

salt on account of the cheapness of the former. Trepani was, on the contrary, found to contain very little. Dr. Farlow advocated that the walls and all the wood-work be scraped, and washed in hot water to kill the plant, and that painted wood be used in preference to the rough natural walls in order to afford as little room as possible for the *Clathrocystis* to lodge itself. He further advised that Trepani salt be used instead of Cadiz. A number of fish-dealers have adopted his suggestion in regard to the salt, and they all inform me that for two summers not a single fish has been lost by 'reddening.' The wood-work contained the plant; and in warm weather old butts turned red on the outside, while the new ones, in which no pickle made from Cadiz salt had been kept, remained perfectly intact. The fish saved by this means more than paid for the difference in price between the two salts. Trepani salt seems to prevent the rapid growth of the plant, while Cadiz rather favors it. Here, as in many other cases, we see that a little scientific thought will accomplish that which would never be brought about without it.

RALPH S. TARR.

MUSEUMS OF NATURAL HISTORY IN THE UNITED STATES.¹

THE state of its public museums, laboratories, and other scientific institutions, gives a very reliable measure of the appreciation and culture of science by a nation. We are often inclined to consider America as a country where money-making suppresses all other interests, where learning, art, poetry, — in one word, all the finer manifestations of the human mind, — can enjoy even a poor existence only in a few places, and find in general very unfavorable ground. One, however, who has had an opportunity of carefully observing American literature during recent years, could certainly not help seeing its intellectual activity; most of all, perhaps, in the case of the sciences, they being intimately connected with practical life, and among these especially those of geology and paleontology. Most of the states created geological surveys for the investigation of the country, and the publication of maps and other results: the general government extended these investigations to the territories. The elegant publications of these geographical and geological institutions, distributed with the greatest liberality, form already a library which contains information of the greatest value concerning the vast country of the United States.

We have often enough heard that they were founding public museums in America, and that, together with their indigenous treasures, they were desirous of obtaining the material of the old world for com-

parison, if, as now and then happened, a valuable private collection had to make its way across the ocean. It would form a long 'list of the missing,' should we enumerate all the valuable scientific objects, which, during the last thirty years, have gone to America from Germany alone. The contributions of England and France towards the enrichment of the transatlantic museums are, of course, not less. But, in spite of all this, the American museums are hardly known among us. While among the eminent learned men of America there are only a very few who have not travelled in Europe at least once, the new world is usually not studied with the same care by the learned men of the mother-countries. The Americans, however, have begun to make their treasures in natural science accessible to the public, as well as to the specialist, in a way which in many respects deserves admiration and imitation.

The following observations on some of the most prominent museums of natural history, made during a short stay in North America, will undoubtedly prove to be incomplete, one-sided, and perhaps in many respects even inaccurate. Their main object is merely to call the attention to those institutions more carefully than has hitherto been done.

Up to the middle of this century, Philadelphia was at the head of scientific investigation in America; and even to-day, when the principal city of Pennsylvania has almost lost its leading position, a visit at the fine museum of natural history will show everywhere the traces of a celebrated past, and of a comparatively old civilization. Among all the larger museums of North America, the museum of Philadelphia shows the strongest European influence in its whole organization, and in the arrangement of the collections. The handsome building belonging to the Academy of natural sciences is in the centre of the city, near one of those beautiful squares full of trees which are the pride of Philadelphia. The first floor contains a rich library, the meeting-rooms of the academy, rooms for officials and for special investigators. The collections are in the upper part of the building, in one large hall surrounded by wide galleries. Stuffed mammals, skeletons, and several large fossil vertebrates occupy the centre of the vast room. Among them a fossil gigantic saurian, with its strong hind-legs and short fore-legs, is conspicuous by its enormous size. The bones which were found at the 'Hopkins' farm in New Jersey, and which furnished the material for the restored skeleton of the *Hadrosaurus*, have been well prepared, and are now kept in show-cases near by, together with the remnants of another gigantic fossil lacertian (*Laelaps*), and together with the nearly complete skeleton of an *Elasmosaurus*, found in the chalk of Kansas, which has much resemblance to *Plesiosaurus*. The restoration of the *Hadrosaurus* was made before the time of Marsh's great discoveries, and before the twenty-four skeletons of *Iguanodons* had been found near Bernissart in Belgium. We must therefore not too severely criticise a few errors made by the restorer in the restoration of the missing parts. By the purchase of the collection of birds from the famous

¹ By Prof. K. A. ZITTEL of the University of Munich. Translated from the supplement to the *Allgemeine zeitung* of Dec. 16.

ornithologist, Gould, Philadelphia got a first-class ornithological museum. For craniologists, Dr. Morton's collection of about twelve hundred skulls is of interest. The collection of recent shells is said to be second in completeness only to that of the British museum, and is rich in originals used in the publications of a large number of active scientific men in Philadelphia.

Through Professor Joseph Leidy, the director of the museum, Philadelphia was the first place to procure the remains of fossil mammals from the territories of Wyoming, Dakota, and Nebraska. By this excellent *savant*, attention was called to those inexhaustible treasure-houses in the far west from which, since that time, a whole world of marvellous fossil animals has been unearthed. The interest of the specialist will be attracted by Professor Gabb's collections made in California and Nevada, and by the petrifications from the tertiary formation in Georgia and Alabama. The museum is also rich in European objects.

The interior arrangement is simple but practical. Sometimes the show-cases are rather crowded, and stand so near together that the light is not everywhere sufficient, in spite of the high windows on all sides of the hall. Already in this comparatively new building there is, as in nearly all European museums, a lack of space.

Naturalists will not leave Philadelphia without having seen Prof. E. D. Cope's celebrated collection of fossil vertebrates. During my stay in Philadelphia, this indefatigable investigator was in New Mexico in order to continue the exhumations with which he now has been occupied for many years at a heavy expense, and with much personal hardship. Very soon his elegant house in Pine Street became too small for the collected treasures, the house next to it had to be bought, and now it is filled from top to bottom with fossil bones. And again no space was left: the larger specimens, therefore, had to be placed in the cellars of a public building. Mr. Wortman, a former pupil and assistant of Professor Cope, was my amiable and well-informed guide through this improvised museum, where almost all the rooms are filled nearly up to the ceiling with cases, shelves, drawers, trunks, and boxes, where one finds piled on the floor, or along the walls, enormous skulls of mastodons and Dinocerata, or bones of gigantic saurians, and where the visitor's eyes are delighted with several complete skeletons of mammals still remaining in their stony matrix. Besides a number of forms already known by way of pictures or descriptions, one may see here the remnants of several hundred fossil vertebrates of which we in Europe know hardly more than the names. Comparing the fossil mammals of the Paris basin with those found in North America in strata of the same period, we discover a striking difference between the two faunas.

The regions of geographical distribution for vertebrates were just as sharply limited during the tertiary period as nowadays. This is the reason why we find a nearly inexhaustible abundance of new orders and species in the so-called Bad Lands of western Amer-

ica. Professor Cope is one of the most eminent authorities of our time in comparative anatomy and paleontology: he has bought the fine osteological collection of Hyrtl at Vienna, and is now busy in editing an extensive work, in which he intends to give descriptions, as well as pictures, of the numerous fossil mammals discovered by him.

While Philadelphia has the oldest museum of North America, Washington is arranging the newest one. In the elegant, beautifully situated capital of the country, with its wide and clean but hardly animated streets, with its vast parks and magnificent edifices, the visitor will be surprised to find unfinished, not only the Washington monument, but also various other edifices. But if once all the enterprises which are now going on are finished, Washington will be one of the most beautiful cities of the world. Not far from the simple home of the President there is a park of about fifty acres, in which we find most imposing public buildings, among them the green-houses of the botanical garden, the Smithsonian institution, and the National museum. The latter is in a palace of red sandstone. The interior of the tasteful building, in Normano-Gothic style,¹ contains in the centre a dome-like hall two hundred feet long, where various collections in a somewhat strange mixture are accommodated. Large glass cases with stuffed animals are put together with Indian curiosities, models, and relief-maps, together with samples of building-materials and ores. Part of the hall and a wing of the building are given to the geological survey. In the other wing we find the excellently arranged prehistoric and ethnographical collection, under the direction of our countryman Karl Rau. The great variety of the tools and weapons made of stone, still used among some Indian tribes, which are exhibited here, is hardly less remarkable than the ability with which these savages work the brittle material. In this respect the American autochthones have undoubtedly attained a higher civilization than the inhabitants of Europe during the stone period. For the present, the National museum, as a whole, can be considered merely as the beginning of a museum of almost universal character; but, with the enormous means which are at the disposal of the central government, it needs only a few influential and energetic men to develop great things out of this promising germ.

A glance at the growth of the American museum of natural history in New York shows what energy, and readiness to sacrifice, may accomplish within a few years. In January, 1869, a few scientific friends met, and decided to found in New York, the metropolis of North America, a museum of natural history, which was to correspond with the means and the importance of this city, and to give its inhabitants an opportunity for recreation and instruction. Within a few weeks forty-four thousand dollars were subscribed. Out of this money the collection of birds made by Prince Maximilian of Wied was bought. Many other objects were given; and very soon the

¹ The writer has here confused the Smithsonian and museum buildings.

halls of an armory, assigned by the city to the museum, proved to be too small. Thereupon the trustees thought of having a home of its own for their collections; and to that end the city government not only gave Manhattan Square, an estate of eighteen acres and a quarter, in the immediate vicinity of Central Park, but also decreed the necessary means for the projected building.

In June, 1874, the corner-stone was laid, in the presence of President Grant, the governor of the state, the mayor of the city, and a number of prominent persons from Boston and New Haven. As early as December, 1877, the large fire-proof building, consisting of nothing but stone and iron, was finished so far that it was possible to transfer the collections, and to make them accessible to the public. To-day the museum is already filled to such an extent, that the trustees ask for three hundred thousand dollars more, in order to put up an additional building of the same size. In regard to the excellent adaptation of the building to its purposes, and also in regard to the practical interior arrangement, the New-York museum deserves to be called a model institution. The exterior of the red-brick building is without any ornamentation. The entrance at the narrow side leads to the basement: the large staircase is opposite. Each floor contains, besides one single large hall of a hundred and seventy by sixty feet, only a few small laboratories near the stairs. Wide and high windows on both sides furnish plenty of light. Between them the walls have openings like loopholes, through which the interior of the cases, which are in a rectangular position against the side-walls, get the necessary light. The wide, well-ventilated halls, provided with heating-apparatus and gas, make a grand impression. On all the floors the main cases are arranged in the same way, and are of the same size; so that it would be easy to move the contents of one hall into another. The rooms, as well as the cases, are well protected against dust. The cases are made of iron; their doors, of a single pane of glass. The tasteful and appropriate furnishings correspond with the contents. In the basement there is a rather small collection of mammals. We do not see here those shabby skins, half-destroyed by moths, nor those ill-shaped, four-legged straw bags which disfigure so many museums of older date. Every thing is new and clean; and some groups — as, for example, the family of orang-outangs, or the *Ornithorhynchus*, with its surroundings — may well be called pictures borrowed from nature. The collection of birds on the first floor deserves similar praise. The laymen will be pleased with the birds of paradise, the macaws, the parrots, and the humming-birds, which display here the beauty of their feathers. The hall of the first floor is thirty feet high, with a wide gallery, forming, so to speak, a floor for itself, with its own windows. Here we find a rich ethnographic and prehistoric collection. American objects predominate; but there is no want of foreign material for comparison, and especially one interested in the European stone period could find here very many valuable things. The next floor contains the geologico-paleontological and the

mineralogical collection. The nucleus of this division is a collection bought for sixty-eight thousand dollars, from Prof. J. Hall in Albany, the Nestor of American geologists. The typical objects, as given in Hall's voluminous work on the state of New York, are arranged here in a way that affords an excellent view of the whole; and I do not think that the enormous mass of paleozoic petrifications of America is better exhibited in any other museum. On the highest floor there is a library, a hall for public lectures, laboratories, and a number of rooms for various specialists and their private collections. A freight-elevator runs from the cellar to the highest floor in an American museum, as a matter of course.

If we consider what has been done in New York within less than fifteen years, we have, indeed, to admire the energy of the superintendent, Prof. A. S. Bickmore. He not only knew how to get some of the richest and most influential citizens interested in his work, but also formed, with the means at his disposal, an institution unrivalled in many respects. The American museum of natural history is open to the public daily; and, on an average, about fifteen thousand persons a week make use of this privilege. The city of New York pays to the museum annually fifteen thousand dollars. All the expenses above that are paid by subscription. Should the plan, as exhibited in the basement, be carried out, the museum would have twelve buildings of the size of the present, which, together with six connecting wings, would cover the whole of Manhattan Square. An enormous cupola would form the centre of the whole. Then New York would decidedly have the largest museum of natural history in the world.

The museum of the state of New York, at Albany, is on a smaller scale. This institution has been founded by the celebrated geologist, J. Hall. During fifty years of investigation he has unearthed the geological and paleontological treasures of his state; and, besides a private collection, he has created a public museum, where the products of the state of New York are exhibited in a fine arrangement. In Germany we have only one local collection, the 'Württembergisches landes museum,' at Stuttgart, which is ahead of the museum of the state of New York in regard to arrangement and completeness.

For study and investigations, the capital of the state of New York, with its unpleasant political life, is not a very favorable place. The university towns of New Haven and Cambridge are far better homes for intellectual culture in North America. There is no better introduction into society than a diploma from Yale or Harvard. These universities are partly imitations of English colleges, partly of German institutions; and for decades there have been first-class learned men among their teachers. The scientific life of America is under the influence of these universities and these independent corporations are so popular that they receive considerable legacies nearly every year. The numerous handsome buildings of Yale college at New Haven show the wealth of this institution. Among the simple dormitories and buildings for lecture-rooms, the museum of

natural history attracts the attention by its height and a fine Gothic front. It owes its existence to a gift of Peabody, the well-known philanthropist. The first story is occupied by a collection of minerals most excellently arranged, by the private laboratories of Professors Dana and Brush, and by lecture-rooms and common laboratories. The middle floor contains the geological and paleontological collection. The highest floor contains collections for zoölogy and prehistoric ethnography.

The centre of interest at New Haven is a collection of fossil vertebrates founded by Prof. O. C. Marsh. Not only the whole first story, but also cellar and attic, are filled with fossil bones. Long rows of piled-up boxes contain the paleontological treasures. Only a very strict order makes it possible to find every thing in these crowded rooms, where a number of assistants are busy in preparing and combining the objects which so often arrive in fragments. In a small additional building a German modeller forms casts of the finest specimens, and afterwards these casts are sent with the greatest liberality to American and foreign museums. To a large extent, the Peabody museum owes its fine condition to the self-sacrificing activity of Professor Marsh.

What at the beginning of this century Cuvier did in Europe for the knowledge of antediluvian vertebrates, has been done in America by Professor Marsh, and his not less active rival Professor Cope in Philadelphia. The great variety of fossil vertebrates in America corresponds with the vastness of the country. Whole cartloads of bones have been dug out in the Bad Lands of the far west: they were carried on the backs of mules hundreds of miles, before they reached the railroads which brought them eastward. For months Professor Marsh and his assistants were camping in the reservations of the Indians, protected by an escort of cavalry. With the great chiefs of the Sioux, 'Red Cloud,' 'Red Dog,' he used to smoke the pipe of peace: against others he had to defend himself, revolver in hand. Professor Marsh's collection of fossil remains of vertebrates, brought together within about fifteen years, is not less complete, and not inferior in value to the collection of the British museum in London. It is infinitely more than all the material ever seen and studied by Cuvier during his whole life. During my visit at New Haven there were about twenty-five gigantic skulls of Dinocerata in the professor's laboratories. Several lithographers were occupied in making plates for the publications in which the fossil mammals and reptiles of America will be described. In an adjoining room a whole series of teeth, and bones of the foot, illustrate the development of the horse species. Though the Indians made the acquaintance of the horse only through the Spanish 'conquistadores,' there is no country where remains of antediluvian horses are so often found as in America. A series of fossil species shows the changes which the ancestors of the horse underwent, before the present type of the solidungulate was attained. Europe, also, has some of the intermediate forms, but not so many. The American predecessors form a

nearly uninterrupted series. From the enormous mass of antediluvian mammals I can mention here only the oldest forms from Jura and tertiary strata, which have been discovered lately in America. Up to that time we knew only several lower jaws found in England, and a few teeth from the keuper of Wurttemberg.

Professor Marsh has brought from Wyoming remnants of at least three hundred specimens, and not only lower jaws, but also skulls, and other parts of the skeleton. They belong, without exception, to little marsupial-like species, usually of the size of a rat or squirrel. In contrast with these dwarfish forms, the reptiles of the Jura and chalk formations excel usually by their gigantic size; and it is just the largest and the clumsiest of them that show a remarkable combination of reptilian and avian peculiarities. New Haven has the largest collection of such dinosaurians. There you may see a complete skeleton of the curious Brontosaurus, — an animal with a small head, a long neck, long tail, high hind-legs, and short fore-legs.

The upper part of the femur of the gigantic Atlantosaurus is about twice as long as the corresponding bone of an elephant. The curious Stegosaurus, thirty feet long, was covered with an armor of enormous bone plates, and armed with thick spines. The cavity of its brain was of a minimum capacity; but, in compensation therefor, the spinal marrow in the os sacrum is swollen into a second brain-like enlargement. Another little saurian (Coelurus) has ring-shaped vertebrae which are entirely hollow. Hadrosaurus has shining teeth, jagged on the sides like shark's teeth, in several rows above each other, and side by side, so that they come into use only one after another. Besides these dinosaurians, some snake-like saurians of the sea, with short swimming-feet (Mosasauridae), attract our attention. A slab three metres high contains a complete well-preserved skeleton of such an animal. On the whole, Professor Marsh may have parts of about sixteen hundred specimens.

America has also flying saurians; though the skeletons are not often so completely preserved as those in the lithographic slate of Bavaria, but they are of considerably larger size. The skull of a Pteranodon, for instance, is three feet long. While this flying saurian differs from its European relatives by toothless jaws, there are in the chalk strata of America a number of birds with well-developed teeth. Professor Marsh has given a description of these curious creatures in a very elegantly executed monograph.

A visit at the Peabody museum, under Professor Marsh's guidance, arouses very mixed feelings in a European colleague. Together with sincere admiration, he necessarily has the disheartening conviction, that, whereas the time of great discoveries has begun in America, it is over in Europe. The character of greatness and magnitude which we find in many conditions of American existence is also prominent here. Compared with the paucity of the discoveries in our own country, the virgin soil of America furnishes, uninterruptedly, new and unexpected objects.

It is beyond question that the future development of geology and paleontology will be essentially influenced by America; but it seems to me, that, for zoölogy also, a model institution for the future, in many respects, has been created in the celebrated Agassiz museum in Cambridge, near Boston, which probably will not be without influence on the development of museums of natural history in Europe. On an extensive plot near Harvard university there has been erected a five-story brick building with numerous windows, but with no ornamentation, and with an almost barrack-like appearance. The simple staircase corresponds with the modest exterior and with the whole interior arrangement. The genial founder of the 'Museum of comparative zoölogy,' as he called it, did not intend to have a brilliant exhibition, but a place for serious labor and study. And the great enterprise called into existence in 1860 by Louis Agassiz has now been nearly completed, according to the ideas of the father, by the energy and the organizing talent of the son. Over three hundred thousand dollars were subscribed in a short time, when Louis Agassiz, twenty-four years ago, came to America, and announced a plan for the erection of his museum. Nobody knew better than he how to arouse the enthusiasm of others for ideal purposes by the power of words; and we may well say that he originated that new movement in the descriptive natural sciences which continues up to the present day. A whole school of young zoölogists grew up at Cambridge. Collections of all kinds were bought in the old and in the new world, expeditions were sent to far-away countries, and the depths of the sea were investigated. The ingenious investigator, who was always full of new ideas, had neither time nor patience for the sifting and arrangement of the extremely rich material: his son and successor undertook this task. As an administrator, Alexander Agassiz may be equalled only by a few; as a naturalist, he belongs, as his father did, to the first names of America. A large fortune, acquired in the copper-mines of Calumet and Hecla, near Lake Superior, makes it also possible for him to promote the interests of the museum financially. To him it must be attributed, that the museum has been entirely withdrawn from the influence of an often-changing government, and has been transferred to Harvard university.

In the well-lighted basement of the museum there are eight rooms assigned to the collections in alcohol, which consist not only of lower animals and fishes, but also of numerous mammals, birds, and reptiles in metal boxes filled with alcohol. A seawater aquarium, a room for the preservation of living animals, and various other storerooms, occupy the rest of the basement.

On the first floor, there are the paleontological and geological collections, together with the necessary laboratories and lecture-rooms. The parts of the collection devoted to scientific investigations are separated from the collections for the show-cases proper; and in those, only a comparatively small selection of objects is exhibited. The second floor contains the rooms of the curator, a rich library, laboratories for

anatomical and physiological investigations, and other workrooms for more advanced students and specialists. Besides the rooms already mentioned, there is on each floor a so-called synoptic room, through which every visitor of the museum has first to pass. A small but well-selected collection gives here a general view of the most important representatives from all classes of the animal kingdom. Large inscriptions on the walls and on the cases make it easier to find one's way. All the specimens are accurately labelled. Dissected preparations explain the anatomical structure of crabs, insects, echini, starfishes, etc. The synoptic room for zoölogy may well be called a model of a collection for purposes of instruction. A similar collection for geology and paleontology is in preparation.

While the two lower floors are chiefly devoted to purposes of instruction, the specialist will find in the three upper stories abundant material for his investigations. The third floor contains a zoölogical collection accessible to the public. In five halls all the more important species and varieties are exhibited in systematic order, and not crowded together. For the vertebrates the stuffed skins, as well as the skeletons, are given.

The zoögeographical collection is a specialty of the Cambridge museum. In two well-lighted halls one finds the whole fauna of America. The typical specimens of the animal kingdom of Africa, of India, of Europe and Siberia, and of Australia, are represented in their respective rooms. A special hall has been reserved for the inhabitants of the ocean; and here it is intended to place the rich treasures acquired by the investigations of the depths of the American seas. Most probably several years will pass by before the arrangement of this extremely interesting division of the museum will be finished,—a collection which will be unique in its way.

In the two highest stories the large and strictly systematic main collection of geology is stored in simple but appropriate cases with glass doors. Thousands of skins of mammals and birds are stored up in drawers. The lower animals are deposited in a similar manner. Every case and every drawer bears a label showing its contents. In many departments Cambridge is said to be even ahead of the British museum. Excellent methods of preparation have been applied with fishes and reptiles. The collection of insects, under the direction of the German entomologist, Dr. Hagen, excels by reason of its abundance of beautiful preparations, showing the whole development of the more important species and varieties.

By a mere hasty visit to the exhibition-rooms no one will get an idea of the magnificence of the Museum of comparative zoölogy. Neither the building, nor the rooms inside, nor the exhibited objects, will make an especially imposing impression. But the strong point of this institution lies in the peculiar arrangement of the collection for the public, and in the strict separation of the large material for scientific investigations. By the constant development of science, by the improved accessibility of distant continents

and islands, by the investigations of the depths of the ocean, collections of natural history will be enlarged almost to infinity; and it will be harder and harder to place them in our museums, and to preserve them. Everywhere buildings begin to be insufficient; and if we were to stick to the old system, according to which a museum exhibits nearly all its objects, the large central depositories of natural history would grow to an enormous extent. The organization of the Cambridge museum tries to meet equally the demands of

modest existence of a learned man to a materially better-paying occupation. In this respect Europe is still far ahead. Circumstances, however, will change, together with the great development of North America; and in some of the Eastern States an alteration can already be noticed. We must therefore keep our eyes open, if we do not wish the experience of having our young cousins across the ocean outstrip us in a field the thorough culture of which, so far, has been the glory of old Europe.

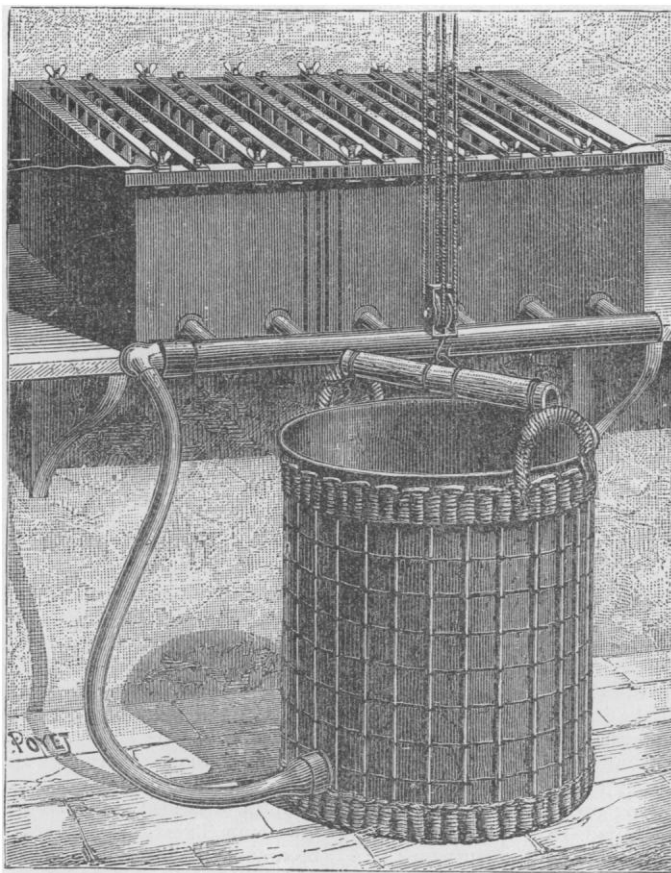


FIG. 3. — Batteries for Tissandier's balloon.

science and the wants of the public which comes for information; and in this sense I have called the Agassiz museum a model museum for the future.

Besides the institutions here mentioned, there are in many other cities of the United States — as Chicago, San Francisco, St. Louis, Cincinnati, Princeton, Baltimore, Charleston, Providence, etc. — smaller museums of natural history. They are almost all supported by societies or schools. There is, therefore, no lack of interest in scientific studies; nor is money wanting. But still the number of those is very small, who, out of pure enthusiasm for science, prefer the

TISSANDIER'S ELECTRIC BALLOON.¹—II.

As we have described our apparatus as a whole, we will now give some details concerning the various parts, and especially concerning the dynamo-electric motor and the bichromate of potassium battery, which was prepared with a view to our experiments.

The motor is a Siemens new model machine, made at Paris especially for us, consisting of a bobbin very long in proportion to its diameter, and mounted on a light wood frame. This machine weighs only fifty-

¹ Concluded from No. 53.