



PCT

- | | |
|---|--|
| (51) International Patent Classification:
<i>E21B 7/04</i> (2006.01) <i>E21B 47/12</i> (2006.01) | (71) Applicant (for FR only): SERVICES PETROLIERS SCHLUMBERGER [FR/FR]; 42, rue Saint Dominique, F-75007 Paris (FR). |
| (21) International Application Number:
PCT/IB2009/053071 | (71) Applicant (for GB, JP, NL only): SCHLUMBERGER HOLDINGS LIMITED; P.O. Box 71, Craigmuir Chambers, Road Town, Tortola (VG). |
| (22) International Filing Date:
15 July 2009 (15.07.2009) | (71) Applicant (for AL, AM, AU, AZ, BF, BG, BJ, BY, CF, CG, CI, CM, CO, CZ, DE, DK, GA, GN, GQ, GR, GW, HU, ID, IE, IL, IT, KG, KP, KR, KZ, LT, MD, ML, MR, MX, MY, NE, NO, NZ, OM, PL, RO, RU, SI, SK, SN, TD, TG, TJ, TM, TN, TR, TT, UZ, ZA only): SCHLUMBERGER TECHNOLOGY B.V. [NL/NL]; Parkstraat 83-89, NL-2514 The Hague (NL). |
| (25) Filing Language: English | |
| (26) Publication Language: English | |
| (30) Priority Data:
12/179,617 25 July 2008 (25.07.2008) US | |
| (71) Applicant (for CA only): SCHLUMBERGER CANADA LIMITED [CA/CA]; 525-3rd Avenue S.W., Calgary, Alberta T2P 0G4 (CA). | |

[Continued on next page]

- (54) Title:** SYSTEM AND METHOD FOR DRILLING A BOREHOLE

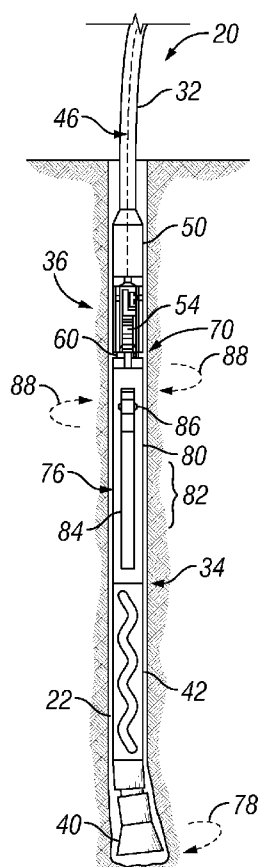


FIG. 3

(57) Abstract: A technique facilitates drilling in a wide variety of applications and environments. The technique utilizes a coiled tubing bottom hole assembly constructed with a sensor system that provides the ability to steer a borehole within a reservoir. An orienter is connected to a top end of the bottom hole assembly to provide rotational movement of the bottom hole assembly. The orienter can be designed to provide continuous and bidirectional rotational movement of the coiled tubing bottom hole assembly. A telemetry system is provided to enable high data rate telemetry between the orienter and a surface location as well as communication between the bottom hole assembly and the orienter.



DK, FR, GA, GB, GN, GQ, GR, GW, HU, ID, IE, IL, IT, JP, KG, KP, KR, KZ, LT, MD, ML, MR, MX, MY, NE, NL, NO, NZ, OM, PL, RO, RU, SI, SK, SN, TD, TG, TJ, TM, TN, TR, TT, US, UZ, ZA): **PRAD RESEARCH AND DEVELOPMENT LIMITED**; P.O. Box 71, Craigmuir Chambers, Road Town, Tortola (VG).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **MORIARTY, Keith A.** [US/US]; 603 Durley, Houston, Texas 77079 (US). **ROCK, Devin** [US/US]; 21502 Indigo Hill Lane, Katy, Texas 77450 (US). **UTTER, Robert** [US/US]; 17 Lake Mist Drive, Sugar Land, Texas 77479 (US).

(74) Agent: **CATE, David**; 110 Schlumberger Drive, MD-1, Sugar Land, TX 77478 (US).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,

HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— without international search report and to be republished upon receipt of that report (Rule 48.2(g))

SYSTEM AND METHOD FOR DRILLING A BOREHOLE

BACKGROUND

[0001] In preparing wells, boreholes are drilled to subterranean reservoirs, and those boreholes can be used for producing desired fluids, such as hydrocarbon based fluids. The boreholes also can be used for treatment applications and a variety of other well related applications. In many environments, directional drilling systems are used to enable an operator to change the direction of drilling to better access a reservoir or other subterranean region.

[0002] A variety of systems and techniques are used to facilitate directional drilling. For example, coiled tubing drilling systems have been used to provide the flexibility needed to drill deviated wellbores. Additionally, a variety of systems and devices, including steerable motors, articulated subs, push-the-bit systems, and other systems or devices have been used to facilitate steering of the drilling operation. However, the available systems and techniques have proven to be limited in certain applications. For example, such systems are not able to sufficiently operate in short radius drilling trajectories in environments having high gas fraction, two-phase drilling fluids.

SUMMARY

[0003] In general, the present invention provides a system and method for drilling in a wide variety of applications and environments. A coiled tubing bottom hole assembly is constructed with a sensor system that provides the ability to geologically steer a borehole within a reservoir. An orienter is connected to a top end of the bottom hole assembly to provide rotational movement of the bottom hole assembly. For

example, the orienter can be designed to provide continuous and bidirectional rotational movement of the coiled tubing bottom hole assembly. Additionally, a telemetry system is able to provide high data rate telemetry between the orienter and a surface location as well as communication between the bottom hole assembly and the orienter.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] Certain embodiments of the invention will hereafter be described with reference to the accompanying drawings, wherein like reference numerals denote like elements, and:

[0005] Figure 1 is a schematic front elevation view of a coiled tubing drilling system positioned in a borehole, according to an embodiment of the present invention;

[0006] Figure 2 is an illustration of one example of an orientation system coupled to a bottom hole assembly for drilling a borehole, according to an embodiment of the present invention;

[0007] Figure 3 is an illustration of an example of a bottom hole assembly for drilling a borehole, according to an embodiment of the present invention;

[0008] Figure 4 is an illustration of another example of a bottom hole assembly for drilling a borehole, according to an alternate embodiment of the present invention;

[0009] Figure 5 is an illustration of another example of a bottom hole assembly for drilling a borehole, according to an alternate embodiment of the present invention; and

[0010] Figure 6 is an illustration of another example of a bottom hole assembly for drilling a borehole, according to an alternate embodiment of the present invention.

DETAILED DESCRIPTION

[0011] In the following description, numerous details are set forth to provide an understanding of the present invention. However, it will be understood by those of ordinary skill in the art that the present invention may be practiced without these details and that numerous variations or modifications from the described embodiments may be possible.

[0012] The present invention generally relates to a system and method for drilling a variety of boreholes and subterranean reservoirs. The system utilizes a bottom hole assembly deployed on coiled tubing and constructed to execute a variety of drilling trajectories in many types of environments. For example, the design of the system enables execution of short radius drilling trajectories with high gas fraction, two-phase drilling fluids while simultaneously providing the capability for precise geological steering within reservoirs. The precise geological steering is facilitated by a sensor system that enables scanning of the borehole along with, for example, acquisition and interpretation of azimuthal measurements and images in real time. The unique functionality is provided in part by the combination of an orienter tool and a bottom hole assembly along with communications systems that provide high-bandwidth telemetry for steering and azimuthal measurements and images. By way of example, the measurements and images may be obtained, at least in part, with a logging while drilling system incorporated into the bottom hole assembly.

[0013] The coiled tubing drilling system may be constructed in different configurations with various components depending on the specific drilling applications. According to one embodiment, the orienter is connected to a top end, i.e. uphole end, of the coiled tubing bottom hole assembly to provide full rotational capability with respect to the bottom hole assembly. The system further comprises a wireline to power the orienter and to carry data to and/or from the bottom hole assembly. The rotational capability of the complete bottom hole assembly combined with a sensor system having

directional, azimuthal, and/or imaging sensors provides the ability to geologically steer the borehole within a reservoir. Additionally, the rotational capability of the complete bottom hole assembly and the position of the orienter on top of the bottom hole assembly greatly reduces the chance of the bottom hole assembly becoming stuck in the borehole. Furthermore, the rotational capability can be continuous and bidirectional. Thus, even if the bottom hole assembly becomes temporarily stuck, the rotational capability and the configuration of the drilling system provide an enhanced ability to free the stuck assembly.

[0014] As described in greater detail below, the structure and configuration of the orienter with respect to the coiled tubing bottom hole assembly enable substantially improved communication. In one embodiment, a wireline is used to provide power to the orienter and to provide data transfer to the bottom hole assembly during a drilling operation. In some embodiments, power can be provided in the bottom hole assembly by batteries, such as batteries disposed in measurement while drilling and/or logging while drilling systems. The design also enables high data rate telemetry from the bottom hole assembly to the orienter and through the wireline to a surface location. To facilitate transfer of signals during operation, a wireless telemetry system can be deployed between the orienter and the bottom hole assembly to provide full signal transfer capability while also providing a fully rotational bottom hole assembly capable of continuous and bidirectional operation. The unique structure and design of the system facilitates many types of drilling operations in a wider variety of environments. In one application, for example, the system can be operated in short radius, ultra-slim hole sizes in many types of fluid conditions, including under-balanced conditions having two-phase flow with high gas fractions.

[0015] Referring generally to Figure 1, one embodiment of a well drilling system 20 is illustrated as being operated to drill a borehole 22 for use in a well 24. The illustrated well drilling system 20 is a coiled tubing drilling system that forms part of an overall coiled tubing drilling installation 26. The coiled tubing drilling installation 26 may have a variety of components and systems, but the example illustrated generally

comprises a coiled tubing rig and injector installation 28 positioned at a surface 30 proximate the top of well 24.

[0016] The drilling system 20 generally comprises coiled tubing 32 connected to a coiled tubing bottom hole assembly 34 through an orienter 36. As illustrated, orienter 36 is connected to bottom hole assembly 34 at an uphole or top end 38 of the bottom hole assembly. Furthermore, the bottom hole assembly 34 may comprise a variety of components but generally includes a drill bit 40 driven to form the borehole 22. Drill bit 40 may be rotated by a motor 42, e.g. a mud motor, or by another suitable driving device. In this embodiment, motor/device 42 is a steerable device, such as a steerable mud motor, that may be directionally controlled to drill borehole 22 along a variety of desired trajectories through a reservoir 44.

[0017] Coiled tubing bottom hole assembly 34 also may comprise a variety of other components depending on the specific application environment. As discussed in greater detail below, the bottom hole assembly may have a variety of sensors and signal transmission systems to provide an operator with real-time data and/or other data helpful in both drilling borehole 22 and in steering the bottom hole assembly. By way of example, bottom hole assembly 34 may comprise measurement while drilling systems and/or logging while drilling systems.

[0018] Referring generally to Figure 2, one example of bottom hole assembly 34 connected to orienter 36 is illustrated. The orienter receives electrical power via a wireline 46 deployed along coiled tubing 32. For example, wireline 46 may be deployed through an interior 48 of coiled tubing 32. The coiled tubing 32 and wireline 46 are connected to orienter 36 via a coiled tubing wireline head 50. In this embodiment, wireline 46 may comprise a single or multi-conductor cable to provide power to orienter 36 while also providing high data rate telemetry between the surface and coiled tubing bottom hole assembly 34.

[0019] In the embodiment of Figure 2, the orienter 36 comprises an outer housing or body 52 enclosing a motor 54 powered via wireline 46. The motor 54 is connected to a gearbox 56 which, in turn, is connected to bottom hole assembly 34 via a shaft 58 and an adapter sub 60 to rotate the bottom hole assembly. The motor 54 and gearbox 56 can be selectively actuated within stationary housing 52 to selectively rotate bottom hole assembly 34 in a continuous and bidirectional manner, i.e. a clockwise or a counterclockwise manner. The orienter 36 also comprises electronics 62 to enable control over motor 54 and for outputting control signals and/or for receiving data from a sensor system 64 and/or other sensor systems. Sensor system 64 is able to provide various data to a surface location via wireline 46. By way of example, sensor system 64 may comprise pressure sensors, such as an internal pressure sensor 66 and an annular pressure sensor 68.

[0020] The electronics 62 also can be used to receive and transmit signals with respect to a communication system 70 over which data is communicated between bottom hole assembly 34 and orienter 36. In the example illustrated, communication system 70 comprises a wireless communication system able to transfer data between bottom hole assembly 34 and orienter 36 at a high data rate. By way of further example, wireless communication system 70 may comprise a "short-hop" system having a stationary communication component 72 and a rotating communication component 74. In the example illustrated, the stationary communication component 72 is mounted in orienter 36, and the rotating communication component 74 is mounted in bottom hole assembly 34. The use of rotating component 74 and stationary component 72 enables the transfer of data between the bottom hole assembly 34 and the orienter 36 during operation of the orienter and rotation of the bottom hole assembly. Depending on the design of the overall drilling system, the communication system 70 enables high data rate, bidirectional transfer of information between the orienter 36 and a variety of systems in the bottom hole assembly 34, including measurement while drilling systems and/or a logging while drilling systems. Data received from the bottom hole assembly is transferred from stationary component 72 to electronics 62 and on to a surface location, or other suitable

location, via wireline 46. Furthermore, the transfer of data can be conducted on a real time basis.

[0021] Another embodiment of drilling system 20 is illustrated in Figure 3. In this embodiment, coiled tubing bottom hole assembly 34 comprises a measurement while drilling system 76 connected to orienter 36. At an opposite end, measurement while drilling system 76 is connected to motor 42 which is in the form of a steerable mud motor able to rotate drill bit 40, as indicated by arrow 78. The steerable mud motor 42 is designed to steer drill bit 40 to enable steering of a borehole along desired trajectories during a drilling operation. The measurement while drilling system 76 obtains data that enables the bit direction and drilling direction to be controlled via steerable motor 42. By way of example, measurement while drilling system 76 may be battery powered.

[0022] Measurement while drilling system 76 comprises an outer housing 80 that encloses and/or supports a directional formation evaluation measurement system 82. The measurement system 82 may comprise a variety of sensors, including direction and inclination sensors 84. The measurement system 82 also may comprise other sensors, such as a gamma ray sensor 86 that can be eccentrically mounted and/or shielded and positioned to generate azimuthal measurements and images of the borehole.

[0023] The orienter 36 is operable to selectively rotate measurement while drilling system 76 and the entire bottom hole assembly 34 in either a clockwise or a counterclockwise direction, as indicated by arrows 88. When the orienter 36 is used to rotate the bottom hole assembly 34 in a continuous mode, the data acquired by measurement system 82 can be used to generate an image covering 360° of the borehole. The data acquired is transmitted to the surface via the short-hop, wireless communication system 70 and wireline 46 for real time evaluation to enable precise control over the drilling via mud motor 42 and drill bit 40. The ability to acquire and transmit data combined with the arrangement and cooperation of the orienter 36 and bottom hole assembly 34 enable operation of the drilling system to create a variety of borehole trajectories in a variety of environments. For example, the unique construction and data

acquisition abilities enable operation of the coiled tubing bottom hole assembly 34 in a manner that executes short radius drilling trajectories with high gas fraction, two-phase drilling fluids while maintaining the ability for precise geological steering within the reservoir by scanning the borehole and acquiring and interpreting azimuthal measurements and images in real time via measurement system 82.

[0024] Another embodiment of drilling system 20 is illustrated in Figure 4. In this embodiment, a logging while drilling system 90 is combined with measurement while drilling system 76. For example, logging while drilling system 90 may be mounted between motor 42, e.g. a steerable mud motor, and measurement while drilling system 76. By way of example, both measurement while drilling system 76 and logging while drilling system 90 may be battery powered and contain a variety of sensors, including direction and inclination sensors and a gamma ray sensor that may be eccentrically mounted and/or shielded in a position to generate azimuthal measurements and images of the borehole.

[0025] In one embodiment, the logging while drilling system 90 comprises a sensor system 92 having desired sensors, including directional sensors 94 specifically designed to enable generation of azimuthal measurements and images of the borehole. By way of example, directional sensors 94 may comprise resistivity sensors constructed with tilted coils or other non-axisymmetric directional sensors. However, sensor system 92 also may comprise a variety of additional sensors, including annular pressure sensors and other sensors as desired for obtaining information on various drilling application related parameters.

[0026] The illustrated embodiment also enables operation of the logging while drilling system 90 and/or measurement while drilling system 76 while orienter 36 rotates bottom hole assembly 34 in a continuous mode. The rotation of bottom hole assembly 34 enables acquisition of data that can be used to generate any image or images covering 360° of the borehole. The acquired data can be transferred at a high rate and in real time to orienter 36 via wireless communication system 70 and on to a desired location via

wireline 46. The continuous rotational capability of the bottom hole assembly 34 enables the precise drilling of desired trajectories, including straight trajectories, while maintaining precise well placement in the reservoir 44 via rotational images and geosteering measurements obtained from sensor system 92 and/or measurement system 82.

[0027] In another embodiment illustrated in Figure 5, the drilling system 20 further comprises a device 96 to induce or facilitate axial movement of the orienter 36 and bottom hole assembly 34. By way of example, axial device 96 may comprise a tractor 98, such as a reciprocating tractor, or another type of axial device, such as a thruster or crawler. Use of a reciprocating tractor alternately pulls coiled tubing 32 and pushes the combined orienter 36 and bottom hole assembly 34. The axial device 96 effectively extends the reach capability of the drilling system by providing added force to overcome friction and to reduce the potential for helical lockup in the coiled tubing due to the resistance incurred during creation of the borehole.

[0028] Referring generally to Figure 6, another alternate embodiment is illustrated in which the drilling system 20 incorporates a different type of axial device 96. In this embodiment, the axial device 96 provides a continuous axial force through a continuous type tractor or crawler 100. The continuous type tractor or crawler 100 imparts continuous force against orienter 36 which facilitates movement of bottom hole assembly 34 during drilling of the borehole along a desired trajectory. As with the embodiment illustrated in Figure 5, the continuous axial force device 100 extends the reach capability of the drilling system by overcoming friction and by reducing the potential for helical lockup in the coiled tubing.

[0029] In operation, the sensor systems in the measurement while drilling system 76 and/or the logging while drilling system 90 are used in combination with the orienter 36 to selectively rotate the complete bottom hole assembly 34 in a manner that facilitates the drilling of boreholes along a variety of trajectories in many types of environments. Additionally, the use of wireless communication system 70 provides the system with

telemetry between the bottom hole assembly and the orienter to enable high rate, real time transfer of data to a surface control system or other control system. The combination of wireless communication system 70 and wireline 46 provides the overall system with high-bandwidth telemetry that facilitates both data accumulation and steering of the drilling system 20. The ability to rotate the bottom hole assembly 34 in either direction on a continuous basis also dramatically improves the ability to geologically steer a borehole along a desired trajectory within a reservoir. Depending on the environment, incorporation of the axial device 96 can further facilitate movement of the bottom hole assembly to precisely create boreholes with desired trajectories.

[0030] Drilling system 20 can be constructed in a variety of configurations for use in many environments and applications. Depending on the specific environment and type of drilling operation, the overall system may comprise a variety of alternate or additional components. Furthermore, the various sensor systems can be adjusted to sense desired parameters appropriate for a given application. In some applications, for example, a variety of other or additional sensors may be incorporated into the measurement while drilling system and/or logging while drilling system. Examples of such sensors include annular pressure sensors, internal pressure sensors, tension sensors, compression sensors, additional inclination sensors, or other parameter sensors.

[0031] Accordingly, although only a few embodiments of the present invention have been described in detail above, those of ordinary skill in the art will readily appreciate that many modifications are possible without materially departing from the teachings of this invention. Such modifications are intended to be included within the scope of this invention as defined in the claims.

CLAIMS

What is claimed is:

- 1 1. A system for drilling a borehole, comprising:
2
3 a bottom hole assembly having a directional drill bit, a motor to drive the
4 drill bit, and a measurement while drilling system;
5 an orienter coupled to the bottom hole assembly and located above the
6 bottom hole assembly, the orienter providing full rotational capability for the
7 bottom hole assembly in clockwise and counterclockwise directions;
8 a coiled tubing coupled to the orienter with a coiled tubing wireline head;
9 and
10 a wireline to deliver power to the orienter, the wireline further providing
11 high data rate telemetry between the bottom hole assembly and a surface location.
- 1 2. The system as recited in claim 1, further comprising a wireless telemetry system
2 to communicate signals between the bottom hole assembly and the orienter.
- 1 3. The system as recited in claim 2, wherein the wireless telemetry system comprises
2 a rotating communication component on the bottom hole assembly and a
3 stationary communication component on the orienter.
- 1 4. The system as recited in claim 1, wherein the bottom hole assembly further
2 comprises a logging while drilling system.
- 1 5. The system as recited in claim 4, wherein the logging while drilling system
2 comprises an imaging sensor to enable geological steering of the borehole within
3 a reservoir.

- 1 6. The system as recited in claim 4, wherein the logging while drilling system
2 comprises an azimuthal sensor to enable geological steering of the borehole
3 within a reservoir.
- 1 7. The system as recited in claim 4, wherein the logging while drilling system
2 comprises a directional sensor to enable geological steering of the borehole within
3 a reservoir.
- 1 8. The system as recited in claim 1, wherein the measurement while drilling system
2 comprises direction and inclination sensors.
- 1 9. The system as recited in claim 1, wherein the orienter comprises a motor coupled
2 to a gearbox, the motor receiving power through the wireline.
- 1 10. The system as recited in claim 9, wherein the orienter further comprises an
2 internal pressure sensor and an annular pressure sensor.
- 1 11. The system as recited in claim 1, further comprising an axial device to facilitate
2 axial movement of the bottom hole assembly.
- 1 12. The system as recited in claim 11, wherein the axial device comprises a tractor.
- 1 13. A method, comprising:
2
3 constructing a coiled tubing bottom hole assembly with sensors to enable
4 precise geological steering during drilling of a borehole;
5 connecting an orienter to the coiled tubing bottom hole assembly at a top
6 end of the coiled tubing bottom hole assembly;
7 providing a high-bandwidth telemetry between the coiled tubing bottom
8 hole assembly and the orienter; and

9 employing a wireline to provide high data rate telemetry and to deliver
10 power to the orienter.

1 14. The method as recited in claim 13, wherein constructing comprises constructing
2 the coiled tubing bottom hole assembly with sensors able to scan the borehole.

1 15. The method as recited in claim 13, wherein constructing comprises constructing
2 the coiled tubing bottom hole assembly with a sensor system able to acquire and
3 interpret azimuthal measurements and images in real time.

1 16. The method as recited in claim 13, wherein constructing comprises constructing
2 the coiled tubing bottom hole assembly with a measurement while drilling system.

1 17. The method as recited in claim 13, wherein constructing comprises constructing
2 the coiled tubing bottom hole assembly with a logging while drilling system.

1 18. The method as recited in claim 13, further comprising operating the coiled tubing
2 bottom hole assembly to drill a borehole.

1 19. The method as recited in claim 18, wherein operating comprises steering the
2 coiled tubing bottom hole assembly through a short radius drill trajectory.

1 20. The method as recited in claim 18, wherein operating comprises utilizing the
2 precise geological steering while operating in high gas fraction, two-phase drilling
3 fluids.

1 21. A system, comprising:
2

3 a coiled tubing bottom hole assembly having a sensor system that provides
4 the ability to geologically steer a borehole within a reservoir;

5 an orienter positioned above and connected to a top end of the coiled
6 tubing bottom hole assembly, the orienter able to provide continuous and
7 bidirectional rotational movement of the coiled tubing bottom hole assembly; and
8 a telemetry system able to provide high data rate telemetry between the
9 coiled tubing bottom hole assembly and the orienter during operation.

1 22. The system as recited in claim 21, further comprising a wireline coupled to the
2 orienter to provide high data rate telemetry between the orienter and the surface
3 while providing power to the orienter.

1 23. The system as recited in claim 21, wherein the telemetry system is a wireless
2 telemetry system.

1 24. The system as recited in claim 21, wherein the sensor system is embodied at least
2 in part in a measurement while drilling system.

1 25. The system as recited in claim 21, wherein the sensor system is embodied at least
2 in part in a logging while drilling system.

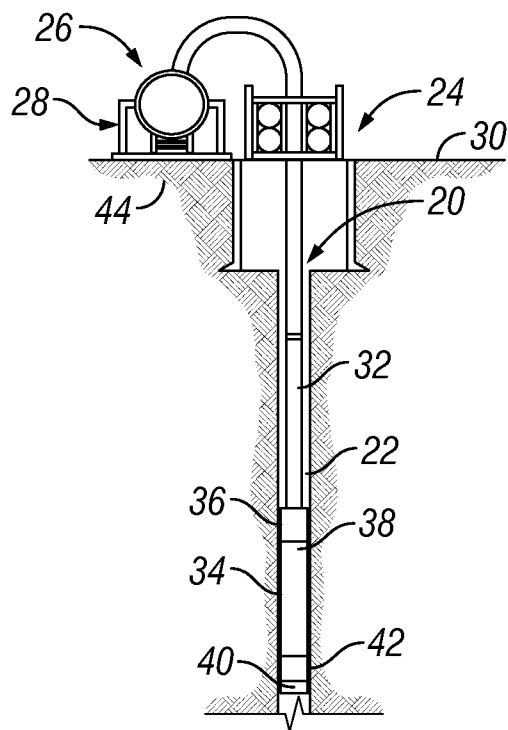


FIG. 1

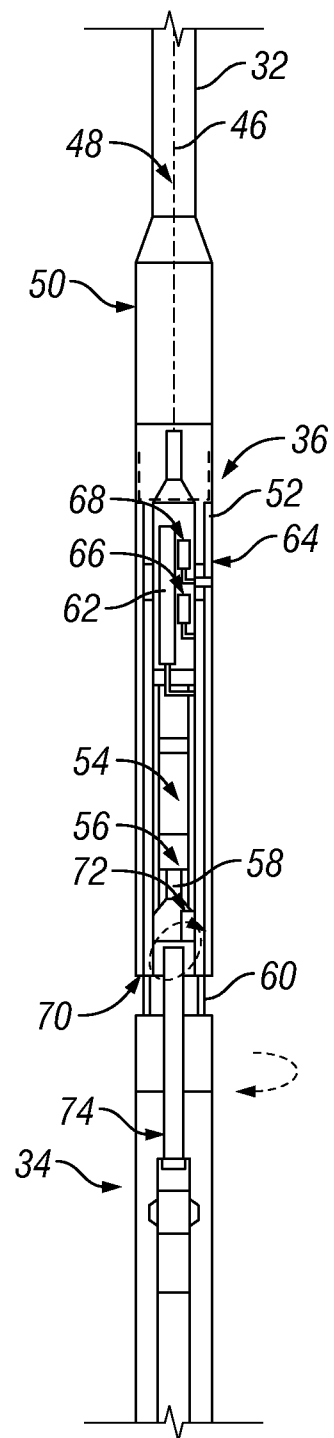


FIG. 2

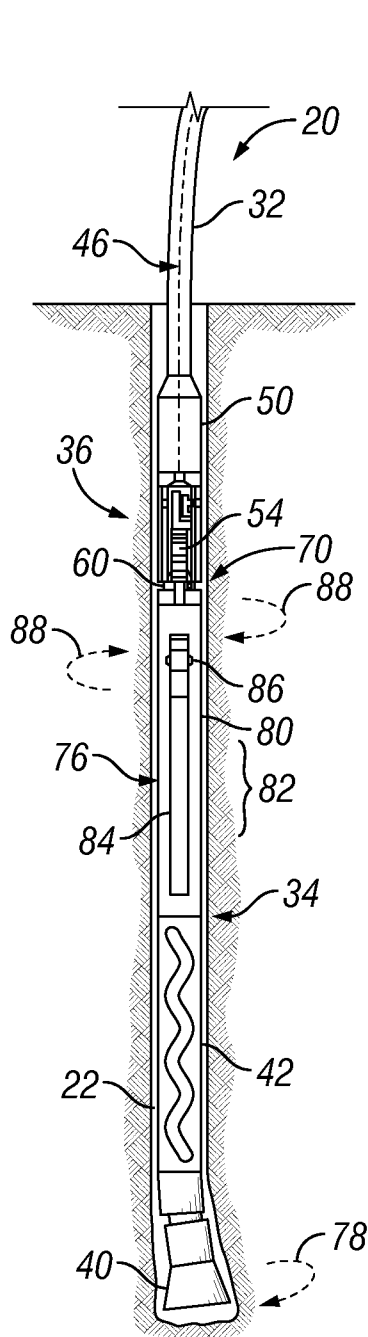


FIG. 3

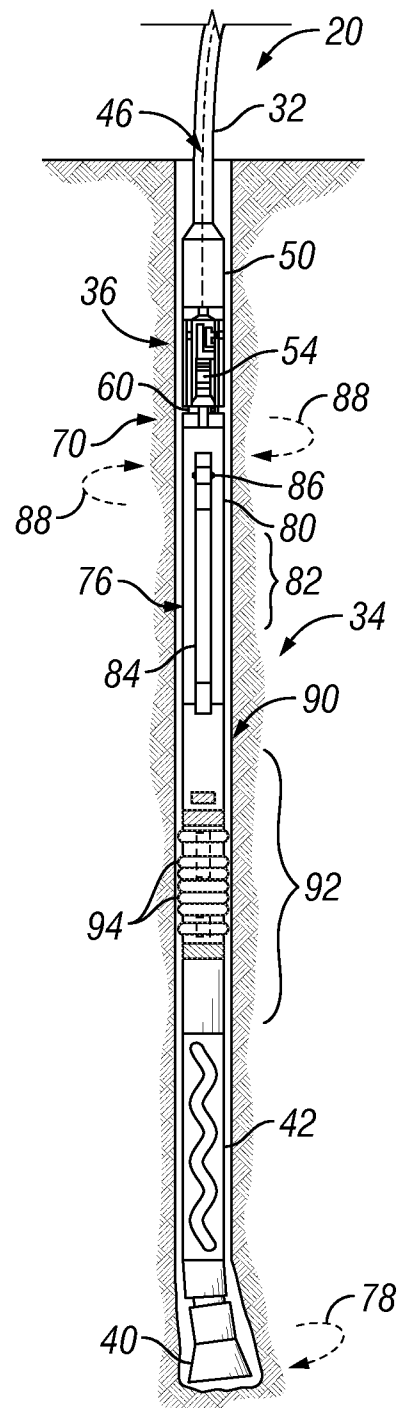


FIG. 4

3/3

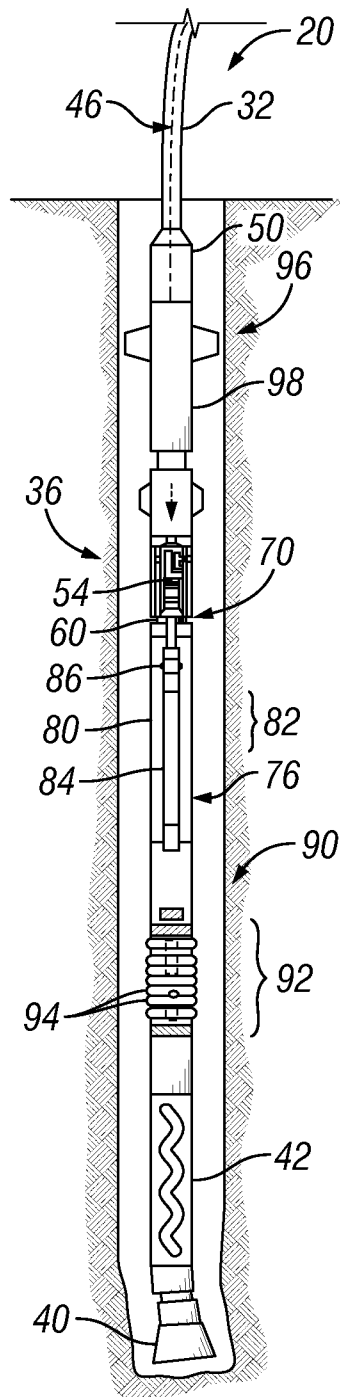


FIG. 5

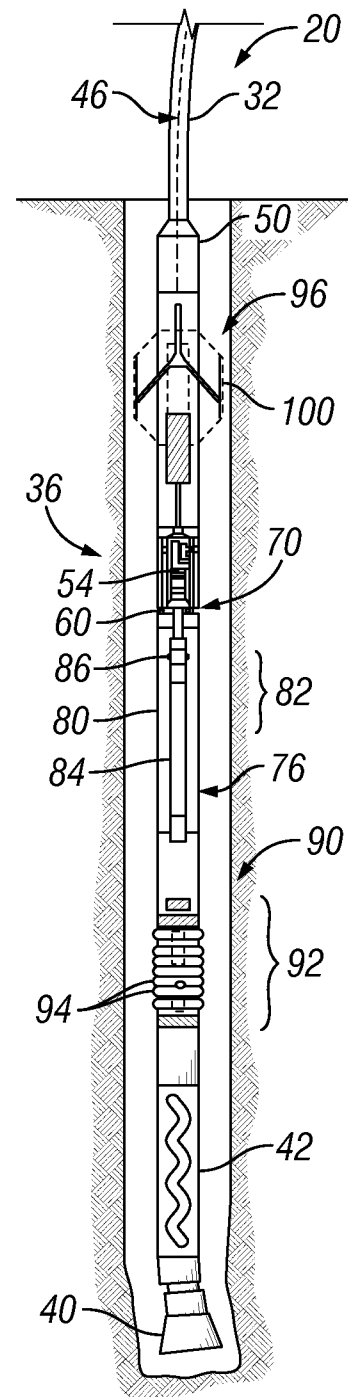


FIG. 6