United States Patent [19]

McClure

[11] 3,894,503

[45] July 15, 1975

[54] **METHOD FOR CONVERTING A FLOATABLE BARGE INTO A SEMI-SUBMERSIBLE VESSEL**

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[73] Assignee: **Brown & Root, Incorporated**, Houston, Tex.

[22] Filed: **Apr. 6, 1973**

[21] Appl. No.: **348,594**

[52] **U.S. Cl.** ..... **114/0.5 R**; 114/65 R; 114/77 A; 212/3

[51] **Int. Cl.** **B63b 35/00**

[58] **Field of Search** ..... 114/0.5 D, 43.5, 77 R, 114/77 A, 65 R; 61/46.5, 72.1, 72.3; 212/3

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Primary Examiner—Trygve M. Blix
Assistant Examiner—Charles E. Frankfort
Attorney, Agent, or Firm—Burns, Doane, Swecker & Mathis

[57] **ABSTRACT**

Methods and apparatus are provided for converting a floatable barge into a semi-submersible vessel. An independently floatable cradle unit is provided which has at least two submersible hulls, a plurality of support columns, transverse braces, and a buoyancy mechanism for selectively ballasting and de-ballasting the submersible hulls. The cradle unit is sunk or at least partially submerged and a barge is floated thereabove, whereupon the cradle is raised to lift the barge from the water. The barge is rigidly connected to the upper portions of the support columns. An inclined lay ramp and/or derrick may be mounted on the cradle to convert the barge into a semi-submersible lay or derrick vessel.

7 Claims, 13 Drawing Figures

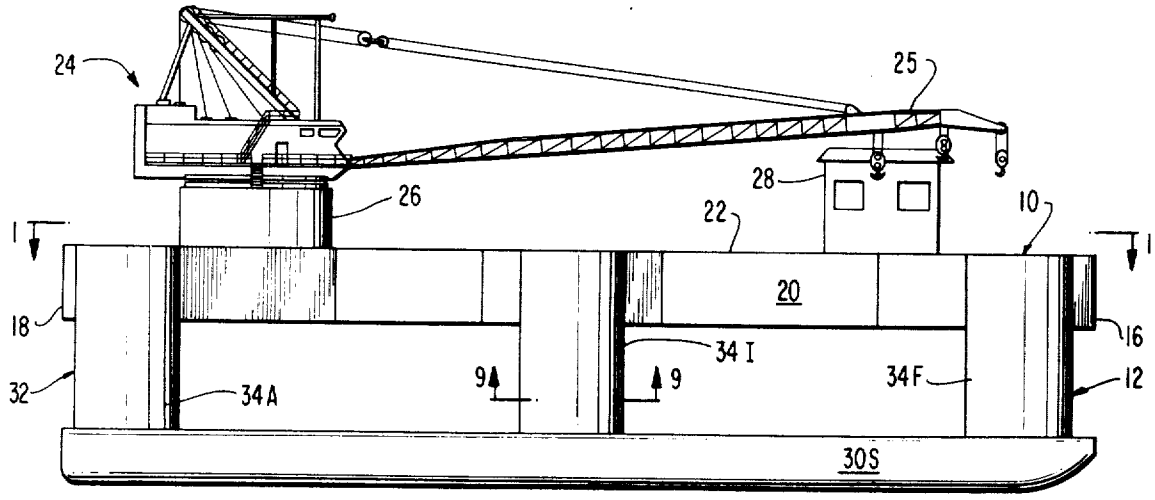


FIG. 1

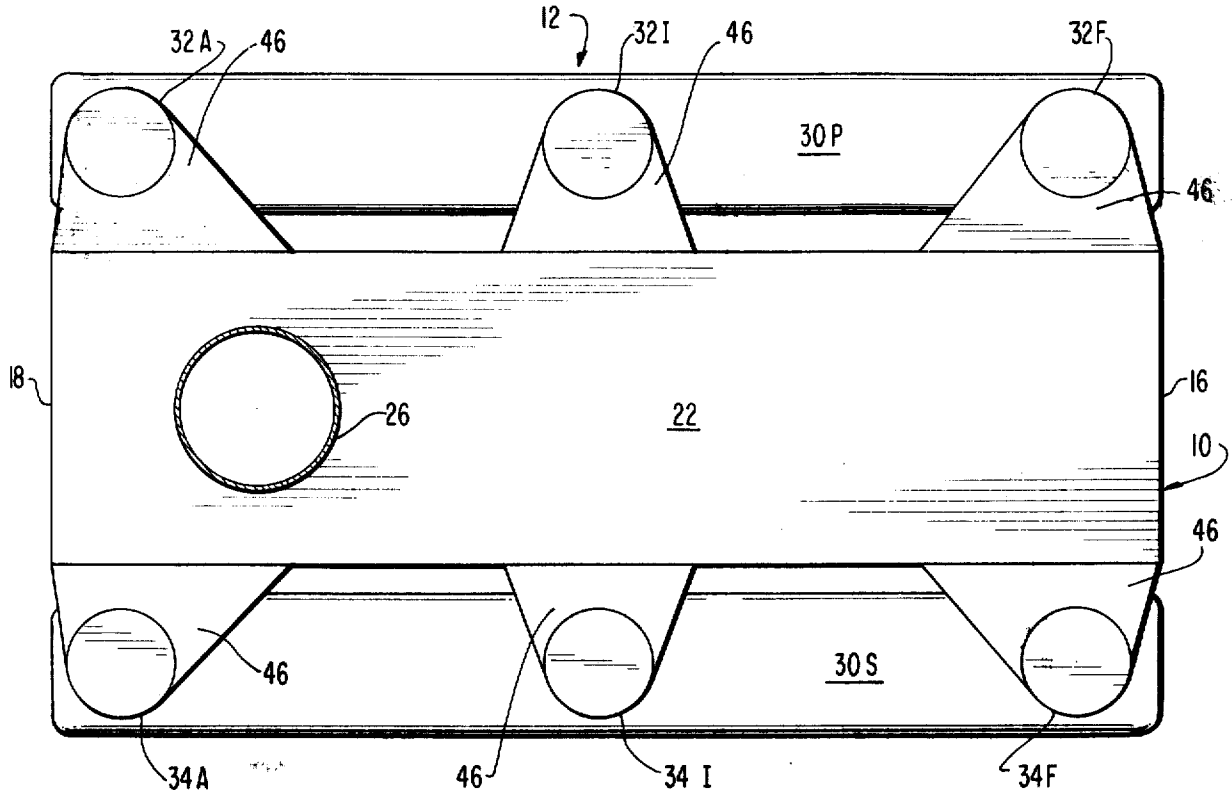

12
32A
46
32I
46
32F
30P
46
18
26
22
16
10
46
46
30S
34A
46
34I
34F

FIG. 2

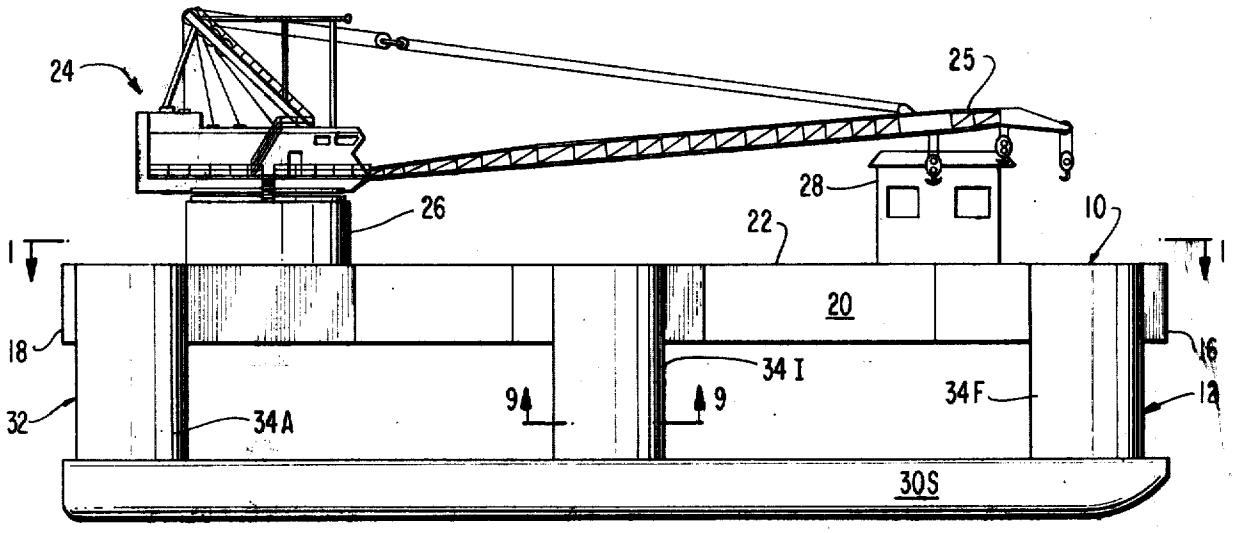

24
25
28
26
22
10
1
1
20
18
16
34I
9
9
34F
32
34A
12
30S

FIG. 3

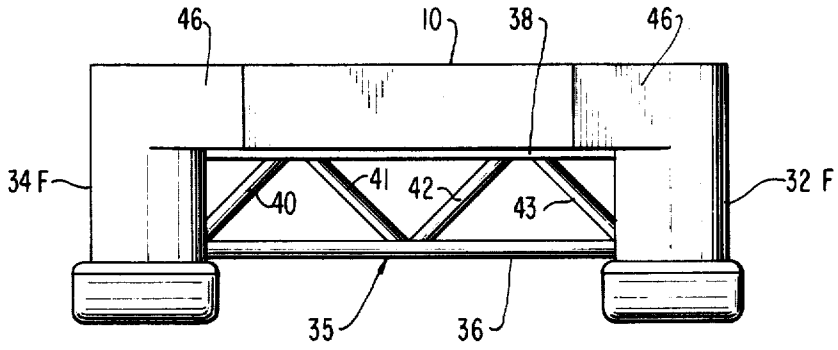


FIG. 4

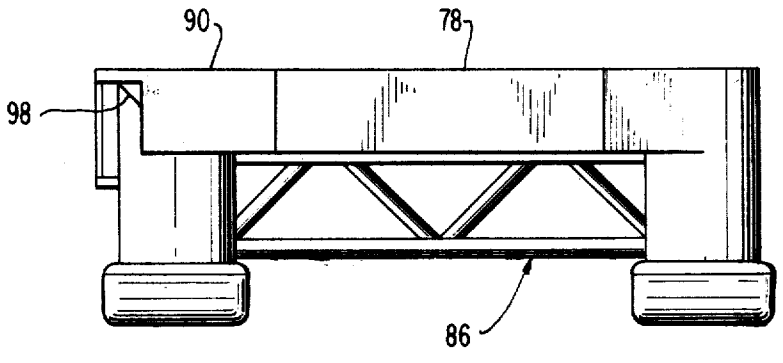


FIG. 5

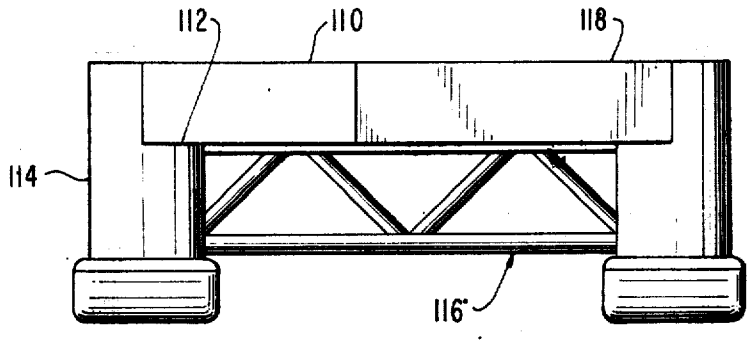


FIG. 6

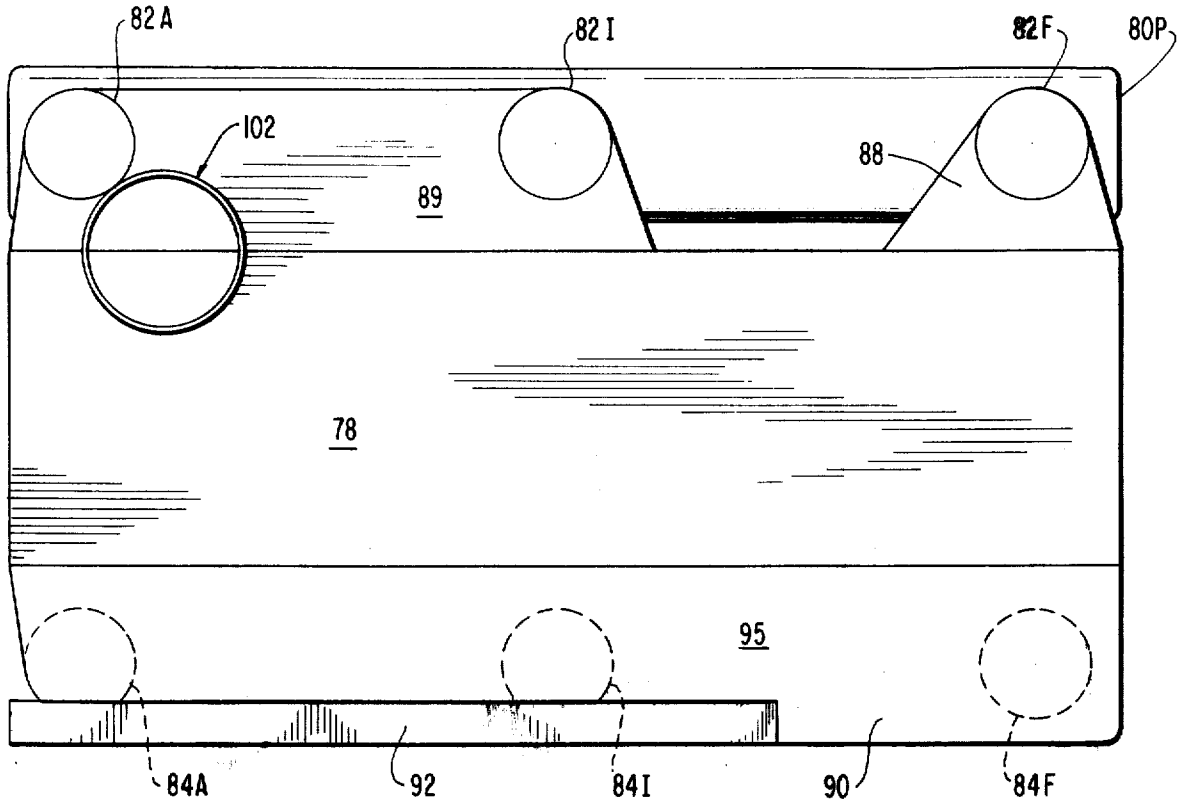
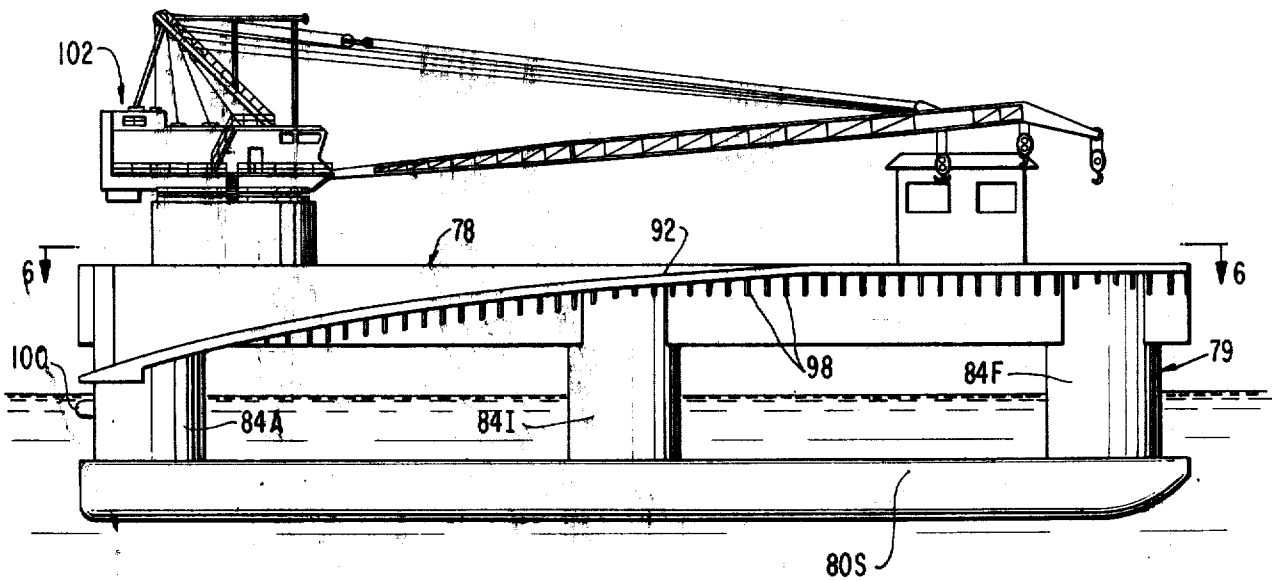

82A
82I
82F
80P
102
88
89
78
95
84A
92
84I
90
84F

FIG. 7


102
78
92
6
6
100
98
84F
79
84A
84I
80S

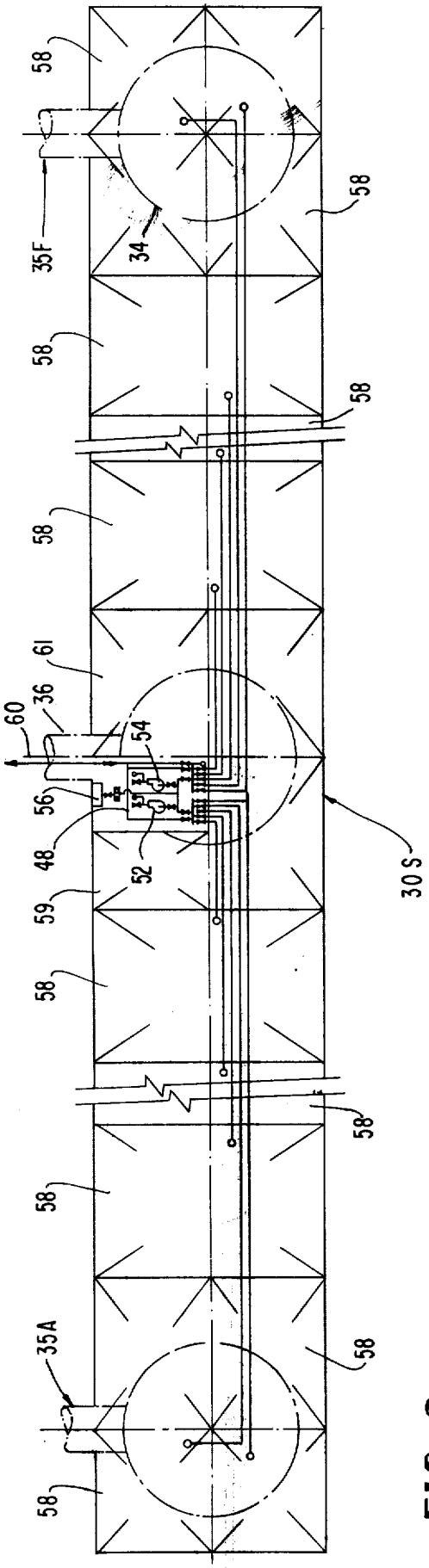

58
35F
34
58
58
58
58
61
60
36
54
56
48
52
30 S
59
58
58
58
58
35A
58
58

FIG. 8

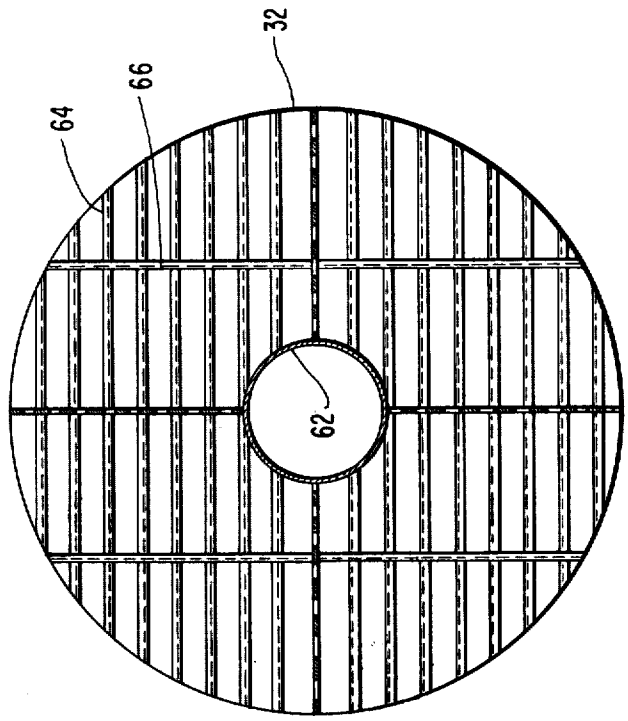

32
66
64
62

FIG. 9

FIG. 10

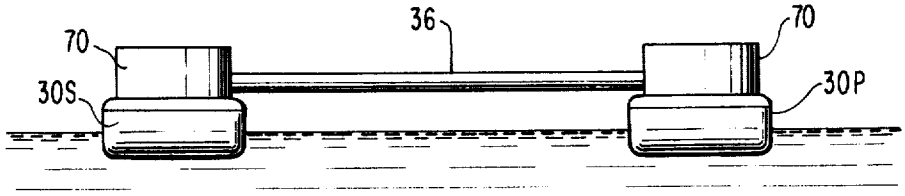


FIG. 11

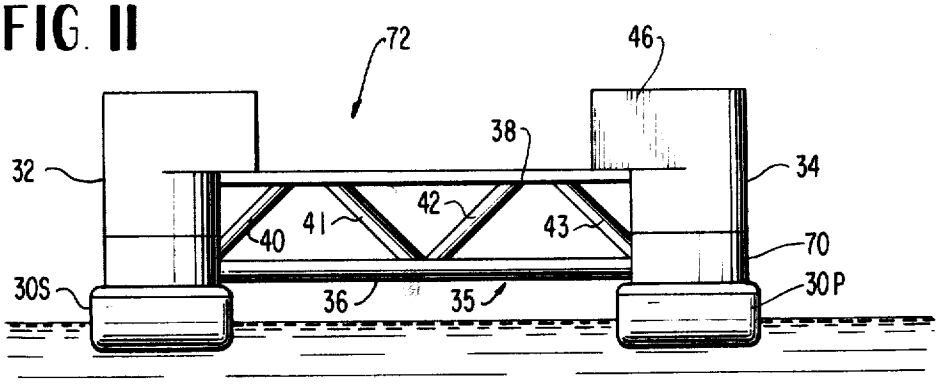


FIG. 12

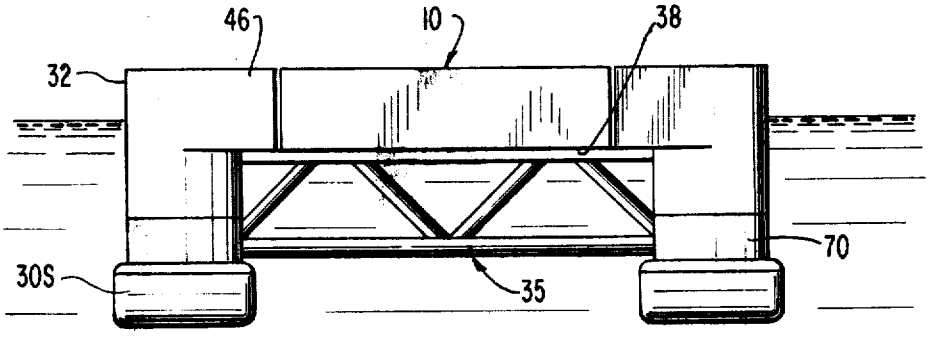
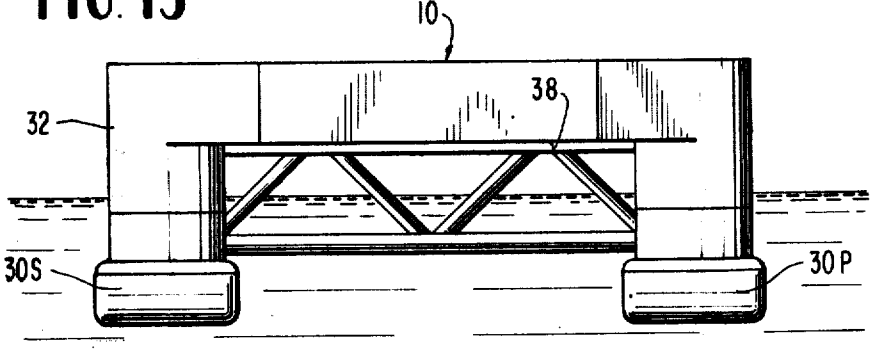


FIG. 13



METHOD FOR CONVERTING A FLOATABLE BARGE INTO A SEMI-SUBMERSIBLE VESSEL

BACKGROUND AND OBJECTS OF THE INVENTION

This invention relates to semi-submersible vessels, and more particularly concerns the conversion of a conventional floatable barge into a semi-submersible vessel.

Various offshore naval operations are being performed in increasing frequency in rough water areas throughtout the world. In the North Sea and Australia, for example, extensive oil drilling and pipeline laying operations are being conducted. The severe wave conditions typically encountered in areas like these greatly limit effective vessel utilization.

Vessels having hull configurations which are characterized by large water plane areas, such as conventional floating barges, for example, are subjected to excessive motion in heave, pitch, and roll directions during rough sea conditions. Consequently, vessels such as these might encounter substantial difficulties during the performance of operations such as pipeline laying, ship to ship material transfer, hoisting operations, platform erection, and other operations which require steady working decks. The dangers produced by such unstable conditions can threaten the safety of the crew as well as result in costly delay.

Vessels of the semi-submersible type, on the other hand, typically exhibit a high degree of stability and thus are being widely employed in rough waters. Semi-submersible vessels typically utilize a pair of buoyant hulls connected below a working platform by means of vertically disposed support columns. The buoyancy of the hulls may be varied to enable the working platform to be selectively raised and lowered in relation to the water surface. In this manner, the buoyant hulls can be submerged to a position below the water surface while maintaining the working platform above the water surface at a higher level than the maximum expected wave heights.

Thus, contact of the semi-submersible with the water surface, where wave action is most severe, is of a limited nature, occuring solely at the vertically projecting support columns. Consequently, the semi-submersible offers minimal obstruction to wave action such that the natural periods of motion of the semi-submersible, during heave, pitch, and roll, are longer than similar periods of normally encountered waves. The resultant stability of the working platform facilitates the performance of sea-based operations, in spite of the presence of a rough water environment.

Numerous problems are involved in satisfying the growing need for semi-submersible vessels to carry out the tasks required in rough-water operations. Among these problems are the considerable time and expenses encountered in constructing a sufficient number of semi-submersibles. It would, therefore, be highly advantageous to provide semi-submersible vessels quickly and economically.

One proposed form of semi-submersible is illustrated in U.S. Pat. No. **3,575,005**, issued on Apr. **13, 1971.** This patent proposes a method of transforming a conventional ship-type vessel into a semi-submersible. It would be desirable, however, that a conventional vessel be transformed into a semi-submersible in a manner

which requires less vessel modification while providing maximum vessel stability and utilization.

It is, therefore, a general object of the invention to provide novel methods and apparatus for obviating or substantially alleviating problems of the types previously discussed.

It is a particular object of the invention to devise novel methods and apparatus for providing semi-submersible vessels at considerable savings of time and cost.

It is another object of the invention to provide novel methods and apparatus for modifying the hull characteristics of conventional floatable barges to minimize the effects of wave action thereon.

It is still a further object of the invention to provide novel methods and apparatus for converting conventional floatable barges into semi-submersible vessels in a manner requiring minimal vessel modification while providing optimum vessel stability.

It is still another object of the invention to provide such novel barge conversion methods and apparatus wherein substantial portions of the conversion operation may be accomplished independently of a physical presence of the barge.

It is yet another object of the invention to provide novel methods and apparatus for converting conventional floatable barges into semi-submersible lay vessels in a manner requiring minimal vessel modification while providing optimum vessel stability.

BRIEF SUMMARY OF PREFERRED EMBODIMENTS OF THE INVENTION

At least some of the foregoing objects are intended to be accomplished by the provision of barge conversion methods and apparatus in accordance with this invention.

In one preferred method aspect of the invention a floatable barge is converted into a semi-submersible vessel. In effecting this conversion, a cradle unit is provided which has a pair, or more, of preferably parallel submersible hull members, a plurality of columns extending transversely upwardly from each hull, transverse bracing structures preferably interconnecting columns of one hull with opposing columns of the other hull, and a buoyancy mechanism for selectively ballasting and de-ballasting the hull members.

The buoyancy mechanism is actuated to cause the cradle unit to sink, at least partially in a body of water, such that the hulls are submerged, the bracing structures define support surface means which may be horizontal and be disposed below the water surface, and the opposing columns define a barge-receiving zone therebetween.

With the cradle thus disposed, the barge is floated on the body of water to a position adjacent the barge-receiving zone, with the underside of the barge located above the horizontal support surface means. The buoyancy mechanism is then actuated to bring the horizontal support surface means into supporting contact with the underside of the barge and lift the barge from the surface of the body of water.

Rigid connection is made between the barge and the upper portions of the columns.

The bracing structures include a plurality of brace beams interconnecting opposing columns, and diagonal brace elements.

The buoyancy mechanism includes ballast pumping equipment in each hull which communicate by a conduit extending through a brace beam.

The barge and cradle are interconnected by extension frames. These frames may include upper surfaces which define extensions of the barge hull and working platform and may serve to support at least part of an offset rotary crane.

During the conversion operation, the barge may be floated to a position adjacent the barge-receiving zone, yet off-set from the center thereof. An extension frame may be provided to serve as an auxiliary working deck.

In an independently significant aspect of the invention the cradle may include an inclined or downwardly curved lay ramp which is suitable for the laying of an elongate flexible structure, such as pipeline, from the vessel. The lay ramp may be supported by columns at one side of the cradle, the columns having ramp-supporting portions of varying height in accordance with the ramp inclination.

The after-most column adjacent the ramp may be provided with a hitch mechanism for supporting a conventional stinger mechanism

Further aspects of the invention relate to combinations of structural elements for implementing the previously described methods.

DRAWINGS

Other objects and advantages of the present invention may be understood from the following detailed description of preferred forms thereof with reference to the accompanying drawings in which like numerals refer to like elements and in which:

FIG. **1** is a schematic sectional view of a barge conversion assembly taken along the line **2—2** in FIG. **2** with the tower portion removed, according to one preferred embodiment of the subject invention;

FIG. **2** is a schematic side elevational view of the barge conversion assembly including the tower portion;

FIG. **3** is a schematic front elevational view of the barge assembly depicted in FIG. **1**;

FIG. **4** is a schematic front elevational view of another preferred barge conversion assembly according to the invention, with the tower portion removed;

FIG. **5** is a schematic front elevational view of a further preferred embodiment according to the invention, with derrick and tower portions removed;

FIG. **6** is a schematic sectional view of the barge conversion assembly taken along line **6—6** in FIG. **7**;

FIG. **7** is a schematic side elevational view of the barge conversion assembly depicted in FIGS. **4** and **6**, including the derrick and tower portions;

FIG. **8** is a schematic longitudinal cross-sectional view through a submersible buoyant hull member forming part of the barge conversion assembly of the invention;

FIG. **9** is a transverse sectional view through a support column, taken along the line **9—9** in FIG. **2**; and

FIGS. **10** through **13** are schematic front elevantional views sequentially depicting various steps in the barge conversion operation of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In accordance with the present invention a barge conversion assembly is provided, comprising a conventional floatable barge and a buoyant cradle unit attachable thereto to form a semi-submersible vessel.

One form of the barge conversion assembly is illustrated schematically in FIGS. **1, 2,** and **3** and comprises a barge **10** and a buoyant cradle unit **12.** The barge **10** is a conventional floating derrick barge having front, rear, and side portions **16, 18,** and **20** and a working deck or platform **22** carried thereby.

Operably disposed on the working deck **22** is a conventional derrick or crane unit **24.** The crane includes a boom **25** which is rotatably mounted on a tub **26** that is secured to the deck **22.** Only a tub portion of the crane is depicted in FIG. **1** to indicate the relative location thereof. In this connection, the rotational axis of the crane is arranged so as to intersect the centerline of the barge. Located at the front of the barge is a control tower **28** from which various barge activities are directed.

It will be appreciated that the barge, when in a floating condition, exhibits a relatively large water plane area, thereby rendering the barge highly sensitive to wave action. Thus, in rough water areas, or where long swells are prevalent, motions of the barge in heave, pitch, and roll directions will tend to restrict the usefulness of the barge.

The cradle unit **12** includes twin submersible hulls, preferably in the form of buoyant caissons or pontoons **30P** and **30S** which are oriented on port and starboard sides in parallel relationship. The pontoons include ballast chambers and equipment for selectively ballasting and de-ballasting these chambers with sea water, as will be subsequently described.

More specifically, each of the pontoons carries a plurality of support columns **32** and **34** which extend transversely relative to the longitudinal axes of the pontoons. While the preferred embodiment described in connection with FIGS. **1, 2,** and **3** discloses three columns associated with each pontoon, it will be appreciated that any suitable number of columns may be employed.

Between corresponding, or opposite, ones of the fore, aft, and intermediate (amidships) support columns **32F, 32A, 32I,** and **34F, 34A, 34I** are provided horizontal transverse bracing assemblies **35F, 35A** and **35I.** Each bracing assembly includes a lower horizontal brace beam **36** and an upper horizontal brace beam **38** secured between oppositely disposed ones of the columns **32** and **34.** A plurality of diagonal brace members **40,41,42** and **43** preferably four in number, are secured at their upper ends to the upper brace beam **38.** The two inner diagonal braces **41** and **42** are connected at their lower ends to the lower brace beam **36.** The two outer diagonal braces **40** and **43** are connected at their lower ends to the opposed support columns **32** and **34,** respectively.

With the pontoons **30,** the columns **32** and **34,** and the bracing assemblies **35** in an assembled condition, the cradle constitutes a unitary floatable structure.

Although the manner of assembling the barge and cradle unit together will be described subsequently in greater detail, it is noted that the columns **32, 34** are secured to the barge by means of steel frame extension

structures **46** which are rigidly secured between the barge and the columns. In their assembled condition, the frame structures **46** define extensions of the barge hull.

Referring particularly to FIG. **8**, it will be understood that the pontoons **30S** and **30A** are substantially identical. Each pontoon is provided with a pump room **48**. Within the pump room are disposed a plurality of pumps **52** and **54** which are suitably connected, via appropriate piping and valve manifolds, between a sea chest **56** and a number of water-tight ballast chambers **58**. The pumps **52** and **54** are operable to regulate the transfer of sea water to the ballast chambers to alter the buoyancy of the pontoons. Additionally, the pump **54** is arranged to transfer ballast water from one pontoon to the other through a conduit **60** extending through the lower horizontal brace beam **36** of the intermediate bracing assembly. In this fashion, the pump mechanism of one pontoon may, if necessary, be utilized to control the buoyancy of both pontoons.

The control room of the control tower **28** is provided with a main ballast control console (not shown) for remotely operating the ballast pumps and their associated valves. Auxiliary ballast controls are desirably disposed in the pontoon pump rooms and are capable of being operated independently of the main control console if such necessity arises.

The pontoons also include chambers **59** and **61** for the storage of fresh water and fuel, respectively. Suitable pumps may be provided for conducting this water and fuel to the barge. Such an arrangement tends to maximize usage of the barge storage facilities.

As can be observed in FIG. **9**, the intermediate ones **321** and **341** of the support columns include central tubes **62**. These tubes provide shear strength across the columns and accommodate access to the pontoon pump rooms via appropriately arranged ladders. The fore and aft support columns **32F**, **32A**, and **34F**, **34A** are also provided with central tubes to facilitate passage of piping between the barge and the pontoons.

The tubes are held in fixed relation within the columns by means of fore-aft bulkheads **64** and transverse bulkheads **66**.

CONVERSION OPERATION

Conversion of a floating barge into a semi-submersible vessel in accordance with the invention is initiated by fabricating the cradle unit **12**. In this connection, and as can be viewed in FIGS. **10** through **13**, the pontoons **30S** and **30P** are constructed and are provided with stub portions **70** of the support columns **32** and **34**.

The pontoons are then launched into a floating condition. While afloat, the pontoons are interconnected by installation of the lower horizontal brace members **36**.

The remaining portions of the support coluns **32** are then erected, defining a barge-receiving zone **72** therebetween. Installation is completed of the remainder of the transverse bracing assemblies **35F**, **35A**, and **35I**, including the upper transverse brace beams **38** and the diagonal braces **40**, **41**, **42** and **43**.

Portions of the hull extension frames **46** are then welded onto the upper ends of the support columns.

As the above-described construction of the extension frames is being carried out, the piping systems, machinery, and wiring are installed within the pontoons, support columns, and hull extension frames.

The cradle unit is then transported to a deep water location where the pontoons **30S** and **30P** are ballasted causing the cradle unit to sink to a depth sufficient to permit the barge **10** to be floated into the barge-receiving zone **72**. With the barge **10** in position, the pontoons will be de-ballasted to raise the cradle unit and thus the brace beams **38** into engagement with the underside of the barge (FIG. **12**). The upper surfaces of the brace beams **38** thus define a generally horizontal barge support surface means. The above-water portions of the extension frames **46** are then connected.

Finally, the pontoons are further de-ballasted to raise the barge out of the water to a position where installation of the hull extension frames **46** may be completed.

As an alternate procedure, portions of the extension frames **46** may be initially constructed on the barge and then extended outwardly to the support columns.

To complete the conversion, the piping and wiring systems between the barge and the cradle unit are interconnected.

Operation of the vessel as a semi-submersible will be substantially the same as that of conventional semi-submersible vessels. For a detailed summary of the operation of vessels of this type, reference may be had to a paper entitled "Development of the Project Mohole Drilling Platform" drafted and presented by the present inventor at an annual meeting of the Society of Naval Architects and Marine Engineers on Nov. **11–12, 1965.**

During semi-submersible operation of the vessel, the cradle unit provides optimum support for the barge by means of the cross bracing assemblies **35**. The bracing assemblies themselves, however, offer minimal obstruction to wave action and thus do not impair vessel stability and movement.

LAY BARGE CONVERSION

In another preferred embodiment of the invention a conventional floatable barge is converted into a semi-submersible lay vessel suitable for the offshore laying of an elongate flexible element, such as pipeline (FIGS. **4**, **6**, and **7**).

In accomplishing this conversion a cradle unit **79** is constructed. This cradle unit **79** includes a pair of port and starboard pontoons **80P** and **80S**, a plurality of upstanding support columns **82F**, **82A** and **82I**, and **84F**, **84A**, and **84I** attached to the pontoons. Bracing assemblies **86**, similar to **35** extend between corresponding, opposite support columns. Extension frames **88**, **89**, and **90** extend between the support columns and the sides of the barge **78**.

Significantly, the support columns **84** and the extension frame **90** are arranged to accommodate a lay ramp **92**. The lay ramp **92** is downwardly inclined in a fore-to-aft direction and is carried at the upper ends of the starboard support columns **34**. The top outer edges of the support columns **84A** and **84I** are disposed at levels of progressively diminishing height in a fore-to-aft direction in accordance with the inclination of the ramp **92**. That is, the support columns **84A** and **84I** are recessed at their top outer edges to define shoulders **94** which support the lay ramp **92**. The forward, upper end of the lay ramp **92** is substantially flush with the extension frame **90** and the deck of the barge. The lower end of the ramp terminates above the starboard pontoon **80S** adjacent the expected water surface level.

The ramp may be of any suitable width, and may extend outwardly of the support columns **34.** Accordingly, appropriately sized bracing flanges **98** may be utilized to support the outwardly extending portion of the ramp.

The hull extension frame **90** extends along substantially the entire length of the barge to define an auxiliary deck surface **95,** which is flush with the working deck of the barge **78.** This auxiliary deck can be used to carry equipment associated with pipeline laying, such as pipe storage units and welding equipment and other apparatus such as described in the previously cited patents.

Known pipelaying techniques and equipment may be utilized in conjunction with a converted lay barge according to this invention. Exemplary thereof are the techniques and equipment described in Lawrence U.S. Pat. Nos. **3,390,532** (issued July **3, 1968**), **3,472,034** (issued Oct. **14, 1969**), **3,487,648** (issued Jan. **6, 1970**) and **3,585,806** (issued June **22, 1971**), Rochelle U.S. Pat. No. **3,507,126** (issued June **13, 1972**), and Jones et al. U.S. Pat. No. **3,668,878** (issued Apr. **9, 1969**). The afore-mentioned patents are assigned to the assignee of this invention and the disclosures of these patents are incorporated herein by reference.

Moreover, additional below-deck quarters may be built into the hull extension frames to accommodate additional personnel, supplies and equipment.

Preferably, the aft starboard support column **34A** is provided with a hitch structure **100** suitable for carrying a conventional stinger mechanism (not shown) during laying operations. Such a stinger and hitch are shown in Lochridge U.S. Pat. No. **3,606,759,** issued on Sept. **21, 1971** and assigned to the assignee of this invention. The disclosure of this Lochridge patent is incorporated herein by reference.

The procedure for converting the barge into a semi-submersible lay barge is similar to that described in accordance with FIGS. **10** through **13.** In this instance the pontoons **80S** and **80P** are constructed and floated. The remaining portions of the cradle **79,** including the lay ramp **92,** are then installed. Subsequently, the conventional barge **78** is floated into position between the support columns, and is raised by the cradle unit such that the frame extensions **88, 89,** and **90** may be connected between the barge and the support columns. In this fashion, the barge is rendered capable of semi-submersible operation for the off-shore laying of elongated flexible elements, such as pipeline.

If desired, conventional auxiliary pipe-laying equipment including a stinger unit and pipe-tensioner unit may be mounted on the cradle prior to the initiation of a pipe-laying operation.

It may be desirable to re-locate the crane **102** from its center-line position to a location P off-set toward the port side in order to compensate for the added starboard weight imposed by the lay ramp and lay equipment. In order to provide maximum compensation, the crane may be partially located on the frame extension **89** which is of a length sufficient to accommodate the crane. Such an arrangement also serves to increase the effective reach of the crane over the port side.

An offset arrangement of the crane may also be utilized in connection with the barge conversion assembly described in connection with FIGS. **1, 2,** and **4,** should it be desired to increase the outward reach of the crane. Compensation for the offset forces imposed by the crane during lifting operations may be provided by suitable ballasting of the submersible hulls **30S** and **30P.**

Although the preceding embodiments of the invention have been discussed in connection with a barge which is positioned substantially centrally between the support columns, it will be appreciated that the other arrangements are possible in accordance with the teachings of this invention. One alternate arrangement is shown in FIG. **5** in which a barge **110** is seated upon shoulders **112** formed in the starboard support columns **114.** The barge is also supported by a plurality of brace assemblies **116** and is connected to a frame extension **118** projecting from the port support columns **120.**

The frame extension **118** defines an auxiliary working deck on which various equipment, such as a crane, can be mounted. Also, additional crew quarters and storage compartments may be installed in the below-deck portion of the frame extension **118.** Assemblage of the structure shown in FIG. **5** is accomplished in a manner similar to the procedure discussed in connection with FIGS. **10** through **13.** In this instance, however, the barge will be floated to an offset position adjacent the barge receiving zone, e.g., wherein its starboard side is situated over the shoulders **112.** Subsequent to being lifted by the cradle unit, the barge is connected to the starboard support columns **114** and to the frame extension **118.**

SUMMARY OF MAJOR ADVANTAGES AND SCOPE OF THE INVENTION

As is apparent, the present invention provides novel methods and apparatus for enabling a conventional floatable barge to be effectively converted into a semi-submersible vessel. In this fashion, a pre-existing barge which meets structural and design standards required of sea-going vessels may be transformed into a semi-submersible with only minimal amounts of barge modification.

Significantly, most of the conversion efforts, i.e., construction of the cradle unit, may be accomplished independently of a physical presence of the barge. Thus, work may be advanced while the barge is engaged in other marine operations. Because of this and the rapid manner in which the final conversion operation is accomplished, use of the barge is lost for only a minimal period.

The cradle unit is constructed in a manner which produces optimum strength and stability, while presenting minimal obstruction to free travel through the water. This is the result of the compact, yet effective, bracing assemblies which rigidify the cradle elements into a unitary, independently floatable structure capable of withstanding highly severe wave environments. The relatively skeletal arrangement of the bracing assemblies, however, assures that the stability and maneuverability of the vessel will not be unduly impaired by wave action.

The bracing assembly also provides a guide for enabling the ballasting systems of the submersible hulls to be conveniently interconnected.

The present invention is also highly advantageous in affording rapid conversion of a conventional barge into a semi-submersible lay barge. By means of a unique design, a lay ramp is carried by the cradle unit and is arranged to be operably associated with the barge working deck.

The provision of frame extensions which are rigidly connected between the barge and the support columns enables the effective working deck area of the barge to be extended, as well as enabling extra below-deck quarters to be added. This added area may be utilized to mount an offset crane, a feature which is particularly advantageous in counterbalancing the barge.

Although the invention has been described in connection with a preferred embodiment thereof, it will be appreciated by those skilled in the art that additions, modifications, substitutions and deletions not specifically described may be made without departing from the spirit and scope of the invention as defined in the appended claims.

What is claimed is:

1. A method of converting a floatable barge having a working deck into a semi-submersible vessel comprising the steps of:

providing an independently floatable cradle unit having

spaced horizontally elongate submersible hull members defining port and starboard submersible hull members,

a plurality of columns extending vertically upwardly from each of said hull members to define port and starboard columns,

transverse bracing means interconnecting said port columns with said starboard columns, said bracing means comprising lower transverse bracing, upper transverse bracing, and intermediate diagonal bracing, and

buoyancy means for selectively ballasting and deballasting said submersible hull members;

actuating said buoyancy means to cause said cradle unit to partially sink within a body of water while maintaining said cradle unit positively buoyant, such that

said submersible hull members are completely submerged,

said upper transverse bracing defines a horizontally disposed support surface means disposed below the surface of the body of water between the port and starboard submersible hull members, and

the upper ends of at least some of the columns of said submersible hull members extend above the water surface to define a barge receiving zone therebetween;

floating said barge on the body of water into said barge receiving zone between said port and starboard columns to orient the underside of said barge over said support surface means, while maintaining said cradle unit positively buoyant;

actuating said buoyancy means for de-ballasting said hull members and increasing the postive buoyancy thereof to:

raise said cradle unit in a manner bringing said support surface means into supporting contact with the underside of said barge, with said barge being located entirely between said port and starboard columns, and

lift said barge from the surface of the body of water, so that said barge is carried above the water solely by buoyant forces acting on said support surface with said submersible hull members being floatingly disposed in said body of water; and

prior to the termination of said method, rigidly welding a plurality of extension frames between the upper portions of at least some of said port and starboard columns and the port and starboard sides of said barge, respectively, with portions of said extension frames being substantially flush with said working deck of said barge to define an extension of opposite sides of said working deck.

2. A method according to claim 1 wherein said step of providing said buoyancy means includes the steps of providing a plurality of ballast chambers and ballast pumping means in each hull, and communicating the ballast pumping means of each hull by conduit means extending through one of said brace beams.

3. A method according to claim 1 wherein the step of floating said barge includes the step of floating a barge having a rotary crane mounted on a working deck thereof with the rotary crane axis extending generally through the centerline of said barge.

4. A method according to claim 1 and further including the step of mounting a pivotal crane at least partially on the upper surface of one of said extension frames.

5. A method according to claim 1 wherein the step of floating said barge includes the step of floating said barge such that the centerline thereof is offset within said barge receiving zone; and said step of rigidly welding includes the steps of welding a frame extension between the barge and the support columns at one side of said cradle unit and arranging an upper horizontal surface of said frame extension to extend along a substantial portion of the length of the barge generally flush with a working deck portion of said barge.

6. A method of converting a floatable barge having a working deck into a semi-submersible lay vessel suitable for laying an elongate flexible means into a body of water, said method comprising the steps of:

providing an independently floatable cradle unit having

spaced horizontally elongate submersible hull members defining port and starboard submersible hull members,

a plurality of columns extending vertically upwardly from each of said hull members to define port and starboard columns,

transverse bracing means interconnecting said port columns with said starboard columns, said bracing means including upper and lower transverse bracing and intermediate diagonal bracing, and

an inclined lay ramp section supported by ramp-supporting portions of the columns of one of said submersible hull members, the ramp-supporting portions being arranged at levels of rearwardly diminishing height in accordance with the inclination of said ramp, and

buoyancy means for selectively ballasting and deballasting said submersible hull members;

actuating said buoyancy means to cause said cradle unit to partially sink within a body of water while maintaining said cradle unit positively buoyant, such that

said submersible hull members and said transverse bracing are completely submerged,

said upper transverse bracing defines a horizontally disposed support surface means disposed below the surface of the body of water between the port and starboard submersible hull members, and

the upper ends of at least some of the columns of said submersible hull members extend above the water surface to define a barge receiving zone therebetween;

floating said barge on the body of water into said barge receiving zone between said zone-defining port and starboard columns to orient the underside of said barge over said support surface means, while maintaining said cradle unit positively buoyant;

actuating said buoyancy means for de-ballasting said hull members and increasing the positive buoyancy thereof to:

raise said cradle unit in a manner bringing said support surface means into supporting contact with the underside of said barge, with said barge being located entirely between said port and starboard columns, and

lift said barge from the surface of the body of water, so that said barge is carried above the water solely by buoyant forces acting on said support surface means with said submersible hull members being floatingly disposed in said body of water; and

at least prior to the termination of said method:

rigidiy welding upper portions of said ramp-supporting columns to one side of said barge so as to establish a lay ramp that extends from an upper location substantially flush with said working deck to a lower position disposed below the underside of said barge for guiding elongate flexible means from said barge, and

rigidly welding a plurality of extension frames between the upper portions of at least some of the columns located opposite said ramp supporting columns and the other side of said barge, with portions of said extension frames being substantially flush with said working deck of said barge to define an extension of said working deck.

7. A method according to claim 6 including the step of attaching a stinger mechanism to said cradle unit at the aft-most column supporting said ramp.

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