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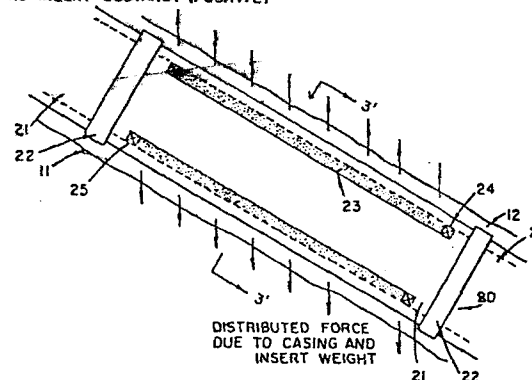
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54 Casing high angle wellbores.

57 Pipe, (20) especially well casing, is run into highly deviated boreholes (11) using solid, buoyant casing inserts (23) within the sections of casing (21) which are to enter the deviated portion of the borehole. The use of the solid buoyant members provides a net buoyant effect which is evenly distributed along the length of each section of casing so as to avoid any net twisting couple which would tend to bring the casing into contact with the walls of the borehole. This reduces the frictional drag and pressure differential sticking which arise when the casing contacts the walls of the borehole. The solid, buoyant inserts may be fabricated from materials which have a specific gravity lower than that of the mud which is in use, suitably foamed and unfoamed plastic resin materials, wood, cork, and wood and cork composites. The inserts are suitably in the form of a hollow cylinder so as to minimize problems with cementing operations and the running of tubing strings subsequent to the setting of the casing.

FIG. 2

DISTRIBUTED FORCE DUE TO CASING
AND INSERT BUOYANCY (POSITIVE)



CASING HIGH ANGLE WELLBORES

The present invention relates to a method of placing pipe within highly-deviated boreholes.

Techniques have been developed for the directional drilling of boreholes which deviate angularly from the vertical axis extending downwards from the drilling rig to reach subterranean locations which are offset from this vertical axis, sometimes by considerable distances. By using suitable deflection tools, a borehole may be deviated to a considerable extent and this may be of great utility, especially in the drilling of offshore wells where it may be desirable to complete a number of wells from a single drilling location. Because wells are usually cased, it has become necessary to devise methods for placing the pipe, including tubulars and casing throughout the length of the borehole, regardless of the deviation of the borehole from the vertical. This, however, may be very difficult in the deviated portion of the hole because here the casing is forced against the bottom surface of the hole by the weight of the pipe as well as by the downward force exerted by the weight of the casing in the upper portion of the hole. Contact between the casing and the borehole causes a frictional drag which opposes the desired advance of the pipe down the borehole. The greater the weight of the pipe and the

greater the deviation from the vertical, the greater is the frictional drag opposing further movement of the pipe.

In addition to the frictional drag created by the downward gravitational forces, the pipe tends to displace some of the drilling mud into the wall of the borehole, particularly in the more porous formations. This causes the pipe to embed itself into the filter cake formed from the solid components of the mud, to form an effective pressure seal around the embedded area. The pressure difference between the fluid in the borehole and the fluid in the formation causes a force to develop across this pressure seal which pushes the pipe more strongly against the wall of the borehole. This force may cause the pipe to become "differentially pressure stuck" in the borehole. The greater the force of the pipe against the borehole wall, the greater is the possibility of the pipe becoming "differentially stuck" and the resultant pressure differential forces will themselves increase the frictional drag forces acting on the pipe.

In order to reduce frictional drag and to reduce the probability of differential sticking, it would be desirable to reduce the forces which the pipe exerts against the walls of the deviated boreholes. It would also be desirable to minimize the area of contact of the pipe with the borehole so as to reduce the probability of differential sticking. By minimizing the contact area, the force required to push the pipe down the borehole will also be minimized.

A technique has now been devised for positioning pipe, e.g. casing or tubulars in a well borehole, particularly deep, highly deviated boreholes,

which minimizes the problems caused by contact of the pipe with the walls of the deviated portion of the borehole. In addition, the technique eliminates the tendency possessed by fluid-buoyed casing to twist during running. Because the frictional drag resulting from sinking, floating and twisting of the casing is minimized, the potential for successful placement of the casing is substantially improved when highly deviated wellbores are being cased or tubulars placed within the hole.

According to the present invention, the pipe is placed in the borehole with the use of a buoyant, solid insert within at least the lower portion of the pipe. The insert may be hollow or solid in configuration and may be fabricated of materials which will give the desired degree of buoyancy to the pipe; foamed and unfoamed plastic resins such as foamed polystyrene, polyethylene, polypropylene and wood/resin composites will be suitable.

In the accompanying drawings:

Figure 1 is a simplified sectional view of a portion of casing in a deviated borehole using a fluid for buoyancy;

Figure 2 is a simplified section of a section of casing in a deviated borehole using a hollow, solid buoyancy member; and

Figure 3 is a cross-section along 3-3' of Figure 2.

Conventionally, deviated boreholes are drilled with the initial portion of the hole near the surface with a vertical axis and with a progressively increasing deviation from the vertical beginning on or at some

distance beneath the surface. In certain operations, it may be desirable, after an initial deviation, to bring the hole back towards a more vertical position or to obtain even more complicated configurations. Directional drilling techniques using equipment components such as permanent and removable whipstocks, knuckle joints and spudding bits are conventionally used in directional drilling although it may also be accomplished through control of the weight on the bit or by the use of mud control, special bits and various specialized rotation speeds or drill assemblies. After the hole has been drilled to the desired depth and horizontal offset, it is normally required to be cased and for this purpose, casing is run into the hole by making up the casing string on the derrick at the surface, after which the string is lowered into the hole and forced downwards by the weight of the casing which is progressively added at the surface. As the casing enters the deviated portion of the borehole, the weight of the casing which still acts in a vertically downward direction, tends to become transferred to the bottom wall of the borehole unless it is counteracted by applying an upward, buoyant force to the casing.

Figure 1 shows a simplified section of fluid-filled casing string 10 as it is passing through the deviated portion of the borehole 11, which is filled with drilling fluid or drilling mud 12. The casing string comprises individual lengths of casing 13 connected serially together by means of casing couplings 14, e.g. threaded couplings. The weight of the casing is evenly distributed over its length and accordingly, the force due to casing weight is also evenly distributed along the length of each section 13 of casing. The liquid 15 within the casing, retained by

means of plugs 16, will exert a downward force by reason of its weight with the resultant force at the lower end of the section of casing, where the liquid is. The upper portion of the section of casing will, however, be subject to an upward buoyant force resulting from gas 17 which is contained in this section of the casing (the downward force of the weight of the gas is negligible). The forces which are created by the use of the liquid and the gas are therefore not evenly distributed, but rather are concentrated, with a net downward force at the lower end of the fluid-filled casing section and a net upward force at the upper end of the fluid-filled section. This couple causes the casing to twist about a transverse, horizontal axis running sideways through the fluid-filled section, with the result that the lower portion of the casing will tend to come into contact with the bottom wall of the borehole and the upper portion into contact with the upper wall of the borehole. This will create undesirable frictional drag as well as the potential for differential pressure sticking at both ends of the casing section.

According to the present invention, the lower section of casing which is to be positioned in the deviated portion of the borehole incorporates a buoyant, solid insert which distributes the buoyant forces evenly along the length of the section of casing which contains it. Figure 2 shows a section of the casing in the deviated portion of the borehole with such an insert. Casing string 20 within deviated borehole 11 filled with drilling mud 12 is made up of a number of lengths of casing 21 joined together by means of casing joints 22 has an annular, solid insert 23 which is held between retaining rings 24 and 25 at its upper and lower ends, respectively. The retaining rings may be fixed to the

casing by welding, screws or other suitable means. The insert is fabricated from a material which will provide the desired degree of positive buoyancy to the casing when it is run open-ended into the mud-filled borehole. Accordingly, the insert will be fabricated of a suitably buoyant material and dimensioned so that the net buoyant force is of the desired magnitude. Thus, if a relatively more buoyant material is used, the insert may be of thinner annular section than if a relatively less buoyant material is used. Suitable materials for making the insert include foamed and unfoamed plastic resin materials such as foamed polystyrene and foamed polyethylene, polyurethane foam, unfoamed polyethylene or polypropylene or other plastic resin materials, low density solids such as wood, cork, reconstituted wood, e.g., composites of wood chips or sawdust bonded by means of resin adhesives, reconstituted cork and other materials of a density which is below that of the drilling mud in use. Thus, by using weighted drilling muds, the range of suitable insert materials can be extended. Combinations of these materials may be used. A preferred material is syntactic foam which is commercially available for use on marine risers and other oilfield applications; this material has high foam strength and may be molded into different configurations. A typical syntactic foam is available from W.R. Grace & Co.. under the trademark Eccofloat, with different grades having densities of about 320-450 kg. m.⁻³ (20-28 lbs. ft.⁻³).

As shown in Figure 2, the downward force resulting from the weight of the casing and the insert is evenly distributed along the length of the section of casing, as is the upward force arising from the buoyant effect of the insert. Thus, the section of casing is

not only held in a state of neutral buoyancy but also has a minimal tendency to twist about the transverse horizontal axis through its center. Because of this, the risk that the casing will come into contact with the walls of the borehole is reduced and positioning of the casing in the borehole is facilitated.

In setting the casing in the borehole, the casing string is made up at the surface using the derrick in a conventional manner. However, the lower sections of casing which are to enter the deviated portion of the borehole are provided with the buoyant inserts to minimize running problems. The casing is left open at its lower end so that as it descends into the hole, the mud enters the casing to provide the desired degree of buoyancy. Depending upon the casing weight and drilling mud in use, the composition and size of the inserts will be suitably determined and the inserts secured within each section of casing as described above. The casing is then run into the mud-filled borehole in the normal manner until all the buoyant sections are beneath the surface. Non-buoyant sections of casing can then be made up into the top portion of the string and, if necessary, additional weight for driving the string down into the borehole may be provided by using heavy weight casing or by filling the upper portion of the casing with a weighting fluid. A plug may suitably be placed at the bottom of the section which is to contain weighting fluid in order to retain the fluid. When the casing string has been run to the desired position in the borehole, it can be cemented in place in the conventional manner by circulating out the mud and pumping cement down the casing and up through the annulus, in the normal way after drilling out or otherwise removing any plugs above

the buoyant section. Because the preferred buoyant inserts have an annular configuration, the cement may be circulated down through the casing string and up into the annulus without interference, but if the inserts are likely to interfere with the cementing operation or with the setting of subsequent casing or tubular strings, the inserts may be readily drilled out using conventional techniques, e.g. with a wire brush. Appropriate shoes at the end of the casing string, e.g., guideshoes, may be provided in order to facilitate running of the casing and the subsequent cementing operations although, of course, these shoes should permit the mud to enter the casing as it is floated down the borehole in a running operation of this type, in order to provide the desired degree of buoyancy.

As an alternative, it may be desirable to run the pipe into the borehole with a closed bottom end so that the mud in the borehole is excluded from the interior of the pipe. This may be desirable, for instance, in running tubulars or relatively heavy weight casing when the buoyant effect of the gas retained within the casing is desired but some additional weight is needed to provide neutral buoyancy. In such cases, the solid insert may provide sufficient additional weight to the pipe.

The insert may be hollow, as described above or, alternatively, may be completely solid, especially when the pipe is to be run into the hole with a closed end. However, when open-ended running is to be carried out, a flow passage through the inserts for the mud to pass up the string should be provided and this will preferably be a central flow passage in a hollow insert, as described above.

The inserts may be pre-formed to the desired shape and size and then inserted into the pipe and fixed in it within retaining rings or other devices, as previously mentioned. Alternatively, pre-formed inserts may be retained with adhesives, e.g. epoxies. Another alternative is to form the insert directly in the pipe so that the pipe acts as a mold for the insert which, upon setting, becomes bonded directly to the pipe, obviating the need for adhesives or retaining devices. Polyurethane foams may be used effectively in this way for forming the inserts.

I Claim:

1. A method of positioning pipe in a well borehole, which comprises:

lowering a string comprising serially connected sections of pipe into a fluid-filled borehole which is angularly deviated from a vertical position over at least a portion of its depth, at least the lower portion of the casing string comprising sections of pipe each having solid, buoyant members retained in a fixed position along the length of each section to provide a distributed buoyant force as the pipe is run into the borehole.

2. A method according to claim 1 in which the buoyant solid member comprises a hollow, cylindrical member inserted into each section of pipe in the lower portion of the casing string.

3. A method according to claim 2 in which each hollow cylindrical buoyant member is retained by means of retaining rings at each of its ends.

4. A method according to claim 1 in which the borehole has an upper, substantially vertical section and a lower, deviated section, and in which the portion of the string which is to be placed in the upper portion of the borehole above the deviated portion is not provided with the buoyant solid members.

5. A method according to claim 4 in which the upper portion of the casing string which is to be placed in the upper portion of the borehole is filled with a weighting fluid while the string is being run into the borehole.

6. A method according to claim 1 in which the pipe comprises casing.

7. A method according to claim 1 in which the string is run into the borehole with an open end at its bottom to permit fluid in the borehole to enter the interior of the string.

8. A pipe for running into a borehole formed in the earth having an internal, solid member retained in a fixed position within its length such that when the pipe is run into the borehole, the weight and buoyant effects of the member are uniformly distributed along substantially the length of the pipe.

9. A casing section for casing a deviated borehole in the earth which comprises a tubular section of casing having an internal, solid buoyant member retained in a fixed position within its length such that when the casing section is run into a mud-filled, deviated borehole, a buoyant force generated by the member is evenly distributed along substantially the length of the casing section.

10. A casing section according to claim 6 in which the buoyant member comprises a hollow cylinder of substantially the same length as the length of the casing.

11. A casing section according to claim 7 in which the buoyant member is fabricated from a plastic resin material.

12. A casing section according to claim 7 in which the buoyant member is fabricated from a foamed plastic resin material.

13. A casing section according to claim 12 in which the buoyant member is fabricated from syntactic foam.

14. A casing section according to claim 7 in which the buoyant member is fabricated from an unfoamed plastic resin material.

15. A casing section according to claim 7 in which the buoyant member is fabricated from wood, a wood/resin composite, cork or reconstituted cork.

FIG. 1

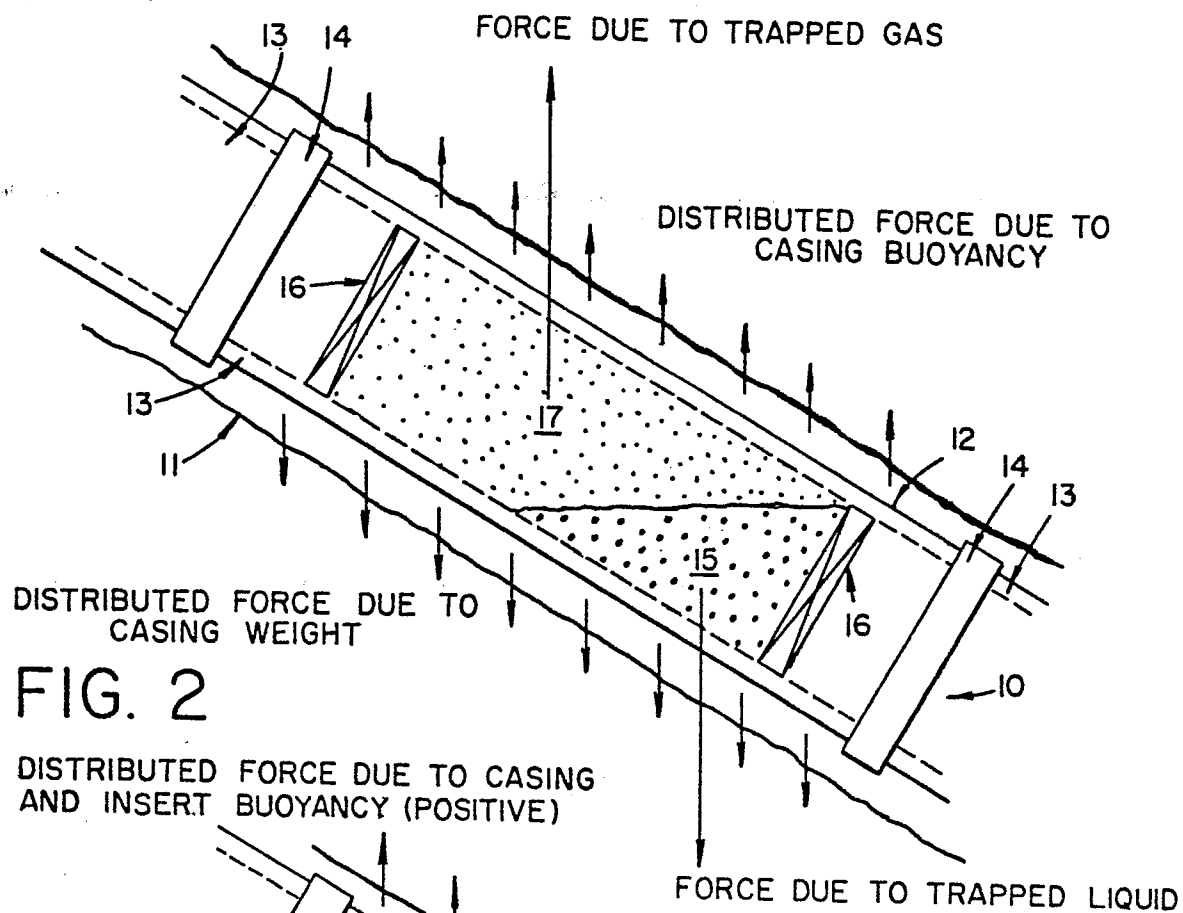


FIG. 2

DISTRIBUTED FORCE DUE TO CASING AND INSERT BUOYANCY (POSITIVE)

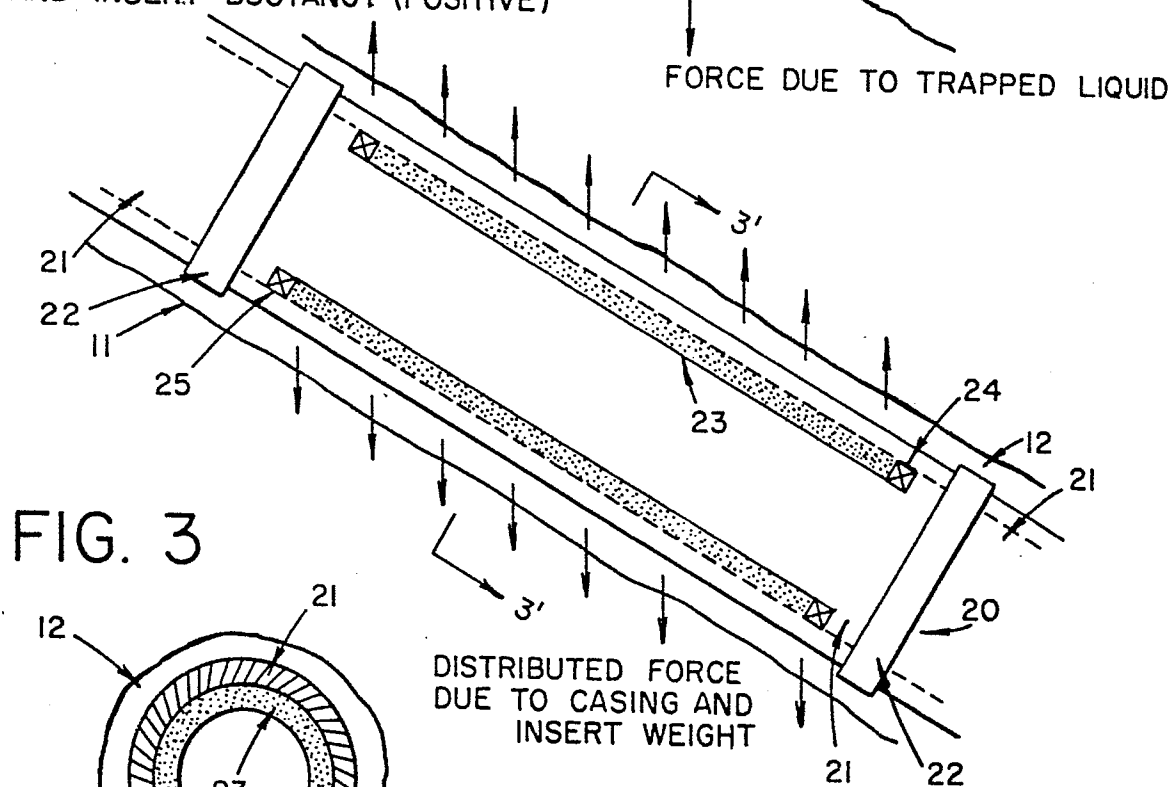
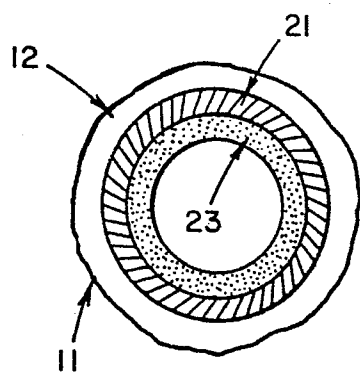


FIG. 3





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EUROPEAN SEARCH REPORT

0186317

Application number

EP 85 30 8593

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 4)
X	US-A-4 484 641 (DISMUKES) * Column 7, lines 19-31; figures 13, 7; column 5, lines 31-35, line 64 - column 6, line 2 *	1-4, 7, 8	E 21 B 7/04 E 21 B 17/00 E 21 B 23/00 E 21 B 43/10 E 21 B 33/14
Y	* Column 7, lines 27-31 *	5, 6, 9-15	
Y	GB-A-2 088 439 (DELLINGER) * Abstract *	5, 6, 9-15	
A		1, 4, 7, 8	
Y	US-A-2 118 708 (JOHNSON) * Page 1, right-hand column, lines 23, 24 *	15	E 21 B
A	US-A-1 746 132 (STOKES) * Whole document *	1-3, 7-10	
A	US-A-4 396 211 (McSTRAVICK) * Whole document *	1-3, 7-10	
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 18-03-1986	Examiner SOGNO M.G.
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			



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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
A	US-A-3 231 019 (CLAY) * Whole document *	1-3, 6-10	
A	DE-B-1 231 190 (THIEMANN) * Whole document *	1, 4, 8, 9-15	
A	US-A-3 526 280 (AULICK) * Abstract; column 4, line 38 - column 5, line 12 *	1, 4-9	
A	US-A-3 572 432 (AULICK) * Whole document *	1, 4-9	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int. Cl.4)
Place of search THE HAGUE		Date of completion of the search 18-03-1986	Examiner SOGNO M.G.
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			