2 Sheets--Sheet 1.

D. CUNNINGHAM.

Construction of Breakwaters.

No. 137,659. Patented April 8, 1873.

FIG. 1.

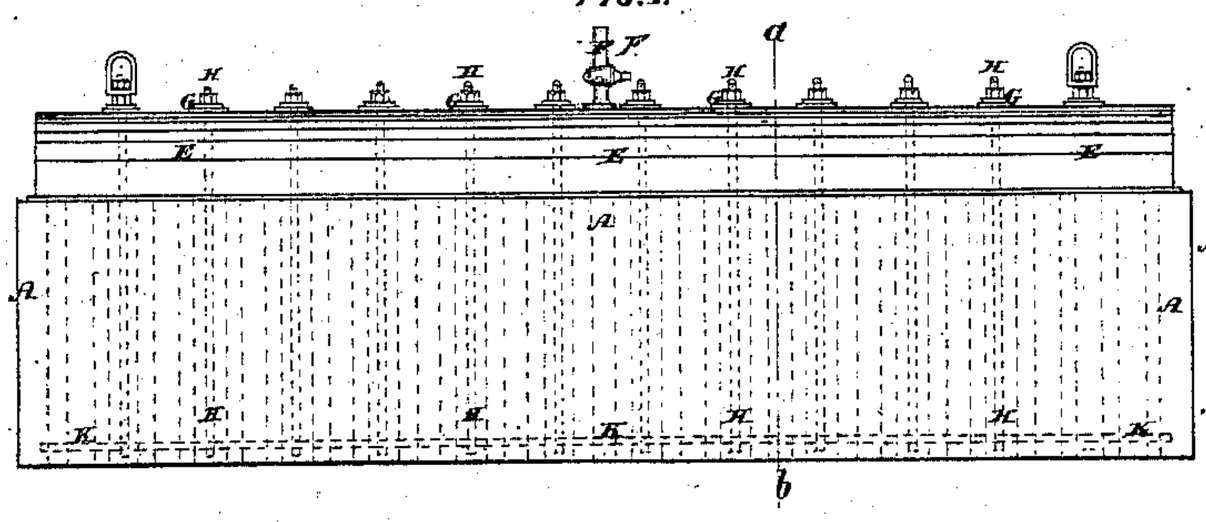
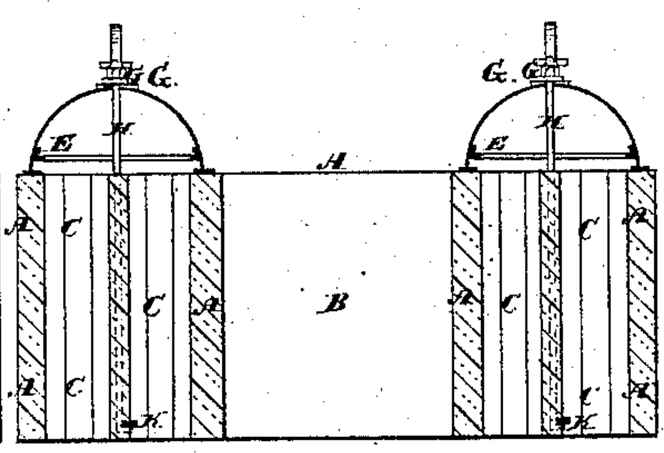


FIG. 2.



Section on the line ab. FIG. 1

FIG. 3.

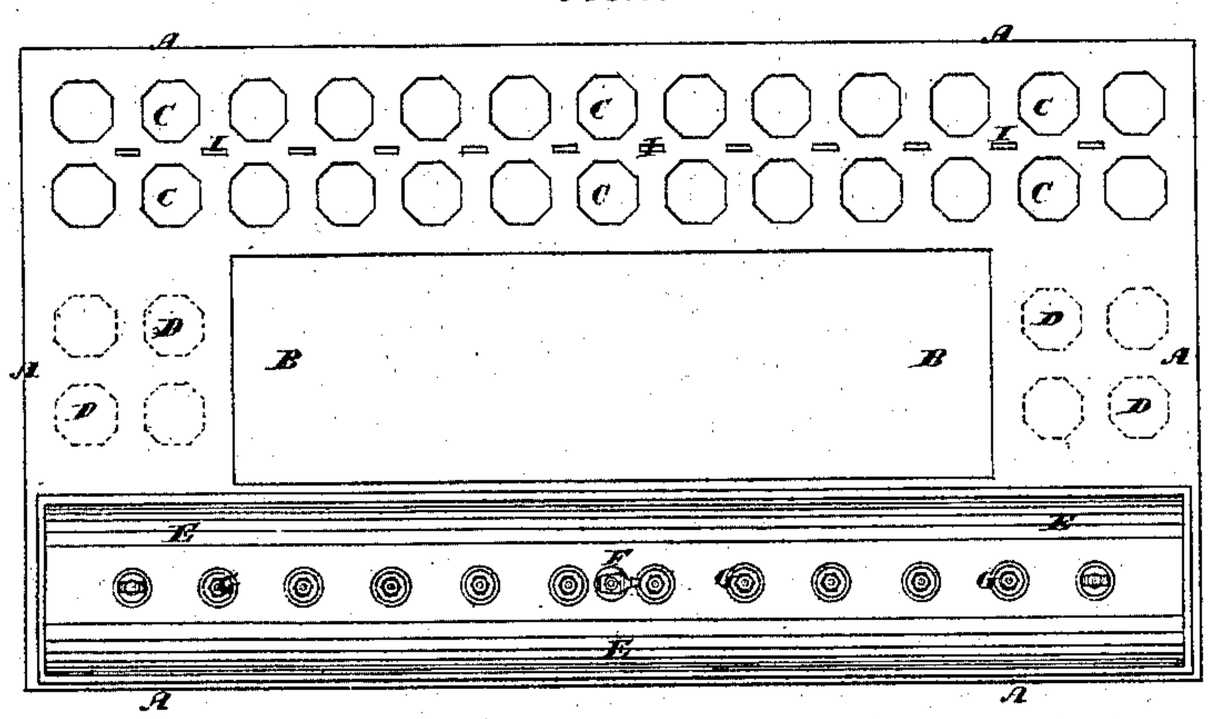


FIG. 8.

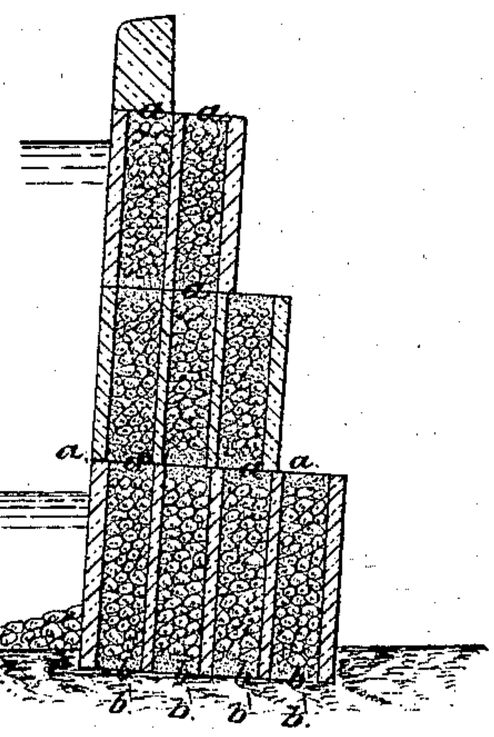
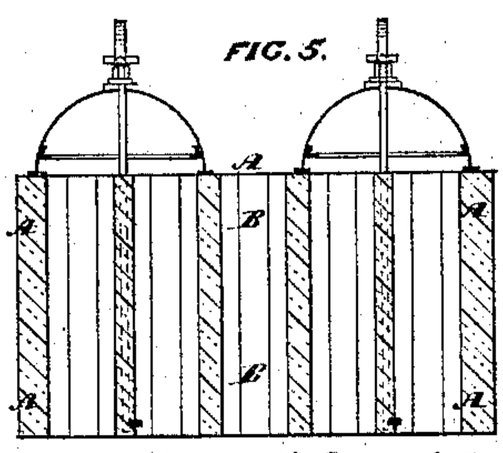


FIG. 4.

FIG. 5.



Section on the line c.d. FIG. 4.

FIG. 6.

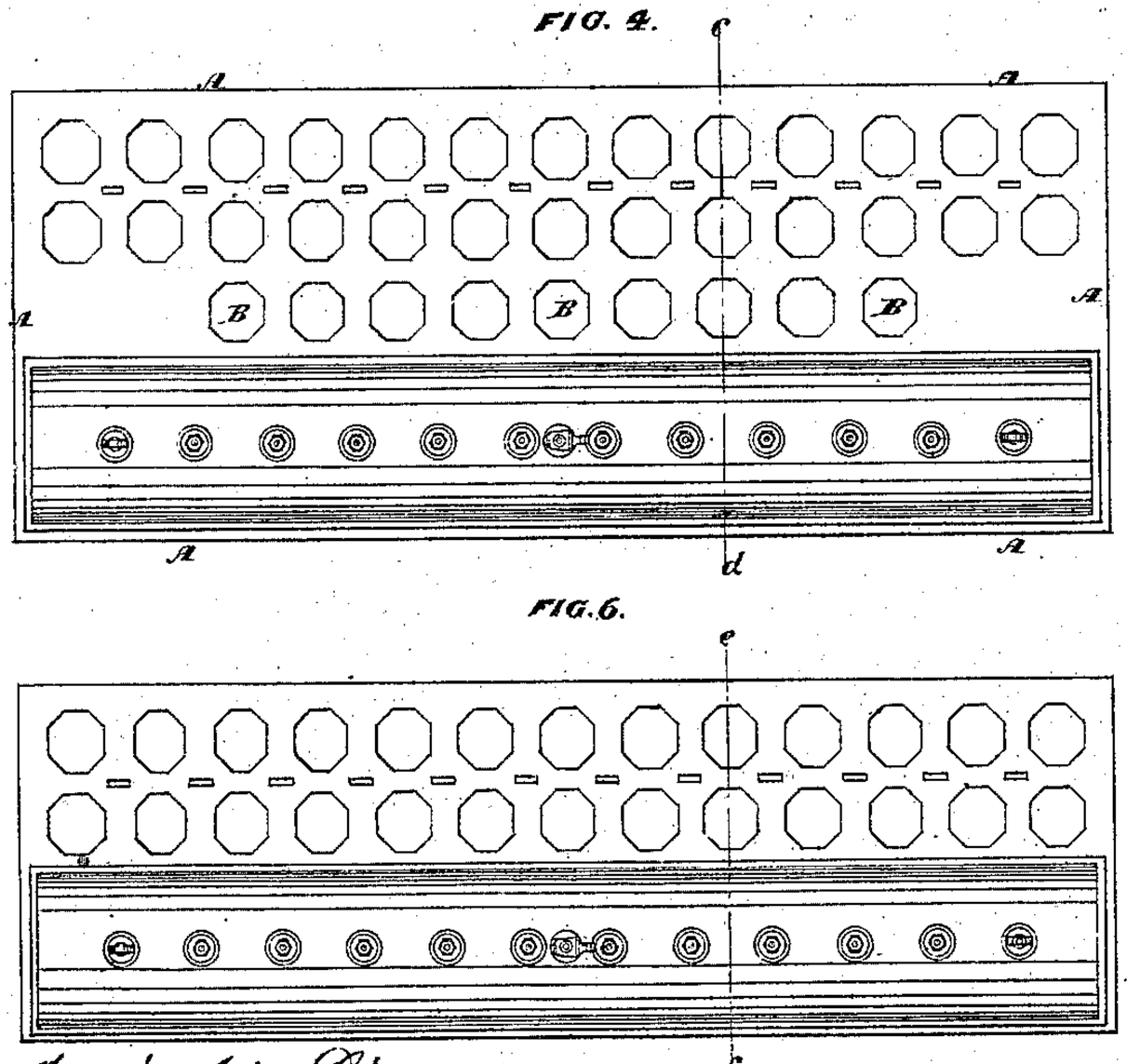
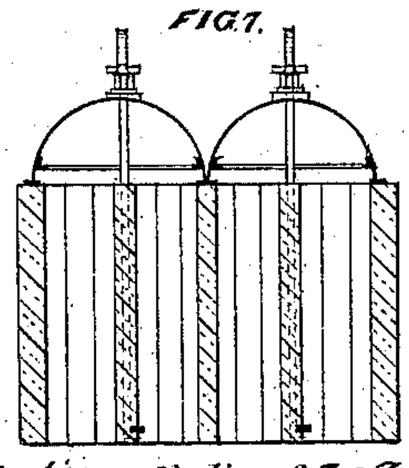


FIG. 7.



Section on the line ef. FIG. 6.

Witnesses,
Frederick John Dick.
E. B. Thornton

Attest,

Inventor, David Cunningham.

2 Sheets--Sheet 2.

D. CUNNINGHAM.

Construction of Breakwaters.

No. 137,659. Patented April 8, 1873.

FIG. 1.

FIG. 2.

FIG. 3.

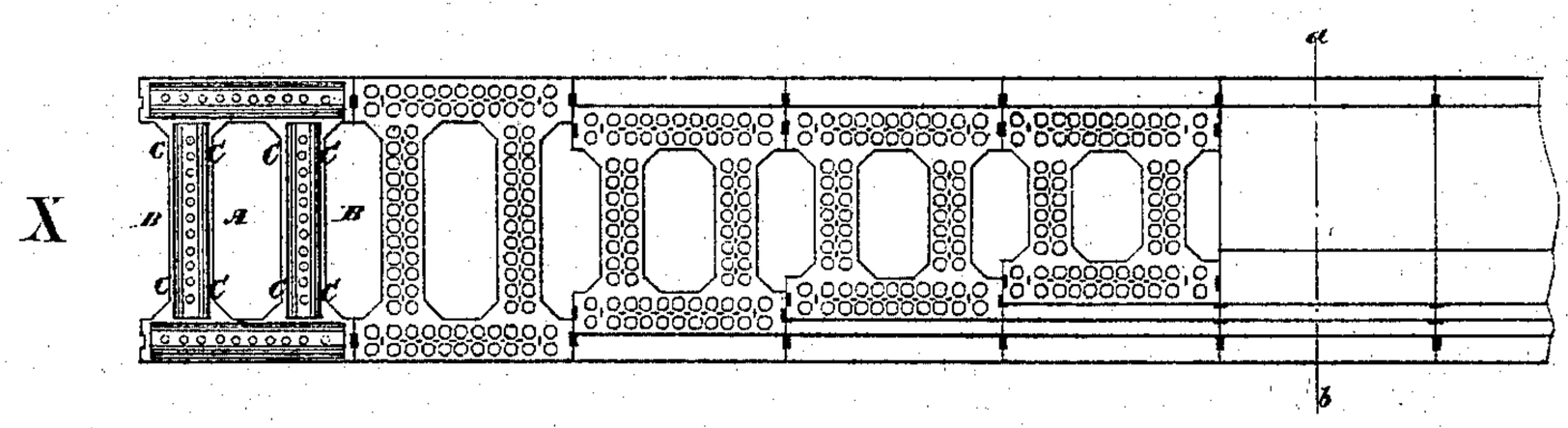
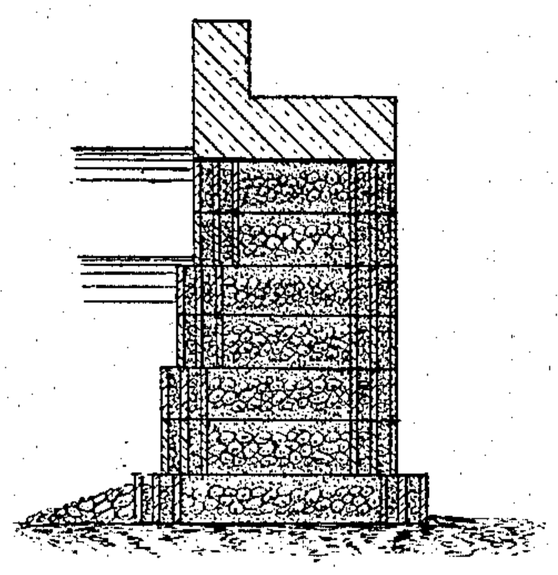


FIG. 4.



Section on the line a. b. Fig. 3.

Attest,
Frederick John Dick
E. B. Thornton

Inventor;
David Cunningham

UNITED STATES PATENT OFFICE.

DAVID CUNNINGHAM, OF DUNDEE, SCOTLAND.

IMPROVEMENT IN THE CONSTRUCTION OF BREAKWATERS.

Specification forming part of Letters Patent No. **137,659**, dated April 8, 1873; application filed March 26, 1873.

To all whom it may concern:

Be it known that I, DAVID CUNNINGHAM, of Dundee, in the county of Forfar, North Britain, civil engineer, have invented Improvements in the Construction of Breakwaters, Sea-Walls, and other subaqueous works, of which the following is a specification:

This invention relates to improvements in the construction of breakwaters, sea-walls, or other subaqueous or marine works; and consists in the employment of concrete blocks formed with a number of hollow spaces extending from or nearly from the upper to or nearly to the under sides of the blocks or material of which such breakwaters, sea-walls, or other subaqueous works are constructed; and the object of this invention is to diminish the mass of concrete employed in such works, and at the same time to render the transport of the blocks less costly and more expeditious.

In constructing the blocks according to one arrangement, the hollow spaces are disposed or arranged in rows throughout the entire area of the blocks, so that in building the blocks on each other spaces in the upper block will be situated immediately above spaces in the block underneath, according to the manner in which they are set upon each other. Each of the spaces is provided with an air-tight door at its upper extremity, or the air-tight doors may be made of such dimensions as to cover the upper extremities of the whole or a series of the spaces in each block, or the said spaces may be connected together in the body of the block and terminated in one or more spaces opening to the upper surface of the block, and which is, or are, provided with an air-tight door or doors. Each such air-tight door is provided with a cock or valve, or the equivalent thereof, so that, in floating the blocks in the usual manner to the situation at which the work is being carried on, the spaces being filled with air materially assist the barge or barges or other means of transport in buoying up the blocks; and thus blocks may be made of much larger dimensions than under existing arrangements of construction. After the block has been submerged its buoyancy may be increased by compressing the air into the spaces, so as to nearly fill them, by means of an air-pump. Blocks constructed, as hereinbefore described, may be made in rectangular or other form, and in cases where the breakwater, sea-wall, or other subaqueous or marine work to be constructed is of considerable breadth the concrete blocks employed in the formation thereof may be constructed with one or more hollow spaces occupying the entire central portion thereof, the said spaces being divided from each other by cross-ties or ribs of concrete extending from one side of the block to the other. The portions constituting the ends or sides, as the case may be, of such blocks are formed with hollow spaces, provided at their upper extremities with air-tight doors similar to those hereinbefore described, and corresponding spaces are also formed on the cross-ties or ribs, which may be furnished with the said air-tight doors, or both extremities of the spaces in the cross-ties or ribs may be closed with the material of which the blocks are composed, and means may be provided for allowing the air to escape, and so filling such spaces with water when required.

When a block, constructed according to any of the arrangements hereinbefore described, has been placed on its foundation, concrete is or may be used so as to close up the lower extremities of the hollow spaces therein, as well as any vacant space left between the ground and any part of the block. On account of any irregularity of the ground surface, the remaining portions of such spaces may then be filled up with sand, clay, stones, or other suitable material, or the whole of such spaces may be so filled up, excepting when desired, so much space as is necessary to contain a layer of concrete, by which to secure the block immediately above in position. These spaces may also be wholly or chiefly filled with the concrete itself.

In lieu of closing the lower extremities of the hollow spaces in the blocks placed in contact with the ground by means of concrete, as hereinbefore set forth, pipes, communicating with an air-pump or exhauster, may be attached to the cocks or valves, or their equivalent, on the doors at the upper extremities of the spaces, and the air, by this means, being partially exhausted from the hollow spaces,

the ground underneath will be forced into the said spaces, and the whole block sunk on its foundation.

It is obvious that the spaces in the hollow blocks may be used for facilitating excavations of the ground when required, after the blocks are placed in position.

Description of Drawing.

On Sheet 1 of the drawing hereunto appended, Figure 1 is a side elevation, Fig. 2 a transverse section on the line *a b*, Fig. 1, and Fig. 3 a plan of a concrete block constructed in accordance with one modification of my said invention, and which is suitable for employment in the construction of breakwaters, sea-walls, and other subaqueous or marine works.

As shown by these figures, the block A is constructed with a space, B, which occupies the central portion thereof, and extends from the upper to the under side of the block, and around which smaller spaces, C and D, are arranged at the sides and ends of the block, as more particularly seen in plan at Fig. 3. The spaces D at the ends of the block extend from the under to near the upper side thereof, and the spaces C at the sides of the block extend from its upper to its under side. The spaces C at both sides are, when the block A is about to be floated from the place of construction to the situation of the breakwater, sea-wall, or other subaqueous or marine work in course of formation, closed at their upper ends by air-tight doors or covers E, each of which, at the figures now under reference, are shown arranged to cover the upper ends of all the spaces at one side of the block A; but the said doors or covers may be arranged to cover a series of such spaces only, in which case a greater number of doors or covers are employed; or an air-tight door or cover may be provided for each such space C. The air-tight doors or covers E are provided with cocks or valves F, and they are secured in position on the upper side of the block A by nuts G screwed onto the upper extremities of rods H, the lower ends of which are formed bent or curved, and are passed down through slots or openings I formed in the block, as shown at Fig. 3, to near the under side thereof, whereat the bent or curved ends of the rods H are passed under horizontal rods or bars K, as shown at Fig. 2, which rods or bars extend from one end of the block to the other. Thus, by screwing the nuts G against plates or rings on the upper sides of the doors or covers E, the rods H are drawn tightly up against the under sides of the rods or bars K, and the air-tight doors or covers E are pressed against the upper side of the block A.

Any suitable packing may be inserted between the under sides of the doors or covers E and the upper side of the block A, in order to render the space inclosed by the doors or covers air-tight. The rods or bars K and the rods H at each end of the block A, while, in conjunction with the other similar rods H, serving the purpose hereinbefore described, also act as suspenders, and sustain the weight of the block while being removed or floated to the situation at which the breakwater, sea-wall, or other subaqueous or marine work is being constructed, the end rods H being provided with rings or eyes at their upper extremities to which chains or ropes are attached when it is desired to transport the blocks, the said chains or ropes being also attached to crabs or winches placed on a barge or barges, or other means of transport. The spaces C, when the blocks have been submerged, being filled with air, which is confined therein by the air-tight doors or covers E, assist the barge or barges in buoying up the blocks, and the buoyancy of the said blocks may be increased by compressing air into the spaces, so as to nearly fill the said spaces, by means of an air-pump or pumps, the air being conducted into the spaces C through the cocks or valves F. Thus concrete blocks may, under this invention, be made of much larger dimensions than under arrangements of construction hitherto practiced.

An air-tight door, furnished with a cock or valve, may be provided for the space B at the central portion of the block A, and in lieu of forming the end spaces D closed at their upper ends, as hereinbefore described and indicated in dotted lines at Fig. 3, Sheet 1, the said spaces may extend from the upper to the under side of the block, and be provided with air-tight doors similar to those hereinbefore described.

Under another modification of my said invention, illustrated in plan at Fig. 4, and in transverse section on the line *c d*, Fig. 4, at Fig. 5 the block A in lieu of being constructed with a large central space, as hereinbefore described and shown at Figs. 1, 2, and 3, Sheet 1, is formed with a number of spaces, B, at the central portion thereof, which may, in transporting the block, be left open at the upper ends, or covered with an air-tight door or cover; or, in lieu of extending the spaces B from the upper to the under side of the block, as shown at Fig. 5, the said spaces may be terminated below the upper side of the block A, as indicated in dotted lines at D, Fig. 3, in which case the material of which the block is composed constitutes the covers of the spaces.

Under another arrangement, illustrated in plan in Fig. 6, and in transverse section on the line *e f*, Fig. 6, at Fig. 7 the central space or spaces may be dispensed with when a block of lesser breadth is required.

When a block, constructed according to any of the arrangements hereinbefore described and shown on Sheet 1 of the appended drawing, has been floated to the situation at which the breakwater, sea-wall, or other subaqueous or marine work is being built, it is placed on its foundation, after which the air-tight cov-

ers or doors are removed from the upper side of the block, and the lower extremities of the hollow spaces are closed up with concrete, as is also any vacant space left between the ground and any part of the foundation-blocks on account of any irregularity of the ground surface. The remaining portions of the spaces within the block are then filled up with stones, clay, sand, or other suitable material, as shown at Fig. 8, Sheet 1, which is a transverse section of a sea-wall built with blocks constructed in accordance with this invention. A layer, *a*, of concrete is placed in the upper end of each space, and also in the lower end of the block superposed, as shown, by which to secure the latter block in position.

In lieu of employing stones, clay, or sand, to fill up the spaces, the said spaces may be entirely filled with concrete; and in lieu of closing the lower extremities of the hollow spaces in the blocks placed in contact with the ground with concrete, as hereinbefore described and shown at *b*, Fig. 8, Sheet 1, pipes communicating with an air-pump or exhauster may be attached to the cocks or valves of the air-tight doors or covers, and the air by this means being partially exhausted from the spaces by the pump or exhauster, the ground underneath will be forced into the said spaces and the whole block sunk on its foundation. By this means the spaces in the blocks may be used for facilitating excavations of the ground when required after the blocks have been placed in position.

When the breakwater, sea-wall, or other subaqueous or marine work to be constructed is of considerable breadth, blocks formed in the manner shown in longitudinal section at Fig. 1, Sheet 2, of the drawing, in side elevation at the end of Fig. 2, marked X, and in plan at the corresponding end of Fig. 3, may be employed in lieu of any of the blocks hereinbefore described and shown on Sheet 1 of the drawing. Under this arrangement the block is formed with a central space, A, and with side spaces B, as more particularly seen in plan at Fig. 3, the said spaces A and B being divided from each other by cross ties or ribs C of concrete, extending from one side of the block to the other. In the sides of the block and also in the cross ties or ribs C spaces are formed, which, when the block is about to be floated to its destination, are closed by air-tight doors, as shown, or the upper and lower extremities of the spaces in the sides and cross ribs or ties may be closed with the material of which the block is composed, and means may be provided for allowing the air to escape and so fill such spaces with water when required.

Fig. 2, Sheet 2, is a side elevation, Fig. 3 a plan, and Fig. 4 a transverse section on the line *a b*, Fig. 3, of a breakwater in course of construction, and composed of the blocks now last described.

Under another arrangement (not shown in the drawing) the spaces in each block may be connected together in the body of the block and terminated in one or more spaces opening to the upper surface of the block, and which is or are provided with an air-tight door or doors. By constructing the blocks as hereinbefore described and shown on the drawing, the mass of concrete employed in building breakwaters, sea-walls, and other subaqueous or marine works is diminished, and the transport of the blocks is rendered less costly and more expeditious.

It is to be understood that this invention is not limited to constructing the blocks hereinbefore described and illustrated under various modifications on the appended drawing wholly of concrete, as such blocks may be constructed partly of stone or other material, and iron or other material may be employed for tying them together; and it is further to be understood that I do not confine myself to construct or arrange the spaces in the blocks under the systems or modes hereinbefore described and shown on the drawing, as the arrangement of such spaces is capable of further modification.

Claim.

The employment, in connection with concrete or other blocks for building breakwaters, sea-walls, and other subaqueous or marine works, when the same are constructed with hollow spaces formed therein, substantially as described, of air-tight covers or doors for closing said spaces in order to retain the air therein during the transportation or moving of said blocks to their place of deposit, under the arrangements herein shown and set forth, or any mere modification thereof.

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

DAVID CUNNINGHAM.

Witnesses:

FREDERICK JOHN DICK,

E. B. THORNTON.