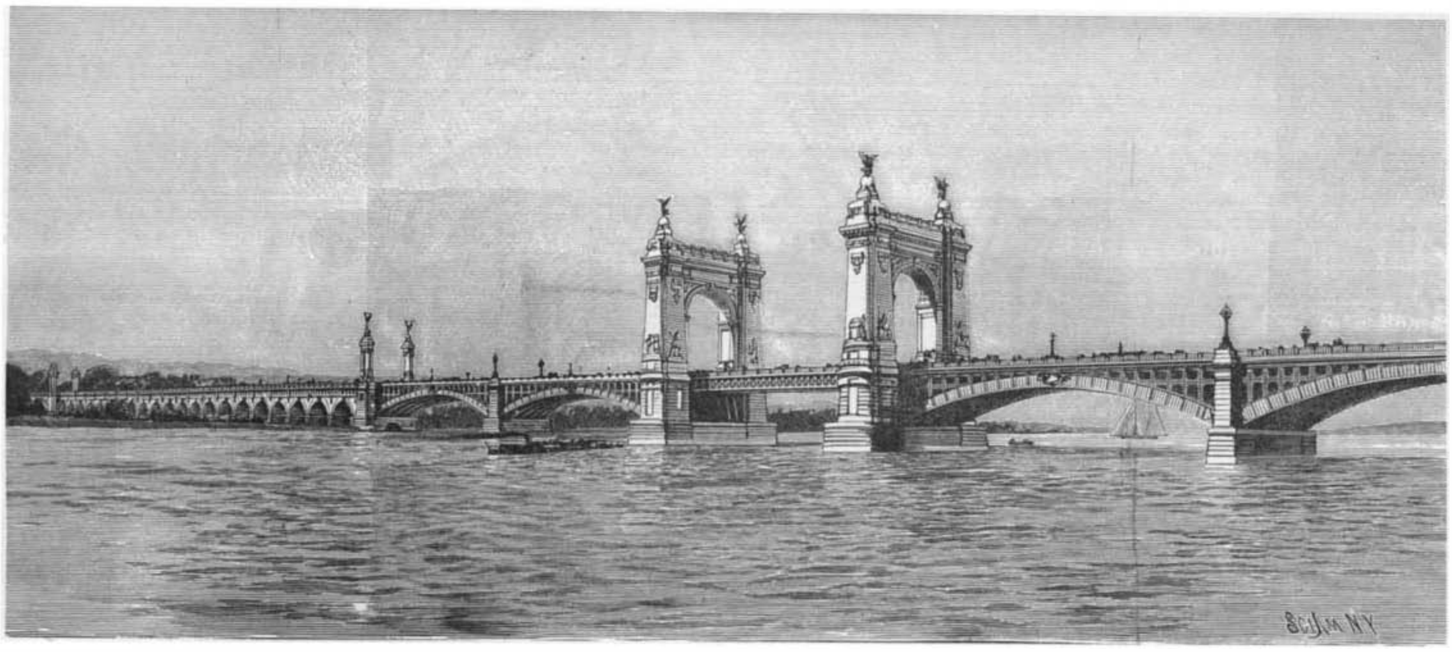
another mass of checkerwork built up alongside the first-named mass, and is conducted to the furnace by two flues, which are located on each side of and above the gas flue. Here the gas and air mingle and combustion takes place at extremely high temperatures, ranging from 2,700° to 3,000° F. The products of combustion pass over the charge and out at the opposite side of the furnace, and through a set of flues and checkerwork exactly similar to those through which the gas and air entered, raising the checkerwork to a high temperature. About every twenty minutes the lever controlling the regulating valves is thrown over and the gas and air are directed through the now heated checkerwork and flues on the left-hand side of the furnace. Here they are regenerated to from 1,500° to 1,800° F. The flow of gas is reversed every twenty minutes during the ten to twelve hours occupied by the process.

It takes about six and a half hours to melt the charge, and four to six hours are consumed in boiling down to get rid of the carbon and various impurities. As soon as the heat is melted, samples are taken from the furnace and carefully analyzed, and these tests are repeated at frequent intervals until the heat is ready for casting. One of the views shown on our front page is taken at the back of the open hearth furnace above the casting pit and shows the process of casting. As soon as the steel has reached its proper composition, a tap hole is opened and the steel is run off into the large ladles, which are shown in the engraving, from which it is run into the molds by opening a tap hole in the bottom, which is ordinarily closed with a plug of fireclay. In all of these castings a considerable excess of metal, known as the "sinking head," is formed at the top of the mold, which serves the double purpose of compressing the lower portion of the ingot, increasing its density, and closing any cracks or holes which might form during cooling. It also serves to collect the impurities in the metal, which rise by their lesser gravity to the surface. The metal which is to be worked up as gun steel, is subjected to hydraulic pressure in what is known as the fluid compression process, a description of which will be given in a succeeding article; but a few of the largest castings for gun steel and all of the armor plate castings, on account of their great size, are cast direct in the form of massive ingots. One of our illustrations represents the great 100-ton ingot which was cast for the manufacture of the 16-inch army gun, which is now nearing completion at the Watervliet Arsenal.

MOLYBDENITE is proving to be of value in the manufacture of steel. The present market value in Pittsburg is $200

PROPOSED NATIONAL MEMORIAL BRIDGE ACROSS THE POTOMAC AT WASHINGTON.

The Secretary of War has just accepted the final plans for the proposed Memorial Bridge to be built across the Potomac to Arlington. The successful winner of the competition is the well-known bridge engineer, Prof. W. H. Burr, of the Department of Civil Engineering of Columbia College, New York. Four prominent bridge constructors, namely, Prof. W. H. Burr, George S. Morrison, Leffert L. Buck and William H. Hutton, all of New York city, were especially invited by the Secretary of War to compete for the honor of designing the Memorial Bridge. The designs and drawings were to be paid for in their order of merit as recommended by the Board of Engineers, as follows: For No. 1, $1,200; No. 2, $1,100; No. 3, $1,000; No. 4, $900. The designs and drawings were then to become the property of the United States.



PROPOSED NATIONAL MEMORIAL BRIDGE ACROSS THE POTOMAC AT WASHINGTON.

The selection of the design marks an important step in this commendable project, which contemplates the spanning of the Potomac River between the government reservations at Washington and Arlington with a monumental structure which shall form a fitting national monument to American patriotism in its highest and broadest sense.

The specifications called for the presentation of two designs, one for a bridge with a draw opening and to provide for street cars as well as for ordinary vehicles and pedestrians; the other for a bridge with draw opening, but without provision for street cars, etc. After full consideration of the various plans for the bridge and approaches, including the architectural features, ornamentations, cost, etc., the board concluded that the general design of Mr. Burr should be designated as first in the order of merit and should be adopted, subject to a few modifications, such as width, slope of roadway, towers, provisions for tramcars, and such other minor modifications as might develop during the progress of the work.

The main features of Prof. Burr's design No. 1 are as follows: The whole structure, with the exception of the bascule over the main channel, will be of arched construction, and will consist of the bridge proper over the river channel, and a long approach at either end; the four main arches and bascule which constitute the former being constructed of steel and the approaches of masonry.

The design is for a double deck bridge, 60 feet in width between railings, providing for two sidewalks, each 10 feet wide, and a roadway 40 feet wide. A double-track street railway is provided for upon the lower deck. The total length of the openwork of the bridge proper and approaches will be 3,440 feet. The bridge is to consist of two 283-foot steel arches, one steel draw span having a clear width of 213 feet, and two more 283-foot steel arches. The draw-span has two bascule arms supported on trunnions, balanced by rear extensions and counter-weights. The clear opening is about 167 feet, and the span from center to center of trunnions, 235 feet. The floor is to be of asphalt cork block. It is proposed to operate the draw by electric motors. The bascule and the adjacent piers are to be built on bed rock by the pneumatic process, the caissons to be filled with concrete; the other piers are also to be founded upon bed rock and built up within cofferdams. The 283-foot steel arches are segments of a circle, the springing line being 24 feet above mean low water. The Washington approach is to consist of fifteen 46-foot spans, masonry arches, back of which is an earthen embankment, 500 feet long. The Arlington approach will consist of twenty-one 46 foot masonry arches, approached by an earthen embankment 1,500 feet long. The principal divisions of the bridge are marked by massive masonry arches and towers, decorated with emblematic groups of statuary, etc., commemorating men distinguished in the foundation and development of the Republic. The cost of the structure is estimated at $4,083,850.

ALEXANDRE III. MEMORIAL BRIDGE, PARIS.

ALEXANDRE III. MEMORIAL BRIDGE, PARIS.

The Pont Alexandre III., though completed, was not relieved of unsightly superstructures until a day or two prior to the official opening of the Paris Exposition. As it stands to-day, this superb bridge, with its four lofty towers, each surmounted by a golden Pegasus that glitters in the sunlight, forms the connecting link between two new sections of the city and the Fair, the fame of which will soon be world-wide. The new avenue, cut through from the avenue of the Champs Elysées and flanked, on either side, by the only permanent buildings of the Exposition, forms the approach to the bridge from the right bank of the Seine.

Leaving the bridge on the left side of the river, the visitor at once beholds the snowy whiteness of those exquisite palaces, on either side of the Esplanade des Invalides, that are devoted to exhibits of the Decoration and Furnishing of Public Buildings and Dwellings. These structures are exquisitely frescoed.

From the center of the bridge, looking right and left, or from either end it, vistas of rare architectural beauty can be obtained.

The bridge has been constructed so as to preserve an uninterrupted perspective, the table of the bridge having been depressed as much as was possible without detriment to navigation on the Seine. Metal has been employed in its construction, giving a great depression, with a platform thickness reduced toward the middle of the arch. The substructure is composed of fifteen arches of cast steel.

A detailed and fully illustrated description of the construction and engineering features of their handsome structure was given in the SCIENTIFIC AMERICAN of March 10, 1900.

To prevent any effect of contraction or dilation of this enormous mass of metal, in any variations of temperature, the arches are joined to the key in a manner that has been seen in the Galerie des Machines and the older bridge Mirabeau.

The massive masonry forming the heads of this noble bridge, adorned with magnificent towers, visible from many distant points of view, constitutes an enduring monument to Messieurs Résal and Alby, engineers in charge of the work.

The laying of the foundation stone of the Pont Alexandre III., formed the most imposing event of the late memorable visit of the Czar and Czarina, to Paris, particulars of which are still fresh in the public mind.

The total cost of this great work has been 7,000,000 francs, 1,000,000 having been spent on the decorations alone.

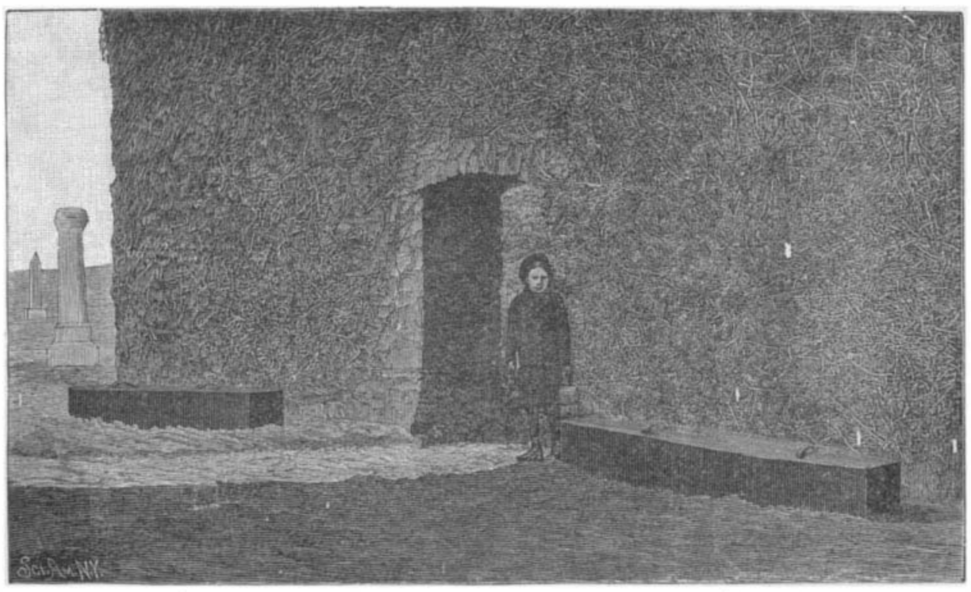
A PAIR OF CURIOUS RELICS AT ABERFOYLE, SCOTLAND.

In the earlier half of the century the practice of stealing bodies from the churchyards where they had been interred, for the purpose of sale as subjects for dissection, which was known as "body-snatching," was for a time very rife.

Various plans were made to defeat the nefarious and sacriligious proceedings of the "body-snatchers" or "resurrectionists" as they were sometimes called, a very common one being the erection of two or more small watch-houses whose windows commanded the whole burying ground and in which the friends of the deceased mounted guard for a number of nights after the funeral.

A usual method of the grave-robbers was to dig down to the head of the coffin, bore in it a large round hole by means of a specially constructed center bit and haul the body to the surface with a hook-rope. It was to counteract this maneuver that the two curious coffin-like relics now lying on either side of the door of the ruined church of Aberfoyle in Perthshire, were constructed. They are solid masses of cast iron, and, as may well be imagined, of enormous weight. On the upper side of each are provided two loops or handles.

When an interment took place one of these massive slabs was lowered by suitable derricks, tackles and chains onto the top of the coffin, the grave was filled in and there it was left for some considerable time. Later on the grave was opened and the iron armor plate was removed and laid aside ready for another funeral.



ARMOR-PLATE FOR COFFINS—A RELIC AT ABERFOYLE, SCOTLAND.

Although these contrivances have not been used for many years, they still lie on the grass of the lonely little church yard, objects of curiosity to the passing cyclist and tourist.

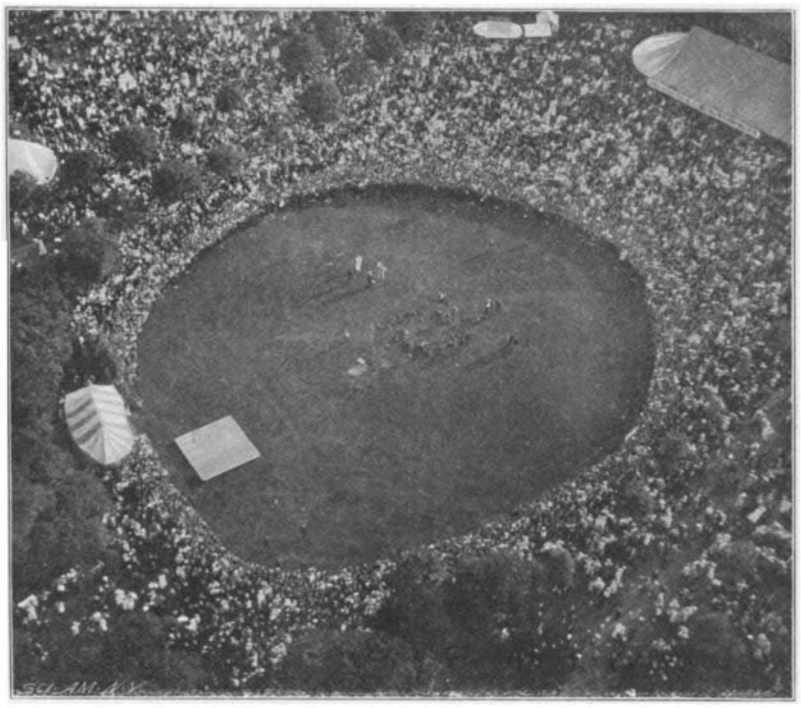
A SUBMARINE cable in actual use will form one of the exhibits of the Paris Exposition. It will run from the Electricity Building to the Vincennes Annex several miles distant along the Seine. A complete cable station will be operated at each end to show the public how trans-oceanic messages are transmitted and received. Souvenir messages may be sent by the public.

AERIAL PHOTOGRAPHY.

BY F. A. A. TALBOT.

We present herewith an interesting photograph which was taken from the car of a balloon in England, at a height of 300 feet. It was taken with an ordinary magazine camera, carrying some forty films, by a well-known aeronaut of London.

Aerial photography appears simple enough from a cursory point of view but the operator who manipulates his camera from the car of a rising balloon has many difficulties against which to contend, that do not present themselves to the photographer who plies his work on terra firma. In the first place, it is imperative that the camera should be provided with a rapid lens, which also possesses long range, and yet gives clear and sharp definition. Again, the magazine contrivance must be of the simplest, quickest, and most reliable description, since one has but very little time to change the plates. When a balloon leaves the earth its upward flight at first is often at the pace of 500 feet per minute, gradually decreasing until it attains its equilibrium. It will be seen from this fact that the operator has to be a very quick worker. The plates must be of exceptional rapidity, since the exposure must be remarkably short; otherwise the resultant photo will be blurred. Cases have been known in which a shutter working instantaneously at the one hundredth part of a second has been too slow, though it would have been quite rapid enough to snap an express train traveling at 60 miles an hour; but in such cases the velocity of the rising balloon has been exceptional. The photographer has no need to trouble about his view-finders. He simply points the camera downward, in the desired direction, and snaps his shutter as rapidly as he can work.



Height, 300 feet. Time, near sunset. Note the clear definition and long shadows.

BALLOON ASCENT, FROM THE AERONAUT'S POINT OF VIEW.

But aerial photography is full of disappointing failures. The aeronaut who secured the accompanying photograph has, on several occasions, ascended in a balloon with his camera fully loaded with forty films, and has exposed the whole of them at varying altitudes; yet when they were developed they were found to be absolutely useless. The atmosphere plays an important part in the success of an aerial photograph. At an altitude of 300 feet a magnificent result may be obtained. You ascend another 100 feet, and expose a second plate, exactly under the same conditions regarding speed, light, etc., as the first, yet the plate ultimately turns out a dismal failure. The exposure proves to be many seconds too short, and the picture is scarcely visible upon the negative. But ascend another 200 or 300 feet, expose again, and you get a result equal in every respect to that obtained at an altitude of 300 feet. There seems to be a thin filmy cloud (not of vapor), that floats above the earth, which appears to have a non-actinic effect upon the plate, and therefore it is under exposed. This phenomenon is apparent to the naked eye.

The accompanying illustration shows the crowd who have watched a balloon ascent. It was snapped at a height of 300 feet, and everything is as sharp and distinct as could be desired. It was not taken under the most advantageous conditions, since the sun was low down in the heavens—see the long shadows cast upon the ground—and therefore the light was inclined to be a little yellowish in color. As a rule an aerial photo is rather flat and uninteresting, owing to the lack of half-tones and shadows, but this photograph is full of life and vigor.

Phosphate Deposits in Christmas Island.

Christmas Island is situated 190 miles south of Java, being 12 miles long by 4 to 9 miles wide, having an area of 43 square miles. Its climate is favorable, the temperature varying from 20° to 30° C.; the soil is very fertile, and contains from 8 to 30 per cent of phosphate of lime. The trees have a remarkable development; in some places the sago palm reaches a height of 60 to 70 feet. Among the representants of the fauna and flora of the island are a few species which exist nowhere else; for instance, a bat of unusual size, which flies in bright sunlight, an owl whose cry resembles the barking of a small dog, and a terrestrial crab which climbs trees, etc. The first mention of this island dates back to 1666, when it figures upon the maps of the time under the name or Moni; on later maps it is called Moni or Christmas Island. The great difficulty encountered in landing and in mounting the heights prevented, for a long time, the thorough exploration of the island. In 1888 the "Challenger" expedition made a landing and devoted ten days to a thorough exploration; paths were traced to the summit, and a great many specimens of minerals as well as of the fauna and flora were sent to England. Among the minerals, the samples of rich phosphates attracted attention and led to a more thorough investigation; a fresh supply of specimens was obtained, and it was found on analysis that the percentage of phosphates reached as high as 80 to 92 per cent.

Mr. Andrews, who was sent to the island to study the phosphate deposits, considers them to be formed by the accumulation of excrements of myriads of sea birds which inhabited the island, which was formerly low and free from forests. Several years ago Mr. Murray of the "Challenger" expedition, and Mr. George Ross established themselves on the island and secured more than 200 specimens, which they had analyzed. The Christmas Island Phosphate Company was formed, which worked a part of the deposits, especially that of the phosphate hill, where a railroad was built to the point of disembarking 1½ miles distant, and special loading apparatus was erected. Several shipments have been made to London, the amount reaching 6,000 tons, and the results having proved satisfactory, they will be continued. The British Museum has recently published a series of observations relating to the geological formations and the fauna and flora of the island, which have been obtained by Mr. Andrews and others.

FOR several years Prof. Omori has studied the subject of earthquake measurement in a brick building, says Nature. One of Prof. Ewing's horizontal pendulum seismographs was fixed near the top of an external wall of the Engineering College at Tokyo, while another was erected on the ground below. During the years 1894–98, ten moderate earthquakes were recorded, and it was found that if the earthquakes consisted of comparatively slow vibrations (say, above half a second in duration), the motion was practically the same in both places; but if of quick-period vibrations, the motion of the top of the wall was about twice as great as that of the ground. Prof. Omori notices that, with destructive earthquakes, the damage of two-storied buildings is generally confined to the upper story.