wooden rim shaped exactly like that which was once fitted within the chariot body.

Such is the delicacy of its workmanship, that the vehicle could hardly have been used as a war chariot. Perhaps it was an *ex voto*, or a ceremonial chariot used by its noble owner on rare occasions. Its workmanship is so delicate that it could hardly have withstood the kick of a horse. Indeed, a frieze that runs about the bottom of the body seems to have been partially destroyed by the heels of animals. In size, the *biga* is quite small. Its entire height is not more than four feet; the wheels have a diameter of about two feet. The thin plates of bronze with which the chariot is covered are elaborately ornamented with symbolical figures, and with decorations so minute that they hardly appear in the photographic reproductions herewith presented. The horses which drew the vehicle must have been small, probably not larger than ponies, judging from the length of the pole.

The copper throughout is hardly as thick as a thin sheet of cardboard. A small nude figure is placed at either side of the central panel at the juncture with the others, and a sculptured band, parts of which have probably been kicked away by the horses, runs around the chariot below. The wheels have no decoration except that eagles' heads appear at the ends of the axle.

The meaning of the figures on the front and side panels has not as yet been definitely determined. The *motif* of the front panel is the passing of a shield and helmet. Alexander S. Murray, the British Museum's well-known authority, has given it as his opinion that the decoration represents Thetis handing a shield and helmet to Achilles. Gen. Di Cesnola believes that the figures are those of Hercules and Minerva, basing his theory upon the manner in which the objects are passed. When one soldier offers his helmet to another, he does it so that the recipient can most readily place it upon his head. From this circumstance, it may be concluded that the god is presenting the shield and helmet, and not the goddess. Furthermore, the symbolical decorations of the shield are those peculiarly associated with Hercules. At this early period of art, the lion's head, the emblem of Hercules, was not placed upon the hero's head, but was confined to his shield, a fact which the director of the museum has had ample opportunity of verifying in the admirable Cyprus collection forming a part of the museum's treasures. Curiously enough, the shield has been placed so that the lion's head appears at the bottom in an inverted position. Still another feature of the decoration of this front panel, which bears out the assumption that the figures are those of Hercules and Minerva, is to be found in the votive offering of a doe, which graces the bottom of the panel beneath the shield. From time immemorial it was the custom of Greek warriors to sacrifice to the temple god when any favor was asked. Obviously, in transferring his shield and helmet to Minerva, Hercules is beseeching divine favor, and his prayer is accompanied by the usual sacrifice of a living thing.

The side panels, according to Gen. Di Cesnola, also symbolize the deeds of Hercules. The panel to the left probably represent Hercules killing one of Laomedon's children. A brief recapitulation of the myth will show how plausible the theory is. Laomedon was the son of Ilus and Eurydice, the father of Priam, founder and King of Troy. For an offense against Poseidon he was forced to offer his daughter Hesione to a sea monster. Hercules found her chained to a rock, and agreed to free her for a pair of magical horses which Zeus had given to Laomedon in exchange for Ganymede. Laomedon failed to keep his promise. Hercules waged battle against him, slew him and all his sons, except Priam. In the panel, one of the daughters lies prostrate. The triumphant Hercules has secured the magical horses and has harnessed them to a chariot, in shape much like that of the vehicle upon which the decoration appears. Particular attention should be called to the peculiar curving of the wings of the magical horses, a formation which is found frequently in the symbolical statues of archaic Greek art. The left panel of the chariot may represent Hercules killing Laomedon, father of Priam. Here it will be observed the shield appears with the lion's head uppermost in contradistinction to the front panel. The tongue or pole of the chariot emerges from a bronze boar's head, and terminates in the head of an eagle.

Mechanically considered, the manner of forming the wheels deserves a little attention. They are made of stout wood, and have each nine spokes. The spokes and the felly are sheathed with bronze. Around the felly a heavy iron tire has been mounted. The entire construction is such that the chariot could easily bear the weight of a man.

The means for studying the symbolical decoration of the *biga* are all at hand in the Metropolitan Museum of Art. Thousands of Greek statues of all periods which are placed at the student's disposal enable him to determine with considerable accuracy the precise period to which this work of ancient craftsmanship belongs, and to fix with some definiteness the probable significance of the allegories depicted. The peculiarly-shaped shield is found in many little statuettes in the Cyprus collection. The representation of Hercules with a pointed beard, and the shield with the lion's head, both find their counterparts in many figures. Convincing proof is thus afforded that the figures represented are probably those of Hercules, Laomedon, and Minerva. Still, the question is one which has by no means been definitely answered, and which will undoubtedly give rise to no little discussion among archæologists.

Like Egyptian art, the art of the Greeks, Romans, and Etruscans in its earliest stages was severely fettered by religious conventions. The deities could be represented only in the traditional way. The ornaments of their shields and head-dresses were those which religious belief had associated with them. It is, therefore, a matter of no great difficulty to fix precisely the characters which are represented in many of the archaic statues of Greece and Italy. It is thus that we are enabled also to determine the time to which a given work of art belongs. We know that it was only after 600 B. C. that the head-dress of Hercules was a lion's head, and that before that time the lion was also placed upon his shield. We also know that in the earlier statues he appears with a pointed beard. It is by the study of such details that the date to which this chariot belongs has been placed with a fair degree of certainty between 700 and 600 B. C.

The treatment as a whole is archaic, technically extremely good and decoratively extremely felicitous. When it was new the chariot must have been a gorgeous sight. The eyes of the goddess and the warrior in the central panel, the eyes and lips in the panel of the Medusa, and the eyes of the animals had all been enameled. The reliefs too were very lightly gilded.

The bits of the horses and the yoke by which they were harnessed have also been preserved. A chart has been placed within the case of the *biga*, which shows very clearly how the yoke was probabaly attached to the pole. In passing, it may be well to mention that the jointed bit, which we are accustomed to regard as a modern invention, was a type used by the Etruscans, judging from that which has been preserved.

HUNDRED-TON NAVAL FLOATING CRANE.

In the work of a great naval dockyard like that of the New York navy yard at Brooklyn, there is a constant effort to reduce the handling of heavy material to a minimum—a most important consideration where such heavy weights as boilers, guns, and gun emplacements have to be handled. In past years this navy yard has suffered for want of adequate accommodation for the many ships that frequent it annually for repairs and refitting; and it has long been felt by the officers in charge of the various departments, particularly that of Construction and Repair, that a remodeling of the yard and the plant would mean a great saving of time and cost of work that is done there. Several years ago an exhaustive plan for the reconstruction of the yard was presented, and after the usual exasperating delay on the part of Congress, the changes were authorized and are now being carried out. These include the construction of a series of parallel docks, some of them extending from Cob dock into the East River, and others extending from the mainland into the channel between the Brooklyn shore and the Cob dock. At the same time large additions were made to the plant on shore, many new buildings were erected, and up-to-date appliances for the transporting and handling of material installed. One of the most important machines which has recently been put in service is the large 100-ton floating crane which is illustrated on the front page of this issue. The crane is designed for the special work of handling turrets, heavy guns, armor, or other massive pieces of material which may have to be put in position on warships or removed therefrom during the course of repairs. We illustrated a few weeks ago a large crane designed for this purpose, and erected at a German shipbuilding establishment. That crane was of the fixed type, being located at the edge of one of the docks, and, of course, if any ship is to avail itself of its services, it must be warped into proper position alongside the crane. The new crane at our navy yard has been built upon a floating pontoon, with the special object of securing mobility, so that it may be brought alongside of a vessel, and the time lost in moving the ship be saved.

The structure consists of a steel pontoon which measures 100 feet in length by 60 feet in breadth and 11 feet 3 inches in depth, the normal draft being 9 feet 3 inches. Above the pontoon and parallel with its longitudinal axis is carried, at a height sufficient to give a lift of 45 feet and a reach of 45 feet beyond each edge of the pontoon, a pair of trusses which form the runway for a traveling crane trolley. The runway is carried upon massive latticed posts and struts, whose position and functions will be clearly seen in our engraving. The pontoon is divided into three compartments by two longitudinal bulkheads. The center compartment is given over to a 300-ton movable counterweight, the two outer compartments containing, one the hoisting and racking engines, and the other the boilers and coal bunkers. The counterweight moves over four lines of 100-pound steel rail, and it is operated by means of an endless wire cable, which passes from the trolley to sheaves located at either end of the pontoon, and from them is led to the drum of the racking engine. At each end of the pontoon is located a tank containing a non-freezable liquid, and each of these has a floating valve which rises and falls with any alteration of the level of the pontoon. The valve is connected to a longitudinal rod, which passes along the wall of the longitudinal bulkhead and serves by its movement to control the racking engine. The mechanism is so arranged that the movement of the counterweight may be automatic, or may be directly controlled from the engineer's platform. Its action is such that when a heavy load is being lifted, the counterweight is drawn back toward the opposite end of the pontoon, to a position in which equilibrium will be maintained and the pontoon kept on a level keel. An ingenious safety clutch is provided, as shown in our illustration. This consists of a pair of heavy wedges at each end of the counterweight, which are normally held clear of the counterweight by the pull of the wire rope by which the counterweight is moved. The wedges are keyed to a horizontal shaft carried at the front of the counterweight, which has a horizontal projecting arm at its center, to which the racking cable is securely attached. Ordinarily the pull of the cable keeps the wedges lifted clear of the car; but should the cable carry away, the wedges will swing down with their own weight and become engaged between the car and the floor of the pontoon, preventing any further movement.

The hoisting ropes are of 1⅛-inch plowed steel, there being eight parts to each block. The hoisting engine cylinders are 12 inches in diameter by 15 inches stroke, and they run at a speed of 200 revolutions per minute. The counterweight engine cylinders are 11 x 18 inches, and the speed of hoisting with a full load of 100 tons is 8 feet per minute; with 50 tons on one block, 9 feet per minute; while the speed with a light load is 25 feet per minute.

The Hatching of Chickens from Preserved Eggs.

The London Lancet recently published an article describing some experiments which had been made for the purpose of determining whether eggs could be hatched which had been preserved for twelve months by immersion in a ten per cent solution of sodium. It was said in the article that chickens had been hatched from these eggs. A correspondent of the Lancet now writes to that journal, narrating some experiments which friends of his undertook for the purpose of verifying the statements made. Twelve eggs were collected in June, and immediately placed in a ten per cent solution of sodium silicate and completely covered by the solution. On September 5 four eggs were taken from the solution and marked and with nine other newly-laid eggs were placed under a hen. All the newly-laid eggs hatched out within three weeks, but the four preserved eggs did not hatch. One of these eggs was boiled and was quite fresh; the other three were broken and the yolk fell out separately from the white. The whites were whipped up and became quite stiff. This is stated to be the best test of a fresh egg. It is of interest to note that these preserved eggs, even when they had been incubated for three weeks, still remain perfectly fresh, seeming to indicate that the shells were still impermeable to external influences.

Assuming that the remarkable preserving effect of the sodium silicate is due to the formation of an insoluble glass with the lime salts of the substance of the shell it is curious that it has been possible to hatch out a chicken without first making the shell again permeable to air. The experiment is one which should be repeated after the shell has by some method again been rendered permeable, for it seems improbable that the hatching of such preserved eggs can take place if the shell remains impermeable to air.

The Current Supplement.

The current SUPPLEMENT, No. 1456, presents the first installment of an article on the Viennese Metropolitan Railway, a road which should be of no little interest to those who have been witnessing the development of rapid transit in New York, Boston, and Chicago within late years. The article is illustrated with photographs that clearly show the engineering features of the work. O. F. Cook writes upon the Central American rubber tree. D. E. Salmon, Chief of the United States Bureau of Animal Industry, read a paper at the recent Farmers' National Congress on Infectious and Contagious Diseases of Farm Animals and Their Effect on American Agriculture. The paper is republished in the SUPPLEMENT. Lord Kelvin in a pleasant way recounts his early training in natural philosophy, and presents an interesting picture of his first teacher. The usual Trade Notes, Selected Formulæ and Consular Reports will be found in their proper places.

Aluminium Plate Printing.

BY PALMER H. LANGDON.

Revolutions in the industrial arts are becoming more common in these days of comparative peace than revolutions political, and such an industrial revolution is now taking place in the branch of printing known as lithography. It is a change which has come with the discovery of a new printing material—aluminium—and which has in turn made it necessary to build entirely new types of printing presses and to change the methods and shop practice of lithographic plants. Before describing this remarkable industrial revolution, it is essential that the various classes of printing be mentioned.

Printing may be classed under three heads. One method is relief printing, in which the design to be printed is raised above the surface of the printing plate. This method includes all type printing, which means that all newspapers come under the head of relief printing.

A second method is intaglio printing, in which the design is cut into a metal plate, the lines, etc., lying below the surface. Steel-plate printing is the most common form of intaglio printing, and intaglio is also popularly known in the form of calling cards, which are printed from engraved copper plates. Intaglio printing is practically limited to hand work, and is consequently slow and expensive.

The third branch of the printer's art is designated as surface printing, in which the design is neither cut below the surface nor is raised above the surface, but lies on the surface. By this method are printed the theatrical and circus posters, fashion plates, insurance policies, portraits, and the great bulk of prints produced in colors, and which are termed color work. Surface printing is far the youngest branch of the printing industry, for it was but a little over a century ago that Alois Senefelder, at Munich, Germany, discovered that a certain quality of lime rock now known as lithographic stone had the property of absorbing sufficiently a design or drawing in ink, to make a reprint of the very drawing without raising or depressing any part of the stone surface.

A picture or design is drawn upon the stone in greasy ink; this the stone absorbs. By washing the surface with an acid solution and gum arabic, the greasy design is rendered insoluble in water, and at the same time those portions of the surface not occupied by the greasy design have attached to them a film of gum arabic, which has an affinity for water. Water and grease will not mix—they are mutually repellent. It is upon this principle that surface printing is based. When the design is ready to print, first a wet roller is passed over the surface—the water adheres to the surface everywhere except where the greasy design lies; there the grease rejects the water. Then the ink roller is passed over the same surface, and the water-covered portions reject the ink, which adheres only to the greasy design. The design being thus inked, the paper is pressed against it and receives an impression of the picture or design. But stone, fine as it is for surface printing, is a cumbersome, fragile material, and the supply is limited. If lithography was to grow like other branches of the printer's art, what was to take the place of stone, which was steadily increasing in price? Lithographers had many years ago experimented with the different metals, but none, with the exception of zinc, was found to possess the right texture and porosity essential for surface printing. Zinc, for which the lithographic trade had high hopes, proved to be of limited capabilities, and lithographers found again that they must rely on stone or find a more suitable material.

Some ten years ago aluminium began to be manufactured in a sufficient quantity to make it commercially useful, and it was soon discovered that this light, white metal could be treated in a way which would give it the property of printing like lithographic stone. The treatment of the metal differed slightly from the preparation of the slabs of the stone. Sheet aluminium was ground with pumice stone to give it an open grain, and then subjected to an acid treatment, which after a number of experiments was found necessary to give the plate the proper surface. The plates were then fastened on blocks, placed on the old flatbed presses, and it was but a short time before the experimenters were able to do creditable color work from aluminium plates. The new aluminium art had developed sufficiently to exhibit work at the centennial held in New York a few years ago to commemorate the discovery of surface printing.

However, the progressive minds were not content to print from aluminium plates in the old-fashioned way, but they must have a new style of machine to do the printing; and it is right here that the revolution is taking place in the complete change of surface printing machinery, which at the present time is going on in lithographic establishments all over the world. It is pleasing to record in passing that America has led in the revolution, and is supplying the revolutionary machinery—so to speak—to Europe, the Orient, and the Occident.

As long as stone was the only surface printing material, only one form of press, that known as the flatbed, was practical. This form of press has a heavy swinging bed, is of slow motion, and is noisy. With a metallic plate it was possible to bend the metal to a cylinder, thus applying the principle of revolution, and making it necessary to build a rotary press. When the press builders were convinced that printing from aluminium plates was no longer an experiment, they quickly put on the market a press especially built for metal plates, and by applying the rotary motion mentioned, were able to get twice as many impressions as from the slow-moving flatbed. With the rotary press it was simply passing the paper sheets between two cylinders, as clothes are passed through a laundry wringer.

When it had been demonstrated that the rotary press was a thoroughly practical machine, the builders decided to go a step further and build a press that would print two colors at one time—a two-color rotary. Never had it been commercially possible in lithography to print two colors from stone in one run through the old flatbed press. Inventors, lithographers, and press builders have striven for years to perfect a machine which would allow them to put on the various colors of a picture in one run through a press. Hundreds of thousands of dollars had been spent and years of time consumed toward this end, but without practical results. The application of surface printing remained the same as in Senefelder's day, viz., that each color is printed separately from the stone, and that if there were ten colors to form the complete picture, there must be ten separate prints made on the press, and each in perfect register with the others.

A perfect register is obtainable in a rotary press, and from the form of construction of the machine it was possible to put in a third cylinder and an additional set of rollers, and put two colors on the sheet of white paper before it had passed through the press. Great as this improvement is in surface-printing machinery, lithographers believe it is but a step to a three-color press, when by the wonderful finished effects which are obtainable with the combination of three colors, it would make three-color lithography, or more properly speaking three-color algraphy, a triumph in the graphic arts.

But it is not alone a gain in multicolor printing which has been brought about by the aluminium plate and the rotary press, but it is the great gain which is accomplished with the single-color rotary, and which at the present time is more widely used. The largest size stone generally used on a flatbed press measured 44 x 64 inches and weighed 1,200 pounds. The same size aluminium plate weighs but 12 pounds. It is possible to make 12,000 impressions a day from a rotary. With stone 5,000 prints is considered a good day's run. The motion of the rotary is continuous, while that of the flatbed is reciprocatory. The difference in motion of the two might aptly be compared with the difference in motion of the steam engine and the electric motor. With the introduction of the rotary there has been indeed a revolution in lithographic establishments, until some of the larger shops now print 90 per cent of their work from aluminium plates and rotary presses. As most of the lithographic plants are located in large cities where storage room is limited, the smaller space taken up by a plate is a particular advantage. A stone of the average size four inches in thickness requires thirty times the space of a one-sixteenth inch plate.

The revolution, however, is not taking place with the haste of the French revolution of history, but is a gradual change from the old method to the new. Stone and the flat bed are still used exclusively by the majority of the litho shops—though this majority is steadily diminishing—and particularly for the class of surface printing known as commercial work. Where there is no color work, stone is preferred. Commercial work borders on relief printing, and no method has as yet been devised whereby the aluminium can be etched high enough to print such fine lines as the stone. There is hope, however, that invention will give a process which will overcome this difficulty, and that even commercial work will be produced entirely from aluminium plates.

In the Zeitschrift of the German Engineers' Association, Mr. L. Austin describes experiments made at Charlottenburg on the co-efficient of thermal surface-conductivity across the surface of separation of a solid and a fluid, giving the following results: From metal to water at the boiling point the resistance is equivalent to a thickness of ½ centimeter to 2 centimeters of iron, but is reduced by stirring by an amount equivalent to about 0.75 centimeter of iron. The resistance increases as the temperature falls, reaching a maximum of 10 centimeters of iron, which is reduced by 1 centimeter by stirring. For flow of heat from water to metal, the resistance appears greater than for the reverse flow if the water is undisturbed, and about the same when the water is stirred.

Correspondence.

In Memoriam of Robert Henry Thurston.

To the Editor of the SCIENTIFIC AMERICAN:

The class of 1904, Sibley College, has requested that a copy of the following resolutions be sent to you, and we hope that you will favor us by publishing the same.

RESOLUTIONS.

Whereas, It has pleased the Almighty God, in His infinite wisdom, to call from among us our Head, Robert Henry Thurston, Director of Sibley College, Cornell University; be it therefore

Resolved, That we, the members of the Senior Class of Sibley College, individually and as a body, feel the loss sustained by this class and college to be unspeakable.

That we mourn him not only as our respected Teacher and Director, but as a true friend of every member of the class.

That we deeply appreciate the exceptional opportunities of having been under his instruction and of having enjoyed the advantages of personal contact with this ideal member of our future profession. Further be it

Resolved, That a copy of these resolutions be sent with our deepest sympathy to his bereaved family.

That a copy of these resolutions be published in the college papers and in the leading engineering journals of the scientific world; and

That a copy of these resolutions be duly engraved and placed in Sibley Hall.

CLASS OF 1904, SIBLEY COLLEGE, CORNELL UNIVERSITY.

HURD ALDRICH,
Committee: R. W. ROGERS,
W. S. FINLAY, JR.

Cornell University, Ithaca, N. Y., November 18, 1903.

The Ninety-Footers.

To the Editor of the SCIENTIFIC AMERICAN:

I have read with great interest your article on the subject, "Is Yacht Designing an Exact Science?"

The anomalies you refer to in the relative performances of "Reliance" and "Shamrock" in light and strong winds can, I think, be shown to be not real, but apparent only.

You say experts predicted that "Shamrock" would relatively do better in light winds because of her lesser wetted surface. But the question of wetted surface must be considered *in relation to sail area.* "Reliance" had close on 2,000 square feet more sail, an area equal to "Reliance's" biggest jack yard topsail. She carried 14 per cent more sail than "Shamrock" on a hull of the same length of waterline, and allowing for "Reliance's" greater wetted surface, it is probable that "Reliance" carried at least 10 per cent more sail *per square foot of wetted surface.*

I contend that the performance of "Reliance" in light winds fully accords with theory if her sail area per square foot of wetted surface exceeds that of "Shamrock," about which there can be no doubt.

In regard to the relatively better performance of "Shamrock" in strong winds reaching, which should in theory be "Reliance's" best point, I think the comparatively good performance of "Shamrock" in strong winds can be accounted for in three ways: First, a cutter of such immense rig as "Reliance" would be more difficult to manage in strong winds and the small sail plan of "Shamrock" would be more effective in proportion to its size. Secondly, "Shamrock's" area of cross-section may be very little larger than "Reliance's," and if this is correct, her relative fineness of hull will be very little fuller. Owing to her shallowness of hull and extreme overhangs, "Reliance's" buttock and diagonal lines will of course be much finer than "Shamrock's," but "Shamrock's" water lines, on the other hand, are much finer, and consequently it is probable there is not much difference in the relative fineness of the hulls of the two boats. If these assumptions are correct, it is in accord with theory that "Shamrock" should develop high speed in conditions favorable thereto. Thirdly, the finer waterlines and sweeter form of "Shamrock" would of necessity cause her to take more kindly to rough water.

It will be remembered that in the trial races on the Clyde, while "Valkyrie III." could sail rings round "Britannia" in light winds, "Britannia" beat "Valkyrie" in strong breezes. The differences in type between these two boats were more pronounced than in the case of the "Reliance" and "Shamrock," but otherwise I think the cases are analogous.

ARCH. BUCHANAN.

Auckland, N. Z., October 15, 1903.

The new leviathan "Baltic," for the White Star Line of the Morgan shipping combine, is rapidly approaching completion at the Belfast shipbuilding yard of Harland & Wolff. This steamship when launched will be the largest vessel afloat, exceeding the "Cedric" by 3,000 tons. The tonnage of the "Baltic" will approximate 24,000 tons.

SCIENTIFIC AMERICAN

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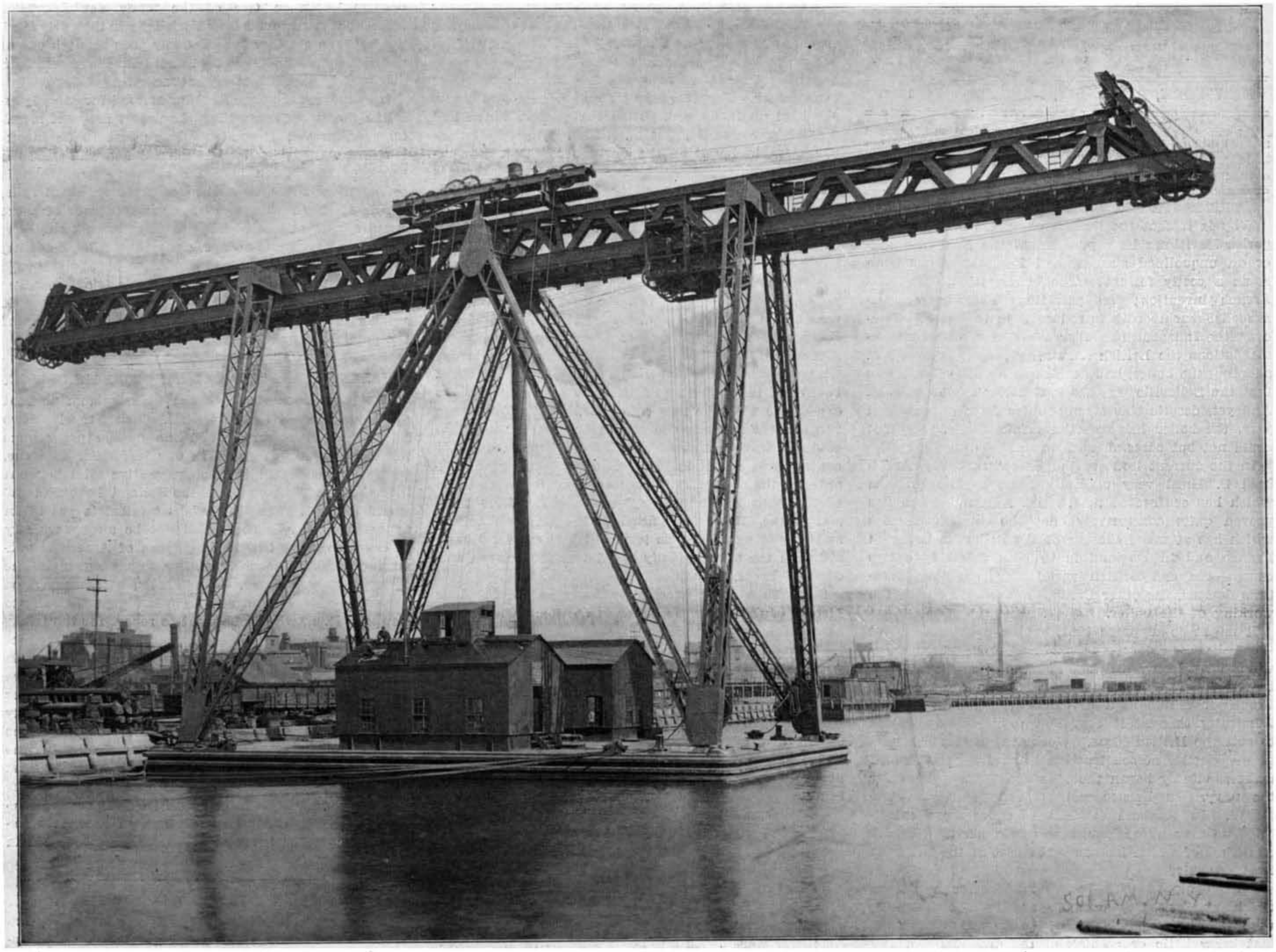
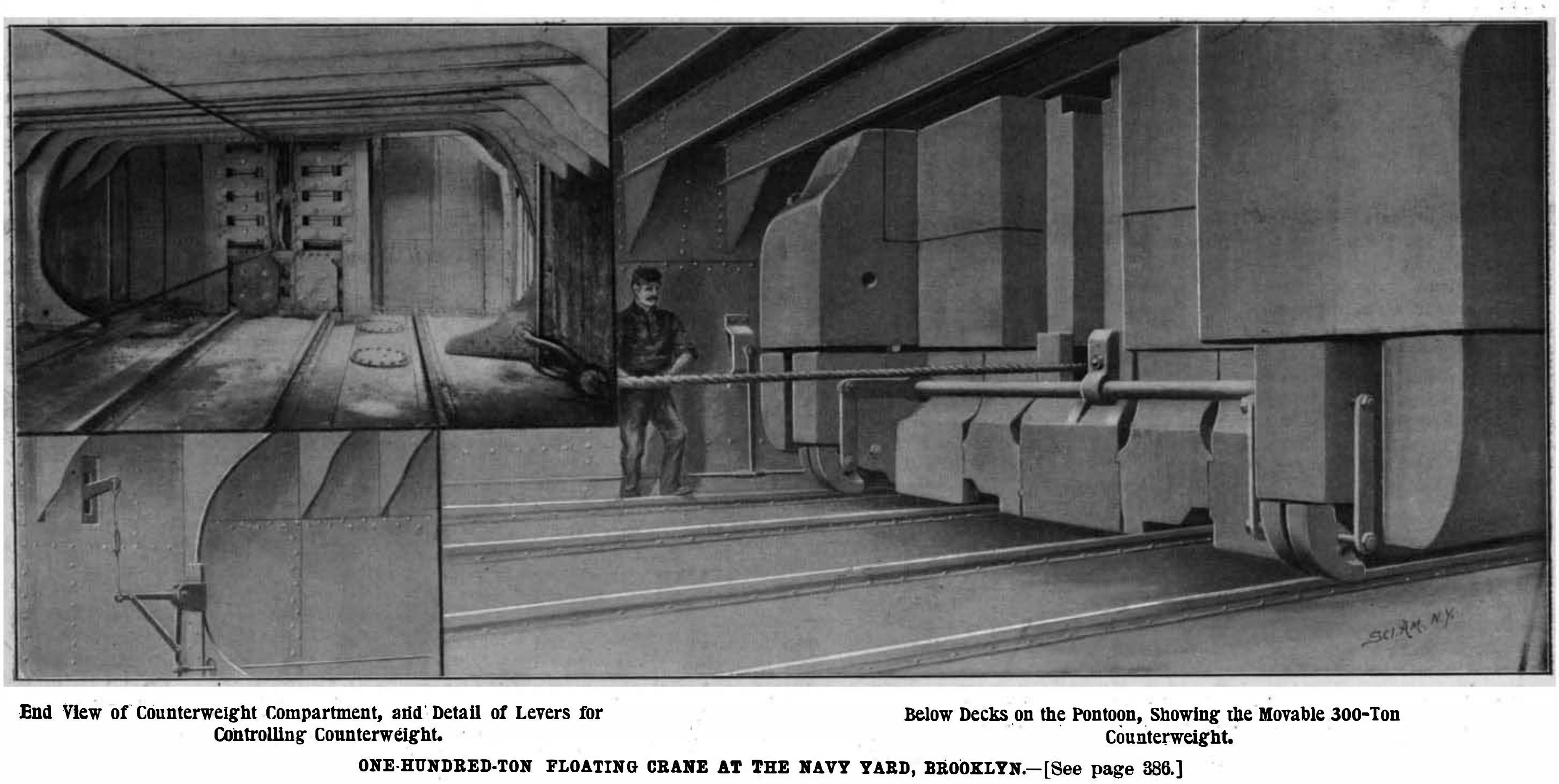


Photo. by E. Muller by permission of Commandant of Navy Yard.

New One Hundred-Ton Floating Crane.



End View of Counterweight Compartment, and Detail of Levers for Controlling Counterweight.

Below Decks on the Pontoon, Showing the Movable 300-Ton Counterweight.

ONE-HUNDRED-TON FLOATING CRANE AT THE NAVY YARD, BROOKLYN.—[See page 386.]