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UNDERWATER WELL DRILLING APPARATUS

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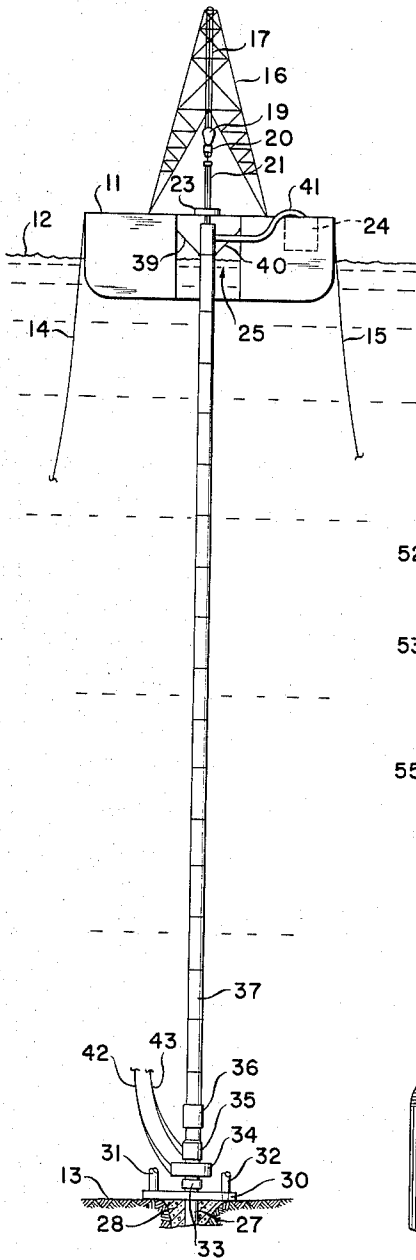


FIG. 1

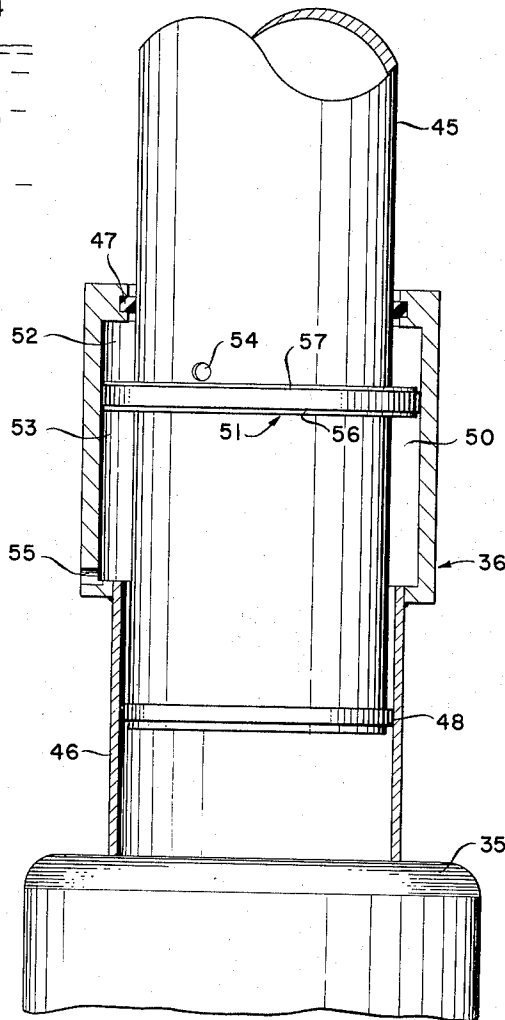


FIG. 2

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UNDERWATER WELL DRILLING APPARATUS
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This invention relates to methods and apparatus for use in drilling, completing and working-over underwater wells wherein the wellhead assembly is positioned below the surface of a body of water. The invention pertains more particularly to a large-diameter pipe, commonly known as a marine conductor pipe, extending between a floating vessel on the surface of the ocean to a wellhead assembly positioned on or near the ocean floor.

In an attempt to locate new oil fields, an increasing amount of well drilling has been conducted at offshore locations, such, for example, as off the coast of Louisiana, Texas or California. As a general rule, the strings of casing in the well, together with the tubing string or strings, extend to a point above the surface of the water where they are closed in a conventional manner that is used on land wells, with a conventional wellhead assembly being attached to the top of the casing. Recently, methods and apparatus have been provided for drilling and completing the well wherein both the well and casinghead and subsequently the wellhead assembly and casing closure device are located under water 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 equipment of this type under water 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. Thus, when drilling and completing or working-over an oil or gas well at an offshore location, the production or drilling wellhead equipment may have to be assembled at its underwater location.

In one method of drilling underwater wells, a large-diameter marine conductor pipe is positioned substantially vertically within the water with its lower end fixedly secured to the wellhead assembly on the ocean floor and its upper end secured to the drilling vessel at the surface. One typical arrangement is shown in U.S. Patent 3,032,125 to W. F. Hiser et al. Since the lower end of a marine conductor pipe is fixedly secured to the top of an underwater well assembly, it is quite apparent that the conductor pipe must be provided with a telescopic joint or a section intermediate the ends thereof so that the conductor pipe may be elongated or shortened as the supporting vessel at the surface rises or falls with the motions of the ocean. Generally, the major portion of a marine conductor pipe is supported by constant-tension winches or counter-balances mounted on the vessel so that constant tension is applied to the conductor pipe independent of the motion of the vessel.

It will be appreciated that a marine conductor pipe is provided extending between an underwater wellhead assembly and a vessel on the surface so as to surround a drill string extending through the rotary table on the vessel, down to the wellhead on the ocean floor and into the well being drilled when drilling operations are being carried on. While the drill string is rotated within the marine conductor pipe, drilling mud is pumped from the vessel down the drillstring to the bottom of the well and

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thence up the annulus between the well borehole wall and the outside of the drill pipe, up through the drilling wellhead assembly and thence upwardly in the annulus space formed between the inner wall of a conductor pipe and the outer wall of a drillstring positioned therein. At the top of the marine conductor pipe, the drilling mud is led through a suitable hose or pipe to a settling pit or storage tank.

While successful drilling operations have been carried out with the above-described apparatus in waters of varying depth, problems are sometimes encountered when drilling into high-pressure formations, and in areas where the marine conductor pipe is exposed to underwater currents or abnormal wave action. Thus, while drilling into high-pressure formations, it is necessary to use a heavier mud than normal, one which may be as much as twice or more the weight of a normal mud used in drilling low-pressure formation. With heavier mud filling the marine conductor pipe, there is a tendency for the conductor pipe to bend laterally and buckle, especially when the marine conductor pipe is moved off a vertical line. Since even an anchored floating vessel has some horizontal movement, it may be readily seen that it is almost impossible to prevent a marine conductor pipe from being moved off a vertical line. As the top of the marine conductor pipe filled with heavy mud starts to bend in one direction, the force of gravity tends to accelerate the bending motion and this may be sufficient to buckle the marine conductor pipe. In addition, the internal pressure inside the marine conductor caused by the heavy mud in itself tends to initiate buckling of the marine conductor.

It is therefore a primary object of the present invention to provide a marine conductor pipe in which heavy drilling mud can be handled with a minimum tendency to bend.

A further object of the present invention is to provide a method and apparatus for applying tension to the lower end of a marine conductor pipe.

Another object of the present invention is to provide apparatus for applying a force to the lower end of a marine conductor pipe that is in direct ratio to the difference in weight between the column of mud in a conductor pipe and the same size column of sea water.

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

FIGURE 1 is a diagrammatic view taken in longitudinal projection illustrating a floating vessel positioned over a drilling location wherein a wellhead assembly is positioned on the ocean floor and a marine conductor pipe extends between the wellhead assembly and the drilling vessel at the surface; and

FIGURE 2 is an enlarged detailed view taken in longitudinal cross section showing tension-applying means carried near the lower end of the marine conductor pipe illustrated in FIGURE 1.

Referring to FIGURE 1 of the drawing, a drilling vessel, barge or platform 11, of any suitable floating or floatable type is illustrated as floating on the surface of a body of water 12 while being substantially fixedly positioned over a preselected well location by suitable vessel-positioning means well known to the art, or by being anchored to the ocean floor 13 by anchor lines 14 and 15 running to anchors (not shown). Equipment of this type can be used when carrying on well drilling operations or well

work-over operations in water varying from 100 to 1500 feet or more in depth. The drilling vessel 11 is equipped with a suitable derrick 16 containing a fall line system 17 which includes a suitable hoist (not shown), travelling block 19, and a suitable hook and swivel or other connector means 20 adapted to be connected to the top of a kelly 21 at the upper end of a drill pipe or drill string during well drilling operations, the swivel or other connector being adapted to circulate drilling fluid therethrough in a manner well known to the art. The vessel 11 is also provided with other auxiliary equipment needed during well-drilling operations, such, for example, as a rotary table 23 positioned on the operating deck, a mud pit or tank 24, etc. The derrick 16 is positioned over a drilling slot or a well 25 which extends vertically through the barge in a conventional manner. When using drilling equipment of the present invention, a slot 25 in the vessel 11 may be either centrally located or extend in from one edge. Alternatively, drilling operations may be carried over the side of the vessel without using a slot. For example, the drilling vessel may be provided with a deck portion which overhangs the hull on the vessel.

It is understood that the underwater well may be started by any of the methods well known to the art wherein a foundation pile or a casing 27 is installed in the hole drilled in the ocean floor and secured therein, as by means of cement 28. The underwater wellhead assembly comprises or includes a base member 30 fixedly secured to the foundation pile 27, the base being provided with suitable guide posts or columns 31 and 32 having guide lines (not shown) extending upwardly to the vessel 11 at the surface. After installing the base 30 on the ocean floor, a drilling wellhead assembly is run down and connected to the wellhead assembly.

A typical drilling assembly comprises a wellhead connector 33, ram-type blow-out preventers 34, sleeve-type blow-out preventer 35, and a telescoping joint 36 in a marine conductor pipe 37 which extends upwardly to the vessel 11. The upper end of the conductor pipe 37 is secured to the vessel against relative vertical motion therewith by means of tie rods or cables 39 and 40. A return mud hose 41 leads mud from the top of the conductor pipe 37 to the mud pit 24. The blow-out preventers 34 and 35 are remotely actuatable from the vessel 11 in a manner well known to the art through hydraulic hoses 42 and 43.

The telescoping joint 36 (FIGURE 1) is shown in greater detail in FIGURE 2 as comprising an upper section 45 which is connected to the lower end of a major portion of the conductor pipe 37 and forms a continuation thereof, and a lower section 46 which is fixedly secured to the top of the blow-out preventer 35, or to the top of any other wellhead component arranged in a series-connected arrangement forming a drilling passage for a drill string. Suitable seals 47 and 48 are provided at the ends of the telescopic section.

An important feature of the apparatus of the present invention is a suitable device for applying tension to a major portion of the length of the marine conductor pipe 37. To accomplish this, suitable tension-applying means are fixedly secured to the lower end of the upper section of the telescopic joint. In one form, the tension-applying means may comprise an annular piston chamber 50 formed about at least a longitudinal portion of the telescopic joint 36 outside the upper section 45 thereof with a piston 51 fixedly carried on the outside of the upper section of the telescopic joint 36 and arranged for sliding movement within the piston chamber 50. Thus, the piston 51 divides the piston chamber 50 into upper and lower piston chambers 52 and 53, respectively. One or more fluid ports 54 extend through the wall of the upper section 45 of the marine conductor 37 and are in communication between the interior of the conductor pipe section 45 and the upper piston chamber 52. Likewise, one or more fluid ports 55 are provided in and extend through the

outer wall of the telescopic joint in communication between the lower piston chamber 53 and the space outside of the conductor pipe 37 or the telescoping joint 36 therein.

The length of the telescopic joint 36 is selected to be preferably greater than the expected rise and fall of the vessel so that the conductor pipe is not subjected to sharp abnormal strains. Since the tendency of the marine conductor pipe to buckle is due principally to the differential in fluid pressure between the column of drilling mud inside and the pressure of the water outside, by using the apparatus of the present invention it is possible to put more tension in the conductor pipe to counteract buckling. To offset any tendency to buckle, the apparatus of the present invention is adapted to apply a force to the lower end of the marine conductor which is preferably substantially equal to the differential weight of the mud column inside the pipe and the water outside. It may be seen that the weight of the mud column within the marine conductor pipe 37 above the telescoping joint 36 is in communication through port 54 above piston 51 with the upper surface of the piston so that a force is applied to the piston and the lower end of the marine conductor pipe to which it is secured, said force being directly proportional to the difference in weights of the mud inside the marine conductor 37 and the weight of the water outside and to the area of the horizontal surface of the piston 51 employed. The piston 51 may take the form of a radially-extending rigid flange 56 having a circumferential sealing ring 57 on the outside thereof. The effective area on the top of the piston 51 is preferably equal to the cross-section of the marine conductor pipe 37, although it may vary from a very small area to an area substantially greater than that of the conductor pipe. Thus, any area employed decreases the buckling tendency of the conductor pipe 37 and would be beneficial. It is clear that as the weight of the column of drilling mud increases, the force applied to the top of the piston also increases.

I claim as my invention:

1. Apparatus for drilling underwater wells comprising a floating vessel on the surface of a body of water, an underwater wellhead assembly positioned beneath the vessel at a substantial depth below the water, a conductor pipe extending from said vessel to said wellhead assembly, the lower end of said conductor pipe being secured to said wellhead assembly, means carried by said vessel for supporting the upper end of said conductor pipe at said vessel, a telescoping joint in said conductor pipe in the lower portion thereof, said telescoping joint having upper and lower sections, connector means carried by said lower section of said telescoping joint whereby said lower section is fixedly secured to said wellhead assembly, and tension-applying means carried by said upper section of said telescoping joint and operatively connected thereto for applying tension in addition to gravity to the lower end of a major portion of said conductor pipe.

2. The apparatus of claim 1 wherein the upper end of said conductor pipe is fixedly secured to said vessel against relative vertical motion therewith.

3. The apparatus of claim 1 including a wellhead connector carried by the lower end of said conductor pipe below said telescoping joint for securing said conductor pipe to said wellhead assembly.

4. The apparatus of claim 1 wherein said tension-applying means comprises a piston chamber affixed to the lower portion and formed about at least a portion of said telescoping joint outside the upper section thereof, piston means fixedly carried on the outside of said upper section of said telescoping joint and arranged for sliding

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movement within said piston chamber, said piston means dividing said piston chamber into upper and lower piston chambers, first port means through said conductor pipe in communication between the interior thereof and said upper piston chamber, and second port means through the outer wall of said telescoping joint in communication between the lower piston chamber and the space outside said conductor pipe.

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