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GRAVING DOCKS

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Fig. 1.

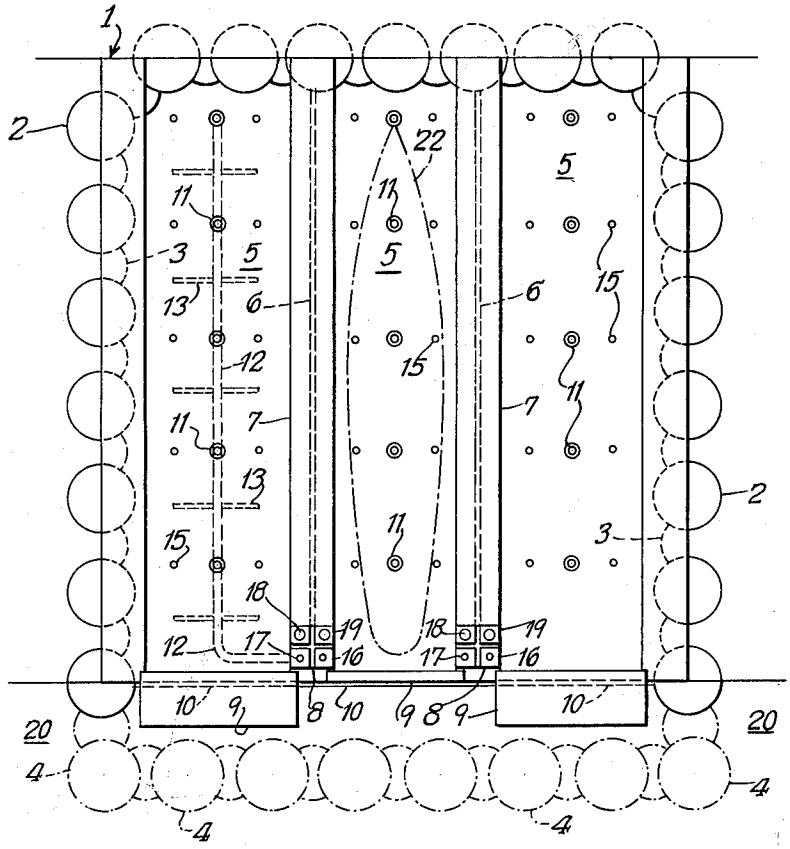
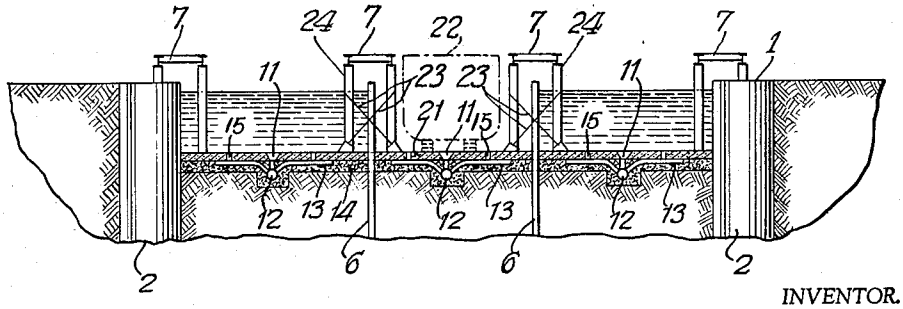


Fig. 2.



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GRAVING DOCKS

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Continuation of application Ser. No. 724,470, Mar. 27, 1958. This application Apr. 5, 1962, Ser. No. 185,360
17 Claims. (Cl. 61—64)

This application is a continuation of my copending application Serial No. 724,470, filed March 27, 1958, and now abandoned.

My invention refers to an improvement in graving docks and it has for its object to provide a graving dock divided into multiple units by sheet bulkheads extending from high tide to the subterranean seepage level and braced to the dock floor by 45° angle braces on both sides and straddled by service piers. The invention has also for its object to provide separate closure gates for the dock sections. Although conventional closure gates may be used, I prefer to use a new type of wicker gate, substantially as described in my copending application for Letters Patent Serial No. 738,220, filed May 27, 1958. Hitherto all graving docks have been designed to dock one big ship at a time and in case a yard was required to dock two ships at a time, two docks were required. The reason, therefore, is that until now all graving docks, when empty, have been designed to withstand a considerable hydrostatic excess pressure on the underside of the flooring, with the floor acting as an inverted arch where the abutments are furnished by the heavy side walls, together with the inert earth friction on the rear of the side walls. In case of a graving dock of double width designed to serve two big ships at one time, the economic span for the inverted arch would be exceeded and the cost of building two conventional graving docks side by side for the two ships would be less than that of one conventional dock that was sufficiently wide to dock the two big ships at the same time.

Now, however, I have discovered, and therein lies my invention, that by combining an under drainage system for the graving dock basin, and dividing the basin into a number of individual sections by sheet bulkheads extending from high tide to the subterranean seepage level and brace the center of the bulkheads by 45° angle braces to the basin floor, I get division bulkheads able to withstand the maximum high water pressure on either side thereof, and a shallow basin floor without the customary hydrostatic excess pressure. Taking advantage of the fact that the required width for service piers is 30 feet, and the fact that they are conventionally situated substantially above the height of the tide water level, the 45° angle braces, when attached to the center of the sheet bulkheads are kept within the 30 foot pier width and do not encroach on the working space around the docked ship.

In the drawing, FIGURE 1 is a plan view of my preferred graving dock, and FIGURE 2 is a vertical section elevation thereof.

In the drawing where like reference characters designate corresponding parts, 1 represents the graving dock which is shown surrounded by permanent cylindrical cells 2, which are formed by interlocking sheet piling and connected to each other by arches 3, which also are formed by interlocking sheet piling.

At the entrance end of the dock, the temporary interlocked cell system 4, is shown in dotted lines on the drawing.

This temporary cell system is removed when the dock is completed. The graving dock 1, is shown divided into three units 5, which are separated by the sheet bulkheads 6. Straddling these bulkheads the service piers 7 finger out longitudinally from the head end of the graving dock

to end up against the entrance abutments 8, against which the closure gates 9 are adapted to press tightly.

The seepage end bulkheads 10, extend from the dock floor to below the seepage line, and the end bulkheads 10, will thus prevent seepage from entering the dock when the temporary cells 4, are removed.

At the center of each dock division 5, I have shown, for the sake of simplicity, a row of catch basins 11, that empty into a drain pipe 12, from which a number of subterranean drain pipes 13, branch out, although I prefer to use at least two rows of catch basins in a wide dock section. These pipes are preferably made of a pervious material and are bedded in a layer of broken stones 14. The customary excess pressure on the bottom of the empty dock section cannot occur as the floor slab 21 is properly vented by a number of vertical open pipes 15, that pierce the floor slab. The main drain pipes 12, discharge into separate pump wells 16, where drainage pumps 17 are located. Separate dewatering pumps 18 are located in the separate pump wells 19. Both the dewatering pumps and the drain pumps discharge through the pier heads into the surrounding water 20.

The docking procedure is as follows:

When a ship 22 is to be docked in a certain dock division, the gate thereof is opened and the ship is pulled into the dock division, preferably at a rising high tide level. After that the ship has been located on the blocks, the entrance gate is closed and the dewatering pumps, as well as the drain pumps, are started. When the dock division becomes empty, the dewatering pumps 18 are stopped, but the drainage pumps 17 continue pumping until a low level cut-out is reached in the pump wells. With the water level in the pump wells rising some three feet because of the continuous seepage, an automatic switch will again start the pumps with consequent cut-out and restarting repeating automatically. The division bulkheads are shown provided with 45° angle bracing 23 extending between sheet bulkheads 6 and the columns 24 which also support piers 7, and it is to be noted that in such a bracing the vertical down pressure on the soil equals the horizontal side pressure thereon, and a most economical bracing results.

It is to be noted that with service piers straddling the division bulkheads, the 45° bracing is kept within the pier limit and does not encroach on the working space around a ship.

I do not desire to be understood as limiting myself to the specific details of construction and arrangements as herein described, and illustrated, as it is manifest that variations and modifications may be made in the features of construction and arrangement in the adaptation of the device to various conditions of use without departing from the spirit and scope of my invention and improvements. I therefore, reserve the right to all such variations and modifications as properly fall within the scope of my invention and the terms of the following claims.

What is claimed is:

1. In a graving dock having a generally continuous, bottom-enclosing floor situated on bearing soil or the like at a depth which is below the natural water level in such soil, the improvement comprising means for reducing excess natural hydrostatic pressure as would otherwise be directed upwardly against the underside of said floor, said means comprising drainage means for removing accumulating water from below said floor including pump means, a seepage bed of material disposed underneath substantially the entire area of said floor, conduit means including portions substantially adjacent the underside of said floor and communicating with said seepage bed to admit entry of said accumulating water from the latter, at least said conduit portions being disposed in direction

which is generally parallel to the general plane of said floor and said conduit means being adapted to conduct said accumulating water to said pump means at a rate which is at least equal to that at which such water naturally accumulates under said floor, and means defining open vent passages between said seepage bed and the atmosphere, said drainage means being disposed to remove said accumulating water at a flow level whereby such natural hydrostatic pressure excess is maintained at negligible value at the level of the underside of said floor.

2. In a graving dock, the improvement in accordance with claim 1 wherein said open vent passages extend between said seepage bed and the interior of said dock, and are disposed such that dock flooding water communicates with said seepage bed.

3. In a graving dock, the improvement according to claim 2 wherein said open vent passages comprise a plurality of substantially vertical openings through said bottom enclosing floor.

4. In a graving dock, the improvement in accordance with claim 1 wherein said conduit means comprises a gravity flow network thereof including a substantially horizontal main conduit extending in one direction of said dock and a plurality of substantially horizontal secondary conduits each feeding into said main conduit and each extending in a direction which is substantially transverse with respect to said direction of the main conduit.

5. In a graving dock, the improvement in accordance with claim 4 wherein said main conduit and said secondary conduits are situated below the underside of said floor and are embedded in said seepage bed.

6. In a graving dock, the improvement in accordance with claim 1 wherein said conduit means comprises a gravity flow network thereof including a substantially horizontal main conduit extending in one direction of said dock and a plurality of substantially horizontal secondary conduits each feeding into said main conduit and each extending in a direction which is substantially transverse with respect to said direction of the main conduit, said main conduit and said secondary conduits being situated below the underside of said floor and embedded in said seepage bed, said main conduit being disposed at an elevation which is below those of said secondary conduits and also below the general elevation of said seepage bed, said secondary conduits lying within such general elevation of said seepage bed, and said pump means includes a pump well disposed to receive such gravity flowing water from said main conduit.

7. In a graving dock, the improvement in accordance with claim 1 wherein said portions of the conduit means extend into said seepage bed and are disposed substantially uniformly throughout the area of the latter, said conduit portions comprising piping adapted to permit entry of said water through the walls thereof.

8. In a graving dock having a generally continuous, bottom-enclosing floor situated on bearing soil or the like at a depth which is below the natural water level in said soil, the improvement comprising drainage means for draining water from the underside of said floor, said drainage means comprising a pump well interior of said dock, pump means for pumping water out of said pump well and out of said dock, a seepage bed of material disposed underneath substantially the entire area of said floor, conduit means substantially situated below the level of the upper surface of said floor and including a main conduit extending horizontally in one direction of said dock at an elevation which is below that of the upper surface of said floor and a plurality of horizontally disposed secondary conduits each feeding into said main conduit, at least portions of said secondary conduits being emebdded in said seepage bed and adapted to admit entry of water from the latter, said pump well having a water collection level which is substantially at the elevation of said main conduit, said conduit means being disposed

so as to conduct water between said seepage bed and said pump well at a flow level whereby excess natural hydrostatic pressure as would otherwise be directed upwardly against the underside of said floor is maintained at negligible value at the level of the underside of said floor, and means defining open vent passages between said seepage bed and the atmosphere, said pump means having pumping capacity for pumping water from said pump well at a rate which is at least equal to the natural rate of accumulation of such water underneath said floor.

9. In a graving dock having a generally continuous, bottom-enclosing floor situated on bearing soil or the like at a depth which is below the natural water level in such soil, the improvement comprising means for reducing excess natural hydrostatic pressure as would otherwise be directed upwardly against the underside of said floor, said means comprising drainage means below the level of the upper surface of said floor including a pump well having pump means therein, a network of substantially horizontal pipe conduits including conduit portions which are situated below the underside of said floor, a seepage bed of material extending underneath substantially the entire area of said floor and substantially surrounding said conduit portions, open catch basin drain means of said floor, said catch basin drain means being connected to said pipe conduit network and adapted for draining water into the latter from the upper surface of said floor, said pipe conduit network being adapted to admit entry of water from said seepage bed and from said catch basin means and to conduct the same to said pump well at a rate which is at least equal to the natural rate of accumulation of such surface water and of water as naturally accumulates below the underside of said floor, said drainage means being disposed to remove all of such water in direction which is generally parallel to the general plane of said floor and at all times at a flow level thereof whereby such natural hydrostatic pressure excess is maintained at negligible value at the level of the underside of said floor.

10. A graving dock comprising a generally continuous, bottom-enclosing floor situated on bearing soil or the like at a depth which is below the natural water level in such soil, peripehral enclosure means extending upwardly of said floor, peripherally disposed seepage bulkhead means projecting downwardly below the level of the underside of said floor, said seepage bulkhead means providing a water drainage compartment for water as naturally accumulates within such soil beneath said floor, and drainage means for removing said water from within said drainage compartment and comprising pump means, a seepage bed of material disposed within said drainage compartment, conduit means including substantially horizontal portions thereof which are situated below the underside of said floor and within said seepage bed of material, said conduit portions being adapted to admit entry of said water from said seepage bed and said conduit means being adapted to conduct said water to said pump means at a rate which is at lease equal to that at which such water naturally accumulates under said floor, and means defining open vent passages between said seepage bed and the atmosphere, said drainage means being disposed to remove said accumulating water at a flow level whereby excess natural hydrostatic pressure as would otherwise be directed upwardly against the underside of said floor is maintained at negligible value at the level of the underside of said floor.

11. The method of reducing at the underside of the bearing-soil supported bottom-enclosing floor of a graving dock the natural, upwardly directed excess bouyant pressure as would otherwise be exerted against the underside of the floor by natural seepage water as accumulates beneath said floor, comprising draining said seepage water from beneath substantially the entire area of the underside of said floor in direction which is generally parallel to the general plane of said floor while maintain-

ing the flow level of the draining water at substantially that at which said excess buoyant pressure is maintained at negligible value at the underside of said floor, and while maintaining vent communication between the underside of said floor and the atmosphere.

12. A graving dock having a bottom-enclosing floor situated on bearing soil or the like at a depth which is below the water level adjacent the dock, a closed wall at one end, a gate at the opposite end and side walls, the tops of the walls being above the high water level adjacent the location of the dock and the bottoms of said walls being lower than said floor of the dock, a single layer of stones extending continuously from wall to wall above the lower ends of said walls, said layer having relatively small thickness, the floor being on the stones and being fully exposed over substantially its whole upper surface, the floor being a layer of concrete extending from wall to wall and of substantially the same area as the inside of the dock, and having relatively small thickness but sufficient to support safely the weight of the water in the dock and the weight of the ship therein also, the floor having openings along its length and means comprising piping adjacent said layer for draining underground water collecting in the dock above and below said floor, one of said side walls comprising sheet piling and having columns on each side extending from the floor of the dock above said wall, a pier on top of said columns, diagonal struts seated against the concrete floor and secured at their upper ends to opposite faces of said wall and diagonal struts secured at their lower ends to opposite faces of said wall and at their upper ends to said columns.

13. A graving dock adapted to receive a plurality of ships therein and comprising a generally continuous, bottom-enclosing floor situated on bearing soil or the like at a depth which is below the natural water level in such soil, peripheral enclosure means extending upwardly of said floor, peripherally disposed seepage bulkhead means projecting downwardly below the level of the underside of said floor, longitudinally extending watertight division bulkhead means extending vertically upward of said floor and disposed for compartmentalizing said dock to receive such plurality of ships, longitudinally extending seepage bulkhead means projecting downwardly below the underside of said floor and below said watertight bulkhead means, all of said seepage bulkhead means being adapted with respect to each other to provide a water drainage compartment within such soil beneath each of the respective compartments of said dock for receiving a ship, and drainage means for removing water from within each of said drainage compartments, such of said drainage means as is associated with any such drainage compartment being adapted for operation independently of such of said drainage means as is associated with any other such drainage compartment and comprising pump means, conduit means substantially situated below the level of the upper surface of said floor and including substantially horizontal portions thereof which are situated below the underside of said floor and within said associated drainage compartment, a seepage bed of material disposed within said associated drainage compartment and substantially surrounding said portions of the conduit means, said conduit means being adapted to admit entry of water from within said associated drainage compartment and to conduct the same to said pump means at a rate which is at least equal to that at which such water naturally accumulates within said associated drainage compartment, and means defining communicating vent passages between said seepage bed and the atmosphere, said drainage means being disposed to remove such water from each of said drainage compartments in direction which is generally parallel to the general plane of said floor and at all times at a flow level thereof whereby excess natural hydrostatic pressure as would otherwise be directed upwardly against the underside of the portion of said floor which is above any such drainage compartment is maintained at negligible value at the level of the underside of said floor portion.

14. A graving dock according to claim 13 wherein said longitudinally extending watertight division bulkhead means comprises a sheet-type bulkhead, and bracing means therefor, said bracing means comprising oppositely disposed diagonal members extending in transverse direction between said sheet-type bulkhead and said floor, each of said diagonal member being attached at one of its ends to said sheet-type bulkhead at an elevation thereon which is spaced from said floor and being attched at the other of its ends to said floor at a location thereon which is spaced from said sheet-type bulkhead.

15. A graving dock according to claim 14 wherein said longitudinally extending watertight division bulkhead means further comprises an upright column member attached to said floor substantially at each of said locations of attachment of said other ends of the diagonal members, and additional oppositely disposed diagonal members extending in transverse direction between said sheet-type bulkhead and said columns, each said additional diagonal member being attached at one of its ends to said sheet-type bulkhead at substantially said elevation thereon and being attached at the other of its ends to one of said columns at an elevation thereon which is above said elevation of attachment to said sheet-type bulkhead, respective pairs of said columns and said oppositely disposed diagonal and additional diagonal members lying within substantially the same transverse plane.

16. A graving dock according to claim 15, wherein all of said oppositely disposed diagonal and additional diagonal members are disposed at an angle of substantially forty-five degrees (45°) to the plane of said sheet-type bulkhead.

17. A graving dock according to claim 15 wherein said longitudinally extending watertight division bulkhead means further includes horizontally disposed pier means extending substantially the length of, and transversely across the top of said sheet-type bulkhead and between such oppositely disposed columns, said pier means adapted to provide a work platform atop said sheet-type bulkhead.

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