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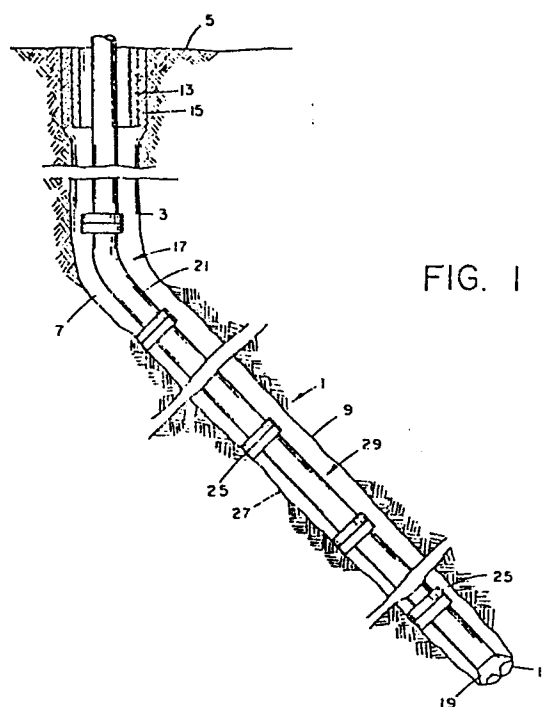
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54 **Method and system of drilling deviated wellbores.**

57 Directional drilling is carried out with a rotary drilling tool having a drill string 17, a drill bit 19, a drill motor 31 for rotating the drill bit independently of the drill string, an extension sub 32 having both axially contracted and axially extended positions for providing weight to the drill bit when moving from a contracted to an extended position so as to effect a drilling stroke by the drill bit into the wellbore bottom when drilling with the drill bit independently of rotation of the drill string and a bent sub affixed below the lower end of the drill string for angularly displacing the axes of the drill bit and extension sub from the axis of the drill string so as to effect a deviation of the wellbore.



METHOD AND SYSTEM OF
DRILLING DEVIATED WELLBORES

The present invention relates to rotary drilling and, more particularly, to a directional drilling technique for providing deviated wellbores at significantly greater inclinations and/or over horizontal distances substantially greater than that currently being achieved by conventional directional drilling practices. The success of such directional drilling should benefit mainly offshore drilling projects as platform costs are a major factor in most offshore production operations. Wellbores with large inclination or horizontal distance offer significant potential for (1) developing offshore reservoirs not otherwise considered to be economical, (2) tapping sections of reservoirs presently considered beyond economical or technological reach, (3) accelerating production by longer intervals in the producing formation due to the high angle holes, (4) requiring fewer platforms to develop large reservoirs, (5) providing an alternative for some subsea completions, and (6) drilling under shipping fairways or to other areas presently unreachable.

A number of problems are presented by high angle directional drilling. In greater particularity, hole inclinations of 60° or greater, combined with long sections of hole or complex wellbore profiles present significant problems which need to be overcome. The force of gravity, coefficients of friction, and mud particle settling are the major physical phenomena of concern.

In the rotary drilling of a highly deviated wellbore into the earth, a drill string comprised of drill collars and drill pipe is used to advance a drill bit attached to the drill string into the earth to form the wellbore. As the inclination of the wellbore increases, the desired weight-on-bit for effective drilling from the drill string decreases as the cosine of the inclination angle, and the weight of the drill string lying against the low side of the wellbore increases as the sine of the inclination angle. The force resisting the movement of the drill string along the inclined wellbore is the product of the apparent coefficient of friction and the sum of the forces pressing the string against the wall. At an apparent coefficient of friction of approximately 0.58 for a common water base mud, drill strings tend to slide into the hole from the force of gravity at inclination angles up to approximately 60°. At higher inclination angles, the drill strings will not lower from the force of gravity alone, and must be mechanically pushed or pulled, or alternatively, the coefficients of friction can be reduced.

In accordance with the present invention, there is provided a method and system for drilling a deviated wellbore into the earth by rotary drilling wherein a drill string is used to advance a drill bit through the earth and a drilling fluid is circulated down the drill string and returned from the wellbore in the annulus formed about the drill string.

A vertical first portion of the wellbore is drilled into the earth from a surface location to a kick-off point by rotating and advancing a drill string and drill bit into the earth. A deviated second portion

is initiated at the kick-off point and is drilled by a drill tool comprised of a drill string, a drill bit, a drill motor, and an extension sub having both contracted and extended positions for providing weight to the drill bit during movement from its contracted to its extended position.

The drill tool is positioned so that the drill bit is a predetermined distance above the wellbore bottom. A rapid dynamic movement downward is imparted to the drill tool so that the drill bit impacts the wellbore bottom and places the extension sub in its contracted position. A drilling stroke of the drill bit into the earth below the wellbore bottom is carried out by simultaneously maintaining the drill string stationary, rotating the drill bit under control of the drill motor, and advancing the drill bit under the weight provided by the extension sub in moving from its contracted position to its extended position.

Upon completion of the drilling stroke, the drill tool is raised so as to again position the drill bit at the predetermined distance above the wellbore bottom. A new drilling stroke is then initiated.

The imparting of downward movement to the drill tool to place the extension sub in the contracted position includes the high-speed rotation of the drill string, in the order of 150 revolutions per minute, to take advantage of the compound coefficient of friction principle and the rapid lowering of the drill tool from a distance of about 9.15 meters (30 feet) above the wellbore bottom.

In a further aspect of the invention, both the drill bit and axial movement of the extension sub in providing weight on the drill bit are angularly directed relative to the axial direction of the wellbore so as to

effect a change in the direction of the wellbore.

A desired weight-on-bit is at least 9,080 Kg (20,000 pounds) when the extension sub is stroked from its contracted position and at least 7,164 Kg (16,000 pounds) when in its fully extended position. In one embodiment, the weight is under spring-loaded control. In alternative embodiments, the weight is under hydraulic or compressed gas control.

FIG. 1 is a schematic drawing of a deviated wellbore extending into the earth and illustrates one embodiment of a rotary drilling tool utilized in the present invention;

FIG. 2 is a more detailed schematic drawing of the lower portion of the rotary drilling tool of FIG. 1; and

FIG. 3 is a diagrammatic drawing illustrating the drilling pattern of the rotary drilling tool of FIGS. 1 and 2.

This invention is directed to a rotary drilling technique for drilling a deviated wellbore into the earth and, more particularly, to a method and apparatus for supplying a desired weight-on-bit for the effective drilling of the deviated wellbore.

In rotary drilling operations, a drill string is employed which is comprised of drill pipe, drill collars, and a drill bit. The drill pipe is made up of a series of joints of seamless pipe interconnected by connectors known as tool joints. The drill pipe serves to transmit rotary torque and drilling mud from a drilling rig to the bit and to form a tensile member to pull the drill string from the wellbore. In normal operations, the drill pipe is always in tension during

drilling operations. Drill pipe commonly varies from 8.9 cm (3-1/2") to 12.7 cm (5") in outside diameter. Drill collars are thick-walled pipe as compared to drill pipe and thus are heavier per linear foot than drill pipe. The drill collars act as stiff members of the drill string. The drill collars are normally installed in the drill string immediately above the bit and serve to supply weight on the bit.

In carrying out rotary drilling techniques, a drilling rig is employed which utilizes a rotary table for applying torque to the top of the drill string to rotate the drill pipe and the drill bit. The rotary drill table also acts as a base stand on which all tubulars, such as drill pipe, drill collars, and casing, are suspended in the hole from the rig floor. A kelly is used as a top tubular member in the drill string and the kelly passes through the rotary table and is acted upon by the rotary table to apply the torque through the drill pipe to the drill bit. Mud pumps are used for circulating drilling fluid or mud intermediate the drilling rig and the bottom of the wellbore. Normally, the drilling fluid is pumped down the drill string and out through the drill bit and is returned to the surface through the annulus formed about the drill pipe. The drilling fluid serves such purposes as removing earth cuttings made by the drill bit from the wellbore, cooling the bit, and lubricating the drill pipe to lessen the energy required in rotation. In completing the well, casing is normally run thereinto and is cemented for the purpose of sealing and maintaining the casing in place.

In the drilling of a deviated wellbore, there may preferably be drilled a vertical first portion of the wellbore into the earth's crust from a surface

location to a kick-off point at about the lower end of the first portion by rotating and advancing a drill string and drill bit into the earth's crust. A deviated second portion of the wellbore is initiated at the kick-off point.

Referring to FIG. 1, there is shown a wellbore 1 having a vertical first portion 3 that extends from the surface 5 of the earth to a kick-off point 7 and a deviated second portion 9 of the wellbore which extends from the kick-off point 7 to the wellbore bottom 11. A shallow or surface casing string 13 is shown in the wellbore surrounded by a cement sheath 15. A drill string 17, having a drill bit 19 at the lower end thereof, is shown in the wellbore 1. The drill string 17 is comprised of drill pipe 21 and the drill bit 19, and will normally include drill collars (not shown). The drill pipe 21 is comprised of joints of pipe that are interconnected together by either conventional or eccentric tool joints 25, in the vertical first portion 3 of the wellbore extending in the open hole portion thereof below the casing 13 as well as in the deviated second portion 9 of the wellbore. The tool joints 25 in the deviated second portion 9 of the wellbore rest on the lower side 27 of the wellbore and support the drill pipe 21 above the lower side 27 of the wellbore.

In drilling of the deviated wellbore, drilling fluid (not shown) is circulated down the drill string 17, out of the drill bit 19, and returned via the annulus 29 of the wellbore to the surface 5 of the earth. Drill cuttings formed by the breaking of the earth by the drill bit 19 are carried by the returning drilling fluid in the annulus 29 to the surface of the earth. These drill cuttings (not shown) tend to settle along the lower side 27 of the wellbore about the drill

pipe 21. The eccentric tool joints 25 resting on the lower side 27 of the wellbore support the drill pipe 21 above most of these cuttings. During drilling operations, the drill string 17 is rotated and the rotation of the eccentric tool joints 25 causes the drill pipe 21 to be eccentrically moved in the wellbore. This movement of the drill pipe 21 tends to sweep the drill cuttings (not shown) from the lower side of the wellbore 27 into the main stream of flow of the returning drilling fluid in the annulus 29, and in particular into that part of the annulus which lies around the upper side of the drill pipe 21, where they are better carried by the returning drilling fluid to the surface of the earth.

Maintaining the desired weight on the drill bit 19 is a serious problem in drilling high-angle wellbores. For example, a drill collar, laying in an 80° deviated wellbore with a zero coefficient of friction has only 17% of its weight available for pushing on the drill bit. A 0.2% coefficient of friction might be expected with oil mud on a sliding smooth surface. At this coefficient of friction, the drill collar will not slide from the force of gravity into the 80° wellbore and will not add any weight to the drill bit. The actual apparent coefficient of friction in the axial direction will most likely be greater than 0.2 with a non-rotating drill string, and, by the principle of compound coefficient of friction, be between 0.0 and 0.2 for a rotating drill string. The edges of the non-rotating tool joints and any stabilizers will dig into the wellbore wall, thereby increasing the apparent coefficient of friction in the axial direction. An even greater problem will be maintaining weight-on-bit when directionally drilling

with a mud motor without rotation of the drilling string since the drill string will provide no weight to the drill bit.

It is, therefore, a specific feature of the present invention to provide a method and apparatus for providing such weight-on-bit when drilling with a mud motor and a stationary drill string. FIG. 2 illustrates such apparatus in detail. Located between the lowermost drill collar 26 and the drill bit 19 are the measuring-while-drilling sub 30, the mud motor 31 and the extension sub 32. Such extension sub 32 is the immediate source of weight on the drill bit 19. It can be powered by hydraulic pressure, compressed gas, mechanical springs, or the like. The extension sub is placed in a contracted position (i.e., compressed) by a rapid dynamic movement downward of the entire drill string 17 by such action as a high-speed rotation, a movement downward from an elevated position, or both simultaneously, until the drill bit 19 strikes the wellbore bottom. On commencement of drilling, the drill bit 19 is advanced or stroked under the weight from the compressed extension sub 32 while the drill string remains stationary. At the end of the drilling stroke, when the extension sub is fully extended from its contracted position at the start of the stroke, there is an end-of-stroke indication, for example, a mud pressure increase or decrease. The entire drill string is then drawn up the wellbore and the drill bit repositioned above the wellbore bottom. The procedure is then repeated with the drill string being lowered to compress the extension sub and the drilling stroke being thereafter again completed. In one example, the drill string is pulled upward until the drill bit is about 9.15 meters (30 feet) above wellbore bottom. The mud

circulation is stopped and the drill string rotation is increased to about 150 rpm. A rapid lowering of the rotating drill string is then initiated to compress the extension sub 32. It is preferred that the compressed extension sub be able to advance the drill bit at least 0.61 - 1.22 m (2 to 4 feet) during each drilling stroke with no drill string advancement. This is accomplished by a soft-spring extension sub delivering 9,080 Kg (20,000 pounds) of weight to the drill bit in the compressed state and 7,164 Kg (16,000 pounds) in the extended state. Use of a compressed gas cylinder would be comparable to use of the soft spring in the extension sub.

In a further embodiment, a hydraulic cylinder similar to the conventional hydraulic drill collar, but without the shoe reaction against the wellbore wall, could be used as the extension sub. Pump pressure would then cause the extension sub to put weight on the drill bit.

For all embodiments of the extension sub, the axial wellbore force reaction to each drilling stroke is the frictional resistance of the drill string against the wellbore wall. Further, it is not necessary that the extension sub 32 be located between the mud motor 31 and drill bit 19 as shown in FIG. 2. It could be located between the mud motor 31 and the measuring-while-drilling sub 30 or, it could be located between the measuring-while-drilling sub 30 and the lowermost drill collar 26.

Use of the present invention will be particularly advantageous when changing the direction of a high-angle wellbore. The greatest problem in such high-angle wellbores is providing the desired weight-on-bit when rotating only with the mud motor, the

drill string remaining stationary. In this situation, a bent sub 33 is located above the mud motor 31 as shown in FIG. 3. To change wellbore direction, the rotation of drill string 17 is stopped, the orientation of the bent sub 33 is set to redirect the drill bit 19 in the desired change of direction, and the rotation of the drill bit 19 continued through only the drill motor 31. This effects a change in the direction of the wellbore from the straight path. When the desired directional change has been completed, as indicated by the measuring-while-drilling sub 30, the rotation of the drill string 17 is restarted.

FIG. 3 illustrates diagrammatically such a change in direction of the second deviated portion 9 of the wellbore. When both the drill string 17 and drill bit 19 are rotated, the borehole follows the direction of the straight path 40 with the borehole size being shown by the dashed lines 42. Preferably, the drill string is rotated at relatively slow speed sufficient to both maintain a straight path and to minimize friction loss from dragging of the drill string along the lower side of the wellbore. Such rotational speed may be in the range of 10 to 25 revolutions per minute, for example. However, slower or faster speeds may also be sufficient. During a change in direction, the drill string is held stationary with the bent sub oriented as indicated by the dashed lines 43. The weight-on-bit is supplied by extension sub 32 such that drilling by the mud motor 31 follows the path 41 with the initial borehole size as shown by the dashed lines 44. Following such direction change, the drill string 17 is again rotated and the borehole of the size shown by dashed lines 42 continues in the new direction 41.

Since such a change in wellbore direction is to be effected without rotation of drill string 17, the weight on the drill bit 19 would drill off immediately and bit advancement would stop without the immediate force of the extension sub 32 on the drill bit 19 since the available weight-on-bit from the drill string is generally not sufficient for high-angle wellbores. For example, an alternative to the use of the bent sub 33 for angularly displacing the axis of rotation of the drill bit 19 from that of the drill string is the use of a bent housing for the drill motor 31. A further alternative is the offsetting of the axis of the drive shaft of the drillmotor 31. Another alternative is the use of non-concentric stabilizers on the drill motor 31.

In only two degrees from an inclination of 80° to 82° with a 0.1 effective coefficient of friction the available bit weight from a drill collar can decrease by one-half (from a factor of 0.075 to 0.040). In one embodiment, as shown in FIG. 3, the bent sub 30 provides a deviation angle θ of $1/4^{\circ}$ from the vertical axis of the drill string 17 and is in the order of 1.05 m (3-1/2 feet) in length. With a distance of about 9.15 m (30 feet) from the bottom of the wellbore to the deviating point of the bent sub 33 and an angle of deviation θ of $1/4^{\circ}$, a drilling offset d of about 3.81 cm (1-1/2 inches) is provided from the center line of the wellbore as shown in FIG. 3. Other angles of deviation may be selected to provide varying drilling offsets. Suitable angles are from about $1/8^{\circ}$ to about $1/2^{\circ}$ at distances of 9.15 m (30 feet) to 3.05 m (10 feet) to the deviating point of the bent sub 30. Drill bit 19 is a 30.12 cm (12-1/4 inch) bit. Drill motor 31 is 19.68 cm (7-3/4 inch) Delta 1000 mud motor supplied by Dyna-Drill Co. of Irvine, California, and which is 7.35 m (24-1/2 feet) in

length. The measuring-while-drilling system 30 can be of the types supplied by The Analyst/Schlumberger of Houston, Texas; Gearhart Industries of Fort Worth, Texas; Teleco Oil Field Services of Meriden, Connecticut; or Exploration Logging of Sacramento, California.

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CLAIMS:

1. A method of drilling a deviated wellbore into the earth by a rotary drilling technique wherein a drill string is used to advance a drill bit through the earth and a drilling fluid is circulated down the drill string and returned from the wellbore in the annulus formed about the drill string, comprising:

a) drilling a vertical first portion of said wellbore into the earth from a surface location to a kick-off point at about the lower end of said first portion by rotating and advancing a drill string and drill bit into the earth,

b) initiating a second portion of said wellbore at said kick-off point;

c) withdrawing said drill string and drill bit from said vertical first portion of said wellbore,

d) running into said vertical first portion of said wellbore a drill tool for drilling said deviated second portion of said wellbore, said specialized drill tool being comprised of a drill string, a drill bit, a motor for rotating said drill bit, and an extension sub having both contracted and extended positions for providing weight to said drill bit during movement from said contracted to said extended position,

e) positioning said drill tool such that said drill bit is a predetermined distance above the wellbore bottom,

f) imparting a rapid dynamic movement downward to said drill tool such that said drill bit impacts the

wellbore bottom and places said extension sub in a contracted position,

g) producing a drilling stroke of said drill bit into the earth below the wellbore bottom by simultaneously maintaining said drill string stationary, rotating said drill bit under the control of said drill motor, and advancing said drill bit under the weight provided by said extension sub in moving from said contracted position to said extended position,

h) raising said drill tool at the end of said first drilling stroke to again position said drill bit a predetermined distance above the wellbore bottom, and

i) repeating steps (f) and (g) so as to provide additional drilling strokes for the drilling of said deviated wellbore.

2. The method of claim 1 wherein said step of imparting downward movement to said drill tool so as to place said extension sub in a contracted position includes the high-speed rotation of said drill string.

3. The method of claim 2 wherein said drill string is rotated at a speed of at least 150 revolutions per minute.

4. The method of claim 1 wherein said drill tool is positioned in step (e) such that said drill bit is at least 9.15 m (30 feet) above the wellbore bottom.

5. The method of claim 1 further including the step of producing an end-of-stroke indication when said extension sub reaches its fully extended position at the end of the drilling stroke.

6. The method of claim 5 wherein said end-of-stroke indication is based on a change in the mud pressure at the wellbore bottom.

7. The method of claim 1 further including the step of angularly directing both said drill bit and axial movement of said extension sub in providing weight on said drill bit relative to the axial direction of said wellbore to effect a change in the direction of said wellbore.

8. The method of claim 1 wherein the step of advancing said drill bit under the weight provided by said extension sub includes the stroking of said extension sub from its contracted position to its extended position under hydraulic pressure control.

9. The method of claim 1 wherein the step of advancing said drill bit under the weight provided by said extension sub includes the stroking of said extension sub from its contracted position to its extended position under compressed gas control.

10. The method of claim 1 wherein the step of advancing said drill bit under the weight provided by said extension sub includes the stroking of said extension sub from its contracted position to its extended position under mechanical spring control.

11. The method of claim 1 wherein said extension sub provides at least 9,080 Kg (20,000 pounds) of weight-on-bit when released from its contracted position.

12. The method of claim 11 wherein said extension sub provides at least 7,164 Kg (16,000 pounds) of weight-on-bit in its fully extended position.

13. The method of claim 1 wherein said second portion of said deviated wellbore is drilled at an inclination such that said drill string provides no weight to said drill bit during drilling.

14. The method of claim 1 wherein said second portion of said deviated wellbore is drilled at an inclination such that the coefficient of friction of the drill string with the lower side of the wellbore in the axial direction of said second portion is between 0.0 and 0.2 for a rotating drill string.

15. The method of claim 1 wherein said second portion of said deviated wellbore is drilled at an inclination of at least 60° from the vertical.

16. The method of claim 15 wherein said second portion of said deviated wellbore is drilled at an inclination of at least 80° from the vertical.

17. A system for the rotary drilling of a deviated wellbore into the earth, comprising

- a) a drill string,
- b) a drill bit,
- c) a drill motor for rotating said drill bit independently of rotation of said drill string, and
- d) an extension sub having both axially contracted and axially extended positions for providing weight to said drill bit when moving from said contracted to said extended position so as to effect a

drilling stroke by said drill bit a predetermined distance into the wellbore bottom when drilling with said drill motor independently of said drill string.

18. The system of claim 17 further including means for directing the axis of rotation of said drill bit and the axial direction of movement of said extension sub between said contracted and extended positions such that they are both angularly displaced from the axis of said drill string.

19. The system of claim 18 wherein the means for directing the axis of rotation of said drill bit and the axial movement of said extension sub between said contracted and extended positions is a bent sub affixing said drill string to said drill motor, said extension sub, and said drill bit.

20. The system of claim 18 wherein the means for directing the axis of rotation of said drill bit includes a bent housing for said drill motor, said bent housing affixing said drill motor to said extension sub and said drill bit.

21. The system of claim 18 wherein the means for directing the axis of rotation of said drill bit includes the offsetting of the axis of said drill string from the axis of rotation of said drill motor, the axis of rotation of said drill bit, and the axial movement of said extension sub between said contracted and extended positions.

22. The system of claim 18 wherein said extension sub is moved from its contracted position to

its extended position during said drilling stroke by means of hydraulic pressure.

23. The system of claim 18 wherein said extension sub is moved from its contracted position to its extended position during said drilling stroke by means of compressed gas.

24. The system of claim 18 wherein the movement of said extension sub from its contracted position to its extended position during said drilling stroke is under spring-loaded actuation.

25. The system of claim 18 wherein said extension sub provides at least 9,080 Kg (20,000 pounds) of weight on said drill bit at the start of said drilling stroke and at least 8,172 Kg (18,000 pounds) of weight on said drill bit at the end of said drilling stroke.

26. The system of claim 18 wherein said extension sub provides a predetermined distance for said drilling stroke of at least 0.61 m (two feet).

27. The method of claim 17 wherein said second portion of said deviated wellbore is drilled at an inclination such that said drill string provides no weight to said drill bit during drilling.

28. The method of claim 17 wherein said second portion of said deviated wellbore is drilled at an inclination such that the coefficient of friction of the drill string with the lower side of the wellbore in the axial direction of said second portion is between 0.0

and 0.2 for a rotating drill string.

29. The method of claim 17 wherein said second portion of said deviated wellbore is drilled at an inclination of at least 60° from the vertical.

30. The method of claim 29 wherein said second portion of said deviated wellbore is drilled at an inclination of at least 80° from the vertical.

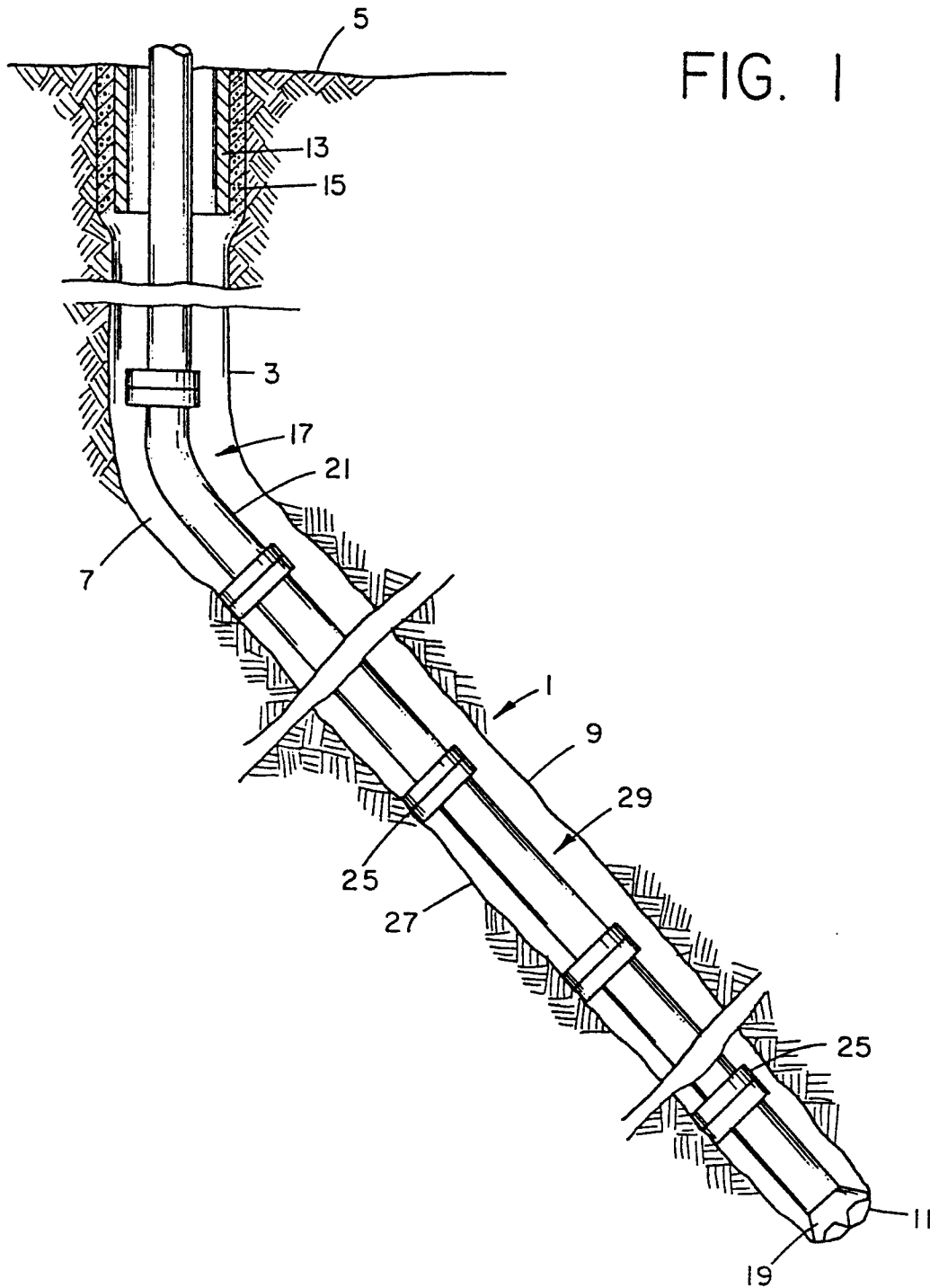


FIG. 2

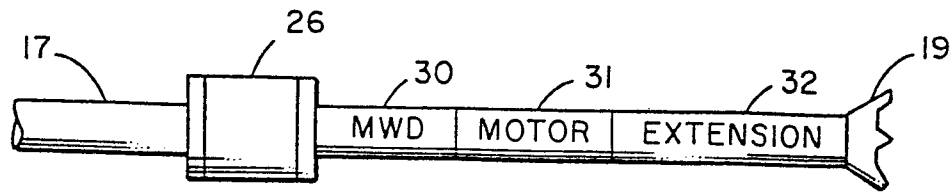
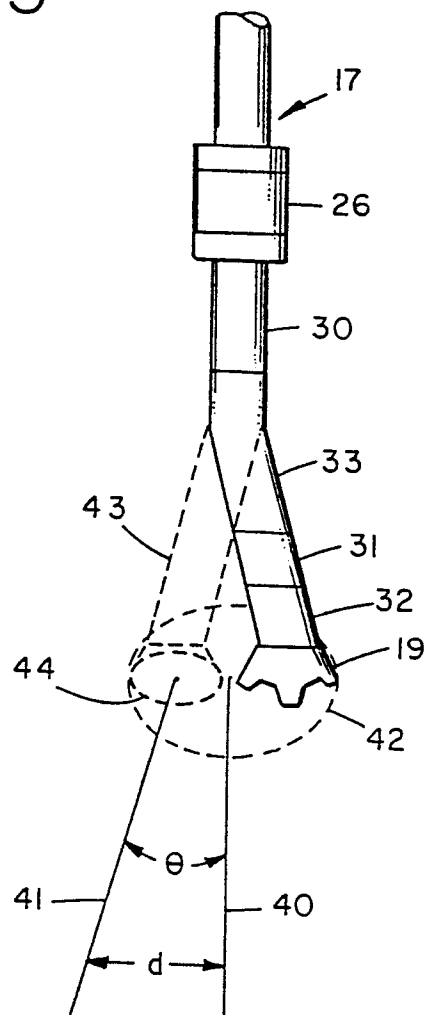


FIG. 3





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-3 978 930 (SCHROEDER) * Column 2, lines 27-32; column 3, lines 33-40; column 4, lines 32-37 *	17,22- 24,27- 30	E 21 B 7/04 E 21 B 4/20 E 21 B 17/07 E 21 B 4/00
Y	---	1,2,5- 16,18- 21,25, 26	
Y	BE-A- 536 490 (SELIGMAN) * Page 7, lines 40-53; page 4, lines 28-34; page 8, lines 7-11; page 5, line 14 - page 5, lines 45,46 *	1,2,8- 12,25, 26	
			TECHNICAL FIELDS SEARCHED (Int. Cl.4)
A	---	17,22	E 21 B
Y	US-A-3 497 019 (ORTLOFF) * Claim 1; column 9, lines 28-32 *	5,6	
A	---	1,8,17 ,22	
	--- -/-		
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 17-02-1986	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			



DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl. 4)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
Y	US-A-3 713 500 (RUSSELL) * Whole document *	7,18-21	
X	GB-A- 764 099 (BATAAFSCHE PETROLEUM MIJ.) * Page 5, lines 44-66 *	17,22	
A		1,8	
X	EP-A-0 110 182 (HORSTMEYER) * Page 13, line 18 - page 14, line 22 *	17,22	
A		1,5,8	
X	US-A-3 827 512 (EDMOND) * Column 3, lines 46-56 *	17,22, 27-30	TECHNICAL FIELDS SEARCHED (Int. Cl. 4)
A		1,5,8, 13-16	
A	US-A-2 776 817 (GREGORY) * Column 1, lines 62-65; column 3, lines 49-58,6-16 *	1,8,11 -17,22, 25-30	
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 17-02-1986	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			



DOCUMENTS CONSIDERED TO BE RELEVANT			Page 3
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 4)
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A	ER-A-2 544 375 (OBRECHT) * Page 7, line 22 - page 8, line 16; page 9, lines 16-22 *	1,3,7, 17-21	
A	US-A-4 465 147 (FEENSTRA) * Whole document *	1,7,17 -21	
A	US-A-4 384 625 (ROPER) * Column 6, lines 50-62; claim 2 *	1,15- 17,29, 30	
E	EP-A-0 171 259 (DELLINGER) * Whole document *	1,7,17 -21	
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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	