Sept. 11, 1945. F. R. HARRIS 2,384,616

BASIN OR GRAVING DRY DOCK

Original Filed March 6, 1943 2 Sheets-Sheet 1

Fig. 1.

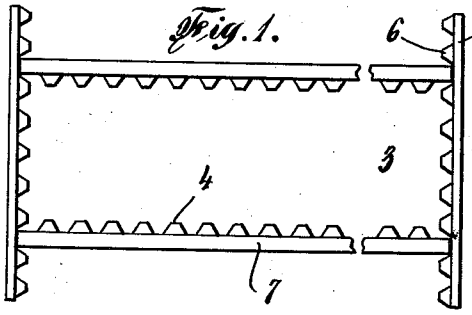



Fig. 3.

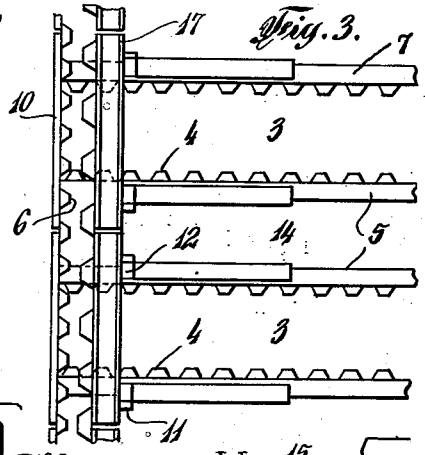
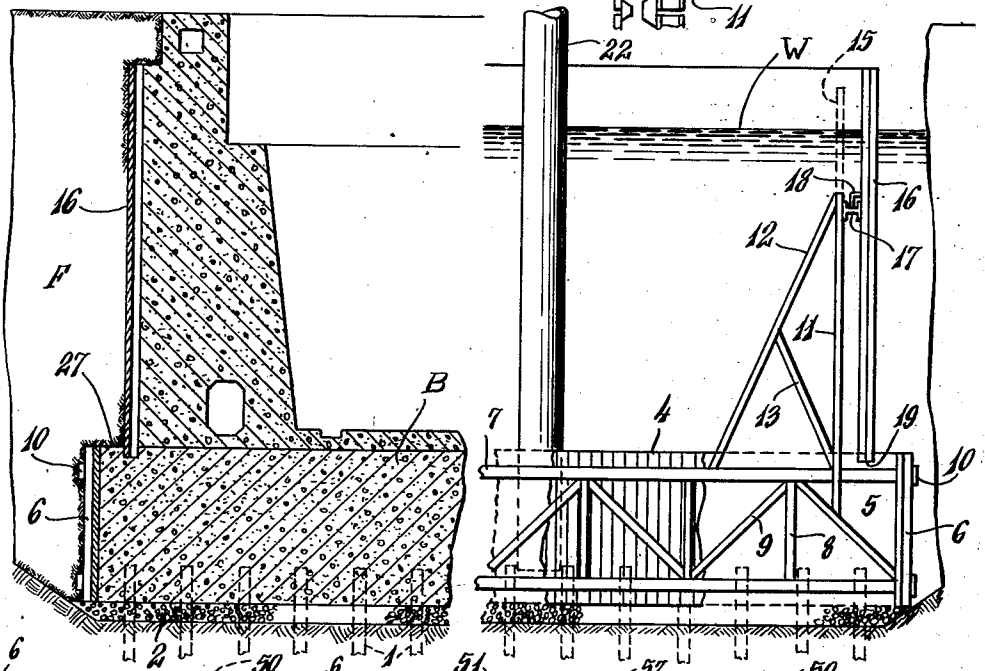



Fig. 2.



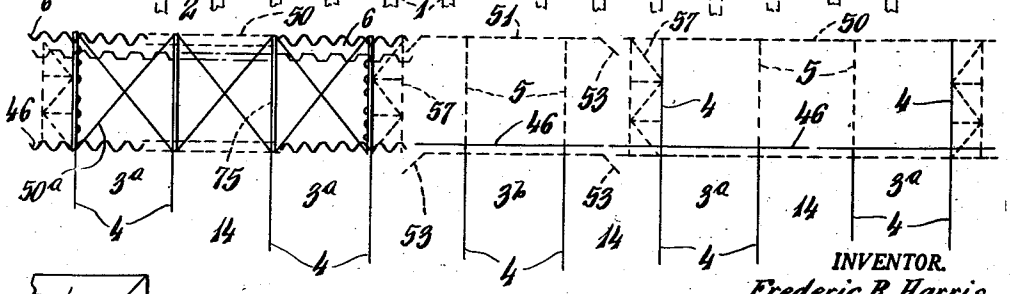




Fig. 5.

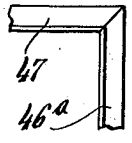



Fig. 10.

INVENTOR.
Frederic R. Harris
BY
William F. Nickel
ATTORNEY

Sept. 11, 1945. F. R. HARRIS 2,384,616

BASIN OR GRAVING DRY DOCK

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Fig. 4.

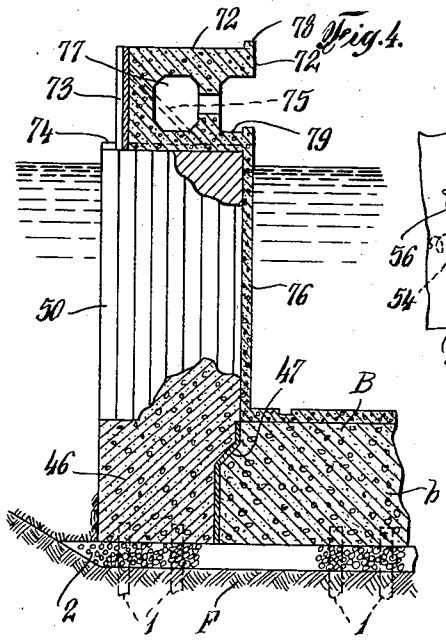



Fig. 11

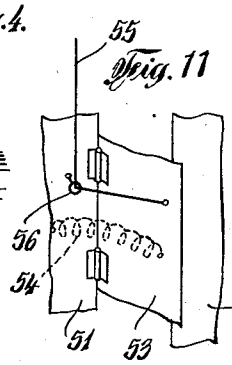



Fig. 6.

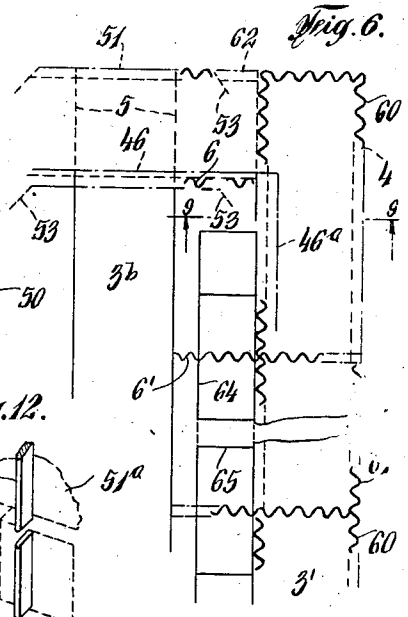



Fig. 12.

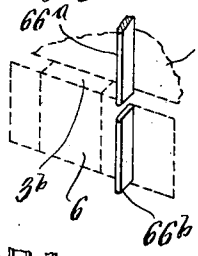



Fig. 9.

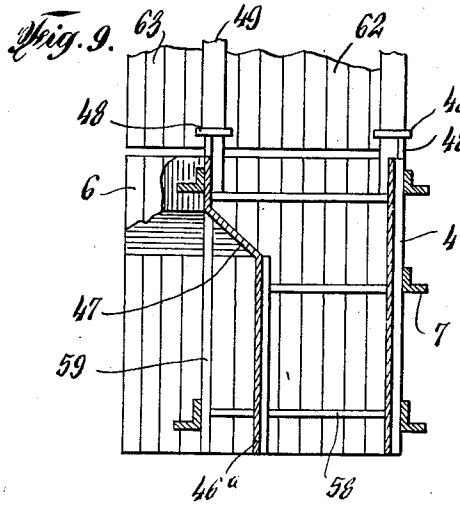



Fig. 8.

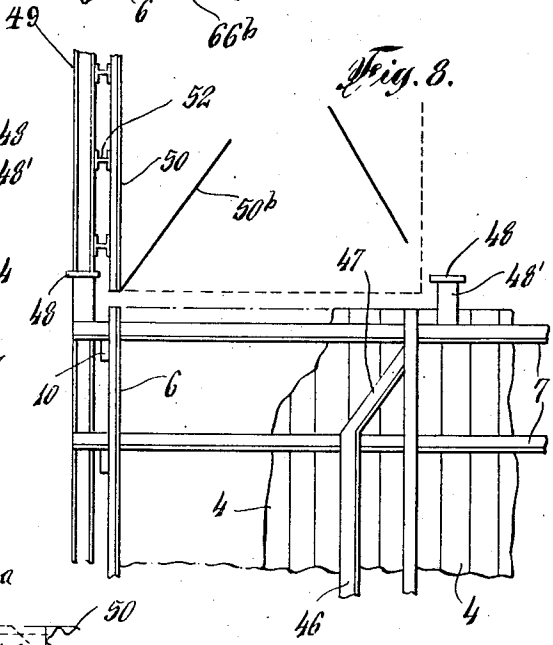
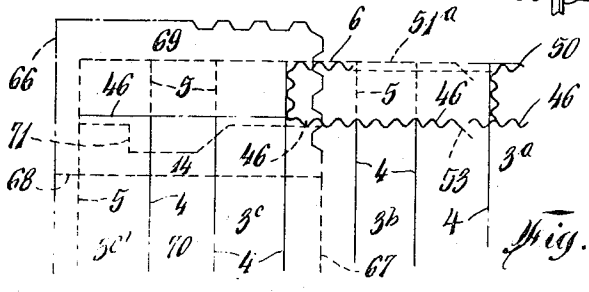



Fig. 7.




INVENTOR.
Frederic R. Harris
BY
William F. Nickel
ATTORNEY

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2,384,616

# UNITED STATES PATENT OFFICE

2,384,616

## BASIN OR GRAVING DRY DOCK

Frederic R. Harris, New York, N. Y.

Original application March 6, 1943, Serial No. 478,274. Divided and this application October 14, 1943, Serial No. 506,135

14 Claims. (Cl. 61—64)

This invention relates to concrete dry docks of the tremie-built type; and especially to the forms or molds into which the concrete is poured during the construction thereof.

This application is a division of my application Serial No. 478,274 for a Graving or basin dry dock, filed March 6, 1943.

The principle of this invention is particularly useful when the concrete is laid and allowed to set under water. My chief object is to provide a means for building a concrete dock with safety, to shorten the time required and reduce the cost thereof.

In practice, wet, plastic concrete is laid by tremie on the bottom of the excavation for the dock, without first unwatering the site, and the deposit of the concrete is controlled and confined, to prevent damage or dilution, and reinforced. Hence, as the concrete hardens, the reinforcements are permanently embedded in it and united to it. The various parts then take shape and the dock can be completed at a great saving in time and cost. When finished it will have all the dependability, stability and security needed.

After the construction of the bottom, the walls can be reared without the evacuation of the water. During this stage, upward pressure of water beneath the bottom can be successfully resisted and the foundations of the dock are in no way damaged.

A more particular object is to ensure the best possible joint or union between the walls and bottom so that outside leakage into the dock will be prevented.

The ensuing description sets forth the invention in detail, but alterations of structure may, of course, be made without departing from the underlying principle.

On the drawings:

Figure 1 is a top view showing a construction employed in the first step of building a dock according to this invention.

Figure 2 is a side view illustrating further the mode of proceeding.

Figure 3 is a top plan view showing in part the appearance of the finished mold forms in position.

Figure 4 shows another modification of my invention relating to the formation of the bottom slab and walls of the dock in cross-section.

Figure 5 is a plan of the construction of the side walls.

Figure 6 is a top view presenting the same method followed in constructing the inner or head end wall of the dock.

Figure 7 shows this method utilized in the construction of the gate end.

Figure 8 shows a portion of part of the framework used with this embodiment of my invention.

Figure 9 is a cross-sectional view thereof; taken on line 9—9 in Figure 6.

Figures 10, 11 and 12 present structural details.

The same numerals of reference identify the same parts on all views.

In Figure 2, the excavation for the dock is indicated at F, and on the bottom of it the concrete slab B is laid. The slab is shown finished at the left only, but it of course extends over substantially the full width of the bottom. The right half of this figure shows in side elevation part of one of the tremie mold forms for the bottom slab, with reinforcing members put into the excavation before the concrete. These forms 3 are laid side by side, but with spaces between them, as illustrated in Figure 3. With the forms and spaces filled with concrete, a continuous layer of concrete of the same thickness as the depth of the forms extends from one end of the dock to the other. The excavation is made by digging or dredging, to the required depth over the selected area. Water collecting in this pit, even to the point of filling the same, as shown at W, need not be removed when the concrete is poured.

For anchoring the bottom slab down, piles 1, made preferably of flanged steel beams of suitable length, are first forced into the subsoil at the bottom of the excavation to a sufficient depth. These become embedded in the bottom slab B at their upper ends when the concrete sets, and are partially relied upon to resist the lifting of the dock by hydrostatic pressure in the soil when the surface water in the excavation is at last pumped out. A layer of stone or gravel 2 is also put down on the bottom, and when this layer and the piles are in position, the piles 1 project about three feet above the layer. Sometimes the dock may have to be designed wholly without reliance on the piles 1, as a precaution against the possibility that the piles might not give any anchoring effect. In such a case, the piles might even be omitted.

Because of water in the soil as above described, there is great upward or lifting pressure against the bottom of the dock. The retention of the water in the excavation at full depth balances this pressure. But with the water in the excava-

tion the concrete must be laid under the water; and it is necessary to prevent concrete in the plastic or fluid state from being diluted and damaged by the water before it sets. Also, much reinforcement of the bottom slab is essential to enable it to resist all stresses when unwatered or empty; but to deposit concrete under water and at the same time reinforce it, as with steel, has not heretofore been regarded successfully accomplished. According to my invention, I lay concrete under water by the use of tremie or pouring equipment, and simultaneously reinforce it; so that, as the concrete hardens, great strength and reinforcing effect are developed.

The tremie forms 3 are fully completed before placing them. They are lowered into the water and come to rest crosswise of the excavation upon the stone or gravel 2. The forms have a width of 12 to 15 feet; and are as deep as the thickness of the slab B; and they have the shape of closed troughs or pockets, the ends and sides of which are provided by the reinforcing material to be combined with the concrete. The piles 1 project up into the forms and spaces between them. In these molds and spaces between, the concrete can be poured without suffering damage before it sets; and in hardening, the concrete becomes so bonded to the reinforcing material that both are strengthened and stiffened greatly.

As illustrated separately in Figure 2, the bottom mold forms consist of steel side plates 4, with transverse or vertical corrugations, steel trusses 5 and corrugated metal end plates 6, with similar corrugations. The sides 4 may be relatively thin and flexible but are stiffened by trusses 5. Each truss includes two or more longitudinal beams 7, rigid with the sides along the outer faces thereof, and connected by vertical struts 8 and diagonal struts 9. Each truss is light but very strong, and all parts of the form are secured to one another by welding or otherwise. To the end plates 6 are fixed outside strips or battens 10. The end plates 6 are joined to the plates 4 and trusses 5 at the extremities of the latter, but project sideways beyond them. The battens reinforce and stiffen the plates 6. Preferably the beams 7 are angle-shaped in cross section with vertical flanges secured to the plates 4, and turned upward. These bottom forms are light, but strong, and a minimum of steel is employed in making them.

The walls of the dock can be erected on the upper surface of the bottom slab, near its edges, or upon the bottom of the excavation and around the edges of the bottom slab, and of course becomes virtually integral therewith. An example of the first method is illustrated in Figures 2 and 3.

Previous to putting the tremie forms down into the dock excavation with this method, frames for bracing sheet piling and for reinforcing the dock walls are mounted on the tremie bottom forms 3. The walls are reared against the inner face of such piling. The frames consist of uprights 11, inclined braces 12, and struts 13. The uprights 11 project down far enough to be embedded in the concrete. These A-shaped frames are affixed by welding or otherwise in upright position to the trusses 5, at each end. Each tremie form, with four such vertical A-frames, is then transferred to the excavation; and with a chain or cable attached to each end and controlled by a crane on the surface near the excavation, lowered till it comes to rest in the right position on the gravel or stone 2. The end plates 6 project beyond the sides to such an extent that when the forms 3 are all down and the plates 6 at each end all in line, spaces 14, closed on all four sides, lie between the forms 3, and provide additional forms of slightly less width than the forms 3, as plainly appears in Figure 3. The four frames then rising from the ends of each form 3 may be entirely submerged, with their tops under the surface of the water W. But straight pieces of timber or metal 15, or other suitable members of sufficient height, may be detachably secured to the tops of the frames to project above the water and serve as markers to show the positions of the tremie forms and frames; and thus facilitate correct alignment when the forms come to rest on the gravel 2. Of course, underwater equipment and even the services of divers could be used for this purpose if necessary.

Next, the sheet piling 16 is set up around the four sides of the area supporting the tremie forms 3 and 14, and encloses a space from which the water can be pumped out when the bottom slab has hardened. For the piling along the sides, horizontal wales or stringers 17 are attached to the outer sides of the aligned A-frames, being bolted, welded or otherwise secured in position; a wale 17 being affixed to each pair of A-frames at the ends of the forms 3, projecting out sideways as far as the end plates 6 and strips 10; and is lowered into the water with the remainder of the structure. All the wales are in straight alignment when the forms and frames are on the bottom of the dock excavation.

This piling may be made up, for example, of members of the kind described in my Patent No. 1,937,738, covering Sheet piling, granted December 5, 1933, jointed or interlocked along their vertical longitudinal edges. They are preferably provided with hooks 18 on their faces. The wales 17 have upturned flanges with which the hooks engage. At their lower ends some of the piling members will fit into recesses 19 in the side plates 4 of the forms; and thus the whole extent of sheet piling at each side will be kept in place. The piling is put up so as to be set back a bit from the ends of the forms 3 and 14 for a purpose to be mentioned later.

Similar frames and piling are erected along the two ends of the dock. This construction is fully set forth in my prior application aforesaid, and need not be described at length here, as it is not a part of the present invention.

Concrete is poured in through pipes of sufficient diameter held with their ends relatively close to the bottom of the forms in the excavation, while through these pipes the concrete is poured till the forms 3 and spaces 14 are filled to their tops. One of these pipes is shown at 22 in Figure 2, but several will be simultaneously employed to fill each form at a number of points between the end plates 6; and one or more forms may be filled together. First the tremie forms 3 are filled and then the intervening spaces 14. The center forms may be taken first, and the pipes shifted towards the forms at the ends. Any suitable means for connecting, supporting, and moving the pouring pipes 22 may be employed. As the concrete rises in the forms or troughs 3, the vertical grooves in the corrugations of the metal plates 4 and 6 are occupied by it. The subsequent filling of the spaces 14 covers the trusses 5, and the concrete embeds all of the metal parts. The various blocks or sections in the forms 3 and spaces 14 become rigidly connected to all the metal work, and immovably joined to-

gether. The final result is a continuous monolithic stratum of concrete as thick as necessary, fully reinforced crosswise, and well calculated to resist bending moments due to either pressure underneath, or the weight of a ship on top. Due to the closeness of the joint between the concrete and the metal, because of the recessed surfaces afforded by vertical corrugations of the plates **4** and **6**, a great reinforcing effect is assured. Hence, the plates and trusses can even be comparatively light in size and weight. The trusses and plates are, therefore, easy to make up, and move into position, and the tremie forms, each of which constitutes a separate reinforcing member, can be readily constructed and at relatively low cost. No large concrete bodies or units have to be first made and then sunk into position.

When the pouring of the concrete into the forms is finished it engages the lower ends of the A-frames and piling **16** and secures them in place as it sets.

In the plates **4** and **6** the vertical corrugations greatly increase the surface of adhesion and produce a most efficient union between the concrete and the metal. Even if the concrete did not fully bond with the metal under water, the concrete after hardening assumes along the sides and ends of the forms, ridges and grooves and other recesses corresponding to the corrugations in the metal plates **4** and other parts. When both the forms **3** and intervening spaces **14** are filled and the concrete sets, the plates **4** and **6** and the trusses **5** are tightly embedded in the bottom and the latter receives all the strength and ruggedness which could be desired.

After the pouring of the concrete is thus completed and hardened, earth or "back fill" is dumped against the sheet piling along the two sides and at the head end. It is heaped on the shoulders **27** of the bottom slab B, outside of the piling and assists in holding the bottom slab in place against upward pressure under it.

When the dock is emptied of water, the weight and strength of the bottom slab, the weight and pressure of the earth on the shoulders **27** and against the piling **16** and the effect of the piles **1**, are sufficient to resist any upward pressure on the bottom of the dock. The bottom with its embedded reinforcements has sufficient beam strength to withstand the weight of a ship; and, when not in use, to resist effectively any water pressure beneath and to offset this pressure by its own weight and the weight of the walls at the sides and ends, when the walls are added.

A further account of the construction of a dry dock by this method is not needed here, but this type of dock will assist in explaining the structures of the remaining views which present the embodiment of the invention which the claims herein recite.

A dry dock built as outlined above, with the walls erected on the top face of the bottom slab, gives a horizontal joint between the slab and the walls. Such a joint or seam in a large, deep dock may allow leakage of water into the dock and require special measures to prevent it. A more efficient and durable union can be produced by connecting the opposite ends of the blocks in the tremie bottom forms to the inner sides of the walls by starting the walls at the bottom of the excavation, as indicated on Figures 4 to 12 inclusive. Both the bottom and the walls are then poured under water.

These views, and particularly Figure 4, indicate that the bottom slab B is of a width no greater than the distance between the side walls along their inner faces, except as will later appear, along the entrance end. The transverse concrete sections or blocks *b* of the bottom slab terminate at plates **46** having inclined shoulders **47**. The concrete at the two ends of the bottom slab sections or blocks and in the lower portions of the side walls hardens against the plates **46**. Thus, in effect, a wedging joint is made. Underground pressure exerted upward on the bottom slab will now hold the ends of the blocks *b* more forcibly against these shoulders **47** and the seal there will be very tight. A similar result is obtained at the head end of the dock.

To this end, tremie bottom forms are constructed with corrugated side plates stiffened by trusses **5**, and end plates **6**; projecting as before (see Figure 1) the same distance beyond the side plates. The plates **46** are affixed to these bottom forms between the side plates and within the end plates **6**. The plates **46** make transverse partitions in the forms, and the trusses **5** extend beyond said plates. The partitions **46** are as long as the end plates **6** and project beyond the sides of the bottom forms as far as these plates **6** and battens **10**. These partitions may be prepared in one piece or in parts, welded or otherwise secured to the inner and outer sides of the trusses and side plates to make in effect a single plate of the same length as the end plates **6**. The bottom tremie forms are shown mostly in outline on Figures 5, 6 and 7, but are constructed essentially the same as presented in Figures 1, 2 and 3, with the partitions **46** added and the A-frames omitted. Some of them, further, have no corrugated plating along part of one side between the partitions **46** and end plates **6**.

Each bottom tremie form also has flat horizontal plates or seats **48** on the top; for example, one at each corner on the ends and two adjacent the plate **46**, to support upright beams or columns **49** which hold the tremie concrete mold forms for the wall sections. These sections are put up by pouring concrete into the wall forms without unwatering the excavation. Each wall section along most of the length of the sides will be as long as the width of three bottom tremie forms. (See Figure 5.)

The wall forms for the side walls are indicated at **50**, alternating with wall forms **51**. The former will cover the ends of two bottom tremie forms and one space **14** between them. The others cover the ends of one bottom tremie form and part of the width of an intervening space at each side. The wall forms **50** will have four sides. The wall forms **51** each will have two sides only, extending across the bottom forms. This arrangement is utilized along each side wall of the dock from the head end to a point near the entrance.

As shown in Figure 5, each wall form **50** may be considered as adapted to cooperate with two bottom tremie forms, marked **3***a*, and the space **14** between them. Each wall form **51** stands upon a similar form **3***b*, which has similar spaces **14** between it and the forms on both sides. Several wall forms **50** and **51** may be needed along each side of the dock. Each row of wall forms will start with a wall form similar to that marked **51** near the entrance end and terminate with a wall form **51** at the opposite end as shown in Figures 7 and 6 respectively. The ends of the bottom forms will be designed so as to cooperate with the wall forms fully when the wall section concrete is poured in.

As in Figure 5, the two adjacent bottom forms 3a to be considered are shown at the left. Their end plates 6 are in alignment and so are their partitions 46. A wall form 50, of metal plating with vertical corrugations, assembled on land and made rigid with bracing, is lowered into place so that it will come to rest with the plating of one long side in the same vertical plane as the upper portions of the partitions 46, and the plating of its opposite long side in the plane of the end plates 6, of the two tremie bottom forms 3a. (See Figure 8.) Its plating at the ends will be in the planes of the corrugated side plates 4, of the bottom forms; but the plating of the long sides of the wall form will project beyond the cross-plating at its ends to the same distance as the plates 6 and partitions 46 project from the sides of the two tremie forms 3a. The outside vertical beams 49 are adjacent the transverse end plating 6 of each wall form 50; and horizontal wales 52 are welded to the columns 49 and to the outer faces of each wall form 50. The wall forms thus can be easily hoisted and lowered. The internal bracing of each wall form shown diagrammatically at 50a and 50b, can be of any design sufficient to serve my purpose; and need not here be set forth in detail.

The mold forms 3a have the corrugated plates 4 along their adjacent or opposed sides, which delineate the spaces 14, terminating at the partitions or plates 46. This construction is indicated in Figure 8, which is a view of the end of the form 3a at the extreme left of Figure 5, viewed from the left. The side plate 4 in line with the cross-plating at the adjacent end of the wall form 50 (the left end of Figure 5) is illustrated as extending past the partition or plate 46 to the end plate 6; but is broken away to show no side plating between said partition and end plate on the opposite side of this form 3a. On the remaining or far side of the other form 3a there is plating 4 between the plates 6 and 46. This design is clearly indicated at the right of Figure 5, which shows the sides of the two forms 3a in line with the cross-plating at the ends of the next wall form 50 in full lines to signify that the plating 4 continues to the plane of the outside face of said wall form 50; while the remaining or adjacent sides of these two forms appear in full lines only up to the inner side of the tremie wall form above the partitions 46; to show that the plating 4 on these two sides terminates at the plates 46. The dashed lines 5 signify that only the truss work of said two sides is continued out to the extreme ends of these forms. It is to be understood, of course, that the next wall form 50 at the right of Figure 5 is of the same construction as at the left. No side plating 4 is needed in the bottom forms 3a below the wall forms 50 at points between the ends of the latter. Therefore, when the concrete is poured in the forms 3a and forms provided by spaces 14 between, it fills these forms from the shouldered plates 46 at one end to those at the other. When a wall form 50 is poured full of concrete, the latter fills the entire space at the ends of the three forms 3a and 14, under the wall form 50, from the bottom of the excavation up to the top of the wall form. The plates 46 of the forms 3a extending laterally from each of said forms half-way out to bridge the intervening space 14, like the end plates 6 of the two forms 3a, are thus entirely embedded.

The wall forms 51 are of little different type; consisting of metal plating at the two long sides only. They also have outside columns 49 connected by wales 52 to which the corrugated plating is affixed. There will be the necessary bracing between the corrugated plating along the opposite sides. The wall forms 51, as stated above, cover the end of one bottom tremie form indicated at 3b on Figure 5, and project about half-way across the adjacent spaces 14. The plating 4 along both sides of this form 3b runs only out to the shouldered plates 46; and the end plates 6 and shouldered plates 46 of this form project out into the two adjacent spaces 14 to bridge half of these spaces; the end plates 6 and partition plates 46 of the adjacent forms 3a under the wall forms 50 bridging the other half. Only the trusses 5 of the forms 3b run from the plates 46 therein out to the extremities or end plates 6 of said form. The side plating of the two neighboring wall forms 50 extends out, beyond the cross-plating of their ends, about half-way over the two spaces 14 at each side of the bottom form 3b. Thus, each of the wall forms 51 will also contain the concrete for a wall section long enough to cover three forms or blocks in the bottom, with the aid of the adjacent forms 50.

Wtih this construction the bottom tremie forms can be filled with concrete poured through the pipes 22 (Figure 2) into them over their entire lengths between the partitions 46. To build a wall section in the wall forms, concrete is poured into the wall forms until the wall rises from the bottom of the excavation to the top of the wall forms. None of the water in the excavation is pumped out till later.

To bridge the gaps between the plating on the long sides of wall forms 50 and 51, the side plating is provided on the vertical edges with closures 53, hinged on in any suitable manner. One or more springs 54 normally tends to pull these closures shut. The springs 53 may be long helical springs, affixed at their extremities to the inner faces of the closures and the sides of the wall forms 51. Cords 55, attached to the closures, pass through eyelets 56 on the wall forms to the top, and hold the closures in the positions shown in Figure 11 when the wall forms are sunk down into position. The cords are then cut or released and the springs 54 then pull all the closures 53 shut.

Each tremie form 3a and 3b can be made up as a complete unit, as before, on the land, with all parts secured rigidly to the trusses 5; the plates 4 extending along the inner sides of the trusses from one partition 46 to the other, in the case of the forms 3b; and continued along one side only out to the end plates 6, in the case of the forms 3a. The partitions 46 are welded or otherwise fastened in place and so are the end plates 6, as before; and additional corrugated plating 4, will be extended along and be affixed to the inner face of the trusses between the end plates 6 and partitions 46 along the one proper side of each form 3a. When the wall forms 50 and 51 are sunk into the water in the excavation, the vertical plating of their longer sides will be separated in practice by gaps of about six inches. These gaps are bridged by the closure panels 53 above described. The next wall form 50 is followed by another like the wall form 51 set upon a form 3b. Suitable bracing indicated at 57, is secured between the projecting ends of the side plating of wall forms 50, and the ends of the plates 6 and 46 under them. Plates 46 are usually corrugated vertically from the shoulders 47 down to their lower edges.

Panels like those shown at 53 may also be used with the bottom tremie forms to bridge the gaps between the plates 46, and between the end plates

6 in every dock containing any of these plates. The spaces between the bottoms of the wall forms and the mold forms of the bottom slab are small and need no closures.

Reference is now made to Figures 6, 9 and 10. Each of the side walls shown in Figure 5 terminates at the head end of the dock in the section set up by means of a wall form 51 spanning a bottom form 3b, as above described. The tremie bottom form at the inner end of the dock beside this form 3b, is indicated on Figure 6 at 3'. This terminal form 3' will have corrugated plating 4 along the full length of its outer side; but along the opposite side, adjacent the form 3b, this plating will be replaced by a shouldered plate 46a extending from the line of plates 46 in one end of the other forms to the line of the same plates in the opposite ends. At its extremities, the plate or partition 46a will be bent at an angle as shown in Figures 9 and 10. The right-angled ends of this plate 46a will line up with the same plates in the forms 3a and 3b. When the tremie wall forms are now reared over the terminal form 3' under water and concrete is poured into same, the head end wall can be built up from the bottom of the excavation to the top of the wall forms and make the same kind of joint between the end wall and the bottom of the dock as is shown in Figure 4. The plate 46a will be corrugated only below the shouldered portion 47. The terminal form 3' will comprise trusses 5 along its two sides, made up of beams 7 and such struts as may be necessary. Some of these struts are indicated in horizontal position at 58 in Figure 9. The top of the plate 46a will of course be more distant from the corrugated side plate 4 in the form 3' than the bottom portion of plate 46a, which bears the corrugations. Vertical struts or braces 59 may be extended from the top portion of the plate 46a downward and be made rigid with the trusses 7 and braces 58. All the mold forms in fact may be braced across wherever necessary. Flat plates 48 on supports 48' will be secured in place above the four corners of the form 3' and at suitable points along the two sides of this form to support the columns 49 of the wall forms. The form 3' may be braced inside in any manner required.

The wall forms for the corners shown at 60 will consist of plating forming two long sides, and cross-plating at the ends as indicated in Figure 6. The plating at one end will be extended sideways as indicated at 62; and similar plating 63 will project out at the same side; to line up with the side plates of the adjacent wall forms 51 for the side walls of the dock. The plating at the opposite end of this wall form 60 away from the corner of the dock will lie in the same plane as transverse corrugated plating 6' put across the extreme end form 3' under all of the wall form ends. This plating 6' will project at one side of the form as far as the side of the adjacent form 3b.

The wall forms 61 between the wall forms 60 need comprise only two long sides of sheet plating similar to the wall forms 51. Closure members 53 may be included, though not shown in Figure 6. Each wall form 61 will likewise have columns 49 to support its sides and rest upon the plates or seats 48, as in Figure 9. This construction will be continued over to the opposite side wall of the dock where a wall form 60 will be used at the corner in conjunction with the side wall form 51 thereat. The wall forms 60 and 61, too, will be braced inside and concrete may be poured into them and the form 3' from the bottom of the excavation to the top, without removing any water. Bracing or trusswork indicated at 64 and 65 is attached to the tremie form 3' in position to extend towards the form 3b, being rigidly connected to the adjacent truss 5, plate 46a and the plating 6'. This bracing will be embedded in the block which fills the intervening space 14, thereby making the inner end of the bottom slab more rigid and immovable, obviating a tendency of the concrete to cause creeping of the form 3' away from said block when the end wall is poured. As stated, the bottom slab is laid by pouring concrete first into the various forms 3a between the plates 46; and then into the spaces 14; and then the walls are made by filling the forms at the head end and sides.

At the opposite or entrance end of the dock, the extremities of the side walls are preferably finished in the dry by enclosing two areas there with sheet piling, and pumping them clear of water. At this end, the line of wall forms along each of the sides will also terminate in a structure of the type 51, placed centrally over a bottom mold form marked 3b. Beyond this there will be two bottom forms 3c and 3c' separated by a space 14. Sheet piling 66 will be driven into the bottom of the excavation along the side of the form 3c' at the left, across the whole width of the dock. It will be continued across the ends of the two bottom forms 3c and 3c' as far as the first side wall form 51a, and from this point it will be continued across the excavation again to the opposite side.

On the outside of said wall form 51a, a rib 66a (Figure 12) will be welded to the plating and a similar rib 66b will be on the outer face of the end plate 6 on the end of the form 3b beneath. To these ribs the last member of the sheet piling 66 can be jointed as the pile members are forced down into the subsoil of the excavation. This piling will enable corrugated plates 6 to be dispensed with across the ends of the two forms 3c and 3c'; these ends being open, with only cross-trusswork or bracing; and will also render unnecessary any side plating for the bottom form 3c' along the entrance end of the floor of the dock. This form, therefore, will have along its outer side only the trusswork indicated by the dashed line 5. Along its opposite side and the adjacent side of the other form 3c, plating 4 extends up only to the shouldered cross-plates 46, in the same position as the corresponding plates of other forms. These plates project as illustrated half-way out from the opposing or adjacent sides of the two forms 3c and 3c' into the intervening space 14; while at their other ends they terminate flush with the sides of the forms bearing them. The remaining side of the inner form 3c, has corrugated plating 4 along its full length, past the plates 46, out to its extreme ends. This plating 4 bridges the space between the plate 46 and end plate 6 of the adjacent form 3b, both of which are extended out across the full width of the intervening space 14.

Thus the bottom forms 3c and 3c' can be filled under water by pouring concrete into them between and up to the partitions 46, and then filling the space 14 between. Then the ends of the forms 3c and 3c' and space 14 between them are filled by pouring concrete between the plates 46 and piling 66. The adjacent form 3b and space 14 between it and the form 3c are filled likewise between and up to the cross-plates 46. With all the bottom forms in place in the excavation, from 3c' to 3', all the bottom forms and spaces 14 can

be poured at the same stage in the construction of the dock. Then the side walls and end walls are put up by pouring concrete in the wall forms **50**, **51**, **51***a*, **60** and **61** as above described. Each wall form **51***a* at the entrance end has its inner and outer side walls extended as far as the side of the form **3***c*, and there connected by end or cross-plating in the vertical plane as the plating **4** of said form **3***c*. These wall forms **51***a* are filled like the others by pouring them full from the bottom of the excavation to their tops.

A line of temporary sheet piling **67** is now erected across the full width of the dock and side walls, and is connected to the piling **66** near the sides of the dock by two lines of temporary piling **68**. Thus cofferdams **69** are built at the entrance ends of the side walls, and a large central enclosed space **70**. The cofferdams **69** are then pumped out, and the outshore ends of the side walls erected to their full height in the free space thus obtained. These ends will be formed with inside shoulders **71** for the pontoon gate. When they are finished, they receive a lining on their inner faces. The floor of the bottom between said ends receives a similar lining and the space **70** between the two lines of piling **68** can be pumped out for this purpose.

The tops of the walls are illustrated in Figure 4 at **72**. To erect them, the head end wall and side walls up to the piling **67** after the tremie wall forms are filled with the concrete, receive lines of sheet piling **73**. These may be attached to the wall forms by bracing **74** and **75**, and the lower ends of the pile members are embedded in the concrete. The bracing may be secured in any suitable manner. When the wall forms have been filled and the concrete has set, the dock may be pumped out to lower the water level down a little below the tops of these forms. All the work to make the tops **72** of the walls can then be done above water. Back fill is finally heaped into the sides of the excavation up to the level of the earth and the columns **49** and plating and piling on the outside faces of the walls completely interred. The finish lining **76** similarly embeds and covers the metal work on the inner faces.

The piling **66**, **67** and **68** each is as high as the finished walls. The piling **67** extends across the tops of the wall forms **51***a*, consisting of shorter members there and embedded in the concrete; and it can be jointed to the sides of the piling **73** and to the inner side of the wall form **51***a* by means such as shown in Figure 12. Between the side walls the temporary piling **67** and **68** are sealed on the floor of the dock by means of troughs put down under the water and in watertight engagement with the floor. The lower ends of the piling are sealed in said troughs. To set the piles **67** and **68** into place, wooden frames are built and sunk down into the water to brace the piling and facilitate its erection. After the completion of the dock the piling **67** and **68**, with framing and other appurtenances, are removed and so is the piling **66** across the entrance end, the remaining piling **66** being covered with earth. The piling **66** and **68** can be taken away first to enable the pontoon gate to be floated into position, the dismantling of the piling **67** then following as the final step.

This dock too, can be made narrower at its ends by building the walls so that they converge somewhat, and making the bottom forms of less length away from the middle of the dock.

By lining with plywood the inside of any of the mold forms for the walls of the dock, a surface can be obtained smooth and finished to such an extent as to make a lining unnecessary.

The tops of the walls **72** have chambers indicated at **77** therein, a roadbed **78** on top for crane tracks, and a gallery or walk **79** for workmen.

Having described my invention, what I believe to be new and desire to secure and protect by Letters Patent of the United States is:

1. A mold form for the bottom of a basin dry dock, having substantially parallel, vertical sides comprising reinforcing members, and vertical transversely extending plates joining said sides adjacent the ends thereof, said plates having horizontal shoulders presented outward of the respective ends.

2. A mold form for the bottom of a basin dry dock having substantially parallel, vertical sides comprising reinforcing members, one of said sides being a vertical plate having a substantially horizontal shoulder near its upper edge running longitudinally over substantially its entire length, and presented towards the opposite side.

3. A mold form according to claim 2, wherein the plate also has transversely extending, outturned ends, and a horizontal outwardly presented shoulder in each of said ends.

4. The mold form according to claim 2, wherein the shouldered plate is vertically corrugated between its shouldered portion and its lower edge.

5. In a basin dry dock, a series of mold forms arranged end to end along the sides thereof, said forms comprising corrugated plating in line at the inner and outer sides, with gaps between the plating, and releasable closure members hinged to the ends of said plating to span the gaps between the side plating of said forms.

6. In a basin dry dock, a plurality of bottom forms having sides including reinforcing members, elevated seats at the tops of some of said forms, and wall forms having supporting columns resting upon said seats.

7. In a basin dry dock, a bottom mold form having plating along its sides and exterior, projecting truss-work running continuously along one of said sides, and beyond the latter.

8. In a basin dry dock, a bottom form having vertical sides and exterior projecting truss-work running continuously along one side and wall forms comprising sides and ends, on the ends of the bottom form, said bottom form having plates projecting outward from one side adjacent the ends of said bottom form, said plates being vertical and each having a horizontal shoulder under the inner side of the wall forms and presented outward of the respective ends.

9. In a basin dry dock, the combination of a pair of forms side by side across the bottom, with spaces between them, said forms each having plates adjacent the ends projecting outward into said spaces to bridge same, and a wall form on each end of said bottom forms, spanning the adjacent sides thereof and projecting beyond said bottom forms over said spaces, said plates being vertical and each having a horizontal shoulder under the inner side of the wall forms and presented outward of the respective ends.

10. In a basin dry dock, the combination of a bottom form having shouldered plates at the ends projecting outward at both sides thereof, and a wall form on each end of the bottom form, and projecting over both sides thereof, said plates being vertical and each having a horizontal shoulder under the inner side of the wall forms and presented outward of the respective ends.

11. In a basin dry dock, the combination of a

bottom form, having a transversely extended end, a wall form on each extremity of the bottom form and projecting beyond the sides thereof, said wall form and the end of said bottom form having outside vertical aligned ribs for connection with adjacent sheet piling.

12. In a basin dry dock, the combination of a bottom form and a wall form thereon, said forms having aligned vertical, outside ribs to connect sheet piling thereto, said ribs being at the outer end of the bottom form and outer face of the wall form.

13. In a basin dry dock, the combination of a bottom form comprising sides and ends, elevated supports adjacent the upper edges of said bottom form, and a wall form having columns above the bottom form, said columns resting at their lower ends upon said supports.

14. In a basin dry dock, the combination of mold forms for concrete with spaces between them, hinged members at the ends thereof to close the intervening spaces, and means connected to said members to hold them in operative position.

FREDERIC R. HARRIS.