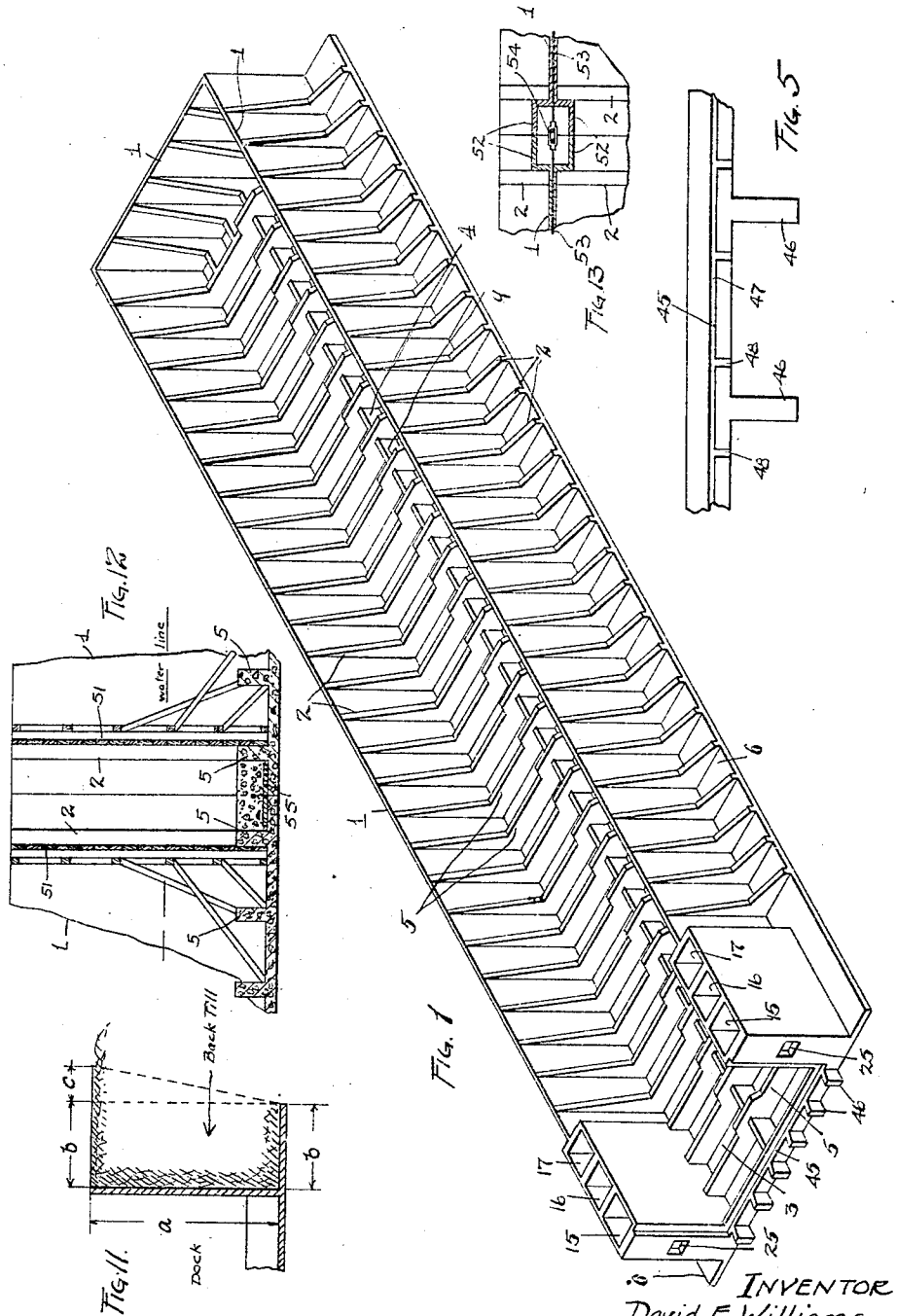
Feb. 17, 1925.

1,526,446

D. E. WILLIAMS

DRY DOCK

Original Filed May 8, 1919 3 Sheets-Sheet 1



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DRY DOCK

Original Filed May 8, 1919 3 Sheets-Sheet 2

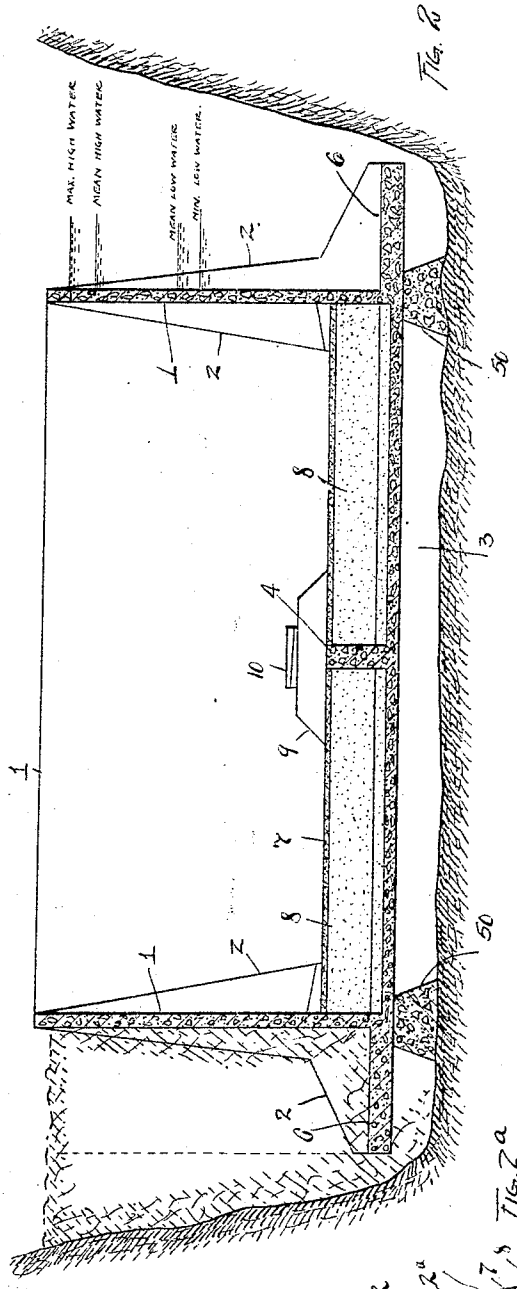


Fig. 2

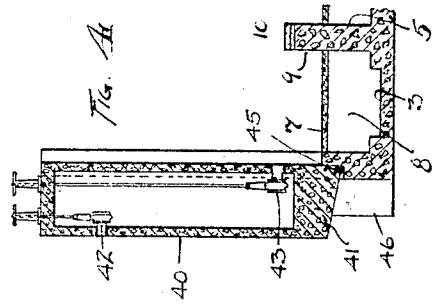


Fig. 4

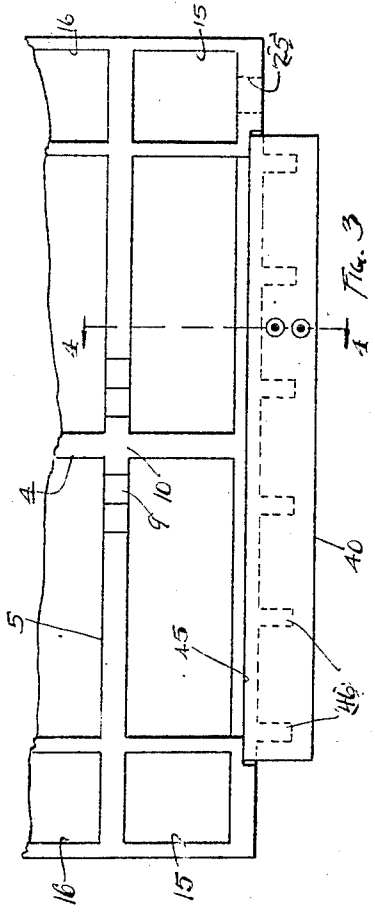


Fig. 3

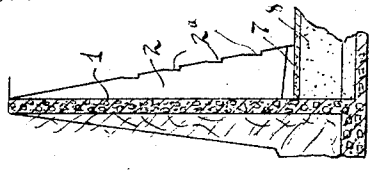


Fig. 2a

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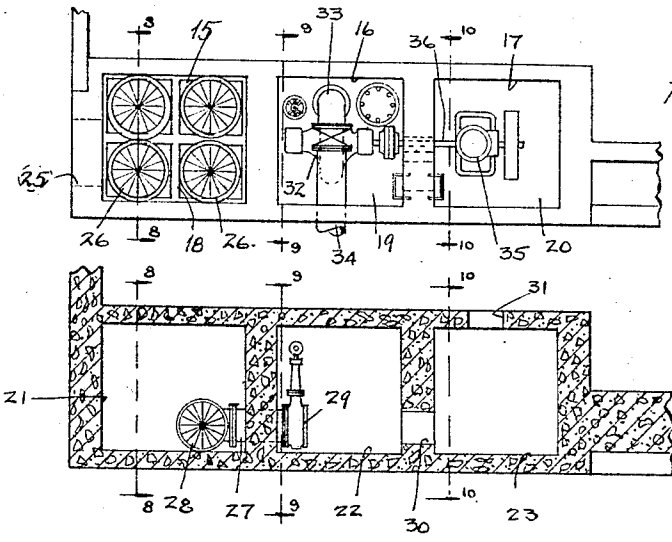


Fig. 6

Fig. 7

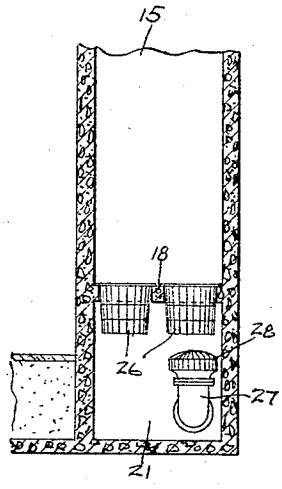


Fig. 8

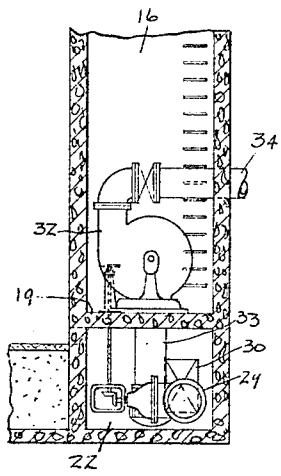


Fig. 9

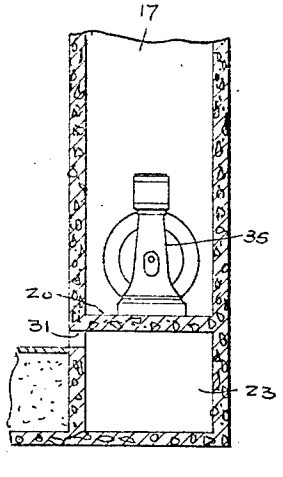


Fig. 10

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UNITED STATES PATENT OFFICE.

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DRY DOCK.

Application filed May 8, 1919, Serial No. 295,722. Renewed July 21, 1924.

To all whom it may concern:

Be it known that I, DAVID E. WILLIAMS, a citizen of the United States, and a resident of Cleveland, county of Cuyahoga, and State of Ohio, have invented a new and useful Improvement in Dry Docks, of which the following is a specification, the principle of the invention being herein explained and the best mode in which I have contemplated applying that principle so as to distinguish it from other inventions.

As is well known, so-called "dry docks" are of three principal classes. The first, or dry dock proper, also called a graving dock, is an excavated basin adjoining navigable water, provided with a gate and so arranged that, after the docking of a ship therein, the water can be pumped out. The method of constructing this type of dock, as at present practiced, is to excavate the basin on the shore and then build up the floor and walls of the dock upon suitable foundations laid in such basin, all such construction requiring to be extremely heavy, to withstand the strains to which the dock is subjected. Furthermore, the excavation must be kept dry during the work of construction by the use of sheet piling or the like to surround the same, thus rendering the building of a dock of this type a very expensive matter indeed. The second type of dock in current use is the so-called floating dock, which is provided with water-tight compartments or tanks, and so adapted to be sunk to the required depth to receive the vessel to be docked by filling said tanks or compartments with water; whereupon, by pumping the water therefrom, the dock is caused to rise, lifting the vessel with it. This type of construction is also obviously quite expensive. The third type of dock is the so-called railway dry dock which consists of the movable platform on declined ways or tracks extending from a distance out of the water to a distance under water of sufficient length to receive a boat riding on the water and hauling same out of water in which position repairs can be made. It is obvious that the three above mentioned methods have their serious deficiencies either in their large first inventment in construction or their inefficient and dangerous method by which the ship can be dry docked.

The object of the present invention is to provide a dry dock, using the term in its general significance, which may be more cheaply constructed than any of the foregoing docks, and which will nevertheless provide all the advantageous features of such docks. A further object is to provide an improved type of caisson or floating gate for use in connection with dry docks, whether of the particular construction in hand or other type. To the accomplishment of the foregoing and related ends, said invention, then, consists of the means hereinafter fully described and particularly pointed out in the claims, the annexed drawings and the following description setting forth in detail certain mechanism embodying the invention, such disclosed means constituting, however, but one of various mechanical forms in which the principle of the invention may be used.

In said annexed drawings:—

Fig. 1 is a perspective or isometric view of a dry dock embodying my present improvements, taken by itself; Fig. 2 is a transverse section through such dock at a point intermediate its ends; Fig. 2ª is a similar section of a detail showing a modification; Fig. 3 is a plan view of the front end of the dock showing the gate in place to close the same; Fig. 4 is a transverse section through such gate and adjacent part of the dock, the plane of the section being indicated by the line 4—4, Fig. 3; Fig. 5 is a plan view of a detail of the front end of the dock: Fig. 6 is a plan view of one of the forward corners of the dock, showing the arrangement of pumping machinery; Fig. 7 is a horizontal section on a plane below the machinery floor; Fig. 8, 9 and 10 are transverse sections of the foregoing taken on planes indicated by the lines 8—8, 9—9 and 10—10, Figs. 6 and 7; Fig. 11 is a diagrammatic sectional view of my improved dock, designed to show the character of the back fill; and Figs. 12 and 13 are respectively a vertical section and a horizontal section showing the manner in which the dock may be assembled in sections.

My improved dock, as illustrated in Fig. 1, is designed to be constructed in the first instance out of water after the fashion of a boat or other vessel; thereupon, it will be launched and towed to a previously prepared slip or basin, being maintained in buoyant state the while by either bulk-heading any open end or setting gates in place; after

which it is lowered to the proper depth to receive vessels requiring to be docked and there held permanently in place in the fashion presently to be described.

The material which I preferably use in the construction of my improved dry dock, both for reasons of expense and otherwise, is concrete. The entire structure, as illustrated in Fig. 1, in other words, where concrete is thus used, is poured or molded in a suitable form or forms so as to be an integral or monolithic concrete vessel, of general rectangular form, with one end wall omitted so as to leave such end open. In order that the walls I may be made as thin as possible, such walls are suitably reinforced by means of metal reinforcing rods or the like embedded therein, and need not be described in detail for the purpose in hand, and are furthermore provided with integral buttresses 2, either within or without, or both within and without, placed at suitable intervals along the sides and the closed end of the structure. The floor 3 of the structure is of relatively thin cross-section and is supported by one or more inverted longitudinal ribs or girders 4 (one being shown) and by a plurality of inverted transverse girders 5 spanning from wall to wall in such a fashion as to provide the same structural strength to resist the forces of bouyancy as would be provided in the event the floor was built of a solid mass of concrete of a thickness equivalent to a double depth of the girder. The transverse girders 5 preferably correspond in location with the aforesaid buttresses, and it will further be noted that such floor extends beyond the walls on either side of the structure, it being upon these lateral extensions 6 of the floor or bottom that the external buttresses 2 have their base.

In the finally completed state of the dock, a second or false floor 7 is preferably provided (see Figs. 2 and 4), likewise shown as of concrete, either molded in place or formed in slabs and then placed in position, such floor being on a level with, or resting upon, the transverse ribs previously described as reinforcing the bottom or floor. The intervening space 8 between the two floors is then filled with sand or other like material to provide the necessary dead weight. The transverse ribs, it will be observed, have central raised portions 9, upon which are placed (see Fig. 2) the wedges 10 whereupon the keel of a vessel being docked will rest, these wedges being located directly over the central longitudinal rib 4. The interior buttresses 2, moreover, may be provided with notches 2^a (see Fig. 2^a) to receive shoring or supports for a ship resting in the dock.

As shown in Fig. 1, and also in more detail in Figs. 6 to 10 inclusive, the forward end of the side walls, adjacent the open end of the dock, is enlarged, and three compartments or wells 15, 16 and 17 are provided therein, through which, under the control of suitable valves and pumping mechanism, water may be admitted to the interior of the dock or exhausted therefrom, as desired. The lower portions of such wells are respectively partitioned off by floors 18, 19 and 20 located on a level with each other and a short distance above that of the upper or false floor 7 of the dock proper, whereby closed chambers 21, 22 and 23 are formed. As shown, the exterior inlet for the water is an aperture 25 in the front wall of the foremost of these wells or compartments. In the floor 18 in the first well are inserted a plurality of strainer baskets 26; and a pipe 27, likewise provided with a strainer 28, and controlled by a gate valve 29, extends through the wall between chamber 21 and the next adjoining chamber 22, whereby water may be allowed to enter such second chamber from the first, thence passing through an opening 30 in the wall between said second chamber and third chamber into the latter. The third or last mentioned chamber communicates in turn through an opening 31 with the interior of the dock on the level of the upper or false floor therein.

On the floor 19 over the second chamber is mounted a centrifugal pump 32, the intake 33 of which extends down through the floor in the chamber in question, while its discharge 34 extends through the outer wall of the well above the floor (see Fig. 9), such pump being driven by an engine 35 which is located on the floor 20 over the third chamber and connected through the intervening wall, by means of a suitable shaft 36, with said pump. A hand wheel operatively connected with the valve 29 in pipe 27, projects through the floor adjacent the pump, and there is also provided in this floor a manhole with water-tight cover, by means of which access may be had to the chamber and such valve if found necessary.

By means of the foregoing arrangement of chambers, valves and pump, it will be seen that with the front end of the dock closed by a gate water may be admitted to the interior of such dock by simply opening valve 29, the water entering through the exterior opening 25, thence passing through the strainers 26, pipe 27 and passages 30 and 31. When it is desired to empty the dock of water, the gate being similarly closed of course, the valve 29 is shut and the pump, which is always primed, is put in operation, with the result that the water will be drawn in reverse direction through such passages and discharged through the discharge pipe 34 leading from said pump.

The gate 40 (see Figs. 3 and 4) for closing the forward end of the dock is of the caisson type previously referred to, being, like the dock, preferably constructed of monolithic

concrete. Said gate is formed hollow, the lower wall 41 thereof being considerably heavier than the side or top walls so as to cause the gate to normally maintain a vertical position when floating in the water, as it will when its interior is empty. The admission of water to the interior is controlled by means of a valve 42 in a suitable opening in the front wall of the gate, while another valve 43, controlling an opening in the inner wall of the gate located near the bottom of the chamber in the latter, permits the water in such chamber to escape into the interior of the dock, when the gate is in place so as to close such dock. The operation of the gate, in other words, involves floating it into place at the front end of the dock, while the interior chamber in such gate is substantially emptied of water; thereupon by opening the valve 42, the other valve 43 being closed, such chamber is filled with water and the gate is caused to settle into place, sealing the dock and rendering it possible to pump the latter empty in the fashion previously described. The valve 42 in the gate is, of course, closed before such pump operation is begun; then when it is desired to open the gate, before the dock is filled with water to float the vessel resting therein, valve 43 is opened so as to allow the water in the chamber to drain into the dock. Thereupon, said valve is closed and when the dock is filled so the water level within the same is equal to that without, the gate can be floated away.

The lower edge of the gate is preferably transversely beveled in the fashion clearly shown in Fig. 4, and the end of the dock, wherewith such gate co-operates, is formed with a complementary recess 45, and, in addition, a series of spaced projections 46 are provided integral with such end of the dock and having their upper faces of corresponding inclination, so as to afford an adequate support for the gate when in closed position. The recess 45 in the end of the dock has a channel or groove 47 (Fig. 5) formed at its inner angle, from which transverse grooves 48 lead to the front face so that any water or mud, such as may tend to collect in these recesses, can be squeezed out as the gate settles into place. The inclination of recess 45 and projections 46, it will be understood, cause the gate when being sunk to bind itself by its own dead weight and the hydrostatic pressure into firm and close contact with the dock, thereby insuring as nearly as may be a water-tight closure.

Particular attention is desired, not so much to the various novel details of construction hereinbefore set forth as to the general construction and manner of installation of the dock as a whole. As previously indicated, the dock is constructed out of water and is then launched into the water and floated under its own buoyancy to the previously prepared location. The slip or basin intended for its reception is left open to the channel, thus permitting the excavation of such slip or basin to be carried on as an ordinary dredging operation without the necessity, in other words, of enclosing the space by means of water-tight piling, as in the case of the contruction of the usual graving dock. After the dock has been properly positioned in the basin thus prepared for it, with its outer end, of course, directed toward the channel, it is sunk to the desired level and there maintained permanently in place by providing just sufficient additional dead weight. This may be accomplished by increasing section of walls and buttresses, or by adding to the amount of sand filling between the floors; or, as shown, this additional dead weight is provided by filling in the earth on the sides of the structure as indicated at the left in Fig. 2, the dead weight of the earth which rests on the laterally projecting bottom of the dock being sufficient to overcome its buoyancy, this without reference to the frictional resistance of the earth thus filled in to break or cleave under any buoyant effort of the dock. Preferably the level at which the dock is brought to rest is determined by a row of piles or concrete blocks 50, which may be located under the respective side and end walls of the dock at suitably spaced intervals, there being no occasion for exact location thereof in view of the fact that they do not have to sustain any considerable load. Where concrete blocks are used, upon which thus to rest the dock, these may be poured into place before the dock has been floated into position and caused to settle to the desired level.

In Fig. 11 the laterally projecting floor having a width b, will evidently support a volume of earth having a section of such width and of the height a of the fill. The dotted line at the right indicates the approximate line on which the fill would tend to cleave from the adjacent solid earth and the frictional resistance to such cleavage, as previously explained, is an additional factor which may be calculated on.

If desired, in order to facilitate the drainage of the dock towards its front end, it may be brought to rest at a slight inclination longitudinally from rear to front end. In this event the blocks or piles 50 will of course be set at the proper slope longitudinally of the dock, it being sufficient, in a dock of ordinary size, to have the front end one foot lower than the rear, so that the inclination will not be noticeable, and will not affect the docking of the vessel in any way.

If desired, for the sake of convenience or economy, the dock, instead of being built in the first instance as a unitary or monolithic structure, can be built in sections, and these

subsequently joined into such a structure. Where it is desired to proceed in this fashion, the sections will be bulkheaded and floated over the position in which they are eventually to be sunk, after being first joined together; or such sections may be thus joined together while floating in any convenient location, and then the consolidated structure or dock complete be thus floated into position and sunk, as previously described.

The manner in which two sections thus separately constructed may be subsequently joined, is illustrated in Figs. 12 and 13, where the adjacent ends of two such sections are shown as being brought into contacting relation while floating in the water. The line of division between the sections as constructed is preferably approximately midway between two transverse girders 5 and correspondingly aligned buttresses 2. The bulkheads 51 can then be braced against the inner faces of such girders and buttresses, leaving a space that will be initially filled with water when the two sections are brought into proper juxtaposition. The side wall of one of each such section is divided, as shown in Fig. 13, into two laterally spaced portions 52, 52, that form a box-like enclosure under the conditions just referred to, rising to the full height of said walls 1. The latter are reinforced with embedded rods 53, the ends of which project between the wall parts 52, and are threaded to receive a turnbuckle 54 or like device whereby such ends may be firmly secured together. The result of tightening such turnbuckles, also serves to draw the two sections of the dock correspondingly close together. With the dock sections thus tied together, the joints between the side walls and bottom may be temporarily caulked if not already tight enough to permit the water to be pumped out of the space between the bulkheads 51 and out of the enclosure formed by the wall parts 52. A slab 55 is then laid over the joint in the floor, and the space between the adjacent girders 5 filled with concrete as shown in Fig. 12, thus effectually sealing such joint and firmly uniting the floor of the sections together. Similarly, the space enclosed by the wall parts 52 is filled with concrete, sealing the joint between the sides of the sections and firmly uniting the latter together, the ends of the reinforcing members 53 as well as the turnbuckles 54 being embedded in such concrete.

From the foregoing description it will be seen that the excavation for my improved dock and its foundations are made under water, thus eliminating all expensive cofferdam construction and the uncertainties due to unstable soil conditions. The carrying capacity of the foundations, consisting of two rows of piles or blocks disposed beneath the respective side-walls of the dock, may be exactly predetermined just as in those of land structures, and according to the best engineering practice. The dock itself is constructed in such a manner that one-half or more of the weight required to overcome buoyancy is composed of inexpensive material, such as soil or sand, as compared with solid masonry or concrete as used in the usual manner of graving dock construction, thus permitting the use of small sections, and the more economical arrangement of material. The forces acting on the bottom of the dock are collected by the floor system and transmitted to the transverse girders, which in turn transmit such forces to the foundations or to the vertical abutments that coincide with such tranverse girders; while conversely the forces acting on the side-walls of the dock are collected and transmitted to the vertical buttresses and in turn transmitted to such coinciding transverse girders.

It will furthermore be seen that the two sets of forces just referred to oppose each other, and to the extent that they are equal, such forces will neutralize each other. In other words, the two rows of piles or blocks upon which the dock is brought to rest with its respective side-walls located thereover, constitute in effect lines upon which the longitudinal halves of the dock may be regarded as being fulcrumed. The hydrostatic pressure acting on the bottom of the dock is converted into a turning effect that is resisted by the counter-turning effect of the pressure against the side-walls, just as if such pressures were applied to the two arms of a bell-crank.

The foregoing statement has regard more especially to the situation where the dock is empty. When it is full, the hydrostatic pressure under the floor is of course more nearly balanced by the weight of the water within. In this condition, it is the pressure against the side walls that requires to be resisted, but here the principle of construction just explained comes into play again, but in reverse fashion, i. e. the bottom system, by being tied to the side walls through the coincident transverse girders and buttresses resists the turning moment, just as before.

Other modes of applying the principle of my invention may be employed instead of the one explained, change being made as regards the steps or mechanism herein disclosed, provided the means stated by any of the following claims or the equivalent of such stated means be employed.

I therefore particularly point out and distinctly claim as my invention:—

1. A drydock comprising a normally buoyant structure of monolithic concrete in the form of an open rectangular vessel having its one end removed and adapted to be closed by a gate, the floor of said vessel ex-

tending beyond the side walls thereof, and a back fill resting on such projecting floor-portion and retaining the structure in place below the water level at a depth adapting the same to receive vessels requiring to be docked.

2. A dry-dock comprising a normally buoyant structure of monolithic concrete in the form of an open rectangular vessel having its one end removed and adapted to be closed by a gate, the floor of said vessel extending beyond the side walls thereof, in combination with two rows of supports extending longitudinally beneath the side-walls of said vessel upon which the latter rests when thus in place.

3. A dry-dock comprising a structure of monolithic concrete in the form of an open rectangular vessel having its one end removed and adapted to be closed by a gate, and a plurality of spaced buttresses rising from the floor of said vessel along the side walls thereof and adapted to collect the forces acting on said side-walls and transmit the same to the bottom of said vessel.

4. A dry-dock comprising a structure of monolithic concrete in the form of an open rectangular vessel having its one end removed and adapted to be closed by a gate, the floor of said vessel extending beyond the walls thereof, and a plurality of spaced buttresses rising from the floor of said vessel along both the inside and outside of the walls thereof.

5. A dry-dock comprising a structure of monolithic concrete in the form of an open rectangular vessel having its one end removed and adapted to be closed by a gate, a plurality of reinforcing ribs extending transversely of the floor of said vessel, and buttresses coinciding in position with said transverse ribs and rising along the walls of said vessel, said ribs and buttresses being adapted to collect the forces acting on the bottom of the latter and on said side-walls, respectively, and to oppose the same each to the other.

6. A dry-dock comprising a structure of monolithic concrete in the form of an open rectangular vessel having its one end removed and adapted to be closed by a gate, and a plurality of spaced buttresses rising from the floor of said vessel along the side-walls thereof and adapted to collect the forces acting on said side-walls and transmit the same to the bottom of said vessel, in combination with two rows of supports extending longitudinally beneath the side walls of said vessel upon which the latter rests when thus in place.

7. A dry-dock comprising a structure of monolithic concrete in the form of an open rectangular vessel having its end end removed and adapted to be closed by a gate, a plurality of reinforcing ribs extending transversely of the floor of said vessel, and buttresses coinciding in position with said transverse ribs and rising along the walls of said vessel, said ribs and buttresses being adapted to collect the forces acting on the bottom of the latter and one said side-walls respectively and to oppose the same each to the other, in combination with two rows of supports extending longitudinally beneath the side-walls of said vessel upon which the latter rests when thus in place.

8. The combination with a dry-dock in the form of an open rectangular vessel having its one end removed, of a gate of the floating caisson type adapted to close such end, the lower edge of said gate being inclined or beveled upwardly and outwardly, and a ledge of complementary inclination adapted to receive such gate.

9. The combination with a dry-dock in the form of an open rectangular vessel having its one end removed, of a gate of the floating caisson type adapted to close such end, the lower edge of said gate being inclined or beveled upwardly and outwardly, and a ledge formed with a recess of complementary inclination adapted to receive such gate, drainage grooves being cut in such recess.

10. The combination with a dry-dock in the form of an open rectangular vessel having its one end removed, of a gate of the floating caisson type adapted to close such end, the lower edge of said gate being inclined or beveled upwardly and outwardly, a ledge formed with a recess of complementary inclination adapted to receive such gate, and correspondingly inclined spaced projections on said ledge adapted to assist in supporting said gate.

11. The method of building a dry-dock, which consists in constructing in sections out of the water an open vessel of general rectangular form, bulk-heading such sections, launching the same, bringing said sections into proper juxtaposition and permanently joining the same together to form the complete vessel, floating said vessel to previously selected location, and there overcoming normal buoyancy of said vessel by weighing same until it sinks to desired depth below water level.

Signed by me, this 6th day of May, 1919.

DAVID E. WILLIAMS.