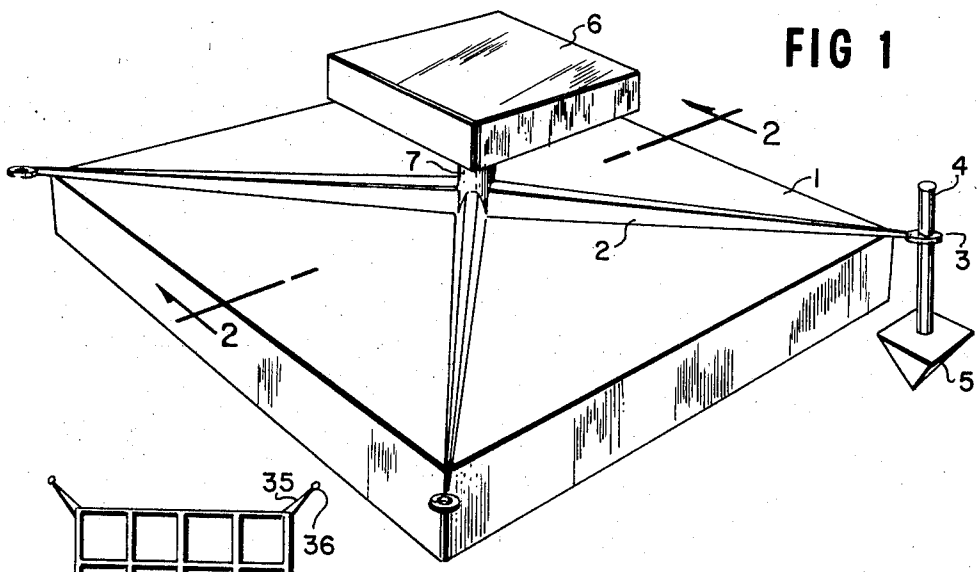
Feb. 4, 1969 H. E. DEMPSTER 3,426,109

METHOD OF FABRICATING A CONCRETE FLOTATION PIER

Filed Oct. 24, 1965

Sheet 1 of 3

FIG 1



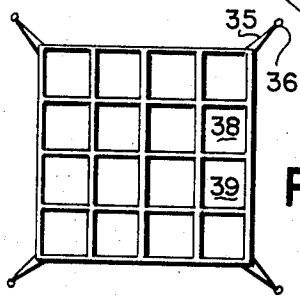
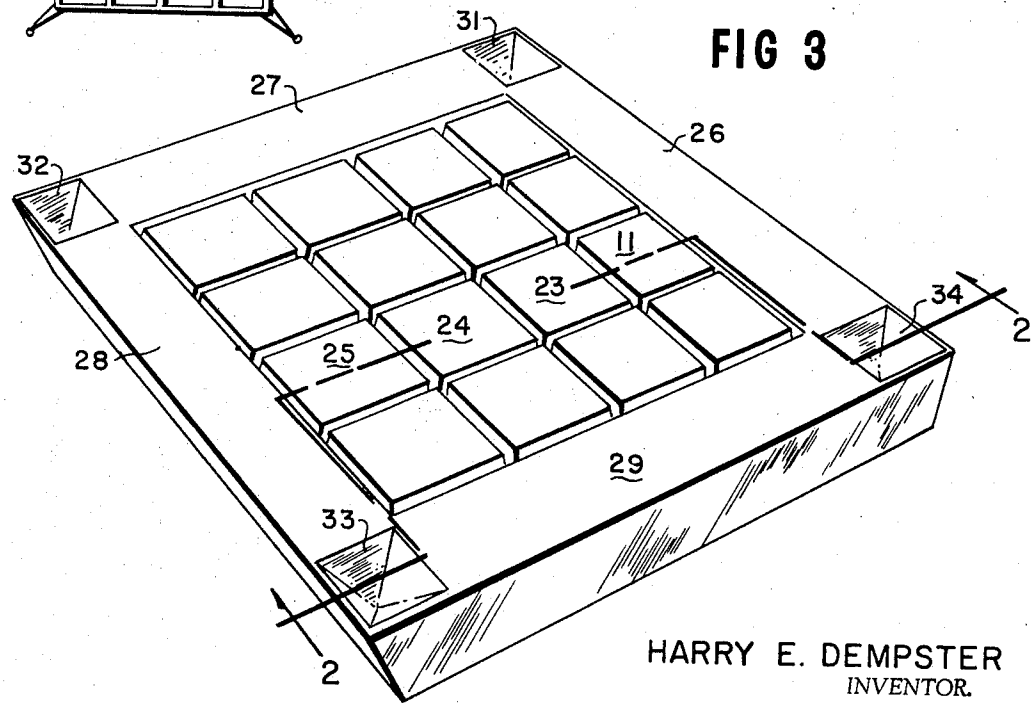


FIG 5

FIG 3



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METHOD OF FABRICATING A CONCRETE FLOTATION PIER

Filed Oct. 24, 1965 Sheet 2 of 3

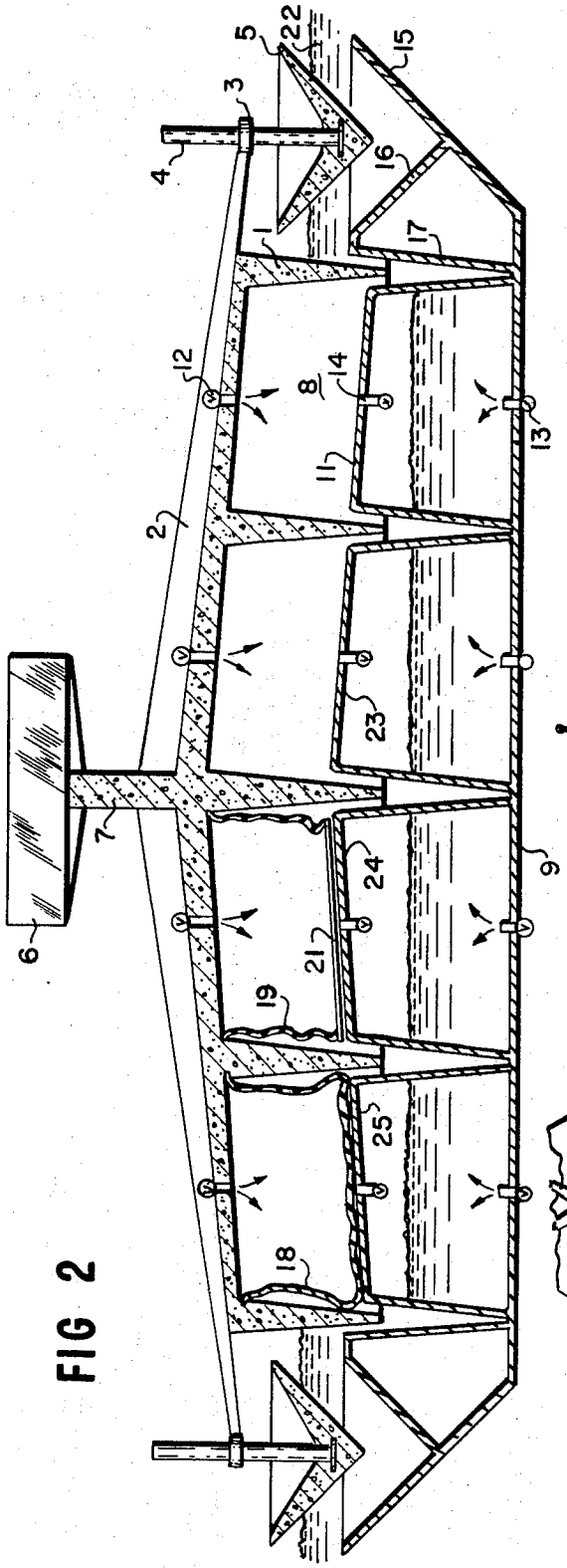

FIG 2

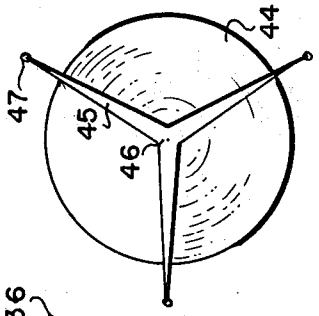

FIG 7

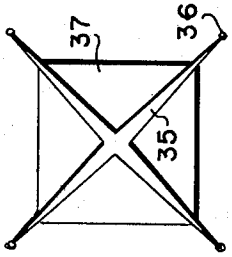

FIG 4

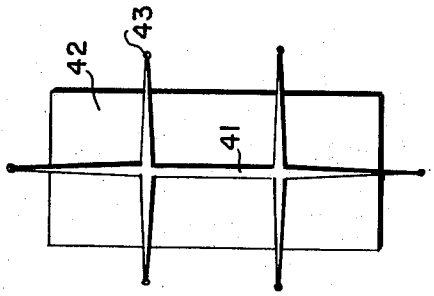

FIG 6

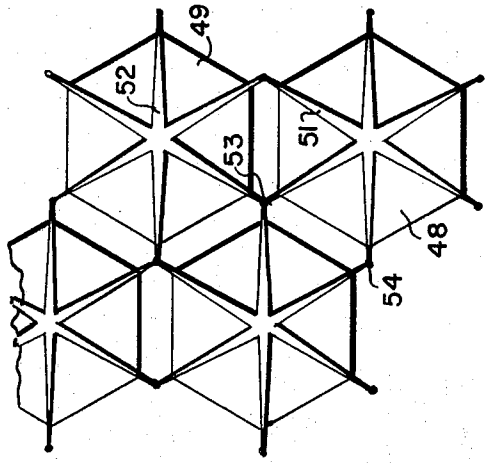

FIG 8

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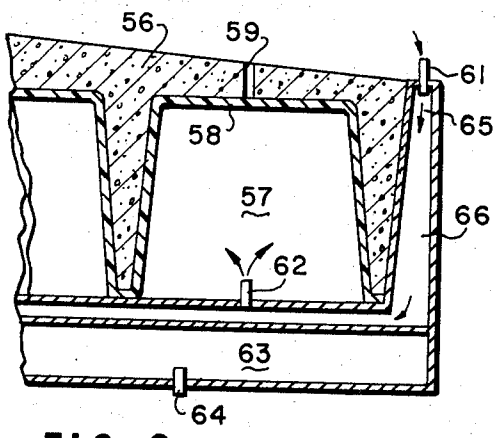

FIG 9

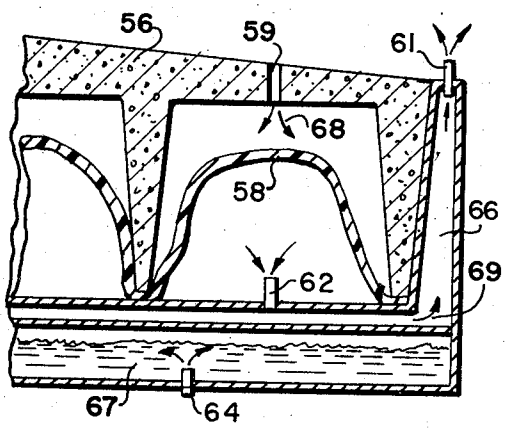

FIG 10

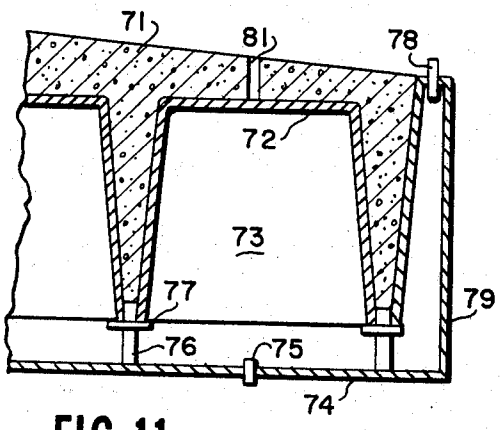

FIG 11

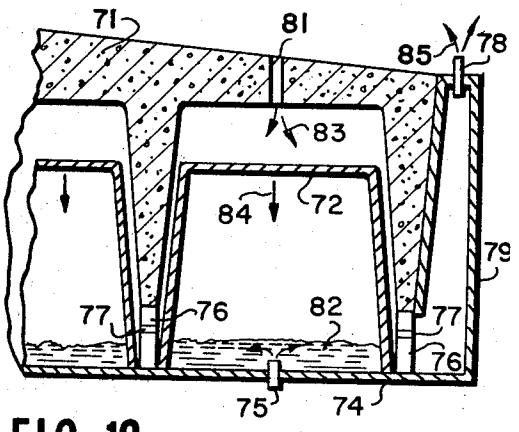

FIG 12

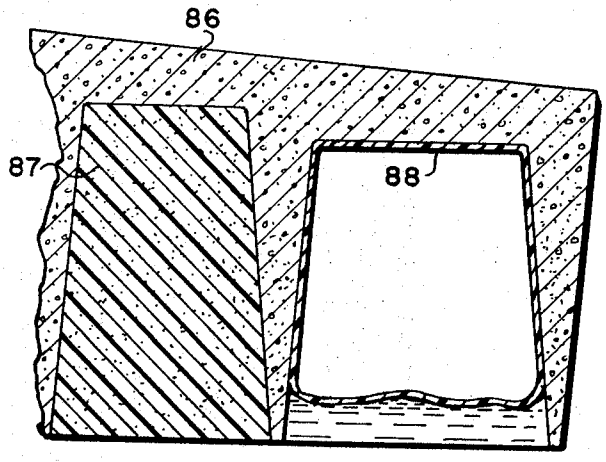

FIG 13

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3,426,109

METHOD OF FABRICATING A CONCRETE FLOTATION PIER

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Filed Oct. 24, 1965, Ser. No. 504,593
U.S. Cl. 264—34 6 Claims
Int. Cl. B63c 1/02

ABSTRACT OF THE DISCLOSURE

A method of casting buoyant pontoons or the like is described in which casting material is poured into a floating form. Thereafter, by sequentially controlling the ingress and egress of water into compartments within the form and also within the cast pontoon, the form is separated from the pontoon and recovered and the pontoon is left floating in the water.

This invention relates to a novel and improved method of constructing floating piers, pontoons, or the like cast from concrete or similar material.

Various means and methods have been proposed heretofore for the construction of floating wharves, piers, and the like, in the form of reinforced concrete units. Such units are, for example, disclosed in U.S. Patent No. 2,857,872 to Usab and U.S. Patent No. 3,022,759 to McCall. The types of structures used heretofore have been found, however, to be unduly expensive to construct, and have been undesirably limited as to the size of the individual units which can be fabricated at one time, thus limiting the application of the invention. By the present invention there is provided a novel method of constructing floating pontoon structure which overcome the disadvantages of prior means heretofore intended to accomplish generally similar purposes, and which permits the economical construction of extremely large floating assemblies. These objectives are met by means of individual pontoon units having great flexibility as to overall size and configuration, and which may be combined into multiple structures. The basic article of manufacture of the present invention comprises a floating unit which relies for its buoyancy upon air trapped in compartments or chambers which may, if desired, have an open bottom.

Hereinafter the basic floating unit will, for the sake of convenience, be referred to as a pontoon. In a preferred construction, each pontoon unit is cast in two steps, from concrete and in the general case by means of two separate casting-form structures. The first casting form is designed to float in the water at the construction site, and has a plurality of upwardly extending cell-cores which are used to form the flotation chambers of the pontoon. These core-cells may supply additional buoyancy to the floating form. Concrete is poured into the form over the cell-cores in order to fabricate the lower portion of the pontoon. The upper portion of the pontoon may, if desired, include a platform structure which is cast after the lower portion has set. A separate platform support form is installed on the lower portion of the pontoon after the casting has set. Thereafter, the floating pontoon, together with its floating casting form is towed from the construction site to the desired mooring site.

At the desired mooring site the buoyant compartments in the floating form are flooded in order to sink the form and thereby separate it from the cast pontoon structure. The form is then recovered by expelling the water from its buoyant compartments by means of compressed air, after which it may be towed back to the construction site. The pontoon thus constructed may also be provided with various extensions, fixtures, and/or attachments which are integrally cast into the structure and which permit it

to be assembled to adjacent pontoons in multiple unit configurations, or to be secured to anchoring means at the mooring site.

The above-described method of construction results in great ease of fabrication as well as a significant reduction in cost of the unit produced. Also, this design provides great flexibility in the end use of the articles produced. It is therefore an object of the present invention to provide a novel and improved floating pontoon structure having low initial cost and great flexibility of application.

Another object of the invention is to provide a novel and improved method of constructing a floating pontoon unit which may be fabricated from concrete or like material which may be combined with a plurality of similar separate units in a variety of patterns, as may be desired.

A further object of the present invention is to provide a novel and improved method of constructing a floating pontoon structure having many years of useful life under constant exposure to an ocean environment.

Yet a further object of the present invention is to provide a novel and improved method of constructing a pontoon structure which is made entirely of concrete and/or other relatively low-cost materials.

Still another object of the present invention is to provide a novel and improved method of constructing a pontoon structure which can be combined together in any one of a variety of patterns by means of integral interconnecting means for securing the pontoon units together, and which may be arranged in such a way that they may be conveniently anchored or secured to the ocean floor or to other structures.

The above and other objects of the inventions will be more readily understood from the following description considered in connection with the accompanying drawings, in which:

FIGURE 1 is a perspective view of a floating pontoon structure as produced in accordance with the present invention.

FIGURE 2 is a cross-sectional view, taken along line 2—2 of FIGURE 1, illustrating the interior of the pontoon and the casting form used in its construction.

FIGURE 3 is a perspective view of the floating form used to cast the flotation cell portion of the pontoon device of FIGURES 1 and 2.

FIGURE 4 is a top plan view of a modified embodiment of a pontoon unit constructed in accordance with the invention.

FIGURE 5 is a bottom plan view of the pontoon unit of FIGURE 4.

FIGURE 6 is a top plan view of still another embodiment of a pontoon unit constructed in accordance with the invention.

FIGURE 7 is a top plan view of a circular pontoon constructed in accordance with the invention .

FIGURE 8 is a top plan view of a plurality of hexagonal pontoons constructed in accordance with the present invention, and which illustrates the manner of interconnection of multiple hexagonal units.

FIGURE 9 is a fragmentary, vertical cross section view, illustrating a modification of the casting form structure used to fabricate a pontoon unit.

FIGURE 10 illustrates the arrangement of the apparatus of FIGURE 9 during the form removal cycle.

FIGURE 11 is a fragmentary, vertical cross section view of still another embodiment of a removable form for casting the buoyant cells of a pontoon.

FIGURE 12 illustrates the manner of removal of the form of the apparatus of FIGURE 11.

FIGURE 13 illustrates embodiments of the pontoon structure wherein closed flotation elements are incorporated into the buoyant cells.

Looking now at FIGURE 1 there is shown a preferred construction of a floating pontoon unit constructed in accordance with the method and apparatus of the invention. The article of construction comprises a pontoon **1** having a ribbed cover **2** which may also serve as a platform support. The ribbed portions of the cover **2** extend beyond each of the corners of the pontoon **1** and each extension is provided with a corresponding attachment ring, a typical one of which is indicated at **3**. Stanchion **4** is adapted to extend upwards through extension ring **3** and is provided at its lower extremity with an anchor **5** which may serve as a ballast or may be used to support the entire structure on the floor of the ocean or other body of water. Platform **6** extends upwardly from ribbed cover **2** and is secured thereto by means of pedestal **7**. It should be understood that the entire structure comprising pontoon **1**, ribbed cover **2**, the attachment rings **3**, pedestal **7**, and platform **6** may be cast as an integral unit. The casting material preferably comprises reinforced concrete although it should be understood that various other casting materials, or lightweight concrete may be employed.

Looking now at FIGURE 2 there is shown additional detail of the structure of FIGURE 1 and further illustrates the casting form used to fabricate the lower portion of the pontoon. The casting form is provided with a plurality of upwardly extending core-cells, such as indicated at **11**, which form the hollow-interior of flotation compartments. A typical flotation compartment is indicated at **8**. The form comprises a floor **9** which supports the individual core-cell **11**.

The form is filled with plastic concrete, as will appear hereinafter, to cast the lower portion of the pontoon **1**. Separation of the cast unit and the form is facilitated by means of a plurality of valves **12–14** which permit the ingress and egrees of water and air in a certain sequence, as will be described in detail hereinafter. The peripheral wall **15** of the form, in conjunction with certain interior walls, one of which is indicated at **16**, provide the form for casting the ballasts **5**. Wall **17** defines the outer wall of compartment **8** and also supports wall **16**.

For the sake of simplicity and clarity, there will now be described the method of construction of but a single cell of the pontoon **1**, it being understood that all of the several cells of the pontoon are simultaneously fabricated in a like manner.

At the commencement of the casting process, cell **11**, is filled with air and valve **13** is closed. Valve **12**, which is supported atop valve **14**, is closed. This will cause the entire form to be buoyant. The concrete is then poured into the form of the level of valve **12**. Next, valves **13** and **14** are opened permitting water **22** to flood cell **11**. Simultaneously, valve **12** is opened and air under pressure, from a source not shown, is forced into compartment **8**. This causes the form to sink. Air entrapped in compartment **8** will cause pontoon **1** to remain floating.

If desired, a water-tight, flexible bladder **18** may be integrally secured to the interior of the buoyant cells to enhance the buoyancy of the resulting pontoon. That is, a compartment of the type indicated at **8** relies on entrapped air to float the pontoon. However, due to the slight solubility of air in water, it may be necessary to re-introduce air under pressure via valve **12** to compartment **8**, from time to time, to maintain the desired degree of buoyancy of the overall structure. The use of an integrally cast bladder as shown at **18** obviates this requirement for occassional replenishment of air in the flotation cell.

A modified form of bladder comprises flexible member **19**, which may be made of a flexible plastic material, and which is secured to rigid, water-tight, base **21**. This arrangement will give greater durability to the exposed lower surface of the pontoon.

The superstructure comprising the ribbed portion of cover **2**, platform **6**, and pedestal **7** may be integrally cast on top of the lower portion comprising the individual compartments (e.g., **8**), by any suitable and well-known means. Also, it should be understood that the size and shape of the superstructure will be determined by the end use to which the device is put.

It should be understood that cells **23–25** are similar in construction and function to the above described cell **11**.

Looking now at FIGURE 3 there is shown the floating form for casting the lower portion of the pontoon **1**, as it appears without the cast pontoon therein. Compartments **26–29** define the peripheral boundaries of the form and in a preferred construction provide a given fixed buoyancy to the overall structure. This fixed positive buoyancy may be overcome by flooding the interior of the cells (e.g., **11**, **23**, **24**, and **25**) in the manner previously described, thus causing the overall structure to have a negative buoyancy and sink.

Cavities or depressions **31–34** in corresponding portions of the upper exterior surface of compartments **26–29** serve to define the casting form for the ballast members (see ballast **5** in FIGURES 1 and 2).

There is shown in FIGURE 4 a top plan view of a pontoon unit **37** generally similar to the one shown at **1** in FIGURES 1–2 except that ribbed portion **35** does not carry a superstructure. The attachment rings, one of which is indicated at **36**, permit the unit **37** to be secured to an anchor, and/or to other similar units. FIGURE 5 illustrates the underside of unit **37** and as can be seen there are a plurality of individual compartments which provide the desired buoyancy to the unit **37**. Typical ones of these compartments are indicated at **38** and **39** in FIGURE 5.

As mentioned hereinabove, the pontoons constructed in accordance with the invention may be suitably modified as to shape to meet a variety of individual requirements and/or applications. For example, there is shown in FIGURE 6 an elongated pontoon **42** wherein the ribbed members extend orthogonally from the pontoon **42** rather than through the corners thereof. The ribbed portion is indicated generally at **41**, and a typical one of the attachment rings or fixtures is indicated at **43**.

If desired, the pontoon may be made circular as shown in FIGURE 7. In this embodiment the pontoon **44** is provided with radially extending ribs—such as shown at **45**— and with an attachment ring **47** at each extremity thereof. If desired, a support pedestal or other superstructure may extend upwardly from the central juncture of the radial ribs **45**.

The manner in which individual pontoon units may be interconnected into a composite structure of any desired area, or which may be made to support any desired load, is shown in FIGURE 8. The pontoon units **48** and **49**, shown in this example, have hexagonal configuration and each have six radially extending rib elements. The outer extremity of each rib element, certain ones of which are indicated at **51** and **52**, are provided with corresponding attachment rings. As can be seen two such rings are interconnected at **54** and three such rings are interconnected at **53**.

Modifications of the method of fabrication of the basic pontoon structure are shown in FIGURES 9–12. Looking now at FIGURES 9 and 10 there is shown a form in which the individual core-cells are made from a flexible material, such as rubber, in lieu of the rigid core-cells (**11**, **23–25**) of the embodiment of FIGURES 2 and 3. This permits them to be selectively inflated and deflated to facilitate removal of the form from the casting. For example, cell **58** is initially inflated prior to pouring the concrete into the form. A conduit **59** is integrally cast into the pontoon **56** to provide fluid communication into the area of chamber **57**. Inflation of cell **58** is accomplished by supplying air under pressure to the interior of the cell via conduits **61** and **62**. Also, air is admitted into sump **63** via conduit **64** which extends through the floor of the form. Air entering in the direction of arrow **65** fills compartment **66** and enters the interior of cell

58 via conduit 62. Thereafter, the concrete is poured into the form.

After the concrete has set, the cell is collapsed as shown in FIGURE 10. This is accomplished by forcing air under pressure through conduit 59 in the direction of arrow 68. This action will collapse the form (cell 58) causing the air therein to escape through conduit 62 in the direction of arrow 69, and thence through conduit 61.

Simultaneously, sump 63 (see FIGURE 9) is flooded with water 67 via conduit 64. This combined action separates the form from the cast pontoon and also causes the form to sink.

In FIGURES 11 and 12 there is shown still another modification which facilitates the separation of the core-cells and the cast pontoon. The pontoon 71 is cast over cell form 72 which defines chamber 73. Form 72 is made of a rigid material such as metal and is supported above floor member 74 by means of support 76 and fastening member 77. Vertical wall 79 joins floor member 74 in air-tight relationship. Conduit 75 extends through floor member 74 and permits flooding of compartment 73 during separation of pontoon 71 and the form. Fastener 77 rotates about the axis of the shaft comprising support 76 and supports form 72 at its bottom edge. Air is admitted to the form via conduit 78 thereby making the form buoyant. Conduit 81 is integrally formed with pontoon 71.

Concrete is poured into the floating form and after it has set, fastener member 77 is rotated thereby releasing cell form 72 and permitting it to fall downwardly. Air under pressure is forced through conduit 81, and water 82 is flooded into chamber 73 via conduit 75. The air escapes via conduit 78 in the direction of arrow 85 and the form 72 drops downwardly in the direction of arrow 84. Thereafter the form may be refilled with air, once the pontoon 71 has been removed, in order to refloat it and permit it to be removed to a convenient location.

While the foregoing embodiments of the invention have been described in terms of a pontoon having buoyancy chambers which are hollow, the invention need not be so limited. For example, a pontoon 86 constructed by any one of the foregoing methods, may have its buoyancy chambers filled, subsequent to the casting step, with a solid buoyant material 87 such as expanded polystyrene foam. Alternatively, the buoyancy chambers of pontoon 86 may contain an impermeable gas-filled bag 88 which maintains the air-tight integrity of the chambers.

While the invention has been shown and described in terms of certain preferred embodiments, it will be obvious to those versed in the art that various substitutions, modifications, omissions, and changes may be made in these embodiments without departing from the scope of the invention. Therefore, it is intended that the invention be limited only by the scope of the following claims.

What is claimed is:

1. The method of constructing a cast structure in an integral casting form having a hollow cell core with means for selectively controlling the ingress and egress of air into said cell core, comprising the steps of:

introducing air into said cell core so as to make said casting form buoyant;

floating said buoyant casting form on a body of water;

introducing a settable casting material into said floating form to cast a hollow cell over said core while forming an air passage in said casting material between the exterior of said cast structure and the hollow cell formed in said cast structure;

expelling the air from said cell core by introducing a fluid therein after said casting material has set, thereby reducing the buoyancy of said form below that necessary to maintain it afloat; and

introducing air under pressure via said air passage simultaneously with the introduction of said fluid to the interface between said cast structure and said cell core to facilitate separation of said cast structure from said form, and to fill said cast hollow cell with air thereby causing said cast structure to become buoyant and float.

2. The method defined in claim 1 wherein said fluid: comprises water from said body of water.

3. The method defined in claim 1 including the step of:

re-introducing air under pressure into said cell core to refloat said casting form.

4. The method defined in claim 1 including the steps of:

placing a superstructure casting form on the exposed upper exterior portion of said structure after the casting material introduced into said floating form has set;

introducing casting material into said superstructure casting form; and

removing said superstructure casting form from said structure after the casting material in said superstructure casting form has set.

5. The method defined in claim 1 including the steps of:

casting an attachment fixture as an integral part of said structure; and

thereafter joining a plurality of said structures together by means of said attachment fixtures.

6. The method of constructing a cast structure in an integral casting form having a hollow cell core comprising an inflatable bladder or the like and a sump with means for selectively controlling the ingress and egress of air into said cell core, and said sump comprising the steps of:

introducing air into said cell core and said sump so as to make said casting form buoyant;

floating said buoyant casting form on a body of water;

introducing a settable casting material into said floating form to cast a hollow cell over said core while forming an air passage in said casting material between the exterior of said cast structure and the hollow cell formed in said cast structure;

expelling the air from said cell core causing it to collapse after said casting material has set and simultaneously flooding said sump, thereby reducing the buoyancy of said form below that necessary to maintain it afloat; and

introducing air under pressure, via said air passage, to the interface between said cast structure and said cell core to facilitate separation of said cast structure from said form, and to fill said cast hollow cell with air thereby causing said cast structure to become buoyant and float.

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U.S. Cl. X.R.

264—250, 314, 335; 249—64, 65, 66; 25—120; 61—63, 5; 18—2; 114—.5