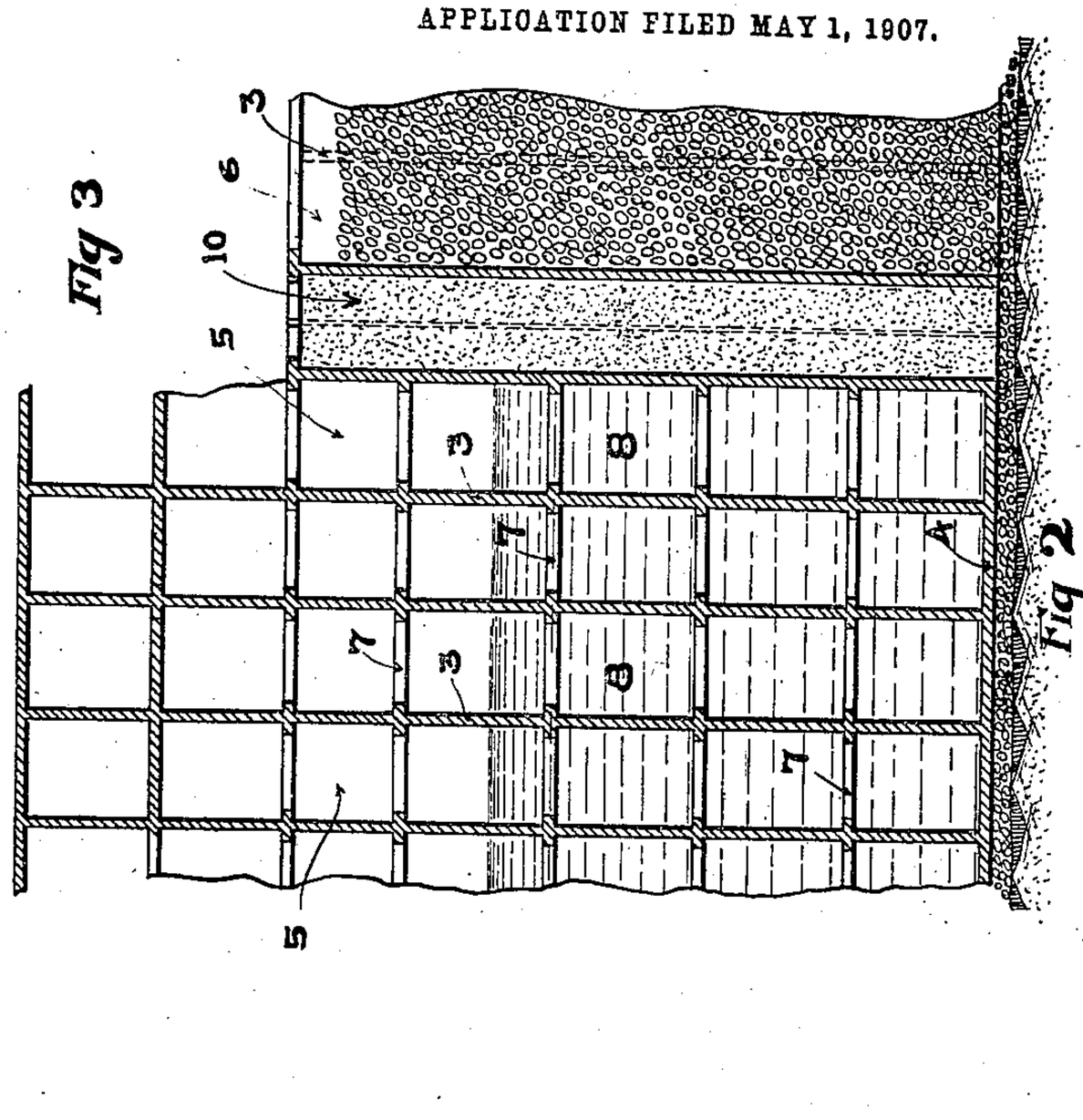
No. 868,092. PATENTED OCT. 15, 1907.

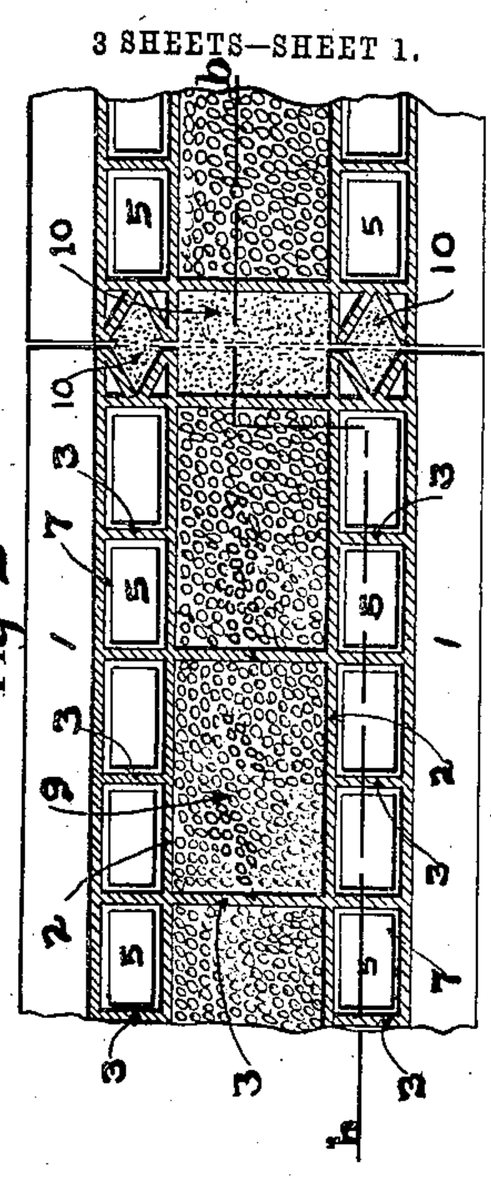
F. HENNEBIQUE.

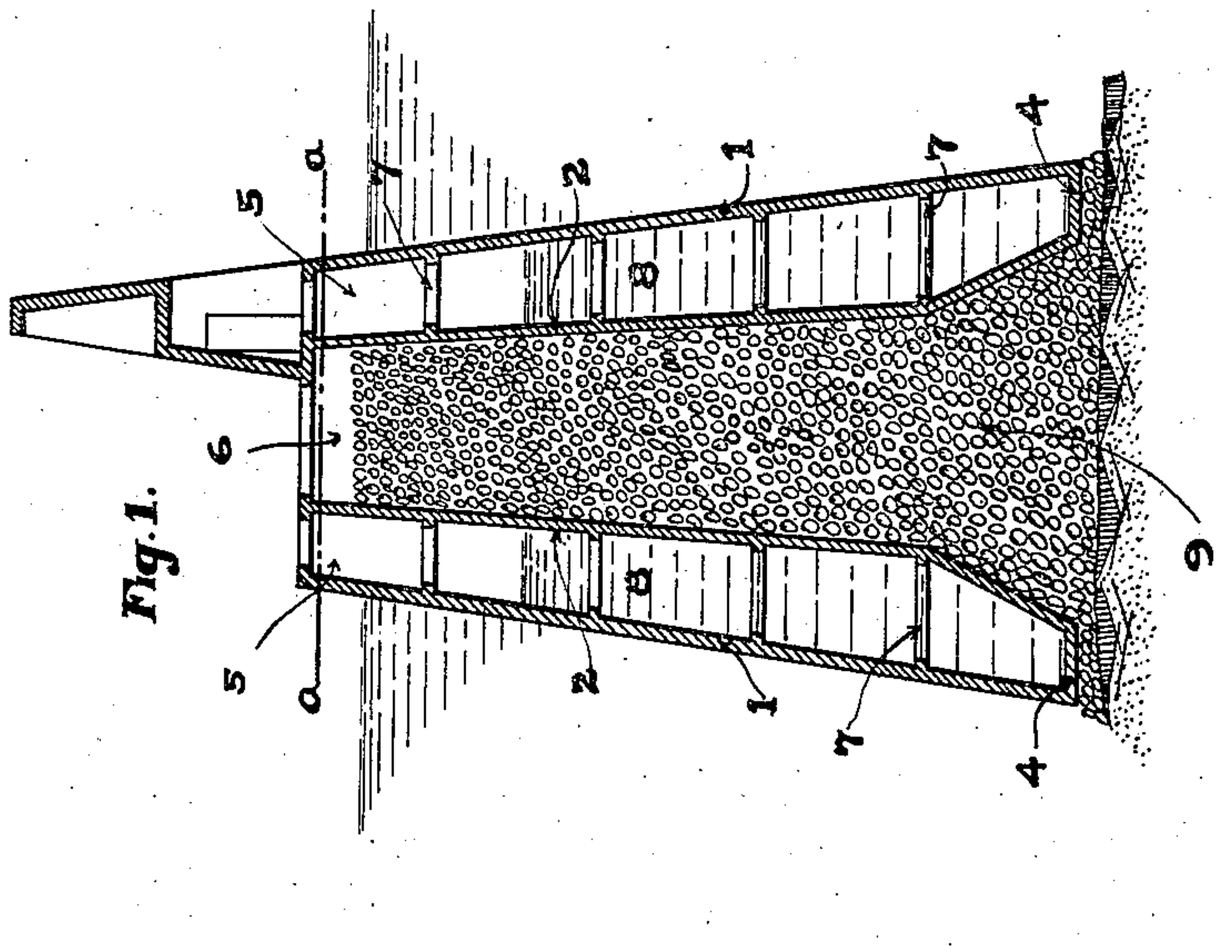
SYSTEM OF CONSTRUCTION FOR FOUNDATIONS, DAMS, SEA WALLS, AND THE LIKE.

APPLICATION FILED MAY 1, 1907.

3 SHEETS—SHEET 1.







Attest:

Raymond Boffey

John M. Scobie.

François Hennebique
Inventor:

by Wm. B. Whitney
Atty

No. 868,092. PATENTED OCT. 15, 1907.

F. HENNEBIQUE.

SYSTEM OF CONSTRUCTION FOR FOUNDATIONS, DAMS, SEA WALLS, AND THE LIKE.

APPLICATION FILED MAY 1, 1907.

3 SHEETS—SHEET 2.

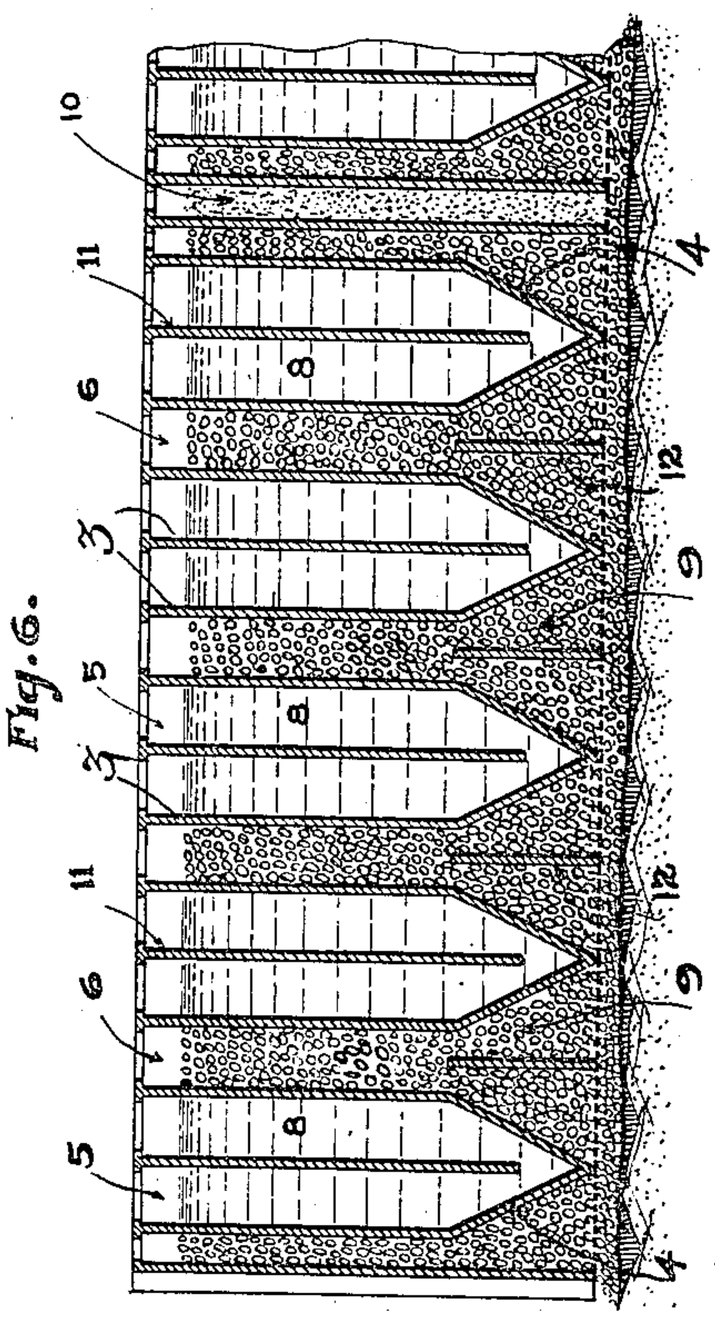


Fig. 6.

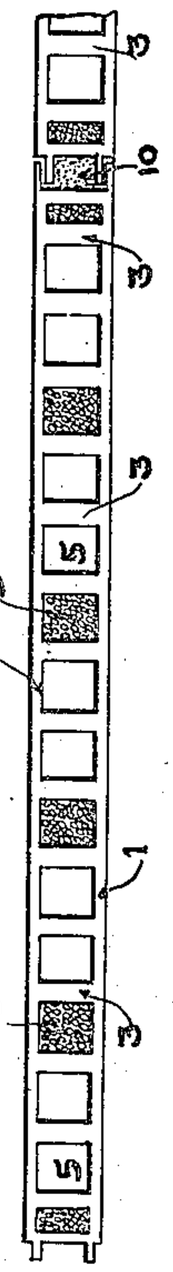


Fig. 5.

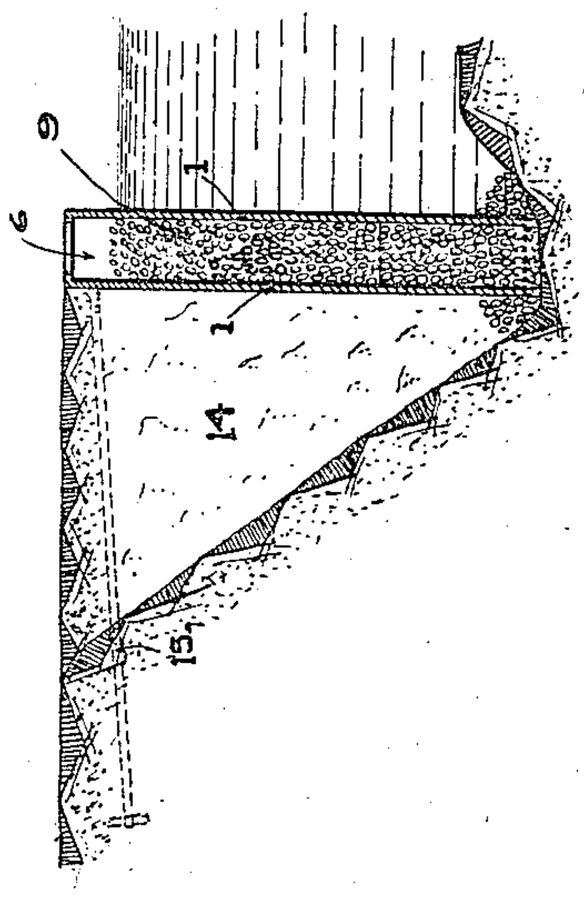


Fig. 4.

Attest:

Raymond Boffey.

John M. Cobble.

François Hennebique

Inventor:

by Wm B. Whitney

Atty

No. 868,092. PATENTED OCT. 15, 1907.

F. HENNEBIQUE.

SYSTEM OF CONSTRUCTION FOR FOUNDATIONS, DAMS, SEA WALLS, AND THE LIKE.

APPLICATION FILED MAY 1, 1907.

3 SHEETS—SHEET 3.

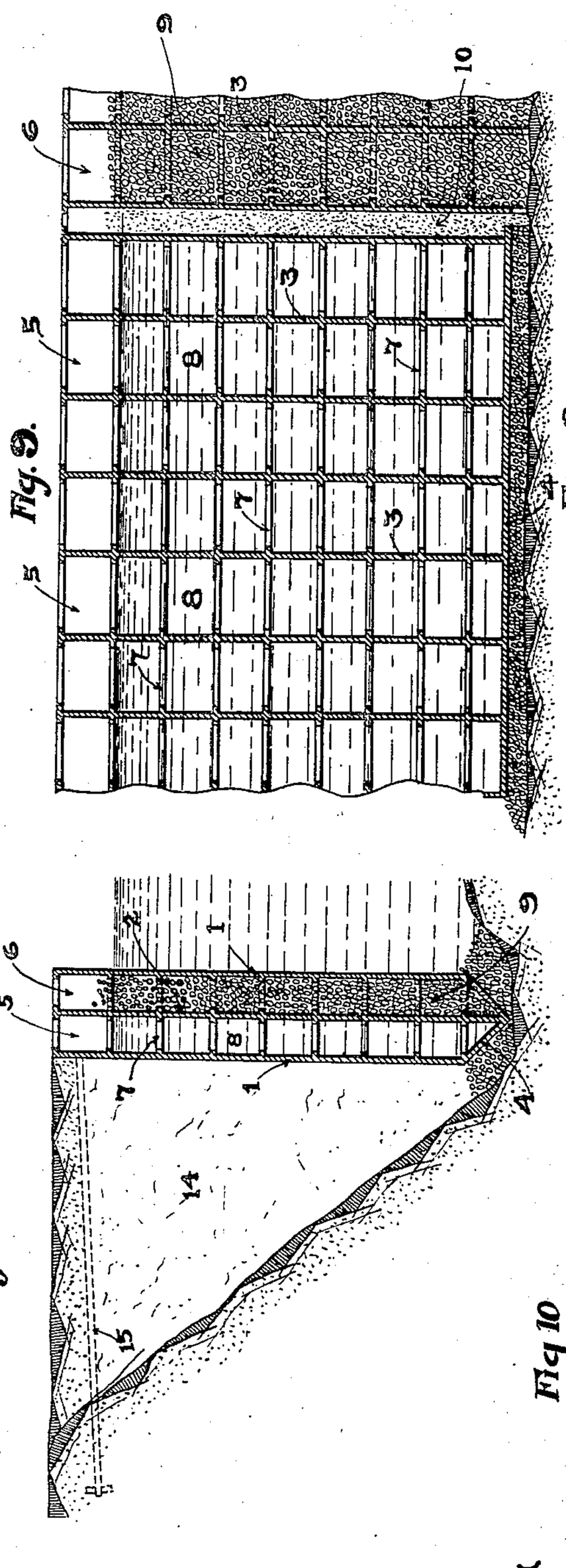


Fig. 9.

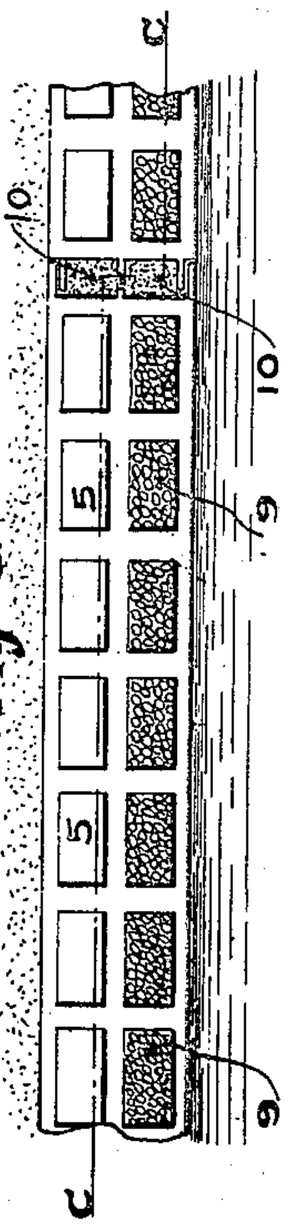


Fig. 8.

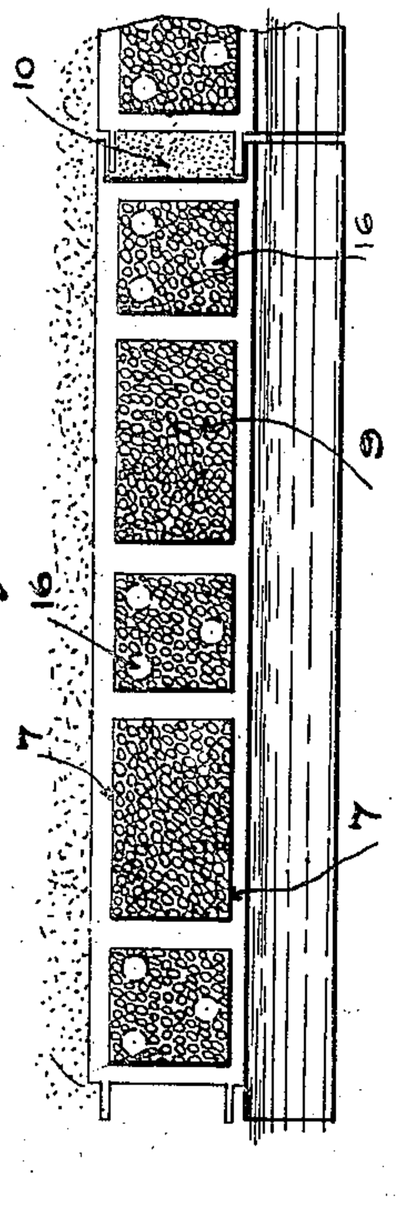


Fig. 11.

Fig. 7.

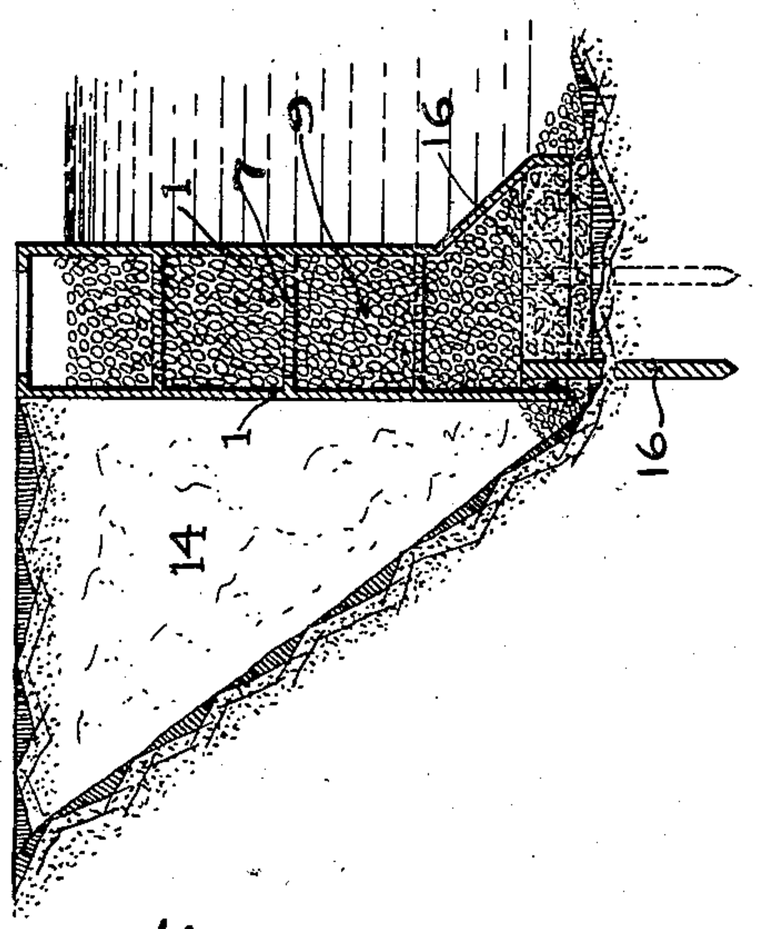


Fig 10

Attest:

Raymond Bassett.

John M. Seeble.

François Hennebique Inventor:

by Wm B. Whitney Atty

UNITED STATES PATENT OFFICE.

FRANÇOIS HENNEBIQUE, OF PARIS, FRANCE.

SYSTEM OF CONSTRUCTION FOR FOUNDATIONS, DAMS, SEA-WALLS, AND THE LIKE.

No. 868,092. Specification of Letters Patent. Patented Oct. 15, 1907.

Application filed May 1, 1907. Serial No. 371,219.

To all whom it may concern:

Be it known that I, FRANÇOIS HENNEBIQUE, a citizen of the Republic of France, residing at Paris, France, have invented a certain new and useful System of Construction for Foundations, Dams, Sea-Walls, and the Like, of which the following is a specification.

My invention relates to the construction of foundations, dams, sea-walls, piers and abutments of bridges, retaining-walls and other similar works to be erected in water; and it has for its object to provide a system wherein a caisson-like structure, built wholly or in part on shore and then launched and floated into position, is so designed and constructed that it can be sunk and secured in place by means adapted and so applied, distributed and localized as to provide a constant even base on which the caisson structure may rest and to best insure its stability under the stresses to which it may be subjected without loading the ground at any point underneath beyond its bearing capacity.

The invention consists, broadly stated, of a caisson-like structure of suitable size and shape formed by joining together side by side a plurality of vertical or vertically disposed water-tight cells some of which are open at the top and closed at the bottom and the others open both at the top and bottom, the former serving to float the caisson into position and then receive loads of ballast sufficient to sink the structure and hold it in place according to conditions while the latter serve as self-feeding magazines, when once the structure is in place, to receive and retain columns of loose material, such as small stones, rubble, or the like, which will spread out through the lower ends over the ground under the closed-bottom cells and fill up any depressions which may exist in or be formed by the settling of the surface of the ground underneath thereby adding in great degree to the stability of the construction.

The application of the invention to several forms of caisson construction and the way in which these caissons are secured in place are illustrated in the accompanying drawings, in which—

Figure 1 is a transverse section of a sea-wall or mole and Figs. 2 and 3, a horizontal section on the line *a a* of Fig. 1 and a sectional elevation on the line *b b* of Fig. 2, respectively, of a longitudinal portion of the same; Figs. 4, 5, and 6, a transverse section and a plan and sectional elevation, respectively, of a portion of quay or embankment wall; Figs. 7, 8 and 9, a transverse section and a plan and sectional elevation, respectively, of a portion of another embankment wall; and Figs. 10 and 11, a transverse section and plan, respectively, of a portion of a third embankment wall.

Like reference characters indicate corresponding parts in the several figures.

The sea-wall or mole shown in Figs. 1—3 comprises outer side walls 1, end walls (not shown), inner longitudinal walls or partitions 2 and transverse partitions 3 which divide it into three longitudinal series of vertical cells or compartments, and bottom walls 4 which close the lower ends of the outer series of compartments, on either side, and make of them water-tight cells or boxes 5, while the lower open ends of the intermediate series of cells 6 are preferably enlarged by an outward inclination of the lower part of the walls 2 as shown.

The closed-bottom cells, strengthened as is usually found desirable by a series of horizontal ribs 7, are loaded with water ballast 8 sufficient in amount and properly distributed to first suitably float the structure and then to sink it and secure it in position, as indicated, and the open-bottom cells are then charged with small stones 9, or other suitable movable material, which by spreading out over the surface of the ground underneath and filling up the irregularities in its surface constantly assure a perfect foundation for the caisson and contribute materially to its stability. The water ballast which is preferably employed in the closed-bottom cells during the preliminary operations of floating and sinking the caisson, because of the convenience with which it can be filled into the cells and withdrawn if necessary, is eventually replaced with other ballast material such as stones, concrete, or masonry, the load in each of these as well as in the open-bottom cells being adapted in each case to the bearing capacity of the ground underneath and the degree of stability required under the conditions to which the structure may be subjected.

A continuous sea-wall can be constructed and placed in sections of suitable length, these sections being joined together by filling with concrete or other suitable material the cells formed by half-cells left at the abutting ends of two adjoining sections, as shown at 10 in Figs. 2 and 3.

In the three examples of embankment walls shown in the remaining figures of the drawing, the first (Figs. 4—6) comprises a single longitudinal series of cells formed by the side-walls 1 and transverse partitions 3, in which closed bottom cells 5 alternate with open bottom cells 6, the bottom walls 4 of the former and the enlarged lower ends of the latter being provided by inclining towards each other until they meet the bottom portions of adjacent transverse partitions. The closed-bottom cells are strengthened and partially sub-divided vertically by the incomplete transverse partitions 11, while other incomplete partitions 12 sub-divide the lower ends of the open-bottom cells and serve both to strengthen their walls and to distribute in its fall the movable material with which they are charged. In the first modification (Figs. 7—9) the interior of the caisson is divided into two longitudinal series of cells, the cells of one series being closed at the bottom by walls 4 inclined inwardly and downwardly from an outer side wall to the inner longitudinal wall which extends down somewhat below the bottom of the side

walls. The third form of embankment wall (Figs. 10 and 11) comprises a single series of alternating closed-bottom and open-bottom cells and has an enlarged base formed by an outward inclination of the lower portion of one of its side walls. In all three cases, the caisson may be built in sections which are joined together at 10 in a manner similar to that hereinabove described. The embankment is completed, after the caissons have been sunk into place and suitably loaded, by filling in with earth or other suitable material 14 along one side thereof. As indicated by the dotted lines 15 in Figs. 4 and 7, the upper part of the embankment wall may be secured against the lateral thrust of the filling material 14 by suitable anchorages placed at intervals. In the last example, this lateral thrust is taken up by the enlarged base of the caisson, the bottom of which may itself be secured against lateral displacement by means of suitable piles 16 (Figs. 10 and 11) which are driven for a portion of their length into the ground below the open-bottom cells before these cells are loaded. In the last example, also, the closed-bottom, as well as the open-bottom, cells are shown as finally loaded with small stones or rubble.

The walls and partitions of the caissons may, of course, be made of any suitable material; but I prefer to use reinforced concrete throughout and to make these structures monolithic. The caissons can, in practice, either be completed before they are launched or their construction can be commenced on shore or on some suitable float and the walls built up to the height required to float them and subsequently completed while afloat in the water. It will also be understood that the specific structures herein shown and described are merely illustrative of my new system of construction and that the system is well adapted for use in many different ways and for many different purposes. In particular, the number and relative disposition of the two kinds of cells, their shape both external and internal, and the manner in which they are reinforced and united together to form caissons of the required shape and size can be varied widely without departing from the principle or sacrificing the advantages of my invention. And, while I prefer, for reasons of convenience as stated, to use a water ballast during the preliminary operations subsequently replacing it with something more permanent, it is obvious that any suitable material, either temporary or permanent, can be employed. Such other modifications can also be made as fall within the scope of the appended claims.

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

1. A caisson construction for foundations, dams, sea-walls, and the like, comprising a plurality of vertically disposed cells some of which are enlarged and open and others contracted and closed at their lower ends.

2. A construction for foundations, dams, sea-walls, and the like, comprising a monolithic caisson of reinforced concrete having outer walls and inner walls or partitions which divide it into a plurality of vertically disposed open-top cells some with closed and others with open bottoms, the open-bottom cells being enlarged and the closed-bottom cells contracted at their lower ends.

3. A caisson construction for foundations, dams, sea-walls, and the like, comprising a plurality of vertically disposed cells some of which are open and others closed at their lower ends and having at an end one or more half or open-sided cells.

4. A construction for foundations, dams, sea-walls, and the like, comprising a caisson made up of a plurality of vertically disposed cells some of which are closed at the bottom and are charged with ballast sufficient to sink the caisson into position while others are open at the bottom and are charged with material capable of filling up irregularities in the surface of the ground underneath and of spreading out under the closed bottom cells.

5. A method of constructing foundations, dams, sea-walls, and the like, which consists in building and launching a caisson composed of a plurality of vertically disposed cells some of which are closed and others open at the bottom, sinking the caisson into place by suitably loading the closed-bottom cells with ballast, and then loading the open-bottom cells with loose material.

6. A method of constructing foundations, dams, sea-walls, and the like, which consists in building a caisson of suitable shape and size and divided by walls and partitions into a plurality of vertically disposed cells some of which are closed and others open at the bottom, sinking said caisson into place by loading the closed-bottom cells with ballast, then charging the open-bottom cells with loose material, and finally replacing the temporary ballast in the closed-bottom cells with other suitable material.

7. A method of constructing foundations, dams, sea-walls, and the like, which consists in building caisson sections composed of a plurality of vertically disposed cells some of which are closed and others open at the bottom, sinking said caisson sections into place end to end by suitably loading their closed-bottom cells with ballast, loading the open-bottom cells with suitable material, and uniting together said caisson sections by filling with suitable material the cells formed by half-cells left at the abutting ends of two adjoining sections.

In witness whereof I have signed my name in the presence of two witnesses.

FRANÇOIS HENNEBIQUE.

Witnesses:
H. C. COXE,
ALPHONSE MEJEAN.