(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 696 101 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
12.03.2008 Bulletin 2008/11

(51) Int Cl.:
E21B 17/20 *(2006.01)* ***E21B 4/04*** *(2006.01)*

(21) Application number: **05290454.7**

(22) Date of filing: **28.02.2005**

(54) **Method and apparatus suitable for hole cleaning during drilling operations**

Vorrichtung und Verfahren geeignet für Bohrlochreinigung während des Bohrens

Système et procédé adapté à être utilisé pour le netoyage du puits pendant le forage

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU MC NL PL PT RO SE SI SK TR

(43) Date of publication of application:
30.08.2006 Bulletin 2006/35

(73) Proprietors:
- **SERVICES PETROLIERS SCHLUMBERGER**
  75007 Paris (FR)
  Designated Contracting States:
  FR
- **SCHLUMBERGER TECHNOLOGY B.V.**
  2514 JG Den Haag (NL)
  Designated Contracting States:
  AT DE DK ES IE IT PL RO SK
- **SCHLUMBERGER HOLDINGS LIMITED**
  Road Town, Tortola (VG)
  Designated Contracting States:
  BE BG CH CY EE FI GB GR HU IS LI LT LU MC NL PT SE SI
- **PRAD Research and Development N.V.**
  Willemstad, Curacao (AN)
  Designated Contracting States:
  CZ
- **Schlumberger Oilfield Assistance Limited**
  Road Town, Tortola (VG)
  Designated Contracting States:
  TR

(72) Inventors:
- **Lavrut, Eric**
  92350 Le Plessis Robinsin (FR)
- **Fotio-Kenne, Serge**
  92120 Montrouge (FR)

(74) Representative: **Hyden, Martin Douglas**
Rouse Patents
1st Floor
228-240 Banbury Road
Oxford, Oxfordshire OX2 7BY (GB)

(56) References cited:
US-A- 2 105 091
US-A- 2 567 451
US-A- 3 007 534
US-A- 4 258 802
US-A1- 2003 034 177
US-A1- 2004 050 589
US-A1- 2004 104 052
US-B1- 6 629 570

EP 1 696 101 B1

Description

Technical field

[0001] The present invention relates to methods and apparatus for hole-cleaning applications that are particularly applicable to re entry and/or slim hole drilling with electrically powered and deployed drilling tools.

Background art

[0002] In conventional drilling, a drilling fluid performs the functions of transporting the drilled cuttings up to surface, ensuring well bore stability (by exerting enough hydrostatic pressure to support the well bore and retain formation fluids in place), cleaning and cooling of the drill bit, lubricating the bottom hole assembly (BHA), and allowing mud pulse telemetry (transmission of information from downhole measurement equipment to surface or vice-versa through pressure pulses). The displacement of cuttings is achieved by standard direct circulation: the drilling fluid is pumped from surface inside the drill string (either made of jointed rotating drill pipes or a length of continuous coiled tubing) and returns to the surface in the annulus between the drill string and the borehole wall where it carries the drilled cuttings in suspension up to surface. The drilled cuttings are then filtered out on surface and the drilling fluid is re-circulated inside the well. The combination of the drill string and surface pumps allows high flow rates to be obtained and therefore sufficient drilling fluid velocity for conveyance of drilled cuttings. The drill string (which serves as a flow conduit) also transmits weight to the drill bit to provide the axial drilling effort.

[0003] In certain situations, reverse circulation is used, in which drilling fluid is pumped down the well in the annulus and returns to the surface inside the drill string via the drill bit. This is not normally practical for situations in which the drilled cuttings have significant size.

[0004] Electric drilling aims to drill without the need for a rig or coiled tubing unit so there is often no drill string to circulate the drilling fluid. Additionally, as electric drilling is aimed at low power and low footprint systems, the electrically generated downhole so the flow conduit does not need to be able to transmit mechanical forces to the bit and can be more flexible and easier to handle on surface.

[0005] US 2004104052 A describes a directional drilling method using a concentric coiled tubing drill string connected to a directional bottom hole assembly. The system allows the drilling fluid and the drilled cuttings to be circulated through the concentric coiled tubing drill string, instead of through the annulus between the drill string and the borehole wall. Modified coiled tubing technologies and directional drilling tools are used to provide for reverse circulation of the drilling fluid, drilled cuttings and produced fluids.

[0006] US 6629570 describes a downhole drilling method using electrically powered bottom hole assemblies in coiled tubing drilling applications. The system also uses direct or reverse circulation of the drilling fluid inside the coiled tubing, through the bottom hole assembly, through the bit and in the well annulus.

[0007] US 6323420 describes a method and apparatus for providing cabling or an electrically conductive path in tubing. A cable or conductive member is housed securely between the outer surface of an inner tube and the inner surface of an outer coiled tubing.

[0008] PCT/WO 204072437 describes a directional drilling method and apparatus in which the bottom hole assembly is electrically powered and deployed in the well with a wireline cable. The system can also perform logging, completion and well instrumentation applications. A bag is used to collect drilled cuttings dowhhole. US20030034177 describes an apparatus using a subterranean electric drilling machine. An umbilical possess insulated electrical wires to connect a power supply to the drilling machine and conveys drilling fluid through. US20040050589 describes a method and apparatus for downhole drilling using coiled tubing connected to a drilling assembly. A cable for supplying power to the motor is disposed along the tubing.

Disclosure of the invention

[0009] The present invention is based on the use of separate fluid lines and electric cables that allows easy handling on surface.

[0010] One aspect of the invention provides an apparatus for drilling operations in underground boreholes, comprising: a drilling assembly that can be located in a borehole and is moved along the borehole during the drilling operation; a flexible fluid line connected to and in fluid communication with the drilling assembly and extending from the drilling assembly to the surface when the drilling assembly is in the borehole; and an electric cable for providing electric power to the drilling assembly and extending from the drilling assembly to the surface when the drilling assembly is in the borehole; wherein the fluid line and the electric cable are separate, the electric cable being outside the fluid line; and characterized in that the apparatus further comprises a secondary fluid line connected to the fluid line in the upper region thereof.

[0011] The fluid line and the electric cable can be connected to each other in at least one location between the drilling assembly and the surface.

[0012] At least one drum can be included for storing and delivering the fluid line and/or cable to the well. Preferably separate drums are provided for the fluid line and electric cable.

[0013] The fluid line and/or the electric cable can be formed from segments joined end-to-end by connectors. In this case, preferably the secondary fluid line can be connected to the fluid line at the connector between the uppermost segment and the adjacent segment.

[0014] A pressure-controlled housing can be provided

in which the drum of the fluid line or the secondary fluid line can be located. The housing may also include a port to allow fluid to be introduced to or withdrawn from the fluid line or secondary fluid line.

[0015] Another aspect of the invention comprises a method for conducting drilling operations using an apparatus as defined above, the method comprising operating the drilling assembly and directing fluid between the surface and the drilling assembly via the flexible fluid line.

[0016] Preferably, the fluid is a drilling fluid which is introduced to the borehole at the surface and circulates from the bottom of the borehole back to the surface via the fluid line so as to carry drilled cuttings away from the drilling assembly.

[0017] The fluid line and the electric cable are fed into or withdrawn from the borehole as the drilling assembly moves along the borehole. The fluid line and electric cable can be connected together at various points along their length as they are fed into the borehole.

[0018] Where the fluid line and/or electric cable are formed from segments, the method can comprises joining the segments with connectors as the fluid line and/or electric cable are fed into the well, or disconnecting the segments at the connectors as the fluid line and/or electric cable are withdrawn from the well.

[0019] In one preferred embodiment, the method includes connecting a secondary fluid line to the fluid line in an upper region thereof, preferably between the uppermost segment and the adjacent segment. In such a case, the secondary fluid line is used to introduce or withdraw fluid from the fluid line. The secondary fluid line is typically shorter than the fluid line such that in use, the secondary fluid line is periodically disconnected from the fluid line and reconnected at another location as the fluid line is fed into or withdrawn from the borehole.

Brief description of the drawings

[0020] In the accompanying drawings,

Figure 1 shows apparatus according to one embodiment of the invention;

Figure 2 shows apparatus according to a second embodiment of the invention;

Figure 3 shows a schematic view of an embodiment of an umbilical cable for use in the present invention;

Figures 4A and B show the manner in which a secondary fluid line is connected to a segmented fluid line; and

Figure 5 shows apparatus using an umbilical cable and separate fluid line and electric cable.

Mode(s) for carrying out the invention

[0021] The present invention provides methods and apparatus that are particularly useful for reverse circulation of drilled cuttings out of a borehole when drilling with electrically powered tools. In such cases, the drilling fluid may be conventional mud, water, oil, an aerated system (aerated mud or foam) or pure air, with or without mist.

[0022] This wellbore-cleaning provided by the invention may be particularly suitable for drilling low pressure reservoirs, accessing unexploited fluids in reservoirs or extending the life of a depleted reservoir. Drilling these types of formations with reverse circulation and low circulating pressures can typically cause less damage to reservoir formation than drilling with direct flow circulation (drilled cuttings are in contact with the formation less, there is less susceptibility to development of washouts), and the ability of the reservoir to produce fluids is generally less compromised.

[0023] The present invention is particularly useful for drilling in overbalanced or underbalanced conditions. Underbalanced drilling is often used to avoid damaging the formation, to improve the rate of penetration and to limit problems of lost circulation.

[0024] The embodiment of the invention shown in Figure 1 involves the deployment of a hydraulic fluid line 10 alongside an electric cable 12. The cable 12 is used to provide power and telemetry to a drilling assembly 14. In the embodiment shown in Figure 1, the drilling assembly 14 is being used to drill a sidetrack 16 from a main borehole 18. Such operations are used to drill into bypassed reserves, or to provide extended drain holes to allow better recovery from a formation. A deflector 20 is positioned in the borehole 18 to assist the drilling assembly in initiating the sidetrack and to allow convenient reentry if it is removed for any reason. The fluid line 10 and cable 12 are each provided with a drum 22 at the surface from which they can be fed into the borehole 18 via pressure control equipment, typically comprising annular rams and/or blind rams and including a stuffing box or grease tube 24 for the electric cable 12 and an injector and stripper 26 for the hydraulic line 10. The hydraulic line 10 can comprises one or more different hydraulic conduits. The electric cable 12 and hydraulic line 10 can be associated to form an electro-hydraulic umbilical cable as is described below.

[0025] The hydraulic line 10 may be a flexible hose compatible with the oilfield environment. The flexible hose may be constructed of:

- Polymer liners made of extruded PTFE, PVDF, PEEK, etc.
- Steel wire or composite re-enforced structure for pressure ratings
- Extruded polymer cover.

[0026] The flexible hose may also be made of any such material capable of withstanding the internal and/or external pressures and the forces developed when deploying or operating the system.

[0027] The hydraulic line can also be a coiled tubing made of steel, fiberglass, composite material or any other material compatible with the oilfield environment and capable of withstanding these pressures and forces.

[0028] The electric cable 12 can be any of the standard wireline cable used in current oilfield electric line operations.

[0029] The drilling assembly 14 attached at the bottom of the circulation system described above runs on electric power supplied by the electric cable 12. These electric drilling tools provide all directional drilling means necessary to steer the well in the desired trajectory. These directional drilling means can include an orientation assembly, a drilling motor, a reverse circulating drill bit and measurement tools. The measurement tools can provide parameters including, inclination, azimuth, natural gamma ray, and formation resistivity. Such drilling tools typically communicate with surface equipment via the electric cable 12. Some data collected downhole are transmitted to surface through high-speed telemetry in the cable 12.

[0030] The drilling system can also comprise a downhole flow control valve. This prevents undesired or uncontrolled flow of fluids, particularly hydrocarbons, from downhole to surface through the hydraulic line 10. The flow control valve is capable of shutting off the flow from the wellbore 18 to the inside of the hydraulic line 10. The operation of the downhole flow control valve can be controlled mechanically (as a one-way valve, for example), or hydraulically or electrically operated.

[0031] The electric cable 12 and the hydraulic line 10 can be bundled together to form an electro-hydraulic umbilical cable as is described in more detail in relation to Figures 2-5 below. An electro-hydraulic umbilical cable can be used to perform some or all of the following functions:

- Deployment of drilling or logging tools
- Electric power transmission to downhole tools
- 2-way high speed telemetry between downhole tools and surface equipment
- Provide one or several flow conduits for fluid injection or hydraulic transport of cuttings

[0032] The electric cable 12 and the hydraulic line 10 can be assembled as an umbilical cable over certain length of the well or over the entire length of the well. They can also be run separately provided they are equipped with systems or means to avoid the twisting of the two cables (for example, by connecting the cable and line to each other at points along their length).

[0033] Figure 2 shows an embodiment of the invention utilising a combined electro-hydraulic umbilical cable. In this embodiment, an umbilical cable 30 is run from the bottom hole assembly 14 up to surface. The umbilical 30 comprises an electric line and one or more flow conduits and is held on a drum 31 located at the surface of the well. The drilling medium (drilling fluid) is reverse circulated from the drill bit 32 up inside the hydraulic conduit (s) of the umbilical 30 to the surface. However, the returning drilling medium and any produced hydrocarbons cannot be circulated safely out in the drum 31 at the surface. The proximity of the electric power cable and the pressurized hydrocarbons in the drum 31 would represent a potential danger (explosion) on surface. To avoid this situation, the returning fluids are diverted from the flow conduit(s) of the umbilical cable 30 to a separate secondary hydraulic line 34 via a connection sub 36.

[0034] The secondary flow line 34 is attached directly at the connection 36 to the lower part 38 of the hydraulic line in the umbilical 30. This secondary flow line 34 may only be a few hundreds of metres long in order that it can be securely housed at the surface on a drum 40 housed in a pressure vessel 42 that can be directly connected to wellhead equipment 44. The returned fluids from downhole are diverted from the umbilical 30 into the secondary line 34 at the connection 36 and so will never flow in the drum 31 exposed on surface. Fluids returned via the secondary line 34 can be removed via a port 46 connected to a separator (not shown).

[0035] Figure 2 shows an embodiment of the invention in which the umbilical cable 31 runs all the way from surface to the bottom of the borehole 18. In this embodiment, the electro-hydraulic umbilical 30 is made in multiple segments (see also Figure 3), each segment being provided in one of two fixed lengths: a long one, typically a kilometre L and a short one, typically a few hundred metres I. The length I is the same length as that of the secondary hydraulic return line 34. The electric line of the umbilical can be either continuous or discontinuous at the connection points. For a continuous electric line, where there is a connection to be made, only a hydraulic connection is made alongside the continuous electric cable.

[0036] When running in hole, down to the starting depth of the first drilling run, long segments of umbilical cable 30L (and some short segments 30I, if required) are joined in order to reach (or be close to the desired depth. From that depth on, the well will be drilled in runs of measured depth I.

[0037] The connection sub 36 diverts the circulating fluids from the lower hydraulic line of the umbilical cable 30 to the secondary return line 34. The connection sub 36 also maintains the electrical and mechanical links between the upper and lower parts of the umbilical cable 30. Only one such connection sub 36 is needed for the entire drilling operations. The position of the connection sub 36 is moved one segment up, to the next connection point on the umbilical 30, after each drilling run.

[0038] After running in hole down to the start depth of the run, the connection sub 36 is positioned at the last connection point to enter the wellhead and connected to the upper part of the umbilical 30 made up of short segments 301. The secondary hydraulic line 34 is also attached to the connection sub 36. Drilling commences and the well is drilled until the next connection point is about to enter the wellhead or until the secondary hydraulic line 34 is completely un-spooled (see Figure 4 A R1). At this point, the borehole 18 is circulated, cleaned and the position of the connection sub 36 is moved up to the top of the next segment 30I:

- The umbilical cable 30 is pulled out and the secondary line 34 is reeled back on its drum 40
- The connection sub 36 is removed and replaced by a normal hydraulic or electro-hydraulic cable connection 38
- The short length segment 301 is connected to the top of the umbilical 30
- The umbilical cable 30 is then run in hole until the connection point at the top of the short segment 301 is at surface level
- The connection sub 36 is then placed at that point and the secondary hydraulic return line 34 is re-connected.

[0039] The system is now ready for a new drilling run until the next connection point of the next short segment is about to enter the well at which point this process is repeated (Figure 4 B R2).

[0040] The energy necessary for the displacement of cuttings in the secondary flow line 34 can be provided in different ways, including:

- A downhole pump that is powerful enough to generate flow up to surface
- A specific power fluid (water or mud), injected from surface, in one of the hydraulic conduits of the upper part of the umbilical cable 30, down to the connection sub 36 where it lifts the cuttings in the return line 34.

[0041] The secondary return line 34 can be made from various materials as described above in relation to the hydraulic line. It can be configured as:

- A continuous length of hydraulic line
- A hydraulic line in multiple sections
- A hydraulic line clamped to the umbilical cable at regular intervals if there is a risk that the umbilical cable and the return line would twist together
- Or any combination of the above options.

[0042] Figure 5 shows another embodiment of the invention in which separate hydraulic and electric lines are connected to the top of the umbilical. In this configuration, the umbilical cable 30 is run over a certain length in the borehole 18. After the umbilical cable 30 is run in, the hydraulic and electric lines 10, 12 are separated in the rest of the well and up to surface and are operated in essentially the same manner as is described in relation to Figure 1. The separate hydraulic line 10 can be deployed with the same configurations as the return line 34 described above:

- Continuous hydraulic line
- A hydraulic line in multiple sections
- Hydraulic line housed in a pressure vessel 40 on surface
- Hydraulic line clipped to the electric line at regular intervals
- Or any combination of the above.

[0043] The present invention has a number of potential benefits over prior art approaches:

- Circulation is performed using relatively small conduits (the hydraulic line(s), so requiring less power consumption to achieve the required fluid velocity to efficiently transport the cuttings and clean the hole.
- Reverse circulation is the preferred approach which means that the drill cuttings do not remain in contact with the formation and cause less damage to the formation.
- The drilling and circulation system could be deployed and operated in live wells conditions, avoiding the need to kill the well and potentially cause formation damage or allowing drilling while producing.
- Because the system is relatively small by design, it is suitable for various hole sizes commonly drilled in hydrocarbon formations.
- Only the bottom hole assembly has to be changed, and not the circulation system, when drilling different hole sizes.

[0044] The embodiments described above are only examples. The various elements of the systems and operations described can be combined and modified while still remaining within the scope of the invention.

Claims

1. Apparatus for drilling operations in underground boreholes, comprising:

- a drilling assembly (14) that can be located in a borehole (18) and is moved along the borehole during the drilling operation;
- a flexible fluid line (10) connected to and in fluid communication with the drilling assembly (14) and extending from the drilling assembly (14) to the surface when the drilling assembly is in the borehole; and
- an electric cable (12) for providing electric power to the drilling assembly (14) and extending from the drilling assembly (14) to the surface when the drilling assembly is in the borehole;

wherein the fluid line (10) and the electric cable (12) are separate, the electric cable being outside the fluid line; and

characterized in that the apparatus further comprises a secondary fluid line (34) connected to the fluid line (10) in an upper region thereof.

2. Apparatus as claimed in claim 1, wherein the fluid line (10) and the electric cable (12) are connected to each other in at least one location between the

drilling assembly (14) and the surface.

3. Apparatus as claimed in claim 1 or 2, further comprising at least one drum (22) for storing and delivering the fluid line (10) and/or cable (12) to the well.

4. Apparatus as claimed in claim 3, wherein a separate drum (22) is provided for the fluid line (10).

5. Apparatus as claimed in any preceding claim, wherein the fluid line (10) and/or the electric cable (12) is formed from segments joined end-to-end by connectors.

6. Apparatus as claimed in claim 5, wherein the secondary fluid line (34) is connected to the fluid line (10) at the connector between the uppermost segment and the adjacent segment.

7. Apparatus as claimed in clam 4 or 6, further comprising a pressure-controlled housing (42), the drum of the fluid line (10) or the secondary fluid line (34) being located inside the housing.

8. Apparatus as claimed in claim 7, further comprising a port (46) in the housing (42) to allow fluid to be introduced to or withdrawn from the fluid line or secondary fluid line.

9. A method for conducting drilling operations using an apparatus as claimed in any preceding claim, the method comprising operating the drilling assembly (14) and directing fluid between the surface and the drilling assembly via the flexible fluid line (10).

10. A method as claimed in claim 9, wherein the fluid is a drilling fluid which is introduced to the borehole (18) at the surface and circulates from the bottom of the borehole back to the surface via the fluid line (10) so as to carry drilled cuttings away from the drilling assembly(14).

11. A method as claimed in claim 9 or 10, wherein the fluid line (10) and the electric cable (12) are fed into or withdrawn from the borehole (18) as the drilling assembly (14) moves along the borehole.

12. A method as claimed in claim 9, 10 or 11, comprising connecting the fluid line (10) and electric cable (12) together in at least one point along as they are fed into the borehole.

13. A method as claimed in any of claims 9-12, wherein the fluid line (10) and/or electric cable (12) are formed from segments, the method comprising joining the segments with connectors as the fluid line (10) and/or electric cable (12) are fed into the well, or disconnecting the segments at the connectors as the fluid line (10) and/or electric cable (12) are withdrawn from the well.

14. A method as claimed in claim 13, further comprising connecting a secondary fluid line (34) to the fluid line in an upper region thereof.

15. A method as claimed in claim 14, comprising connecting the secondary fluid line (34) between the uppermost segment and the adjacent segment.

16. A method as claimed in claim 14 or 15, wherein the secondary fluid line (34) is used to introduce or withdraw fluid from the fluid line (10).

17. A method as claimed in claim 14, 15 or 16, wherein secondary fluid line (34) is typically shorter than the fluid line (10), the method comprising periodically disconnecting the secondary fluid line (34) from the fluid line (10) and reconnecting it at another location as the fluid line (10) is fed into or withdrawn from the borehole (18).

18. A method as claimed in any of claims 9-17, further comprising storing the fluid line (10) and/or secondary fluid line (34) in a pressure-controlled housing (42).

19. A method as claimed in claim 18, wherein the housing (42) is maintained at or near borehole pressure, the method comprising feeding the fluid line (10) and/or secondary line (34) between the housing (42) and the borehole (18) while being maintained at or near borehole pressure.

Patentansprüche

1. Vorrichtung für Bohrvorgänge in unterirdischen Bohrlöchern, umfassend:

- eine Bohrbaugruppe (14), die in einem Bohrloch (18) platziert werden kann und entlang des Bohrlochs während des Bohrvorgangs bewegt wird,
- eine biegsame Fluidleitung (10), die mit der Bohrbaugruppe (14) verbunden ist und mit dieser in Fluidkommunikation steht sowie sich von der Bohrbaugruppe (14) zu der Oberfläche erstreckt, wenn die Bohrbaugruppe in dem Bohrloch ist, und
- ein elektrisches Kabel (12) zum Zuführen von elektrischer Leistung zur Bohrbaugruppe (14), das sich von der Bohrbaugruppe (14) zu der Oberfläche erstreckt, wenn die Bohrbaugruppe in dem Bohrloch ist,
- wobei die Fluidleitung (10) und das elektrische Kabel (12) getrennt sind und das elektrische Ka-

bel außerhalb der Fluidleitung ist, und

dadurch gekennzeichnet, dass die Vorrichtung ferner eine Sekundärfluidleitung (34) umfasst, die mit der Fluidleitung (10) in einem oberen Bereich hiervon verbunden ist.

2. Vorrichtung nach Anspruch 1, wobei die Fluidleitung (10) und das elektrische Kabel (12) an mindestens einer Stelle zwischen der Bohrbaugruppe (14) und der Oberfläche miteinander verbunden sind.

3. Vorrichtung nach Anspruch 1 oder 2, ferner umfassend mindestens eine Trommel (22) zum Lagern und Liefern der Fluidleitung (10) und/oder des Kabels (12) zu dem Bohrloch.

4. Vorrichtung nach Anspruch 3, wobei eine getrennte Trommel (22) für die Fluidleitung (10) vorgesehen ist.

5. Vorrichtung nach einem der vorhergehenden Ansprüche, wobei die Fluidleitung (10) und/oder das elektrische Kabel (12) aus durch Verbinder zusammengefügte Verbindungssegmente ausgebildet ist.

6. Vorrichtung nach Anspruch 5, wobei die Sekundärfluidleitung (34) mit der Fluidleitung (10) an dem Verbinder zwischen dem höchsten Segment und dem benachbarten Segment verbunden ist.

7. Vorrichtung nach Anspruch 4 oder 6, ferner umfassend ein druckgeregeltes Gehäuse (42), wobei die Trommel der Fluidleitung (10) oder der Sekundärfluidleitung (34) innerhalb des Gehäuses angeordnet ist.

8. Vorrichtung nach Anspruch 7, ferner umfassend eine Öffnung (46) in dem Gehäuse (42), um zu ermöglichen, dass Fluid in die Fluidleitung oder die Sekundärfluidleitung eingebracht oder aus dieser herausgezogen wird.

9. Verfahren zum Durchführen von Bohrvorgängen unter Verwendung einer Vorrichtung nach einem der vorhergehenden Ansprüche, wobei das Verfahren umfasst Betreiben der Bohrbaugruppe (14) und Leiten des Fluids zwischen der Oberfläche und der Bohrbaugruppe über die biegsame Fluidleitung (10).

10. Verfahren nach Anspruch 9, wobei das Fluid ein Bohrfluid ist, das in das Bohrloch (18) an der Oberfläche eingeführt wird und vom Boden des Bohrlochs zurück zu der Oberfläche zirkuliert über die Fluidleitung (10), um gebohrte Schneidabfälle von der Bohrbaugruppe (14) wegzutragen.

11. Verfahren nach Anspruch 9 oder 10, wobei die Fluidleitung (10) und das elektrische Kabel (12) dem Bohrloch (18) zugeführt oder aus diesem herausgezogen werden, wenn die Bohrbaugruppe (14) sich längs des Bohrlochs bewegt.

12. Verfahren nach Anspruch 9, 10 oder 11, umfassend Verbinden der Fluidleitung (10) und des elektrischen Kabels (12) zusammen an mindestens einem Punkt, solange wie sie in dem Bohrloch zugeführt werden.

13. Verfahren nach einem der Ansprüche 9 bis 12, wobei die Fluidleitung (10) und/oder das elektrische Kabel (12) aus Segmenten gebildet sind, wobei das Verfahren umfasst Zusammenfügen der Segmente mit Verbindern, wenn die Fluidleitung (10) und/oder das elektrische Kabel (12) in das Bohrloch geführt werden oder Lösen der Segmente an den Verbindern, wenn die Fluidleitung (10) und/oder das elektrische Kabel (12) aus dem Bohrloch herausgezogen werden.

14. Verfahren nach Anspruch 13, ferner umfassend Verbinden einer Sekundärfluidleitung (34) mit der Fluidleitung in einem oberen Bereich hiervon.

15. Verfahren nach Anspruch 14, umfassend Verbinden einer Sekundärfluidleitung (34) zwischen dem obersten Segment und dem benachbarten Segment.

16. Verfahren nach Anspruch 14 oder 15, wobei die Sekundärfluidleitung (34) verwendet wird, um Fluid in die bzw. aus der Fluidleitung (10) zu führen bzw. herauszuziehen.

17. Verfahren nach Anspruch 14, 15 oder 16, wobei die Sekundärfluidleitung (34) typischerweise kleiner ist als die Fluidleitung (10), wobei das Verfahren periodisches Lösen der Sekundärfluidleitung (34) von der Fluidleitung (10) und Wiederverbinden an anderer Stelle, wenn die Fluidleitung (10) in das bzw. aus dem Bohrloch (18) geführt bzw. herausgezogen wird, umfasst.

18. Verfahren nach einem der Ansprüche 9 bis 17, ferner umfassend Lagern der Fluidleitung (10) und/oder der Sekundärfluidleitung (34) in einem druckgeregelten Gehäuse (42).

19. Verfahren nach Anspruch 18, wobei das Gehäuse (42) auf bzw. nahe dem Bohrlochdruck gehalten wird und das Verfahren umfasst Zuführen der Fluidleitung (10) und/oder der Sekundärleitung (34) zwischen dem Gehäuse (42) und dem Bohrloch (18), während sie auf oder nahe dem Bohrlochdruck gehalten wird.

Revendications

1. Système pour opérations de forage de puits, comprenant :

   - un ensemble de forage (14) qui peut être situé dans un puits (18) et qui est déplacé le long du puits durant l'opération de forage ;
   - une conduite flexible pour fluide (10) connectée à et en communication fluidique avec l'ensemble de forage (14) et qui s'étend de l'ensemble de forage (14) à la surface quand l'ensemble de forage est dans le puits ; et
   - un câble électrique (12) qui fournit une alimentation électrique à l'ensemble de forage (14) et qui s'étend de l'ensemble de forage (14) à la surface quand l'ensemble de forage est dans le puits ;

   dans ledit système la conduite pour fluide (10) et le câble électrique (12) sont séparés, le câble électrique étant extérieur à la conduite pour fluide ; et
   ledit système est **caractérisé en ce qu'**il comprend en outre une conduite secondaire pour fluide (34) raccordée à la conduite pour fluide (10) dans une région supérieure de celle-ci.

2. Système selon la revendication 1, dans ledit système la conduite pour fluide (10) et le câble électrique (12) sont connectés l'un à l'autre en au moins un emplacement entre l'ensemble de forage (14) et la surface.

3. Système selon la revendication 1 ou 2, comprenant en outre au moins un tambour (22) destiné à stocker la conduite pour fluide (10) et/ou le câble (12) et à les délivrer dans le puits.

4. Système selon la revendication 3, ce système est en outre doté d'un tambour séparé (22) pour la conduite pour fluide (10).

5. Système selon l'une quelconque des revendications précédentes, dans ce système la conduite pour fluide (10) et/ou le câble électrique (12) sont constitués de segments joints bout à bout les uns aux autres par des connecteurs.

6. Système selon la revendication 5, dans ce système la conduite secondaire pour fluide (34) est connectée à la conduite pour fluide (10) au niveau du connecteur situé entre le segment le plus haut et le segment adjacent.

7. Système selon la revendication 4 ou 6, comprenant en outre un logement à pression contrôlée (42), le tambour de la conduite pour fluide (10) ou de la conduite secondaire pour fluide (34) étant situé à l'intérieur du logement.

8. Système selon la revendication 7, comprenant en outre un orifice (46) aménagé dans le logement (42) pour permettre que le fluide soit alimenté à ou soit retiré de la conduite pour fluide ou soit alimenté à ou soit retiré de la conduite secondaire pour fluide.

9. Procédé applicable à la conduite d'opérations de forage utilisant un système selon l'une quelconque des revendications précédentes, le procédé comprenant l'utilisation de l'ensemble de forage (14) et l'acheminement d'un fluide entre la surface et l'ensemble de forage par le biais de la conduite flexible pour fluide (10).

10. Procédé selon la revendication 9, dans ce procédé le fluide est un fluide de forage qui est introduit dans le puits (18) à la surface et qui circule ensuite pour remonter du fond du puits à la surface par le biais de la conduite pour fluide (10) de manière à dégager les déblais de forage produits par l'ensemble de forage (14).

11. Procédé selon la revendication 9 ou 10, dans ce procédé la conduite pour fluide (10) et le câble électrique (12) sont alimentés dans le et retirés du puits (18) en même temps que l'ensemble de forage (14) se déplace le long du puits.

12. Procédé selon la revendication 9, 10 ou 11, comprenant la connexion de la conduite pour fluide (10) et du câble électrique (12) l'un avec l'autre en au moins un point en même temps qu'ils sont alimentés dans le puits.

13. Procédé selon l'une quelconque des revendications 9 à 12, dans ce procédé la conduite pour fluide (10) et/ou le câble électrique (12) sont constitués de segments, le procédé comprenant la connexion des segments au moyen de connecteurs en même temps que la conduite pour fluide (10) et/ou le câble électrique (12) sont alimentés dans le puits, ou la déconnexion des segments au niveau des connecteurs en même temps que la conduite pour fluide (10) et/ou le câble électrique (12) sont retirés du puits.

14. Procédé selon la revendication 13, comprenant en outre la connexion d'une conduite secondaire pour fluide (34) à la conduite pour fluide dans une région supérieure de celle-ci.

15. Procédé selon la revendication 14, comprenant la connexion de la conduite secondaire pour fluide (34) entre le segment le plus haut et le segment adjacent.

16. Procédé selon la revendication 14 ou 15, dans ce procédé la conduite secondaire pour fluide (34) est utilisée pour introduire du fluide dans ou pour retirer du fluide de la conduite pour fluide (10).

17. Procédé selon la revendication 14, 15 ou 16, dans ce procédé la conduite secondaire pour fluide (34) est typiquement plus courte que la conduite pour fluide (10), le procédé comprenant la déconnexion périodique de la conduite secondaire pour fluide (34) de la conduite pour fluide (10) et la reconnexion à un autre emplacement en même temps que la conduite pour fluide (10) est alimentée dans le ou retirée du puits (18).

18. Procédé selon l'une quelconque des revendications 9 à 17, comprenant en outre le rangement de la conduite pour fluide (10) ou de la conduite secondaire pour fluide (34) dans un logement à pression contrôlée (42).

19. Procédé selon la revendication 18, dans ce procédé le logement (42) est maintenu à la pression du puits ou à une pression proche de celle-ci, le procédé comprenant l'alimentation de la conduite pour fluide (10) et/ou de la conduite secondaire pour fluide (34) entre le logement (42) et le puits (18) alors que ledit logement est maintenu à la pression du puits ou à une pression proche de celle-ci.

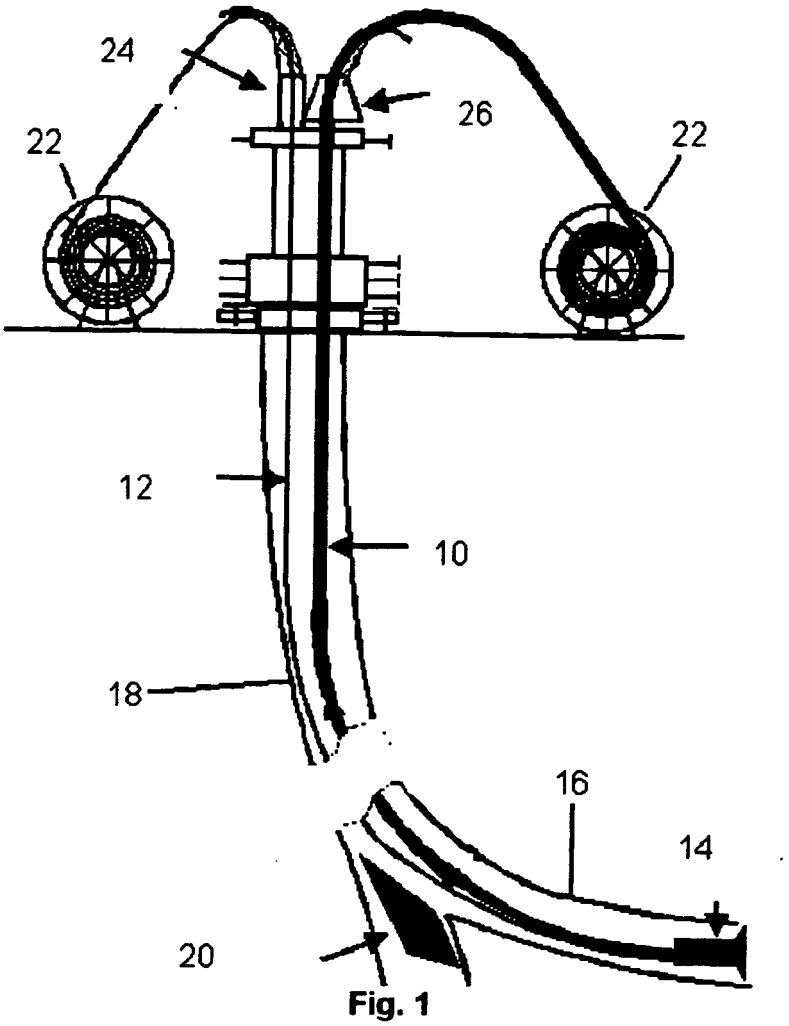

Fig. 1

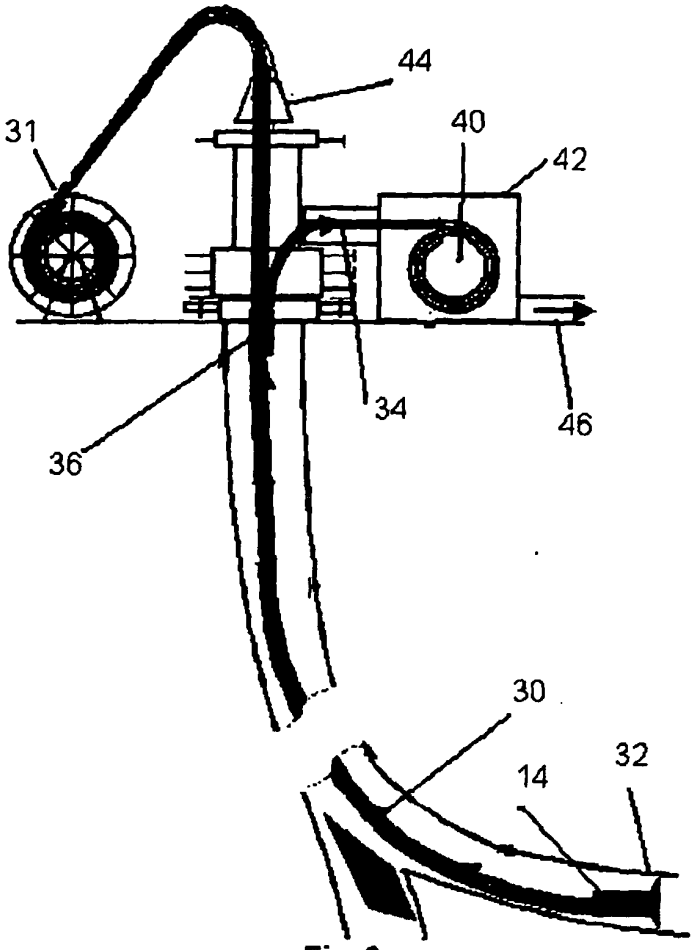

Fig. 2

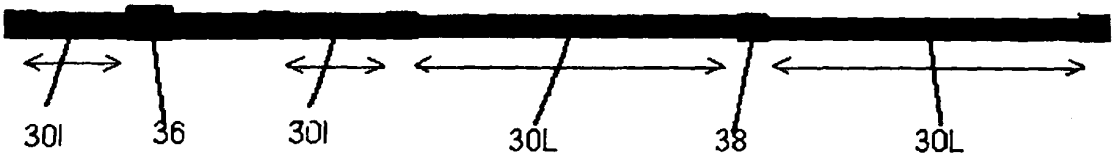

Fig. 3

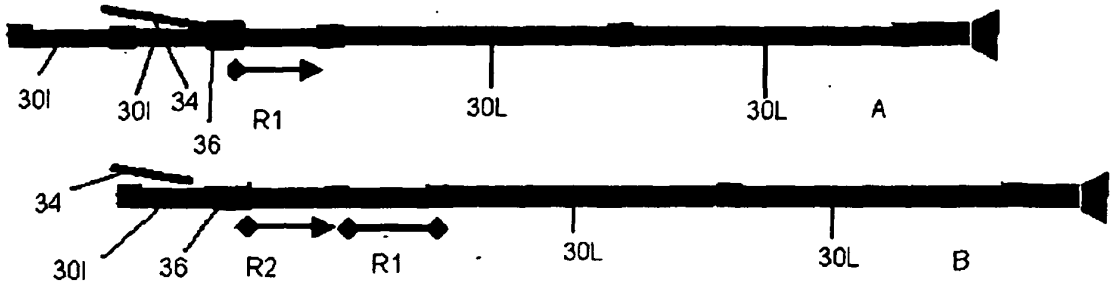

Fig. 4

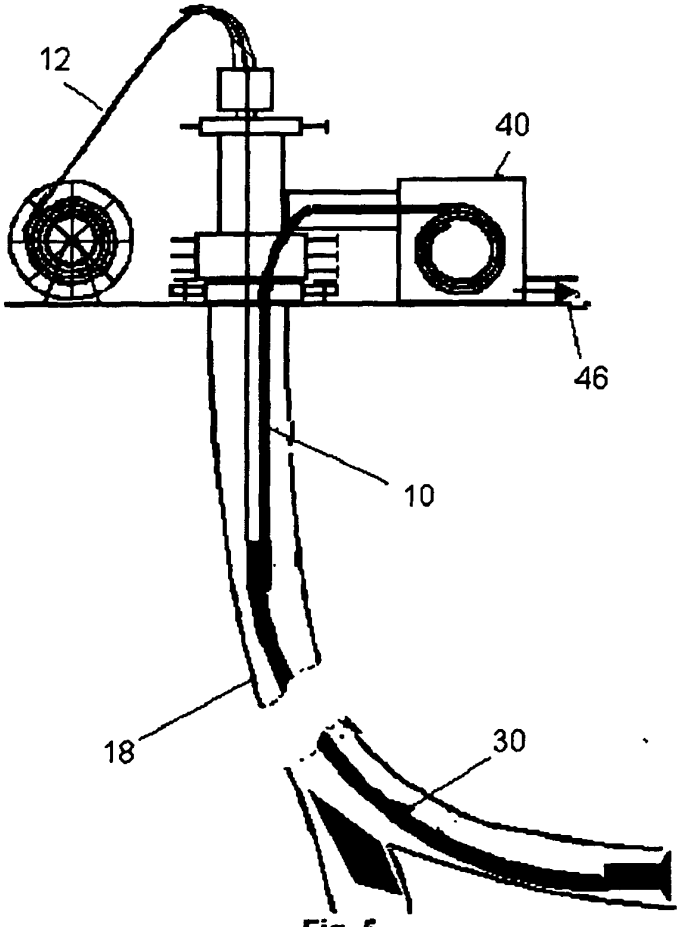

Fig. 5

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 2004104052 A **[0005]**
- US 6629570 B **[0006]**
- US 6323420 B **[0007]**
- WO 204072437 A **[0008]**
- US 20030034177 A **[0008]**
- US 20040050589 A **[0008]**