No. 738,346. PATENTED SEPT. 8, 1903.

G. L. MOUCHEL.

STRUCTURE IN OR ADJACENT TO WATERWAYS.

APPLICATION FILED MAR. 4, 1903.

NO MODEL. 4 SHEETS—SHEET 1.

Fig. 1.

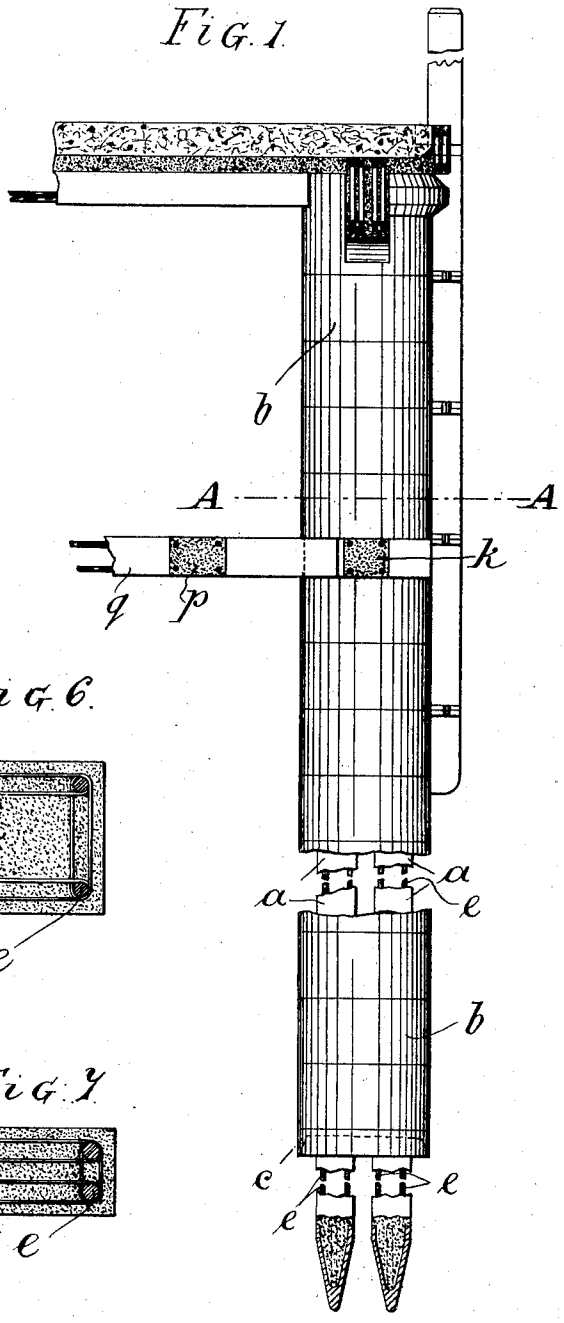


Fig. 6.

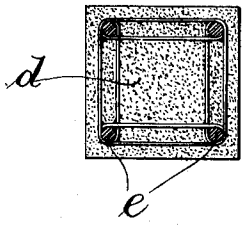


Fig. 7.

WITNESSES:

Fred Whitz

Thomas Wallace

INVENTOR:

Gustave Louis Mouchel,

By his Attorneys:

Arthur O. Dresser & Co.

No. 738,346. PATENTED SEPT. 8, 1903.

G. L. MOUCHEL.

STRUCTURE IN OR ADJACENT TO WATERWAYS.

APPLICATION FILED MAR. 4, 1903.

NO MODEL. 4 SHEETS—SHEET 2.

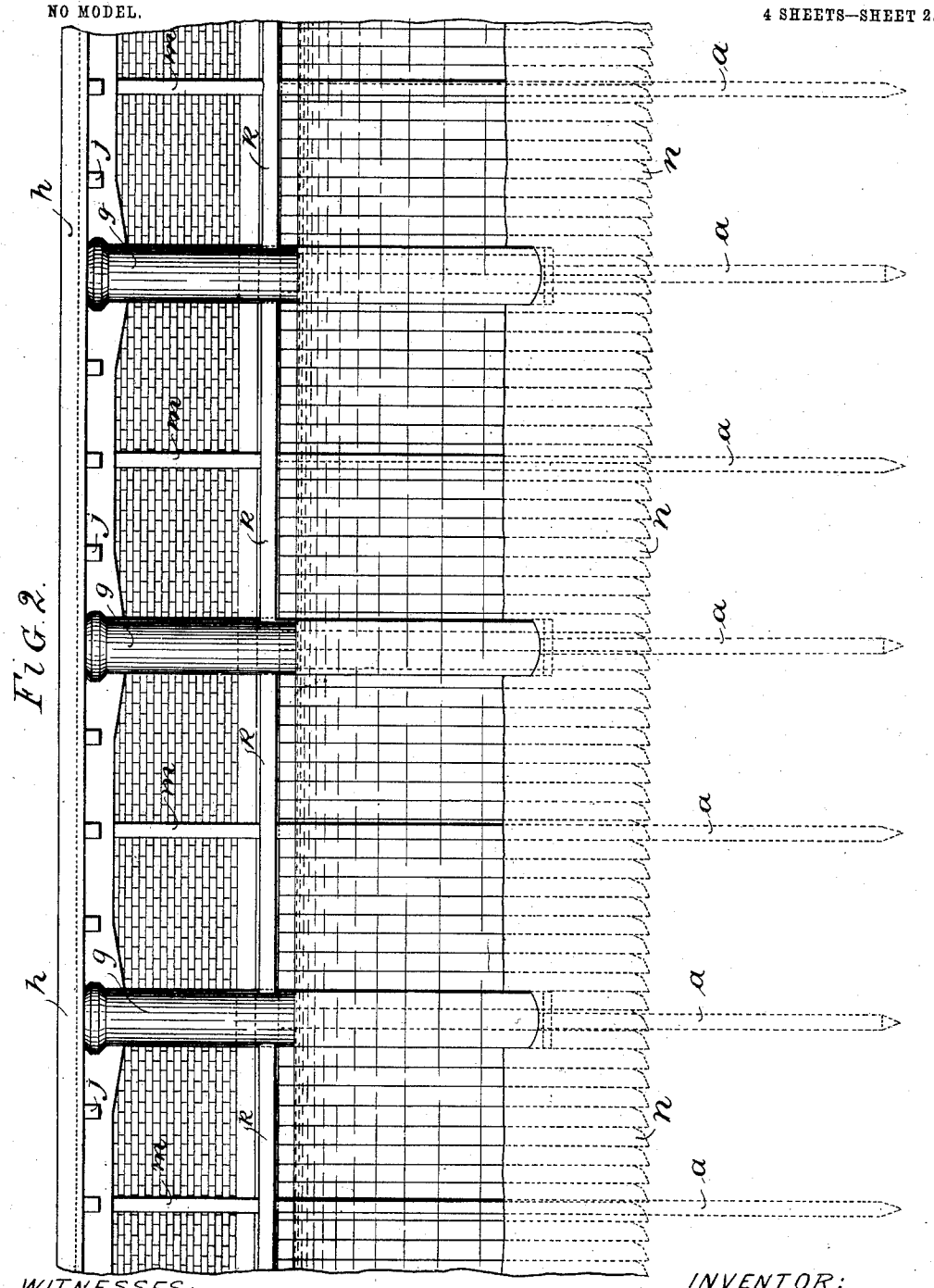


FIG. 2.

WITNESSES:
Fred Whitz
Thomas Wallace

INVENTOR:
Gustave Louis Mouchel,
By his Attorneys:
Arthur C. Fraser & Co.

No. 738,346. PATENTED SEPT. 8, 1903.

G. L. MOUCHEL.

STRUCTURE IN OR ADJACENT TO WATERWAYS.

APPLICATION FILED MAR. 4, 1903.

NO MODEL. 4 SHEETS—SHEET 3.

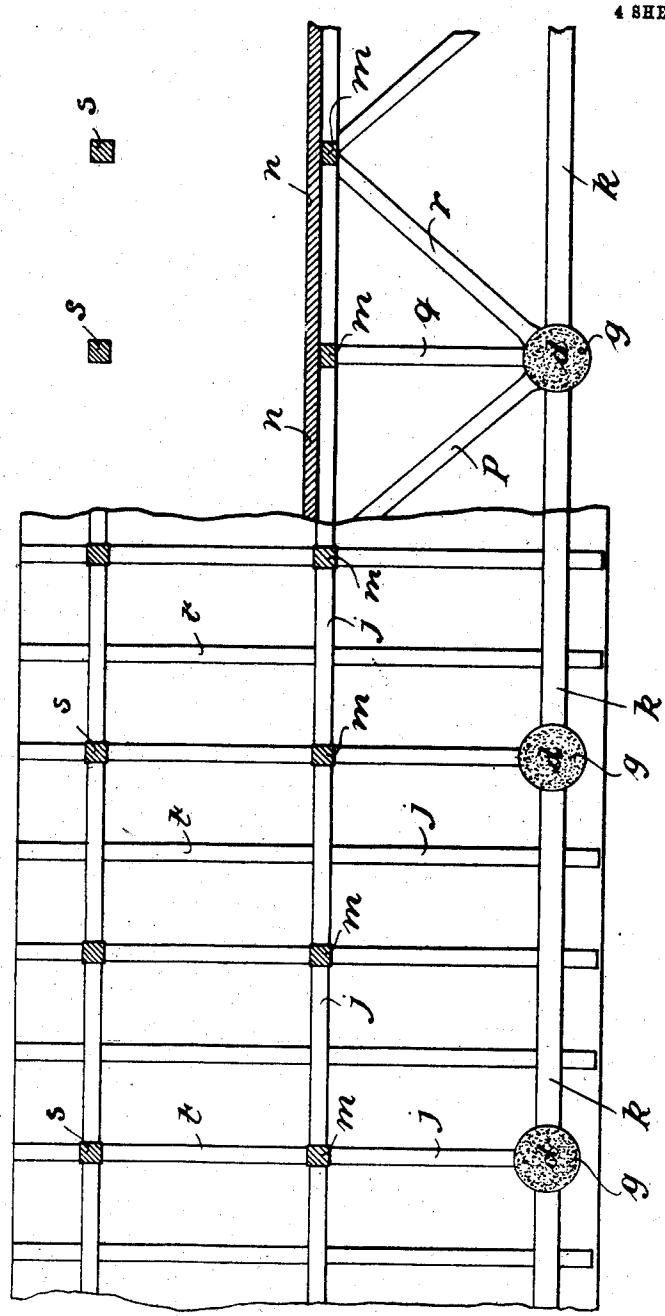


Fig. 3.

WITNESSES:
Fred Whitz
Thomas Wallace

INVENTOR:
Gustave Louis Mouchel,
By his Attorneys:
Rubin O. O'Neal & Co

No. 738,346. PATENTED SEPT. 8, 1903.

G. L. MOUCHEL.

STRUCTURE IN OR ADJACENT TO WATERWAYS.

APPLICATION FILED MAR. 4, 1903.

NO MODEL. 4 SHEETS—SHEET 4.

Fig. 4.

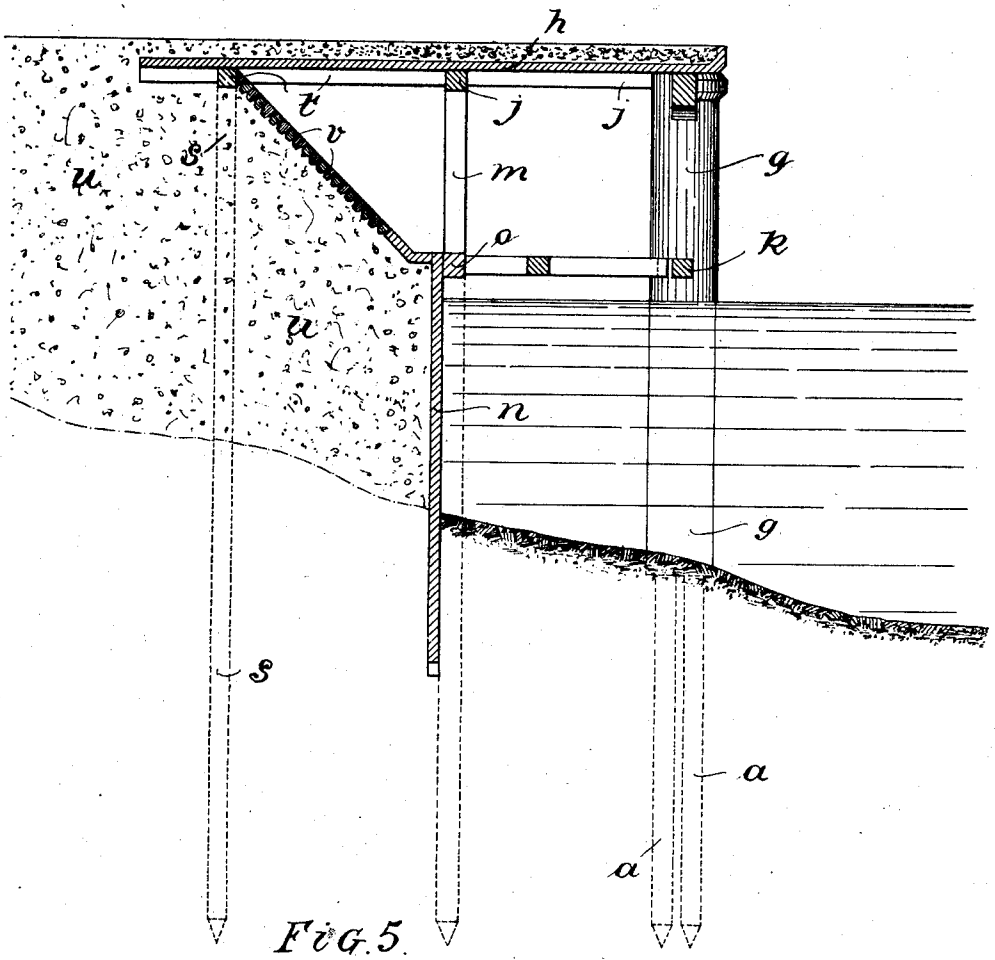
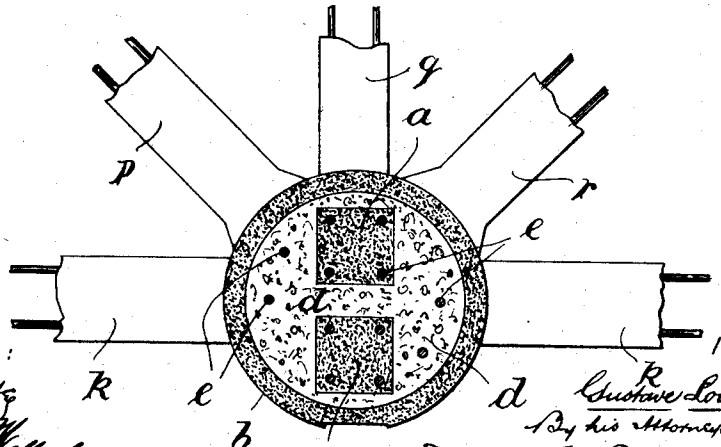


Fig. 5.



WITNESSES:

Fred White

Thomas Wallace

INVENTOR:

Gustave Louis Mouchel

By his Attorneys:

Arthur G. Fraser & Co

No. 738,346. Patented September 8, 1903.

UNITED STATES PATENT OFFICE.

GUSTAVE LOUIS MOUCHEL, OF LONDON, ENGLAND.

STRUCTURE IN OR ADJACENT TO WATERWAYS.

SPECIFICATION forming part of Letters Patent No. 738,346, dated September 8, 1903.

Application filed March 4, 1903. Serial No. 146,072. (No model.)

To all whom it may concern:

Be it known that I, GUSTAVE LOUIS MOUCHEL, engineer, residing at 38 Victoria street, Westminster, London, England, have invented certain new and useful Improvements in Structures in or Adjacent to Waterways, of which the following is a specification.

This invention relates to improvements in structures in and adjacent to waterways, such as wharves, quay-walls, dock-walls, bridge-abutments, cylinders, pillars, piles, and the like.

In structures made in accordance with my invention I employ one or more piles, tubes, or bars or a cluster of piles, tubes, or bars of strengthened concrete or other material surrounded by a cylinder or casing of strengthened concrete or any other material, said piles being anchored or driven into or resting on the ground or rock with a hearting of concrete, sand, grout, or other material rammed down between the piles and casing and with or without strengthening-bars embedded in the concrete or filling between the casing and the piles or tubes in order to strengthen the whole body to enable it to better resist top weights, thrusts, and strains. These bars do not necessarily form anchors. Upon the internal piles or on the piles and casing or cylinders is placed the superstructure or decking-beams or a floor of strengthened concrete or other material.

Where my invention is applied to the construction of wharves, a monolithic wall of sheet-piles and piles of strengthened concrete or other material is so disposed as to take the blows or pressure received by the front of the cylinders, and at the back of the said monolithic wall is a filling or cushion of earth in which it is lost or distributed. The piles may be solid or hollow and of any material and may be provided with screws or shoes or otherwise and may be of strengthened concrete or filled and surrounded with strengthened concrete or otherwise. Diaphragms of concrete, strengthened concrete, or other material may be provided in the piles, whether solid or hollow.

Referring now to the drawings, Figure 1 is a sectional elevation of one form of pillar made in accordance with my invention. Fig. 2 is a front elevation of a wharf constructed in accordance with my invention. Fig. 3 is a sectional plan, and Fig. 4 is a sectional elevation thereof. Fig. 5 is a section on line A A. Fig. 6 is a section of a pile. Fig. 7 is a section of a sheet-pile.

In Figs. 1 and 5, *a a* are concrete piles strengthened with iron and disposed in a shell *b b* of suitable material, form, and thickness, and is preferably of strengthened concrete and formed in segments or sections. This shell is or may be provided with a cutting edge *c*.

d is a hearting of concrete, grout, cement, gravel, sand, or other material. In some cases rods of steel *e* are embedded in the concrete hearting and tied together by hoops or otherwise. The whole structure forms what may be termed a "compound" pillar.

When constructing and anchoring a compound pillar or column according to my invention, one pile or cluster of two or more strengthened concrete piles are driven into the ground. Over these piles is placed a series of hollow shells of strengthened concrete, iron, steel, or other suitable material. The lowest section may be driven a short distance into the ground by a pile-driver or weights, if desired, or they may be sunken by water-jets issuing from pipes embedded in the shell or otherwise. The shells or sections may be simply laid one upon the other, or they may be jointed together with quick-setting cement concrete of any suitable composition either while they are lowered in position or after they have been laid in their final position. The intervening space between the shell or sections and the internal piles is then filled up with a hearting of concrete, cement, grout, sand, gravel, or other packing. In some cases rods of steel or iron are embedded in the hearting, as may be desired. The piles will be of sufficient length to extend to the top, or nearly so, of the pillar or column, and in the case of supporting pillars for some kinds of work they are extended above the top shell or section, so that the load is sup-

ported on the piles alone, thus making it independent of the shell or casing and of the hearting, or on the whole body, cylinder, hearting, and piles.

In applying my invention for use on rocky ground a hole or holes may be formed by blasting, drilling, or jumping in the rock at the place where the piles are to be situated. Into these holes the piles or cluster of piles are placed, and around said piles the shell or casing is formed or placed, the said shell resting on the rock. The interior of the shell is then filled up, as before described. In some cases a hole may be formed in the rock of sufficient dimensions to receive the bottom of the shell or casing and the piles dropped or placed therein and the packing material filled in, as before described.

In any of the constructions hereinbefore described the piles may be of strengthened concrete made by molding or ramming concrete around a metal skeleton or framework, or they may be of hollow or tubular cast-iron, steel, or other suitable metal driven, dropped, placed, or screwed into place and filled with cement, concrete, or grout of suitable composition strengthened or not with metal rods.

Instead of using a cluster of two or more piles for each block, caisson, cylinder, column, pillar, or the like, as before described, I may in certain cases use only one such pile disposed concentrically with the outer casing or otherwise.

In constructing and anchoring a strengthened concrete caisson much the same method is employed. The shell may be conveniently made in a mold and formed of a skeleton of iron, steel, or other metal strutted, tied, and braced together and surrounded by concrete, or it may be of cast-iron, steel, or other suitable material.

In Figs. 2, 3, and 4, *g g g* represent a front row of compound pillars similar to that shown in Fig. 1. The piles *a a* penetrate into the bed of the river a considerable depth. The outer shells or casings *b* of the pillars *a* and the piles inclosed thereby may be built entirely up to the decking or under part of the quay, or the piles, or both the piles and the outer casings, may terminate at a lower level than the under part of the quay and be built up *in situ* to the level thereof. When the upper part of the outer casing of the pillars is thus built up *in situ*, the part so built up or molded may be strengthened with iron rods of suitable section in a similar manner to the strengthening-bars, which, as above described, may be embedded in the hearting of the pillars. The upper ends of this row of pillars are united together by struts and beams of ferroconcrete or other suitable material. The upper ends of the casings and their inclosed piles may be carried up to the same level, so that the fore part of the decking *h* of the quay will be supported by the piles *a*, casing *b*, and hearting *d* of the pillars *g*; but the piles *a* are preferably extended above the casing *b* and the decking is supported thereon, thus making it independent of the casing *b* and hearting *d*. At a suitable point or points of their height and preferably above the spring-tide low-water mark all the pillars are tied together by means of beams or struts *k*, of strengethened concrete or other suitable material. Behind the front row of compound pillars thus constructed and anchored a second row of single piles *m m* at suitable intervals apart is driven or embedded, these piles extending up to, or approximately to, the level of the tie-beams or struts *k* or to uppermost series of ties, beams, or struts *j j*. Immediately behind the row of piles is constructed a wall or curtain of sheet-piles *n n*, of strengthened concrete or other suitable material, closely driven and grouted together or otherwise secured, thus producing a wall, curtain, or diaphragm, all the parts of which are intimately connected together and in which the transmitted blows are not localized, but spread.

o is a beam of strengthened concrete or other suitable material disposed on the curtain of sheet-piles *n*, this beam uniting the piles *m* and sheet-piles *n* firmly together. This beam, or the piles and sheet-piles, is united to the front row of pillars by means of horizontal beams *p q r*, of strengthened concrete or other suitable material, radiating from each pillar. Three such radiating beams may be employed with advantage to each pillar, the middle member *q* of each group or series being disposed at right angles to the front of the quay and the two side members at a suitable angle thereto. The row of piles at the rear of the compound pillars is then built up to the level of the under part of the decking of the quay. One or more additional rows of piles *s s* may be driven behind this row, the piles of such additional row or rows being connected together at their upper ends and to the top of the piles or the row or rows of piles in front by means of longitudinal and transverse beams *t t*, of strengthened concrete or other suitable material. In place of a row or rows of piles driven or embedded at the back of the outer row of pillars, as described, a row or rows of compound pillars, constructed and anchored as hereinbefore described, are employed. The pillars of such rear row or rows will be connected together at top, and if more than one such row is employed the pillars of such rows will be also connected at top to the pillars of the other row or rows by means of struts of strengthened concrete or other suitable material, as hereinbefore described. Instead of driving or embedding the wall of sheet-piles at the back of the row of piles or pillars which is next behind the outermost line of pillars it may be driven or embedded at the back of any of the rows of piles or pil-

lars behind the outermost line of pillars. It will be understood, however, that the row of piles or pillars behind which the wall of sheet-piles is driven will preferably extend only to the level of the top of the sheet-piles to enable the beam before mentioned to be laid or formed thereon and be then built up to the decking of the quay; but the piles or piling may be of any length and may extend to or stop at any level. The piles or pillars of all the rows extend or are built up to the level of the under part of the decking of the quay, which is then constructed or laid thereon. I preferably make the decking of strengthened concrete. The space at the back of the wall or curtain of sheet-piles is then filled up with earth and the earth *u u* cut away to a suitable slope. A pitching of stones, brickwork, gravel, rubble or a curtain or slab of concrete, strengthened concrete, or other suitable material *v* is then laid on the slope, this pitching or curtain extending upward from the beam on the sheet-pile wall to the decking.

In a quay-wall or other similar structure made in accordance with my invention the members are so braced that the angles are not distorted by the pressure or blows to which said structures may be subjected.

The advantages of my method of construction are:

First. That I obtain a solid mass rooted to the substrata as stoutly as in the case of a cast-iron cylinder sunk to the solid in the manner now generally adopted without having to incur the great trouble and expense incidental to cylinder-sinking.

Second. That by putting all the weights of the superstructure in the piles and treating the external cylinder and the filling as mere protection to the piles the strength of the structure is not impaired if repairs are neglected, and above all if the external parts are attacked by sea-water or otherwise damaged.

Third. By having a backing of sheet-piles and piles filled in behind as described and bracing it to the decking and front piles a very strong and durable structure is formed at a comparatively low cost. It is obvious that if the sheet-piles were driven in a line with the front piles they would have to sustain a much heavier and larger prism of earth or filling than when driven some way behind the front row and would have to be stronger and better supported, thereby rendering the structure more costly.

Fourth. The casing forms a protection against the destructive action of the sea-water on the concrete piles and prevents the consequent destruction of the sheet-skeleton. The casing can be readily removed, replaced, or repaired without interfering with the structure itself, and this is of great importance in harbor and dock work.

Fifth. The use of a casing of concrete in place of cast-iron or steel in cylinders is of great importance, as the former can be carried to the spot in bulk and molded to the desired shape on the works, and other obvious advantages.

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

1. In structures in and adjacent to waterways, the combination of a pile which penetrates the ground, a casing which encircles the pile, a hearting between the pile and casing, a row of sheet-piles disposed behind the said casing, a filling behind the sheet-piles and struts between the casing and the sheet-piles, substantially as described.

2. In structures in and adjacent to waterways, the combination of a pile which penetrates the ground, a casing which encircles the pile, a hearting between the pile and the casing, a row of piles behind said casing, a row of sheet-piles disposed behind said row of piles and secured thereto, a filling behind said sheet-piles and struts between the casing and the row of piles, substantially as described.

3. In structures in and adjacent to waterways the combination of a pile which penetrates the ground, a casing which encircles the pile, a hearting between the pile and casing, a row of piles behind said casing, a row of sheet-piles disposed behind said row of piles and secured thereto, another row of piles behind the sheet-piles, a filling behind the sheet-piles, an apron disposed on the slope of the filling, struts between the piles and between the casing and sheet-piles, substantially as described.

4. In structures in and adjacent to waterways, the combination of a pile which penetrates the ground, a casing which encircles the pile, a hearting between the pile and casing, a row of piles behind said casing, a row of sheet-piles disposed behind said row of piles and secured thereto, another row of piles behind the sheet-piles, a filling behind the sheet-piles, an apron disposed on the slope of the filling, struts between the piles and between the casing and sheet-piles, beams and decking carried by the piles, substantially as described.

5. In structures in and adjacent to waterways, the improved compound pillar comprising a pile which penetrates the ground, a casing which encircles the pile, and a hearting between the pile and casing, substantially as described.

6. In structures in and adjacent to waterways, an improved compound pillar comprising in combination a plurality of piles which penetrate the ground, a casing which encircles the piles and a hearting between the piles and the casing, substantially as described.

7. In structures in and adjacent to waterways, an improved compound pillar comprising a plurality of piles which penetrate the ground, a casing which encircles the piles and

a hearting between the piles and the casing with metal rods disposed in the hearting.

8. In structures in and adjacent to waterways, a compound pillar comprising a shell of strengthened concrete, a hearting of concrete, metal bars embedded in the hearting of concrete, substantially as described.

9. In structures in and adjacent to waterways the combination of piles, an external cylinder protecting the piles, and a superstructure with its weight supported upon the piles.

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

GUSTAVE LOUIS MOUCHEL.

Witnesses:

REGINALD EATON ELLIS,

ROBERT MILTON SPEARPOINT.