United States Patent

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[54] METHOD AND APPARATUS FOR CONNECTING A FLOWLINE TO AN OFFSHORE INSTALLATION

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[52] **U.S. Cl.** **61/72.3**, 72/380

[51] **Int. Cl.** **F16l 1/00**, B21d 11/02

[58] **Field of Search** 61/72.1, 72.3; 72/380; 166/.6; 285/18, 24

[56] **References Cited**

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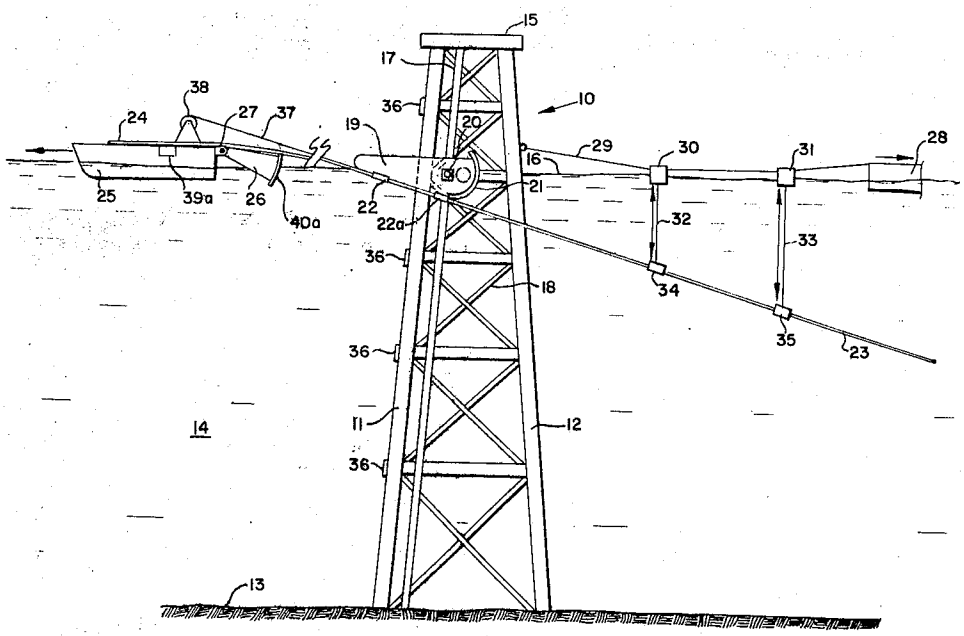
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[57] **ABSTRACT**

A method and apparatus for connecting a flowline having a major portion adapted to lie along the floor of a body of water to an offshore installation of the type having a substantially vertical support positioned on the floor of a body of water and a platform carried by the support. The flowline is positioned at the water surface adjacent the installation and terminated a distance beyond the installation approximately equal to the depth of the water. The portion of the flowline adjacent the installation is slidably connected to the support and the flowline is lowered to the floor of the body of water while gradually bending the flowline in such a manner that the portion of the flowline between the support and its terminal end is substantially parallel to the support when the flowline reaches the floor of the body of water. The terminal end of the flowline is subsequently connected to the platform. In this manner, the flowline has a sufficient curvature to prevent buckling thereof.

11 Claims, 4 Drawing Figures



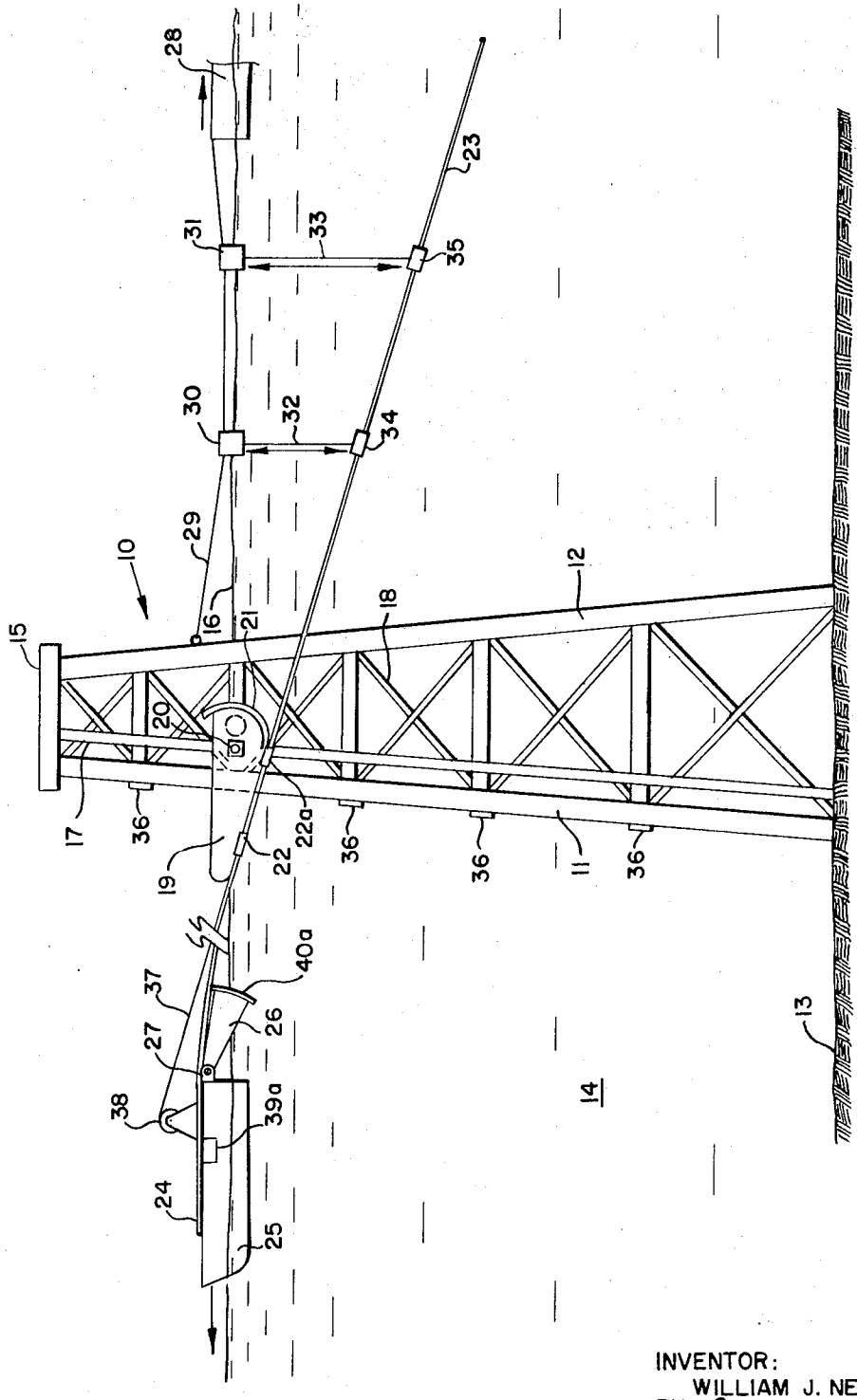


FIG. 1

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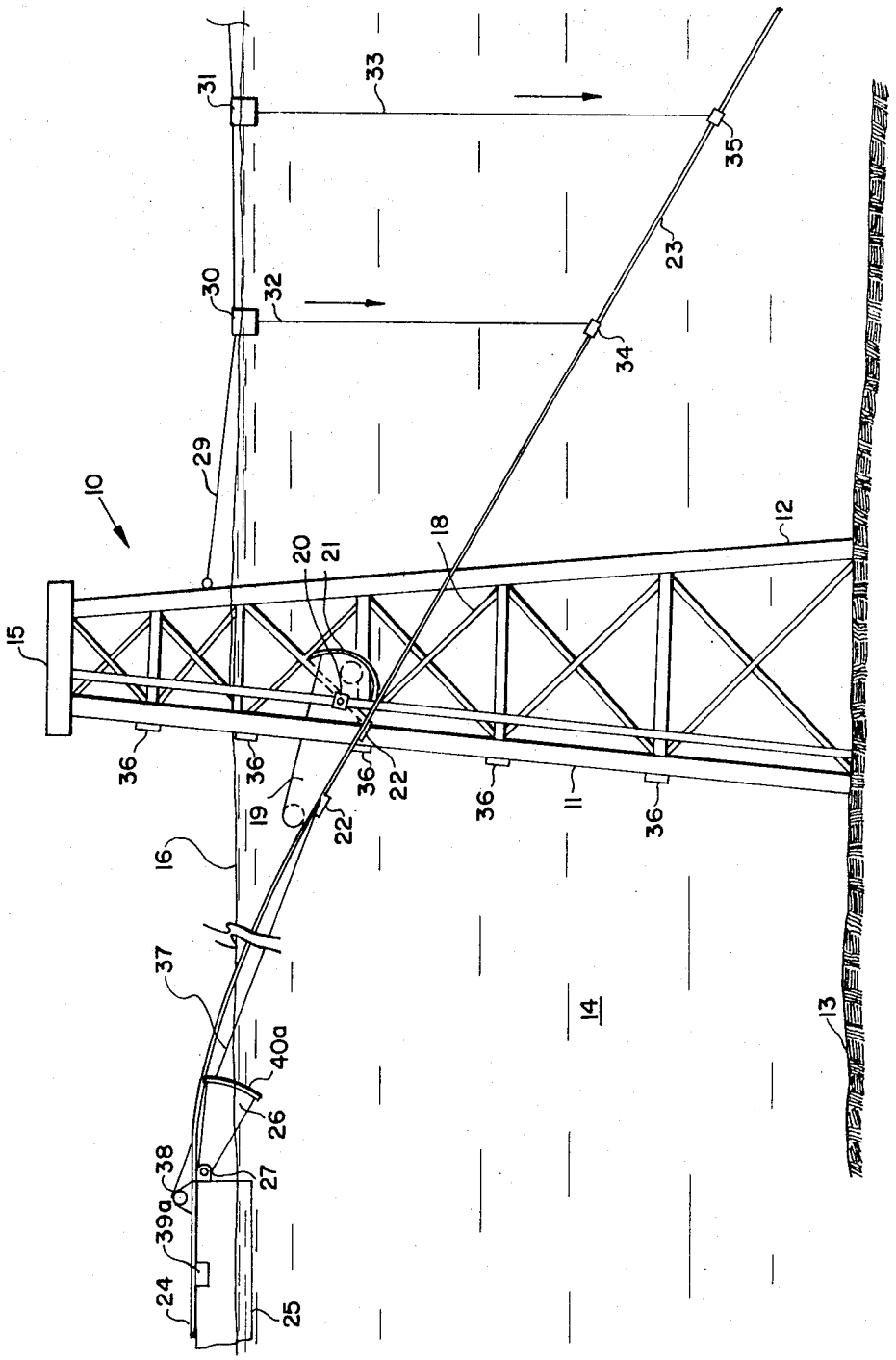


FIG. 2

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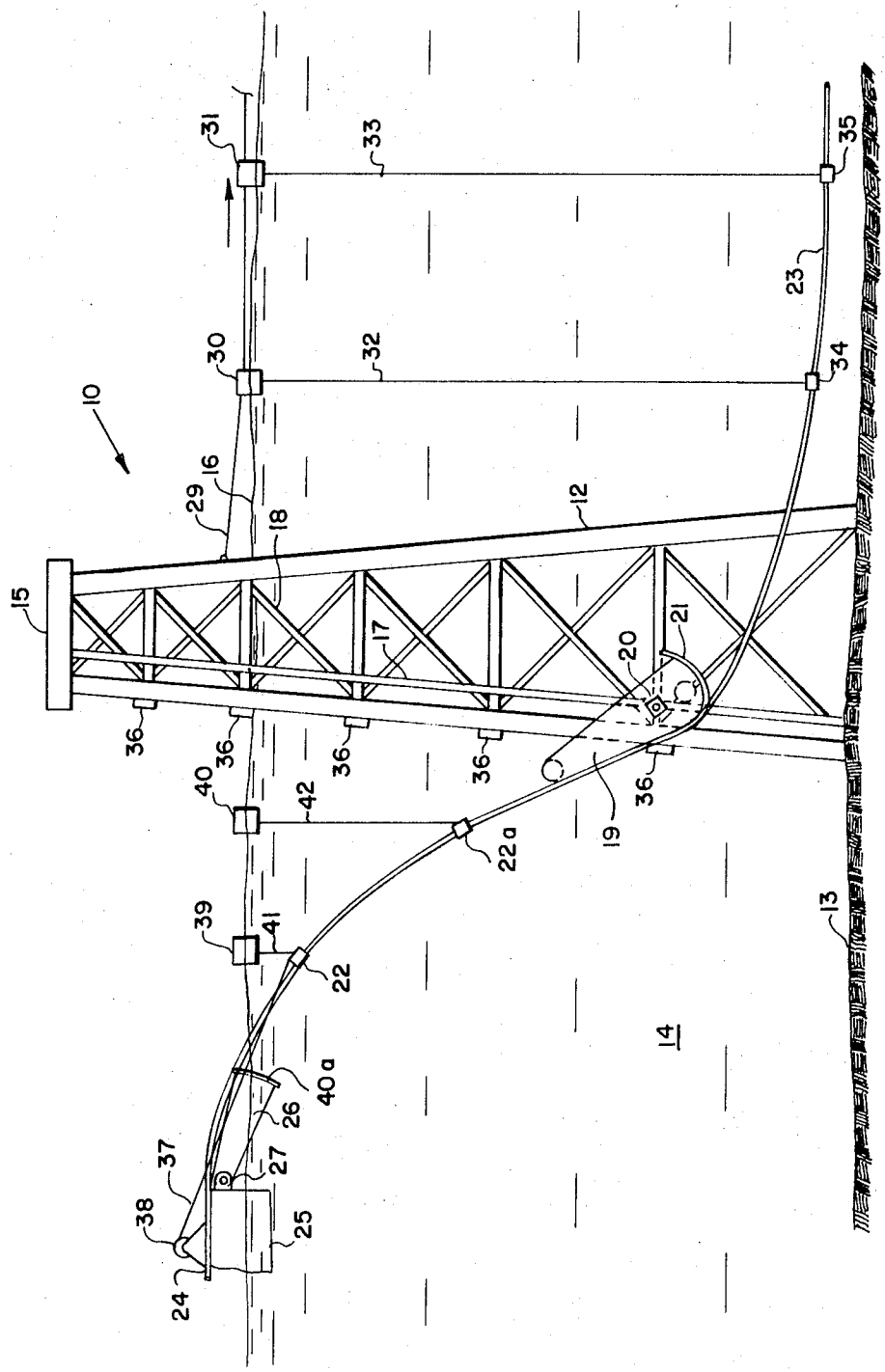


FIG. 3

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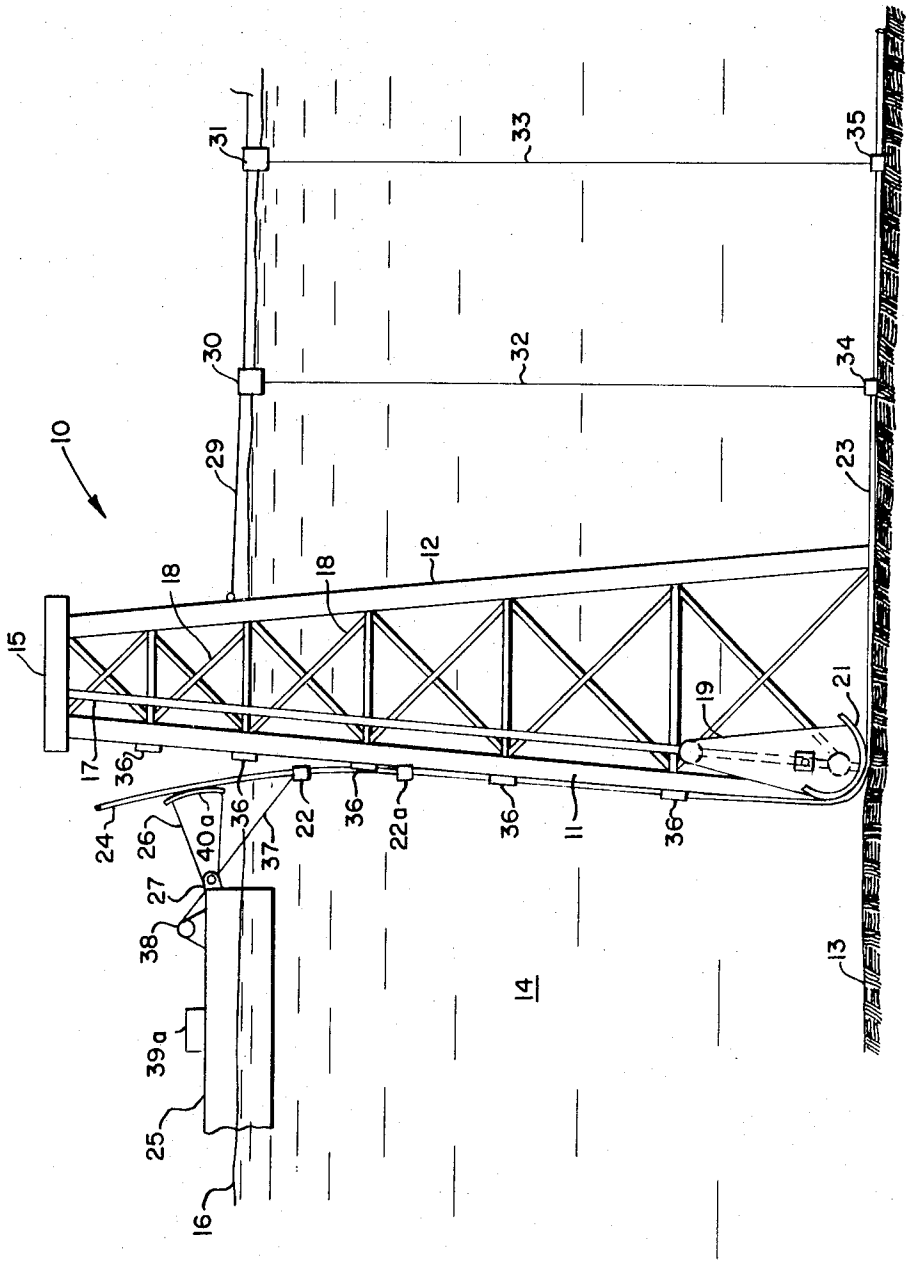


FIG. 4

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METHOD AND APPARATUS FOR CONNECTING A FLOWLINE TO AN OFFSHORE INSTALLATION

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to underwater flowlines and more particularly, to a method and apparatus for connecting an underwater flowline to an offshore "platform".

2. Description of the Prior Art

The development of offshore oil and gas wells frequently necessitates the use of offshore installations or so-called "platforms". These installations are used, for example, for drilling and subsequently for producing a well or wells. Accordingly, it is often desirable to provide one or more flowlines from a platform to a remote point, for example, to shore or to another platform. The flowlines may serve many purposes, the most common being to carry off the output of oil or gas from a well. Since the flow line (also referred to as a pipeline) lays in a substantially horizontal position along the floor of the body of water in which the platform is located, a problem arises in establishing fluid communication between the flowline and the surface of the platform which is above the surface of the body of water. It will be thus apparent that either the flowline must be bent from its horizontal position on the ocean floor to a vertical position extending to the upper surface of the platform or a separate vertical extension must be installed and connected to the flowline on the ocean floor. The vertical portion is generally referred to as the flowline "riser".

The present practice for installing the "riser" is to provide a vertical flowline or pipeline segment along the side of the platform which extends to the floor of the body of water and is connected to the underwater flowline by divers. However, this is a generally cumbersome and expensive operation, particular in relatively deep water where the divers' effectiveness is severely impaired.

At greater than diver depths, connections cannot be made by divers on the ocean floor. In this case, it is known to first connect the "riser" to the flowline and lower the assembly down a leg of the platform while simultaneously laying the flowline from a barge proceeding away from the platform. However, the procedure also has drawbacks in that the lowering and laying operation must be carefully programmed to prevent damage to the pipeline and/or riser. In addition, the method is only applicable where a pipeline is laid away from a platform and cannot be readily and easily employed where a pipeline approaches a platform.

SUMMARY OF THE INVENTION

It is an object of this invention to provide a method and apparatus for installing a flowline riser to an offshore platform which eliminates the need for making an underwater connection.

Another object of this invention is to provide a method of installing a riser in which the underwater flowline and the riser may be formed of one continuous pipeline.

A further object of this invention is to bend the underwater flowline to provide an upstanding portion which serves as a riser.

A still further object of this invention is to bend the flowline to form a riser while maintaining the radius of curvature above a predetermined minimum so as to prevent buckling of the pipeline.

These and other objects are preferably carried out by connecting a flowline having a major portion adapted to lie along the floor of a body of water to an offshore installation of the type having a substantially vertical support positioned on the floor of a body of water and a platform carried by the support. The flowline is positioned at the water surface adjacent the installation and terminated a distance beyond the installation approximately equal to the depth of the water. The portion of the flowline adjacent the installation is slidably connected to the support and the flowline is lowered to the floor of the body of water while gradually bending the flowline in such a manner that the portion of the flowline between the support and its terminal end is substantially parallel to the support when the flowline reaches the floor of the body of water. The terminal end of the flowline is subsequently connected to the platform. In this manner, the flowline has a sufficient curvature to prevent buckling thereof.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a vertical view of an offshore installation showing a flowline connected thereto in accordance with the teachings of my invention; and

FIGS. 2 through 4 are vertical views similar to FIG. 1 showing the sequence of steps for carrying out the teachings of my invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawing, FIG. 1 shows an offshore installation **10** having substantially vertical support means in the form of a plurality of legs (only legs **11** and **12** being shown for convenience of illustration) adapted to rest on the floor **13** of a body of water **14**, such as an ocean. A generally horizontal platform **15** is carried by the legs extending above the water surface **16**. A rail **17** extends generally from platform **15** to the ocean floor **13** and is connected thereto in any suitable manner. Although rail **17** is shown as a separate element in FIG. 1, it may form one of the legs of the support means and is thus considered to be part of the "support means" for supporting platform **15**. Suitable bracing **18** may be provided between the legs **11** and **12** for bracing the installation **10**.

A bending shoe **19** is slidably connected to rail **17** in any suitable manner and is adapted to tilt or pivot about its point of connection **20** to rail **17**. Shoe **19** includes a bending surface **21** adapted to engage a flowline as will be discussed further hereinbelow. Shoe **19** also includes a plurality of slip clamps **22** and **22***a* or the like. In this manner, flowline **23** may be coupled to shoe **19** by engagement of clamps **22** and **22***a* as illustrated in FIG. 1.

The terminal end **24** of flowline **23** is preferably coupled to a barge or similar vessel **25**. The opposite end of flowline **23** extends to a suitable location, such as an on shore location or an offshore gathering station (not shown). Vessel **25** further includes a barge shoe **26** or the like for engaging flowline **23**. Shoe **26** is pivotally attached to vessel **25** at clamp **27**. Shoe **19** also includes suitable ballast means (not shown), such as a water ballast, for both lowering shoe **19** through the body of water **14** along rail **17** and gradually tilting or pivoting shoe **19** as will be discussed further hereinbelow.

A tensioning barge or similar vessel **28** is coupled to the installation **10** through an anchor line **29**. A plurality of floats **30** and **31**, two being shown for convenience of illustration, are connected to anchor line **29** and float of water surface **16**. Floats **30** and **31** are in turn coupled to suspension cables **32** and **33**, respectively, which are coupled to flowline **23** through conventional automatic release clamps **34** and **35** at spaced positions along flowline **23**. Suitable takeup winches (not shown) may be included in floats **30** and **31** for raising and lowering flowline **23**. In this manner, as indicated by the arrows leading from both vessels **25** and **28**, and at cables **32** and **33**, the flowline **23** may be supported when tension is released and the assembly (i.e., flowline **23**, shoe **19**, cables **34**, **35**, etc.) is lowered down rail **17** to the ocean floor **13**. A plurality of flowline clamps **36** are preferably disposed along leg **11** of installation **10** at a plurality of spaced intervals for reasons to be discussed further hereinbelow.

In operation, as illustrated in FIG. 1, the flowline **23** is positioned at the water surface **16** adjacent installation **10**. The terminal end **24** of flowline **23** is extended past installation **10** to vessel **25** a distance approximately equal to the depth of the body of water **14** from surface **16** to the ocean floor **13**. The portion of flowline **23** adjacent the installation **10** is slidably connected to shoe **19** through slip clamps **22** and **22***a*. A winch line **37** is coupled at one end to one of the clamps, such as

clamp 22, and at the other end to a winch 38 on vessel 25. A suitable flowline tensioning device 39 is disposed on vessel 25 for holding flowline 23. At this point, flowline 23 is supported under tension by means of vessels 25, 28, and cables 32 and 33, as indicated by the arrows. When tension is released and water ballast is added to or transferred within shoe 19, the shoe slides down rail 17 as illustrated in FIG. 2. Line 37 is payed out from winch 38 while cables 32 and 33 are controlled in such a manner that flowline 23 is supported as it is being lowered. Also, as illustrated in FIGS. 2 through 4, bending shoe 19 tilts or pivots about its connecting point 20 until bending surface 21 engages flowline 23 (FIG. 3). At this time, additional floats 39 and 40 may be provided between vessel 25 and installation 10. These floats are in turn coupled to suitable cables 41 and 42, respectively, similar to cables 32 and 33, connected to clamps 22 and 22*a*. As in the case of floats 30 and 31, takeup winches may also be provided in floats 39 and 40. Thus, the portion of flowline 23 between shoe 19 and barge 25 may be supported as the flowline 23 is being lowered.

Finally, as illustrated in FIG. 4, shoe 19 reaches the ocean floor 13 where it is shown as having tilted or pivoted to a substantially vertical position. The bending surface 21 of shoe 19 gradually bends flowline 23 so that the portion of flowline 23 between shoe 19 and vessel 25 assumes a position substantially vertical (i.e., generally parallel to the legs 11 and 11*a* of support 12). The floats 39 and 40, and cables 41 and 42, are released for flowline 23. At this time, the terminal end 24 is released from the tensioning device 39 on vessel 25 and the bending shoe 26 may be used to push the flowline 23 to its point of engagement with leg 11. The terminal end 24 of flowline 23 may then be coupled to the platform 15 by any suitable means (not shown) known in the art after fastening the portion of flowline 23 between shoe 19 and vessel 25 to the clamps 36 along leg 11. Clamps 22, 22*a*, 34 and 35 may then be released from flowline 23 (not shown).

In this manner, the vertical or "riser" potion of the flowline 23 extending to the upper surface of the platform 15 may be connected to processing equipment handling the output of a well drilled through one of the legs of the platform (not shown) or may be connected directly to a well or to another pipeline leading to the platform. Although the "riser" is shown in a vertical position, it should be understood that the riser may be installed at any angle from the horizontal (i.e., generally or substantially vertical to installation 10) without departing from the spirit of the invention. For example, the flowline could be bent to a 45° angle and then joined with another section to provide communication with the upper surface of the platform 15. In addition, the riser need not extend to the surface. It may, for example, extend only a short distance past the upper end of the flowline bending shoe 19. Pipe lengths could subsequently be added to the end of the flowline 23 to form a riser extending to the surface of the platform 15.

The degree of a curvature or bending of the flowline 23 may be predetermined from techniques well known in the pipeline art so as to maintain the radius of curvature of flowline 23 above a predetermined minimum so as to prevent buckling thereof. For example, the techniques disclosed in U.S. Pat. No. 3,466,882 may be used.

I claim as my invention:

1. A method of connecting a flowline having a major portion adapted to lie along the floor of a body of water to an offshore installation of the type having substantially vertical support means positioned on the floor of a body of water and platform means carried by the support means, said method comprising the steps of:

positioning said flowline at the water surface of said body of water adjacent said offshore installation said flowline extending to and past said installation;

terminating said flowline past said installation a distance approximately to a depth of said water from said water surface to the floor thereof;

slidably connecting the portion of said flowline adjacent said installation to said support means; and

lowering said flowline to the floor of said body of water while gradually bending said flowline so that the portion of said flowline between said floor of body of water and said terminal end is substantially parallel to said support means when said flowline reaches the floor of said body of water.

2. A method of connecting a flowline having a major portion adapted to lie along the floor of a body of water to an offshore installation of the type having substantially vertical support means positioned on the floor of a body of water and platform means carried by the support means, said method comprising the steps of:

positioning said flowline at the water surface of said body of water adjacent said offshore installation said flowline extending to and past said installation;

terminating said flowline past said installation a distance approximately equal to the depth of said water from said water surface to the floor thereof;

slidably connecting the portion of said flowline adjacent said installation to said support means wherein said support means includes a flowline bending shoe means slidably movable along said installation from the water surface to the floor of said body of water wherein the step of slidably connecting said flowline to said installation includes the step of connecting said flowline to said shoe means; and

lowering said flowline to the floor of said body of water while gradually bending said flowline so that the portion of said flowline between said floor of body of water and said terminal end is substantially parallel to said support means when said flowline reaches the floor of said body of water.

3. The method of claim 2 wherein the step of lowering said flowline to the floor of said body of water includes the step of lowering said flowline while lowering said bending shoe means while bending said flowline about said bending shoe means whereby the portion of said flowline between said bending shoe means and said terminal end gradually moves from a substantially horizontal position at the water surface to a substantially vertical position at the floor of said body of water.

4. The method of claim 1 including the step of connecting the terminal end of said flowline to said platform means.

5. The method of claim 3 including the step of maintaining under tension the end of said flowline opposite said terminal end leading away from said platform while lowering said flowline to the floor of said body of water.

6. The method of claim 5 including the step of supporting under tension the portion of said flowline between said shoe means and said terminal end while lowering said shoe means to the floor of said body of water.

7. Apparatus for connecting a flowline to an offshore installation comprising:

substantially vertical support means positioned on the floor of a body of water;

platform means carried by the support means;

flowline bending shoe means having a bending surface thereon, said bending shoe means being connected to the support means and movable therealong from a position adjacent the water surface of said body of water to the floor thereof, said flowline bending shoe means including flowline connecting means for slidably connecting a flowline thereto; and

rotating means operatively engaging said bending shoe means for rotating said bending shoe means from a position whereby a flowline slidably connected to said shoe means is adapted to be substantially parallel to said water surface at said water surface and substantially perpendicular to the floor of said body of water at said floor when moved along said support means from the water surface to the floor thereof.

8. The apparatus of claim wherein said support means includes rail portion and said bending shoe means is slidably movable therealong.

9. The apparatus of claim 7 wherein said bending shoe means is pivotable about a pivot point at substantially the point of connection of said shoe means to said support means.

10. The apparatus of claim 7 including flowline support means operatively engaging said installation and adapted to support under tension a flowline being lowered from the water water surface to the floor thereof.

11. The method of claim 2 including the step of connecting the terminal end of said flowline to said platform means.

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