No. 710,658. Patented Oct. 7, 1902.

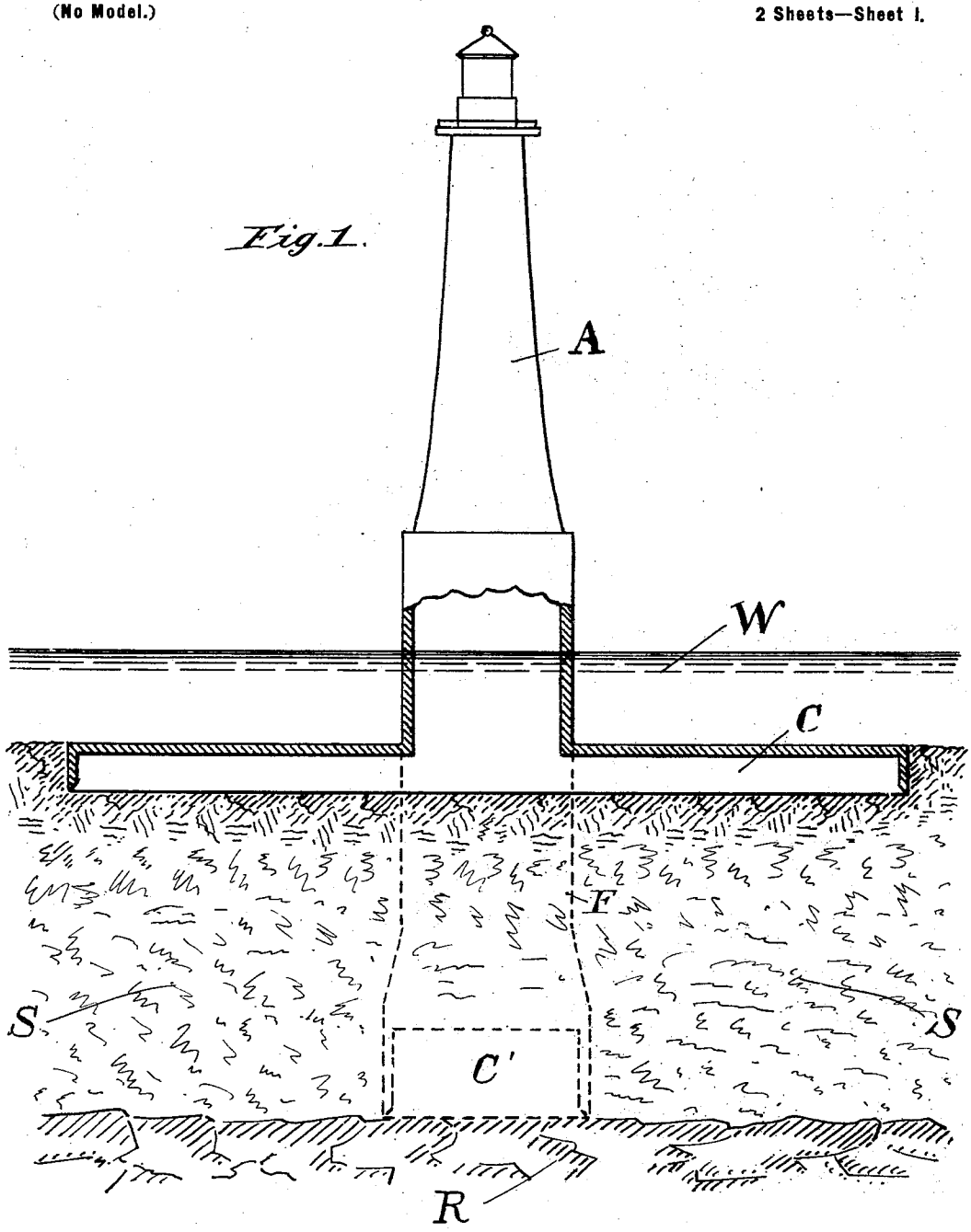
E. BECKER.

METHOD OF ERECTING MARINE STRUCTURES.

(Application filed May 10, 1902.)

(No Model.) 2 Sheets—Sheet 1.

Fig. 1.



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B. Riggs

Inventor:
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THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

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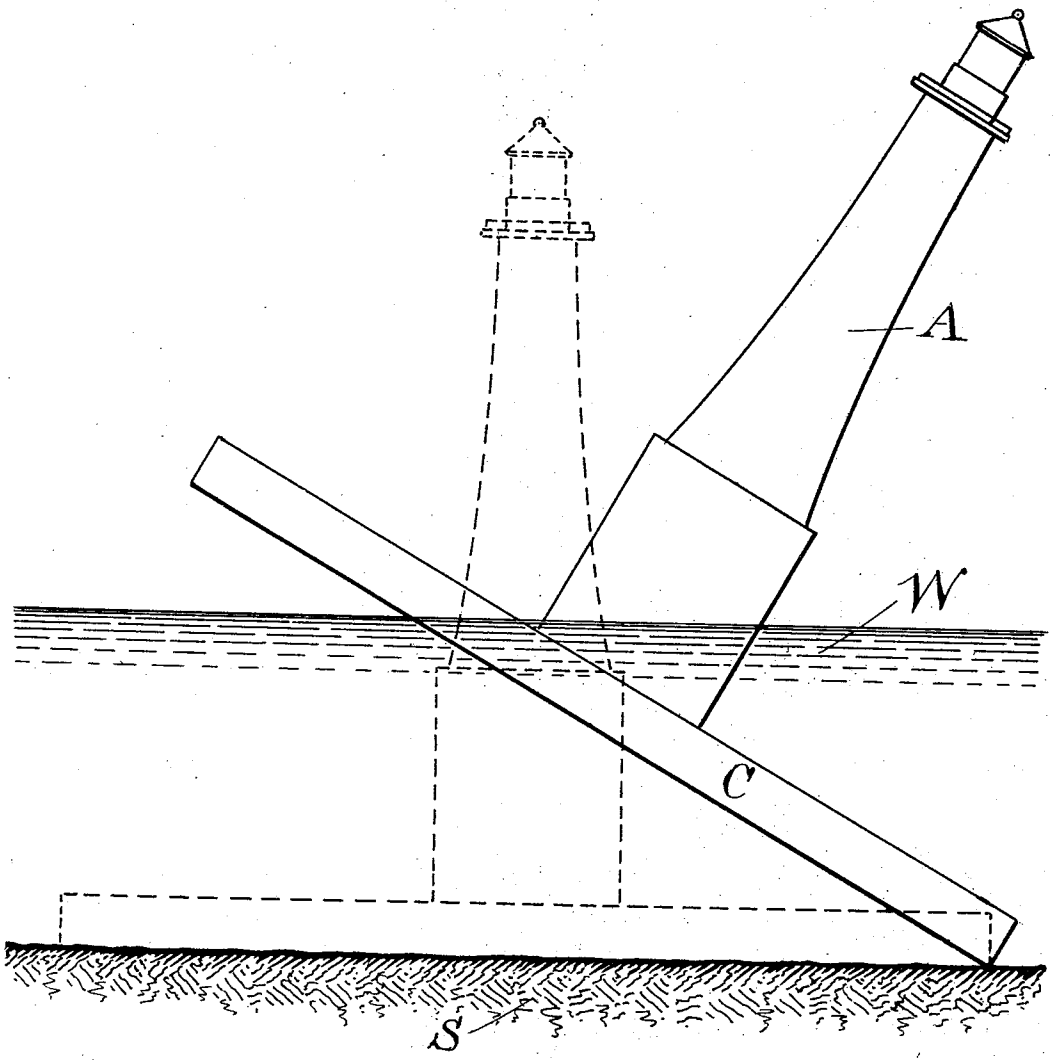
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(Application filed May 10, 1902.)

(No Model.) 2 Sheets—Sheet 2.

Fig. 2



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UNITED STATES PATENT OFFICE.

EDMUND BECKER, OF WASHINGTON, DISTRICT OF COLUMBIA.

METHOD OF ERECTING MARINE STRUCTURES.

SPECIFICATION forming part of Letters Patent No. 710,658, dated October 7, 1902.

Application filed May 10, 1902. Serial No. 106,806. (No model.)

To all whom it may concern:

Be it known that I, EDMUND BECKER, a citizen of the United States, residing at Washington, District of Columbia, have invented certain new and useful Improvements in Marine Structures and in Methods of Erecting the Same, of which the following is a specification.

My invention is an improvement in those methods of establishing subaqueous structures in which the foundation and its superstructure are built and assembled to form an integral structure which is floated from the place of construction to its destination, where it is to be set in place by being first grounded and then sunk into the soil.

The general object of my invention is to cure the old method of the principal defects which have caused its failures and restricted its general usefulness; and the main object of my invention is to avoid the dangers of scouring during erection of the structure. My method results in a new and improved marine structure which has, with other advantages, a high factor of stability and which is permanently safe against undermining by scouring. Scouring is a washing away of the soil at the foot of upright marine structures and is caused by the eddies and whirls generated in the moving waters as they meet with the structure. This destructive agency where it exists is a constant menace to the safety of marine structures and is also one of the great evils to contend with in erecting them, as may be seen by perusal of the reports of the United States Light-House Board. The report of 1886, on page 127, gives an idea of the magnitude of scouring effects met with in the sinking of the light-tower of Fourteen-Foot Bank, and the report of 1891, on page 91, describes the complete swamping and destruction of the Anderson and Barr tower at Diamond Shoal. It may be assumed under ordinary circumstances that the scouring action does not extend in any direction farther than one and a half diameters from the base of the tower. It rarely extends farther except where the free motion of the water is further interfered with by piling riprap around the foot of the tower. Riprap is, moreover, a form of protection that is expensive—that is, subject to be washed in and that requires constant attention and renewal. I do away with the expensive and unreliable riprap and avoid the dangers of scouring both during and after erection, and I also secure other great advantages by extending the foundation laterally outward beyond the range of the scouring action due to the tower and by sinking the whole structure only so much as is necessary to make the lateral extension a continuation and virtually part of the sea-bottom.

In the accompanying drawings, Figure 1 is an elevation, partly in section, of a light-tower erected according to my invention; and Fig. 2 is a similar view of the same as it appears in two different phases of the process of erection.

I use a rigid base C of the greatest practicable horizontal extent, upon which I erect the greater part or all of the pier or tower A, so that the two shall form an integral or rigid compound structure. This structure is to be floated as a whole from the place of construction to destination, where it is allowed to simply sink of itself without any preliminary grading, piling, planking, cementing, or other preparation of the natural bottom S. After being grounded the structure is further sunk by excavating until its base C is embedded in and flush with the sea-bottom. The total height of base and attached superstructure should be greater than the height of the water-level over the soil at the final place of erection or destination. It will be convenient hereinafter to express the same idea by stating that the height of the compound structure must exceed the depth of the water at the final place of erection. The base itself is made shallow. It must extend laterally beyond the range of scour and must also have the surface necessary to reduce the load per unit of supporting-surface well below the safe limit as estimated from the nature and general conditions of the bottom. I prefer, however, to make it of greater extent than required by these conditions, and I therefore make it as wide and as long as it can be made without exceeding the intended cost. Great extent of base permits of planning the structure so it shall be self-buoyant and non-capsizable—that is, so as to dispense entirely with scaffolds, floating and sinking or other

external apparatus, which when used in running water must necessarily cause scour or spread scouring action. It will thus be seen that the tower or pier, with its footing, constitutes a structure which provides within its own outline means for rendering it stable, self-buoyant, and self-sinkable and that this outline, which is its protection against scour, can be preserved throughout the process of erection. The protective outline need not be preserved, however, except from the moment of grounding, and therefore auxiliary floats that do change the outline could be used if the same should in any case be required for conveying the structure from the place of construction to the final place of erection. The operation of grounding requires no special precautions, for the base is so extensive as compared with the depth of the water at the final place of erection that it will strike bottom with one edge before the structure can be inclined to the capsizing-point. If the structure is leaned even as much as indicated in full lines, Fig. 2, it will by virtue of the great purchase of the righting force simply turn on such edge as on a hinge until the base rests flat on the soil, as shown in dotted lines. When the structure has been towed to destination and grounded—that is, sunk to the position indicated by dotted lines in Fig. 2—it is stable, and the work of sinking into the soil can be proceeded with leisurely and in perfect safety regardless of the weather. Even where the bottom is inclined there is no danger, because of the extensive hold had by the edges of the raft and also because of the great factor of stability of my structure as a whole. Should any scour occur at the edges of the raft before the same is intentionally sunk into the soil, the structure would sink until the base C had sunk flush with the soil S. The sinking would necessarily be uneven and require subsequent correction; but with a base as extensive as mine it would neither endanger the stability of the structure nor throw it much out of plumb. Where the bottom is solid, there can be no danger of scour, and no sinking into the soil is required except for arighting.

I prefer to build my base C in the form of a caisson and have so shown it in the diagram; but any raft-like foundation which may be floated, submerged, and then sunk into the ground will answer. In the drawings the edge of the base C is at two diameters from the tower, so it shall be well outside of the scouring-whirls. This proportion is not absolute; but in ordinary cases it secures full protection against scour and certainty that the base will strike bottom before the structure can be leaned to the capsizing-point. At the same time it reduces the load per unit of bearing-surface to about one-twentieth of what it would be according to the usual practice. The margin of safety is so large that borings for testing the soil become superfluous. As such borings are costly and often unreliable and also cause delays, the possibility of dispensing with them is a great advantage. My caisson may be higher than shown. I prefer, however, to make it not higher than required to secure the needed transverse stiffness and the buoyancy necessary for floating the structure. In this way I reduce the draft, which is already very light owing to the great horizontal extent. Light draft is so great an advantage where shoals are shallow that upon it alone may depend the practicability of erecting a tower in a given location. When the structure, which is non-capsizable, is also made self-buoyant and self-sinkable, the process of building and erecting in all its completeness reduces itself to the following simple steps, which are all performed without the aid of external apparatus except such as may be required for towing, to wit: first, building at the nearest convenient place a rigid base of the horizontal extent and of the height determined by the conditions specified above; second, building on this base a rigid superstructure firmly connected with the base to form a rigid compound structure having a total height greater than the depth of the water at the final place of erection; third, floating to the final place of erection; fourth, grounding; fifth, excavating to righten the structure and to sink the footing into and substantially flush with the soil; sixth, completing the tower or pier. I prefer to design the base to float the whole of the tower, as shown in Fig. 2, so the tower may be completed in the second operation. This is generally possible in using my method and is one of its great advantages over the old practice. The fifth operation may, as explained earlier, in certain cases be automatic, and the excavating is then omitted except to perfect the righting of the structure.

The apparatus necessary for floating, for grounding, and for excavating are all contained within the structure. Every step of the process is simple, safe, and sure and insures safety in the steps that follow.

To better illustrate the differences between the old practice and mine, I have shown mine in the accompanying diagram as applied to a tower similar to the above-mentioned Anderson and Barr or Diamond Shoal tower. This tower was lost before completion, as before stated, owing solely to the inherent defects of the old system, which had been carried out in as perfect a manner as possible and at great expense. The Anderson and Barr tower had a cylinder foundation terminating in a caisson, both added in dotted lines at F and C′ in my diagram, where they are drawn exactly to scale as given in the report of the Light-House Board for 1890, page 222.

My method when I use a caisson-raft is seen to be a radical departure from the old caisson method in that it changes the functions of the caisson. In the old practice the caisson is virtually a continuation of the tower

and is used to reach by sinking a solid substratum R immediately under the structure to be supported, substratum which may be deeper than the caisson can be carried. In my method the caisson is extended laterally to form a rigid table which is sunk into the soil for the sole purpose of arighting the structure and of making the upper surface of the caisson as nearly as possible continuous with the sea-bottom. It covers those parts of the sea-bottom which would otherwise be subject to the scouring action. It transmits the load to parts of the sea-bottom which are not beneath the tower, and thus distributes the load over the large area which in the old system is covered with riprap. Riprap, as before stated, by producing secondary eddies and whirls extends the scouring action of the tower and is easily washed in, whereas my caission being flush with the surrounding sea-bottom opposes no resistance to the flowing water and could not possibly be disturbed except as a whole. General disturbance is opposed by the stability, which in my structure is several times greater than in the old. The gain in stability due to increase in horizontal extension is obvious; but there is an equal, if not greater, gain due to the fact that my base is established at as high a level as possible. For a light of given height raising the base of the tower shortens the tower, and therefore shortens the lever-arm of the overturning forces of wind and water and ice-floes, and thus adds to stability in the same way as widening the base does by increasing the lever-arm of the retaining force or weight. In the old practice the factor of stability has never exceeded five and could not be made greater without exorbitant outlay. In my system it would hardly ever be as small as five and can cheaply be made as much larger as may be desirable. The great extent of the base allows for considerable inequality in subsequent settling without throwing the structure too much out of plumb, which is of great value, especially during erection. In the old practice the cylinders, owing to their limited factor of stability, often lean during erection to an alarming extent.

I have shown my caisson as extending symmetrically in all directions; but in rivers and in other places where the water-currents are mainly in one direction the range of the scour is eccentric with respect to the axis of the tower and the foundation may to save needless expense be made somewhat eccentric to correspond.

My invention is seen to have for its specific object to establish the foundation at as high a level as practicable, making up for the want of certainty and solidity in the soil by horizontal extension of the base, which base is, on the one hand, a rigid and integral part of the supported structure and, on the other hand, a mere continuation of the sea-bottom.

The advantages resulting from the above practice may be summarized as follows: avoidance of scour during and after erection, stability during and after erection, avoidance of deep sinking with its hardships and expense, avoidance of expensive riprap, reduction of draft, avoidance of the expense and trouble of testing of the soil by borings, and finally as a consequence of all these great saving in trouble and expense with increase in general utility and practicability.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. The method of erecting towers or piers on submerged ground, which consists in: providing the tower or pier with an extended base which will reach laterally beyond the region of scour when the tower or pier is finally located; then floating the structure to the final place of erection; then grounding the structure by allowing it to sink of itself, independent of external appliances.

2. The method of erecting towers or piers on submerged ground, which consists in: providing the tower or pier with an extended base which will reach laterally beyond the region of scour when the tower or pier is finally located; then dispensing with external erecting apparatus by providing means within the outline of the structure as a whole, to make the structure self buoyant and sinkable.

3. The method of erecting towers or piers on submerged soil, which consists in: providing the tower or pier with a rigid footing which will reach laterally beyond the region of scour when the tower or pier is finally erected; then sinking the structure to the bottom; then allowing the structure to be further sunk automatically by the scour which takes place at the edges of the footing as long as the same remains projecting out of the soil; then excavating if necessary to righten the structure.

4. The method of erecting towers or piers on submerged ground, which consists in: providing the tower or pier with an extended base or footing which will reach laterally beyond the region of scour when the tower or pier is finally located; then floating the structure to the place of final erection; then grounding the structure; then excavating to righten the structure and to further sink it until the footing is embedded in and substantially flush with the soil.

5. The method of erecting towers or piers on submerged ground, which consists in: providing the tower or pier with an extended base or footing which will reach laterally beyond the region of scour when the tower or pier is finally located; then providing means within the structure to make it as a whole self buoyant and sinkable; then floating the structure to the final place of erection; then grounding the structure; then excavating to righten the structure and sink it until the footing is sunk into and substantially flush with the surrounding sea-bottom.

6. In the establishment of subaqueous foundations for towers or piers, the method of

avoiding scour, which consists in first providing the tower or pier before final erection with a footing which will extend laterally beyond the region of scour when the tower is finally erected; then erecting the structure by allowing it to sink of itself, independent of external appliances.

7. In the establishment of subaqueous foundations for towers or piers, the method of avoiding scour, both during and after erection, which consists in providing the tower or pier, before grounding the same, with a footing which will extend laterally beyond the region of scour when the tower or pier is finally located.

8. In the establishment of subaqueous foundations for towers or piers, the means of avoiding scour which consists in a laterally-extended foot of the tower or pier, substantially at the upper level of the soil beyond the scouring region.

9. A marine tower or pier provided with a submerged foundation integral therewith and extending laterally therefrom at substantially the surface-level of the submerged ground.

10. A marine tower or pier provided with a foundation integral therewith and extending laterally therefrom to a distance beyond the normal action of the scour due to the wash of the water against the upright structure.

11. A marine tower or pier provided with a foundation integral therewith and extending laterally therefrom at substantially the surface-level of the submerged ground to a distance beyond the normal action of the scour due to the wash of the water against the upright structure, whereby stability and safety against undermining are secured.

12. A marine structure comprising a raft-like base and a superstructure connected with said base to form a compound rigid self-buoyant and self-sinkable structure having a total height exceeding the depth of the water in which the structure is to be sunk for erection.

13. The combination with a metallic tower or pier, of a laterally-extending shallow metallic foundation rigidly connected with the tower or pier, to form therewith an integral structure and adapted to be floated for transportation and sunk for erection.

14. The combination with a tower or pier, of a shallow caisson foundation having the horizontal extent necessary to reach beyond the range of the scouring action due to the tower or pier.

15. The method of erecting towers or piers on submerged ground, which consists in extending the foot of the tower or pier laterally beyond the range of scour, then raising the tower or pier to a height greater than the depth of the water at the place of erection, to form a rigid, light-draft, self buoyant and sinkable structure, then floating the structure as a whole to its place of erection without external apparatus, then grounding the structure, finally, sinking it into the soil until the extended base is sunk substantially flush with the surrounding sea-bottom.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

EDMUND BECKER.

Witnesses:
JOSEPH BECKER,
GUY E. PADGETT.