation as to what we could accomplish with a battery giving from two to three times the capacity per pound over those in use to-day. As the weight of the battery is about 40 per cent. of the total load carried, and we are designing a vehicle to carry two persons, we will assume that our carriage and its occupants will weigh 1,300 pounds complete. Of this total weight, 500 pounds will be in the batteries. Now, our normal speed will be 15 miles per hour. To drive our carriage at this rate requires two horse power, and as our battery has this capacity for 4.5 hours, it is plainly to be seen that we should be able to cover between sixty and seventy miles on one charge. These figures are based on good macadam roads, with practically no hills. The cost per mile to operate such a

carriage would be 1.5 cents with current at the regular Edison rates. I stated this as a supposititious case, but as I have before stated, I expect to see such a carriage in a very short time. I hardly think it necessary to enlarge upon the advantages of the electric automobile, but it is the only carriage that a lady can operate, and it also appeals more to our æsthetic taste than any other form of motor.

THE TERRACES OF THE AUTOMOBILE CLUB.

TERRACED roofs are by no means a novelty. In the south of France, in Italy, in Spain and in Oriental countries, houses are covered in this manner with success. A simple pavement of flagstones or tiles laid in

This system has long been employed in Germany for both ordinary and luxurious habitations, and numerous applications of it may be seen at Eupen, Cologne, Coblenz, Mayence, etc. It is much employed, too, in Holland, Belgium and Switzerland. It is in France only that the system has remained almost unknown, and it was but a short time ago, after M. Eugene Pigneux obtained the right to exploit the German patent in France, that terraced roofing of volcanic cement obtained a foothold in our country and that our architects began to employ it.

The Automobile Club, recently installed on the Place de la Concorde, has seen fit to adopt this system in the beautiful structure in which it has its home; and the terraces constructed by M. Rives, the architect, perfectly fulfill the programme proposed by the members of the organization.

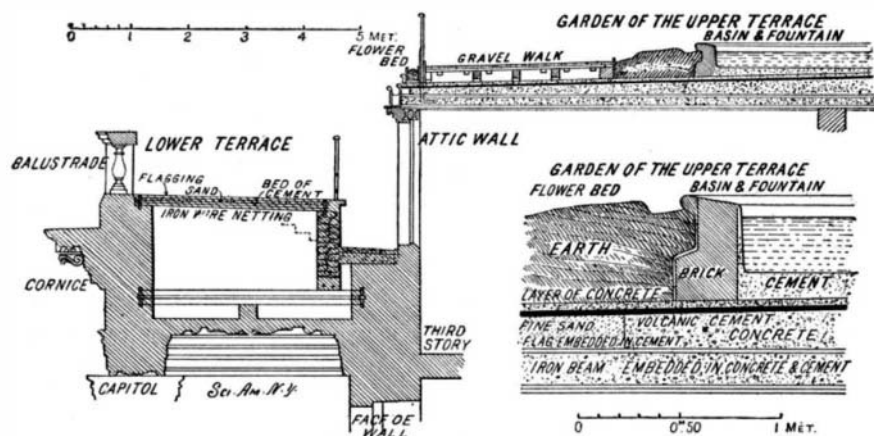


FIG. 1.—SECTION OF THE TERRACES FORMING THE ROOFING OF THE QUARTERS OF THE AUTOMOBILE CLUB.

a bed of mortar or cement suffices in these climates, since the terraces never have to undergo the action of frosts such as occur in northern countries. Beneath the terraces in Italian palaces we frequently see ceilings that have been decorated with fresco paintings for many years, and yet have never been injured by humidity due to infiltrations of water. In our climate the conditions are not the same, and so our architects rightly avoid the use of terraced roofs in planning their edifices.

The castle of St. Germain, rebuilt by Francis I., and the upper terraces of which were renovated by Louis XIV., offered a fine example of such roofs. Francis I., according to Félibien, intrusted the construction of his castle to the Italian architect Sébastien Serlio, who covered the entire edifice with stone terraces and ornamental balustrades, after the Italian manner. This mode of construction was not adapted to our destructive climate. The humidity of French winters and serious infiltrations had long before ruined the castle when, in 1862, M. Millet, the architect, was commissioned to make an entire restoration of it. In order to assure the solidity of the palace, M. Millet covered the old terraces of stone with a series of small sloping roofs protected with lead and provided with gutters.

In order to effect the reconstruction according to a new plan, M. Rives was obliged to remove the entire roof of the building. The terrace roofing, however, offered him the advantage of gaining one story in height without exceeding the limits permitted by the city regulations. He was thus enabled to install, directly beneath the upper terrace, a dining room, which is shown in the section given in Fig. 1. This section shows, too, the construction, as a whole, of the two floors of the new terrace. The place reserved for the sheets of volcanic cement covered with a thin layer of concrete may be seen in the details on a larger scale to the right of the engraving. This necessary facing is isolating and protective when the terrace is to serve only as a roofing. When it is to be utilized, and free access to it is to be had, as in the case under consideration, there may be arranged upon it either vegetable soil in which to plant shrubs or flowers, or light foundations of concrete for the establishment of a basin and fountain, etc.

Any rain or other water that may filter through the concrete facing will flow over the volcanic cement, which remains impermeable, and fall into the gutter arranged along the upper terrace.

At the Automobile Club, the upper terrace is a genu-

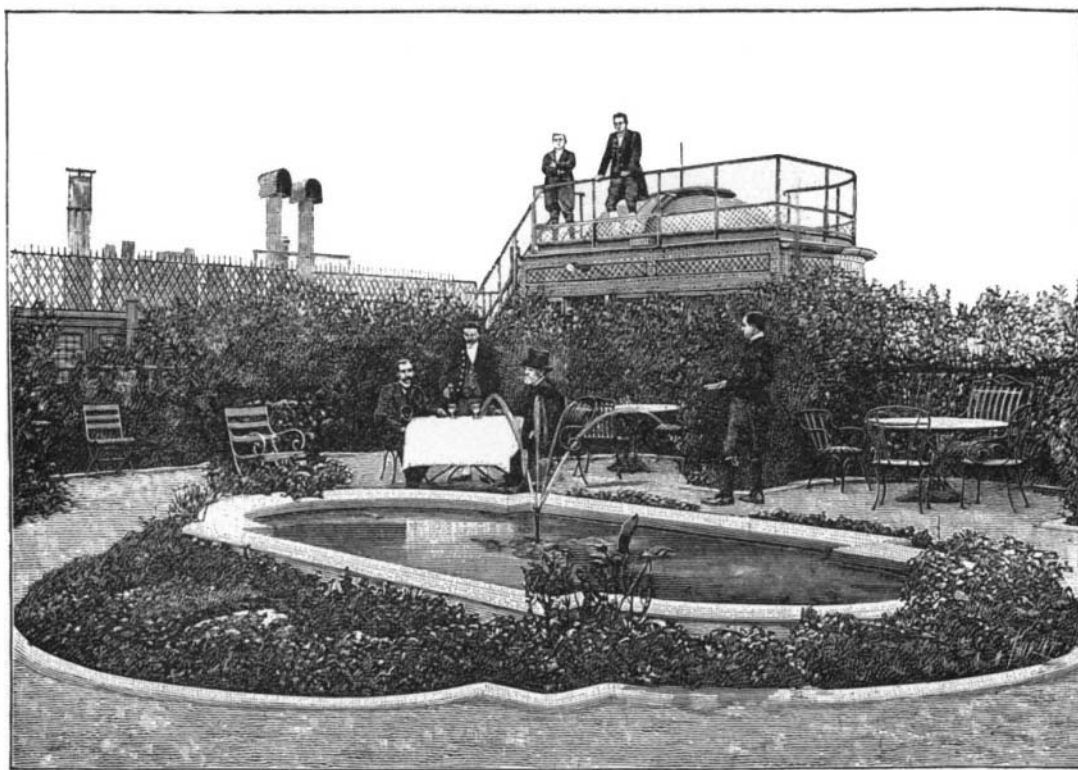


FIG. 2.—GENERAL VIEW OF THE GARDEN.

M. Millet was not acquainted with the invention of M. Haeusler, who, in 1888, devised an ingenious system of terraced roofing capable of perfectly resisting the inclemency of our climate. Such roofing may be constructed upon either a wooden or iron platform. Upon the external surface of the latter is laid a bed of concrete having a slope of from 0.03 to 0.05 cm. to the meter, and over this is spread a thin layer of fine sand. Upon the latter are laid four thicknesses of strong paper, which, manufactured especially for the purpose, possesses peculiar properties. These thicknesses of paper, cemented together by a hot solution of an elastic substance, remain both inalterable and impermeable. This composition, which is kept a secret, constitutes what is now called "terraced roofing of volcanic cement."

ine hanging garden. The panorama that unfolds itself in the direction of Place de la Concorde is remarkable. The observer sees the Seine with the Champs Elysées and the gardens of the Tuileries, and Notre-Dame and the Pantheon, while the dome of the Invalides towering over the palaces of the Exposition of 1900 completes the admirable view of the capital.

Fig. 2 gives a general view of the suspended garden with its beds of flowers, shrubbery and central basin. The stand in the background is designed for occupancy by musicians, whose duty it will be to make things cheerful for the members of the club, who during fine weather take their meals amid the shrubbery or under an awning erected to shelter them from the heat of the sun. The elevator is located beneath the musicians' stand.—La Nature.

APPLIED SCIENCE IN MUNICIPAL WORK.

THE city of Marshalltown, Iowa, has just issued in pamphlet form the "preliminary data for the design of a proposed sewage system," which illustrates in an unusually satisfactory manner the rare case in which municipal authorities have displayed enough of wisdom and of familiarity with the resources of their country to bring to bear upon their problems of construction the best scientific knowledge available. The committee of the city council applied to Prof. Marston, the civil engineer, Prof. Weems, the chemist, and Prof. Pammel, the botanist of the University of Iowa, for advice, and under their direction the data reported were collected. The work of the survey in detail was done by trained students, largely, and the drawings were made by Miss Wilson. The city of Marshalltown paid all expenses and its officials seem to have heartily seconded the endeavor of the chemists and engineers of the university.

The city has a population of 12,000 and is the county seat of Marshall County and the commercial center of a rich agricultural country. There is some manufacturing, the principal shops of the Iowa Central Railroad and large beet-sugar manufacturing establishments being located there. The sewer system contains about ten miles of sewers and laterals. Water is supplied from drive wells and to the amount of about 1,300,000 gallons per day, the glucose and packing houses taking a large fraction of that used for other than domestic purposes. It contains about 300 parts solid matter in the million, mainly lime and magnesia salts. Deeper wells of artesian character, belonging to the glucose company, show about 900 parts solid matter, of which about two-thirds seem to be lime and magnesia salts and 15 per cent. organic matter, although the wells are 300 feet in depth. The city water in May, 1899, showed 1,040 bacteria per cubic centimeter. The sewage is passed into the Iowa River, which flows, at a minimum, about 3,250,000 gallons per twenty-four hours, and contamination by sewage is at all times serious. Where thus contaminated, its color is dark, its odor offensive, and its mean content of bacteria at times as high as about 100,000 per cubic centimeter, and probably more. The outcome of litigation directed against the city by residents of the country below, along the banks of the stream, has been the determination of the city to adopt a system of purification of the sewage, and it is to this end that the experts of the university were consulted.

It was promptly discovered that the glucose sewage was very different from that of the city, in respect to content of bacteria, as was to have been expected. Its bacteria ranged up to, in one case, nearly 10,000,000 per cubic centimeter. While not unwholesome when fresh, it is subject to putrefaction of a seriously objectionable character. The packing house sewage also contains large quantities of bacteria and has a characteristic composition. The result of intermixture of these various kinds of sewage is a peculiarly offensive and troublesome compound.

In seeking the best remedy for this state of affairs at Marshalltown, the data printed in the report were gathered. The work included a study of the topography of the country, of the character of the soil, the available materials for construction, of filtering and settling tanks, and the cost of labor and material. It is stated that the works should be completed before November of the present year.

In the performance of the work of the consulting chemists and bacteriologists, the methods of the Massachusetts Board of Health were usually followed.—R. H. Thurston in Science.

ON THE DISCOVERY AND OCCURRENCE OF MINERALS CONTAINING RARE ELEMENTS.*

By Baron A. E. NORDENSKIÖLD.

THE first mineral referred to is scheelite, and the next cerite, which contains no less than four rare metals. The incandescent light produced when the latter mineral is fused with charcoal powder was first observed by Cronstedt in 1751. The discovery of glucina, lithia, selenium and yttria is next referred to. Minerals containing yttria and oxides related to it were, at one time, thought to be almost limited to certain pegmatite veins running in a broad zone on both sides of the sixtieth parallel of latitude. Latterly, fluorocerite, orthite, and gadolinite have been found in Dalecarlia; and among these minerals Denédicks discovered a silicate of yttrium containing 1.5 per cent. of nitrogen and helium. The author discovered kainosite, a silico-carbonate of yttrium and calcium, among minerals from Hitterö; and the same mineral was subsequently discovered in the flucan, fissures, and drusy cavities at the Nordmarken mines. The last mentioned discovery and others related to it appear to suggest that the mode of formation of fissure-minerals is not so unlike that of the pegmatite-veins of the Primary rocks as is generally supposed.

Thorium, discovered by Berzelius in 1829, was originally obtained from the rich mineral locality of Langesund (called Brevig in mineralogical literature), but it has since been recorded from other localities, including Arendal and Finnish Lapland. It is now obtained from the monazite sand of rivers in the Brazils and South Carolina. Thorite contains about 0.5 per cent. of inactive gas, probably a mixture of nitrogen and helium; but the latter element was first obtained from the mineral cleveite, also containing thorium, discovered by the author in 1877. Other minerals bearing nitrogen, argon, or helium are referred to; and under the head of minerals bearing tantalum, mention is made of Giesecke's discoveries in Greenland. Among these is fergusonite, one of the richest sources hitherto known for obtaining that mysterious gas, or mixture of gases, which on our planet seems to be almost exclusively confined to minerals containing rare earths. "The group of earths, as well as the group of gases, of which we are here speaking, might therefore be compared with certain genera among organic beings, whose species, having not yet fully differentiated, offer to the descriptive zoologist or botanist difficulties analogous to those with which chemists meet in endeavoring to separate the rare earths and rare gases."—From The Chemical News.

* Read before the Geological Society of London, April 4, 1900.