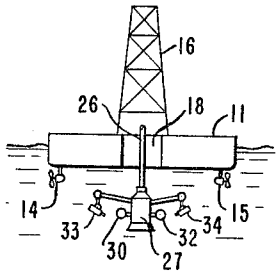
Aug. 9, 1966 B. J. WATKINS 3,265,130

METHOD AND APPARATUS FOR DRILLING UNDERWATER WELLS

Filed May 23, 1962

5 Sheets-Sheet 1



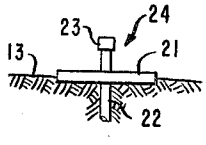


FIG. 1

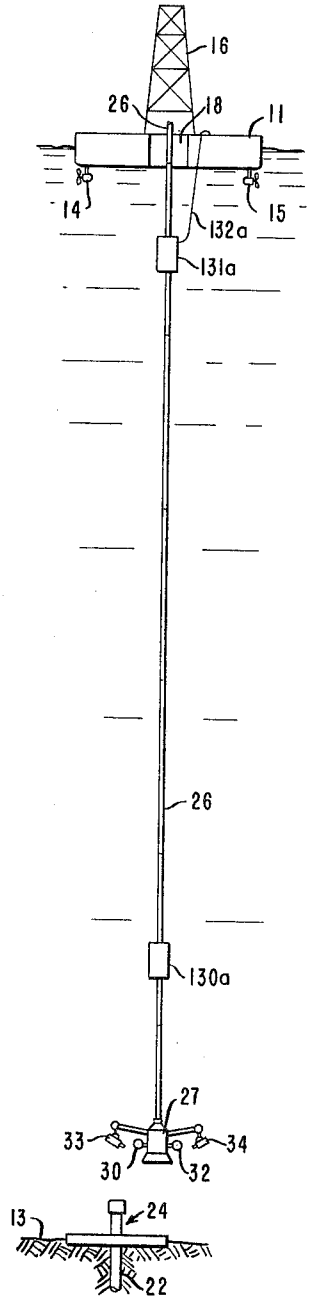


FIG. 2

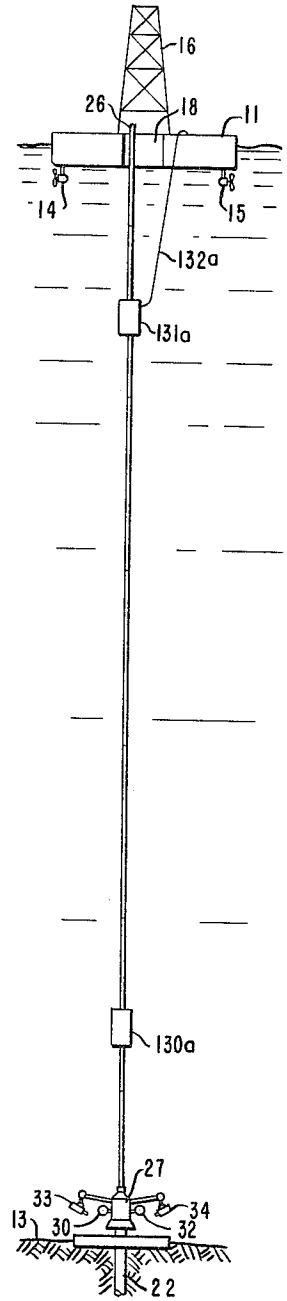


FIG. 3

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Aug. 9, 1966 B. J. WATKINS 3,265,130

METHOD AND APPARATUS FOR DRILLING UNDERWATER WELLS

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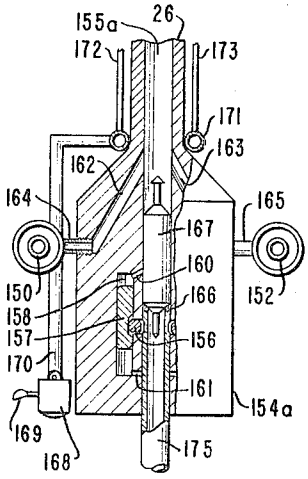


FIG. 9A

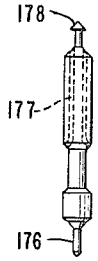


FIG. 9B

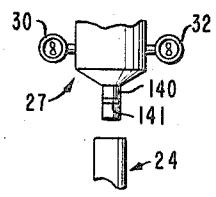


FIG. 10

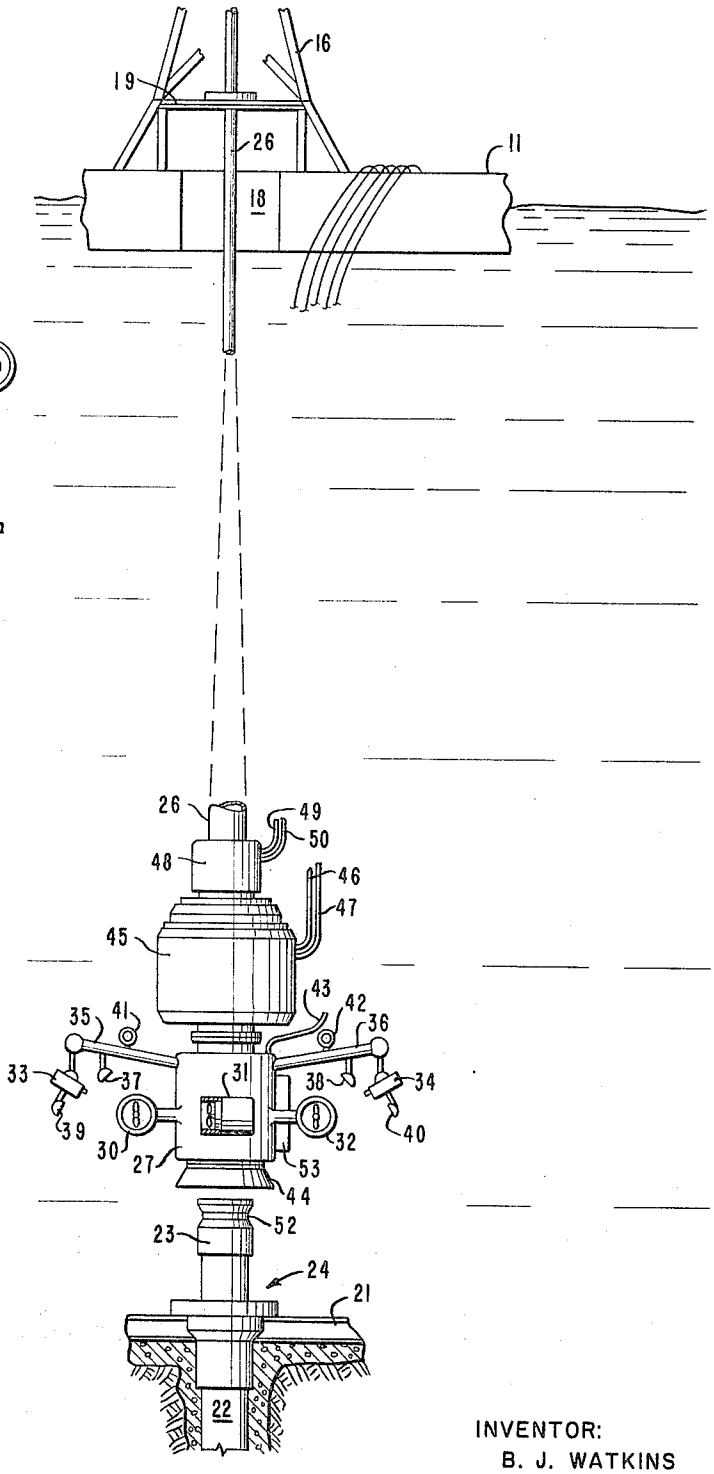


FIG. 4

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METHOD AND APPARATUS FOR DRILLING UNDERWATER WELLS

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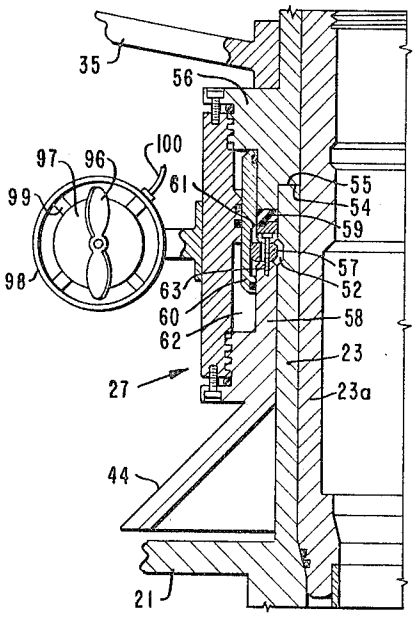


FIG. 5

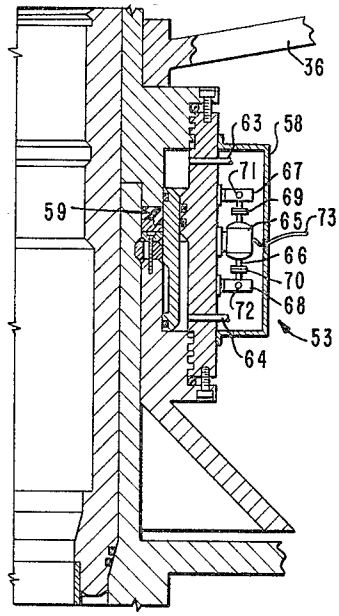


FIG. 5A

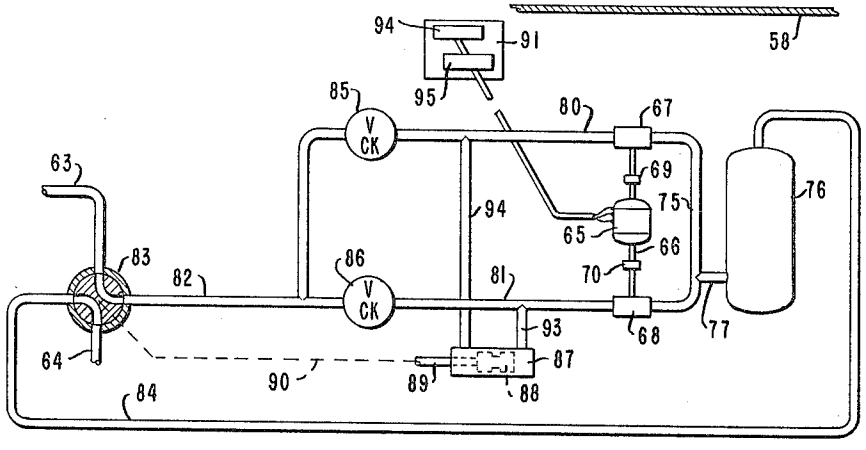


FIG. 6

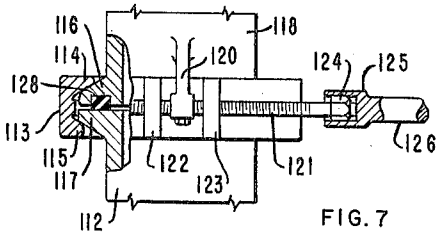


FIG. 7

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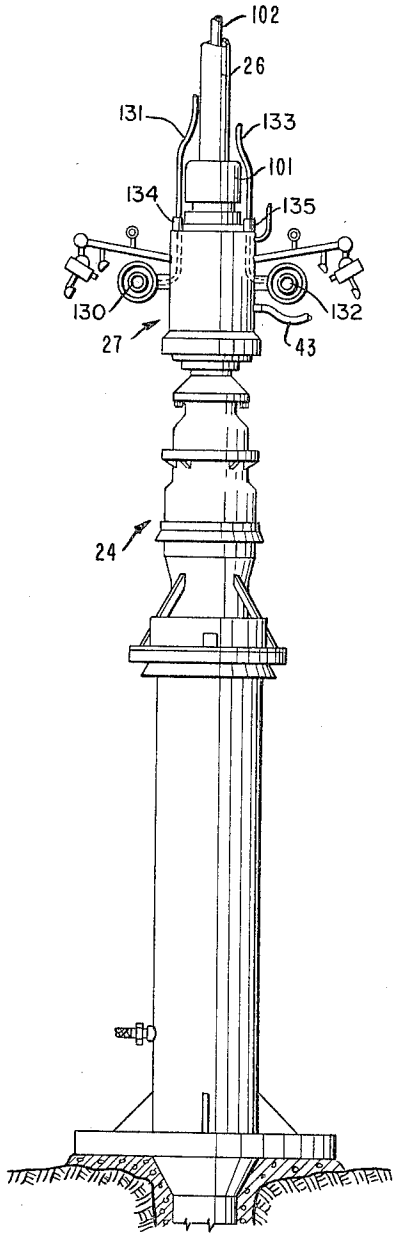


FIG. 9

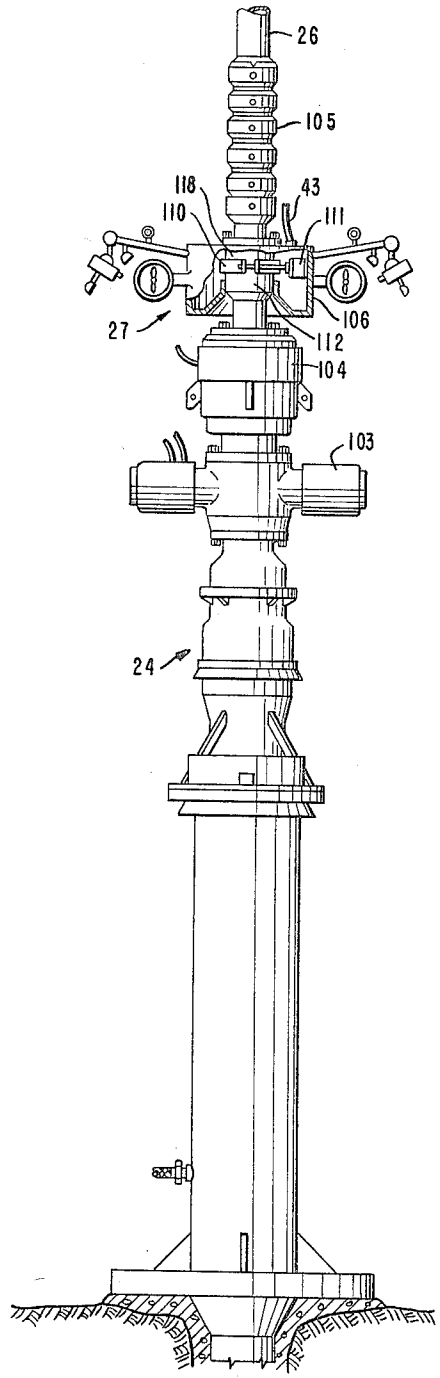


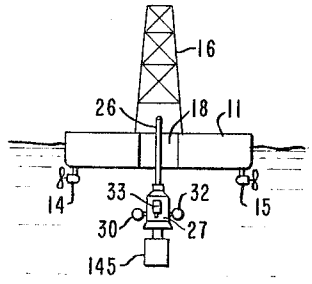
FIG. 8

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Aug. 9, 1966 B. J. WATKINS 3,265,130

METHOD AND APPARATUS FOR DRILLING UNDERWATER WELLS

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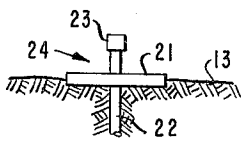


FIG. 11

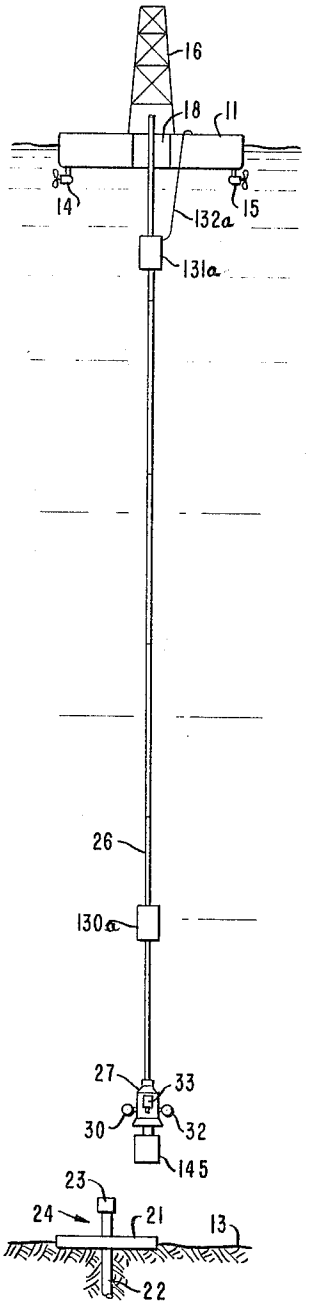


FIG. 12

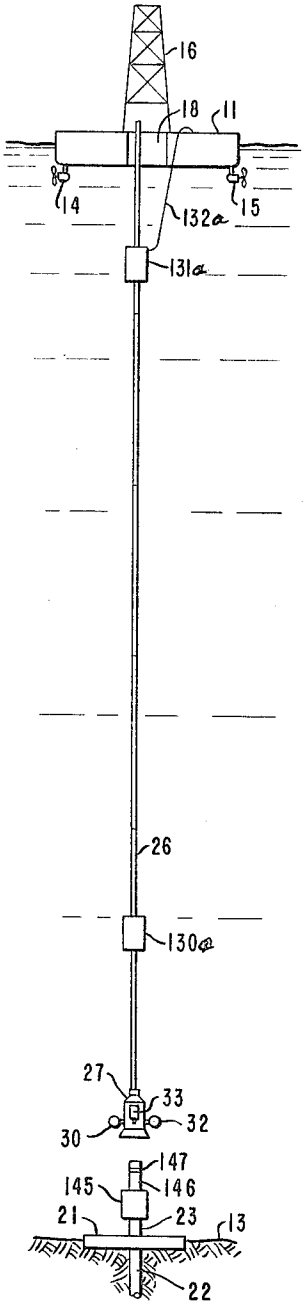


FIG. 13

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United States Patent Office 3,265,130 Patented August 9, 1966

3,265,130
METHOD AND APPARATUS FOR DRILLING UNDERWATER WELLS

Bruce J. Watkins, West Covina, Calif., assignor to Shell Oil Company, New York, N.Y., a corporation of Delaware

Filed May 23, 1962, Ser. No. 197,105
5 Claims. (Cl. 166—46)

This invention relates to a method and apparatus for use in drilling, completing and working over oil and gas wells at offshore locations, and pertains more particularly to a method and apparatus for establishing fluid communication between a vessel on the surface of a body of water and a wellhead assembly positioned on the ocean floor or at a substantial depth below the surface of the water.

In an attempt to locate oil fields, an increasing amount of well drilling has been conducted at offshore locations, such for example, as off the coast of Louisiana, Texas and California. Methods and apparatus have been recently developed for drilling and completing wells wherein both the well casinghead and subsequently the wellhead assembly and casing closure device are located underwater at a depth sufficient to allow ships to pass over them. Preferably, the casinghead and wellhead closure assemblies are located close to the ocean floor. In order to install well drilling equipment underwater at depths greater than the shallow depth at which a diver can easily operate, it has been necessary to design entirely new equipment for this purpose.

Wells drilled in deep water, that is, water ranging from 100 to 1500 feet or more in depth, are drilled from floating vessels of varying designs commonly known as drilling barges or drilling vessels. In one method of drilling, a large-diameter pipe known as a marine conductor pipe is put together and arranged to extend from the drilling wellhead assembly on the ocean floor to the vessel on the surface of the water. In this method a drill pipe rotates within the conductor pipe with drilling fluid being circulated down through the drill pipe, through the bit at the bottom thereof, up the outside of the drill pipe and thence upwardly through the annular space between the conductor pipe and the drill pipe to return to the vessel.

One of the problems in drilling underwater wells is that of placing the wellhead equipment on the ocean floor and subsequently establishing communication between the wellhead equipment and the vessel on the surface of the water by means of a marine conductor pipe. There are two general methods by which a marine conductor pipe may be made up and lowered from the vessel at the surface of the water and guided into register with the top of the wellhead, or the top of the drilling wellhead assembly, which may be positioned several hundred feet below the surface of the water. In one method a plurality of guide lines are arranged between the wellhead assembly on the ocean floor and the vessel at the surface of the water. A guide bracket may be slidably mounted between the guide lines and connected to the lower end of a marine conductor pipe at the surface. Thus, as the marine conductor pipe is lowered through the water its lower end will be guided by means of the guide lines and guide bracket into register with the top of the wellhead or the wellhead assembly.

In the second method, a well is started and a large-diameter pipe string is cemented therein prior to running blowout preventers and a marine conductor pipe into place at the top of the well by stripping it down over the drill string or another pipe string extending from the well to the vessel at the surface. In this stripping operation, the marine conductor pipe, being of larger diameter than

drill pipe or a cementing pipe string in the well, is lowered down over the pipe and concentric therewith, the inner smaller diameter pipe string being employed as a guide for the marine conductor pipe. After the lower end of the marine conductor pipe has been seated on the top of the well or wellhead assembly, the drill pipe or other pipe string inside the marine conductor may be withdrawn to the vessel with a marine conductor pipe acting as a guide for future operations in running pipe into the well or in drilling.

The present invention is concerned with another method by which a marine conductor pipe may be run into place and secured to an underwater wellhead assembly to established communication between an underwater well and a vessel on the surface of the water. The use of flexible guide lines is a cumbersome method since it is difficult to replace the guide lines or attach them to the underwater well head assembly when it is desired to go back and re-enter the well for work-over operations or after disconnecting from the wellhead during a storm. In the event that the guide lines are attached to a buoy for subsequent use, they become a navigation hazard. In the event that the guide lines are dropped to the ocean floor, they often become entangled and cannot be readily used in future operations. The stripping of a marine conductor pipe over drill pipe or another pipe string extending from the wellhead assembly to the vessel at the surface is a time-consuming and difficult operation.

It is therefore a primary object of the present invention to provide a method and apparatus for establishing a fluid communication between a vessel at the surface of a body of water and an underwater well or wellhead assembly positioned at a substantial depth in the water.

A further object of the present invention is to provide a marine conductor pipe which may be lowered from a vessel on the surface of the water and guided into register and seating position on a wellhead or wellhead assembly without employing any flexible guide means or pipe means extending between the well and the vessel.

Another object of the present invention is to provide a method and apparatus for readily connecting the lower end of a marine conductor pipe to a wellhead assembly in a fluidtight manner whereby various pieces of well drilling, completing and work-over equipment may be lowered through the marine conductor pipe into the well.

A further object of the present invention is to provide a method and apparatus for lowering various wellhead components, such for example, as a blowout preventer during drilling operations, or a wellhead bonnet during completion operations, into register and on or in the top of a wellhead assembly without the use of any guide means extending from the wellhead assembly to the vessel on the surface.

Another object of the present invention is to provide a marine conductor pipe assembly of rugged design which can be assembled in sections and lowered through the water from a vessel without guide means so that the lower end of the marine conductor pipe assembly may be readily locked on the top of an underwater wellhead assembly in a fluidtight manner.

These and other objects of this invention will be understood from the following description taken with reference to the drawing, wherein:

FIGURES 1, 2 and 3 are diagrammatic views taken in longitudinal projection illustrating sequential steps in the method of the present invention of lowering a marine conductor pipe from a vessel on the surface of the ocean to a seated position at the top of a wellhead assembly on the ocean floor;

FIGURE 4 is a diagrammatic view taken in longitudinal projection illustrating the marine conductor pipe of the

present invention provided with a blowout preventer and a landing head about to be seated on the top of a casinghead of an underwater wellhead positioned on the ocean floor;

FIGURES 5 and 5A are longitudinal views taken in partial cross section of one form of a landing head assembly in its unlocked and locked positions respectively;

FIGURE 6 is a flow diagram of one form of an electrohydraulic actuating apparatus for providing an operating pressure fluid to actuate the locking components of the landing head of FIGURE 5;

FIGURE 7 is a longitudinal view, taken partially in cross section, of one form of a pipe coupling means;

FIGURE 8 is a diagrammatic view taken in longitudinal projection illustrating a marine conductor pipe of the present invention secured to the top of an underwater wellhead having blowout preventers mounted thereon;

FIGURE 9 is a diagrammatic view taken in longitudinal projection of an underwater wellhead having another form of the marine conductor pipe of the present invention secured to the top thereof;

FIGURE 10 is a fragmental view taken in longitudinal projection of another form of the lower end of a marine conductor pipe about to be seated in the casinghead of an underwater well; and

FIGURES 11, 12 and 13 are diagrammatic views taken in longitudinal projection illustrating sequential steps of a method of installing a wellhead component on an underwater wellhead by the apparatus of the present invention.

Referring to FIGURE 1 of the drawing, a drilling barge or vessel **11**, of any suitable floatable type is illustrated as floating on the surface of a body of water **12** and being substantially fixedly positioned over a preselected drilling location by suitable barge positioning means or by being anchored to the ocean floor **13** by suitable anchors (not shown) which would be connected to the vessel **11** by anchor lines. One suitable form of a vessel positioning device may be a plurality of outboard motors **14** and **15** having propellers opposingly-directed and operated either continuously or intermittently to maintain the vessel substantially fixedly positioned in the water. A derrick **16** is vertically positioned over a slot **18** in the barge which may be either centrally located or may extend in from one edge. Some well-drilling or work-over operations may be carried out over the side of the barge or vessel without the use of a slot. Additionally, it is to be understood that the equipment of the present invention may also be used when drilling a well from any suitable operational base positioned above the surface of the water, such for example, as a drilling barge having legs extending to the ocean floor or from a platform permanently positioned on the ocean floor.

A typical underwater wellhead structure during the early stages of drilling operations is illustrated in FIGURE 1 as comprising a base member **21** which is positioned on the ocean floor **13** and is fixedly secured to a conductor pipe or large-diameter casing **22** extending into a well, which has been previously drilled, and is preferably cemented therein. Thus, the base structure **21** is rigidly secured to the ocean floor in order to support a Christmas tree or a production wellhead assembly to be attached to the top of any suitable type of casinghead **23** after the well has been completed. The underwater wellhead assembly will be referred to herein generally with reference to numeral **24** no matter what form of wellhead assembly is used, whether the wellhead assembly be partially completed as in the early stages of the well, or whether it be in the form of a drilling wellhead assembly or a production wellhead assembly.

Lowerable from the vessel **11** is an elongated marine conductor pipe **26** having a suitable landing head **27** at the lower end thereof. The marine conductor pipe **26** is in the form of a large-diameter pipe, say from about 10 to 20 inches or so in diameter, which is adapted to extend from the vessel **11** to the wellhead assembly **24** and the

upper end to the casinghead **23** thereof. The length of the marine conductor pipe **26** depends upon the depth of the water at the drilling location, while the diameter of the conductor pipe is governed by the size of the drill bit which is intended to pass through the conductor pipe and into the well in order to continue drilling of the well. During drilling operations the drill pipe or string with the drill bit attached to the lower end thereof extends through the marine conductor pipe from the barge and is rotated therein. Simultaneously, drilling fluid is pumped from the barge down the drill pipe, out the bit at the bottom thereof, and thence up the annular space between the drill pipe and the marine conductor pipe to return to the barge for recirculation during drilling operations. Thus, it will be seen that during this mud circulation operation it is necessary for the landing head **27** at the lower end of the marine conductor pipe **26** to be secured to the wellhead assembly in a fluidtight manner so that drilling fluid is not lost to the ocean. Additionally, since there may be some movement of the vessel which is transmitted to a vertical movement of the marine conductor pipe **26**, it is preferred that the landing head **27** be locked on the casinghead **23** on top of the wellhead assembly **24**. In other operations it is not necessary that the landing head **27** be secured to the wellhead assembly **24** in a fluidtight manner as the marine conductor pipe **26** may be merely used as a guide through which equipment, such as a tool or a string of well tubing, may be guided from the vessel **11** into the wellhead assembly **24**.

In order that the landing head **27** at the lower end of the marine conductor **26** may be guided into substantial axial aligned position above the casing **23** of the wellhead assembly **24**, the landing head is provided with a suitable propulsion apparatus together with observation or viewing equipment and/or well locating devices by which a wellhead assembly may be located. As shown in more detail in FIGURE 4, the landing head **27** is provided with any suitable type of propulsion means which may take the form of one or more electrically-actuated motor driven propeller units **30**, **31** and **32** mounted outboard of the landing head housing.

The observation or viewing means carried by the landing head **27** may comprise swivel-mounted television cameras **33** and **34** which may be remotely positioned by means of controls on the vessel **11** at the surface. Television cameras **33** and **34** are shown as being mounted on outwardly-extending arms **35** and **36** although it is to be understood, that if desired, the television cameras **33** and **34** may be mounted in any suitable means, including being fixedly secured to the outside of the landing head **27** pointed downwardly. In order to illuminate the area in the vicinity of the landing head **27** suitable flood lights **37** and **38** are provided. At least a pair of flood lights **39** and **40** are arranged to the area in front of the television cameras **33** and **34**. If desired, the landing head is equipped with any suitable object locating system, such for example the well known SONAR system, which is diagrammatically represented on the present apparatus by elements **41** and **42**. The SONAR system may be used in addition to or as an alternate for the television camera. In the event that wellhead was supplied with a source of radioactive material, the elements **41** and **42** could be radioactive detectors used for locating the wellhead instead.

Power for operating the propulsion units **30**, **31** and **32**, television cameras **33** and **34**, lights **37**, **38**, **39** and **40** and the SONAR system is provided through an electrical transmission cable **43** which extends to the vessel **11**. Preferably, the cable **43** is strapped to the outside surface of the marine conductor pipe **26** and extends therealong to the vessel **11**.

To facilitate bringing the landing head **27** in register with the casinghead **23**, the lower end of the end of the landing head **27** is preferably provided with a skirt-like guide member **44** having a diameter substantially greater

than that of the casing 23. In the early stages of drilling a well, it may be desirable to provide a suitable blowout preventer 45 which is actuated by pressure fluid through one or more conduits 46 and 47. The lower end of the marine conductor pipe 26 may be fixedly secured to the top of the blowout preventer 25 in any suitable manner, as by means of bolting, or by a suitable connector device 48 which may be of the type that can be latched or unlatched remotely by means of a pressure fluid flowing through one or more conduits 49 and 50.

The casinghead 23 is preferably provided with a groove 52 in the outer wall thereof so that the landing head 27 may be securely locked thereon. The wellhead connector may be actuated to lock onto the casinghead 52 by means of electric or hydraulic power provided through separate lines from the vessel similar to lines 46 and 47 to the blowout preventer 45. However, the wellhead connector or landing head 27 is preferably provided with a self-contained electro-hydraulic unit represented in FIGURE 4 diagrammatically by element 53 which is provided with operating power through the electrical transmission line 43 running to the barge 11 at the surface.

One form of a landing head is shown in greater detail in FIGURES 5 and 5A wherein the landing head 27 is shown as in its seated position on the casinghead which is formed of outer and inner members 23 and 23*a*. The top of the casinghead 23 forms a shoulder 54 for mating with a cooperating landing surface 55 formed on the inner wall of the landing head housing 56. The landing head housing 56 has a vertical bore extending therethrough of a size to receive the casinghead 23–23*a*. A plurality of laterally-extendible latching elements or locking dogs 57 are slidably mounted in openings through the inner wall 58 of the housing 56. An annular piston 60 having a camming surface 61 on its inner face is slidably mounted for limited vertical movement within a chamber 62 formed in the housing 56. The latching elements 57 are slidable laterally relative to holding screws 63 which prevent the latching elements 57 from falling out of the housing. The latching element 57 is shown in its retracted position in FIGURE 5 so that the landing head 27 could be withdrawn vertically off the casinghead 23–23*a*.

In FIGURE 5A the piston 60 is shown as having been forced downwardly by pressure being applied through conduit 63 while fluid was being exhausted from below the piston 60 through conduit 64. As the annular piston 60 is forced downwardly, its camming face 61 also actuates an annular seal 59 carried by the housing wall 58 which forms a fluidtight seal between the landing head housing and the casinghead 23–23*a*. Fixedly secured on the outside of the housing 56 of the landing head and carried thereby is an electric motor 65 whose shaft 66 is operatively connected to drive a pair of pumps 67 and 68 through a pair of over-riding clutches 69 and 70. The over-riding clutches may be of any suitable design such for example as those manufactured by Morse Chain Company, Ithaca, New York, Catalog No. SP–59, page 131, the clutches 69 and 70 forming unidirectional drive assemblies mounted on the shaft between the motor and each of the pumps and arranged so that one pump operates or rotates when the motor turns in one direction and the other pump operates when the motor 65 reverses direction. Thus, it will be understood that only one pump 67 or 68 is operating at a time. The discharge ports 71 and 72 of pumps 67 and 68, respectively, are in fluid communication through a suitable piping circuit with pressure conduits 63 and 64. The entire hydraulic system is enclosed within a watertight housing 58 through which electrical lead 73 extends.

One typical type of piping arrangement is illustrated diagrammatically in FIGURE 6 wherein the intake ports of the pumps 67 and 68 are connected to a conduit 75 which in turn is in communication with a reservoir tank 76 through a conduit 77. The discharge conduits 80 and 81 from the pumps 67 and 68 join to form a common conduit 82 which enters one port of a four-way valve 83. The four-way valve 83 is preferably of the rotary type as illustrated diagrammatically, but may be of any suitable type well known to the art, for example a piston and slide valve type. Two of the other ports of the four-way valve are connected to the fluid conduits 63 and 64 while the fourth port is in communication through conduit 84 with the reservoir 76. Conduits 80 and 81 are provided with check valves or other unidirectional flow devices 85 and 86.

The four-way valve is provided with a hydraulically-operated valve operator diagrammatically shown as comprising a housing 87 having a piston 88 slidably mounted therein, with a piston rod 89 extending therefrom and machanically linked to the rotating four-way valve 83, as represented by the broken line 90. One end of the valve operator housing 87 is in communication through conduit 93 with conduit 81 connected to the discharge of one pump 68, while the opposite end of the valve operator housing 87 is in full communication through conduit 94 with the conduit 80 in communication with the discharge of the other pump 67. The pumps 67 and 68 are preferably of the vane type but may be of any other suitable type. The electric motor 65 employed to drive the pumps 67 and 68 is a reversible motor, preferably a polyphase induction motor having no brushes which reduces the number of elements in the underwater system that would be subject to failure. Switching means would be provided in the controller 91 at the surface on the vessel 11, so that the power input to two of the leads of the motor 65 could be reversed in order to reverse the motor. The reversing switch 94, diagrammatically represented by a box in FIGURE 6 may be of any suitable type well known to the art. Additionally, leads are preferably provided with suitable automatically reset tripping switches 95 which may be either magnetic trip switches or thermal cut-out or overload switches. Thus, by running the motor 65 in one direction or the other to selectively run either pump 67 or pump 68, pressure fluid would be either supplied to conduit 63 or conduit 64 (FIGURE 5A) to actuate the piston 60 in one direction or the other, thus locking or unlocking the landing head 27 to the casinghead 23–23*a*. Alternatively, the landing head may be a mandrel seal without latching means, the seal being in the form of a bag-type rubber member inflatable by fluid pressure to seal against the well casinghead or any other tubular member in a manner described in U.S. Patent 2,808,229 to R. F. Bauer et al.

In FIGURE 5 one form of a propulsion unit for the landing head is illustrated as comprising a propeller 96 driven by a motor 97 and surrounded by a protective shield 98 which is spaced from the motor by means of lugs 99. Current is supplied to the motor through lead 100.

In FIGURE 9 a marine conductor pipe 26 in accordance with the present invention is directly connected by means of a coupling 101 to its landing head assembly 27 which in turn is illustrated as having been secured to the top of a wellhead assembly 24. A drill string or other pipe string 102 is shown as extending down through the marine conductor pipe 26.

In FIGURE 8 another form of a wellhead assembly 24 is shown as having mounted thereon a ram-type blowout preventer 103 and a bag-type blowout preventer 104 having control lines which extend to the surface. Although a marine conductor pipe has some degree of flexibility to it, in many cases it is preferred that a flexible joint 105 be connected between the lower end of the marine conductor pipe 26 and the upper end of the landing head assembly 27. The landing head housing 106 of FIGURE 8 is provided on the inside with a coupling unit 110 and a reversible motor 111 for actuating the coupling 110 and connecting the landing head or the lower end of the marine conductor pipe assembly to the

top of a landing mandrel **112** secured to the upper blowout preventer **104**.

The coupling unit **110** of FIG. 8 is shown schematically in FIGURE 7 as comprising a flexible ring **113** having inwardly-directed upper and lower flanges **114** and **115**, respectively. The spacing between the inwardly directed flanges **114** and **115** is sufficient to contain a pair of flanges **116** and **117** formed on an upper mandrel **118** within the landing head and on the top of the seating mandrel **112** attached to the top of the blowout preventer **104** (FIGURE 8), respectively. With flange **114** extending inwardly further than flange **115**, the coupling ring **113** is carried suspended from the flange **116** in its expanded position so that the lower flange **115** can pass vertically over flange **117** as the landing head **27** (FIG. 8) is raised or lowered off the landing mandrel **112** of the blowout preventer **104**. A boss **120** extending from the side of the mandrel **118** includes an opening or bearing in which a lead screw **121** may rotate. The lead screw passes through threaded flange portions formed at the open ends of the coupling ring **113**. The lead screw **121** is provided with a reverse pitch on opposite sides of the bearing **120** so that upon rotation of the screw head **124** by wrench socket **125** in opposite directions the coupling ring will open or close, as desired, to engage or disengage it so that flanges **116** and **117** can be separated. The socket wrench **125** is connected to a shaft **126** which is driven by the motor **111** (FIGURE 8). Preferably, an annular seal **128** is carried by one of the flanges **116** or **117** to form a fluidtight closure when the flanges **116** and **117** are pulled against each other by tightening of the coupling **113**. A motor **111** (FIGURE 8) is actuated from the surface through control line **43**.

While the apparatus has been described hereinabove with regard to the use of propulsion units **30** and **32** (FIGURE 4) utilizing motor-driven propellers, other types of propulsion units may be employed. For example, in FIGURE 9 the propulsion units are illustrated as a pair of jets **130** and **132** to which fluid under pressure is supplied in any suitable manner, as through conduits **131** and **133** which extend down along the marine conductor **26** and through, or along side the landing head **27**, to be connected to the jets **130** and **132**. The conduits **131** and **133** may be either rigid pipe or flexible hose provided with disconnect couplings **134** and **135** so as to pull the conduits free and back to the vessel after the landing head **27** has been seated on the wellhead.

In practicing the method of the present invention for establishing communication for fluid flow between the drilling platform positioned on a vessel above a body of water and an underwater wellhead assembly at the top of a well, it is first necessary to position the platform **19** (FIGURE 4) of the vessel substantially above the underwater wellhead assembly. In the event that the wellhead has been previously drilled, the exact location of an underwater well is definitely known and has been marked on a map so that it is possible to send a vessel back to the location and locate it by suitable ship-positioning systems, such for example as LORAN or other systems well known to the art so that the vessel is substantially over the wellhead. The vessel is then maintained in that position either by anchors or by motors **14** and **15** (FIGURE 1).

When on location the landing head **27** of the marine conductor pipe **26** is suspended below the vessel **11** at the end of the marine conductor pipe **26** (FIGURE 1). The marine conductor pipe may be made up of many sections of pipe say from 20 to 90 feet long which are connected together end to end and lowered into the water until the landing head assembly **27** is in the vicinity of the wellhead structure, as shown in FIGURE 2. If desired, buoyancy tanks **130***a* and conductor **131***a* may be secured, along with others, if desired to the marine conductor pipe to reduce the weight of the pipe in the water. One or more of the tanks **131***a* may have a control line **132***a* extending thereto from the vessel **11** so that the tank **131***a* may be selectively flooded or made more buoyant by pumping water or air into the tank. As the landing head assembly **27** approaches the wellhead **24**, the lights **37**, **38**, **39** and **40** (FIGURE 4) carried by the landing head assembly illuminate the area in the vicinity of the wellhead **24** and the wellhead can be located by scanning the area with the television cameras **33** and **34**. In the event that the television cameras are not remotely movable in any direction from the vessel, but are fixedly secured to the landing head assembly **27**, the landing head assembly **27** may be rotated from the surface by means of the marine conductor string **26** to cause the entire landing head assembly **27** and the television cameras to rotate sufficiently to locate the wellhead assembly **24**.

As shown in FIGURE 2, it has been noted by means of the television cameras **33** and **34** that the landing head assembly **27** is a few feet off from being in axial register with the wellhead assembly **24**. Thus, the propellers **30** and **32** are actuated and the entire landing head assembly **27** turned by the marine conductor pipe **26** from the surface if necessary to permit the propeller units **30** and **32** to propel the landing head **27** to the left until it is axially aligned with the landing head **24**. During the moving of the lower end of the conductor pipe **26** and its landing head **27** to a position over the wellhead assembly **24**, the marine conductor pipe **26** would pivot slightly from its suspended position on the vessel. Thus, when the lower end of the conductor pipe and its landing head **27** are over the wallhead assembly, the upper end of the marine conductor pipe **26** is preferably moved in the same direction until it is again in a vertical position. If it is only necessary to move the upper end of the marine conductor pipe a few feet, this may be done within the limits of the slot **18** in the vessel **11**, as shown in FIGURE 3. After this movement the marine conductor pipe **26** and its landing head **27** would be lowered into seating position on the top of the wellhead assembly **24** and drilling operations could be carried out by running a drill pipe down through the marine conductor pipe **26** in a manner well known to the art. In the event that it is necessary to move the top of the marine conductor pipe a considerable distance to bring it into vertical alignment again, it would be necessary to reposition the vessel on the surface of the water with regard to the wellhead structure **24** on the ocean floor.

Although the landing head apparatus of the present invention has been described hereinabove with regard to a unit that fits down over a tubular member of an underwater wellhead assembly, it is to be understood that the landing head assembly may be of the type having a downwardly-extending mandrel **140** having a sealing member **141** and if desired latching means (not shown) carried thereon, which would fit within the bore of the wellhead assembly **24** instead of fitting outside it. The seal **141** may be a static seal or one that was actuated after the landing head **27** (FIGURE 10) was set in the wellhead assembly **24**.

The apparatus of the present invention also has great utility in lowering equipment into place on an underwater wellhead assembly or other underwater installation from a vessel positioned at the surface of the water. Thus, as shown in FIGURES 11, 12 and 13, the landing head assembly **27** at the lower end of the marine conductor pipe **26** is shown as being fixedly secured to a piece of apparatus diagrammatically represented at **145**, such as a blowout preventer or a wellhead closure member. By locking the landing head **27** to the top of the equipment **145** in a manner described in FIGURES 5 and 5A with regard to locking the landing head **27** to the top of a casinghead **23–23***a*, a piece of equipment can be lowered down through the water as shown in FIGURE 12 and by observing through the television cameras can be precisely

positioned on the upper end of the casinghead 23. An upwardly extending portion 146 of the piece of equipment 145 would be provided with recesses or a groove 147 to which locking elements of the landing head assembly 27 could be engaged. In the event that the marine conductor pipe and its landing head assembly 27 are not provided with propulsion equipment but merely with underwater observation equipment, the lower end of the marine conductor pipe could be seated on the wellhead assembly by suspending the pipe from the vessel and movably positioning the entire vessel into more accurate alignment over the underwater wellhead. With the vessel substantially aligned over the underwater wellhead the marine conductor pipe could be moved within the slot of the vessel until it was observed to be directly over the wellhead. It would then be lowered so that the landing head would engage the top of the wellhead assembly.

While the apparatus of FIGURE 9 has been described as having jet propulsion units 150 and 152 supplied by fluid under pressure through conduits 151 and 153 extending downwardly from the vessel 11, it is to be understood that pumps on the vessel could be connected to the upper end of the pipe string or conductor pipe 26 for supplying fluid under pressure to the jets 150 and 152. One arrangement of a landing head is illustrated in FIGURE 9A as having a body member 154 with a vertical bore 155 therethrough and any suitable type of connector means, for example, a plurality of locking dogs 156 actuated by a camming piston 157 which would operate in a manner described hereinabove with regard to FIGURES 5–5A.

The piston 157 is slidably mounted in a chamber 158 in communication with the bore 155 of the body member 154 through flow passageways 160 and 161 at the upper and lower ends of the chamber 158. The body member is also provided with flow passageways 162 and 163 in communication through conduits 164 and 165 between the jets 150 and 152 and the bore 155 of the body member 154. A seating shoulder 166 is provided in the bore 155 of the body member to seat a dart 167 of a size to close the bore 155 and the upper flow passageway 160.

Thus, in operation of the apparatus of FIGURE 9A, fluid is pumped, as from the mud pumps on the vessel 11, down pipe 26 where it is deflected by dart 167 through flow passageways 162 and 163 to jets 150 and 152. Jetting fluid from the jets 150 and 152 moves the body member 154 horizontally in a body of water as the pipe 26 is supported by its upper end at the vessel. To determine where the member 154 is relative to an underwater object such as a pipe or a wellhead, one or more horizontally or vertically positioned and/or remotely positionable TV cameras 168 and lights 169 are carried on the body member 154 or may be carried on a depending frame 170 preferably secured to a ring guide element 171 which was adapted to slide up or down pipe 26. The frame 170 and guide element 171 could be raised or lowered between the vessel 11 and the body member 154 by one or more cables 172 and 173, one of which would be an electrical transmission cable for supplying current to the lights and television camera and for transmitting signals from the latter. With jets fixedly positioned on the body member 154, the direction in which the member 154 is moved by the jets may be controlled by turning the top of the pipe 26 at the vessel 11 through the desired angle.

When the body member 154 is finally positioned on a tubular member 175, the pipe 26 is lowered to seat the body member 154 on the pipe 175 as illustrated. After discontinuing the flow of fluid to the jets 150 and 152, the dart 167 may be recovered with any suitable tool well known to the art. The locking dogs 156 could then be actuated by dropping another dart 176, having by-pass conduits 177 therein, down the pipe 26 to seat it on shoulder 166. The dart is of a shape, as shown in FIGURE 9B, to close flow passageways 162 and 163 and to open port 160. Pressure fluid would then be pumped down through pipe 26 and by-pass line 177 into port 160 to drive the piston down and lock the dog 156 in pipe 175. Dart 176 would then be fished out by fishing neck 178 and brought back to the vessel. If desired, the television camera 168, lights 169 and carrier frame 170–171 could be pulled up to the vessel also. Other types of pipe connectors having other types of locking dogs 156 may be employed, as desired.

It is understood that the motor 97 of FIGURE 5 may be a hydraulically-operated motor supplied with power fluid from the vessel through a conduit in place of lead 100, or supplied with power fluid in a manner described hereinabove with regard to FIGURE 9A.

I claim as my invention:

1. A marine conductor assembly for use in drilling, completing and servicing offshore wells and adapted to be sealingly secured to and extend from an underwater wellhead assembly upwardly to a vessel on the surface of a body of water, said apparatus comprising

(a) an elongated tubular element of a length to extend at least from the surface of the water to an underwater wellhead assembly,

(b) coaxially-aligned tubular landing head means secured to the lower end of said tubular element,

(c) remotely-actuatable lock means carried by said landing head for locking it to the cooperating member of said wellhead assembly,

(d) underwater observation means carried by said marine conductor assembly near the lower end thereof for observing the relative position of the landing head as it is lowered along with said tubular element into the proximity of and subsequent engagement with said cooperating member of said underwater wellhead assembly,

(e) fluid jet-type propulsion means carried by said marine conductor assembly near the lower end and outboard thereof for moving the lower end of said marine conductor assembly laterally in a body of water, and conduit means connected to and extending from said fluid jet-type propulsion means to a source of pressure fluid on the vessel at the surface.

2. The apparatus of claim 1 including

(f) radially-actuatable sealing means carried by said landing head and adapted to be positioned between said landing head and a cooperating member of said underwater wellhead assembly when the two are in telescopic engagement.

3. A marine conductor assembly for use in drilling, completing and servicing offshore wells and adapted to be sealingly secured to and extend from an underwater wellhead assembly upwardly to a vessel on the surface of a body of water, said apparatus comprising

(a) a plurality of pipe sections secured together in length to extend at least from the surface of the water to an underwater wellhead assembly,

(b) coaxially-aligned tubular landing head means secured to the lower end of the lowermost pipe section, said landing head having a bore extending into the bottom thereof of a size to receive therein in telescoping arrangement a cooperating tubular member of said underwater wellhead assembly,

(c) radially-actuatable sealing means carried by said landing head and adapted to be positioned between said landing head and a cooperating tubular member of said underwater wellhead assembly when the two are in telescopic engagement,

(d) remotely-actuatable lock means carried by said landing head for locking it to the tubular element of said wellhead assembly,

(e) guiding and orienting means carried by said landing head for observing the relative position of the landing head as it is lowered along with said pipe sections into the proximity of end subsequent engagement with said tubular member of said underwater wellhead assembly, and

(f) fluid jet-type propulsion means carried by said landing head outboard thereof for moving the lower end of said marine conductor assembly laterally in a body of water and conduit means connected to and extending from said fluid jet-type propulsion means to a source of pressure fluid on the vessel at the surface.

4. A method of establishing communication for fluid flow between a drilling platform positioned on a vessel above a body of water and an underwater wellhead assembly at the top of a well, said method comprising

positioning the platform of said vessel substantially above said underwater wellhead assembly,

providing an elongated tubular element with connector means for securing it in engagement with a cooperating tubular element of said underwater wellhead assembly,

mounting underwater observation and fluid jet-type propulsion equipment near the lower end of said elongated tubular element, movably suspending said elongated tubular element from the vessel with its lower end in the water,

lowering said elongated tubular element and its associated equipment substantially vertically from said vessel until the lower end of said elongated element is at substantially the depth of said underwater wellhead assembly,

illuminating the area in the vicinity of the wellhead assembly and observing on the vessel the location of the underwater wellhead assembly relative to the lower end of the tubular element,

pumping fluid under pressure from the vessel to said propulsion equipment to jet the fluid therefrom and propel the lower end of said elongated tubular element laterally into substantial vertical alignment with a cooperating portion of said underwater wellhead assembly,

lowering said elongated tubular element into telescopic mating engagement between the lower end thereof and said cooperating portion of said underwater wellhead assembly, and

moving the upper end of said elongated tubular element into substantial vertical alignment and subsequently raising the observation equipment from the lower end of the tubular member to the vessel at the surface of the water.

5. The method of claim 4 wherein the propulsion equipment is of the fluid jet-type in communication with the lower end of the elongated tubular element near the lower end thereof, said method including the steps of closing the lower end of the elongated tubular element near the lower end thereof at a point below its communication with the jet type propulsion equipment, and subsequently pumping fluid down the elongated tubular elements and through the jet-type propulsion equipment to move the lower end of the elongated tubular element laterally through the water.

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