

tardy, and the rate of fire only about once a minute; but the gun is excellently constructed, and has very fine ballistics. It weighs 20 tons, fires a 250-pound projectile, and has velocities up to 3,000 foot-seconds, though the service velocity is lower than this. Its service penetration is about 8 to 9 inches of Krupp armor at 3,000 yards. The new 7-inch is the United States gun it most nearly resembles in power; but its energy is better on account of the heavier projectile.

The 6-inch rapid-fire is of 45 calibers, and fires shell of both 111 and 88 pounds weight. The service velocity is 2,460 foot-seconds, and the weight of the gun about 7 tons. It is nominally equal to 6 inches of Krupp armor at 3,000 yards. Its rate of fire is moderate. In the latest ships it is mounted in a completely circular shield inside the casemate. The "Czarevitch" carries this gun on a twin mounting, as do the "Poltava" class. This mounting has given very satisfactory results as such mountings go. They always leave something to be desired. The 4.7-inch is a piece of 45 calibers about on a par with corresponding pieces in other navies.

All these guns have the Schneider-Canet breech mechanism, which is not equal to the Welin for rapidity, though less liable to derangement. A Russian innovation is a carrier below the breech block, so that when the latter is opened, its weight is not thrown on the hinges. The mounting details and rifling follow the Canet system.

Most Russian ships have electric hoists. Their guns all use nitro-cellulose smokeless powder. The projectiles are capped armor-piercing shell, and common shell. No solid shot is used, as the Russians claim to find their capped armor-piercing shell equally penetrative. High explosives are not yet introduced. Fuses are the weak point in Russian gunnery.

Newspaper reports have made the aiming very bad; but enough account was not taken of the range at Port Arthur. There are some very good shots in the Russian fleet, and the average gunnery officer is efficient. He is able, and often acts as captain of a gun, as do other officers. Where the Russian fleet came to grief was in the fact that gunnery was totally neglected by Admiral Stark, who devoted his time to battle evolutions of the parade ground type.

In conclusion, mention may be made of a few other guns in the Russian service. A 9-inch piece exists in some small coast defenders and armored gunboats. It is an obsolete gun, of which little is known and still less is worth knowing. There is also an old 8-inch in the "Rossia" and "Rurik." It is 35 calibers long, and its highest velocity is 1,922 foot-seconds. Its penetration is poor and its firing slow—it is less penetrative, in fire, than modern 6-inch guns.

#### THE MOTHER OF EXHIBITIONS.

BY HERBERT W. HORWILL.

In the centuries before the nineteenth, the nearest approach to an international exhibition appears to have been the Frankfort fairs of the sixteenth century. Henry Estienne, the scholar, describes this institution as "the epitome of all the markets of the world." But it is from an event within the memory of many persons now living that the fairs at Philadelphia, Chicago, Buffalo, and St. Louis trace their genealogy. The mother of all such displays was the exhibition held in London in 1851. This was itself an outgrowth of a series of exhibitions of art manufactures held by the Society of Arts, at the suggestion of its secretary, Mr. F. Whishaw, from 1847 to 1849. These consisted merely of a collection of articles made in the British Isles; and the Prince Consort, who was president of this society, improved on the experiment by making the bolder proposal that there should be brought together an exhibition representing the skill of the whole of the civilized world. It is surely one of the curiosities of history that such democratic institutions as these exhibitions are considered to be should have owed their impulse not to any popular movement whatever, but to a suggestion that came from Buckingham Palace, and that needed all the weight of royal influence to overcome the obstacle of popular indifference and opposition.

On June 30, 1849, the matter was laid before a meeting of the Society of Arts called by the Prince Consort at the palace. On October 17 of the same year, the leading bankers and merchants in the city of London were consulted. On January 3, 1850, there was taken the important step of the appointment of a royal commission to be responsible for managing the venture. Its members were Henry Cole (afterward secretary of the Science and Art Department), C. W. Dilke (father of the present baronet), Robert Stephenson, and Digby Wyatt. One of its secretaries was Stafford Northcote, distinguished later as a cabinet minister and Conservative leader in the House of Commons. Northcote's exertions in connection with this project did much to bring on the physical weakness which afterward lessened his effectiveness as a statesman. The exhibition also owed much to Lyon Playfair, the scientist, whose biography shows that at one time his tact prevented the whole undertaking from coming to grief. Playfair's special skill was in organization and in the ap-

plication of scientific discovery to industrial improvement—talents which found special opportunities of exercise in this connection.

The scheme was fully launched on March 21, 1850, at a Guildhall banquet to which the Lord Mayor invited the chief officers of state, the foreign ambassadors, and the mayors of the provincial towns. The principal speaker was the Prince Consort himself, who asked their co-operation in the attempt "to give the world a true test, a living picture, of the point of industrial development at which the whole of mankind has arrived, and a new starting point from which all nations will be able to direct their further exertions." The reception of the proposal at this dinner was gratifying, but to obtain the active assistance of those whom the guests represented was a wearisome task. The forces of old-fashioned Toryism in Parliament, and the press, deliberately set themselves to ruin the whole thing. The most violent opponent in the House of Commons was a certain Col. Sibthorp, who especially feared the demoralization of the national character that would ensue from the visit to England of a large number of persons from the Continent. "Take care of your wives and daughters; take care of your property and your lives," was the warning he passionately and sincerely addressed to his fellow countrymen. The Times was dead against the plan, and Punch did its best to turn it into ridicule. In one of Leech's cartoons the Prince Consort was represented as "The Industrious Boy," holding out a cap on which was inscribed, "Please remember the exposition."

As the various details of the scheme developed, its opponents attacked them in turn. There was, for instance, the question of the site. The government first offered the area included in Somerset House, but this was obviously much too small for anything on the scale projected. The Prince suggested Hyde Park. An outcry arose against the spoiling of one of the most delightful spots in the metropolis. A petition sent to the House of Lords against the use of the park received the support of Lord Brougham, and a resolution to the same effect was introduced into the Lower House also. In a letter of the Prince's to Stockmar, dated June 28, 1850, he says: "The exhibition is now attacked furiously by the Times, and the House of Commons is going to drive us out of the park. There is immense excitement on the subject. If we are driven out of the park, the work is done for. Never was anything so foolish." In a letter to the Duchess of Kent, dated July 4, there is a similar reference, from which it appears that the opposition party were urging that if such a nuisance must take place, a site should be found for it in the Isle of Dogs—a dismal swampy region further down the river, occupied to-day by the West India and Millwall docks. Happily, on the same date as the second of these letters, the Parliamentary opponents of the Hyde Park site were defeated in a division, and that difficulty was overcome.

Then came the problem of finance. In view of the strength of the antagonism to the scheme, the Prince wisely forbore making any attempt to secure an appropriation from Parliament, and trusted entirely to the public spirit of his supporters. Mr. Samuel Peto, with his partners in the well-known banking firm which bore his name, led the way on July 12, 1850, by the offer of \$250,000 to a guarantee fund. Ultimately the actual subscriptions toward the cost of the exhibition amounted to \$375,000, and the guarantee fund to \$1,000,000. The undertaking was so entirely experimental that there was no knowing whether the whole of this sum would not be required to meet the cost.

Both site and money having been obtained, the way seemed clear for the prosecution of the work. But just at this point the commission was confronted by one of the most puzzling situations in the history of the movement. In what kind of structure should the exhibits be housed? Out of two hundred and thirty-three plans submitted, not one appeared satisfactory. Each of them contemplated the erection of a huge brick building, which would have justified all the protests that had been made against the defacement of the park. At the last moment light came, not from a professional architect, but from a gardener. Joseph Paxton, whose solution of this problem made him famous, was the son of a Bedfordshire farmer. In his youth he drifted from place to place in pursuit of his occupation as gardener. In 1826, at the age of 25, he was on the point of emigration to this country, as his earnings were only eighteen shillings (four and a half dollars) a week; but he happened to attract the attention of the Duke of Devonshire, who made him superintendent of the gardens at Chatsworth. Later he was promoted to be responsible for the woods and forests on the estate also. In 1840 he completed the erection of the Chatsworth Conservatory, the largest of the kind hitherto constructed. One day, while waiting for his train at a railway station, and reflecting upon the difficulty of the exhibition commissioners, he was suddenly struck by the idea that an adaptation of the conservatory system would get them out of their *impasse*. Sitting at the table of the waiting room, he hurriedly sketched on a piece of blotting paper a rough outline of a build-

ing, and within nine days completed a set of plans which were immediately accepted. The essential feature of his scheme was that the structure should be, not of brick, but of glass and iron, with the exception, of course, of the flooring and joists.

Paxton's plans were accepted on July 16, 1850. The actual building operations commenced on September 26. The contractors were Messrs. Fox and Henderson, to whom it was agreed to pay \$399,000, or \$750,000 if the building was retained as a permanency. The exhibition structure, which covered eighteen acres, was in the form of a parallelogram 1,851 feet (corresponding to the number of the year) by 408, with a projection on the north 936 feet long. Col. Sibthorp's kindly prayer that lightning or a hailstorm might destroy the building while in course of construction was not answered. By New Year's Day it was complete, and was handed over to the commissioners.

What especially impressed the imagination of those who inspected the building was the sight of giant elms, former ornaments of the park, which rose toward the roof without any more obstruction than if the space on which they stood were still uncovered. On February 12, 1851, the building was opened to exhibitors for the reception of their goods.

Even when this stage had been reached, the malcontents had not all been converted. From a letter of the Prince Consort's as late as April 15, it appears that there were predictions that foreign revolutionists would use the opportunity to upset the monarchy and establish a republic, and that the confluence of so great a multitude would cause an outbreak of plague. The apprehension was as great in some circles on the Continent as in England. Mr. Sidney Lee, in his biography of Queen Victoria, notes that the wish of the Queen and her husband that all national rulers or their representatives should be their guests on this occasion, had to meet the fear of many foreign sovereigns lest the assembly of several crowned heads in one place should be an incitement to the attempts of conspirators. It was with great difficulty that the Prince of Prussia was persuaded to accept an invitation to be present with his son. The Prussian minister in London wrote home that a number of madmen had already assembled, and intended to work irretrievable disaster by interrupting the succession to the Prussian throne. Lord Granville suggested to the diplomatic colony in London that on the opening day they should present an address to the Queen in recognition of the fact that the object of the exhibition was not purely British, but international, but they declined to do so.

The opening ceremony on May 1, 1851, was naturally awaited with the greatest anxiety by the promoters of an undertaking which had been regarded with so much doubt in some quarters and open animosity in others. It was a brilliant success. One of the most interesting descriptions of the event may be read in the "Letters of Dean Stanley." He speaks of what happened immediately the public were admitted as "one of the most ridiculous scenes I ever saw." Nobody stayed to look at a single exhibit, but everyone made his way, first at a trot and then at a full gallop, to the transept, where the Queen was presently to appear and declare the exhibition opened. As the crowd entered from several doors on each side of the building, this throng converging at racing speed upon the center must indeed have provided a comical spectacle to those who were not in too great a hurry to look around them. The opening ceremony itself was dignified and impressive. In all the assembly the persons to whom the success or failure of the exhibition meant most were the Prince Consort, by whose initiative it had been undertaken and who had staked upon it his influence in the country; and the Queen herself, so closely affected as she always was by everything that concerned the welfare or honor of her husband. It is little wonder that Stanley describes her as flushed with a kind of excitement he had never witnessed on any other human countenance. Never before, too, says Stanley, had he seen her look so thoroughly regal. Still possessing a youthful capacity for a quick response to outside impressions—for she was then only in her thirty-second year—she spoke of it afterward as the proudest and happiest day of her life. No disaster or even disturbance marred the celebration. There were 25,000 persons in the building at one time, and 700,000 lined the route of the royal procession between the exhibition and Buckingham Palace, yet there was not one accident or police case.

The tide of public opinion had now turned. In the reaction, forecasts of revolution and disorder were succeeded by the most extravagant forecasts of millennial peace, which would directly result from the friendly meeting of citizens of many nations. How was it possible that those who had thus learned to associate in the gentle rivalry of invention and industrial skill could ever again draw the sword against one another? The Crimean war, three years afterward, was the answer to these imaginations, to say nothing of later conflicts which have embroiled in deadly struggles almost every leading power represented at

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## THE MOTHER OF EXHIBITIONS.

(Continued from page 419.)

this festival of amity. In all parts of England itself the exhibition aroused intense enthusiasm as long as it remained open. One reads, for example, of an old Cornish woman who had trudged on foot three hundred miles from her native county to see the wonderful palace of glass. The feeling of London showed itself at a ball given in the Guildhall, when the passage of the Queen and the Prince Consort through the city was made the occasion of the most jubilant demonstrations of loyalty, even on the return journey, though it was as late as one o'clock in the morning.

On October 15 the Prince Consort declared the exhibition closed, and the awards were published. The fair had been divided into four great departments—raw materials, machinery, manufactures, and fine arts—and these were subdivided into thirty classes. One-half the space had been allotted to England and the colonies, and one-half to foreign countries. There were 17,000 exhibitors, of whom 2,918 received prize medals and 170 council medals. The estimated value of the articles exhibited, exclusive of the Kohinoor diamond, was \$8,909,645. During the 144 days during which the exhibition was open, there was a total of 6,170,000 visitors. The largest number entering in one day was 109,760 (on October 8), and the largest number present at one time was 93,000 (at 2 o'clock on October 7). Haydn's "Dictionary of Dates" is responsible for the statement that the latter is the largest number of persons recorded in history to have ever been present at one time in one room, though larger crowds have assembled simultaneously in the various buildings of other exhibitions and in the open air.

Long before the final accounts came to be made up, it was evident that there would be no tax upon the guarantors. The amount paid for admission was \$2,525,535. After all expenses had been met, this left a surplus of \$1,066,525. There was much discussion as to what should be done with it, for such a result was so unexpected that no provision had been made for it in the original scheme. Some advocated that it should be spent upon a winter garden; but others, notably the Prince Consort, thought it would be an anti-climax to connect with a mere place of amusement the memory of an exhibition which had been a landmark in the history of industrial art. The wiser counsel prevailed, and the money went to form the nucleus of what was afterward known as the South Kensington Museum, an institution which has been not only a permanent collection of valuable exhibits, but a center of artistic and scientific education throughout the British Isles.

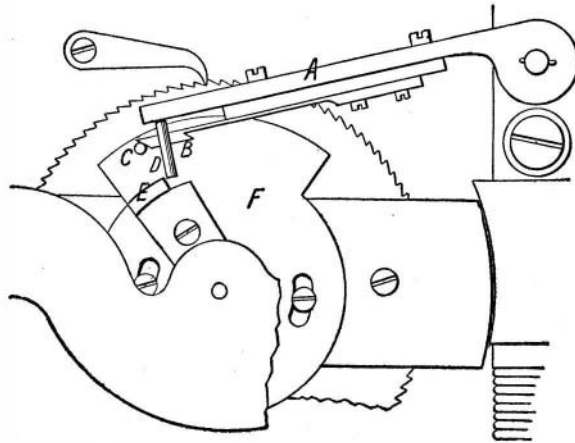
And what was to happen to the actual building? Some who had at first vehemently opposed the desecration of Hyde Park by any such monstrosity, were now eager that it should remain forever where it was. This plan, however, was not generally thought to be expedient. On December 1 the building was surrendered to the contractors, who sold the materials for \$350,000 to a company which proceeded to re-erect it on the top of a hill in the suburb of Sydenham. The services of Paxton, who had received the well-deserved distinction of knighthood, were brought again into requisition, but this time the work was carried out in more leisurely fashion, for it was not until June 10, 1854, that the transplanted building was opened on its new site. From that time until the present the "Crystal Palace," as it came to be called, has been well known to every Londoner and every visitor from the country. It has been especially noted for its musical festivals, and has many times recalled the memories of its original function by affording a home for exhibitions, generally of some special scope, as bicycle shows, chrysanthemum shows, etc. A notable occasion was a service held on the fast day for the Indian Mutiny, when Mr. Spurgeon preached to a congregation of 23,000 people.

In cost, size, and number of visitors the exhibition of 1851, though spoken of at the time as "the Great Exhibition," appears small in comparison with such an enterprise as the St. Louis Fair. But no successes of later undertakings in the same line can rob the promoters of the Hyde Park project of the distinction that belongs to the pioneer. On the other hand, the very expansion of the international exhibition movement is itself the greatest possible tribute to the wisdom and courage of those who made the strange idea familiar. And, as Mr. Justin McCarthy has put it in his account of the event in the "History of Our Own Times," although later exhibitions have been far superior, "the impression which the Hyde Park Exhibition made upon the ordinary mind was like that of the boy's first visit to the play—an impression never to be equaled, no matter by what far superior charm of spectacle it may in after years again and again be followed."

The largest producer of sulphur is Sicily; its deposits occur in Miocene limestone, with unaltered beds of gypsum below, and it exported in 1903 475,508 tons, of which nearly one-third was for the United States.

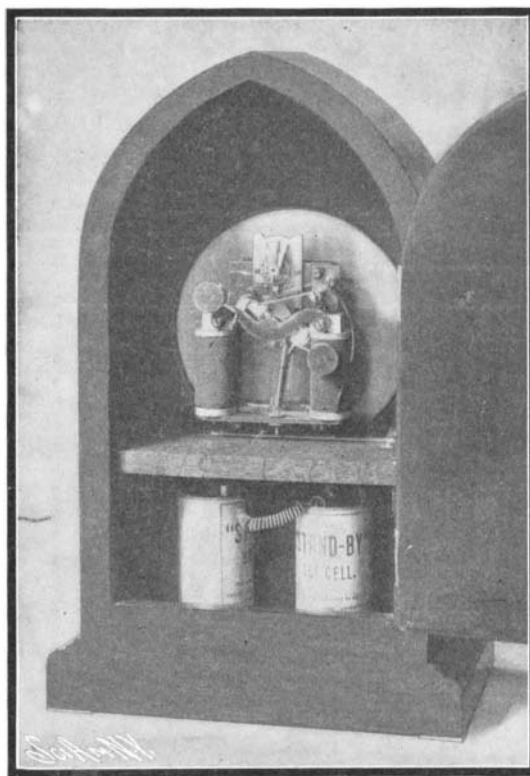
## AN ELECTRICALLY-OPERATED CLOCK.

It is the usual practice in clocks driven or wound by electricity to arrange the pendulum to make the electric contact at regular intervals; but heretofore great difficulty has been found in keeping the contact points bright and clean, owing to excessive sparking on breaking the circuit. The clock which we illustrate herewith is so designed as to entirely overcome this defect, and, furthermore, is so constructed as to reduce friction of the parts to a minimum—a prime requisite in all electric clocks. As a result of embodying these two features in this movement, but little current is required to operate it, two small dry cells being amply sufficient to keep the clock running for three years without renewal. The improved electric clock comprises an electro-magnet, between the poles of which



POSITIVE CONTACT FOR ELECTRIC CLOCK.

an armature is pivoted to swing. A pawl attached to this armature engages a ratchet wheel connected with the gear train of the clock, and a spiral spring attached to the armature near one end serves to draw it slowly out of line with the magnet poles, thus operating the clock movement. The latter may be regulated either by a balance wheel or a pendulum escapement, as desired. Electric contact is made at the end of every six minutes, the current serving to energize the magnet and draw the armature back to horizontal position against the tension of the spiral spring. The contact is made by means of a very efficient arrangement which is shown in our detail view. One terminal, *E*, consists of a metal segment which is carried on a plate, *F*, secured to the armature. The other terminal, *D*, consists of a pin which is secured to a swinging arm, *A*. Fastened to this arm, but insulated therefrom, is a flat spring provided at its free end with a



CLOCK WOUND EVERY SIX MINUTES BY ELECTRICITY.

head or cam, *B*, adapted to engage a pin, *C*, on the plate, *F*. The ends of the cam, *B*, are beveled, as illustrated, so that when the armature moves away from the poles, the cam will ride over the pin, *C*, lifting the contact pin, *D*, out of engagement with the segment, *E*. When the pin, *C*, passes the inner end of the cam, the pin, *D*, will drop onto the segment, *B*, completing the circuit through the magnet coils and causing the armature to swing back, and the cam then riding under the pin, *C*, will press the terminal, *D*, down against the segment, *E*, insuring a perfect contact. During the fraction of a second which is taken up by the armature in swinging to horizontal position, the clock movement is actuated by a second spring, not shown in our illustration, which is put under tension by the movement of the armature. The striking mechanism of

the clock is actuated by another spring which is wound up by the movement of the clock hands. The form of the main spring, that which acts on the armature, is quite novel in construction. Due to its spiral form it does not lose its elasticity as rapidly as the usual type of clock spring, particularly since its extension is very slight compared to its length. By means of a thumb-screw adjustment at its lower end, its tension may be very accurately regulated. Mr. Max Moeller, of 73 Palmaille, Altona, Elbe, Germany, owns the patents on this improved electric clock.

## The Scientific American in the Schools.

It is pleasing to know that the SCIENTIFIC AMERICAN is widely read in schools. We have recently been favored with a circular issued by the Superintendent of the Whitinsville, Mass., schools, which says: "A friend of the schools has been gratified at finding the names of so many pupils on the honor roll for the past year. He most thoroughly believes that one of the best lessons to be learned in the schools is that of punctuality and regularity; after the habit of honesty and truthfulness in word and deed, and earnestness and thoroughness in doing, no habit of greater value can be formed in youth than that of fulfilling our duty at the appointed time. In recognition of your faithful attention to this duty of regular attendance, a year's subscription to your choice of one of the periodicals named on the inclosed card will be sent you if you will mark, sign, and return the card." One of these circulars was sent to every pupil on the honor roll. It is gratifying to note that ten of the pupils selected the SCIENTIFIC AMERICAN in place of papers which deal with lighter subjects. The SCIENTIFIC AMERICAN should find its way into every schoolroom.

## The Current Supplement.

Two striking pictures with a brief article on the Craig-Goch Dam, Birmingham, England, open the current SUPPLEMENT, No. 1482. Rear Admiral John Lowe presents a solution of the problem of the screw propeller which will doubtless be of interest to naval engineers. "Oil from Livers of the Cod and Related Species" is the title of a treatise by Charles H. Stevenson, whose articles on the fish industry of this country will doubtless be remembered by readers of the SUPPLEMENT. The English correspondent of the SCIENTIFIC AMERICAN describes in a very exhaustive manner the method by which the Duddell oscillograph records alternating-current wave-forms. The recent architectural discoveries at Pompeii are made the subject of an interesting account. To those who are not familiar with the fine instincts of animals, an article entitled "How Animals Detect Poison" will give a vast amount of information. Dr. R. V. Wagner describes an X-ray tube with adjustable focus. The usual engineering notes, electrical notes and trade suggestions from United States consuls are also to be found in the SUPPLEMENT.

## Engineering Notes.

Another step in the direction of technical education has been made in the city of Dresden in the establishment of a school for locomotive driver apprentices. The initiative was taken by the Locomotive Drivers' Association of Saxony, which succeeded in interesting the members of the Dresden city council in the scheme, as well as the directors of the technical school and the administration of the Royal State Railroads. The purpose of the new school, which is managed in connection with the Dresden Technical School, is to better equip men who are to become locomotive drivers. The school is for apprentices between 25 and 30 years of age who are employed in the Dresden car shops. Among the subjects taught are German, arithmetic, graphics, and the mechanism of locomotives. For the present the course has been fixed for one year. The lectures and class-room work will be held on three evenings during the week and on Sunday mornings.

An important alteration has been made in the armament of the six armored cruisers of the improved County class, now in course of construction for the British Admiralty. Heavier guns than those originally designed are to be supplied, the alteration representing an increased outlay of \$1,000,000 for the six vessels. The original armament for each of these vessels comprised fourteen 6-inch guns; but when Mr. Watts succeeded to the office of Chief Constructor of the Navy, two 7.5-inch guns were substituted for four of the 6-inch guns. In this last revision four more of the 6-inch guns are to be dispensed with, and in their place two 7.5-inch weapons are to be installed. Thus four 7.5-inch and six 6-inch guns will be carried. The 7.5-inch guns will be mounted as follows: One placed forward in a turret, and another aft. The other two will be in casemates, firing ahead or on the broadside. Thus three 7.5-inch weapons will fire ahead, and as many on the broadside. By this change the battery will be considerably strengthened and improved, for the 7.5-inch gun fires a 200-pound shell, as against the 6-inch gun's 100-pound shell, and will perforate a much greater thickness of armor.