# Scientific American.

ESTABLISHED 1845

MUNN & CO., - - - EDITORS AND PROPRIETORS.

PUBLISHED WEEKLY AT

No. 361 BROADWAY, - - NEW YORK.

*TERMS TO SUBSCRIBERS*

One copy, one year, for the United States, Canada, or Mexico ..... $3.00
One copy, one year, to any foreign country, postage prepaid. £0 16s. 5d. 4.00

*THE SCIENTIFIC AMERICAN PUBLICATIONS.*

Scientific American (Established 1845) ..... $3.00 a year
Scientific American Supplement (Established 1876) ..... 5.00 "
Scientific American Building Edition (Established 1885) ..... 2.50 "
Scientific American Export Edition (Established 1878) ..... 3.00 "

The combined subscription rates and rates to foreign countries will be furnished upon application.
Remit by postal or express money order, or by bank draft or check.
MUNN & CO., 361 Broadway, corner Franklin Street, New York.

NEW YORK, SATURDAY, JUNE 1, 1901.

The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.


## THE NEW EDISON STORAGE BATTERY.

The first authentic account of the new Edison storage battery was presented at the eighteenth annual meeting of the American Institute of Electrical Engineers, held in New York May 21. The paper was read by Mr. Arthur E. Kennelly. It is well known that the history of the storage cell is essentially that of the lead cell discovered by Planté in 1860, in which lead peroxide is the depolarizing substance. An enormous amount of labor has in the aggregate been expended upon the improvement of this cell in the hands of experimentalists. As a result of that labor the storage battery has at last become a recognized adjunct to direct-curent central stations; but it has limitations that seem to withstand further attempts toward improvement. Of late years hardly any success has been met with in the direction of reducing its weight for a given energy-storage capacity without detriment to endurance, and this weight is the great drawback of the storage battery in electric storage battery traction, and has been the principal obstacle to its advance in this direction for the past twenty years. In practice the storage energy per unit mass of the modern lead battery may be expressed as follows: The battery weighs from 124.5 pounds to 186.5 pounds per horse power hour at its terminals. While it is possible to increase the energy per unit mass by making the electrodes very light, this has always been found to be followed by a very heavy deterioration. Many attempts have also been made to perfect storage cells of the alkaline zincate type, but the great difficulty of depositing zinc in coherent form from the solution, as well as the lack of a depolarizer that shall be insoluble in the electrolyte, has stood in the way of this cell's success. Mr. Edison set himself to the task of finding a cell which should possess the following advantages: absence of deterioration by work; large storage capacity per unit of mass; capability of being rapidly charged and discharged; capability of withstanding careless treatment; and inexpensiveness. The negative pole or positive element of Mr. Edison's cell, corresponding to the zinc of a primary cell or the spongy lead of a secondary cell, is iron. The positive pole or negative element, corresponding to the carbon of a primary cell or lead peroxide of a secondary cell, is a superoxide of nickel, believed to have the formula $NiO_2$. The cell is, therefore, a nickel-iron cell, a name which suggests the structural material—nickel-steel. The electrolyte is potash, viz., an aqueous solution containing 10 per cent to 40 per cent by weight, but preferably 20 per cent of potassium hydroxide. In practice with the ordinary storage battery the storage-energy per unit mass of the modern lead battery is from 4 to 6 watt hours per pound of battery; but the storoge capacity of the Edison cell per unit of total mass of steel is 14 watt hours per pound. Expressing the same statement in another way, the weight of the battery per unit of initial energy at the terminals is 53.3 pounds per E. H. P. hour. If the stored energy in the ordinary storage battery available at the terminals were all expended in gravitational work, a battery could raise its own weight to a vertical distance of from 2 to 3 miles. With the Edison battery it could lift its own weight to a vertical distance of approximately 7 miles. The normal discharge period is 3½ hours. The cell may be discharged at a relatively high rate in approximately one hour. Charging and discharging rates are alike. That is to say, the cell may be charged at the normal rate of 3½ hours, or it may be charged at a relatively high rate in one hour with no great detriment beyond a somewhat lower electrical efficiency.

The positive and negative plates are mechanically alike and can scarcely be distinguished by the eye. They differ only in the chemical contents of their pockets. The construction of the battery is fully described in Mr. Kennelly's paper, which is published in full in the current issue of the SUPPLEMENT.

The cell is an oxygen-lift. Charging pulls the oxygen away from the iron and delivers it temporarily to the nickel. The condition is then stable, until the circuit of the cell is completed. The discharge then allows the oxygen to fall back from the nickel to the iron with the natural affinity of iron and oxygen. This action is very different from that which takes place in the lead storage cell. In the new Edison cell the theoretical action of the potash solution is merely to provide the proper channel through which the oxygen ions may travel in one direction or the other—positive plate to negative plate in charge, and negative plate to positive plate in discharge. Secondly, the amount of solution needs only to be sufficient to fulfill mechanical requirements. As regards cost it is believed that the new cells can be produced at a price per kilowatt hour not greater than the prevailing price of lead cells.

## LAST OF THE CABLE SYSTEMS IN NEW YORK.

By the time this issue is in the hands of our readers, the cable system of street traction which has done such yeoman service in New York city will be a thing of the past, and electrical traction will have taken another important step toward that day when it will be the only method of traction employed in the transportation of passengers in New York city. It was just a quarter of a century ago that the first cable road built on this continent was constructed in the city of San Francisco, and the system has fully lived up to the high hopes which were entertained of it when the San Francisco lines were opened. Although subsequent to that date, and prior to the inauguration of the Broadway line in New York city, electric traction had begun to assert itself as a practicable system, it was not at first believed to be equal to the successful handling of the enormous traffic which was certain to be encountered on Broadway at the time the cable line was put in. Even as late as the year 1897, President Vreeland, of the Metropolitan Street Railway Company, stated to the editor that the management of that road considered that the cable was better adapted than electrical traction for handling the extremely heavy traffic of that thoroughfare. An experimental underground trolley line, however, was at that time in operation on Lenox Avenue, and the Metropolitan Street Railway Company was carrying on a course of experiments, which have resulted in the equipment of the whole of their north and south lines with the underground trolley system. The first important thoroughfare to be so equipped was the Fourth Avenue and Madison Avenue line. Following this came the electrical equipment of the Sixth Avenue and Eighth Avenue lines. The results, judged from any and every standpoint, have been so invariably successful (the capacity of the line being enormously increased and the operating expenses reduced) that it was only a question of time when the steel cables would be withdrawn from the conduits and the electric cables put in their place. The preliminary work of installing the necessary manholes, insulators, etc., was done last year; and now, with a very brief interruption to traffic, the cable cars have been withdrawn, and the standard electric cars of the company placed on both the Lexington Avenue and Broadway systems. New York city now stands at the very front of the great cities of the world in the matter of rapid, cheap, and convenient street railway service.

## OPENING OF THE PAN-AMERICAN EXPOSITION.

The opening of the very complete and altogether beautiful Exposition at Buffalo was marked by several features which render this Exposition unique among the many which are being conceived and carried out with ever-increasing frequency—a frequency which is, in itself, a striking sign of the commercial activity and development of our times. Among the features which entitle this latest effort to distinction are the fact that in conception and execution it is practically the work of a single city; and that in the combined harmony and strong individuality of its grounds and buildings it surpasses any like undertaking that preceded it. Moreover, the Exposition, which was so happily dedicated on the 20th of May, acquires distinction from the fact that there is about its aims and purposes a definiteness which has been lacking in some of the expositions, large and small, which have recently been held.

The proposal to make the Buffalo Exposition distinctly Pan-American seems to have appealed from the very first to the country at large, and to the many republics which are embraced under the comprehensive name adopted. The United States government gave practical proof of its indorsement by an appropriation of $500,000, and emphasized its approval by the statement: "It is desirable to encourage the holding of a Pan-American Exposition on the Niagara frontier, in the city of Buffalo, fittingly to illustrate the marvelous development of the Western Hemisphere during the nineteenth century by a display of arts, industries, manufactures and the products of soil, mine and sea." Invitations were extended by the national government to the various governments of the Western Hemisphere, from Canada on the north to the Argentine Republic on the south. The handsome assistance of the national government, and the hearty and ready co-operation of the governments of the Western Hemisphere found a quick response from the citizens of Buffalo. The matter was taken in hand with such thoroughness that the necessary funds, estimated at $10,000,000, for the larger scope which the plans of the Exposition thereupon took on, were readily forthcoming. New York State appropriated $300,000 and other appropriations, ranging from $75,000 by Illinois to $10,000 by North Dakota, were voted by the various States, with the result that the sponsors of the Exposition were enabled to plan the grounds and buildings on a scale, and with an architectural beauty and finish, which entitle it to rank as one of the largest, and as many will think, the most harmonious and beautiful display of the kind ever attempted. Before leaving the question of finance and management, it is only just to say that the successful carrying out of such an ambitious scheme is the highest possible tribute to the energy, the resourcefulness, and the great public spirit of the citizens of Buffalo and the western section of New York State.

A fact which has contributed largely to the success of the Pan-American Exposition was the timely recognition on the part of the committee in charge of the planning of the grounds and buildings, that both the landscape treatment and the architectural and sculptural elements of the Exposition should be made as highly distinctive and characteristic as possible. Since this was to be an American exposition, it was decided to plan the buildings so that they should be strongly suggestive of the architecture of the new world. At the same time, realizing that in the aptly-named "White City" at Chicago the possibilities of treatment entirely devoid of color had been perhaps exhausted, it was decided to give a general color treatment to the whole group of the Pan-American building as such. The preparation of plans along these lines was intrusted to a board of architects whose work can be appreciated only by a visit to the Exposition itself.

In planning the Exposition the board were favored by the fact that they were not cramped for room. The ground at their disposal being of generous proportions, and of a fairly rectangular shape, they did not have to conform the layout of the buildings and the ornamental features of the ground to any hard-and-fast, predetermined lines. The grounds are about one mile in length and half a mile in width. At the Buffalo end the landscape features are greatly enhanced by two large lakes of water, surrounded by gently sloping and richly wooded grounds, in which are to be found the two permanent buildings of the Exposition—one the Albright Art Gallery and the other the New York State building. Both of these are built of gray-white marble and are classically treated. Passing down through the center of the Exposition grounds, entrance is made to the magnificent approach to the Exposition buildings; and here one has to admit, even with the beauties of the Paris Exposition of last year fresh in mind, that the present effort is more successful, not merely in one, but in every element of its landscape and architectural effects. As the eye ranges down through the long perspective of the Fore Court, the vast Esplanade with its accommodations for a quarter of a million people, the Court of Fountains and the Grand Basin, until it rests upon the stupendous pile of the Electric Tower, which last may truly be called the dominating feature of the whole Exposition, one feels that there is a pervading harmony and proportion which has too often been wanting in displays of this kind. Particularly happy is the way in which the water effects have been worked in among the assembled buildings, whether in the way of winding canals, or broad, placid lakes, or laughing fountains. As one wanders from plaza to courtyard, from courtyard to boulevard, one has a feeling that everything is just about where it should be, that nothing could be omitted without a sense of loss, nor added without a sense of crowding and over elaboration. Amid so much successful treatment, it is difficult to select any feature for special mention; but no doubt there will be a consensus of opinion that the bridge between the Fore Court and the Esplanade, and the Electric Tower with its grandly curving wings springing sheer from the clear waters of the Grand Basin, are two of the most striking among the many beautiful effects which distinguish the Exposition.

Dedication day was a pronounced success, both in respect of the large attendance, which was over 101,000, and the high character of the addresses which marked the opening ceremonies. As was natural, the keynote of the speeches was to be found in the name which is borne by the Exposition. It was certainly pardon-

able that "America for the Americans" should have been the burden of the addresses; and it was natural, in view of the astonishing progress which has marked the closing years of the old and the opening year of the new century, that there should be an undertone of conviction, sometimes spoken and at all times suggested, that the center of wealth and civilization was finding its way by the inevitable operation of economic and ethnical laws from the Old to the New World.

## HIGH-CLASS WORK AT OUR NAVY YARDS.

The successful withdrawal of the damaged gun of the "Kearsarge" and the substitution of a new gun in its place, as carried out at the navy yard, Brooklyn, is another evidence of the high state of efficiency to which this yard has been brought in the past few years—an efficiency, we are happy to say, which, as far as the personnel is concerned, whether in the office or the shops, can be matched at any of the other yards of the navy. From the illustrations and description of these repairs which are given elsewhere in this issue it can be understood that the problem presented was as unprecedented as the method of its solution was ingenious and skillful. We are informed by Naval Constructor Capps, who is now filling the position at the yard vacated by Rear-Admiral Bowles on the latter's recent appointment as Chief of the Bureau of Construction and Repair, that much of the credit for this work is due to the intelligence and skill of the workmen and the great interest which they showed in the successful carrying through of an admittedly difficult job. By the same authority we are assured that his experience of the work and methods at both private and government yards justifies him in saying that results at our naval yards are to-day not merely equal but superior to those secured at the civil establishments. It was not always thus; and the present satisfactory condition of things is to be attributed largely to the emancipation of our navy yards from the last vestige of political control.

## THE "FACTOR OF SAFETY" IN "SHAMROCK."

BY OUR ENGLISH CORRESPONDENT.

In the designing of previous challengers for the "America" Cup, Mr. George L. Watson has always been held more or less in check by considerations of cost. On this occasion Sir Thomas Lipton gave him an absolutely free hand in the spending of money, and this is probably the reason why so much experimental work has been done in connection with "Shamrock II." The elaborate tank tests by which the shape of the hull was determined were only the beginning of the experimental work done in connection with the yacht. Sections of every tubular spar, and of every bit of wire used for rigging, were taken and tested to destruction before the weight of materials was fixed. In deciding upon these weights the margin left for safety was of the smallest, and the result brought disaster in the first three or four trials sailed.

The first time she was under canvas in anything of a breeze brought out an abnormal stretch in the running gear and rigging, and the strain of bobstay and jib halyards on the bowsprit end found a decided weakness in the butts in which the heel of the bowsprit is set. They started from the deck, and before she could be brought out again a collar had to be fitted taking in the bowsprit heel and bracing it to the stemhead. When these things were made good she was started again, and this time she caught a shrieking squall which put her to rather a severe test. Again it was demonstrated how small has been the margin allowed for safety; for though the squall was nothing worse than might be expected, even in summer weather, it left her lying helpless like a crippled seabird. It is said that trouble started as she drove before the wind with the breaking of one of the backstay blocks. The boom was square off and one backstay was, of course, slacked away. When the other stay broke the mast whipped like a fishing rod, and it looked for a time as if every spar was going overboard. The mast stood, but the gaff broke short off. The topsail yard was a hollow wooden spar made for "Valkyrie III." and would probably have stood well enough had the gaff held. The gaff was, however, built of steel plates only three-sixteenths of an inch thick, and the jerk of the mast was fatal to it. Discussing the accident afterward Sir Thomas Lipton stated, wisely enough, that if these things were too weak for racing strains, it was better that they should go then than in the actual contest. There is much good sense in this view; but the fact that so many accidents happened in weather which cannot be called abnormal proves how much Mr. Watson has sacrificed to the saving of weight. It has been a commonplace saying with British yachtsmen that the principal factor aiding the Americans in their successful defense of the cup has been the three thousand miles of ocean which divides Great Britain and Sandy Hook. One of the lessons of the trials has been to show that in the building of the latest of the challengers little has been conceded to the demands of the passage. Had the yacht carried any handicap, in the shape of extra weight thrown in to strengthen her for the ocean passage, it is not likely that she would have developed so many weaknesses during the trials.

[The truth of our correspondent's estimate has received a dramatic indorsement in the most unfortunate wrecking of the "Shamrock" by a sudden squall in the Solent. He is right, moreover, in showing that it is not the *dangers* of the Atlantic passage that handicap the challenger so much as the *delay*—the loss of that invaluable time for tuning up, which enables a "Columbia," for instance, though beaten at the start of the season by a "Defender," to beat the older boat by ten minutes before the tuning-up process is over.

For the first time in the history of the races the English yachtsmen have had a good start and a trial boat; but this accident will rob them of all opportunity for tuning-up trials, unless Sir Thomas Lipton is given a sufficient extension of time to compensate him for the delay. The New York Yacht Club has an excellent opportunity to extend a sportsmanlike favor to a gentleman whose sportsmanlike ways have strongly commended him to the American public. There is a further reason for the extension in the fact that the end of August is a most unfavorable time for a contest, and the beginning of October will probably provide better cup-contest conditions than the date at first agreed upon.—ED.]

## THE HEAVENS IN JUNE.

The most conspicuous object in the sky during the short June nights will be Jupiter, low in the southeast and south, with Saturn, much less bright, a short distance to the east. The two planets are now moving slowly to the west among the stars in their retrograde motion, and, in consequence of the more rapid motion of Jupiter, are slowly separating. By September the retrograde motion will have ceased, and the two planets will be moving eastward with gradually increasing speed. Jupiter, making the eastward circuit of the heavens in eleven years, will overtake Saturn, moving much more deliberately eastward, in a period of thirty years; and at the end of November will pass by, nearly a moon's diameter to the south.

That Jupiter is much brighter than Saturn, several times as bright, indeed, is evident. But to estimate with any approach to the truth the number of times as bright, without instruments of measurement to assist the vision, is something quite beyond human psychology. In fact, even the measures are not so accurate as might be desired, when the photometer is introduced to suppress a measured percentage of Jupiter's light, so as to have the image seen by transmitted portion, varied at will, to be adjusted equal to the undiminished image of Saturn.

The brightness of either planet varies considerably from time to time. The planet is sometimes a little farther from the sun than the average, and so is less strongly lighted by the central luminary, on whom he is entirely dependent for the light he sends out. He is somewhat nearer to the earth when both are on the same side of the sun, and so he looks a little bigger (in the telescope) and seems a little brighter than when they are on opposite sides of the sun. And in the case of Saturn the splendid ring may be edgewise toward the earth, when, on account of its excessive thinness, the light from it is substantially *nil*; or the ring may be turned up toward us at such an angle that its apparent short diameter is half its long diameter, in which case the ring gives fully as much light as the ball of the planet.

Assuming that the reflecting power of the surface of Saturn is equal to that of the surface of Jupiter, the theoretical ratio of their brightness is readily calculated. Taking the planets as now situated, the distance of Saturn is almost double that of Jupiter, so that, in accordance with the law of inverse squares, a unit of surface on Saturn would receive from the sun scarcely more than a fourth as much as a unit of surface of Jupiter; the distance of Saturn from the earth is a trifle over double that of Jupiter, so that if Saturn's actual radiation were equal to Jupiter's he would seem from the earth to be scarcely a fourth as bright. Of the sun's radiated light, then, Saturn renders to the earth one-sixteenth as good an account per unit of surface as Jupiter. As the diameter of Saturn is 70,000 miles, and that of Jupiter 86,500, the ratio of their surfaces is about as two to three, which would give for the light from the ball of Saturn about one-twenty-fourth, or 4 per cent, of the light of Jupiter. The light from Saturn's ring, which is now only beginning to recede from its widest open position, may be taken equal to that from the ball, so that the total light from Saturn should be, if the reflecting power of the surfaces of the two planets is equal, 8 per cent of the light from Jupiter. That the surface-reflecting power is the same in the two cases seems not to be quite true; photometric measures of the brilliancy of two planets, carefully taken, and compared with their theoretical brilliancy, indicate that the surface of Jupiter reflects about 60 per cent of the light received, and the surface of Saturn about 70 per cent. Perhaps it would be safe, at the present time, to take the brightness of Jupiter to be ten times the brightness of Saturn.

After their opposition to the sun in July both will decline a little in brightness, Jupiter a little more than Saturn.

Aside from the ring of Saturn, which is absolutely unique, the two planets are much alike. They are much larger than any of the other planets of the solar system. They both have a very low density, Jupiter a little more, Saturn a little less, than water. Both are brighter at the center than at the edge, and both have belts as their chief surface markings. Both rotate in about ten hours. Their spectra are very similar, giving strong atmospheric indications. On Jupiter at least the movements of the numerous spots are incompatible with a solid surface such as the earth's, while presumably Saturn's surface is similarly mobile; indeed, some suspicion exists that possibly there may be nothing of a true solid about either planet, even at the center.

### THE PLANETS.

Mercury will be visible the entire month, just after sunset, near to the horizon, a little north of west. This will be an unusually good opportunity to look at the innermost planet, which so few people have ever seen; in fact, in spite of the smallness of the area of the eclipse track of May, 1900, probably many more people saw Mercury, then close to the sun's corona, than have seen him the world over for the last ten years. Venus will be far enough away from the sun after the middle of the month to be comfortably seen; and at the end of the month will begin to be a good evening star, with Mercury a few degrees to the south. Mars will be seen in the west in the evening, having decreased in brightness so much as to be no longer conspicuous. Jupiter and Saturn will rise about dark and will be prominent objects the entire night, low in the southeast and south. Uranus will be visible to the unassisted eye as a very faint star about ten degrees east of the bright star Antares.

### THE CONSTELLATIONS.

Bootes will be overhead in the early evening, with Arcturus the most conspicuous star. Virgo will be in the southwest, and Scorpio in the south, the long curving line of stars of the latter stretching down from Antares being readily traceable on nights when the haze will permit. Ursa Major, with the big dipper conspicuous, will be in the northwest, rather high up. Aquila will be coming up in the east, and Lyra and Cygnus in the northeast. This portion of the heavens, while not very brilliant, is still a great improvement on the very dull constellations of the spring months.

## SCIENCE NOTES.

Dr. Franz Melde, professor of physics in the University of Marburg, died recently.

Dr. William Jay Youmans, for many years the editor of the Popular Science Monthly, died April 10. He established the monthly in 1875.

A new form of sealing wax has recently been devised. It differs from the ordinary stick wax in that it is inclosed in a glass tube, from which it may be poured by heating the cylinder.

The St. Louis World's Fair, which is to celebrate the centennial of the Louisiana Purchase, may be said to have made a beginning by the passage of an ordinance by the city of St. Louis authorizing the issue of $5,000,000 in bonds. Congress may appropriate an equal sum at its next session.

The Peary Arctic Club has chartered for its work this summer the steamer "Erik," which was recently purchased from the Hudson Bay Company. The cruise of 1901 is the fourth of the series under the direction of the club to assist Lieutenant Peary. The "Erik" will sail from Sydney about the middle of July, and will return about two months later with full details of what has transpired in the two years since Peary has been heard from.

The eclipse expeditions report varying success in the observation of the eclipse on May 18. At Singkel, Sumatra, Prof. Todd reports that while the weather was good the sky was cloudy, and during the total eclipse of the sun no instruments could be operated except the polariscope and the X-ray apparatus. Six auxiliary stations were established on adjacent islands within 33 miles, and three of them showed a clear eclipse. No shadow bands were seen and the corona was invisible. President Pritchett, of the Massachusetts Institute of Technology, received a cable message from Prof. Burton, in charge of the Technology eclipse party, announcing that important results had been obtained. The weather was cloudy during a portion of the eclipse, but all four contacts were observed and a brilliant corona was shown at totality which lasted nearly six minutes. Photographs were obtained. The most interesting and novel work of the party consisted in the observations obtained photographically of the shadow bands.