Apparatus and methods for drilling out from a casing string in a borehole. A reaming assembly is introduced into the borehole and fixed at a predetermined location. A drillable collar is interposed between the reaming assembly and a casing. A drilling assembly introduced into the casing and is then positioned so as to drill through the drillable collar at a predetermined angle into a formation surrounding the borehole.
CASING REAMING ASSEMBLY

[0001] The present invention relates to a method for drilling out of a casing string which has been run and fixed in place with the use of a sacrificial motor assembly.

[0002] It is known to drill out sections of a casing string in order to drill side-tracked holes that run off the casing string. Casing is run after drilling a hole section to close off unstable and low pressure formations and provide hole stability. Various known methods are deployed to assist in ensuring that the casing string reaches the total depth of the drilled section. Typically, this can be achieved using a reaming assembly connected directly to the bottom of a casing. These components are then run to the bottom of a borehole and cemented in place.

[0003] In order to create a hole running off the main borehole, a whipstock, which is a cylindrical triangular metal device, is positioned at a point near the bottom of the casing along with a milling assembly. The whipstock is oriented with a gyro device to the desired direction of drilling and fixed in place. The milling assembly is then mechanically detached from the whipstock and activated so as to mill a section of the casing to create a window at and around the whipstock. After this has been done the milling assembly is pulled out of the casing. Depending on the condition of the window created by the milling assembly, a second run of the milling assembly may be required. After this, a steerable drilling assembly is run inside the casing and on passing over the whipstock is guided to point in a set direction, thereafter, drilling is initiated and continues to the prescribed target.

[0004] Typically the distance from the surface to the borehole is around 10,000 to 11,000 feet, this means that it takes around 24 hours to complete one round trip to and from the surface for any of these components. Clearly, any reduction in the number of round trips required would produce significant savings of rig time and therefore cost.

[0005] In accordance with a first aspect of the present invention there is provided a method for drilling out from a casing string in a borehole, the method comprising the steps of:

- introducing a reaming assembly into the borehole to a predetermined location; fixing the reaming assembly in position, wherein a drillable collar is attached between the reaming assembly and a casing introducing a drilling assembly into the casing; and positioning the drilling assembly so as to drill through the drillable collar at a predetermined angle into the formation surrounding the borehole.
- Preferably, the point at which the drilling assembly enters the formation surrounding the borehole is at least in part determined by the thickness of the drillable collar through which the drilling assembly drills.
- Preferably, the drilling assembly is a bent housing motor assembly with a drill bit.
- Optionally, the drilling assembly is a rotary steerable system combined with a drill bit.

[0010] Preferably, the drill bit used comprises a PDC drill bit.

[0011] Preferably, the reaming assembly is fixed in place using cement.

[0012] In accordance with a second aspect of the invention there is provided an apparatus for drilling out from a casing string in a borehole, the apparatus comprising a drillable collar attached between a reaming assembly and a casing string.

[0013] Preferably, the drillable collar is provided with a borehole extending from the reaming assembly to the casing string.

[0014] Preferably, the drillable collar is made from aluminum, or other high strength but easily drillable material.

[0015] Aluminium is preferred because it is drillable and sufficiently robust to retain its integrity in the conditions found in boreholes. Other materials with similar properties may be used in place of aluminium.

[0016] The present invention will now be described by way of example only with reference to the accompanying drawings of which:

[0017] FIG. 1 shows a casing reaming assembly in accordance with the present invention;

[0018] FIG. 2 is a cross sectional view of a drillable collar; and

[0019] FIG. 3 shows the effect of a change in width of the collar.

[0020] Referring to FIG. 1, the assembly 1 is shown with respect to the base of an unstable subsea formation 15. The assembly 1 comprises a casing 3 which in this example is of 9¾ inch diameter connected to a float collar 5 which is in turn connected to a drillable collar 7. The drillable collar 7 is connected to a reaming assembly 10 which consists of a mud motor 9 having, on its end, a 12¼ inch bit 11.

[0021] FIG. 1 also shows a side-tracked hole 13, which is created by the use of a drilling assembly (not shown) capable of drilling through the drillable collar 7. In this example a borehole is drilled to a casing point to provide a 12¾ inch diameter hole. This drilling assembly is then removed from the borehole. Thereafter a reaming assembly also known as a sacrificial reaming assembly is constructed. This consists of a reaming assembly as shown having a mud motor with a 12¾ inch drill bit connected to its end. This reaming assembly is connected to the drillable collar 7. In this example, as shown in FIG. 2, the drillable collar is made from aluminium and has an outer diameter of 9¾ inch and an inner diameter of 3 inches. Therefore the annular thickness of the drill collar is ¾ inches.

[0022] The collar 7 is connected to a float collar 5, which is in turn connected to the casing 3. The reaming assembly 10 and casing 3 are then run into the bore hole until the bottom of the casing 3 and the drill collar 7 are set in an appropriate formation.

[0023] Thereafter cement is added in order to complete the casing and reaming assembly in place and to land the cement plug in the float collar. In this example, the collar is 40 feet in length.

[0024] In order to create a side tracked hole a steerable drilling assembly capable of fitting inside the casing is run into the hole. In this example the drill assembly consists of
a 1.5 degree bent housing steerable motor assembly having a 6¾ inch outside diameter and a PDC drill bit having an 8½ inch diameter. This drilling implement is controllable from the surface in a known manner. This steerable drill assembly is used to drill through the drill collar and is aligned remotely so as to drill in a predetermined direction towards a target position.

[0025] The use of a drillable collar as described above allows the passage of drilling fluid from the casing string to the reaming motor which provides hydraulic and mechanical power to and from the motor for reaming operations.

[0026] In addition, the bore 8 contained in the collar provides a passage to allow the addition of cement in order to cement the casing string in place. Furthermore, the collar 7 serves as a hard plug to enable the steerable motor assembly of the second drill to deviate in the direction of the next well path into new formation.

[0027] Whilst the above example shows an aluminium collar, it will be appreciated that a drill collar may be made of any other material that is drillable and mechanically robust enough to perform the functions of the collar described in the conditions typically found in a bore hole.

[0028] Referring now to FIG. 2, this shows the variation in exit point of the drill that may be achieved simply by varying the annual thickness of the collar 7.

[0029] The sideways displacement can be calculated by using the following equation.

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\text{Sideways displacement} = \frac{\text{hole diameter} + \text{collar diameter}}{2}
\]

[0030] Therefore, if the collar diameter alone is increased, the sideways displacement will be increased.

[0031] FIG. 2 shows the exit point from the drillable collar where an 8 inch collar 7 is used in comparison to the exit point where a 9½ inch collar is used. This clearly shows that the exit point for the 9½ inch collar is displaced.

[0032] Whilst the above examples show a borehole of 12¼ inches with a drillable collar and casing sized appropriately, it will be appreciated that the present invention is not restricted to boreholes and casings of these dimensions and that the above is an illustrative example of the general concept set out in the statements of invention and claims.

[0033] The present invention contains a number of advantages with respect to the prior art. In particular, it reduces the number of round trips from the surface required, therefore reducing the amount of rig time required; a whipstock is not required, these cost around 100,000 to buy and take a significant time to orient; and the cost and time of milling a window is removed from the process.

[0034] Improvements and modifications may be incorporated herein without deviating from the scope of the invention.

1. A method for drilling out from a casing string in a borehole, the method comprising the steps of: introducing a reaming assembly into the borehole to a predetermined location; fixing the reaming assembly in position, wherein a drillable collar is attached between the reaming assembly and a casing introducing a drilling assembly into the casing; and positioning the drilling assembly so as to drill through the drillable collar at a predetermined angle into the formation surrounding the borehole.

2. A method as claimed in claim 1 wherein the point at which the drilling assembly enters the formation surrounding the borehole is at least in part determined by the thickness of the drillable collar through which the drilling assembly drills.

3. A method as claimed in claim 1 wherein the drilling assembly is a bent housing motor assembly with a drill bit.

4. A method as claimed in claim 1 wherein the drilling assembly is a rotary steerable system with a drill bit.

5. A method as claimed in claim 3, wherein the drill bit comprises a PDC drill bit.

6. A method as claimed in claim 1 wherein the reaming assembly is fixed in place using cement.

7. Apparatus for drilling out from a casing string in a borehole, the apparatus comprising a drillable collar attached between a reaming assembly and a casing string.

8. Apparatus as claimed in claim 5 wherein the drillable collar is provided with a borehole extending from the reaming assembly to the casing string.

9. Apparatus as claimed in claim 5 wherein the drillable collar is made from aluminum.

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