United States Patent

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[54] **METHOD AND APPARATUS FOR CONNECTING FLOWLINES TO UNDERWATER WELLHEADS**

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[52] **U.S. Cl.** **166/.5**, 61/72.3

[51] **Int. Cl.** **E21b 43/00**

[58] **Field of Search** ..... 166/.5, .6; 61/72.3

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[57] **ABSTRACT**

Apparatus and method for connecting flowlines to underwater wellheads by attaching a pulling head to the flowline and anchoring a pulling head fixture to the wellhead. A releasable pulling tool having a wireline in slidable engagement with the fixture on the wellhead is connected to the flowline pulling head and the head is pulled into engagement with the fixture. When in proper position, the pulling tool is released and fluid communication may then be provided between the wellhead and the pulling head and thus with the flowline.

8 Claims, 13 Drawing Figures

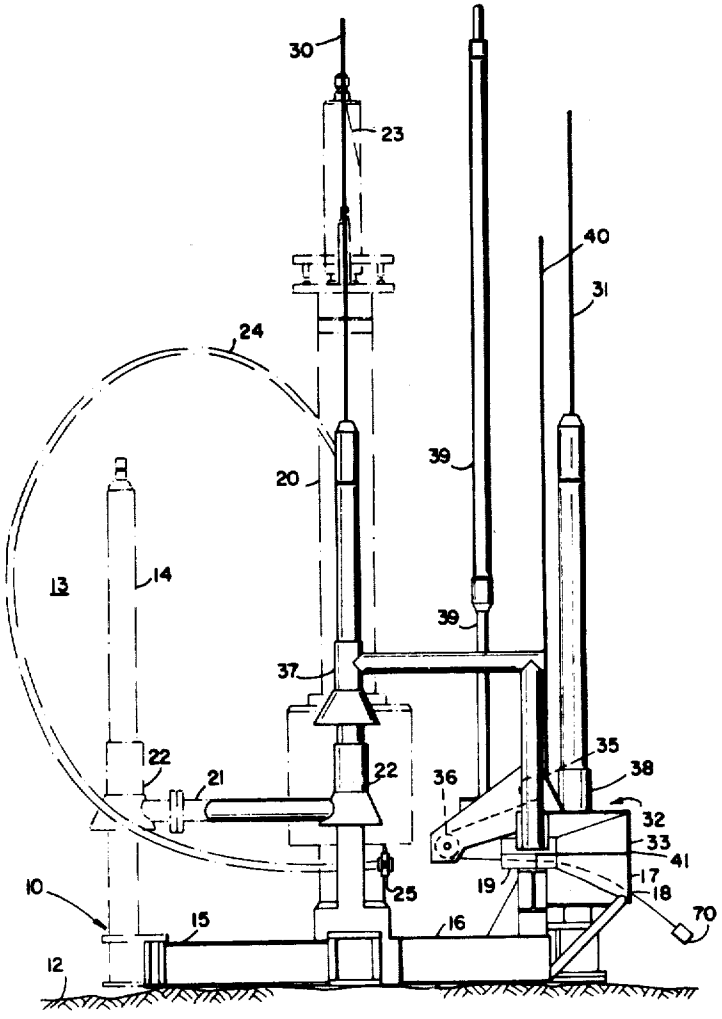
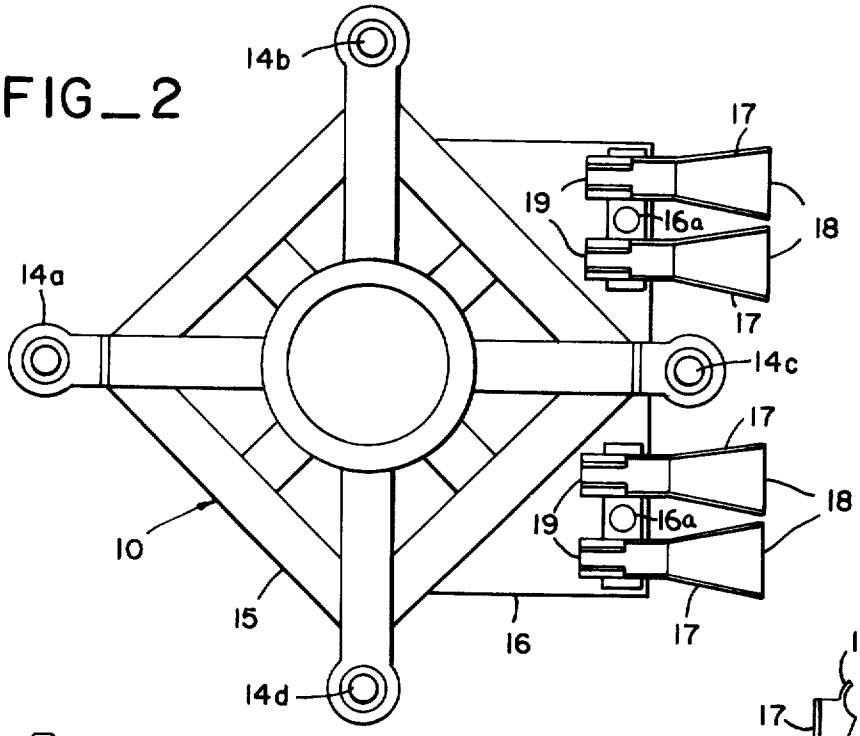


FIG_2



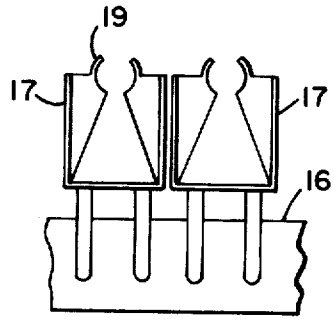


FIG_3

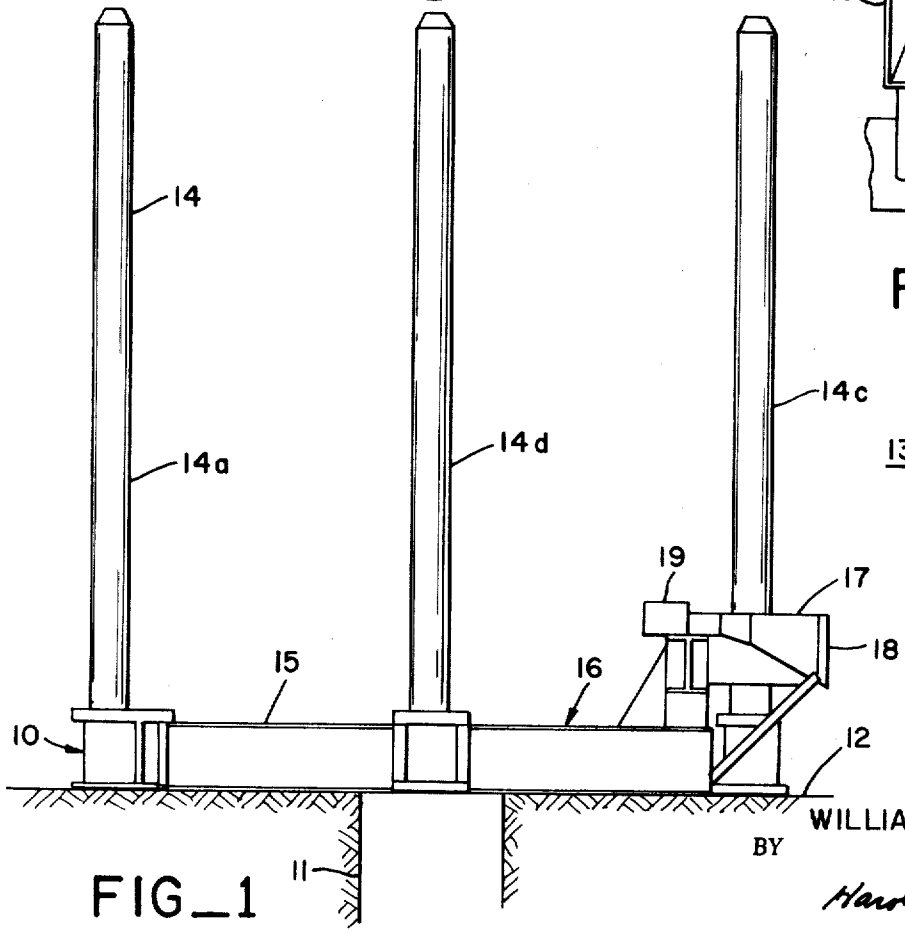


FIG_1

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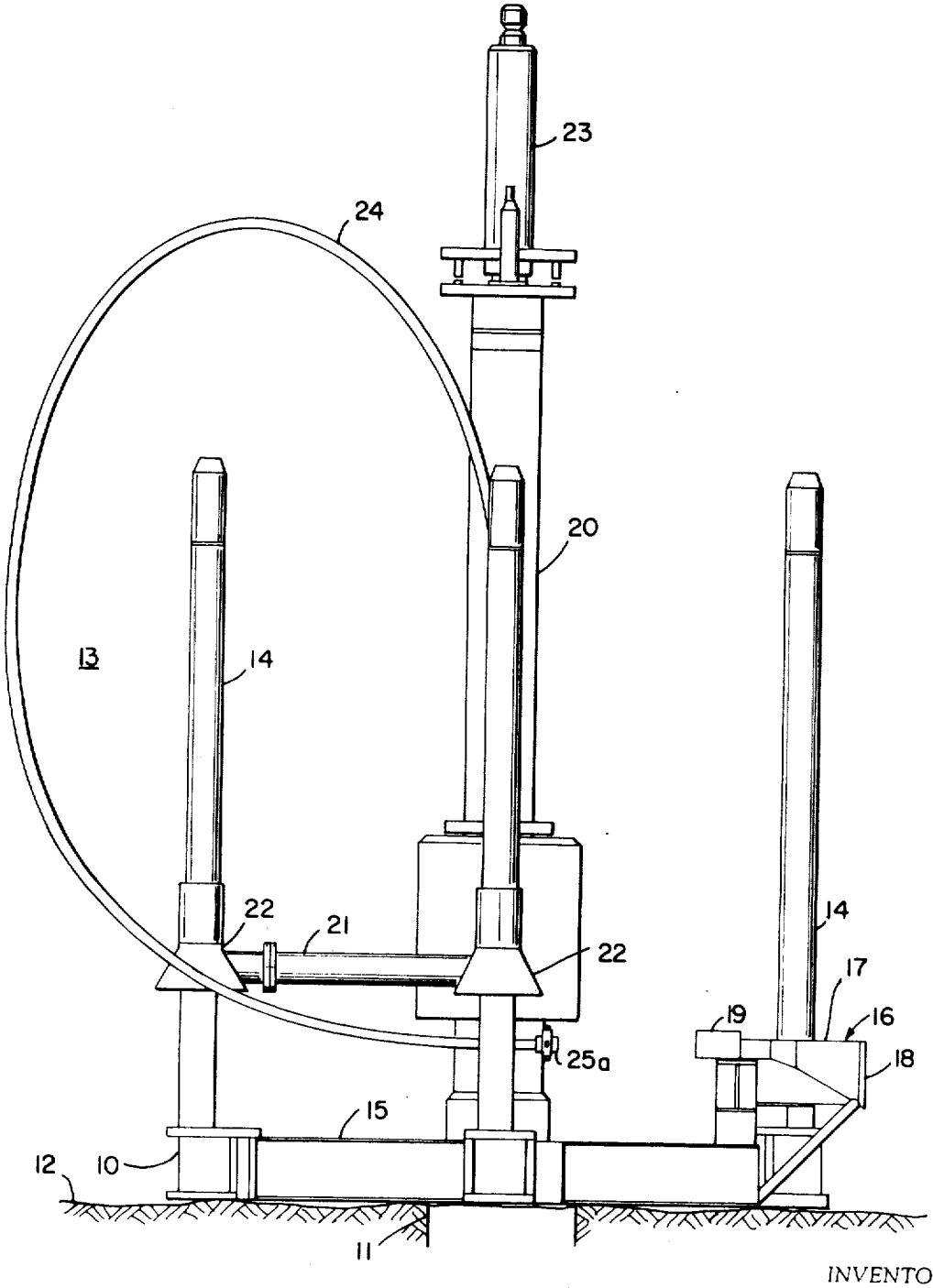


FIG_4

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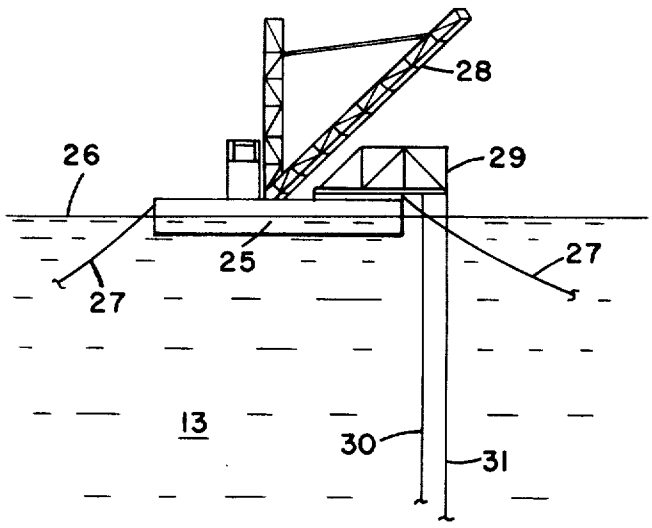


FIG_5

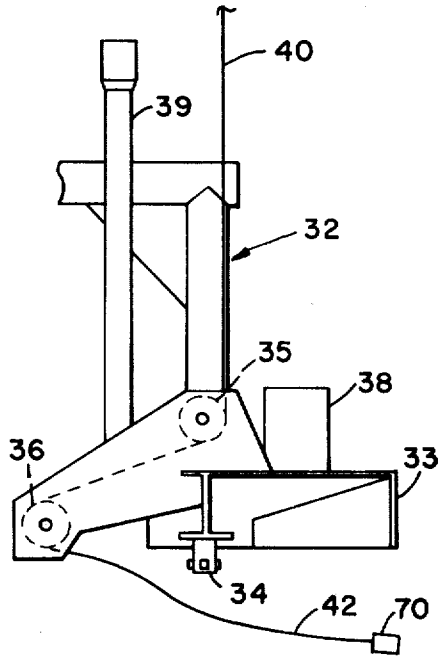
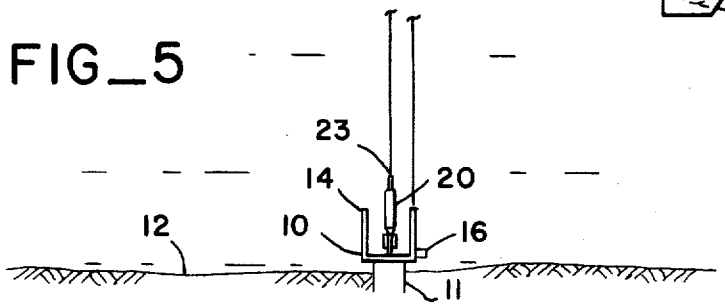
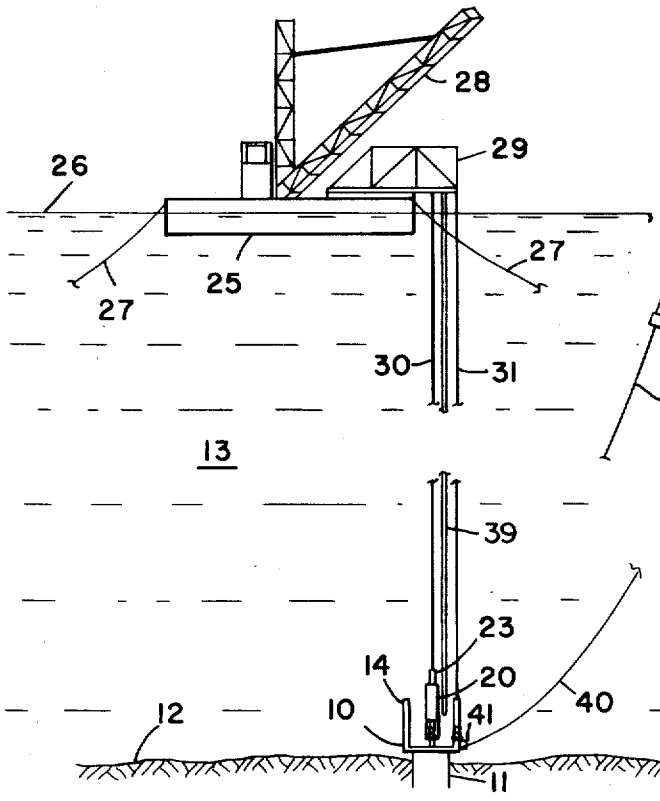


FIG_6





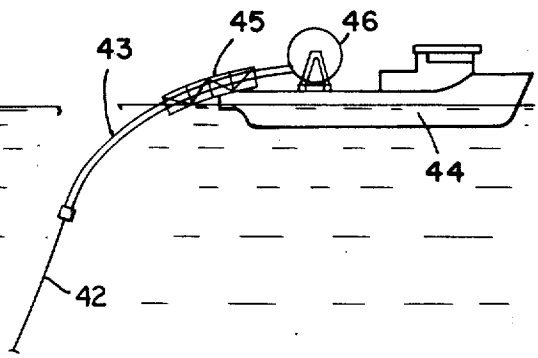


FIG_9

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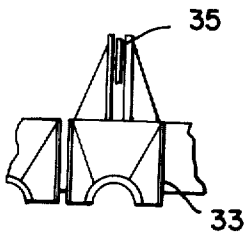


FIG_7

FIG_8

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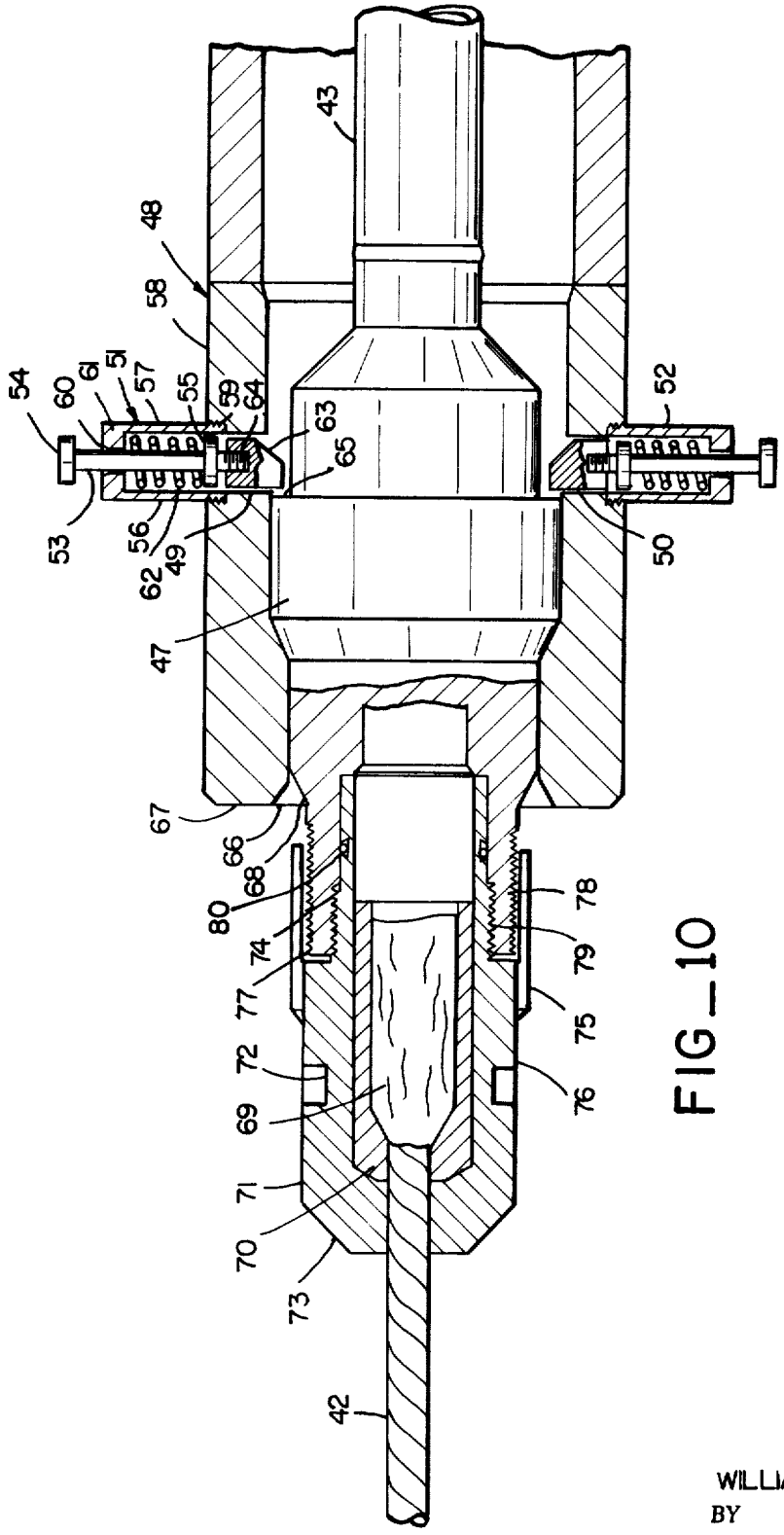


FIG_10

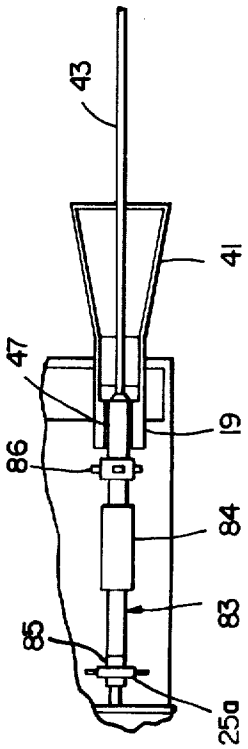
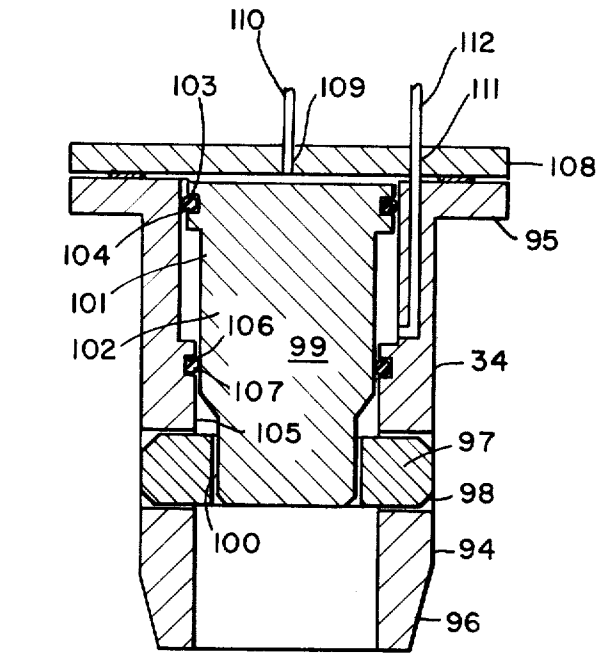


FIG_11

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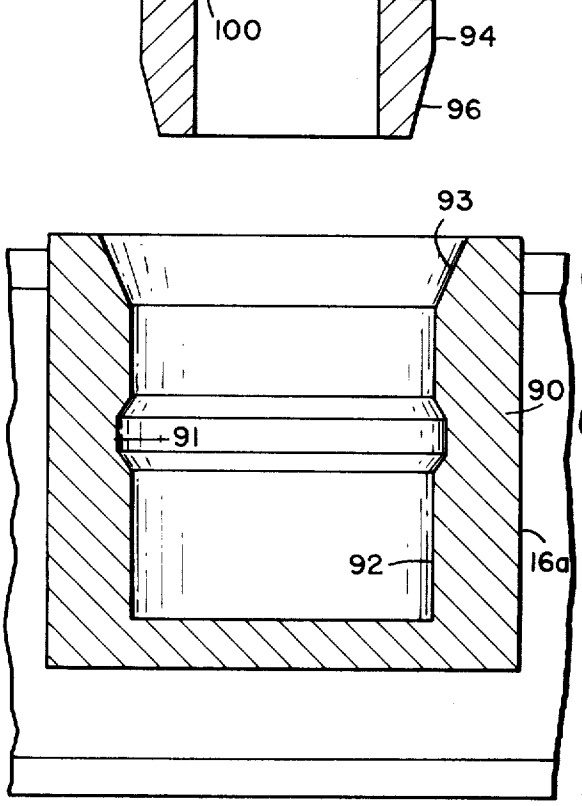


FIG_12

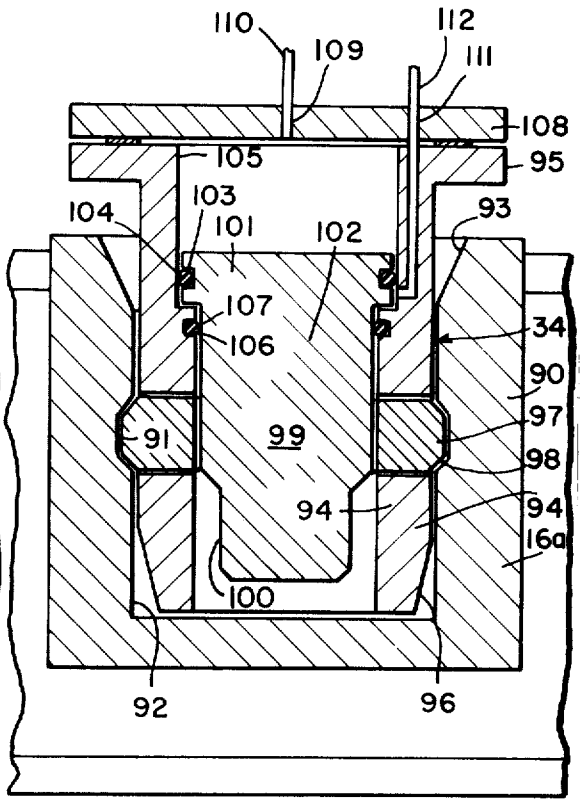


FIG_13

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METHOD AND APPARATUS FOR CONNECTING FLOWLINES TO UNDERWATER WELLHEADS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to underwater flowlines; and, more particularly, to a method and apparatus for connecting underwater flowlines to wellheads extending into the floor of a body of water.

2. Description of the Prior Art

The development of offshore oil and gas wells involves the extension of wells into the ocean floor. It is often desirable to provide one or more flowlines from the wellhead of such wells to a remote point, as for example, to shore or another wellhead. The flowlines may serve many purposes, the most common being to carry off the output of oil or gas from the well. Since the flowline (also referred to as a pipeline) lays in a substantially horizontal position along the floor of the body of water, a problem arises in coupling such flowlines to the wellhead in a manner providing fluid communication therebetween.

Present flowline connecting equipment and methods have not proven satisfactory. There exists a need for flowline connecting equipment that can be used to readily and economically connect one or more flowlines to a wellhead on the ocean floor.

SUMMARY OF THE INVENTION

It is an object of this invention to provide a method and apparatus for connecting one or more flowlines to a wellhead on the ocean floor.

It is a further object of this invention to provide a method and apparatus for pulling one or more flowlines into fluid communication with a wellhead on the ocean floor.

These and other objects are preferably accomplished by attaching a pulling head to the flowline and anchoring a pulling head fixture to the wellhead. A releasable pulling tool having a wireline in slidable engagement with the fixture on the wellhead is connected to the pipeline pulling head and the head is pulled into engagement with the fixture. When in proper position, the pulling tool is released and fluid communication may then be provided between the wellhead and the pulling head and thus the flowline.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a vertical sectional view of a wellhead guide structure for carrying out the techniques of my invention;

FIG. 2 is a top plan view of the guide structure of FIG. 1;

FIG. 3 is a detailed view of one of the lower-half horn assemblies of the guide structure of FIGS. 1 and 2;

FIG. 4 is a vertical sectional view of the guide structure of FIG. 1 showing a Xmas-tree assembly in place on the structure;

FIG. 5 is a vertical sectional view of a surface work vessel and its relation to the wellhead equipment of FIG. 4 for carrying out the techniques of my invention;

FIG. 6 is a detailed view of a portion of the apparatus of FIG. 5;

FIG. 7 is a detailed view of a portion of the pull-in fixture of FIG. 6;

FIG. 8 is a vertical sectional view, similar to FIG. 4, showing the pull-in fixture of FIGS. 6 and 7 in place on the wellhead guide structure;

FIG. 9 is a vertical sectional view, similar to FIG. 5, showing a pipe laying vessel in conjunction with the work vessel for carrying out the techniques of my invention;

FIG. 10 is a vertical sectional view of a portion of the apparatus of FIG. 9;

FIG. 11 is a top plan view of a portion of the apparatus of FIG. 8 showing the flowline after installation on the wellhead guide structure; and

FIGS. 12 and 13 are detailed views of a portion of the apparatus of FIG. 4.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. 1 of the drawing, a wellhead guide structure 10 is shown communicating with a well 11 extending into the floor 12 of a body of water 13. Guide structure 10 includes a plurality of upwardly extending guide structure posts 14 (such as posts 14*a*, *b*, *c* & *d* of FIG. 2) having suitable bracing 15 extending therebetween. A flowline connector is carried by guide structure 10. Flowline connector 16 includes one or more outwardly flared flowline guide members (FIG. 2) in the preferable form of the bottom half of a horn 17 as shown in FIG. 3. Each of the bottom-half horns 17 is open at its flared end 18 for receiving a flowline therein, and, at the rear end, includes a split sleeve-type receptacle 19 (FIG. 3), open at the top, for receiving the pulling head of a flowline as will be discussed further hereinbelow. The flowline connector 16 is preferably fastened to the guide structure 10 before running the structure 10 into engagements with well 11 as is well known in the art. The connector 16 also includes at least a pair of receptacles 16a for receiving lock down mechanism (not shown) therein as will be described further hereinbelow.

At this point, a conventional Xmas-tree-type assembly 20 is lowered into engagement with guide structure 10 as is also well known in the art. Thus, as seen in FIG. 4, Xmas tree assembly 20 includes guide arms 21 having a plurality of guide sleeves 22 thereon for slidably engaging posts 14 (only two such sleeves being shown in FIG. 4). Conventional pipe string connecting means 23 is carried at the upper end of assembly 20. At least one wellhead flowline 24 preferably extends in a loop from fluid engagement with the portion of assembly 20 in fluid communication with well 11 for removing fluids therefrom. Obviously, each horn 17 may include a flowline 24 extending thereto. A pipe coupling 25*a* is disposed at the free end of flowline 24 and is adapted to be coupled to the flowline which is to be connected to horn 17 for flowing fluids therethrough as will be discussed further hereinbelow.

These operations, i.e., the installation of the guide structure 10 and Xmas-tree assembly 20 as discussed hereinabove, may be carried out from a conventional platform structure, such as a large drilling rig (floating or bottom-supported). After the tree assembly 20 is installed, the drilling rig (not shown) moves off and a smaller work barge 25 is moved to install and connect the flowlines. Thus, vessel 25 is shown in FIG. 5 floating on water surface 26 and anchored over well 11. The

platform structure may be permanently anchored in place or, as shown, be temporarily anchored by mooring lines **27** or the like leading to suitable anchors (not shown) on the ocean floor **12**. Vessel **25** preferably includes suitable working equipment thereon, such as a crame **28**, a work platform **29**, etc. A plurality of guidelines are connected to the guide structure posts **14** of guide structure **10**. The guidelines are preferably connected at least to the posts **14** adjacent to the flowline connector **16**. For example, the guidelines are connected to posts **14***b*, *c* & *d* of FIG. **2**, only guidelines **30** and **31** (connected to posts **14***d* and **14** *c* respectively) being shown in FIG. **5**. These guidelines may be connected to the posts by any suitable means known in the art, as for example, by either underwater divers or remote means (not shown).

Referring now to FIG. **6**, a pulling tool fixture **32** is used in pulling the flowlines into flowline connector **16**. The tool fixture **32** includes four individual upper halfs of horns **33** (FIG. **7**) adapted to mate with the lower-half-horns **17** of connector **16** as will be discussed further hereinbelow with respect to FIG. **8**. As can be seen in FIG. **6**, pulling tool **32** includes a pressure-actuated locking mechanism **34** adapted to engage mating receptacle **16***a* (FIG. **2**) on connector assembly **16**.

Referring now to FIG. **12**, locking mechanism **34** is shown about to be lowered into engagement with receptacle **16***a*, various portions of the apparatus of my invention being omitted for convenience of illustration. Receptacle **16***a* includes a generally U-shaped housing **90**, open at its upper end, and an annular groove **91** extending about its inner wall **92**. The upper portion of inner wall **92** may be upwardly and outwardly tapered, as at taper **93**.

Locking mechanism **34** includes an outer body member **94** having an upper flange **95** and being slightly tapered inwardly and downwardly at its lower end as at taper **96**. Locking means **97** is disposed in an aperture **98** in body member **94**. The outer extent of locking means **97** is generally flush with the outer wall of body member **94** prior to installation in receptacle **16**a.

Mechanism **34** includes a member **99** slidably disposed within body member **94**. Member **99** has a reduced portion **100** at its lower end and an enlarged portion **101** at its upper end. Mid body portion **102** is thus greater than portion **100** but less than portion **101**. Portion **101** may include a groove **103** therein for receiving a conventional O-ring **104**. The inner wall **105** of body member **94** may include a similar groove **106** for receiving a like O-ring **107**. A plate **108** closes the top of flange **95** and is sealed thereto by any suitable means. A latching inlet **109** extends through plate **108** for connection to a hydraulic hose **110** for latching mechanism **34** is receptacle **16***a*. An unlatching outlet **111** extends through plate **108** and body member **94** for connection to a hydraulic hose **112** for unlatching mechanism **34** from receptacle **16**a.

Referring now to FIG. **13**, mechanism **34** is lowered into engagement with receptacle **16***a* and hose **110** is actuated thus forcing member **99** down within body member **94**. Locking means **97** is pushed by portion **102** outwardly and engages groove **91** on the inner wall **92** of receptacle **16***a*. By means of hose **112**, fluid may be withdrawn from the coupled position of FIG. **13** and the mechanism **34** may be disengaged from receptacle **16***a*.

A pair of sheaves **35** and **36** are carried by pulling tool fixture **32** (see also FIGS. **6**, **7** & **8** for each horn **33**). Pulling tool fixture **32** also includes suitable guide sleeves thereon sleeves **37** and **38** being shown in FIGS. **6** and **8**, for engaging posts **14***d* and **14***c*, respectively (the guide sleeve for post **14***b* not being shown for convenience of illustration). The pulling tool fixture **32** is lowered on pipe **39** which preferably include a bumper sub (telescopic element) **39**–*a* to accommodate vertical heaving motions of the work barge **25**. A hydraulic hose (or hoses)—not shown—may be attached to pipe landing string **39***b* (FIG. **9**) to actuate the lock-down mechanism **34** on the pulling tool fixture **32**.

A pulling wire **40**, extending from surface vessel **25** (see FIG. **8**) extends under sheave **35**, then over sheave **36** where it is adapted to be attached to a suitable flowline (see the dotted lines in FIG. **6**--the free end of wire **40** not shown in FIG. **6** as attached to a flowline). Preferably, wire **40** is prethreaded onto sheaves **35** and **36** prior to lowering pulling tool fixture **32** into place.

Referring now to FIG. **8**, the pulling tool fixture **32** is lowered on pipe running string **39b** into engagement with flowline connector **16**. As can be seen, the upper-half horn **33** mates with the lower-half horn **17** to form a complete horn **41**. Guide sleeves **37** and **38** telescopingly fit over posts **14** as shown and discussed hereinabove. The locking mechanism **34** (FIG. **6**) is actuated through hydraulic hoses attached to pipes **39** and **39***a* thus locking pulling tool fixture **32** to flowline connector **16**. The free end **42** of pulling wire **40** now extends through the horn **41**.

As can be seen in FIG. **9**, the free end **42** of wire **40** is next attached to a flowline **43** which is being payed out from a suitable spool barge **44** or the like floating on the water surface **26** a suitable distance laterally of well **11**, say 600 feet. Barge **44** preferably carried suitable pipe laying equipment, such as a stinger **45**, a pipe reel **46**, pipe tensioning means (not shown) and the like. Small diameter pipe is often installed by reeling the pipe off a large spool.

Each flowline that is to be connected to the horns **41** formed by flowline connector **16** and pulling tool fixture **32** is preferably equipped with a pulling head **47** (see FIG. **10**) in selective fluid communication with the flowline adapted to engage the split sleeve, receptacle **19** of FIG. **3**. Split sleeve receptacle **19** includes a plurality of apertures, such as apertures **49** and **50** extending therethrough for receiving retaining assemblies **51** and **52**, respectively. Each retaining assembly comprises a pin **53** having an enlarged head **54** at its outer end (i.e., greater than the diameter of apertures **49** and **50**) and an inner piston-type member **55** adapted to slide within a cavity **56** formed within a housing **57** screw-threaded or otherwise mounted on the outer wall **58** of receiving fixture **48**, as at threads **59**. Pin **53** passes through an aperture **60** in the upper wall **61** of housing **57**. A spring **62** is disposed between piston-type member **55** and wall **61** for biasing the retaining assembly **51** (or **52**) inwardly of the receiving fixture **48**. Each pin **53** includes at its innermost end an enlarged wedge-type portion **63**, fastened thereon as by threads **64**, which is adapted to engage an abutment surface **65** on pulling head **47**. In this manner, by ac-

tuating pins 53, the split sleeve receptacle 19 may be released from engagement with pulling head 47. Wedge-type portion 63 and surface 65 prevent rearward movement of pulling head 47 while a wedge-shaped portion 66 on the forward end 67 of receptacle 19 engages an abutment surface 68 to prevent the forward movement of head 47. Surface 68 is so configured as to fit into rear end 19 of horn 41 as will be discussed hereinbelow. Thus, spring-loaded assemblies 51 and 52 capture pulling head 47 when the head 47 is in proper position in receptacle 19.

The free end 42 of pulling wire 40 is prepared with a conventional spelter socket-69 to fit into a hollow sleeve 70*a* in a removable pulling tool 70. A locking sleeve 71 surrounds sleeve 70*a* and includes an annular groove 72 for receiving a diver-operated tool (not shown) for unscrewing the pulling head tool 70 from pulling head 47. Sleeve 71 includes a reduced diameter portion 74 at its rear end. A skirt 75 is secured to the outer surface 76 of sleeve 71 to protect threads on the pipeline pulling head 47. The forward end 67 of pulling head 47 includes a forwardly directed extension portion in the form of a ring 78 or the like which fits into the annular space 77 and releasably locks therein, as by the engagement of 79 on ring 78 with threads 80 on reduced diameter portion 74 as can be seen in FIG. 10. When the pulling wire 40 is to be attached to flowline 43, as discussed hereinabove, the free end 42 of pulling wire 40 is equipped with the removable pulling tool 70 (see FIGS. 6 and 8), and the tool 70 is threaded onto pulling head 47 and head 47 is pulled from barge 44 into engagement with the receptacle 19 of connector 16 shown in FIG. 9.

As seen in FIG. 9, flowline 43 is pulled into engagement with horn 41 by hoisting in on the pulling wire 40 at work vessel 25 until the pulling head 47 engages horn 41 and is captured by latching dogs -63. The removable pulling tool 70 is removed from the pulling head 47 as by releasing ring 78 from engagement in annular space 77. This may be accomplished by sending a diver from vessel 25 to the wellhead structure 10. The pulling tool 70 may then be recovered and other flowlines may be connected to each horn 41 in like manner.

It is now necessary that interconnecting means be provided between coupling 25*a* on the wellhead flowline 24 (or flowlines) and the pulling head 47 of flowline 43. Thus, as seen in FIG. 11, this may be accomplished by a diver installing a connecting spool 83 having mating couplings 85 and 86 at each end for engaging both coupling 25a and pulling head 47, respectively, the spool 83 having a telescoping interpiece 84 for varying the length thereof. Alternatively, spool 83 may have a fixed length with a long nut or the like (not shown) at one end for "pulling up" and thus engaging coupling 25a of the loop of wellhead flowline 24.

Obviously, each flowline 43 may be pulled either singularly or simultaneously into engagement with each horn 41 in like manner. Thus, although it is possible to prethread the pulling wires 40 to pull all the flowlines 43 in one operation, it is preferred to raise the pulling tool 70 after each connection to rethread the pulling wires 40 therein.

I claim as my invention:

1. A method for connecting a flowline to a wellhead extending into the floor of a body of water, said flowline having a pulling head attached thereto, said wellhead having the lower half of a pulling head receiving fixture attached thereto, said method comprising the steps of:

lowering and suitably mating the upper half of said pulling head receiving fixture with the lower half of said pulling head receiving fixture;

attaching a removable pulling tool having a wireline secured thereto to the pulling head of said flowline;

pulling said wireline and thus said tool through said fixture until said attached pulling head engages said fixture; and

removing said pulling tool from said pulling head fixture.

2. The method of claim 1 including the step of providing fluid communication between said pulling head within said fixture and said wellhead.

3. The method of claim 1 wherein the step of pulling said wireline and thus said tool through said fixture includes the step of pulling said tool through said fixture until said tool locks in said fixture.

4. The method of claim 1 wherein the step of pulling said wireline through said fixture includes the step of passing said wireline from a work vessel floating on the water surface through said fixture in slidable relation thereto, and securing said tool thereto prior to attaching said tool to said pulling head.

5. The method of claim 1 wherein the step of pulling said wireline includes the step of paying out said attached flowline from a pipe laying vessel on the water surface while pulling said wireline through said fixture.

6. Apparatus for connecting flowlines to a wellhead structure extending into the floor of a body of water, comprising:

at least one flowline having a pulling head attached thereto and in selective fluid communication therewith;

pulling head receiving fixture means adapted to receive said pulling head said fixture means comprising at least one lower half horn-shaped member fixed to said wellhead structure, said pulling head fixture having at least one mating upper half-horn-shaped member selectively removable on said wellhead structure, said upper and lower half-horn-shaped members forming at least one unitary complete horn-shaped member having a flared mouth and a rear end communicating therewith for receiving said pulling head therein; and

said pulling head including selectively releasable pulling tool means thereon adapted to engage said pulling head for pulling said pulling head through and into engagement with said pulling head fixture means.

7. The apparatus of claim 6 wherein said pulling tool means includes a wireline extending through said fixture means in slidable relationship thereto.

8. The apparatus of claim 6 including interconnecting means extending between said wellhead structure and said pulling head for providing fluid communication therebetween.

* * * * *