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(54) **METHOD AND APPARATUS FOR THE OFFSHORE INSTALLATION OF MULTI-TON PACKAGES SUCH AS DECK PACKAGES AND JACKETS**

METHODE UND VORRICHTUNG FÜR DIE OFFSHORE INSTALLATION VON SCHWERLASTEN WIE DEKSTRUKTUREN UND PLATTFORMUNTERBAUTEN

PROCEDE ET APPAREIL POUR L'INSTALLATION OFF-SHORE DE BLOCS DE PLUSIEURS TONNES, TELS QUE DES BLOCS DE PONTS, ET DE TREILLIS

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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to the placement of large multi-ton prefabricated deck packages (e.g. oil and gas platforms, oil rigs) in an offshore environment upon a usually partially submerged jacket that extends between the seabed and the water surface. Even more particularly, the present invention relates to the use of a moving lifting assembly which is preferably barge supported that can place a very large deck package upon an offshore marine jacket foundation without the use of enormous lifting booms such as form a part of derrick barges, offshore cranes, and the like, and wherein opposed short booms are connected with a frame or compressive spreader members that enable use of suspended slings to lift the deck package

2. General Background

[0002] In the offshore oil and gas industry, the search for oil and gas is often conducted in a marine environment. Sometimes the search takes place many miles offshore. Oil and gas well drilling takes place in many hundreds of feet of water depth.

[0003] The problem of drilling oil wells offshore and then producing these wells has been solved in part by the use of enormous fixed or floating platform structures with foundations that are mostly submerged, but usually extending a number of feet above the water surface. Upon this foundation (or "jacket", tension leg platform ("TLP"), or SPAR, etc. as it is called in the art) there is usually placed a very large prefabricated rig or deck platform. The term "deck platform" as used herein should be understood to include any of a large variety of prefabricated structures that are placed on an offshore foundation to form a fixed or floating offshore platform. Thus, a "deck-platform" can include, e.g. a drilling rig, a production platform, a crew quarters, living quarters, or the like.

[0004] As an example of one offshore foundation a supporting jacket is usually a very large multi-chord base formed of multiple sections of structural tubing or pipe that are welded together. Such jackets have been used for a number of years for the purpose of supporting large deck platforms in an offshore environment.

[0005] The jacket or foundation is usually prefabricated on land in a fabrication yard, preferably adjacent to a navigable waterway. The completed jacket can be placed upon a large transport barge so that it can be moved to the drill site where it will be placed upon the ocean floor. As an example, an offshore jacket can be several hundred feet in length. The size of the jacket is of course a function of the depth of water in which the rig will be placed. A 150 m (five hundred (500) foot) water depth at the drill site (or production site) will require a jacket which is approximately 150 m - 170 m (500-550 feet) tall. The jacket is usually partially submerged, with only a small upper portion of the jacket extending slightly above the water surface. An offshore jacket as described and in its position on the seabed can be seen, for example, in the Blight, et al Patent No. 4,252,469 entitled "Method and Apparatus for installing integrated Deck Structure and Rapidly Separating Same from Supporting Barge Means." Specifically, Figures 1, 2 and 3 of the Blight, et al patent show an offshore jacket on the seabed.

[0006] A small upper portion of the jacket extends above the water surface. This exposed portion of the jacket is the portion upon which the "deck platform" is placed and supported by. This upper portion of the jacket is usually equipped with a number of alignment devices which enhance the proper placement of the deck package on the jacket. Such alignment devices are referred to variously as stabbing eyes, sockets, or the like. The use of such alignment devices, sockets, or stabbing eyes can be seen in the Blight, et al Patent Nos. 4,252,468 and 4,252,469 as well as in the Kansan U.S. Patent No. 4,242,011. For purposes of background and reference, the Kansan patent 4,242,011 is incorporated herein by reference.

[0007] Deck platforms or topsides can be extremely large and have correspondingly heavy weights. For example, it is not uncommon for a deck platform such as a drilling rig crew quarters, production platform or the like to be between five hundred and five thousand (500 and 5,000) tons gross weight. Topsides in excess of ten thousand (10,000) tons have been installed, and others that are being planned may weigh as much as thirty thousand (30,000) tons. Such enormous load values present significant problems in the placement of deck platforms on offshore jacket structures. First, the placement is done entirely in a marine environment. While the jacket can be laid on its side and/or floated into position, the platform is not a submersible structure, and must be generally supported in an upright condition above the water surface to prevent water damage to the many components that form a part of the drilling or production platform (such as electrical systems, wall constructions, and other portions that will be inhabited by individuals and used as oil and gas well drilling or production equipment).

[0008] The art has typically used enormous derrick barges for the purpose of setting or placing deck packages on jackets in an offshore environment. These derrick barges are large, rectangular barge structures with a high capacity lifting boom mounted at one end portion of the deck of the barge. The barge, for example might be 90 m - 120 m (three hundred to four hundred (300-400) feet) in length, 15 m - 23 m (fifty to seventy five (50-75) feet) in width, and 7.5 m - 15 m (twenty-five to fifty (25-50) feet) deep. These figures are exemplary.

[0009] A derrick barge might have a lifting capacity of for example, two thousand (2,000) tons. For very large structures such as for example, a five thousand (5,000) ton deck package, two derrick barges can be used, each

supporting one side portion of the deck platform with a multiline lift system supported by an enormous structural boom extending high into the air above the package during the lift.

[0010] The boom simply works in the same way as an anchor lifting boom, namely the loadline raises and/or lowers the package into its proper position upon the jacket. While the use of such derrick barges has been very successful in the placing of offshore deck packages on jackets through the years, such derrick barges are generally limited in their capacity to packages of two thousand (2,000) tons or less. Further, derrick barges of such an enormous capacity are extremely expensive to manufacture and operate. Many thousand of dollars per hour as a cost of using such a device is not uncommon. Although there are five (5) or six (6) derrick barges that can lift in excess of six thousand (6,000) tons, they are extremely costly and limited as to the water depth in which they can operate.

[0011] However, when very large loads of, for example six thousand - ten thousand (6,000-10,000) tons are involved, the limitation of the derrick barge usually prohibits such a placement on an offshore jacket. The topside must then be pieced and finished offshore.

[0012] In U.S. Patent 4,714,382 issued to Jon Khachaturian there is disclosed a method and apparatus for the offshore installation of multi-ton prefabricated deck packages on partially submerged jacket foundations. The Khachaturian patent uses a variable dimensional truss assembly is supported by the barge and forms a load transfer interface between the barge and the deck package. Upper and lower connections form attachments between the truss members and the deck package at upper and lower elevational positions on the deck package. The variable dimension truss includes at least one member of variable length, in the preferred embodiment being a winch powered cable that can be extended and retracted by winding and unwinding the winch. Alternate embodiments include the use of a hydraulic cylinder as an example.

[0013] An earlier patent, U.S. Patent No. 2,598,088 issued to H.A. Wilson entitled "Offshore Platform Structure and Method of Erecting Same" discusses the placement of drilling structure with a barge wherein the legs of the drilling structure are placed while the drilling structure is supported by two barges. The Wilson device does note use truss-like lifting assemblies having variable length portions which are placed generally on opposite sides of the deck package. Rather, Wilson relates to a platform which is floated in place and the support legs are then placed under the floating platform. Thus, in the Wilson reference, an in-place underlying supporting jacket is not contemplated.

[0014] The Natvig, et al U.S. Patent No. 3,977,346 discusses a method of placing a deck structure upon a building site such as a pier. The method includes the preassembly of a deck structure upon a base structure on land so that the deck structure extends outwardly over a body of water. Floating barges are provided for supporting the deck structure outwardly of the building site. The deck structure is then transferred to the supportive base structure by means of barges. The Natvig reference uses two barges which are placed on opposite sides of a platform with pedestal type fixed supports forming a load transfer member between the barges and the platform. However, the fixed pedestal of Natvig is unlike the truss-like lifting arrangement of applicant which include movable portions at least one of which can be of a variable length.

[0015] U.S. Patent No. 4,249,618, issued to Jacques E. Lamy, discloses a method of working an underwater deposit comprising the following stages: a) constructing an positioning a platform structure, equipped before or after positioning with drilling devices and installations, b) executing drilling using these devices and installations, c) constructing and equipping, during stages a) and b), a production bridge fitted with devices and installations required for production, d) transporting the production bridge to, and positioning it on, said platform structure, and e) commencing production from deposit. The drilling bridge may remain in position on the platform structure during stages d) and e) or it may be removed to make way for the production bridge.

[0016] U.S. Patent No. 4,744,697, issued to Anton Coppens, discloses a vessel that is provided for installing or removing a module on or from a support structure erected in a body of water. The vessel is able to suspend the module over the support structure by cranes enabling installation or removal of the module to be accomplished while the module is being suspended

[0017] U.S. Patent No. 5,037,241, issued to Stephen D. Vaughn et al. discloses an improved apparatus for setting a deck structure or other marine superstructure using a barge mounted cantilevered support structure. The cantilevered support structure is attached at one end of a floating vessel. The cantilevered support structure extends past the edge of the vessel and, in one embodiment, includes means for rotating parallel support members about the deck of the floating vessel permitting the cantilevered support structure to be raised and lowered while it remains substantially parallel with the top of the offshore platform enabling the superstructure to engage the top of a previously installed offshore platform in a synchronized manner. Alternatively, this superstructure may be aligned directly over the platform. A cantilevered drilling rig is then aligned over the cantilevered support structure and used to lift the deck structure or marine superstructure, permitting the vessel and cantilevered support structure to move. The drilling rig is then used to lower the marine superstructure onto the top of the previously installed offshore platform. It is known from WO 96/28616 and US 5,609,441 to provide a lifting apparatus including a pair of barges each supporting a plurality of lift booms. The lift booms have cylindrical lifting end portions that axially fit into corresponding cylindrical recesses provided on a package to be lifted.

BRIEF SUMMARY OF THE INVENTION

[0018] The present invention provides an improved method and apparatus for the lifting and/or placement of a multi-ton package such as a deck package, jacket, or sunken vessel. Also the present invention provides an improved method and apparatus for the removal of a multi-ton package from a marine environment, water surface, or ocean floor (i.e., sunken vessel) or from an offshore jacket.

[0019] The present invention discloses an improvement to the variable dimension truss assembly disclosed in U.S. Patent 4,714,382.

[0020] The apparatus includes one or more barges defining a base that supports the large multi-ton load of the deck package.

[0021] According to the invention the truss-like lifting device includes a barge mounted on each side of the deck package to be lifted during operation.

[0022] According to the invention two barges are used respectively, each having at least one truss-like lifting device on its upper deck surface. The truss includes inclined and opposed booms mounted respectively on each barge, and a horizontal chord member of variable length that employs a cable wound upon a winch on each barge so that the cross-sectional dimensions of the truss can be varied by paying out or reeling in cable from the winch.

[0023] The truss forms a load transfer between each barge and the package to be lifted (e.g., deck package, or jacket) and/or placed. Upper and lower connections are formed between the lifting truss and the deck package at respective upper and lower elevational positions,

[0024] Power is provided, preferably in the form of the winch and its cable mounted on each barge for changing the length of the horizontal chord, variable length member of the truss so that elevational position of the deck package with respect to the barge can be varied such as during a lifting or lowering of the package (such as to or from a jacket foundation).

[0025] In the method of the present invention, the multi-ton deck package is first transported on a transport barge to the site where it will eventually assist in the drilling oil and/or production of a well.

[0026] The lifting assembly is attached to the package on generally opposite sides of the package and at upper and lower positions.

[0027] One element of the truss-like lifting assembly preferably includes a movable horizontal chord portion which has a variable length. In the preferred embodiment, the movable portion is a winch powered cable extending from each winch to a padeye connection on the package (e.g., using sheaves) to be lifted or lowered, wherein the cable can be extended or retracted between the lift barge and the deck package being lifted or lowered.

[0028] According to the invention two lift barges support respectively first and second pluralities of truss-like lifting assemblies which in combination with the package form an overall truss arrangement. That is, the deck package itself can form a portion of the truss during the lift (typically carrying tension), and may carry both compression and tension loads.

[0029] The truss-like lifting assemblies have multiple booms (e.g., four) on each barge that are connected at their upper end portions to the package using a boom lifting end portion that elevates to engage a receptacle on the package. An improved connection between the booms and package is provided that uses a specially configured lifting end portion on each boom and a corresponding number receptacles on the deck package (e.g., welded thereto).

[0030] The lifting end portions support the package and can elevate it above the surface of any transport barge so that the transport barge can be removed as a support for packages such as jackets or deck packages. This allows the package to be placed vertically above a jacket foundation and aligned with the foundation so that the deck package can be placed upon the foundation by lowering. In the case of a jacket, the transport barge can be removed so that the jacket can be lowered into the water and floated prior to installation.

[0031] The present invention allows a dimensional change in the cross-sectional configuration of the truss with respect to a vertical cross section of the truss and provides a means of raising and lowering the selected package.

BRIEF DESCRIPTION OF THE DRAWINGS

[0032] For a further understanding of the nature objects, and advantages of the present invention, reference should be had to the following detailed description, read in conjunction with the following drawings, wherein like reference numerals denote like elements and wherein:

FIGURE 1 is a perspective view of the preferred embodiment of the apparatus of the present invention;

FIGURE 2 is a partial perspective view of the preferred embodiment of the apparatus of the present invention;

FIGURE 2A is a partial sectional elevational view of the preferred embodiment of the apparatus of the present invention;

FIGURE 3 is a perspective fragmentary view of the preferred embodiment of the apparatus of the present invention illustrating the lifting end portion thereof;

FIGURE 4 is a sectional view taken along lines 4-4 of Figure 3;

FIGURE 5 is a fragmentary perspective view of the preferred embodiment of the apparatus of the present invention illustrating the receptacle portion thereof;

FIGURE 6 is a partial sectional elevational view of preferred embodiment of the apparatus of the present invention illustrating engagement of the

boom lifting end portion and receptacle such as during lifting of a heavy deck package;

FIGURE 7 is a fragmentary perspective view of the preferred embodiment of the apparatus of the present invention illustrating the bridle plate and variable length tensile member portions thereof; and

FIGURE 8 is a perspective fragmentary view of the preferred embodiment of the apparatus of the present invention illustrating the boom and heel pin padeye portions thereof.

DETAILED DESCRIPTION OF THE INVENTION

[0033] Figures 1 and 2 show generally the preferred embodiment of the apparatus of the present invention designated generally by the numeral 10 in Figure 1. Lifting apparatus 10 utilizes a pair of spaced apart marine barges 11, 12 each having a respective deck 13, 14. The barges 11, 12 float on water surface 15 adjacent an underwater jacket 16 having its uppermost portion exposed in the form of a plurality of vertical columns 18 as shown in Figures 1 and 2.

[0034] The use of underwater jackets 16 for the purpose of supporting any number of offshore structures is well known in the art. Typically, a drilling platform, production platform, machine shop, storage facility, or like offshore structure is manufactured on land as a heavy deck package and then transported to a selected offshore marine location for placement on a jacket 16. The jacket is also usually manufactured on land as a one-piece unit, towed to a selected site on a transport vessel such as a barge, and then transferred from the barge to the marine environment. The lower end portion of the jacket engages the ocean floor or seabed with the upper vertical columns 18 extending above the water surface 15 as shown in Figures 1 and 2. This procedure for placing jackets so that they can support a heavy deck package 17 in a marine environment is well known in the art.

[0035] In the past, placement of such deck package 17 upon the vertical columns 18 of a jacket 16 has been accomplished using large lifting devices known as derrick barges, a huge barge having a crane thereon with a multiton lifting capability.

[0036] In my prior U.S. Patent No. 4,714,382, there is provided a variable truss arrangement that uses two spaced apart barges for placing a deck package on a jacket. The Khachaturian '382 patent uses a variable dimensional truss assembly that is supported by the barge and forms a load transfer interface between the barge and the deck package Upper and lower connections form attachments between the truss members and the deck package at upper and lower elevational positions on the deck package. The upper connection in the '382 patent is a pinned connection. The variable dimension truss of the '382 patent includes at least one member of variable length, in the preferred embodiment being a winch powered cable that can be extended and retracted by winding and unwinding the winch.

[0037] The present application relates to improvements to the subject matter of prior U.S. Patent No. 4,714,382.

In Figure 2, the deck package 17 is spaced above the vertical columns 18 of jacket 16. In order to place the deck package 17 on the jacket 16, the lifting apparatus 10 of the present invention slowly lowers the deck package 17 to the jacket 16 until lower end portions 19 of the deck package 17 engage and form a connection with the vertical columns 18 of the jacket 16.

[0038] Deck packages 17 are usually constructed of a plurality of welded steel pipe members including at least some of the members that are vertical. In Figures 1 and 2, a plurality of vertical members 20 are shown, each having a lower end portion 19 that connects with the vertical columns 18 of jacket 16.

[0039] Each of the barges 11, 12 carries a plurality of booms 21, 22. The first barge 11 has four booms 21 in Figures 1 and 2. Likewise, the second barge 12 has four correspondingly positioned booms 22. In Figures 1 and 2, the booms 21, 22 are equally spaced along the deck 13 or 14 of the corresponding barge 11 or 12 and corresponding to the position and horizontal spacing of the vertical members 20 of package 17. Further, each of the booms 21, 22 is supported upon a load spreader platform 23 or 24.. The load spreader platform 23, 24 can be a combination of static load spreader platforms 23 and movable load spreader platforms 24. For example, if each barge 11,12 has three booms, one platform 24 can be movable. If four booms, two or three platforms 24 can be movable.

[0040] The static load spreader platforms 23 are rigidly welded to and connected to the deck 13 of barge 11, or to the deck 14 of barge 12. Base plate 27 is rigidly welded to platform 23. Each load spreader platform 23, 24 has a pair of spaced apart boom heel pin padeyes 25, 26 mounted on structural base plate 27. The base plate 27 can be welded for example to its load spreader platform 23 if a "fixed" platform 23 is desired.

[0041] Each load spreader platform 23, 24 can be constructed of a plurality of perimeter beams 28 and a plurality of internal beams 29 with plate 27 mounted thereon.

[0042] The booms 21, 22 can be constructed of a pair of diagonally extending compression members 30 that form an acute angle. In Figures 1-2 and 8, each compression member 30 has a pair of spaced apart end caps 31 attached to each of its end portions. This is preferably a removable connection so that compression members 30 of differing lengths can be used for different lifts and the end caps 31 can be reused. Cross bar 30A spans between connecting members 35 as shown in Figure 1, its ends being connected to members 35 using pinned connections with pins 39.

[0043] Each end cap 31 is preferably comprised of a cylindrical sleeve 32 and a plurality of plate members 33 as shown in Figure 8. Each plate member 33 has an opening 34 that receives a pin 39. Connecting members 35 form a pinned connection with end cap 31 as shown

in Figures 1, 2, and 8. The connecting member 35 includes a plurality of plates 36 that are parallel and a second plurality of plates 37 that are perpendicularly positioned with respect to the first plates 36 as shown in Figure 8.

[0044] Each of the plates 37 has an opening 38 for accepting pin 39 when the connecting member 35 is attached to end cap 31 as shown in Figures 2 and 8. The connecting member 35 has openings 40 in each of the plates 36. This enables the plates 36 to be attached with a pinned connection to the heel pin padeyes 25, 26 as shown in Figures 2 and 8.

[0045] A variable length tensile member 42 extends between heel pin padeyes 25, 26 and a vertical member 20 of package 17. As shown in Figure 1, this centers a variable length tensile member 42 and a boom 21 or 22 on each vertical member 20. As shown in Figure 1, there are four spaced apart vertical members 20, each having a respective boom 21 or 22 connected thereto and each having a variable length tensile member 42 extending from the barge 11 or 12 to the vertical member 20.

[0046] Each variable length tensile member 42 includes a cable 43 wound upon a pair of sheaves 44, 45 as shown in Figures 2, 2A, and 7. The sheave 45 is constructed of a pair of plates 46 that are spaced apart so that padeye 50 fits in between the plates 46. A pinned connection can be formed between padeye 50 and plates 46 of sheave 44 using pin 52 that is inserted through the openings 47 of plate 46 and the opening 51 of padeye 50.

[0047] The padeye 50 is structurally connected (welded, for example) to bridle plate 48. The bridle plate 48 includes a structural plate body 49 having a pair of plates 53 and 54 at its end portions respectively as shown in Figure 7. Each of the plates 53, 54 has openings 55 through which pin 41 can be inserted when the plates 53 or 54 are connected to respective heel pin padeyes 25, 26, as shown in Figures 2 and 7 e.g., with a load cell.

[0048] Each boom 21, 22 provides a lifting end portion 56 that is shown particularly in Figures 2 and 3-6. The lifting end portion 56 of each boom 21, 22 forms a connection with a receptacle 70 that is mounted on vertical member 20 as shown in Figures 1, 2, 5, and 6. The lifting end portion 56 is constructed of a plurality of spaced apart parallel plates 57. Each plate 57 has an opening 58. Gaps 59, 60 are provided for receiving plates 33 of an end cap 31. This connection can be seen in Figures 2 and 6. The lifting end portion 56 provides a pair of inner plates 61 that can be parallel to one another and a pair of outer plates 62 that can form an acute angle.

[0049] Roller 63 is positioned in openings formed through the plates 61 as shown in Figures 3 and 4. Each roller 63 is preferably of an hour glass shape, having a narrow or neck portion 64 and a pair of cylindrically-shaped end portions 65. Arrow 66 in Figure 4 illustrates that the roller 63 can move side to side for adjustment purposes when the booms 21 and 22 are connected to the receptacle 70 and thus to the deck package 17. In order that roller 63 be allowed to move from side-to-side, there are provided gaps 68 on each side of the roller 63 as shown in Figure 4. Stop plates 67 are shaped to limit movement of the roller 63 as it moves from one side to the other as shown by arrow 66.

[0050] Lifting end portion 56 can be connected to the selected boom 21 or 22 with pin connections 69 as shown in Figure 6. The openings 58 in plates 57 receive a pin therethrough, that pin also passing through the openings 34 in plates 33 of end cap 31.

[0051] Receptacle 70 is shown more particularly in Figures 2, 5, and 6. Receptacle 70 includes a curved plate 71 that is attached to vertical member 20 of deck package 17. being structurally affixed thereto by welding, for example.

[0052] Receptacle 70 is formed of a plurality of flat plates including a center plate 72 and a pair of smaller side plates 73, 74, as shown in Figure 5. Recess 75 receives roller 63 upon engagement of lifting end portion 56 and receptacle 70 as shown in Figure 6. The neck 64 portion of roller 63 is of a reduced diameter and is shaped to engage inclined edge 76 of plate 72, then travel upwardly along inclined edge 76 until the neck 64 of roller 63 fully nests in recess 75 of receptacle 70. This fully engaged position of lifting end portion 56 and receptacle 70 is shown in Figure 2.

[0053] The receptacle 70 is formed of a pair of vertical sections 77 and 78, and a transversely extending section 79. The section 79 can have a flat upper surface that receives reinforcing plate 80, that can be a horizontally extending plate. In Figure 6, further reinforcement of the attachment of receptacle 70 to deck package 17 is seen. In Figure 6, the horizontal plate 80 is rigidly affixed to the bottom of a horizontal beam 81 by welding, for example. This enables the loads transmitted from lifting end portion 56 to receptacle 70 to be transferred to the deck package 17 at vertical member 20 and at horizontal beam 81.

[0054] In Figures 2 and 6, arrows 82 illustrate the upward movement of lifting end portion 56 that is used to nests roller 63 in recess 75 of receptacle 70. In Figure 2, arrow 83 illustrates the upward and downward movement of lifting end portion 56 of booms 21 and 22 to either engage or disengage the boom 21 or 22 from the deck package 17.

[0055] In order to lower the deck package 17, the cable 43 is unwound using a winch that is carried on the surface of deck 13 or 14 of barge 11 or 12. This lengthens the distance between heel pin padeyes 25, 26 and the deck package 17. By lengthening the distance between the padeyes 25 and 26 of the respective barges 11 and 12, the variable length tensile member 42 is elongated so that the booms 21 and 22 rotate downwardly about their heel pin padeyes 25, 26 creating a smaller and smaller angle between the compression members 30 and the barge decks 13, 14.

[0056] This procedure is reversed in order to lift a deck package 17 upwardly with respect to water surface 15 and jacket 16. In such a lifting situation, the winch mounted on the deck 13 or 14 of the barges 11 and 12 winds

the cable 43 to shorten the distance between sheaves 44, 45. This likewise shortens the distance between the heel pin padeyes 25 and 26 on barge 11 with respect to the heel pin padeyes 25 and 26 on barge 12. The effect is to elevate the lifting end portion 56 and to increase the angle between the compression members 30 and the barge decks 13, 14.

[0057] In such a lifting situation, tension member 85 can be used in between opposed vertical members 20 as shown in Figures 1 and 2. Padeyes 87, 88 can be welded, for example, to vertical member 20 for forming an attachment between tension member 85 and the vertical column 20. Likewise, a tension member 86 can be placed in between padeye 87 and sheave 45 as shown in Figure 2. Thus, a continuous tensile member is formed in between the heel pin padeyes 25, 26 of barge 11 for each boom 21, and the corresponding heel pin padeyes 25, 26 on barge 12 for each of its booms 22.

[0058] During a lifting of a package 17, hook-up is first accomplished. The booms 21, 22 are positioned so that the lifting end portion 56 of each boom 21, 22 is positioned below the corresponding receptacle 70 on package 17.

[0059] An operator or operators then begin hook-up by attaching the cables 43 and sheaves 44, 45 to the corresponding vertical members 20, configured as shown in Figures 1, 2, and 2A. The winch W1 then shortens cable 43 pulling barges 11, 12 toward package 17. In such a situation, the lifting end portion 56 will engage vertical member 20 at a position below receptacle 70. The plates 62 of lifting end portion 56 will engage vertical member 20 and end portion 56 then slides upwardly on the vertical member 20 as cable 43 is shortened until end portion 56 reaches receptacle 70. Continued shortening of the cable 43 increases the angle of inclination of each boom 21, 22 relative to the deck 13, 14 respectively of barges 11, 12 until lifting end portion 56 registers completely in recess 75 of receptacle 70. Then, continued shortening of the cable 43 associated with each boom 21, 22 effects a lifting of the padeyes 17 as the boom 21, 22 angle of inclination relative to the barge 11, 12 deck 13, 14 further increases. The booms 21, 22 are simultaneously elevated and inclined continuously so that each of the booms 21, 22 shares a substantially equal part of the load. This can be monitored using load cell link 89 that can be used to monitor the tension between bridle plates 48 and the pinned connection that joins padeyes 25, 26 and connecting members 35.

[0060] A second winch W2 can be rigged with a wound line or cable for pivoting each boom 21, 22 relative to the deck 13, 14 of barge 11, 12 respectively (see Figure 2A) such as may be required during an initial positioning of the booms 21, 22 before a hook-up.

[0061] The following table lists the parts numbers and parts descriptions as used herein and in the drawings attached hereto.

PARTS LIST

Part Number	Description
10	lifting apparatus
11	barge
12	barge
13	deck
14	deck
15	water surface
16	jacket
17	deck package
18	vertical column
19	lower end portion
20	vertical member
21	boom
22	boom
23	static load spreader platform
24	movable load spreader platform
25	boom heel pin padeye
26	boom heel pin padeye
27	floating heel pin base plate
28	perimeter beam
29	internal beam
30	compression member
30a	cross bar
31	end cap
32	cylindrical sleeve
33	plate
34	opening
35	connecting member
36	plate
37	plate
38	opening
39	pin
40	opening
41	pin
42	variable length tensile member
43	cable
44	sheave
45	sheave
46	plate
47	opening
48	bridle plate
49	body
50	padeye
51	opening
52	pin
53	plate
54	plate
55	opening
56	lifting end portion
57	plate
58	opening

(continued)

Part Number	Description
59	gap
60	gap
61	inner plate
62	outer plate
63	roller (hourglass shape)
64	neck
65	cylindrical end
66	arrow
67	stop plate
68	gap
69	pinned connection
70	receptable
71	curved plate
72	plate
73	plate
74	plate
75	recess
76	inclined surface
77	vertical section
78	vertical section
79	transverse section
80	horizontal plate
81	horizontal beam
82	arrow
83	arrow
84	arrow
85	tension member
86	tension member
87	padeye
88	padeye
W1	winch
W2	winch

Claims

1. A lifting apparatus (10) for lifting a multi-ton package (17) such as a deck package, sunken vessel, or offshore jacket, comprising:

a) a pair of barges (11,12), each defining a base (13,14) that can support a large multi-ton load;
b) a lifting assembly supported respectively by the barges (11,12) and positionable about the periphery of the package (17) for forming a load transfer between the barges (11,12) and the package (17) to be lifted;
c) each said lifting assembly including at least one diagonally extending lift boom (21,22) on each barge (11,12), each lift boom (21,22) having a lower end attached to a barge (11,12) and an upper end that can be attached to the deck package (17);
d) lower connections (42) for forming attachments between each barge (11,12) and the package (17);
e) each boom (21,22) having a free end with a lifting end portion (56);
f) a receptacle (70) attached to the package (17) that is adapted to receive the boom lifting end portion (56), the receptacle (70) having first and second sides (73,74) with a recess (75) formed therein;
g) wherein the lifting end portion (56) is adapted to engage the receptacle (70) as the angle of inclination of the boom (21,22) is gradually increased; and
h) powered means (W1,W2) for raising and lowering the combination of booms (21,22) and the supported package (17);

characterised in that the lifting end portion (56) of the boom (21,22), when engaged with the receptacle (70) and fully nested in the recess (75), laterally extends past said first and second sides (73,74).

2. The lifting apparatus (10) of claim 1 further comprising at least one lifting assembly member (42) of variable length that defines said lower connections.

3. The lifting apparatus (10) of claim 2 wherein there are two opposing booms (21,22) that are each pinned to a different one of the barges (11,12) and which are angularly disposed with respect to each other during use, wherein each boom (21,22) includes a compression member (30) and end caps (31) that form a detachable interface with the compression member (30).

4. The lifting apparatus (10) of claim 1 further comprising a flexible cable (43) that extends between each barge (11,12) and the package (17).

5. The lifting, apparatus (10) of claim 1 wherein a portion (63) of the lifting end portion (56) is adapted to slide side to side for effecting adjustment during connection of a lifting end portion (56) to its receptacle (70).

6. The lifting apparatus (10) of claim 5 further comprising a wound cable (43) that comprises part of the power means (W1) extending between a pair of sheaves (44,45), wherein the distance between the sheaves (44,45) can be lengthened or shortened.

7. The lifting apparatus (10) of claim 1 wherein each lifting boom (21,22) is an "A" frame shaped boom that comprises a pair of longitudinal boom members (21,22) that form an acute angle, a pair of lifting end portions (56) that form a detachable interface be-

tween each longitudinal boom member (21,22) and a barge (11,12), the free end portion (56) having a structural member and a pair of end caps (31) that form a detachable connection between the longitudinal boom members (21,22) and the lifting end portion (56).

8. A method for the offshore lifting a multi-ton package such as a deck package (17), jacket or submerged vessel, comprising the steps of:

a) transporting a lifting assembly (10) to a desired site having the deck package (17), jacket or submerged vessel;
b) attaching the lifting assembly (10) to the package (17) at multiple elevational positions on the package (17), including upper and lower positions that are at least on generally opposite sides of the package (17);
c) wherein the lifting assembly (10) includes opposed floating barges (11,12) having diagonally extending lifting booms (21,22) thereon connected at their upper ends with a lifting end portion (56) to a receptacle (70) on the deck package (17);
d) structurally supporting each of the lifting booms (21,22) at the lower end portion thereof with one of the barges (11,12), each boom (21,22) being pivotally attached to its barge (11,12);
e) wherein the package (17) has receptacles (70) thereon, each with first and second sides (73,74) and a downwardly oriented recess (75) that receives the lifting end portion (56) of a boom (21,22) as the boom inclination increases relative to a deck (13,14) of the barge (11,12); and
f) elevating the package (17) by changing a length of a horizontal chord (42) so that the lifting end portion (56) gradually elevates to engage the downwardly oriented recess (75);

characterised in that the lifting end portion (56) of the boom (21,22), when engaged with the receptacle (70), extends laterally past said first and second sides (73,74).

9. The method of claim 8, wherein the lifting end portion (56) includes a roller (63).

10. The method of claim 8 or 9, wherein one portion of the lifting assembly (10) includes a plurality of compression carrying diagonally extending lift booms (30), each with opposing end portions and a plurality of end caps (31) that removably attach to the end portions.

11. The method of any one of claims 8 to 10, wherein each barge (11,12) has a winch (W1) structurally mounted thereon and a lower connection (42) formed with the deck package (17) includes a flexible cable (43) wound upon sheaves (44,45) and extending between the winch (W1) and the deck package (17).

12. The method of claim 11, wherein the lifting assembly (10) includes a plurality of non-extensible diagonally extending lift booms (21,22), each removably connecting at its ends to an end cap (31).

Patentansprüche

1. Hubvorrichtung (10) zum Heben einer tonnenschweren Baueinheit (17), wie zum Beispiel einer Baueinheit für ein Deck, eines tiefliegenden Wasserfahrzeugs oder eines Offshore-Mantels, mit:

a) einem Paar von Lastkähnen (11, 12), die jeweils eine Basis (13, 14) definieren, die eine große tonnenschwere Last tragen kann;
b) einer Hubeinrichtung, die jeweils durch die Lastkähne (11, 12) gestützt wird und um den Rand der Baueinheit (17) angeordnet werden kann, um eine Lastübertragung zwischen den Lastkähnen (11, 12) und der zu hebenden Baueinheit (17) zu bilden;
c) wobei jede Hubeinrichtung zumindest einen sich diagonal erstreckenden Hubausleger (21, 22) bei jedem Lastkahn (11, 12) umfasst, wobei jeder Hubausleger (21, 22) ein unteres, an einen Lastkahn (11, 12) angebrachtes Ende und ein oberes Ende aufweist, das an der Baueinheit (17) für ein Deck angebracht werden kann;
d) unteren Verbindungen (42) zum Bilden von Befestigungen zwischen jedem Lastkahn (11, 12) und der Baueinheit (17);
e) wobei jeder Ausleger (21, 22) bei einem Hubendteil (56) ein freies Ende aufweist;
f) einer Aufnahme (70), die an der Baueinheit (17) angebracht ist, welche zum Aufnehmen des Auslegerhubendteils (56) angepasst ist, wobei die Aufnahme (70) eine erste Seite (73) und eine zweite Seite (74) mit einer darin ausgebildeten Aussparung (75) aufweist;
g) wobei das Hubendteil (56) angepasst ist, in die Aufnahme (70) einzugreifen, wenn der Neigungswinkel des Auslegers (21, 22) schrittweise erhöht wird; und
h) angetriebenen Mitteln (W1, W2) zum Heben und Senken der Kombination aus Auslegern (21, 22) und der gestützten Baueinheit (17);

dadurch gekennzeichnet, dass sich das Hubendteil (56) des Auslegers (21, 22), wenn es mit der Aufnahme (70) in Eingriff ist und in der Aussparung (75)

vollständig eingenistet ist, seitlich an der ersten Seite (73) und der zweiten Seite (74) vorbei erstreckt.

2. Hubvorrichtung (10) nach Anspruch 1, die des Weiteren zumindest ein Hubeinrichtungsglied (42) mit variabler Länge aufweist, das die unteren Verbindungen definiert.

3. Hubvorrichtung (10) nach Anspruch 2, wobei es zwei sich gegenüberliegende Ausleger (21, 22) gibt, die jeweils mit einem anderen Lastkahn der Lastkähne (11, 12) verstiftet sind und die während einer Verwendung mit einem Winkel relativ zueinander angeordnet sind, wobei jeder Ausleger (21, 22) ein Kompressionsglied (30) und Endkappen (31) umfasst, die eine abtrennbare Schnittstelle mit dem Kompressionsglied (30) bilden.

4. Hubvorrichtung (10) nach Anspruch 1, die des Weiteren ein flexibles Seil (43) aufweist, welches sich zwischen jedem Lastkahn (11, 12) und der Baueinheit (17) erstreckt.

5. Hubvorrichtung (10) nach Anspruch 1, wobei ein Teil (63) des Hubendteils (56) angepasst ist, um von einer Seite zur anderen Seite zu gleiten, damit eine Einstellung während einer Verbindung des Hubendteils (56) mit seiner Aufnahme (70) bewirkt wird.

6. Hubvorrichtung (10) nach Anspruch 5, die des Weiteren ein verdrilltes Seil (43) aufweist, das einen Teil der angetriebenen Mittel (W1) darstellt und sich zwischen einem Paar aus Seilscheiben (44, 45) erstreckt, wobei die Entfernung zwischen den Seilscheiben (44, 45) verlängert oder verkürzt werden kann.

7. Hubvorrichtung (10) nach Anspruch 1, wobei jeder Hubausleger (21, 22) ein Ausleger mit einem "A"-förmigen Rahmen ist, der ein Paar Längsauslegerglieder (21, 22), die einen spitzen Winkel bilden, und ein Paar Hubendteile (56) aufweist, die eine abtrennbare Schnittstelle zwischen jedem Längsauslegerglied (21, 22) und einem Lastkahn (11, 12) bilden, wobei das freie Endteil (56) ein strukturelles Glied und ein Paar Endkappen (31) aufweist, die eine abtrennbare Verbindung zwischen den Längsauslegegliedem (21, 22) und dem Hubendteil (56) bilden.

8. Verfahren für das Offshore-Heben einer tonnenschweren Baueinheit (17), wie zum Beispiel einer Baueinheit für ein Deck, eines Mantels oder eines überfluteten Wasserfahrzeugs, dass die Schritte aufweist:

a) Transportieren einer Hubeinrichtung (10) an eine gewünschte Stelle, die die Baueinheit (17) für ein Deck, den Mantel oder das überflutete Wasserfahrzeug aufweist;
b) Anbringen der Hubeinrichtung (10) an der Baueinheit (17) an mehreren Höhenpositionen an der Baueinheit (17), einschließlich einer oberen und unteren Position, die zumindest allgemein auf gegenüberliegenden Seiten der Baueinheit (17) liegen;
c) wobei die Hubeinrichtung (10) sich gegenüberliegende, schwimmende Lastkähne (11, 12) mit sich diagonal erstreckenden Hubauslegern (21, 22) darauf umfasst, die an ihren oberen Enden mit einem Hubendteil (56) mit einer Aufnahme (70) an der Baueinheit (17) für ein Deck verbunden sind;
d) strukturelles Stützen jedes Hubauslegers (21, 22), bei dem unteren Endteil davon, mit einem der Lastkähne (11, 12), wobei jeder Ausleger (21, 22) verschwenkbar an seinem Lastkahn (11, 12) angebracht ist;
e) wobei die Baueinheit (17) daran Aufnahmen (70) aufweist, wobei jede eine erste Seite (73) und eine zweite Seite (74) und eine nach unten orientierte Aussparung (75) aufweist, die das Hubendteil (56) eines Auslegers (21, 22) aufnimmt, wenn sich die Auslegerneigung relativ zu einem Deck (13, 14) des Lastkahns (11, 12) erhöht; und
f) Anheben der Baueinheit (17) durch Ändern einer Länge einer horizontalen Sehne (42) derart, dass sich das Hubendteil (56) schrittweise hebt, um in Eingriff mit der nach unten orientierten Aussparung (75) zu kommen,

dadurch gekennzeichnet, dass sich das Hubendteil (56) des Auslegers (21, 22), wenn es sich im Eingriff mit der Aufnahme (70) befindet, an der ersten Seite (73) und der zweiten Seite (74) vorbei erstreckt.

9. Verfahren nach Anspruch 8, wobei das Hubendteil (56) eine Rolle (63) umfasst.

10. Verfahren nach Anspruch 8 oder 9, wobei ein Teil der Hubeinrichtung (10) eine Vielzahl von sich diagonal erstreckenden, kompressionstragenden Hubauslegern (30) umfasst, wobei jeder sich gegenüberliegende Endteile und eine Vielzahl von Endkappen (31) aufweist, die entfernbar an den Endteilen angebracht sind.

11. Verfahren nach einem der Ansprüche 8 bis 10, wobei jeder Lastkahn (11, 12) eine Winde (W1) aufweist, die strukturell daran befestigt ist, und wobei eine mit der Baueinheit (17) für ein Deck ausgebildete, untere Verbindung (42) ein flexibles Seil (43) umfasst, welches um Seilscheiben (44, 45) gewickelt ist und sich zwischen der Winde (W1) und der Baueinheit (17) für ein Deck erstreckt.

12. Verfahren nach Anspruch 11, wobei die Hubeinrichtung (10) eine Vielzahl von nicht verlängerbaren, sich diagonal erstreckenden Hubauslegern (21, 22) umfasst, die jeweils an ihren Enden entfernbar mit einer Endkappe (31) verbunden sind.

Revendications

1. Appareil de levage (10) pour le levage d'un bloc de plusieurs tonnes (17) tel qu'un bloc de pont, navire, ou tubage offshore, comprenant :

a) une paire de barges (11,12) chacune définissant une plate-forme (13,14) pouvant supporter un grand chargement de plusieurs tonnes ;
b) un assemblage de levage supporté respectivement par les barges (11,12) et positionnable autour de la périphérie du bloc (17) pour former un transfert du chargement entre les barges (11,12) et le bloc (17) destiné à être levé ;
c) chaque assemblage de levage incluant au moins une flèche de levage (21,22) s'étendant de manière diagonale, sur chaque barge (11,12), chaque flèche de levage (21,22) ayant une extrémité inférieure attachée à une barge (11,12) et une extrémité supérieure pouvant être attachée au bloc de pont (17) ;
d) des connexions inférieures (42) pour former des attachements entre chaque barge (11, 12) et le bloc (17) ;
e) chaque flèche (21,22) ayant une extrémité libre avec une partie d'extrémité de levage (56) ;
f) un réceptacle (70) attaché à le bloc (17) qui est adapté à recevoir la partie d'extrémité (56) de la flèche de levage, le réceptacle (70) ayant un premier et un second côtés (73,74) avec un renfoncement (75) formé dans le réceptacle;
g) où la partie d'extrémité de levage (56) est adaptée pour engager le réceptacle (70) à mesure que l'angle d'inclinaison de la flèche (21,22) est progressivement augmenté ; et
h) des moyens de puissance (W1, W2) pour lever et abaisser la combinaison de flèche (21,22) et le bloc supporté (17) ;

caractérisé en ce que la partie d'extrémité de levage (56) de la flèche (21,22), quand elle est engagée dans le réceptacle (70) et est complètement logée dans le renfoncement (75), s'étend latéralement après lesdits premier et second côtés (73,74).

2. Appareil de levage (10) selon la revendication 1, comportant en outre au moins un membre de l'assemblage de levage (42) de longueur variable qui définit lesdites connexions inférieures.

3. Appareil de levage (10) selon la revendication 2, où deux flèches opposées (21,22) qui sont chacune tourillonnées sur une des différentes barges (11,12) et qui sont disposées de manière inclinée l'une par rapport à l'autre lors de l'utilisation, où chaque flèche (21,22) comprend un membre de compression (30) et des capuchons d'extrémité (31) qui forment une interface détachable avec le membre de compression (30)

4. Appareil de levage (10) selon la revendication 1, comportant en outre un câble flexible (43) qui s'étend entre chaque barge (11,12) et le bloc (17).

5. Appareil de levage (10) selon la revendication 1, où une partie (63) de la partie d'extrémité de levage (56) est adaptée à se déplacer d'un côté à l'autre pour effectuer l'ajustement pendant la connexion d'une partie d'extrémité de levage (56) à son réceptacle (70).

6. Appareil de levage (10) selon la revendication 5, comportant en outre un câble à enroulement (43) comprenant une partie des moyens de puissance (W1) s'étendant entre une paire de poulies (44, 45), où la distance entre les poulies (44,45) peut être raccourcie ou allongée.

7. Appareil de levage (10) selon la revendication 1, où chaque flèche de levage (21,22) est en forme de « A » qui comporte une paire de membres de flèche longitudinale (21,22) qui forme un angle aigu, une paire de parties d'extrémité de levage (56) qui forme une interface détachable entre chaque membre de flèche longitudinale (21,22) et une barge (11,12) les parties d'extrémité libre (56) ayant un membre de structure et une paire de capuchons d'extrémité (31) qui forme une connexion détachable entre les membres de flèche longitudinale (21,22) et la partie d'extrémité de levage (56).

8. Procédé pour le levage offshore d'un bloc de plusieurs tonnes tel qu'un bloc de pont (17), tubage ou navire, comprenant les étapes :

a) transporter l'assemblage de levage (10) en un site souhaité ayant le bloc de pont (17), tubage ou navire ;
b) attacher l'assemblage de levage (10) au bloc (17) en des positions en élévation multiple sur le bloc (17), incluant des positions supérieures et inférieures qui sont au moins sur des côtés opposés de manière générale de le bloc (17) ;
c) où l'assemblage de levage (10) inclut des barges de flottaison (11,12) opposées ayant des flèches de levage (21,22) s'étendant de manière diagonale sur celle-ci attachées à leurs extrémités supérieures avec une partie d'extrémité de levage (56) à un réceptacle (70) sur le bloc de

pont (17) ;
d) supporter de manière structurelle chacune des flèches de levage (21,22) à la partie d'extrémité inférieure de celle-ci avec une des barges (11,12), chaque flèche (21,22) étant attachée en pivotement sur sa barge (11,12) ;
e) où le bloc (17) possède des réceptacles (70) sur celui-ci, chacun avec un premier et second côtés (73,74) et une cavité orientée de haut en bas (75) qui reçoit la partie d'extrémité de levage (56) d'une flèche (21,22) à mesure que l'inclinaison de la flèche augmente par rapport à une plate-forme (13,14) d'une barge (11,12); et
f) élever le bloc (17) par un changement d'une longueur d'une corde horizontale de façon que la partie d'extrémité de levage (56) s'élève progressivement pour engager la cavité orientée de haut en bas (75) ;

caractérisé en ce que dans la partie d'extrémité de levage (56) de la flèche (21,22), une fois engagée dans le réceptacle (70), s'étend latéralement après lesdits premier et second côtés (73,74).

9. Procédé selon la revendication 8, où la partie d'extrémité de levage (56) inclut un rouleau (63).

10. Procédé selon la revendication 8 ou 9, où une partie de l'assemblage de levage (10) comprend une pluralité de flèches de levage (30) se prolongeant de manière diagonale et de portage en compression, chacune avec des parties d'extrémités opposées et une pluralité de capuchons d'extrémité (31) qui fixe de manière détachable les parties d'extrémité.

11. Procédé selon l'une des revendications 8 à 10, où chaque barge (11,12) possède un enrouleur (W1) monté structurellement sur celle-ci et une connexion inférieure (42) formée avec le bloc de pont (17) inclus un câble flexible (43) enroulé sur des poulies (44,45) et s'étendant entre l'enrouleur (W1) et le bloc de pont (17).

12. Procédé selon la revendication 11, où l'assemblage de levage (10) inclut une pluralité de flèches de levage (21,22) s'étendant de manière diagonale non extensible, chacune étant reliée de manière détachable à ses extrémités aux capuchons d'extrémité (31).

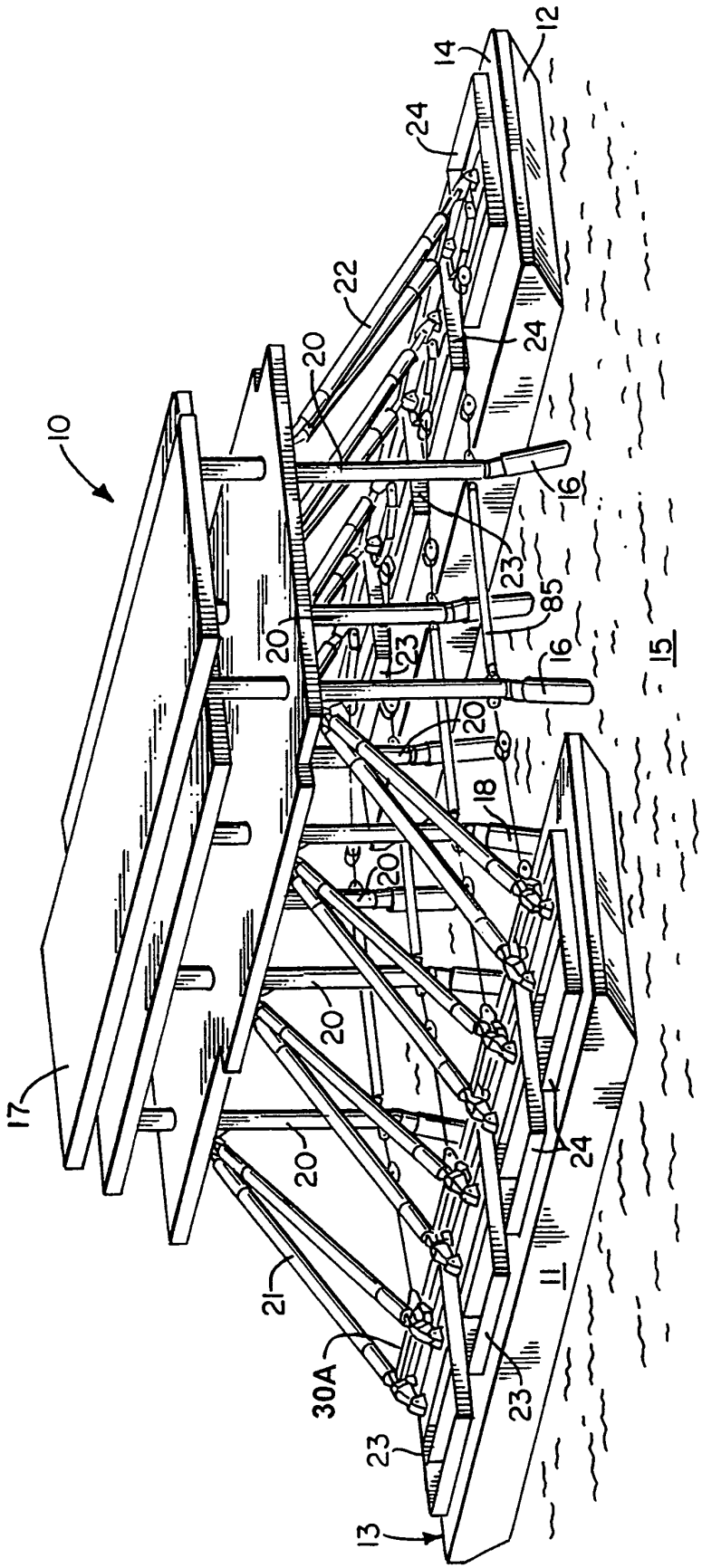

FIG. 1.

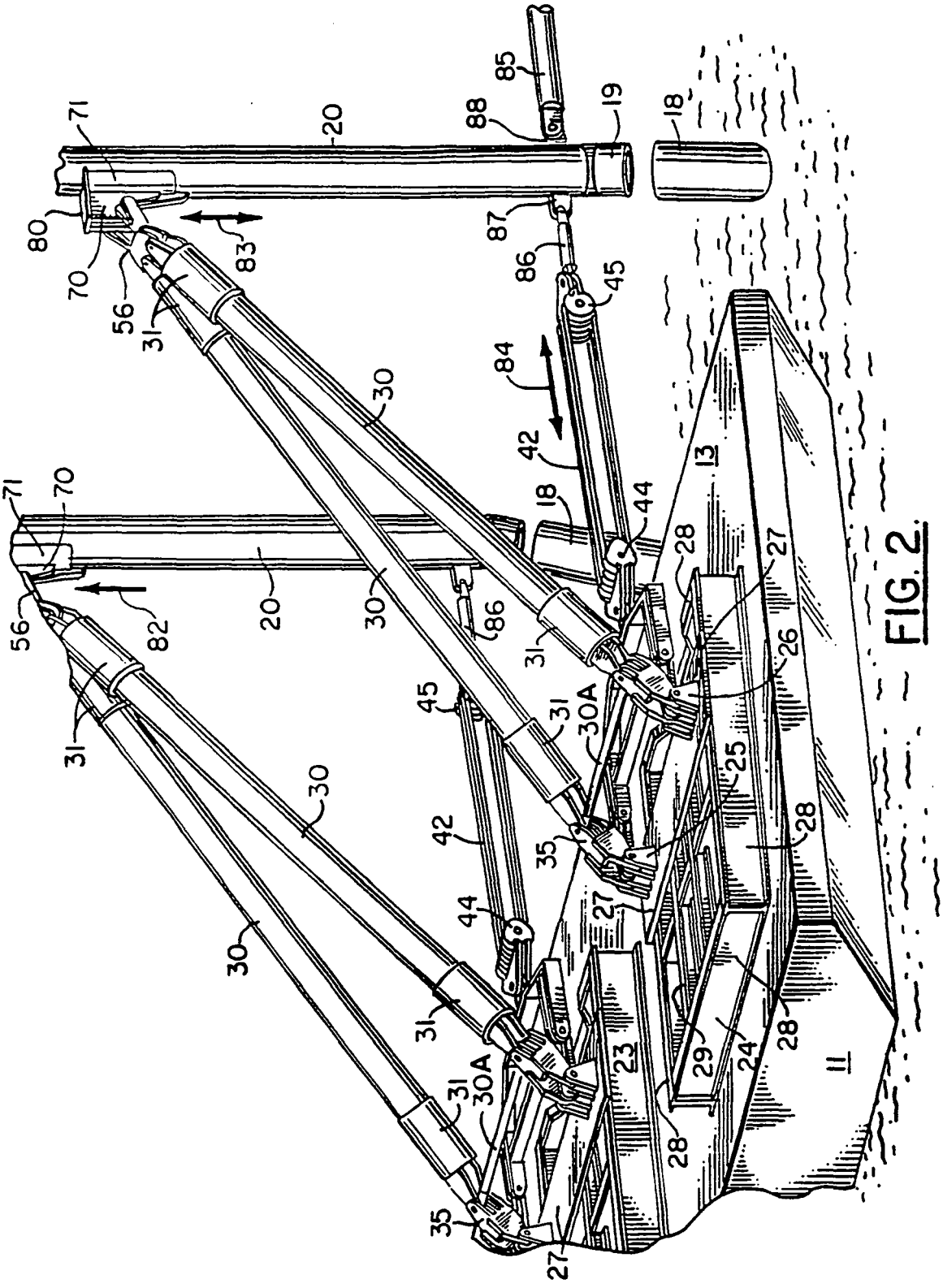
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FIG. 2.

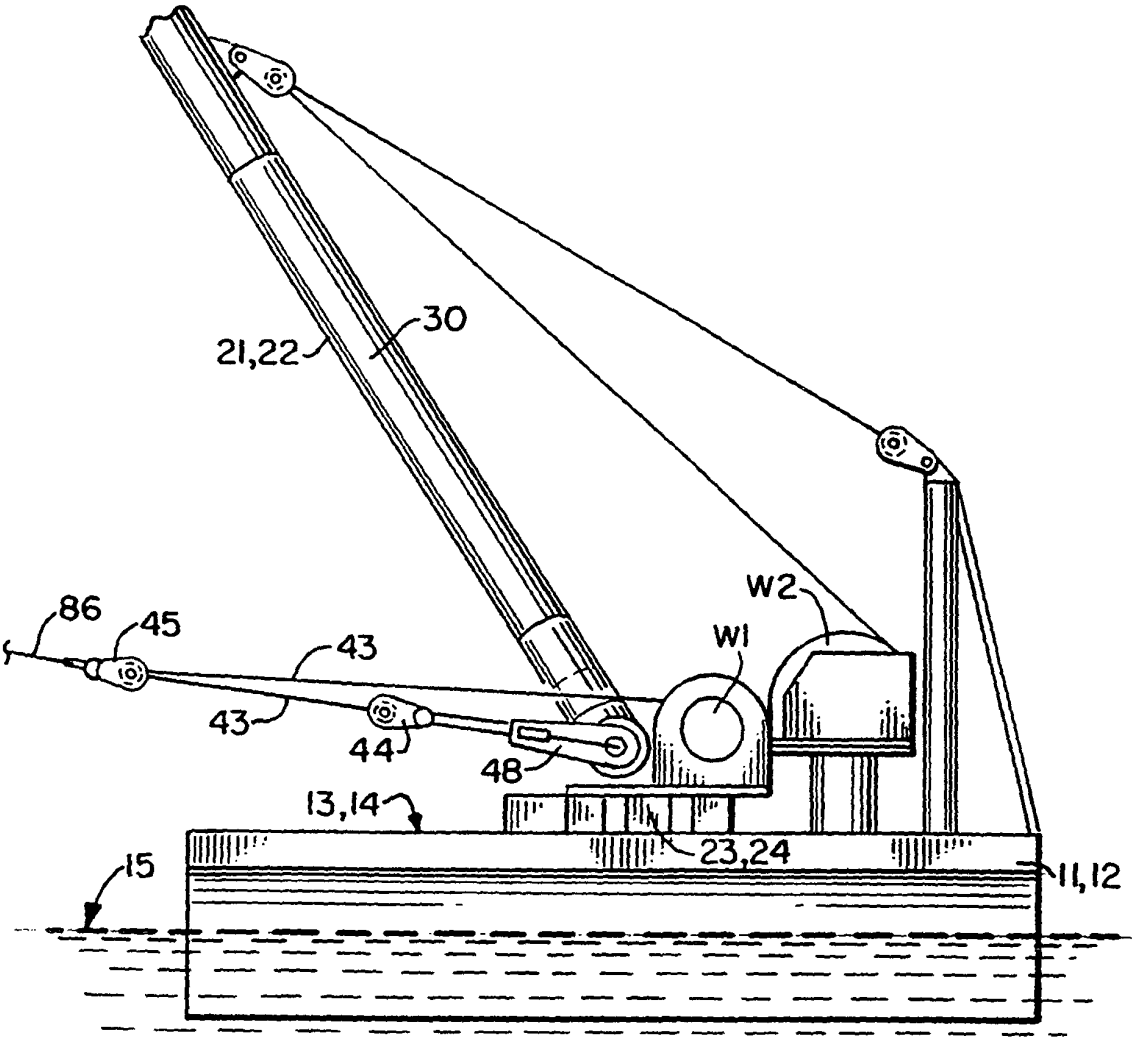

FIG. 2A.

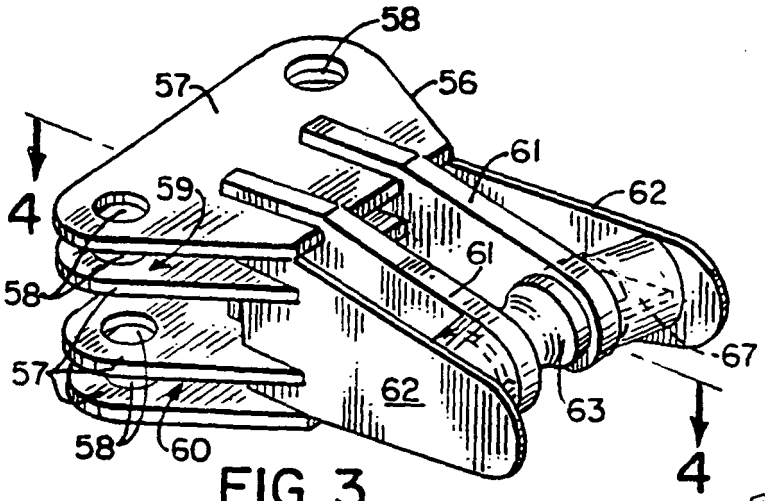

FIG. 3.

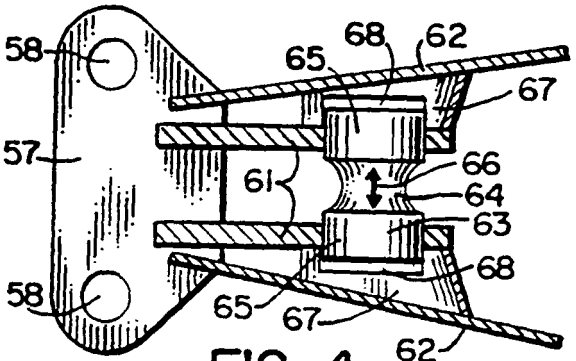

FIG. 4.

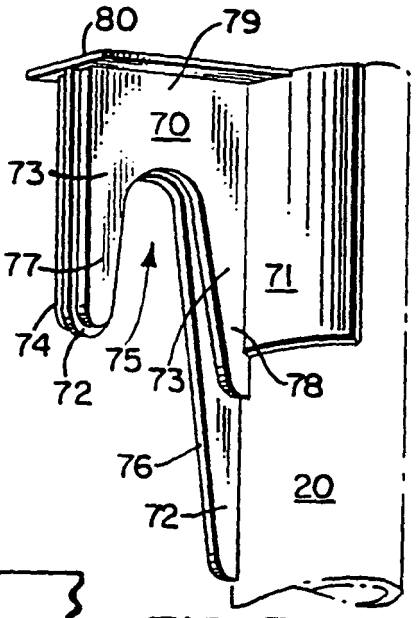

FIG. 5.

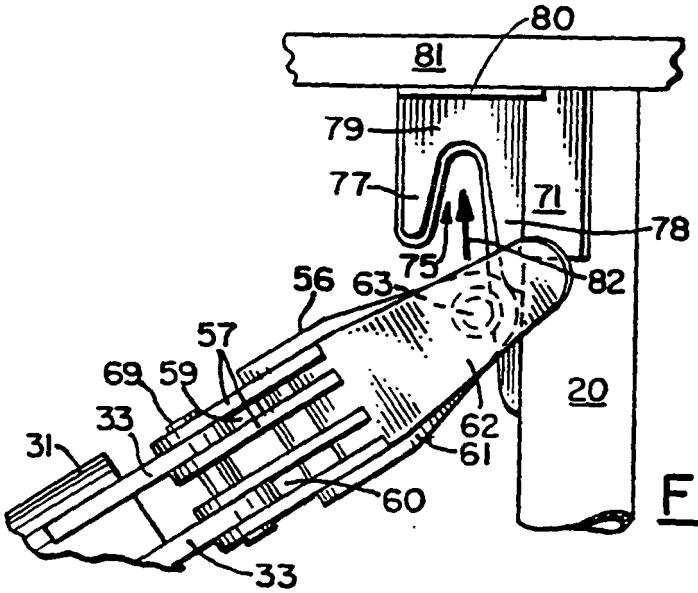

FIG. 6.

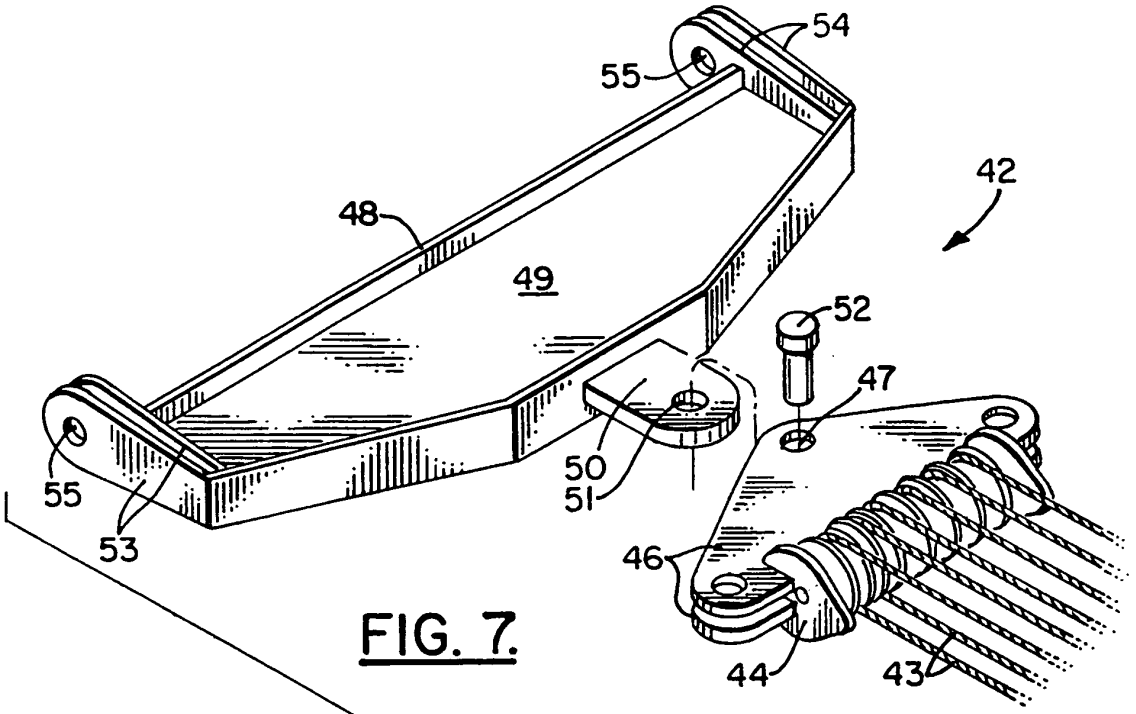
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FIG. 7.

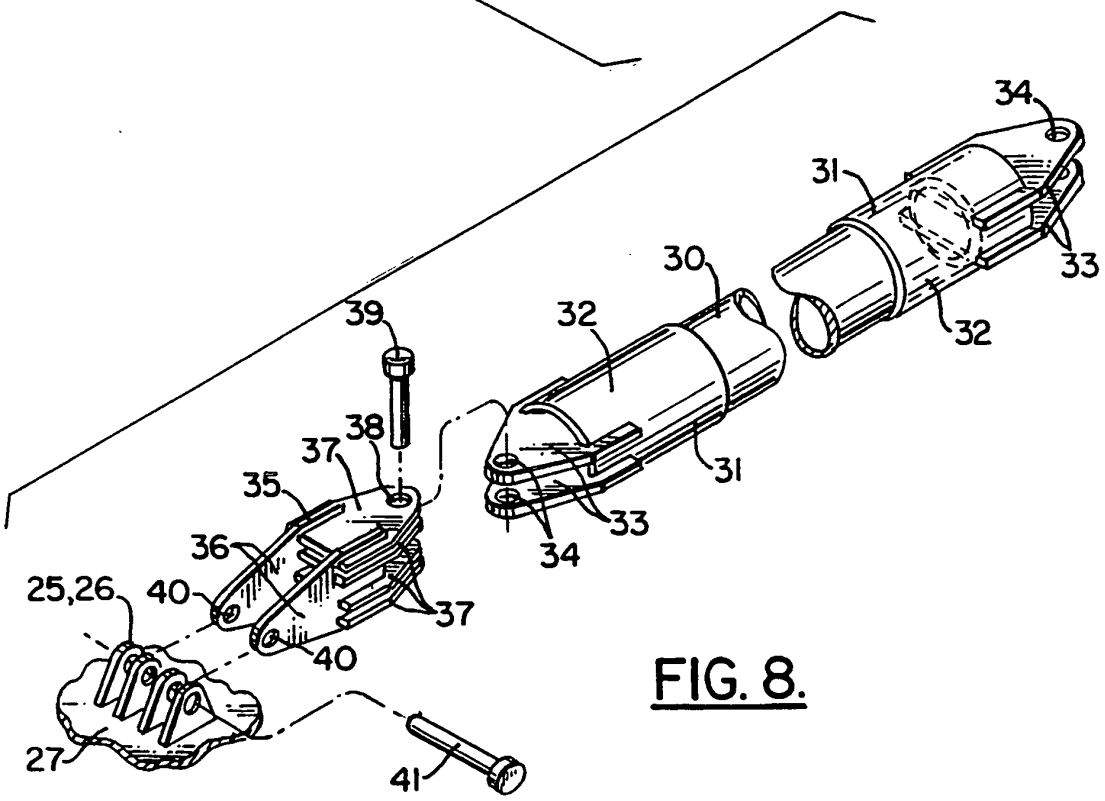
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FIG. 8.