REINFORCED CONCRETE AS A BUILDING MATERIAL FOR BOATS.

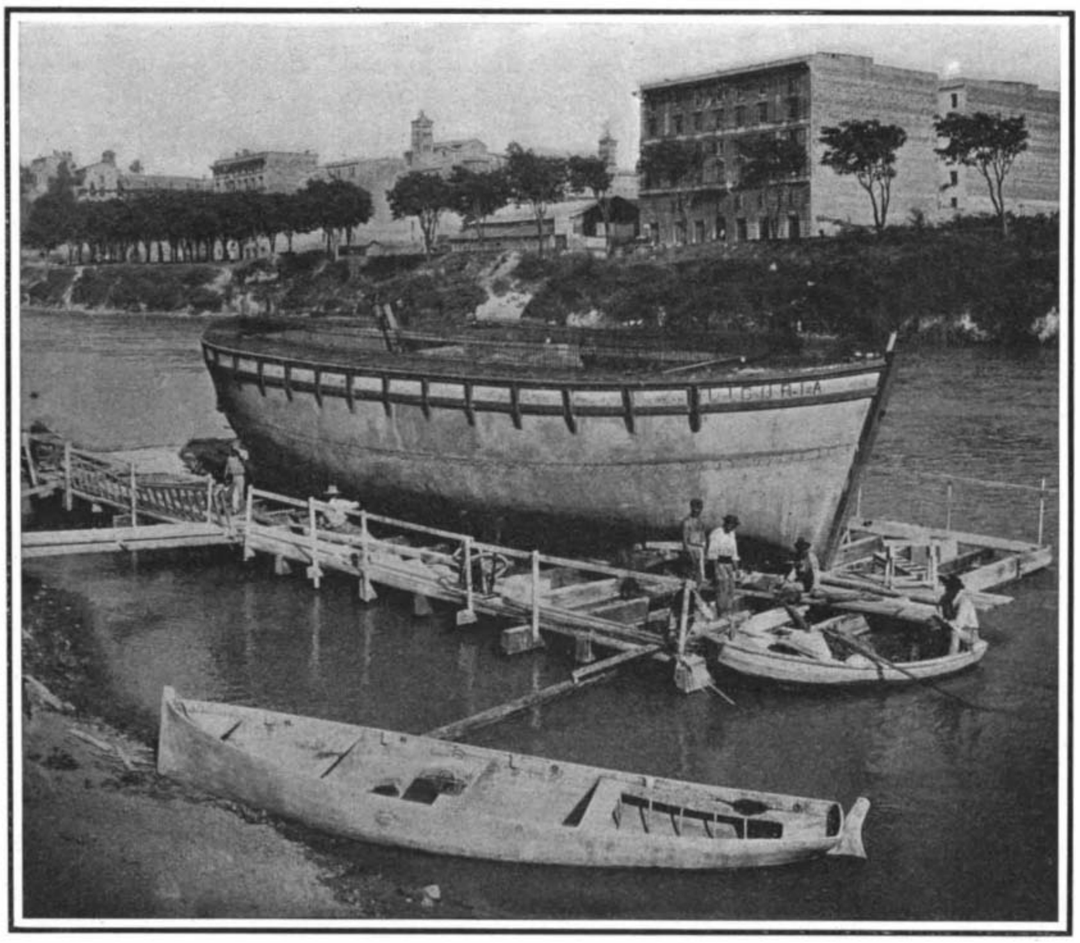
BY THE ENGLISH CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

The utilization of reinforced concrete as a constructional material for various purposes for which masonry, wood, or ironwork has been previously employed, has undergone considerable development during the past few years. One of the most novel applications of the system, however, is that which has been evolved and perfected by a well-known Italian engineer, Signor Carlo Gabellini, of Rome; namely, its adoption for the construction of boats and floating structures in general, such as pontoons, floating bridges, and so forth.

Signor Gabellini first drew attention to the possibility of extending such a system to maritime purposes, as far back as the nineties; and in order to demonstrate the feasibility of the idea, built a small rowing boat capable of carrying some four or five people. The whole of the craft from keel to gunwale, including seats and rudder, was carried in armored cement, and upon launching was kept in the water at Port d'Anjio for four years, to illustrate on a practical scale that the immersed cement surface is not damaged by sea water and offers no suitable adherence surface to seaweed and other marine growths. To-day the boat is still in service, the hull never having once been cleaned, and is in as good condition as when first placed in the water. That salt water exercises no deleterious effect upon the cement sheathing is perfectly obvious; and although the boat has been in constant use for some eleven years, the surface is without the slightest pitting or traces of decomposition. During the whole of this period the hull has required no repairs whatever, which fact points to the durability and serviceability of reinforced concrete for such purposes.

The signal success of this initial practical experiment was followed in the same year by the construction of a floating châlet or boathouse for the Aniene rowing club, which is still moored to the bank of the Tiber. Similarly, in this instance the whole of the building, including both the pontoons and the superstructure, was carried out in reinforced concrete.

There are eight pontoons disposed in two outer rows extending to a total length of 67 feet by 21 feet beam. Each pontoon measures approximately 16 feet in length by 9 feet beam. They are of rectangular section, of the flat-bottom type, there being a slight batter of about 15 degrees from the bottom to water level, whence the sides rise vertically to the top of the structure. The shell is of the single-wall type, strengthened transversely by cross beams, also executed in the same material. The iron skeleton comprises iron rods of round section with iron network or expanded metal between, around which the concrete is built. The pontoons after construction were towed to their destination and bolted firmly together in two rows, the intervening space of some 3 feet between each row being occupied by transverse reinforced-concrete girder members extending from the water level to the upper edges of the pontoons, placed at intervals so as to come in line with the transverse supports of the pontoons, thereby giving continuous strength at those points from side to side of the structure. The whole was bolted up to form a rigid homogeneous floating mass, the ends of the pontoons on the upstream face being wedge shaped to form cutwaters, the other extremities being left square in section. Upon this raft the boathouse was built, consisting of a single floor at either end with a double-decked house in the center, the roof line of which runs at right angles to the main building, which extends longitudinally. The vertical uprights of the iron reinforcement of the building rise from the floor level, and the intervening spaces between are filled with expanded metal, the roof being built upon the same lines. As may be seen from the accompanying illustration, the external characteristic appearance of a châlet is preserved, the pseudo-wooden joists being relieved with rough-cast.



The Barge "Liguria" in Course of Construction on a Floating Pontoon. The Boat in the Foreground Is One of the First Boats Built of Reinforced Concrete.

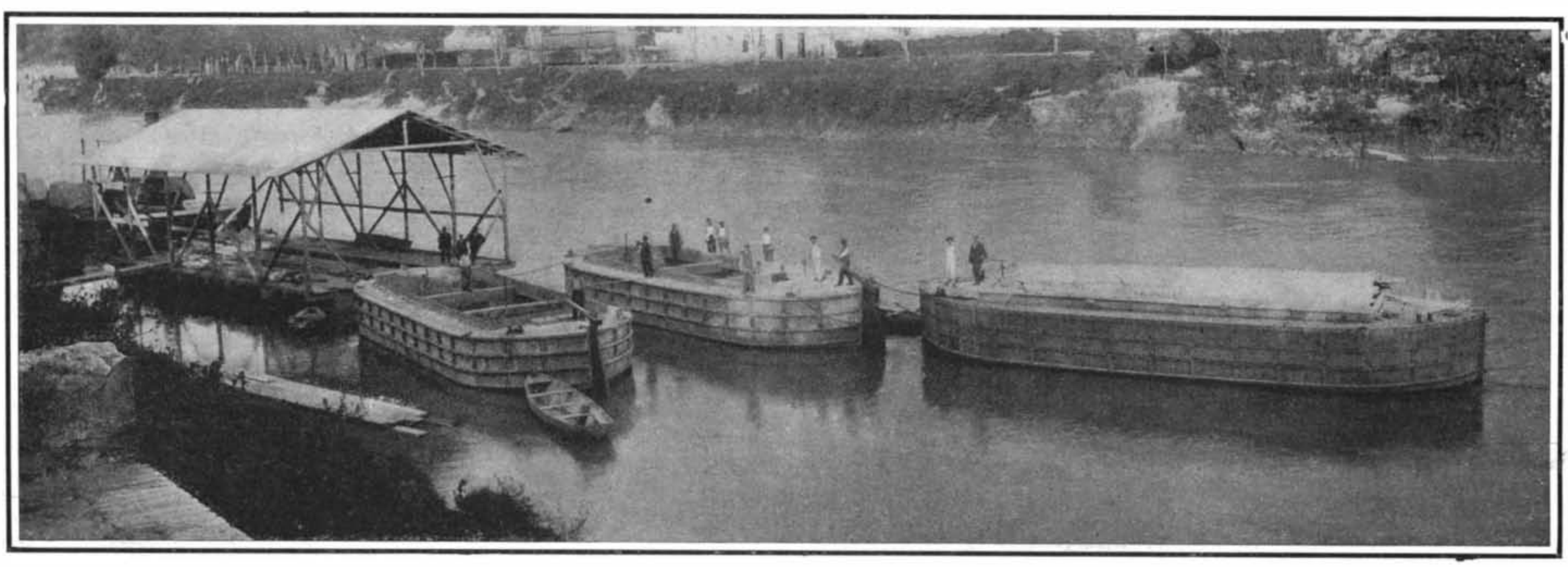
In the past two or three years, the efficiency of the system having thus been demonstrated over a period of nearly a decade, the principle was applied to larger vessels, such as freight barges, one of the first of these being the "Liguria," the construction of which was commenced in 1905. This craft is 54 feet in length with a beam of 18 feet. Construction was carried out upon the same lines, and the disposition of the iron reinforcement and expanded metal may be seen in the accompanying illustration, where the hatchway is being completed. In order to reduce resistance to the water to the minimum, the outer surface is cleaned, rubbed down, and smoothed until it has the appearance of polished marble and experience has shown that once this effect is achieved, the surface is preserved indefinitely, so that the craft always offers a minimum of skin friction in the water.

The illustration also shows the manner in which the vessel was constructed. Instead of being built upon an inclined slip on the river bank and then launched when completed in the usual manner, the stocks were provided on a floating pontoon dock, built in reinforced concrete. When ready for transference to the water, the pontoons at one end were submerged, in this manner providing the necessary inclination to insure the boat's traveling down the slipway into the river.

Upon completion the "Liguria" was towed down the Tiber from the building stage to Genoa, and is now in daily service in the harbor, transporting coal. During the two and a half years it has been in commission, the barge has given complete satisfaction. There have been no maintenance charges whatever, and the slight resistance offered to the water, owing to the smoothness of the outer surface of the hull and its immunity from clogging by marine growths, has been a noticeable feature, in comparison with the difficulties encountered in this direction by other wooden, iron, and steel vessels plying in these waters. In consequence concrete craft maintain a constant high degree of efficiency.

The results that have already been achieved have proved the complete adaptability of armored cement to marine construction. Although a boat so built is somewhat heavier than if wood were employed, it has the compensating advantage of being far more economical to maintain. Construction itself can be carried out as rapidly if not more expeditiously as in either wood or metal. Researches have shown the tenacity of the adherence of the cement to iron, and Signor Gabellini has carried out several experiments in this direction himself. In his laboratory he erected a small mechanical apparatus supporting a block of cement about eight inches square, in which was imbedded a section of round iron rod such as he uses in his system. A weight of 1,320 pounds was suspended from the iron rod, the object being to force it away from the cement, but although the strain was applied continuously for three months, no evidence of separation was observable, and the block was found as perfect and as intact as the day upon which it was made.

The question naturally arises as to the capability of such a structure to withstand such shocks as pounding against piers and other craft. Tests in this direction have conclusively proved that although the fabric



Three 100-Ton Reinforced Concrete Cargo Boats, Built for the Italian Government, Ready to be Towed to the Military Harbor of Spezia.

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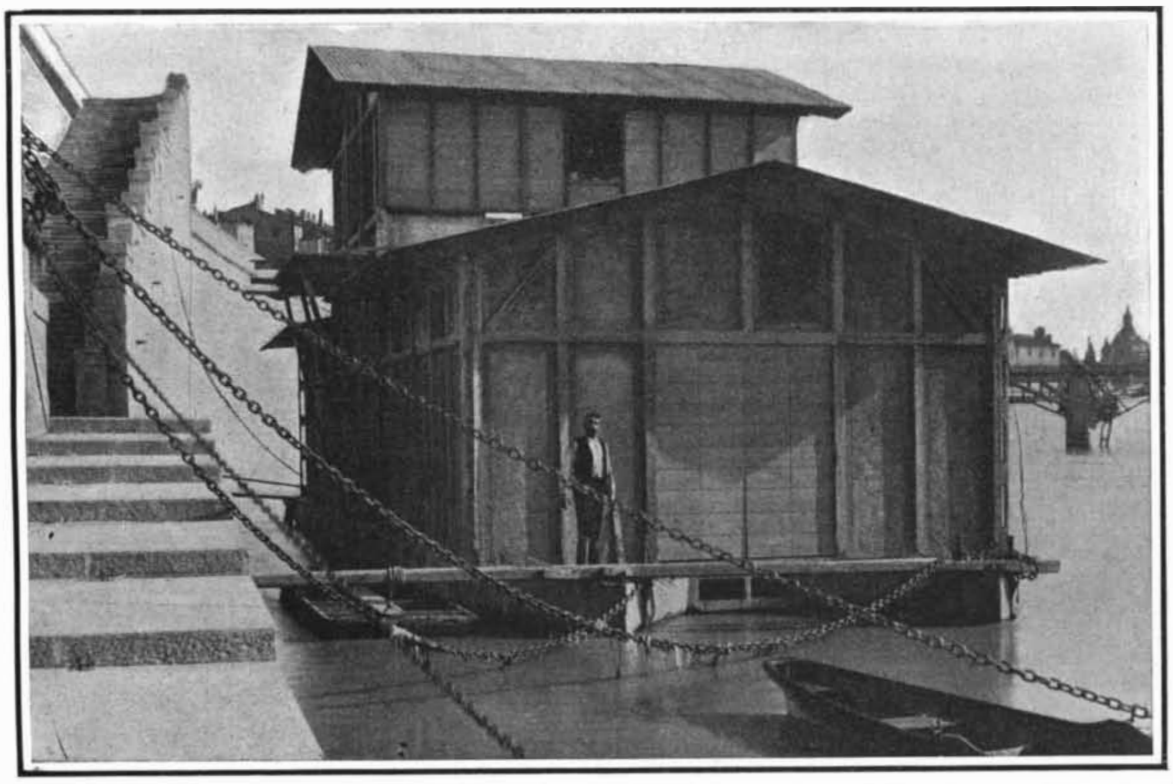
has great rigidity, yet it possesses a certain degree of elasticity, and even should the blow be sufficiently violent as to damage the fabric, the injury is purely local in character.

The system of construction is very simple. The keel is laid in the usual manner, the iron rod reinforcement being anchored to the armoring of the former, and being brought up the sides of the hull in conformity with the desired lines of the craft. The iron rod generally used has a diameter of about 0.4 inch. The expanded metal, which has a mesh of about 0.2 inch, is stretched between the vertical supports, to which it is attached by suitable metal clips. The concrete is then applied to the skeleton fabric in layers inside and out equally, the thickness of this sheathing varying according to the dimensions of the craft. It will thus be realized that building can be carried out very cheaply, while it also does not call for such highly skilled labor as ordinary shipbuilding. The cement work completed, the outer surface is subjected to a thorough cleaning to give the requisite polished, marble-like appearance.



Floating Chalet of Reinforced Concrete for the Aniene Rowing Club on the Tiber.

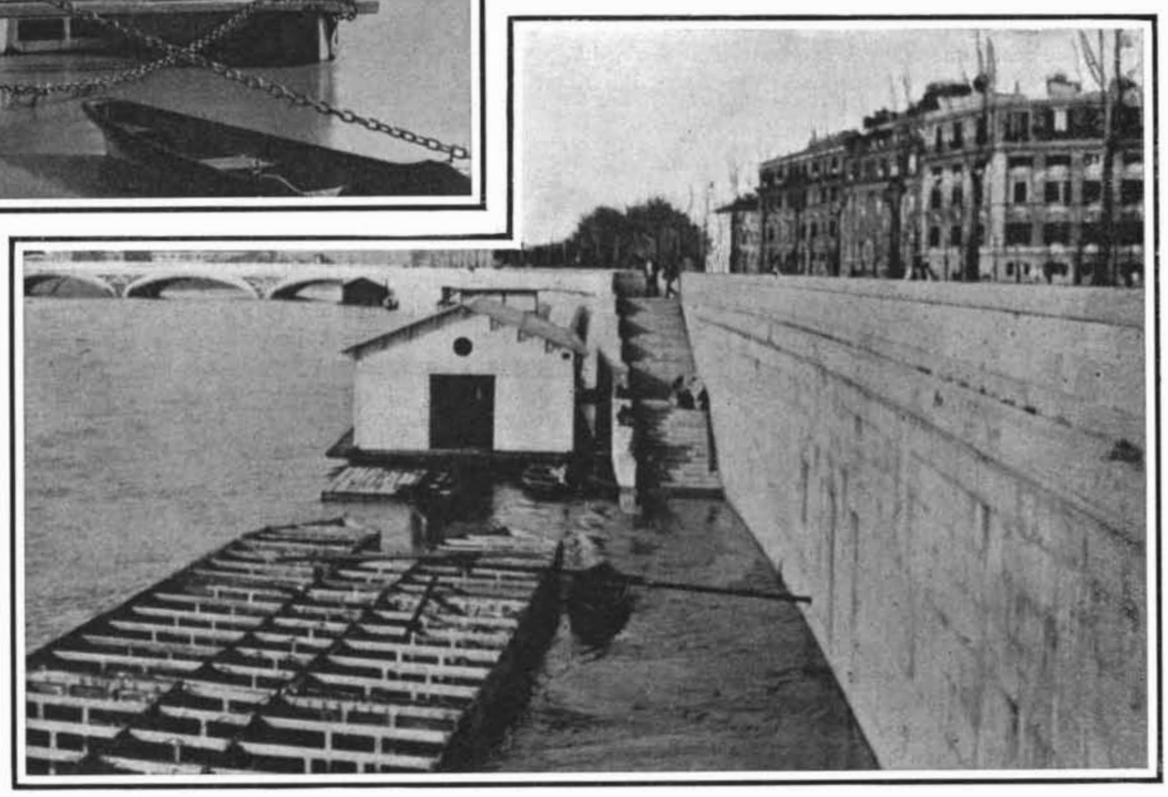
The system has been utilized for the peculiarly shaped boats which serve to support the decks of the quaint floating bridges to be found on the River Po. Hitherto wooden boats have been strung across the waterway, the deck planking, built in sections, being laid transversely across them. When a vessel desires to pass in either direction, the necessary opening is made by withdrawing a certain number of boats together with the bridge decking clear out of the way, thus leaving an uninterrupted channel, the bridge being reformed merely by rowing the boats into their normal position. The boats are of peculiar design, having sharp-pointed rising ends. In such reinforced concrete the same general lines are preserved, only the ends are made blunter, a greater midship beam is provided, while they have perfectly flat bottoms, forming a kind of pontoon. Each boat is 45 feet in length, with a beam of 12 feet and a depth of 3.6 feet. So satisfactory have the craft proved in service, the absence of repairs being a pre-eminently distinguishing feature, that the wooden boats for these quaint floating bridges are being superseded by the reinforced concrete craft as rapidly as possible, over one hundred having already been built for this service.

A few months ago the Italian government, whose engineers had reported favorably upon this system of construction, contracted with the Gabellini Company for the construction of a special type of 100-ton cargo boat which should be suitable to their requirements, for the purpose of submitting the principle to a series of exacting tests to determine practicability, efficiency, stability, and seaworthiness. The boat was built at the floating shipyard of the company on the Tiber at Rome. The boat has an overall length of 51 feet, with a beam of 16 feet and a depth of 7.5 feet, the draft without cargo being 3 feet. The type adopted is pointed fore and aft with a single clear hold. In outward appearance it differs slightly from the "Liguria." The hull has a double shell, the intervening space being subdivided into a number of water-tight compartments, each complete in itself, while the outer shell above the waterline, where it is subject to the greatest possible damage from collision with other objects, such as quays, piers, and other vessels, is especially strengthened, so that in the event of one or more compartments being pierced, the craft will still remain afloat.

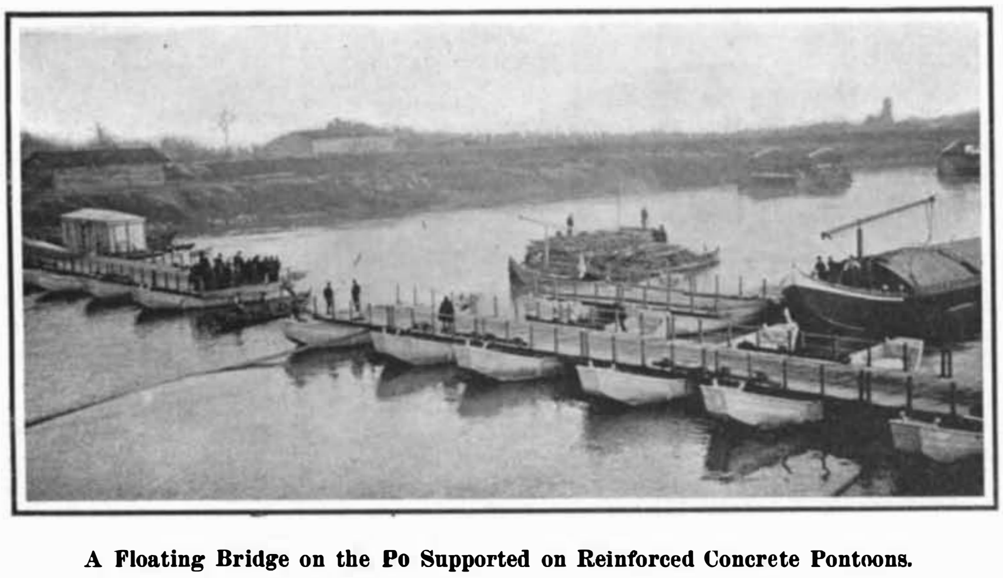
Upon completion this freighter was towed to the military harbor at Spezia, where it was subjected to a severe series of tests by the military department. These proving completely satisfactory, the government ordered four similar barges of the same dimensions and tonnage, which are now being completed. These craft are additionally strengthened transversely by concrete beams, which extend straight across the holds. The external shell is divided into panels, and when a rent is made in the fabric, it is necessary only to lay bare the iron reinforcement at the point of injury, repair the damaged sections of metal armoring and network, and apply the coating of cement. In this manner the most extensive injuries can be easily repaired in the course of a few hours. The system moreover is more hygienic than either wood or iron, and can easily be maintained in a perfectly clean condition, the holds being flushed out with a hose.

Signor Gabellini is advocating the manufacture of armor plates upon this principle. The system is fundamentally the same as adopted in torpedo boats, but is considerably strengthened. The plate is built up to the requisite thickness of superimposed layers of the armoring, with intervening layers of cement, and so made as to form a perfectly homogeneous plate. In this arrangement the iron rods are disposed at right angles to one another in each layer, to secure the maximum effect of resistance and strength. The number of layers of reinforcement can be varied as desired. From the experiments the inventor has made he has determined that it is possible to secure the same degree of resistance to projectiles as a given steel plate with from 33 to 50 per cent less metal. The advantage of such a plate, he points out, in addition to its high degree of resistance to penetration, is the facility with which it can be repaired.

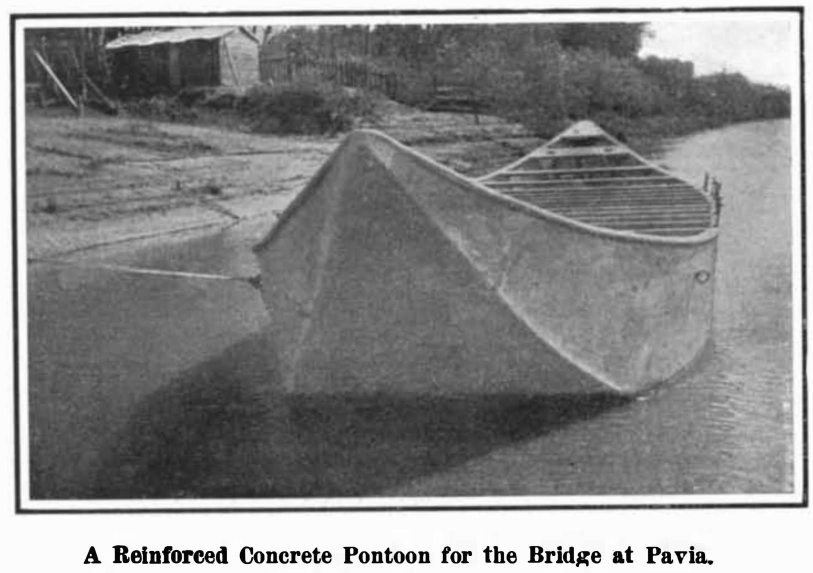
Concrete boats are not altogether a novelty in the United States. An engineering firm in Missouri has been engaged for some time in building small concrete power-propelled boats for river use.



The Pontoons Which Support the Floating Boathouse.



A Floating Bridge on the Po Supported on Reinforced Concrete Pontoons.



A Reinforced Concrete Pontoon for the Bridge at Pavia.

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Henri Becquerel.

Antoine Henri Becquerel died in Paris on August 25, 1908. With his death there has passed away one of the world's most distinguished physicists, one of a line of distinguished men of science.

Prof. Henri Becquerel was the grandson of a celebrated physicist, Antoine César Becquerel, and the son of an equally illustrious physicist, Alexandre Edmonde Becquerel. At the time of his death Henri Becquerel was professor of applied physics. When he first began his course of lectures in 1892, at the Museum, with characteristic modesty he never once referred to his own name in passing in review work of his predecessors, despite the fact that these predecessors were his father and his grandfather. His educational activities were not confined to the Museum, for he was actively engaged at the Conservatoire des Arts et Métiers, and was also one of the Chief Engineers of the Department des Ponts et Chaussées.

Henri Becquerel first came prominently before the public when he began the investigation of phosphorescent and fluorescent substances shortly after the discovery of the X-rays, for the purpose of ascertaining whether their phenomena might not be attributed to causes similar to those which give rise to the properties of the Crookes tube. He found that they projected emanations entirely different in character—emanations which have been fittingly named "Becquerel rays."

Born in 1852, Henri Becquerel entered the Ecole Polytechnique at the age of 20. The three years from 1874 to 1877 were spent at the Ecole des Ponts et Chaussées, a preparatory school in which the construction of roads and bridges and civil engineering in general is taught. Although an engineer by training, Becquerel was soon attracted to the study of pure science, following in the footsteps of his eminent grandfather and father. In 1878 he entered the Museum of Natural History, an institution with which the name of Becquerel will be ever linked. Since 1895 he filled a professor's chair at the Ecole Polytechnique. He was a member of the Academy of Sciences since 1889.

Becquerel's laboratory work was admirably systematic. For weeks he experimented and observed the results of his experiments in accordance with a well-defined plan. Probably it would not have been impossible for him to have stated far in advance what particular phase of scientific research was to have received his attention on a certain day a year hence. And this systematic plan, which he followed more or less throughout his entire career, may be considered a continuation of the work of his father and grandfather. Despite the fact that there was hardly a branch of pure science in which he did not make some important discovery, he occupied himself chiefly with the problem of those mysterious luminous phenomena which his father before him had studied, and the solution of which his grandfather had dimly foreseen. This continuity of scientific purpose and investigation lends a peculiar interest to the labors of the Becquerel dynasty.

Henri Becquerel labored long and faithfully in the fields of electricity, magnetism, optics, and meteorology, but the researches which he carried on in these fields are really part of a well-defined system having for its object the study of electro-optic phenomena such as the invisible infra-red spectrum and the absorption of light. All his investigations were carried on in the physical laboratory of the Museum of Natural History which was the scene of the labors of his father and grandfather before him. Starting with Faraday's splendid discovery of the relation of electro-magnetism to light, Becquerel succeeded in showing the existence of a fundamental relation between the rotary magnetic power of bodies and a very simple function of their index of refraction. The limitations of this article prevent me from following in detail the interesting development of Becquerel's theories. Hundreds of observations were made which lead to the conclusion that the phenomena of electro-magnetism are intimately connected with the speed of propagation of luminous waves, and to an inter-molecular magnetic action. Negative rotations in the plane of rotation of light were studied minutely, and clearly and simply explained. The Faraday phenomena were discovered in gases, an entirely new domain, by means of wonderfully ingenious and sensitive apparatus. The magnetic influence of the earth as part of this systematic plan of investigation was likewise studied, and the results obtained have fully confirmed the conclusions which have been inductively drawn by scientists. So far, indeed, were these investigations carried, that a method was devised for determining the rotary magnetic power of a body, and of ascertaining by simple optical measurements the absolute intensity of terrestrial magnetism. Naturally Becquerel was ready to approach from an entirely new standpoint the phenomena of atmospheric polarization, with the result that he had made discoveries that are ill described by the simple word "startling."

Becquerel's study of invisible infra-red radiations was not the least interesting work which he accomplished. Here he followed directly in the footsteps of his father, who had discovered that these thermo-rays cause the phosphorescence of a substance which has been previously rendered luminous. This may be said in a measure to be the starting-point of the discovery of the radio-activity of matter. By projecting on a phosphorescent surface discontinuous spectra of incandescent metallic vapors, he discovered a series of rays, the existence of which had never been suspected. He was thus led to examine the invisible vapors of different metals. This opened up an entirely new field in spectroscopy.

Becquerel's interesting investigations of the absorption of light by various bodies bring us nearer to the subject of radio-activity; for the compounds of uranium were used in studying the phenomena of phosphorescence. He proved the variability of the spectra with the direction of the luminous vibrations by which they were traversed. All these researches led to a new method of spectrum analysis, based on the independence of the various substances of which a single crystal is composed, and rendering it possible to determine the structure of the crystal without fracture. It was this work that earned for him a place among the members of the Academy of Sciences. While continuing his studies of phosphorescence and light, he still found time to investigate fluorine.

It is impossible in the brief space at my disposal to enumerate all the discoveries which have been made by Prof. Becquerel. A modern scientific bibliography, however, would be very largely composed of studies bearing his name; they would include monographs of all kinds on radio-active substances and radio-activity.

The Rateau System of Power Generation from Exhaust Steam.

Of late there has been a very considerable amount of work done in the reclaiming of the large powers usually dispersed to waste in the exhaust of the heavy power engines of mines and steel works. The common type of hoisting engine running with high-pressure steam and exhausting to atmosphere is by itself an extremely inefficient power unit. It has for many years been apparent that some means of collecting and utilizing the considerable energy carried in these high-pressure exhausts would introduce great economies in the working cost of an establishment. With the development of the steam turbine it became evident that here was a machine suitable in every way for operation, in conjunction with a condenser, at a steam supply of atmospheric or slightly higher pressure, but to adapt the low-pressure turbine for operation with the exhaust steam of winding or rolling mill engines meant facing the difficulty that such a steam supply is extremely intermittent. It became necessary, therefore, to devise some means of leveling the pressure or supply of the exhaust steam available so that the turbine should receive steam supply constant in pressure and volume. Prof. Rateau, of the School of Mines, Paris, invented and patented what he terms heat accumulators, which, interposed between the main engine exhaust and the turbine supply, serve the purpose of economically receiving and storing the exhaust steam, giving up a constant pressure supply to the turbine. The first working application of this system was made in France in the year 1902 and its success is well exemplified by the very many similar installations which are now at work in England, on the Continent, and in America. The first plant to be put down in Great Britain was that of the Steel Company of Scotland for their Hallside works in May, 1905.

As will be readily understood, the accumulator is the essential feature of this modern means of generating power from exhaust steam. This invention is based upon the well-known principle regarding the reciprocal action of saturated steam and steam-saturated water; when these two fluids are brought together they preserve a state of equilibrium, and any variation in this balance determines the transformation of either steam to water or water to steam with a definite heat liberation or absorption respectively. This principle is applied in a number of types of accumulator, any one of which may be adopted as desired by the engineer or as deemed expedient under certain local conditions. The most usual form of accumulator, known as the water type, consists of a cylindrical shell carrying two or more oval perforated tubes running throughout its length. The main engine exhaust feeds into the oval tubes and is spread or dispersed into the water which just covers the tubes, a baffle plate over the tubes serving to prevent priming of the accumulator, from the upper portion of which steam is drawn direct for the turbine supply. Several of these accumulators may be used where large powers are handled, or a large single accumulator can be arranged with two or more compartments divided off by a suitable horizontal diaphragm. The accumulator is fitted with the necessary special automatic relief valves, draw valves, water level regulators, gages, etc. As will be understood, the arrangement of the long, finely perforated tubes insures the thorough and rapid circulation of the water. In other types the circulation of the water has been obtained by means of steam injection, pumping water over trays, and mechanical agitation.

Another type of accumulator which is giving every satisfaction in use is one which consists of an inclosed vessel packed with a very large quantity of scrap iron so that an enormous surface of metal is interposed in the main engine exhaust. Thus in some few cases where old rails and other similar metals abound an old boiler shell has been packed with these and served very well as an accumulator. It will be evident in this case that the regeneration depends upon the quantity of water condensed by the mass of rails and held up in the interstices between them.—The Electrical Magazine.

The Current Supplement.

The current Supplement, No. 1705, presents an excellent portrait of the late Prof. Henri Becquerel. The fourth dimension is simply discussed by H. Addington Bruce. In an excellent article Ernest Solvay discusses some novel ideas suggested by the experiments of Myers, Dixon, Baker, Lebeau, and others to formulate the general principles which distinguish absolute physico-chemical reactions between absolutely pure substances from thermo-catalytic reactions effected by an organization which is developed under the influence of foreign bodies. In other words, Mr. Solvay shows the relation which physico-chemistry bears to biology. Under the title "An Economical Fire Alarm," an article is published which describes how a locomotive tire can be used as a village fire-alarm bell. The Bellini-Tosi experiments in directive wireless telegraphy are described in detail. The second installment of the article on Galvanizing appears. "Free Lime in Cement" is the title of an article which gives many a useful suggestion. H. M. Ripley writes competently on applications of oil-burning apparatus. Physiology has long since passed the stage where unaided observation alone is of value, and has become pre-eminently an experimental science. Its modern tendencies are excellently set forth by Prof. Frederic Schiller Lee of Columbia University. Pictures of the wreck of the Zeppelin airship are also published, and an account of the circumstance which brought about the destruction of the great craft.

Current Rushes During Switching.

In a recent issue of the Electric Journal, Mr. J. S. Peck deals with the current rushes at switching on transformers. When transformers at low frequencies—25 to 33 alternations—are switched on to a circuit there are at times heavy rushes of current sufficient to open circuit-breakers, although these may be set for a current much in excess of the full-load current. It is shown that these take place when the phase of the impressed voltage is at or near zero, since if there happens to be no residual magnetism in the transformer and the switching on is at the instant the impressed voltage is zero, the maximum induction in the iron will be double the normal induction, and the primary current double or more than the normal; the effect of the ohmic resistance will be to reduce the current to the normal after a few complete periods have elapsed. The effect of residual magnetism will be either to increase or reduce the maximum value of the induction, according to its value and direction, in relation to the phase of the impressed voltage at the instant of switching. The reason that this phenomenon is practically unknown at high frequency is that on these circuits transformers are seldom worked at a higher induction than 6,000 c.g.s.-lines per square centimeter, while on 25 alternation circuits inductions of twice this value are adopted.

The use of kieselguhr in Germany is now very extensive, states the United States consul at Chemnitz, who furnishes the following information concerning the deposits of infusorial earth in Germany and the articles manufactured therefrom: Large amounts are employed in the manufacture of dynamite, where the remarkable absorbent properties of the material come into play. Its use alone as a fertilizer, and also in the preparation of artificial fertilizers, especially in the absorption of liquid manures, is widespread. There is also an extended use of the earth for rapid filtration purposes, as well as for covering steam pipes, lining refrigerators, and filling the walls of fireproof safes. In the manufacture of water glass, of various cements, of glazing for tiles, of artificial stone, of ultramarine and various pigments, of aniline and alizarin colors, of paper, sealing wax, fireworks, gutta-percha objects, Swedish matches, solidified bromine, scouring powders, papier-maché, and a variety of other articles, there is a large and steadily growing demand. For some of the purposes in question, and especially when kieselguhr is used to absorb nitro-glycerine in the preparation of dynamite, it is of prime importance that the earth should be freed as far as possible from moisture.