United States Patent

Dobler et al.

[15] **3,677,310**

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[54] **METHOD FOR CONNECTION OF AN UNDERWATER RISER TO A FLOATING FACILITY**

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[52] **U.S. Cl.** **141/1**, 141/388

[51] **Int. Cl.** **B65b 1/04**, B65b 3/04

[58] **Field of Search** 137/236; 61/1, 46, 46.5; 141/279, 284, 387, 388, 1; 114/15; 9/8

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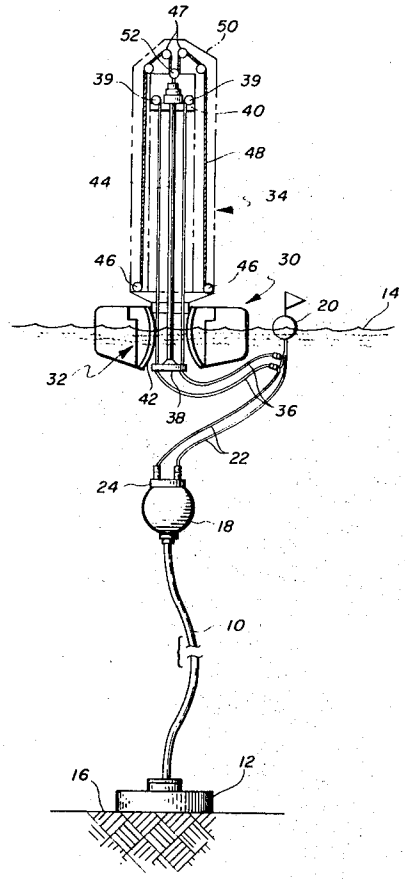
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[57] **ABSTRACT**

This specification discloses a method and apparatus for connecting a flowline of a well or satellite system which is located at a substantial distance beneath the surface of a body of water. A flowline, which is known as a riser, is provided at a well head or riser manifold. At the upper free end, off the flowline, there is a riser buoy which is releasably attached to a tanker during flowing operations and disconnectable during storms or otherwise violent sea conditions. In the disconnected mode, the riser remains submerged under the ocean surface to avoid excess structural loading. The riser is supported by means of a float to maintain tension within acceptable stress limits throughout a wide range of changes in vertical and some horizontal movements when the riser is disengaged from the tanker.

9 Claims, 4 Drawing Figures



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SHEET 1 OF 2

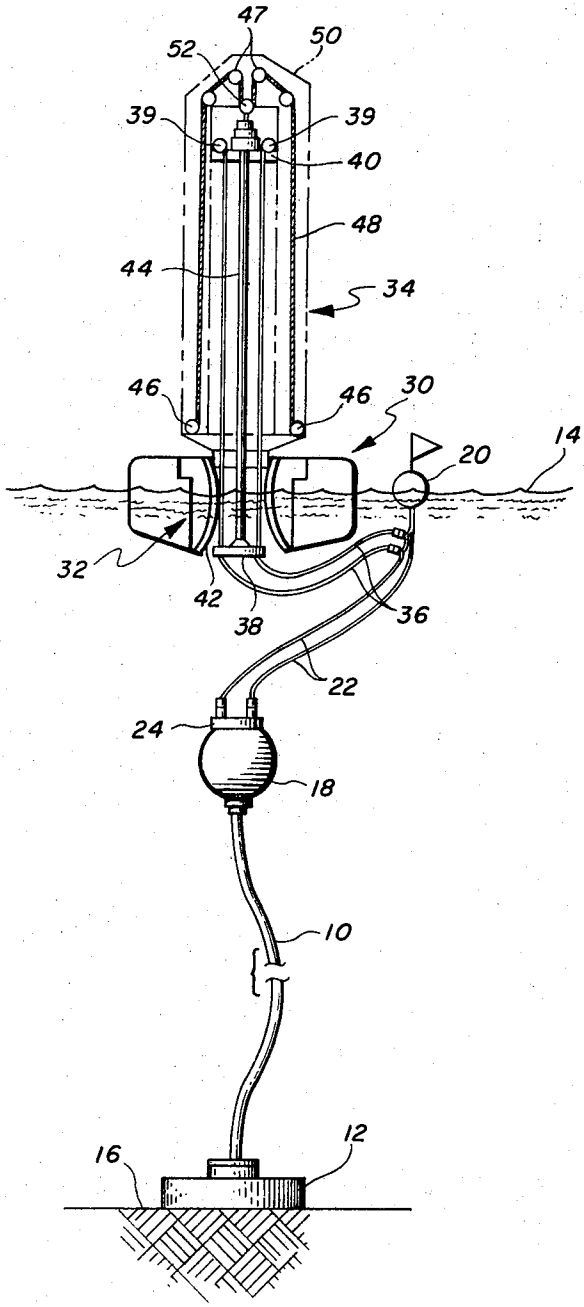


FIG. 2

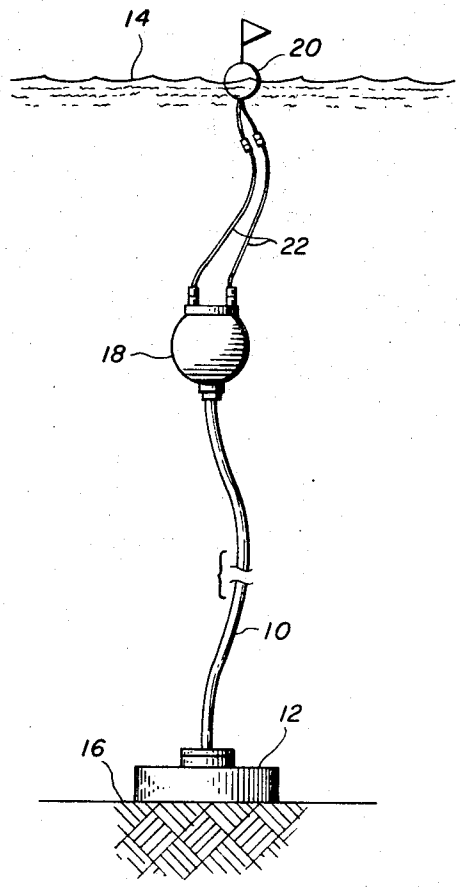


FIG. 1

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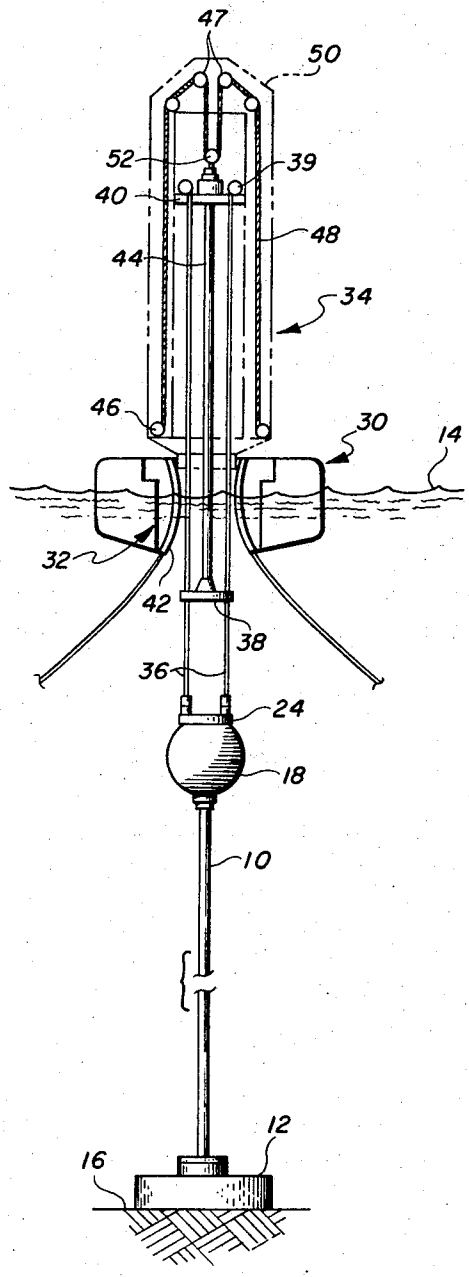


FIG. 3

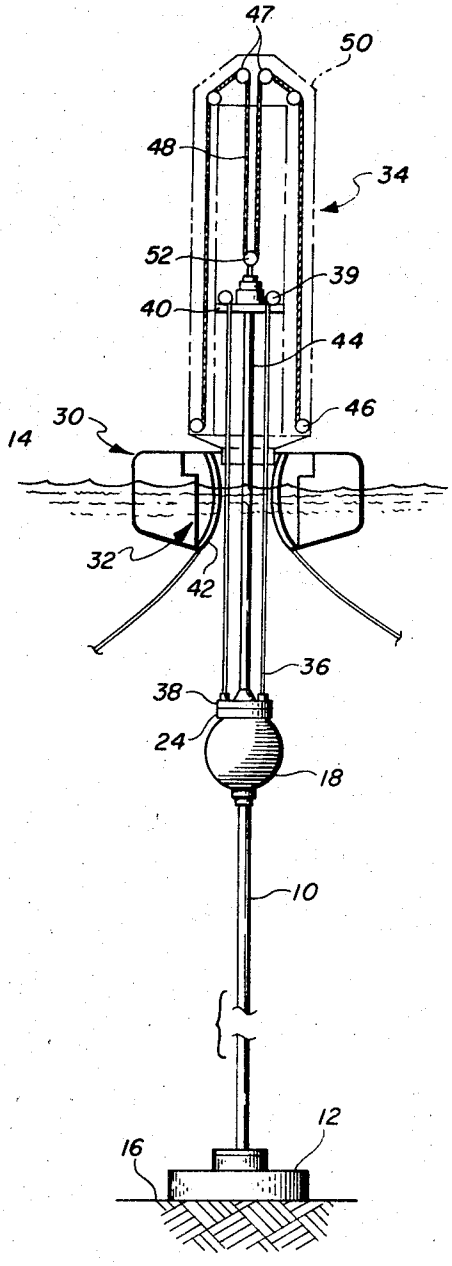


FIG. 4

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METHOD FOR CONNECTION OF AN UNDERWATER RISER TO A FLOATING FACILITY

BACKGROUND OF THE INVENTION

In offshore petroleum production offloading of crude oil collected from various points of the ocean floor, a storage tanker or other similar floating facilities are necessary. One method in current widespread use involves attachment of a riser to a floating swivel buoy which in turn forms a connecting point for storage tankers. During storms or severe sea states, the tanker can be disconnected from the buoy which floats upon the surface of the water. The buoy can thereafter, at this point, be torn loose from the riser resulting in damage and possible complete loss of the riser.

The problem of successfully connecting and disconnecting risers to floating tankers and the like in deep offshore locations has received considerable attention in recent years and has resulted in numerous innovations in both equipment and methods. Prior art has shown no satisfactory solution to the problem of remotely connecting and installing flowline risers after a disconnect condition was necessary due to an adverse condition.

SUMMARY OF THE INVENTION

The invention herein described contemplates a riser communicating between a collection storage tank or a riser manifold on the ocean floor and a tanker on the surface. A riser is attached to the storage tank and extends upwardly toward the surface of the water but terminating considerably below same. There is secured to the upper free end of the riser a buoyant body for positioning the riser in a substantially vertical position above the riser manifold. When disconnected, the buoyant body causes an upward tension on the riser. Due to the specific length of the riser, the buoyant body is suspended below the water surface far enough so that adverse conditions at or near the surface do not substantially affect the riser. To locate the riser and buoyant body, a marker buoy is releasably connected to the body and floats on the surface of the water.

When connection is to take place, the tanker is then positioned above the riser whereby coupling of the riser with a mating member from the tanker can readily be accomplished. The tanker is moored to a separate mooring system within the immediate area of the riser line. The storage tanker ship is fitted with a mooring swivel unit in which a riser may pass therethrough for connecting with an adjustable tension riser head. The tension is accomplished by a tethering winch mounted on the upper end of the riser head.

A general object of the invention is, accordingly, to provide a practical method and means for connecting and disconnecting a riser line during adverse ocean surface states.

Another object of the invention is to provide a method for ease of operation in locating and connecting to a disengaged free mooring riser line.

A further object of the invention is to provide a method for connecting an underwater riser to a floating facility equipped with a mooring swivel plug using a controlled rate of closure.

A still further object of the invention is to provide a method which allows the floating facility to remain connected in more severe storms or sea conditions.

And still another object of the invention is to provide, in the event damage to a riser is feared, a floating facility which can disconnect itself but still remain moored in position (on site) and, at the same time, remain tethered to the riser.

These and other more specific objects will appear upon reading the following specification and claims and upon considering in connection therewith the attached drawings to which they relate.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows the riser in a fully disconnected mode;

FIG. 2 shows the floating facility attached to the marker buoy;

FIG. 3 shows the tethering lines secured to the floating facility just prior to the complete connection mode; and,

FIG. 4 shows the riser in a fully connected mode of operation.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. 1, there is illustrated a flexible transfer riser indicated at 10 consisting of a typical elongated pipe. This riser is secured at its lower end to a base or platform 12 which may be one of many subsea units for the production of crude oil. These subsea units could consist of such items as a flowline, a collection of storage tanks, or a riser manifold. Units of this nature are generally located at great depths below the sea level such as 14 and are generally anchored to the sea floor such as 16. As can be seen in the above figure, the riser 10 is in a fully disconnected mode and is held in a substantially vertical position by a suspension means. Said suspension means is shown as a riser buoy 18 which is attached at the upper free end of the riser 10. Thus, with the aid of the riser buoy 18, a predetermined tension is applied to the riser. The length of the riser 10 is determined by the depth of the sea floor relative to the sea surface, that is the riser extends upwardly but considerably short of the surface whereby a surface indicator or marker buoy 20 is releasably attached by tethering lines 22 to a lower portion of a detachable connecting means indicated at 24. This lower portion of the connecting member 24 is attached to the riser buoy 18 for later joining with an upper portion of the detachable connecting means, which will be hereinafter described.

Therefore, together with a flexible riser 10, the riser buoy 18 and the predetermined length of the riser 10, the mode as shown in FIG. 1 is capable of withstanding adverse conditions at or near the surface of the water.

When the connection between the riser 10 and a storage tanker is required for flow of oil from the bottom of the sea, whether it be from offshore petroleum production lines or loading of crude oil from various points on the ocean floor, a floating facility is necessary to be positioned above the riser 10 and connected thereto. This is accomplished by the mode of operation illustrated in FIG. 2. In this figure there is shown a floating facility generally indicated by reference character 30 which is provided with a mooring swivel plug indicated generally at 32 whereby said floating facility may rotate about a given area. Movably supported thereto is a gimbal tower generally indicated at 34 together with the swivel plug 32, which is schematically shown. After the facility is positioned, the marker buoy 20 is then picked up and the tethering lines 22 are connected to additional tethering lines 36. The lines 36 are then attached through the upper portion of the detachable connecting means indicated at 38 to tethering winches 39 which are mounted on a traveling platform 40. Vertically positioned and axially aligned with the central opening 42 of the swivel plug 32 is a riser head 44 which is movably secured at its upper free end to the traveling platform so that the riser head can be lowered or raised depending upon the connection mode required. In the mode shown in FIG. 2, the riser head is in the raised position with the upper disconnect member fixedly secured to the lower end thereof.

At this time the mode of operations changes to that shown in FIG. 3 wherein the tethering lines 22 are interconnected with the tethering lines 36. Tension is then applied to the lines by a tensioning means, said means having a constant force which is provided by tension winches 39.

In addition, FIG. 3 shows the riser head 44 being lowered into position by employing the tethering lines as a means to guide the traveling platform 40 into a connect position. As the riser head 44, along with the upper connecting member 38, travels in a downward direction, alignment with the lower connecting member 24 is assured by virtue of the constant taut lines 36. Tension is maintained on the taut lines as the riser head moves downwardly by means of the uniformly controlled winch means 39. The vertical movement of the riser head 44 is accomplished by controlled means comprising a winch device indicated at 46, a series of pulleys 47, and each of the pulleys being interconnected by a cable system 48. The control means

is supported within a gimbaled tower **50** which is disposed directly above the swivel plug **32** and is attached thereto for rotation therewith. The joining of the control means and the riser head is achieved by a line swivel which is mounted to the traveling platform **40** at one end and a pulley **52** attached to the opposite end for engagement with the cable system **48**. The maintaining of a constant tension on the tension lines **36**, together with lowering the riser head **44** at a controlled rate of closure, eliminates much of the wave motion or excursions of the floating facility **30**. This then permits proper connection between the upper and lower disconnect units. Production and transfer of fluids may now be successfully accomplished. This last step of completing the connection between the floating facility and the riser **10** is illustrated in FIG. **4**.

In the event that the sea state becomes so severe that damage to the riser **10** is feared, the reverse of the above method should take place. That is, the riser head is disconnected from the riser and the platform **40** is hoisted up into a predetermined position in the gimbal tower **50**. The floating facility can then ride out the storm connected to its mooring lines and still be attached to the lower disconnect by means of the tethering lines. However, depending upon the situation, the floating facility may be detached completely from the riser and the marker buoy again attached to the flexible riser by means of the tethering lines **22** as shown in FIG. **1**.

It is also contemplated that other changes and modifications can be made without departing from the scope of the invention as defined in the appended claims.

What is claimed is:

1. The method for detachably connecting a riser head on a floating facility with a subsea well installation wherein fluid can be transferred therebetween and said riser head can move vertically toward said sea well, said riser head being guided during movement by a flexible guide line passing therethrough, and said installation comprising a riser base and a flexible transfer riser connected thereto, the upper end of which is located at a substantial distance below sea level, and having attached thereto a detachable surface indicator comprising the steps of:

providing a means for suspending said flexible riser in a substantially vertical position above said riser base so that the top of the riser is below sea level;

detachably connecting said surface indicator to said suspending means for locating said underwater transfer riser;

positioning said floating facility substantially above said transfer riser;

attaching said flexible guide line from said floating facility to said transfer riser;

lowering said riser head from said floating facility for connection with said transfer riser so that the riser head is guided by said guide line; and,

detachably securing said riser head to said transfer riser for fluid flow therethrough.

2. The method as recited in claim **1** wherein the following additional steps are included:

detaching said surface indicator after said guide line has been attached to said transfer riser; and

providing a predetermined tension on said guide line before lowering said riser head.

3. The method as recited in claim **2** wherein an additional step includes:

mooring said floating facility prior to lowering said riser head.

4. A method as recited in claim **2** wherein the following additional steps are included:

disconnecting said riser head from said flexible riser; and

hoisting the riser head to a predetermined position on said floating facility.

5. The method as recited in claim **4** wherein an additional stop includes:

relaxing said guide line whereby movement of the floating facility will not affect said subsea well installation.

6. In combination, a riser and a floating storage facility having a vertical opening therethrough:

said riser comprising:

at least one fluid flow conduit extending from a subocean installation towards the ocean surface and having relative flexibility,

a buoyant means disposed at the upper end thereof and submerged under the surface to support said conduit in a substantially vertical position, and

a first pair of tethering lines connected to the top of said riser and adapted to be connected to a marker buoy so that said marker buoy is capable of moving with the tides and wave action, and

said floating storage facility comprising:

a riser head disposed to move vertically through said opening,

a gimbal tower mounted on said facility over said opening and disposed to guide said riser head,

a second pair of tethering lines engaging the lower end of said riser head in sliding relation therewith and having means on their ends adapted to engage said first pair of lines so that said riser head can be guided when lowered to engage the top of said riser.

7. The combination of claim **6** wherein control means are provided for vertically positioning said riser head.

8. The combination of claim **7** wherein tensioning means are provided for applying constant tension to said second pair of lines when said control means is lowering said riser head.

9. The combination of claim **8** wherein said facility further includes a swivel plug rotatably mounted within said vertical opening so that said gimbal tower is mounted on said plug to rotate therewith.

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