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APPARATUS FOR CARRYING OUT WELL DRILLING OPERATIONS FROM FLOATING STRUCTURES
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APPARATUS FOR CARRYING OUT WELL DRILLING OPERATIONS FROM FLOATING STRUCTURES

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ABSTRACT OF THE DISCLOSURE

Suspension mechanism for supporting a drilling string from a floating platform to allow the platform to move vertically under the influence of wave action while maintaining the string in engagement with the bottom of a well bore during a well drilling operation. The invention includes extensible mechanism of the cylinder and piston type connected to the string and platform to yieldingly support the string and means for varying the pressure of fluid applied to the cylinder and piston in response to changes in the weight of the drilling string during the progress of the drilling operation to maintain the weight applied to the drilling bit substantially constant. The mechanism also embodies means for maintaining the piston and cylinder constantly lubricated by continuously supplying lubricant to the external surface of the piston and the surrounding internal surface of the cylinder.

This invention relates to the drilling of wells beneath the surface of water, and more particularly to apparatus for supporting a drilling string from a floating structure during the drilling of a well under water.

In the drilling of wells by the use of a rotary drilling string some means must be provided for supporting the string to control the weight which is applied to the drilling bit, and when such operations are carried out under water by the use of floating structures it is necessary that the string be suspended in a manner to prevent pounding of the drilling bit on the bottom of the bore due to vertical movements of the string with the floating structure resulting from wave action.

The present invention has for an important object the provision of suspension mechanism for supporting a drilling string on a floating structure embodying means whereby the structure may move vertically under the influence of wave action while maintaining the downward force exerted on the drilling bit substantially constant.

Another object of the invention is to provide suspension mechanism for supporting a drilling string on a floating platform, including cylinder and piston means forming an extensible and retractable connection between the platform and string, and embodying means for maintaining substantially constant pressure of fluid in the cylinder while allowing variations in the volume of such fluid due to vertical oscillation of the platform resulting from wave action, whereby the downward force of the string on the drilling bit may be maintained substantially constant.

A further object of the invention is the provision in drilling string suspension mechanism of the kind referred to of means for varying the pressure of fluid applied to the cylinder and piston means in accordance with changes in the weight of the drilling string during the progress of the drilling operation to maintain the weight applied to the drilling bit substantially constant.

A still further object of the invention is to provide a cylinder and piston arrangement for use in the suspension of a rotary drilling string, which is constructed to withstand the high weight loads and fluid pressure required in apparatus of such character, and in which means is embodied for the continuous supplying of lubricant to the cylinder and piston.

The above and other important objects and advantages of the invention will be apparent from the following detailed description of a preferred embodiment of the same when considered in conjunction with the appended drawings, wherein:

FIGURE 1 is a perspective view of the suspension apparatus of the invention adapted to be supported on a floating structure and connected to a drilling string to support the same therefrom while allowing vertical movements of the supporting structure relative to the string;

FIGURE 2 is a fragmentary view, partly broken away and partly in cross-section and on a greatly enlarged scale, of a preferred embodiment of the cylinder and piston mechanism by which the drilling string is connected to and supported from the floating structure; and

FIGURE 2A is a fragmentary view, partly in cross-section, and on a greatly enlarged scale showing the upper end portion of the cylinder and piston apparatus, FIGURE 2A being an upward extension of the apparatus shown in FIGURE 2.

Referring now to the drawings in greater detail the apparatus of the invention is intended primarily for use on a floating structure, such as a drilling barge, or the like, not shown, which is furnished with upright support means such as a conventional derrick, or the like, or which may conveniently be of the form illustrated in FIGURE 1 wherein the support is generally designated 10, having the uprights 12, suitably secured to the platform of the floating structure, as by means of base blocks 14, and suitable braces, such as those shown at 16, and which carry at their upper ends a cross frame 18.

Suitable travelling block mechanism, designated 20 is carried by a cable 22 supported on the cross frame and which leads to the usual cable winding mechanism 24 mounted on the platform.

Rotary table mechanism 26, of the usual type is located on the platform between the uprights 12 which is adapted to rotate a kelly 28, or the like, on which a drilling string extending downwardly from the floating structure may be rotated to drill a hole in the earth formation beneath the water.

The travelling block 20 is provided with the usual hook 30, or the like, by which it is connected to an elevator 32, of a well known kind, and the kelly 28 is attached at its upper end to the usual rotatable connection 34 by which a hose 36 is attached to the kelly through which well fluid is supplied to the drilling string during the drilling operation.

A return hose 38 is connected to a fitting 40 which is in communication with the usual casing which surrounds the drilling string and through which well fluid is returned upwardly from the well bore.

The above described drilling mechanism is of a well known type and forms no part of the present invention but is included here for the purpose of more fully disclosing the nature and intended use of the same.

The apparatus of the present invention includes an elongated main pressure cylinder 42, having at its lower end a hook 48 by which the cylinder is connected to the swivel 34, and within the cylinder a piston is movably disposed, having a piston rod 44 which is connected at its outer end to the elevator 32.

The pressure cylinder mechanism is thus connected between the travelling block 20 and the kelly 28 so that upon the application of a sufficiently high pressure of fluid to the cylinder 42 above the piston therein, the weight of the drilling string, or a desired portion of such weight string will be supported by the fluid.

The cylinder 42 of the pressure cylinder mechanism is closed at its lower end by a screw plug 46 of which
the hook 48 forms a part, the plug being conveniently threaded into an internally threaded sleeve 50, which in turn is threadably connected to the lower end of the cylinder. At its upper end the cylinder rod 44 is slidably extended, the cap being provided with suitable packing, such as that shown at 56 to form a fluid tight seal between the cap and rod.

With the cylinder 42 a piston 58 surrounds the lower end of the rod 44, to which the piston is attached, as by means of a ring 60 having an internally shouldered portion 62 against which the lower end of the rod 44 is seated and attached by means of screws 64. The ring 60 is secured to the piston by screws 66.

The plug 46 is provided with a passageway 68 through which fluid in the cylinder 42 beneath the piston 58 may escape upon downward movement of the piston relative to the cylinder and also through which fluid from the exterior may enter the cylinder beneath the piston when the piston moves upwardly relative to the cylinder.

The tubular piston rod 44 is closed at its lower end by a plug 70 which seats on the internally shouldered portion 62 of the ring 60 and which has a passageway 72 in communication with a passageway 74 in the piston through which lubricant is supplied between the external surface of the piston and the surrounding internal surface of the cylinder.

Suitable packing is provided, such as that shown at 76, on the piston to form a seal between the piston and the surrounding wall of the cylinder. The piston also has a central extension 78 formed with a counterbore 90 of larger diameter than and into which the piston rod 44 is extended, and within which the piston rod has openings 82 through which fluid may flow into and out of the cylinder above the piston through the piston rod.

At its upper end the piston rod 44 has an externally enlarged cap 84 formed with a downwardly tapering external surface 86 for engagement with the elevator 32 by which the pressure cylinder mechanism is supported.

The cap 84 has a central bore 88 in communication with the interior of the piston rod and is provided with a side port 90 which is internally threaded for the attachment thereof to a hose connection fitting 92 to which a pressure base 94 is connected to conduct pressure fluid into and out of the cylinder through the piston rod.

The cap 84 also has a central opening 96 therethrough, through which a lubricant pipe 98 is extended, whose upper end is connected to a lubricant reservoir 100, which is threadably attached to the cap. The pipe 98 extends downwardly in the piston rod 44 and is threadably connected at its lower end to the plug 70 in communication with the passageway 72 to allow lubricant to flow to the external surface of the piston which is in sliding contact with the surrounding wall of the cylinder.

A cylinder 102 of relatively small diameter, called a repeating cylinder is suitably supported on and extends longitudinally alongside of the main cylinder 42. The repeating cylinder has a piston movably disposed therein to which a piston rod 104 is connected which is also suitably connected to the piston rod 44, externally of the main cylinder, as seen at 106 in FIGURE 1, whereby extension and contracting movement or oscillations of the main cylinder mechanism are repeated by the repeating cylinder.

The lower end of the repeating cylinder is connected at its lower end by a pressure line or hose 108 with a suitable instrument designated 110 in FIGURE 1 which causes changes in the position of the piston in the repeating cylinder whereby oscillations of the main cylinder mechanism may be readily observed.

For the purpose of maintaining a desired pressure in the main cylinder 42 above the piston 58 to support the weight of the drilling string, a pressure accumulator, generally designated 112 in FIGURE 1 is provided, which may be made up of a number of heavy walled pressure cylinders forming a battery of large volume, so that relatively large variations in the volume in the main cylinder 42 may take place without causing a substantial change in the pressure in the accumulator.

An auxiliary pressure line 134 may also be provided for supplying fluid under pressure for the operation of any other desired equipment.

Under some circumstances it may be desired to provide additional accumulators, not shown, and for this purpose a pressure line 136 may be provided leading to an indicator 138 on panel 122.

In the operation of the apparatus, constructed and arranged as described above, a drilling string is attached to the kelly 28 to be supported on the swivel 34 for rotation by the rotary table 26. The cylinder 42 is then pressurized to support the weight of the string, or a desired proportion thereof with the drill in engagement with the bottom of the well bore.

The drilling operation is then carried out in the usual manner and during such operation vertical movements of the floating structure from which the string is suspended will result in variations in the volume of the fluid in the cylinder 42. A substantially constant downward force on the bit will be exerted due to the maintenance of a relatively small pressure differential resulting from the variations in the volume of the air in the cylinder in response to vertical movements of the floating structure. Upon downward movement of the floating structure an increase in the volume of the fluid in the cylinder 42 will take place, and upon upward movement of the floating structure a corresponding decrease in such volume will occur. By providing an accumulator having a relatively large volume, however, very little change in pressure will take place, so that the downward force exerted by the drilling string will remain substantially constant. Moreover, the drilling string will remain in contact with the bottom of the well bore during the drilling operation which is carried out in the usual manner by lowering the string by operation of the winding mechanism of the cable 22 as the drilling progresses.

When it becomes necessary to add sections of pipe to the drilling string, this may be accomplished in the usual manner, the pressure in the cylinder 42 being suitably adjusted by the operator to compensate for the additional weight thus added to the string.

By carefully checking the changes in the position of the piston 58, as indicated on the indicator 110 associated with the repeating cylinder 102, the extent of the vertical movement of the vessel relative to the drilling string may be readily determined. The pressure which is supplied to the cylinder 42 may also be carefully regulated by suitable actuation of the control lever 125 to maintain the piston therein at a predetermined location as indicated by the gauge 110 of the repeating cylinder 102, to properly support any load on the string and maintain the same at the same vertical location during the drilling operation.
It will thus be seen that the invention, constructed as described above provides suspension mechanism which is particularly useful for the suspension of a drilling string from a floating structure and by which the string may be supported against vertical oscillation while allowing vertical movement of the supporting structure due to wave action.

Having thus clearly shown and described the invention, what is claimed as new and desired to secure by Letters Patent is:

1. Well equipment suspension apparatus comprising, a cylinder, a piston movable disposed in the cylinder for longitudinal and rotational movement therein, a hollow piston rod connection to said piston for movement therewith extending to the exterior of the cylinder and in communication with the interior of the cylinder at one side of said piston, means for connecting one of said cylinder and piston rod to a support above a well bore, means for connecting the other of said cylinder and piston rod to equipment to be suspended in the bore, means for connecting said piston rod in communication with a source of fluid under pressure to position the piston at a location to suspend said equipment in said bore, and means for introducing a lubricant into said cylinder at a location between said piston and the surrounding internal surface of said cylinder.

2. The apparatus as specified in claim 1 wherein said piston is formed with a passageway opening at one end to the exterior of the piston at a location opposite the surrounding wall of the cylinder, and means extending into said piston rod and in communication with said passageway for introducing a lubricant into said passageway.

3. The apparatus as specified in claim 1 and including means for indicating the position of the piston in the cylinder including movable means connected to said piston for movement therewith and pressure responsive means for indicating the position of said movable means.

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