

structed in the ordinary manner, which consists in sinking piles into the river bed, upon which a long scaffolding is built reaching from one bank to the other, leaving only a narrow opening in the center for the passage of boats. According to the terms of agreement, the constructors were required to leave a passage of at least fifty meters (164 feet) in width in the center of the river, as on account of the curvature of the Seine at this point, the trains of merchant boats, which sometimes have a length of 150 meters (500 feet) could not pass without difficulty in a narrower space, and the agreement stipulated that there should be no interruption of navigation during the work of erecting the bridge.

For this reason, the construction of the arches was carried out entirely from above, by means of a temporary bridge called the "Passarelle," extending from one bank to the other. It was supported on rollers at each end, as shown at the right-hand end of our larger view, and could thus be moved from side to side as the work required; upon it were established the steam engines, hoists, and cranes for the transport and putting in place of materials. Its length was about 130 meters (420.5 feet); its width, (6 meters 19.68 feet); and height, 7½ meters (24.6 feet), and it was the largest construction of this kind yet made. It was built on the right bank of the river on a high scaffolding, the other end being upheld by a floating scaffolding in the river; when one-third of the passarelle was finished, it was drawn forward by means of ropes attached to drums, thus permitting the second part to be constructed in the rear. This was drawn forward in turn, and thus the whole construction was extended across the river between the abutments.

The supports on which it rolled back and forth over the arches were formed at the base by a strong iron frame upon which a pyramidal construction was built to sustain the inward end of the passarelle. These pyramids were about 6 meters (19.68 feet) in height; the base rested upon ten rollers arranged in two series of five each, rolling on rails 4 meters (13.12 feet) apart. To give additional stability to the passarelle, a series of piles was driven in the stream near the bank, upholding an iron structure which supported the passarelle at that point.

The bridge proper is composed of fifteen great metallic arches placed side by side and connected one to the other by intermediate pieces, as will be seen in the end-view of these arches. Upon the arches are secured vertical steel frames supporting the horizontal I beams above. Upon these will be laid the iron planking and wood pavement of the bridge. The arches are built up of sixty-four short sections or voussoirs, which are bolted together end to end. These sections are massive steel pieces having a length of 3 meters (9.84 feet) and weighing 7,000 kilogrammes each (15,432 pounds). Their section resembles that of a T, having 6 centimeters (2.36 inches) thickness in the web.

Two arches at a time are constructed for a given position of the passarelle; traveling cranes take up the voussoirs from the end of the passarelle and bring them into the proper places on the arch. The method of construction of this bridge somewhat resembles that used in the case of stone bridges. The piece constituting the origin of the arch is solidly fixed into grooves made in the granite blocks of the abutment, and upon this piece is fixed the first voussoir, it being held by a cylindrical key of special construction, thus forming a movable joint at the beginning of the arch. The piece corresponding to the keystone of the arch carries a similar articulation, the rest of the voussoirs being solidly bolted together. Before bolting, however, their position must be regulated with care. To this end the voussoir is first brought into its approximate position by the movable carriage on the passarelle above, it being upheld by timber supports. For the final regulation, thin metal plates are inserted between the two voussoirs, until the required form is obtained as determined by the template of the arch, after which the voussoir is solidly bolted in place. The regulation of the arch as a whole then remains to be made. This is accomplished by means of the joint arranged for the purpose in the keystone. Here thin metal plates are added or taken out until the desired form is obtained. This is determined by surveying instruments placed at different positions on either bank.

The first two arches being thus finished, the passarelle was moved into position over the second pair. This was done by means of capstans acting upon its rollers. In this manner eight different positions were successively taken in order to complete the fifteen parallel arches of the bridge. Since the photograph was taken the passarelle has been taken down as it has served its purpose in the construction and the assembling of the metallic parts of the bridge proper is practically finished. The finished bridge presents a curve having 7 meters (22.96 feet) distance from height to base. Its total length is 110 meters (360.91 feet) between the abutments and its width 40 meters (131.24 feet). It is to have two sidewalks of 10 meters (32.81 feet) wide, leaving a central space of 20 meters (65.62 feet) for vehicles.

The approaches to the bridge are upheld by a series of stone arches, of which the outside series is shown in one of the upper illustrations on front page, and is built of blue granite; behind this are a second and third series of arches; these arches, being concealed from view, are of inferior materials. Upon these arches will be laid the I beams and flooring constituting the approaches. In another illustration on the extreme left will be seen the iron footing of the bridge resting against the stone abutment.

As the bridge has been constructed in view of the Exposition, its decorative effect has been made prominent, and it will harmonize with the buildings now being erected on either side of it. There will be two large and handsome pylons at either end, one of these being shown surrounded with scaffolding and the sculptors' temporary house. These pylons resemble in their material and architectural motifs the construction used in the great and smaller palaces. Each of the pylons will have an allegorical figure and will be surmounted by a bronze group, designed by Fremiet and other sculptors. At either side of the pylons is a large carved figure of a lion led by a child. The bridge is to have a handsome stone balustrade upon which will be mounted a series of decorative bronze lamp posts.

#### RADIO-ACTIVE MATTER IN MAGNETIC FIELD.

M. Becquerel has given an account to the Academie des Sciences of a remarkable phenomenon which he has observed in the course of his experiments upon radio-active matter. He finds that a magnetic field has a marked effect upon the action of these bodies, and when placed between the poles of a powerful electro-magnet, the radiation which they emit is changed in direction and becomes concentrated upon the poles. In the first experiment, the effect was observed with the radiation parallel to the magnetic lines of force. Between the pole pieces of the electro-magnet were placed two circular soft iron disks, fourteen millimeters in diameter, so arranged that their distance could be varied from a few millimeters to sev-

Fig. 1.

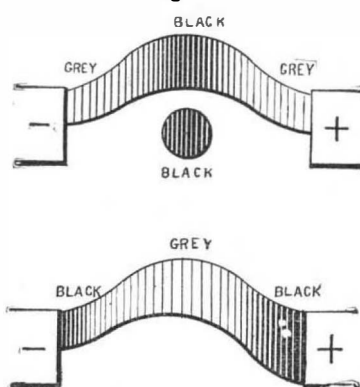


Fig. 2.

eral centimeters. Upon exciting the magnet, a powerful field is established between the disks. Near the center of one of the disks was disposed the radio-active matter, containing the supposed new element, radium, whose action is very powerful; this was placed upon paper and covered with a thin leaf of aluminium. Against the other pole was placed a fluorescent screen, such as platinoeyanide of barium, double sulphate of uranium and potassium, etc. When the electro-magnet was unexcited, the phosphorescence excited in the screen by the radio-active matter appeared as a large luminous spot extending beyond the polar surface containing the screen; at a distance of one centimeter between the disks, the screen is but feebly phosphorescent. Upon exciting the electro-magnet, the luminous spot is seen to contract and become more intense; the illuminated area scarcely reaches beyond the limits of the pole-piece, upon which all the rays of the active matter seem to be concentrated, with a resulting increase of brilliancy. Upon reversing the magnetization, no appreciable difference is observed. The interposition of screens, such as black paper, glass, etc., cause only a diminution of intensity. If a photographic plate is substituted for the phosphorescent screen, one may obtain, with exposures of a few instants, an interesting series of negatives. Among others, M. Becquerel shows a plate which he obtained at a distance of fifteen millimeters; upon this may be seen first the feeble impression when the magnet is not excited, then the more strongly marked and concentrated effect caused by the magnetic field.

To observe the effect when the direction of the screen is parallel to the magnetic flux, the radio-active matter, covered as before with aluminium, was placed in the center of a glass tube arranged in the axis of the field; the interior walls of this tube being covered with fluorescent matter, forming a cylindrical screen. Upon exciting the magnet, the phosphorescence is seen to diminish considerably, even to a point where it is scarcely perceptible. In another experiment, the active matter is placed between the pole-pieces, somewhat below the center, and a flat screen is placed at an equal distance above and parallel to the lines of force.

Under these conditions, the effect changes with the direction of magnetization; in one case the luminous spot becomes more brilliant, in the other it diminishes. This may be very well observed by using a photographic plate. In one experiment, the plate, wrapped with black paper, is placed between the poles and parallel to the field, the distance between the poles being forty-five millimeters; the magnet is first excited, and upon the plate, midway between the poles, is placed a small quantity of radio-active matter. After a few minutes' exposure under these conditions, the plate was developed, and it was found that the impression, which was very intense, was not uniformly distributed around the source, but was entirely thrown over to one side of the field, this being to the positive pole of the magnet. Outside of the black spot marking the position of the active matter, the maximum impression is distributed over a relatively limited region, giving somewhat the effect shown in Fig. 1, which shows the direction of the curve and the relative values, but not the actual appearance of the plate. The maximum of luminous effect as well as of curvature is in the center of the field; on either side the curve bends in and joins the polar surfaces somewhat above their centers. The experiment was then tried with the active matter placed near one of the poles, with the plate in the same position. The effect differs from the former, as shown in Fig. 2. The action is strong in the vicinity of the active matter near the + pole, and from this the intensity diminishes, reaching a minimum in the center of the field, from which it augments in approaching the other pole. Near the pole it becomes again very intense, but less so than on the other side. By varying the position of the active matter between the poles, a series of curves may be obtained whose maxima are opposite the point occupied by the source, the maximum has, however, a tendency to approach the neighboring pole. When the active matter is but a short distance from the pole, a second maximum appears near the opposite pole, the effect being analogous to that of Fig. 2.

#### Commerce of the Great Lakes.

A suggestion of the extent of the commerce of the great inland sea extending from Buffalo to Chicago and Duluth, known as the "Great Lakes" is supplied by some figures which have been issued by the Treasury Bureau of Statistics, showing the details of the commerce passing through the Sault Ste. Marie Canal, which connects Lake Superior with Lakes Michigan, Huron, Erie and Ontario. This necessarily registers only the traffic between the single lake, Superior, with Duluth, as its great concentrating and distributing point, and the chain, Michigan, Huron, Erie and Ontario with Chicago, Detroit, Toledo, Cleveland and Buffalo, the great points of concentration and distribution. The commerce passing through the canal thus registers accurately the movement between the single lake penetrating the wheat and iron producing regions and the chain tributary to the corn, provision and coal producing and iron manufacturing regions. It is the great gateway through which wheat, oats, flour, iron ore, copper and lumber of Montana, the Dakotas, Minnesota and Northern Wisconsin move to the consuming and manufacturing sections, while through the same gateway moves in the reverse direction the coal manufactures and miscellaneous merchandise from Lake Erie and Eastern points.

All of the traffic moving between Lake Superior and the chain of Lakes from Chicago to Buffalo must pass through either the American or Canadian Canal which lie side by side. Of the total business through the two canals in 1899, 88 per cent was carried by the American Canal, while of the passenger business 68 per cent passed through the same canal. It is only by a comparison of figures of 1899 with those of earlier years that the importance of this commerce can be realized, especially as regards its rapid growth. The actual number of passages through the canal, counting each vessel as it passed through it, was 20,055, during 1899, against 9,579 in 1889, having thus more than doubled during a period of ten years. The total freight business passing through the canal in 1899 was 25,255,810 tons against 7,516,022 tons in 1889, showing that the freight tonnage has increased much more rapidly than the number of vessels, thus indicating in some degree the rapid increase in the size and capacity of freight-carrying vessels of the Great Lakes. The development of grain production of the extreme Northwest during the decade is indicated by the fact that the wheat carried through the canal in 1899 was 58,297,335 bushels, while in 1889 16,231,854 bushels were carried, while grain other than wheat in 1899 amounted to 30,900,935 bushels, while in 1889 it was but 2,133,245 bushels.

THE current through the iron gate of the Danube is still far too rapid owing to the sharp incline and the work of excavation does not suffice to secure the expected depth. The navigable channel created by blasting under water is not quite regular. Ridges have been discovered and through additional lines of buoys have been fixed, further work will be required.

## Science Notes.

An appendicitis club has been formed in Cleveland, Ohio. To become a member of this unique organization, one must have been operated upon for appendicitis.

Our excellent contemporary, "Science Abstracts," has just been enlarged and several new features have been added. There is included in it an entirely new section on steam plant, gas and oil engines and also abstracts dealing with motor cars of all kinds.

The Royal Geographical Society has awarded the "Wollaston Medal" to Grove K. Gilbert, geologist of the United States Geological Survey. The medal was received in behalf of Mr. Gilbert by Henry White, Esq., Secretary of the United States Embassy. This makes the third time that the honor has gone to an American.

M. Raphael Bischoffsheim, has made over the freehold of the Nice Observatory which he founded, together with \$500,000 to be devoted to the maintenance of the establishment. The total value of the gift is considered to be worth a million dollars and the continuance of the work is assured by this munificent gift.

The archaeological explorations in Algeria are lagging, owing to lack of funds. Only about \$10,000 a year is available for the work at Timgad. The government has assigned \$100,000 to pay for researches in Delphi, and all the objects found become the property of the Greek government, so it is little wonder that Frenchmen are dissatisfied at the favor shown to Greece. There are still over one hundred acres to be excavated at Timgad, and the work can be carried on only very slowly.

The Christmas-tree business has assumed large proportions, and the result is that considerable injury is done to forests by the cutting of young firs which serve for Christmas trees and other decorative purposes. Some hold that this thinning out improves the forests, but the Hon. J. Sterling Morton, Ex-Secretary of Agriculture, states that this is not the case and forests which have not been thinned out for Christmas decorations produce unequalled specimens of the long and straight coniferæ.

We have received Part I, of the 19th Annual Report of the United States Geological Survey and accompanying atlas, consisting of a collection of papers and reports descriptive of the forests of the West, especially of certain of the forest reserves created by executive order on February 22, 1896, prominent among which are Black Hills, Big Horn, Teton, Yellowstone Park, Priest River, Bitter Root, and Washington Reserve Forests. As is usual with all the publications of the Geological Survey, the volumes are handsomely printed and bound.

Incandescent electric lamps have been employed in the laboratory as a source of heat involving the boiling or distilling of volatile inflammable liquids. They are especially applicable for the Soxhlet extraction apparatus, a number of bulbs being enclosed in a mantle surrounding the entire apparatus. This admits of perfect regulation of temperature. In order to still further eliminate the danger of explosion the light bulbs may be immersed in the water used for the water bath. Of course the control is perfect and instantaneous.

The Third Assistant Postmaster-General has decided to issue stamps in book form at so small an advance in cost that the public will gladly pay the difference. As is well known large numbers of postage stamps are wasted by sticking together, or to the pocket, so that a stamp book is really a necessity. The books will be of convenient size, and will contain stamps to the amount of 24, 48 and 94 cents. An advance of one cent on each book is all that is to be charged to the public and it is thought that the government will make an excellent profit on the investment.

A bill has been prepared in Colorado which, if passed, will place the granting of marriage licenses in that State in the hands of the board of medical examiners. In each county there is to be a board to consist of three physicians, no two of the same school, and where possible the board is to have one or more female members. Licenses are to be granted to men not less than twenty-five and women not less than twenty-two years. To secure licenses, men and women must be free from certain diseases, and there must be no blood relation between the contracting parties. Should this bill become a law, the towns over the border will probably do a large matrimonial business.

A German novelty consists of India rubber nails for use in places where ordinary nails are liable to corrosion. It is said that they may be driven into soft woods in sizes up to 1 inch long, without boring a hole for their reception. In larger sizes it is necessary to bore holes to start them, and for the largest sizes holes for their entire length. They are said to be very useful in chemical factories, dye houses, breweries, etc., and they are also used in building accumulator cells and other electrical apparatus. It is said that they clinch fairly well. They may be used about explosives where a spark from a nail head when struck by a hammer might prove fatal.

## Engineering Notes.

A huge wine-barrel weighing seventy tons has just been built at Nancy for the Paris Exposition. Its cost was \$30,000.

Flexible shafting has been put to a new use. It is arranged so as to be attached to a source of motive power for tree trimming.

Letter, copying presses operated by compressed air or hydraulic pressure from local water mains are in use in offices on the Rock Island road.

The production of aluminium in the United States last year, did not greatly exceed that of the previous year when the output was 5,200,000 pounds.

When straightening the curves on the main line of the C. B. & Q. Ry., at Rome, Iowa, a gang of men dug up a bone of a prehistoric mammal of considerable size.

As is well known glycerine is a by-product of soap and candle factories, and something like 40,000 tons of this commodity are made yearly. The South African war has resulted in an increased demand for glycerine.

An acetylene town lighting plant has been installed at Hawes, Yorkshire, England. It was built on a capital of \$3,500. There are two large generators, in which the gas is washed by passage through the water. The holder has a capacity of 1,000 cubic feet. About a mile of the mains have thus far been laid.

The New York, New Haven & Hartford Railroad has regulated the publications which are sold on its trains. Certain of them were barred owing to complaints to the railroad company. This is the first case in which we remember a railroad company exerting their undoubted right as a censor in this matter.

In Paris it has been customary for cyclists to go to the nearest restaurant and to inflate their tires with the help of the carbonic acid apparatus, which is used to give a head to the beer, but it is found that a pneumatic tire inflated with carbonic gas soon loses its resiliency and the gas escapes with remarkable rapidity.

Our Consular Agent at Eibenstock, Germany, Mr. Harris, states that in 1890 2,000,000 tons of logs were imported into Germany. In 1898 2,600 tons were imported, or an increase of 30 per cent. During this same period sawed lumber increased from 1,200,000 tons to 2,200,000 tons, or an increase of about 100 per cent. Sawmill owners of the German Empire are beginning to agitate in favor of a higher tariff on sawed lumber.

Artificial sponges are being made in Germany by Dr. Gustav Pum, of Graz. His experiments are based upon the action of zinc chloride solution upon pure cellulose, says The Trade Journal's Review. The resultant product swells enormously with water, but turns to a horn-like substance on drying. In order to retain for the product the property for also absorbing water after drying, alkali-haloids are employed in treating the cellulose with the zinc chloride. The mass after manipulation and molding is said to take the place of sponge in all its uses. It is claimed that a real rubber substitute may come from this field.

A Colorado inventor has recently invented a simple and inexpensive device capable of being attached to any swing door so that during the act of opening the door sufficient power will be stored or accumulated to enable the device to automatically close the door. In brief it consists of a frame which is secured to the inside of the door at the lower swing corner. The wheel is revolved by contact with the floor, and it transmits motion to a shaft to which is secured a spring. This causes a contraction or winding of the spring. When the door is released after having been opened a desired distance, the spring will expand and in expanding will cause the door to close, forcing the wheel to travel in the opposite direction to accomplish this result.

An inventor of Schweinfurt, Bavaria has invented a new machine for the sorting of steel balls according to quality, and it prevents the cracked balls being passed as perfect. Formerly it was tried to sort out the cracked balls (which cannot be avoided even by using the best quality of steel) by skillful workmen examining each ball by the aid of a magnifying glass. This entails a great deal of work and time, and is after all not reliable as many of the defects cannot be detected by a magnifying glass. The working of the machine is based on purely physical laws, especially the law relating to the rebound of elastic objects. In brief it consists of a cylinder provided with a piston, which moves up and down upon a fixed axle. The balls are placed on the top of this piston and they are raised by mechanical means and are allowed to drop over the edge of the cylinder down an inclined flange. The balls all describe a parabolic trajectory which is practically independent of the condition of the balls. The balls then rebound upon an impact surface and those having the desired degree of elasticity will clear a stop or barrier formed by a ring, while balls which owing to a defect in hardness or homogeneity having an inferior degree of elasticity will, strike the barrier and fall back into the central space. This is a very ingenious and clever invention.

## Electrical Notes.

The St. Louis Hospital at Paris has a new laboratory for electro-therapeutics and radiography.

Electric cars are immensely popular in England, and the equipment companies can hardly keep up with their orders.

Communication has been established between De Aar and Orange River, about seventy miles away, with the aid of kites and wireless telegraphy.

Balloon wireless telegraphic communication is to be attempted at Portsmouth, England, with a view to establishing communication between the sea and a land force.

The principal shell factory of the Boers was entirely destroyed recently by an accidental explosion. It was operated by electricity and the machinery is said to have cost some \$400,000.

In one case \$265,000 has been saved owing to the establishment of wireless telegraphy between the East Goodwin lightship and the South Foreland. This is denied however, by the elder brethren of Trinity House.

The Metropolitan Street Railway Company, of New York city, has 284 miles of track and last year carried on them 255,835,000 passengers or about half the number carried on all of the steam railroads of the United States.

The house No. 7 West Twenty-second Street, New York city, has been destroyed to make room for a modern building. It was occupied for many years by Professor S. F. B. Morse who died in this house. A marble tablet commemorated the fact that there the great electrician resided.

The electric exhibit at the Paris Exposition bids fair to be one of the most attractive parts of the show. There will be a complete retrospective exhibit of electrical and mechanical apparatus of historical character, and the special exhibit will be housed in the "Court of Honor" built of staff.

It is proposed to construct an electrically worked aerial bridge crossing the Usk, say The English Electrical Review. The width of the river at this point is 240 yards and the time occupied by the carrier going from one bank to the other is estimated at about a minute. The bridge will cost \$325,000.

The Milwaukee Electric Railway and Light Company has just let a contract for 300 clocks of the navy lever type for use on the street cars of Milwaukee, says The Street Railway Journal. Conductors will be expected to look after the clocks seeing that they are properly set. It is thought that their use will result in the saving of possible controversies regarding the hours when commutation tickets are available. As the clocks have been in successful use on battleships, it is believed that they will withstand the vibrations of the cars.

According to a German electric journal an association of farmers in Bavaria is building large electrical works which will be devoted to agricultural uses. The current is produced near the village of Schaftersheim, a distance of seven miles. It is supplied partly by steam and partly by water and is sent to the surrounding villages at a pressure of 5,000 volts. Movable motors are used for driving thrashing machines, chaff cutters, bruising mills, etc. The motors are very simple in construction and can be easily handled by the farm hands.

The Grand Rapids, Michigan, Street Railway Company has allowed mail bags to be put on its cars. They are placed at either end of the cars and an opening will be made in the front of the car for slipping letters in the box. In order to permit persons to deposit letters whether they wish to take passage or not, the street car company has given instructions to its motormen to stop at all street corners for that purpose provided that the stoppage does not interfere with schedule time. The post office authorities have arranged, says The Street Railway Journal, to collect the mail, from each car each trip at some point near the post office.

The Alexian Brothers at their hospital in Chicago have an interesting electric light bath, which is essentially a large wooden box, the walls and top of which are lined with mirrors and studded with incandescent lamps. The interior horizontal dimensions of the cabinet are  $3\frac{1}{2} \times 4\frac{1}{2}$  feet, with a height of about 7 feet. The bottom side walls and the ceilings are lined with rectangular plate glass mirrors, between which are narrow wooden strips with porcelain sockets for the incandescent lamps. In the lower half of the cabinet there are sixty lamps, and in the upper there are thirty-six. The cabinet is carefully insulated to prevent the radiation of heat. The door of the cabinet is in two parts, the lower one being lined with mirrors on the inside and the top one formed of clear glass. The temperature varies from 110° to 140° Fahrenheit, says The Western Electrician, from which we glean our facts. The electric light bath is used for the treatment of nervous diseases, Bright's disease and fatty degeneration of the heart. There are only two similar baths in the country.