

[54] OFFSHORE PLATFORM STRUCTURES

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[22] Filed: May 4, 1973

[21] Appl. No.: 357,446

[52] U.S. Cl. 61/46.5

[51] Int. Cl. E02b 17/00

[58] Field of Search 61/46.5, 46, 50, 52;
52/146, 152

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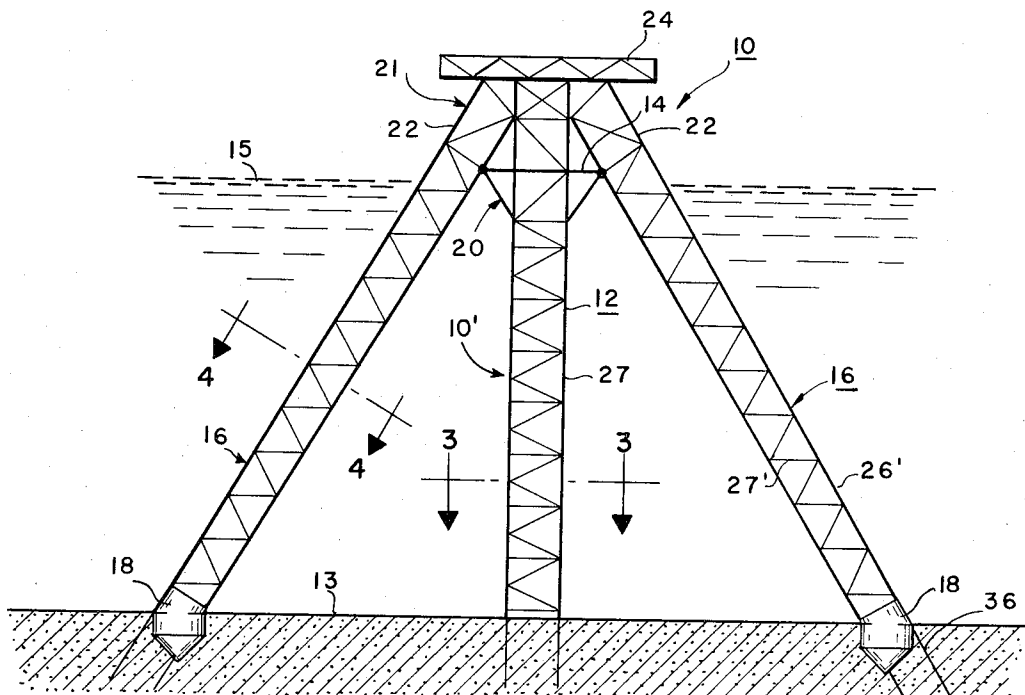
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Attorney, Agent, or Firm—Michael P. Breston

[57] ABSTRACT

This invention relates to the construction of offshore platforms on selected sites on the sea floor. The method includes transporting to the site at least one center column and at least three batter columns, erecting the center column so that its upper end extends above the water's surface and its lower end is fixedly secured to the sea floor, and then erecting the batter columns around the center column in bracing relation to the center column and to each other thereby forming a support structure, and constructing a working platform on the erected support structure.

6 Claims, 21 Drawing Figures



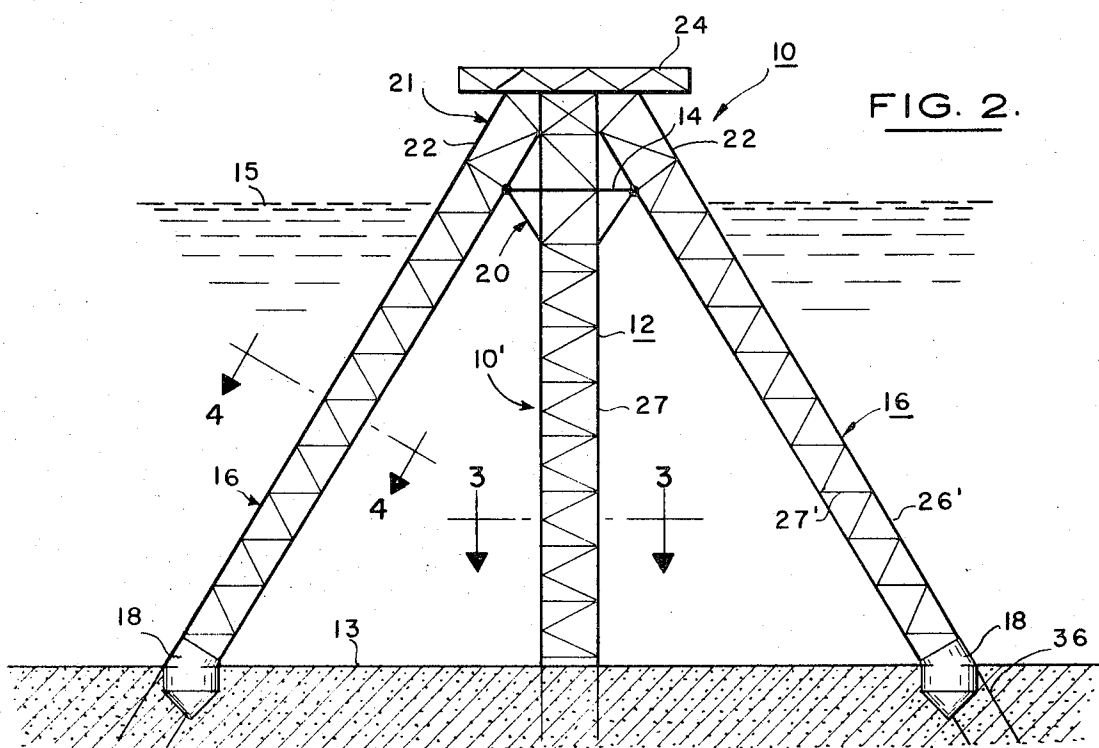
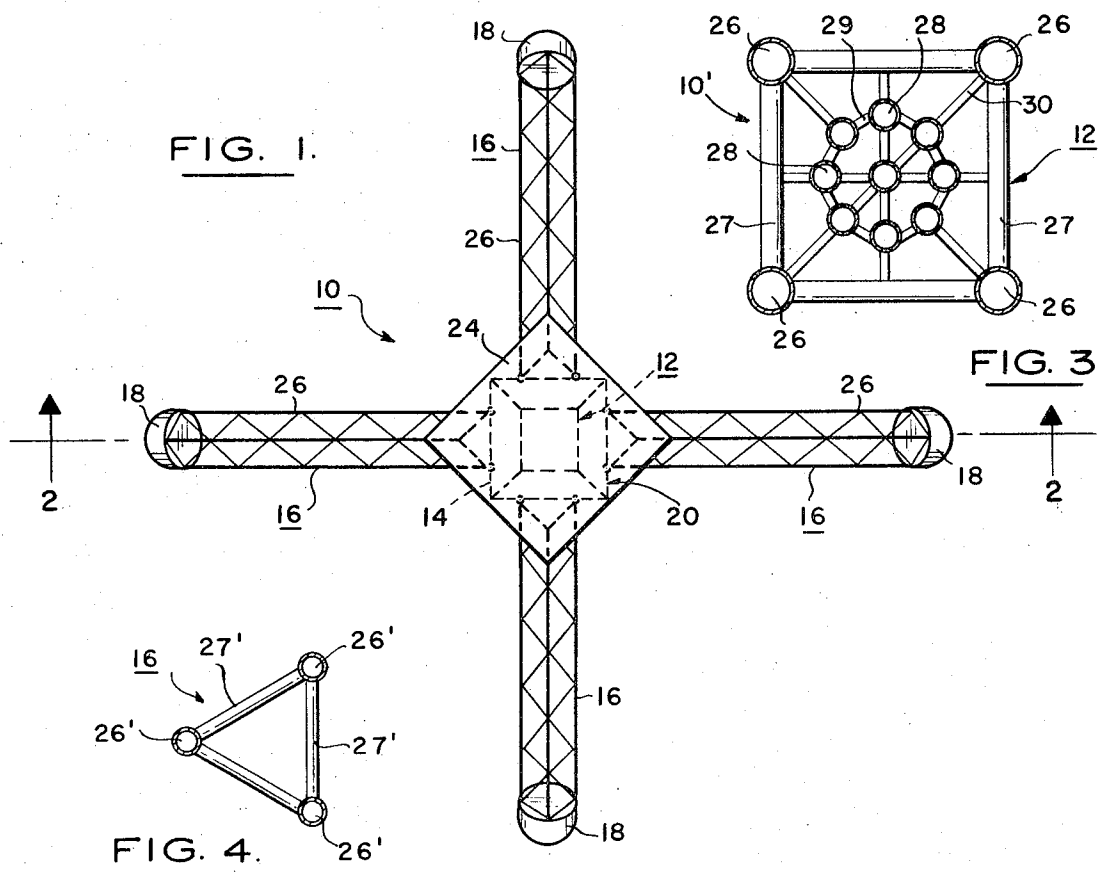


FIG. 5.

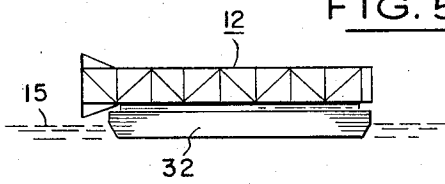


FIG. 6.

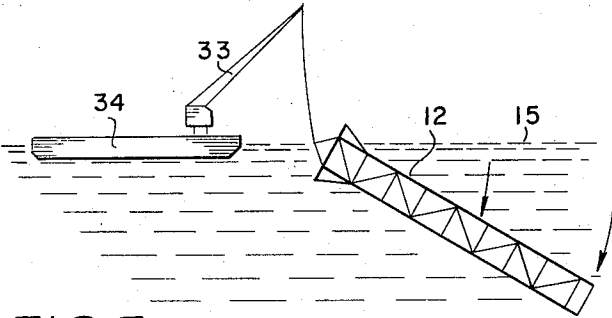
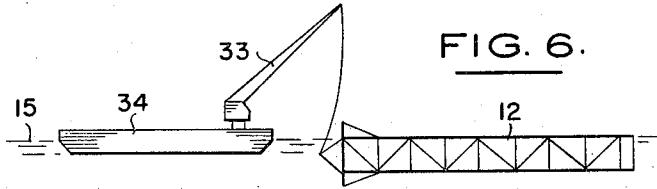


FIG. 7.

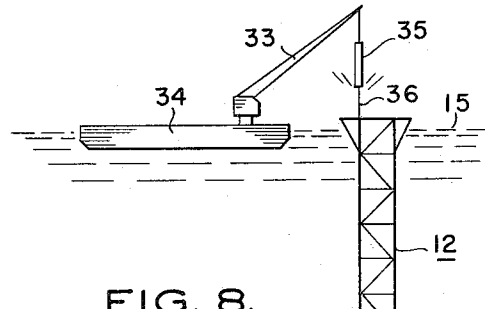


FIG. 8.

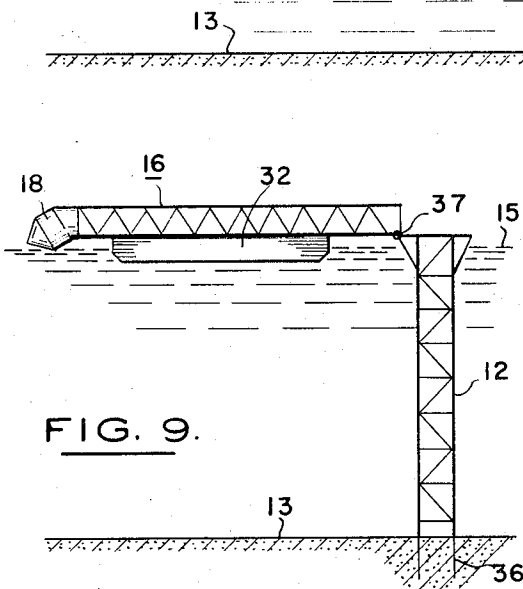


FIG. 9.

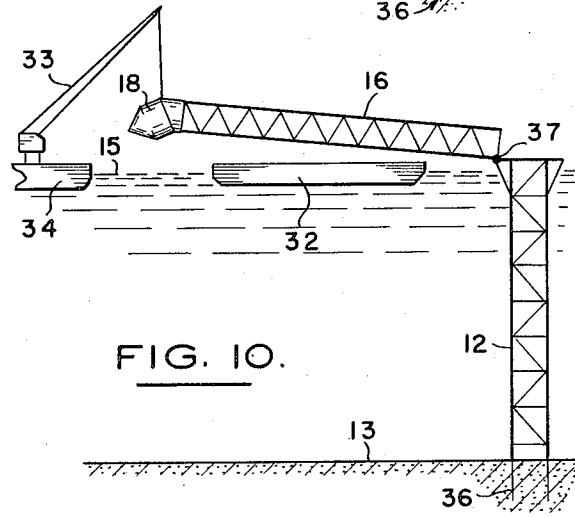


FIG. 10.

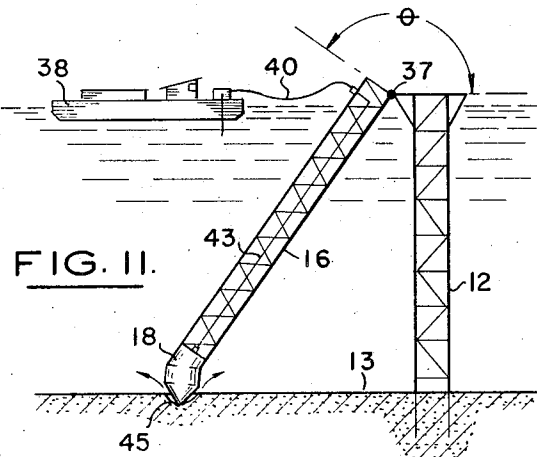


FIG. 11.

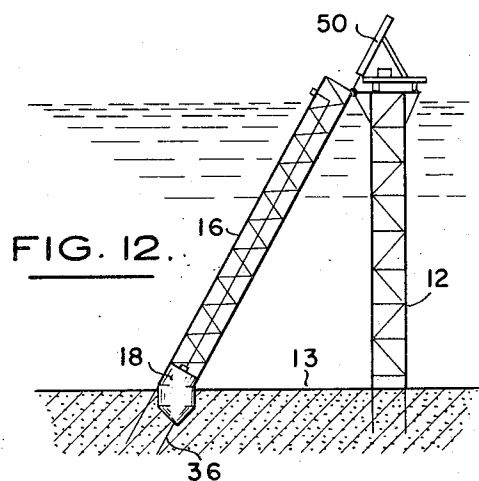


FIG. 12.

FIG. 13.

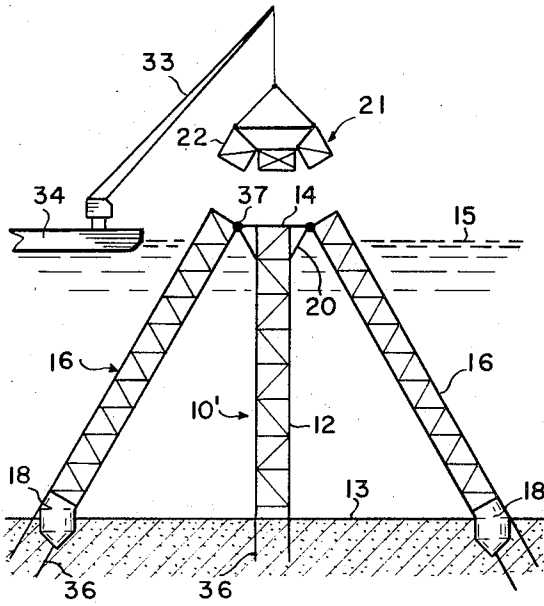


FIG. 14.

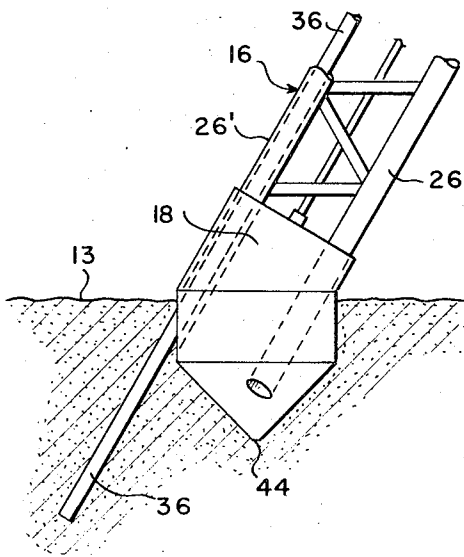
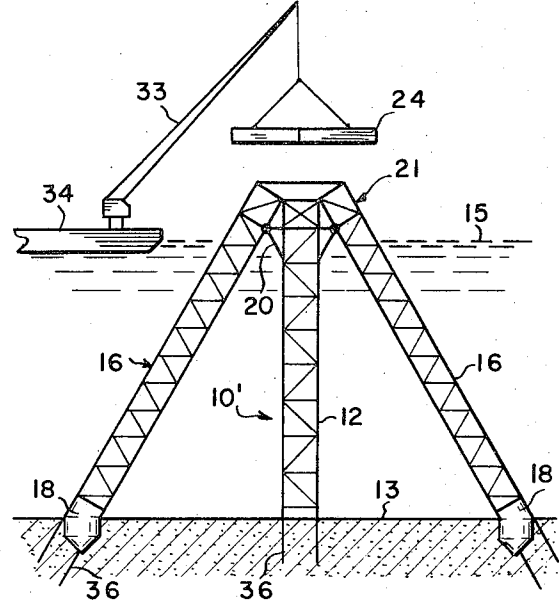


FIG. 16.

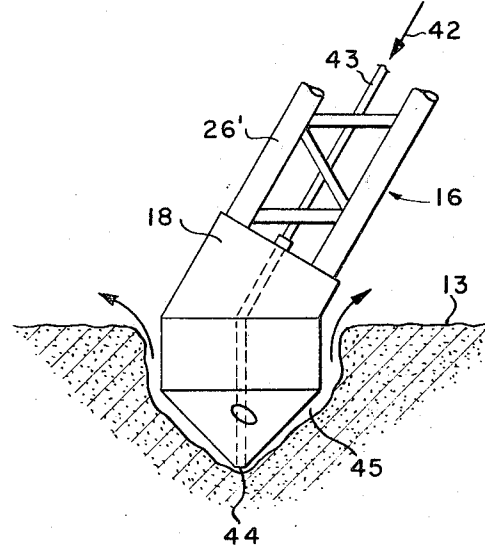


FIG. 15.

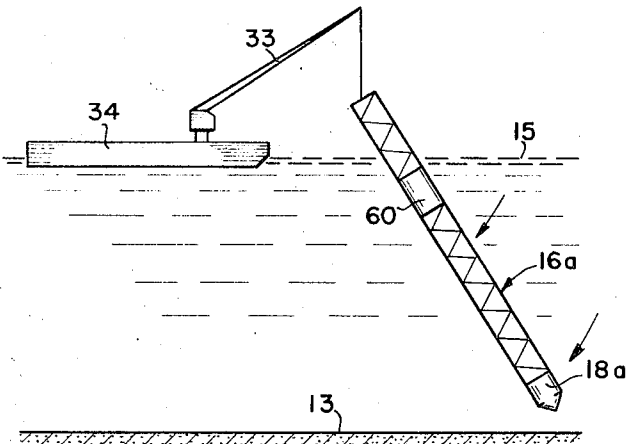
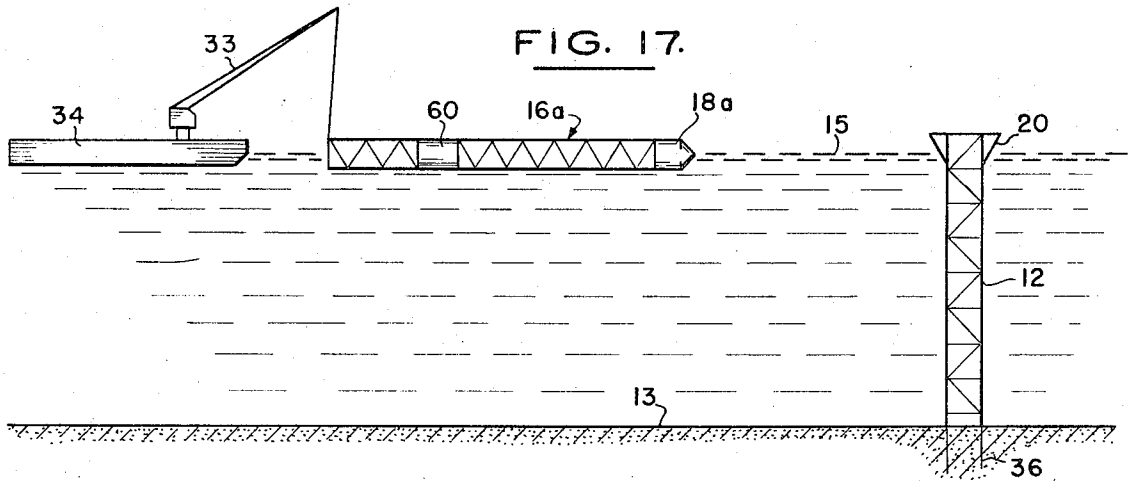


FIG. 18.

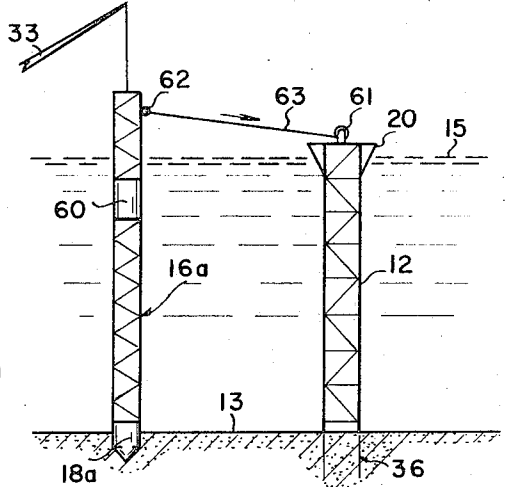


FIG. 19.

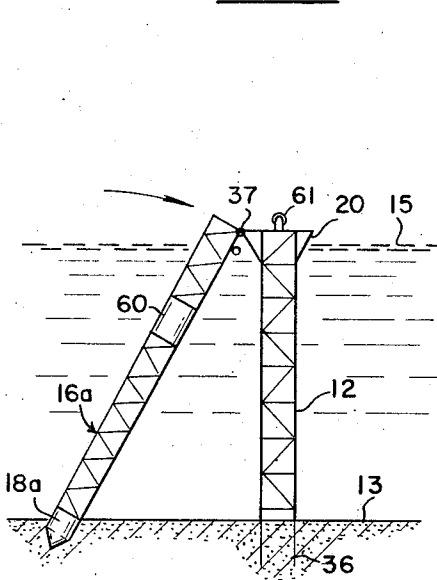


FIG. 20.

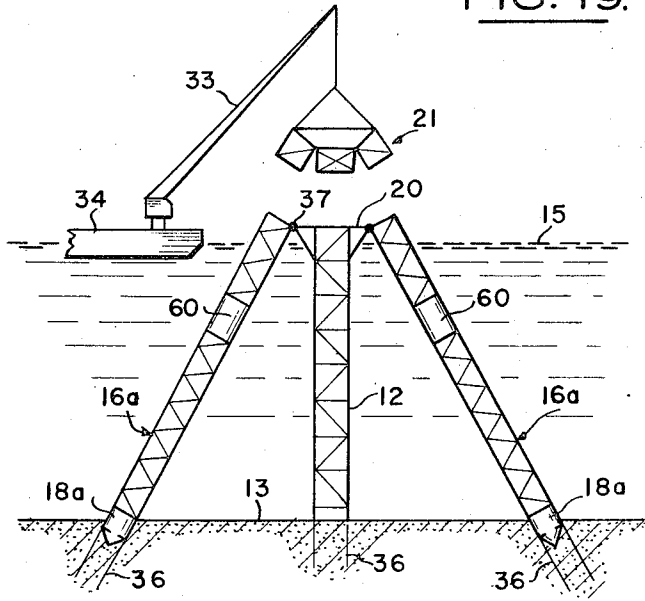


FIG. 21.

OFFSHORE PLATFORM STRUCTURES

BACKGROUND OF THE INVENTION

During the early stages of offshore construction, limitations were imposed by the available equipment for handling large structural members. Most platform structures were erected in shallow waters say between 5 to 65 feet. As a fundamental substructure there was used a four-legged template or jacket made of tubular legs reinforced by horizontal and diagonal braces. The jackets were fabricated in onshore fabrication plants and then transported to the offshore erection site. Depending on the desired overall working area for the platform, several such jackets might have been required. Each jacket was uprighted next to each other with their lower ends or legs secured to the sea floor and their upper ends secured to each other. The legs of the jackets were secured to the sea floor by driving piles therethrough. Thereafter, a working platform would be constructed over the jackets. The known method had two chief drawbacks: it required several jackets and an excessive amount of onsite construction.

Efforts were made to greatly increase the lifting capacity of the cranes on the derrick barges and to improve the methods for manipulating relatively large substructures on barges as well as on the offshore erection site. These increased handling capabilities allowed the use of relatively large jackets so that the number of jackets required to support a given area of the working platform could be reduced. However, the reduction in the number of required jackets was accompanied by an increase in the number of tubular legs per jacket and in their diameters.

As the search for oil moved to deeper waters, say between 65 to 3 hundred feet, the weight handling capabilities of the cranes on existing derrick barges again became limiting factors in the construction of offshore platforms using jackets as the basic support frame. These limiting factors prompted the rapid development of jacket-launching techniques from the decks of barges into the water.

There is now a demand for structures positioned in water depths greater than 300 feet. The conventional jacket-type structures now in use in shallow waters are not well suited for such depths because they would be difficult to tow to the construction site, they would not frame enough piles to provide lateral support, and the required wall thickness for their standard members would make it difficult for them to float or to be launched from the decks of barges.

It has been proposed for such great depths to construct jacket-type structures having great diameter legs that would provide flotation. But such large structures require special fabrication facilities which are not readily available. Such facilities would have to be located onshore to minimize problems of transporting such large substructures over land waterways and under existing bridges. To allow the jackets to float, the large-diameter legs of the jackets would have to be constructed of relatively thin walls, relative to their diameters, and they would require considerable stiffening to protect them against collapse by hydrostatic pressure. The very large-diameter tubular legs have the inherent disadvantage in that they present an excessive planar area to winds and storms and hence are subject to excessive lateral loads. To resist such lateral loads, a great

number of piles are required to ground the legs of the jackets to the sea floor. Yet, even though the jackets are constructed of relatively large diameter legs, they may not be able to frame the required number of piles. Finally, the erected platform structure would still be relatively limited in its overall dimensions at its base, a fact which tends to reduce the lateral stability of the entire platform structure.

Accordingly, it is a main object of the present invention to overcome many of the above-described and other apparent drawbacks of known offshore platform construction methods.

In particular, it is an object of the present invention to provide a method of constructing an offshore platform which requires substructures which can be fabricated within inland fabrication yards, which can be transported on inland waterways with existing transportation barges, which require relatively small-diameter legs, and which require a reduced number of piles per leg.

SUMMARY OF THE INVENTION

A method of constructing an offshore platform on a selected site on the sea floor by transporting to the site at least one center column having a length which is greater than the depth of the body of water at the site, also transporting to the site at least three batter columns each having a length which is considerably greater than the length of the center column, first erecting the center column on a selected area of the site so that its upper end extends above the water's surface and its lower end is fixedly secured to the sea floor, then erecting the batter columns around the center column so that their upper ends are secured to angularly spaced portions about the upper end of the center column and their lower ends are fixedly secured to the sea floor in bracing relation to the center column and to each other thereby forming a support structure, and thereafter constructing a working platform on the erected support structure.

In one method aspect of this invention, the top ends of the batter columns are pivotably secured to the upper end of the center column while they are substantially horizontally maintained on the water surface and thereafter the free ends of the batter columns are gradually lowered to the sea floor toward selected points on the construction site.

In another method aspect of the invention, the batter columns are first vertically erected around the uprighted center column and then their upper ends are moved toward and secured to the upper end of the center column.

In both method aspects, securing means such as piles are driven through the legs of the center column and of the batter columns as required to maintain the support structure fixed to the sea floor. By removing such securing means, the platform structure can be disassembled and moved for erection to another construction site.

The method of the present invention lends itself advantageously for constructing a platform structure over an existing offshore well site over which the center column is required to be erected. The center column will allow the servicing of a plurality of wells say up to two or three dozen wells. The center column is used as a reference for the erection of the batter columns.

The platform structures constructed in accordance with the present invention are characterized by lateral stability of the working platform. This advantage is of great significance since any appreciable lateral displacement of the platform becomes highly objectionable, for example, if a drilling platform were to become displaced too far from its position above the wellbore, then the equipment interconnecting the drilling platform with the wellbore could become severely damaged or perhaps completely destroyed.

Since the batter columns are widely spaced-apart at their lower ends, making the overall base dimensions of the erected support structure relatively large, the axial load on the piles can resist a great portion of the lateral load on the platform structure resulting from wind storms.

The platform structures in accordance with the method of the invention are cheaper to manufacture, require less onsite fabrication, and are relatively lightweight, thereby achieving considerable savings in the amount of steel required.

Also, since platform structures periodically become subjected to hurricane force winds which produce great fluctuations in the depth of the water body above the marine floor, the platforms are generally conservatively elevated above the highest expected water surface under them. The platform structures constructed in accordance with the method of the present invention are particularly well adapted, with their widely spaced-apart batter legs, to support such highly elevated platforms.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic plan representation of one illustration of an embodiment of a platform structure assembly constructed in accordance with the method of this invention and adapted to support a working platform;

FIG. 2 is a schematic sectional representation on line 2—2 in FIG. 1;

FIGS. 3 and 4 are sectional views taken on lines 3—3 and 4—4, respectively, in FIG. 2;

FIGS. 5—8 illustrate the method steps of transporting the center column to and uplifting it on the selected offshore site;

FIGS. 9—12 illustrate one method aspect of the invention for transporting the batter columns and horizontally maintaining them in the body of water while their top ends are being pivotably secured to angularly spaced-apart points on the upper end of the center column. Thereafter, the free ends of the batter columns are gradually lowered to the marine bottom;

FIGS. 13 and 14 illustrate the manner of positioning a working platform on the erected support structure;

FIGS. 15 and 16 illustrate steps which may be used for securing the legs of the support structure to the marine bottom;

FIGS. 17—21 illustrate another method aspect of the invention wherein FIG. 17 illustrates the launching of the batter columns to the construction site;

FIG. 18 illustrates the uprighting of a batter column;

FIG. 19 illustrates a method of moving the upper end of each batter column toward the upper end of the center column; and

FIGS. 20 and 21 illustrate the completion steps of the platform structure.

Generally, the invention relates to methods of constructing from columnar members fixed offshore working platforms such as are used for supporting equipment and supplies, as in drilling for or producing oil and gas wells. Each column is preferably made in an onshore fabrication plant and each is typically provided with buoyancy controlling compartments and with conventional means (not shown) for controllably ballasting and deballasting the column. Such means are so generally employed in the offshore construction art that they need not be described herein, and any such widely used and known means or their equivalents may be employed to move the lower end of each column toward or away from the marine bottom.

Referring now more specifically to the drawings and in particular to FIGS. 1—4 thereof, there is shown a platform structure generally designated as 10, erected from onshore-fabricated columns in a body of water having a floor 13 and a water line 15. Platform structure 10 is shown as comprising an upright center column 12 positioned in the body of water and being adapted to angularly receive a plurality of batter or stabilizing columns 16 (FIGS. 1 and 2). Center column 12 ordinarily has a height when landed on the marine floor 13 such as to project its upper end 14 slightly above the water line 15. The upper end of center column 12 is provided with an enlarged linking frame 20 adapted to receive the upper ends of a plurality of batter columns 16. The terms "upper" and "lower" ends when referring to a particular column are with reference to the upright position of the column in the body of water.

The minimum numbers of columns 12 and columns 16 required are one and three, respectively, but a greater number of each of such columns 12 or 16 may be employed. In the embodiment shown in FIG. 1, four such columns 16 are illustrated as being symmetrically and angularly positioned relative to the linking upper frame 20. Each batter column may be provided at its lower end with a suitable grounding leg 18 which, in its simplest form, may be a large can, as better illustrated in FIGS. 15—16.

When the center column 12 is grounded after landing on the marine bottom and the batter columns 16 are attached thereto in bracing relationship, they form a support structure 10' adapted to receive on the upper end thereof a prefabricated transition structure 21 having a plurality of legs 22 arranged to mesh and longitudinally align with the center column 12 and with the batter columns 16. The transition frame 21 is adapted to support the desired working platform 24 which typically carries equipment and supplies for drilling or producing oil and gas wells, or for other purposes as may be required.

FIG. 3 illustrates a center column 12 which may comprise a plurality of relatively large-diameter, long, tubular legs 26 which can be used to define ballasting and deballasting compartments (not shown) for controllably turning the center column in the body of water. The vertical legs 26 are interconnected by cross-bracing tubular members 27 which also can define fluid compartments in fluid communication with the compartments in the legs 26. When the center column 12 is used in a platform structure adapted for drilling operations, it is conventional to provide inside column 12 a plurality of conductor guides 28 interlinked by cross-bracing members 29. The assembly of conductor guides 28 is framed

to the vertical legs 26 by members 30. Conductor pipes are then installed through the guides after the support structure 10' is erected.

While the center column 12 is shown as having a rectangular configuration, it could have a triangular plan configuration, and while only four legs 26 are shown more than four legs would normally be employed. Also, to save material, each batter column 16 may have a triangular configuration, as shown, constructed from three long hollow tubular legs 26' interconnected by bracing members 27' (FIG. 4). The number of hollow tubular legs 26' could of course vary and each would normally also define fluid compartments (not shown) for selectively and controllably ballasting the same with conventional means (not shown). The bracing framework 27' is constructed to provide maximum rigidity to the batter columns.

The rate of ballasting of the center column 12 and of each batter column 16 can be controlled so that the lower end of each column slowly sinks relative to its upper end, thereby uplifting the column toward an upright or inclined position in the body of water. Ballasting of each column is controlled from the water surface and may be continued until the column rests on and is firmly grounded in the marine floor 13. It will be understood that by removing the grounding means, each column could be tilted back to its horizontal floating position in the water body.

The method aspects of the invention, used in constructing the platform structure 10 shown in FIGS. 1-4, will now be illustrated with reference to FIGS. 5-16 and FIGS. 17-21.

FIGS. 5-8 illustrate the preferred steps used to erect the center column 12 and fixedly ground it to the marine bottom 13. In FIG. 5 the center column 12 is shown as being transported on a cargo barge 32 and carried to the selected offshore site. At the construction site, center column 12 is removed from the deck of barge 32 and allowed to float in the body of water. A crane 33 of a crane barge 34 is connected to the upper end of column 12 (FIG. 6). The column is then selectively and controllably ballasted to cause it to tilt (FIG. 7) slowly until the lower end thereof lands precisely on the desired point within the site which could be a marked well head on the marine bottom 13. Crane 33 will then assist to upright column 12. While maintaining the center column 12 in such an upright position, a pile driver 35 (FIG. 8) will drive piles 36 through the column's tubular legs 26 into the marine bottom 13 thereby securely grounding the center column 12 thereto. The piles could be removed, if and when desirable, and the process reversed to bring column 12 back to its original horizontal position.

A method of installing the first batter column 16 is illustrated with reference to FIGS. 9-12. The same method could be used to install the remaining batter columns 16.

After transporting column 16 on a cargo barge 32 or by floating it to the construction site, the upper end thereof is hingedly secured to the linking frame 20 by suitable pivot means 37 while the column 16 remains on the deck of the barge 32 (FIG. 9). The lower end of column 16 is then raised upwardly by crane 33 (FIG. 10) to allow the cargo barge 32 to move out from under column 16. Thereafter the lower end of column 16 is lowered into the body of water and selectively and controllably ballasted until its leg 18 lands at a desired lo-

cation on the marine bottom 13. It will be appreciated that column 16 can float in the body of water so that the assistance of crane 33 in the process of tilting column 16 can be reduced to a minimum.

The length of column 16 is considerably greater than the length of column 12 and hence than the maximum anticipated depth of the body of water near center column 12. Therefore, leg 18 of column 16 lands at a point which is at a considerable distance away from the grounded end of center column 12. Depending on the depth of the water, this distance may be on the order of several hundred feet.

It will be appreciated that in the platform structure constructed in accordance with the present invention, the lower ends of the batter columns 16 are not required to be secured to any bottom base member such as was conventional with completely prefabricated platform assemblies moved to the desired offshore location and grounded to the marine bottom either fixedly or removably.

The grounding of can 18 for clay and sand bottoms can be accomplished by first jetting a cavity 45 in the marine bottom 13 with the aid of a service vessel 38 (FIG. 11). It has an umbilical cable 40 within which are housed a plurality of flexible conduits for supplying jet streams 42 to a plurality of jetting hoses 43, each having an outlet 44 (FIG. 16). The jetting action will remove the soil around can 18 to allow it to become buried completely in cavity 45. After can 18 is completely forced into the marine bottom 13 (FIGS. 15-16), piles 36 are then driven by a pile driver 50 (FIG. 12) through the tubular legs 26' and can 18 of column 16. In this fashion, can 18 is now firmly grounded to the marine bottom.

For hard soils, known digging methods including jetting could be employed to ground cans 18, as will be apparent to those skilled in the art.

The batter column 16 will be inclined at an angle θ relative to the center vertical column 12 (FIG. 11). If this angle θ is too small, there may be a need to employ not a pile driver 50 for hammering the piles 36 into the marine bottom 13, but a combination of driving and drilling (not shown) to install the piles 36 into the marine bottom. After piles are installed through the tubular legs 26' of column 16, they are subsequently welded to the top ends thereof in conventional manner.

After installing the first column 16, a second such column is then pivotably connected to the pivot means 37 on the linking frame 20 and ballasted as above described until its leg 18 lands on a desired point on the marine floor 13. The landing point can be easily determined since the angle θ of the second column 16 with reference to the center vertical column 12 will generally be the same as that of the first column 16. Leg 18 of the second batter column 16 is then grounded as above described.

The third and fourth columns 16 are then installed in succession in the same manner, thereby completing the erection of the support substructure 10'.

The method of installing the working platform is illustrated with reference to FIGS. 13-14. An onshore fabricated intermediate structure 21 is transported to the site and lowered by crane 33 in position on top of the primary substructure 10' so that its legs 22 mesh and become in longitudinal alignment with the upper ends of the center and batter columns. After being so positioned, the intermediate structure 21 is fully struc-

turally integrated with the primary structure 10' and, if desired, the pivots 37 are welded off.

To complete the installation, the working platform 24 itself, which may be of unitary or sectionalized construction, is now lowered by crane 33 on top of and framed to the intermediate structure 21. Platform 24 is now ready to receive equipments and supplies.

In another aspect of the invention the erection of the platform structure can be carried out as illustrated in FIGS. 17-21. The erection of the center column 12 will be carried out in the manner previously described in connection with FIGS. 5-8. A batter column 16a is launched and brought to the construction site. Each batter column includes between its ends a buoyancy chamber 60 and a large can 18a at the lower end thereof. The tilting of each batter column 16a is accomplished substantially in the manner previously described in connection with the tilting of first batter column 16 (FIGS. 9-12).

Whereas in the first aspect of the invention, the upper ends of the batter columns are first consecutively pivotably secured to the upper end of the center column and then the lower ends of the batter columns are gradually tilted toward their preselected positions on the marine bottom 13, in the second aspect of the invention, the batter columns are first erected in a substantially upright position at their selected points around the center column 12 and then their upper ends are moved toward the center column, as by a winch 61 having a rope 63 attached to a ring 62 on each batter column 16a, and/or with the assistance of crane barges.

After thusly inclining all batter columns toward the center column, their upper ends are welded securely to the linking frame 20 on the center column, as previously described in connection with the first aspect of the invention, thereby completing the erection of the support structure 10'.

All columns will again have their lower ends grounded to the marine bottom by piles 36. The completion of the construction job is again accomplished by positioning on top of the support structure 10' an intermediate structure 21 and framing thereto the working platform 24.

While this invention has been illustrated in connection with preferred embodiments thereof, it will be apparent that various modifications are possible all falling within the scope of the claims attached hereto:

What is claimed is:

1. A method of constructing an offshore platform structure on a selected site on the sea floor, comprising:

transporting to the site at least one center column having a length which is greater than the depth of the body of water at said site;

transporting to said site at least three batter columns, the central column and each batter column having a multi-legged structure consisting of at least three legs, each leg having an upper end, a lower end, and each batter column having a length which is considerably greater than the length of said center column;

erecting the center column on a selected area within said site whereby its upper end extends above the water surface;

securing the lower end of said center column to said floor;

erecting the batter columns around said center column, welding the upper ends of the batter columns to angularly spaced portions about the upper end of the center column above the water surface and fixedly securing their lower ends to said floor in bracing relation to said center column and to each other thereby forming a support structure;

driving piles through the entire length of certain ones of the legs in each column to thereby fixedly secure each column to the sea floor, whereby the axial load on each pile resists a substantial portion of the lateral load on said support structure; and framing a working platform onto the erected support structure.

2. The method of claim 1 wherein the erecting step of said batter columns includes:

first pivotably securing the upper end of each batter column to said center column while maintaining it in a substantially horizontal position within the body of water, and

gradually tilting each batter column toward its selected position on said site.

3. The method of claim 1 wherein said erecting step includes of said batter columns:

first positioning the lower ends of said batter columns on their selected positions on the floor of said site, and

subsequently moving the upper ends of said batter columns toward said center column.

4. A method of constructing an offshore platform structure positioned in a body of water and extending from the bottom thereof to support a working platform above the water's surface, comprising:

erecting a vertical center column in the body of water having pivot means at angularly spaced apart points on the upper end of said column;

pivotably securing a plurality of batter columns to said pivot means while maintaining said batter columns in a substantially horizontal position, each batter column having a multi-legged structure consisting of at least three legs, each leg having an upper end, a lower end, and a length which is considerably greater than the length of said center column;

controllably ballasting the batter columns until their lower ends land on the marine bottom;

affixing the lower ends of all batter columns to the marine bottom in bracing relation to the center column and to each other, whereby said center column and said batter columns form a support structure;

driving piles through the entire length of certain ones of the legs in each batter column to thereby fixedly secure each column to the sea floor, whereby the axial load on each pile resists a substantial portion of the lateral load on said platform structure; and

framing onto said support structure a working platform.

5. An offshore platform structure comprising:

at least one upright center column extending above the water surface;

at least three batter columns, each column having a multi-legged structure consisting of at least three legs, each leg having an upper end, a lower end, and each having a length which is considerably greater than the length of the center column to pro-

vide a large batter angle relative to the vertical, the upper ends of the batter columns being welded above the water surface to angularly spaced portions about the upper end of the center column and the lower ends of the batter columns being secured to the marine bottom in bracing relation to the center column and to each other;

a plurality of driven piles through the entire length of certain ones of the legs in each column to thereby fixedly secure each column to the sea floor, whereby the axial load on each pile resists a substantial portion of the lateral load on said platform structure; and

a working platform framed to the upper ends of said center column and batter columns.

6. A method of constructing an offshore platform structure extending over a selected site on the sea floor, comprising:

transporting to and erecting on said site a central column having a length which is greater than three hundred feet;

transporting to said site at least three batter columns, each batter column having a multi-legged structure consisting of at least three legs, each leg having an

upper end, a lower end, and a length which is considerably greater than the central column;

uprighting each batter column by pivotally securing it above the water surface to the upper end of the central column and by ballasting its lower end, whereby the lower ends of said batter columns are widely spaced apart;

grounding the lower end of each uprighted batter column;

welding above the water surface the upper ends of said batter columns to said center column;

driving piles through the entire length of certain ones of the legs in each batter column to thereby fixedly secure each column to the sea floor, whereby the axial load on each pile resists a substantial portion of the lateral load on said platform structure;

lowering a transition structure having a plurality of legs over the welded upper ends of said columns;

welding the legs of said transition structure to the welded upper ends of said columns; and

framing a working platform onto said transition structure.

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