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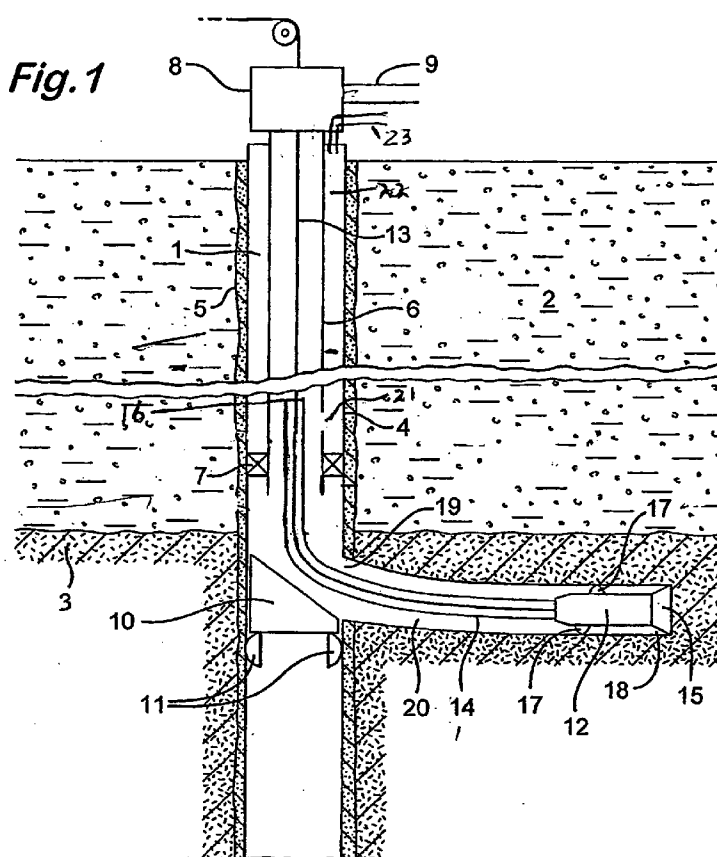
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[Continued on next page]

(54) Title: DRILLING METHOD AND APPARATUS



(57) Abstract: Apparatus for drilling a borehole from a first subterranean location to a second subterranean location, comprises a casing (4) extending longitudinally inside a borehole, a conduit (6) extending longitudinally inside casing (4), and capable of being in sealing relationship therewith, at least one entry line (23, 24) for liquid into the apparatus, a first annulus (22) between the casing (4) and conduit (6), at least one entry for liquid in the conduit, a tubing (14) having a first end and a second end (16), a remote controlled electrically powered drilling device (12) and remote controlled electrically powered pump, the device and pump being capable of being in fluid contact with the first end of the tubing (14), the second end (16) of the tubing (14) being inside the conduit (6) at a location more remote from the drilling device (12) than the entry for liquid in the conduit (6), with the conduit (6), tubing (14) and first end and second end (16) of the tubing (14) being adapted to provide routes for liquid contact between conduit (6) and drilling device (12), the routes being respectively internally and externally of the tubing (14).



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DRILLING METHOD AND APPARATUS

FIELD OF THE INVENTION

5 The present invention relates to a method of drilling a borehole from a selected location in an existing wellbore penetrating a subterranean formation using a remotely controlled electrically operated drilling device wherein the drilling device is introduced into the existing wellbore through a conduit and water is pumped over the cutting surfaces of the drilling device using a remotely controlled electrically operated pumping means to
10 cool the cutting surfaces and to transport drill cuttings away from the drilling device.

BACKGROUND OF THE INVENTION

 In conventional methods of wellbore drilling a drill string including a drill bit at its lower end is rotated in the wellbore while drilling fluid is pumped through a longitudinal passage in the drill string, which drilling fluid returns to surface via the annular space
15 between the drill string and the wellbore wall. There are certain restrictions to the drilling process, and particularly to the length of the wellbore intervals at which casing is to be installed in the wellbore.

 WO2004/011766, the disclosure of which is herein incorporated by reference, describes a method of drilling a borehole from a selected location in an existing wellbore
20 penetrating a subterranean earth formation having at least one hydrocarbon bearing zone wherein the existing wellbore is provided with a casing and a hydrocarbon fluid production conduit is arranged in the existing wellbore in sealing relationship with the wall of the casing, the method comprising:

 passing a remotely controlled electrically operated drilling device from the surface through
25 the hydrocarbon fluid production conduit to the selected location in the existing wellbore;
 operating the drilling device such that cutting surfaces on the drilling device drill the borehole from the selected location in the existing wellbore thereby generating drill cuttings wherein during operation of the drilling device, a first stream of produced fluid flows directly to the surface through the hydrocarbon fluid production conduit and a
30 second stream of produced fluid is pumped over the cutting surfaces of the drilling device via a remotely controlled electrically operated downhole pumping means and the drill

cuttings are transported away from the drilling device entrained in the second stream of produced fluid.

In the process described in WO 2004/011766, hereinafter called the wireline drilling process, the produced fluid, which is hydrocarbon liquid and/or water, is used to lubricate, cool the drilling and to transport the drill cuttings away from the drilling device. The slurry of cuttings may be passed along the tubing from the device into the production conduit and hence to the surface.

This wireline drilling process can only be performed in this manner if the drilling is into a production well producing oil or water. It is not suitable for producing wells, that are not producing because they are shut in or have insufficient formation pressures, or for water injection wells in water bearing formations, or barren formations bearing neither water or liquid hydrocarbon. There is a need for a wireline drilling process suitable for such wells.

SUMMARY OF THE INVENTION

A method and apparatus have been invented that meet this need which can be used irrespective of the nature of the formations being drilled. The present invention provides a method of drilling a borehole from a first subterranean location to a second subterranean location, which method comprises

- (i) passing liquid into an apparatus which comprises a casing extending longitudinally inside said existing borehole, a conduit extending longitudinally inside said casing, and capable of being in sealing relationship therewith, a first annulus between said casing and said conduit, entry for said liquid in said conduit, tubing having a first end present in said first location and a second end present inside said conduit above said entry for liquid in said conduit, remote controlled electrically powered drilling device located in said first subterranean location and a remote controlled electrically powered pump
- (ii) and passing a first stream of said liquid from inside the casing to said first location where it is pumped to said drilling device
- (iii) drilling said borehole in the presence of said liquid to produce a slurry of drill cuttings in said liquid
- (iv) passing said slurry along said tubing from said first end to said second end where said slurry is emitted into a second stream of said liquid moving in said return conduit from said entry.

Preferably the method comprises passing liquid into an apparatus in at least one location, said apparatus comprising a casing extending longitudinally inside a borehole, a conduit extending longitudinally inside said casing, and capable of being in sealing relationship therewith, said conduit having an interior, a first annulus between said casing and said conduit, entry for said liquid in said conduit, tubing having a first end in a first subterranean location and a second end, remote controlled electrically powered drilling device and a pump and a first passage capable of being in fluid contact with said second end of said tubing, said drilling means having a second passage in fluid contact with said first passage via said pump, means for supporting said drilling device from the surface and means for carrying power and for controlling said drilling device, which may be the same or different from said support means, said support means and carrying means being located at least partly inside said interior of said conduit and tubing, said conduit, tubing and first and second passages in said drilling means being adapted to provide two routes for liquid contact between said conduit and said drilling device, said routes being respectively internally and externally of said tubing, and said second end of said tubing being inside said conduit at a location more remote from said drilling device than said entry for liquid in said conduit,

and passing a portion of said liquid to said drilling device, drilling in the presence of said liquid to produce an slurry of drill cuttings which is passed into said tubing, and towards said second end of tubing into said conduit ,said aqueous liquid, which is usually substantially free of drill cuttings, meeting said aqueous slurry of drill cuttings emitted from said second end of tubing.

The present invention also provides apparatus for drilling a borehole from a first subterranean location to a second subterranean location, which apparatus comprises a casing extending longitudinally inside a borehole, a conduit extending longitudinally inside said casing, and capable of being in sealing relationship therewith, at least one entry line for liquid into said apparatus, a first annulus between said casing and said conduit, at least one entry for liquid in said conduit, tubing having a first end and a second end, a remote controlled electrically powered device, a remote electrically powered pump, said second end being inside said conduit at a location more remote from said drilling device than said entry for liquid in said conduit, and said device and pump capable of being in fluid contact with said first end of said tubing, said conduit, tubing and first end and second end of said

tubing being adapted to provide two routes for liquid contact between said conduit and said drilling device, said routes being respectively internally and externally of said tubing.

Preferably the apparatus comprises a casing extending longitudinally inside a borehole, a conduit extending longitudinally inside said casing, and capable of being in sealing relationship therewith, a first annulus between said casing and said conduit, at least one entry for liquid in said conduit, tubing having a first end and a second end, a bottom hole assembly comprising remote controlled electrically powered drilling device and pump and a first passage capable of being in fluid contact with said second end of said tubing, said drilling device having a second passage in fluid contact with said first passage via said pump, means for supporting said drilling device from the surface and means for carrying power and for controlling said drilling device, which may be the same or different from said support means, said support means and carrying means being located at least partly inside said interior of said conduit and tubing, said conduit, tubing and first and second passages in said drilling device being adapted to provide two routes for liquid contact between said conduit and said drilling device, said routes being respectively internally and externally of said tubing, and said second end of said tubing being inside said conduit at a location more remote from said drilling device than said entry for liquid in said conduit.

Preferably said liquid which may be organic but is preferably aqueous, flows into said apparatus and there is produced a first stream of said liquid and a second stream of said liquid, said first stream, which is usually substantially free of drill cuttings, passes upwards past said second end of said tubing, and said second stream passes downwards externally of, but in fluid contact with, said tubing towards said first end to said drill device for lubrication and cooling, drilling into said bore hole is performed with said drill device to produce a slurry of drill cuttings, said slurry is passed into said first end of said tubing, through said tubing and emitted from said second end into said first stream inside said conduit.

By use of the method and apparatus of the invention it is possible to drill into dry formations, without oil or water in the formation being drilled, or into formations, not previously drilled, from which there are no formation liquids, or formations with insufficient pressure to emit formation liquids of water and/or oil with the wellbore. It is also possible to drill into formations containing water and/or oil under pressure.

In a preferred embodiment of the method, the liquid passes into said first annulus and at least a part thereof passes into said conduit. In a preferred embodiment of the apparatus the entry for liquid is into said first annulus, and the interior of said conduit and said first annulus are capable of being in liquid contact.

5 In a more preferred embodiment of the method substantially all the liquid passes from the annulus through the wall of the conduit, while in a more preferred embodiment of the apparatus the first annulus has sealing means such as a packer sealing it from liquid flow therethrough, and liquid contact between said conduit and said first annulus is substantially all through the wall of said conduit.

10 One benefit of these more preferred embodiments is that the annulus has the sealing means such as a packer stopping flow out of the annulus at its bottom and directing it into the conduit thereby retaining the presence of the packer or other sealing means, which is highly desirable for safety and legal reasons.

The liquid when aqueous may be water, such as sea, formation e.g. connate water, 15 brackish water, spring or purified water. The liquid may also contain organic additives e.g. viscosifiers or fluid loss additives or inorganic additives such as weighting agents e.g. Barite or salts such as calcium chloride. The liquid when organic is usually a hydrocarbon such as diesel oil or production oil.

The method may be used to drill a new wellbore section which is:

- 20 (a) a wellbore extending into the hydrocarbon or water fluid bearing zone of the formation from a selected location immediately above said zone;
- (b) a continuation of an existing wellbore that penetrates the hydrocarbon or water fluid bearing zone of the formation, or
- (c) a side-track well, or
- 25 (d) a lateral well.

By "side-track well" is meant a branch of the existing wellbore where the existing wellbore no longer produces hydrocarbon fluid in a producing well or is capable of receiving water in a water injection well. Thus, the existing wellbore is sealed below the selected location from which the side-track well is to be drilled, for example, with 30 cement. By "lateral well" is meant a branch of the existing wellbore where the existing wellbore is capable of producing hydrocarbon fluid in a producing well or is capable of receiving water in a water injection well. Suitably, a plurality of lateral wells may be

drilled from the existing wellbore. The lateral wells may be drilled from same location in the existing wellbore i.e. in different radial directions and/or from different locations in the existing wellbore i.e. at different depths. By "lateral exploration well" is meant a well that is drilled to explore the formation matrix and formation fluids at a distance from the existing wellbore, as described in more detail below.

Suitably, the casing may be run from the surface to the bottom of the existing wellbore. Alternatively, the casing may be run from the surface into the upper section of the existing wellbore with the lower section of the existing wellbore comprising a barefoot or open-hole completion. Where the selected location in the cased wellbore lies below the production conduit, the borehole formed by the drilling device may be a window in the casing. It is also envisaged that the selected location in the cased wellbore may lie within the production conduit, in which case the borehole formed by the drilling device may be a window through the production conduit and through the casing of the wellbore. The casing of the existing wellbore at the selected location may be formed from metal in which case the cutting surfaces on the drilling device should be capable of milling a window through the casing by grinding or cutting the metal as described further in WO 2004/011766. Thus, the term "drilling device" as used herein encompasses milling devices and the term "drill" encompasses "mill". Alternatively, the casing at the selected location in the existing wellbore may be formed from a friable alloy or composite material such that the window may be milled using a drilling device fitted with a conventional drill bit.

Advantageously, the method of the present invention may also be used to drill through mineral scale that has been deposited on the wall of the existing wellbore and optionally such mineral scale deposited on the wall of the hydrocarbon fluid production conduit thereby enlarging the available borehole in the existing wellbore and, optionally, the available borehole in the production conduit.

The method of the present invention is particularly suitable for use in artificially lifted wells in which the pressure of the hydrocarbon-or water bearing zone of the subterranean formation is naturally insufficiently high so that the produced hydrocarbon or water could not flow to the surface through the conduit by means of natural energy only.

The drilling produces the slurry of the entrained cuttings particularly an aqueous slurry and the slurry is emitted from the second end of the tubing in the conduit into an upward moving stream of the liquid in the conduit to produce a mixture, which is usually

transported to the surface. The cuttings may be removed from the mixture at a processing plant using conventional cuttings separation techniques, for example, using a hydrocyclone or other means for separating solids from a fluid stream. However, it is also envisaged that at least a portion of the cuttings may disentrain from the mixture and may be deposited in
5 any rat hole of the existing wellbore. Parameters affecting disentrainment of the cuttings include the flow rate of the slurry, the viscosity of the liquid, the density of the cuttings and their size and shape.

Suitably, the drilling device is passed from the surface to the selected location in the existing wellbore suspended on a cable. Preferably, the cable is formed from
10 reinforced steel. The cable may be connected to the drilling device by means of a connector, preferably, a releasable connector. Preferably, the cable encases one or more wires or segmented conductors for transmitting electricity or electrical signals (hereinafter “conventional cable”). The cable may also be a modified “conventional cable” comprising a core of an insulation material having at least one electrical conductor wire or segmented
15 conductor embedded therein, an intermediate fluid barrier layer and an outer flexible protective sheath. Suitably, the intermediate fluid barrier layer is comprised of steel. Suitably, the outer protective sheath is steel braiding. Preferably, the electrical conductor wire(s) and/or segmented conductor(s) embedded in the core of insulation material is coated with an electrical insulation material.

20 Preferably, the drilling device is provided with an electrically operated steering means, for example, a steerable joint, which is used to adjust the trajectory of the new wellbore section as it is being drilled. This steering means is electrically connected to equipment at the surface via an electrical conductor wire or a segmented conductor embedded in the cable.

25 Preferably, the existing wellbore has an inner diameter of 12.7 – 25.4 cm (5 to 10 inches). Preferably, the return conduit has an inner diameter of 6.35 – 23.2 cm (2.5 to 8 inches), more preferably 8.89 – 15.24 cm (3.5 to 6 inches). Suitably, the drilling device has a maximum outer diameter smaller than the inner diameter of the return conduit thereby allowing the drilling device to pass through the return conduit and out into the
30 existing wellbore. Preferably, the maximum outer diameter of the drilling device is at least 1.27 cm (0.5 inches), more preferably at least 2.54 cm (1 inch) less than the inner diameter of the return conduit. The cutting surfaces on the drilling device may be sized to form a

new wellbore section having a diameter that is less than the inner diameter of the conduit, for example a diameter of 7.62 – 12.7 cm (3 to 5 inches). However, the drilling device is preferably provided with expandable cutting surfaces, for example an expandable drill bit thereby allowing the wellbore that is drilled from the selected location to be of larger diameter than the inner diameter of the conduit.

Preferably, the drilling device has a first drill bit located at the lower end thereof and a second drill bit located at the upper end thereof. This is advantageous in that the second drill bit may be used to remove debris when withdrawing the drilling device from the wellbore. The drilling device and pump may form a bottom hole assembly.

Suitably, the drilling device may be provided with formation evaluation sensors and/or steering sensors which are electrically connected to recording equipment at the surface via the electrical conductor wire(s) or segmented conductor(s) in the cable. Suitably, the sensors are located in proximity to the cutting surfaces on the drilling device.

Optionally, the conventional cable or modified cable from which the drilling device is suspended may be provided with a plurality of sensors arranged along the length thereof. Preferably, the sensors are arranged at intervals of from 152.4 cm to 609.6 cm (5 to 20 feet) along the length of the cable. This is advantageous when the drilling device is used to drill a lateral “exploration” well as the sensors may be used to receive and transmit data relating to the nature of the formation rock matrix and the properties of the formation fluids at a distance from the existing wellbore. The data may be continuously or intermittently sent to the surface via the electrical conductor wire(s) and/or segmented conductor(s) embedded in the conventional cable or modified conventional cable. The lateral “exploration” well may be drilled to a distance of from 3.048m to 3048 m (10 to 10,000 feet), typically 30.48m to 609.6m (100-2,000 feet) from the existing wellbore. The drilling device and associated cable may be left in place in the lateral “exploration well” for at least a day, preferably at least a week, or may be permanently installed in the lateral “exploration” well. Suitably, a plurality of expandable packers are arranged at intervals along the length of the cable. The expandable packers may be used to isolate one or more sections of the lateral “exploration” well thereby allowing data to be transmitted via the cable to the surface relating to the formation conditions in the sealed section(s) of the lateral “exploration” wellbore. Once sufficient information has been obtained from the sealed section of the lateral “exploration” wellbore, the expandable packers may be

retracted and at least one new section of the lateral "exploration" wellbore may be isolated and further data may be transmitted to the surface.

The cable from which the drilling device is suspended lies within a length of tubing. Suitably, the interior of the tubing is in fluid communication with a fluid passage
5 in the drilling device. The term "passage" as used herein means a conduit or channel for transporting fluid through the drilling device. Suitably, the drilling device is attached either directly or indirectly to the tubing. The tubing extends from the drilling device along the cable, extending into the return conduit, and is thus usually longer than the desired length of the new wellbore section. It is envisaged that sensors may be located
10 along the section of cable that lies within the tubing and/or along the outside of the tubing. Where sensors are located on the outside of the tubing, the sensors may be in communication with the electrical conductor wire(s) and/or segmented conductor(s) of the cable via electromagnetic means.

The tubing has an outer diameter smaller than the inner diameter of the return
15 conduit thereby allowing the tubing to pass into/through the return conduit. Preferably, the tubing has an outer diameter that is at least 1.27 cm (0.5 inch), more preferably at least 2.54 cm (1 inch) less than the inner diameter of the return conduit. Typically, the tubing has an outer diameter in the range 5.08 – 12.7 cm (2 to 5 inches).

Typically, the tubing may be steel tubing or plastic tubing. Where the tubing is
20 steel tubing, optionally a housing, preferably a cylindrical housing, may be attached either directly or indirectly to the end of the steel tubing remote from the drilling device, for example, via a releasable connector. Thus, the drilling device may be attached to a first end of the steel tubing and the housing to a second end of the steel tubing. For avoidance of doubt, the cable passes through the housing and through the steel tubing to the drilling
25 device. An electric motor may be located in the housing and electricity may be transmitted to the motor via an electrical conductor wire or segmented conductor encased in the cable. The electric motor may be used to actuate a means for rotating the steel tubing and hence the drilling device connected thereto. Preferably, the housing is provided with electrically operated traction means which may be used to advance the steel tubing and hence the
30 drilling device through the new wellbore section as it is being drilled. Electricity is transmitted to the traction means via an electrical conductor wire or segmented conductor

encased in the cable. Suitably, the traction means comprises wheels or pads which engage with and move over the wall of the conduit.

The drilling device may be provided with an electric motor for actuating a means for driving a drill bit. Typically, the means for driving the drill bit may be a rotor. As discussed above, a drill bit may be located at the lower end of the drilling device and optionally at the upper end thereof. It is envisaged that the upper and lower drill bits may be provided with dedicated electric motors. Alternatively, a single electrical motor may drive both drill bits. Suitably, the electric motor(s) is located in a housing of the drilling device, preferably a cylindrical housing. Electricity is transmitted to the motor(s) via an electrical conductor wire or segmented conductor encased in the cable. The housing of the drilling device may also be provided with an electrically operated traction means which is used to advance the drilling device and steel tubing through the new wellbore section as it is being drilled and also to take up the reactive torque generated by the means for driving the drill bit. Electricity is transmitted to the traction means via an electrical conductor wire or segmented conductor encased in the cable. Suitably, the traction means comprises wheels or pads which engage with and move over the wall of the new wellbore section. It is envisaged that the drilling device may be advanced through the new wellbore section using both the traction means provided on the optional housing attached to the second end of the steel tubing and the traction means provided on the housing of the drilling device.

The liquid may be drawn to the drilling device through the annulus formed between the tubing and the wall of the new section of wellbore, and the entrained cuttings stream may be transported away from the drilling device through the interior of the steel tubing ("reverse circulation" mode). Accordingly, the housing of the drilling device is preferably provided with at least one inlet to a first passage in the housing. This first passage is in fluid communication with a second passage and a third passage in the housing of the drilling device. The second passage has an outlet that is in fluid communication with the interior of the steel tubing while the third passage has an outlet in close proximity to the cutting surfaces of the drilling device. Typically, the liquid is drawn through the inlet(s) of the first passage via a pumping means, for example, a suction pump, located in the housing. The liquid can be divided into a first divided liquid stream and second divided liquid stream. The first divided liquid stream flows through the second passage in the housing of the drilling device and into the interior of the tubing while the second divided

liquid stream flows through the third passage in the housing of the drilling device and out over the cutting surfaces such that the drill cuttings are entrained therein. The resulting entrained cuttings stream is then passed over the outside of the drilling device before being recycled through the inlet(s) of the first passage in the housing of the drilling device. The majority of the cuttings pass into the interior of the tubing entrained in the first divided liquid stream. The first divided liquid stream containing the entrained cuttings is discharged from the second end of the tubing, that is remote from the drilling device, into the conduit where the cuttings are diluted into the aqueous liquid that is flowing directly to the surface through the conduit.

Where the new wellbore section is a lateral well, the portion of the steel tubing which passes through the existing wellbore before entering the conduit may be provided with a valve comprising a sleeve which is moveable relative to a section of the steel tubing that has a plurality of perforations therein. When the valve is in its closed position the sleeve will cover the perforations in the section of steel tubing so that produced fluids from the existing wellbore are prevented from entering the conduit. When the sliding sleeve is in its open position the plurality of perforations are uncovered and produced fluids from the existing wellbore may pass through the perforations into the steel tubing and hence into the hydrocarbon fluid production conduit.

As discussed above, the tubing may also be plastic tubing. Unlike steel tubing, plastic tubing is deformable under the conditions encountered downhole. Accordingly, the liquid can be drawn to the drilling device through the annulus formed between the plastic tubing and the wall of the wellbore, and the cuttings stream is transported away from the drilling device through the interior of the tubing ("reverse circulation" mode). Suitably, the liquid is drawn to the drilling device via a pumping means, for example, a suction pump, located in a housing, preferably a cylindrical housing of the drilling device. The pumping means may be operated as described above. Preferably, the housing of the drilling device is provided with an electric motor used to actuate a means for rotating a drill bit located at the lower end of the drilling device; for example, the electric motor may actuate a rotor. Preferably, the housing of the drilling device is provided with an electrically operated traction means, for example, traction wheels or pads, which engage with the wall of the new wellbore section and which are used to advance the drilling device through the new wellbore section as it is being drilled and to take up the reactive torque

generated by the electric motor used to drive the drill bit. The entrained cuttings stream/slurry is passed to the surface through the conduit together with the liquid. It is also envisaged that at least a portion of the cuttings may be deposited in the rat hole of the existing wellbore, as described above.

5 In a yet further embodiment of the present invention, the drilling device is suspended from tubing having least one electrical conductor wire and/or at least one segmented electrical conductor embedded in the wall thereof (hereinafter "hybrid cable"). Suitably, a passage in the drilling device is in fluid communication with the interior of the hybrid cable. Preferably, the drilling device is connected to the hybrid cable via a
10 releasable connection means.

An advantage of the hybrid cable is that the tubing is provided with at least one electrical conductor wire and/or at least one segmented electrical conductor embedded in the wall thereof for transmitting electricity and/or electrical signals. A further advantage of the hybrid cable is that the liquid may be passed to the drilling device through the annulus
15 formed between the tubing and the wall of the new section of wellbore and the entrained cuttings stream may be transported away from the drilling device through the interior of the tubing ("reverse circulation" mode).

Further details of the hybrid cable and its operation are given in WO 2004/011766.

Preferably, the drilling device, which may optionally be connected to the hybrid
20 cable, comprises a housing that is provided with an electric motor for actuating a means for driving a drill bit or mill located at the lower end of the drilling device and an electrically operated traction means, and an electrically operated pumping means. Optionally, the housing is provided with an electric motor for actuating a means for driving a drill bit or mill located at the upper end of the drilling device. As discussed above, it is envisaged that
25 a single electric motor may actuate both of the drive means. Alternatively, each drive means may be provided with a dedicated electric motor.

An electrically operated pumping means, for example, a suction pump, may also be located in the housing of the drilling device. The drilling device, suspended on a conventional or modified conventional cable, may be passed to the selected location in the
30 existing wellbore from which the new wellbore section is to be drilled. As the new wellbore section is being drilled, the pumping means located in the housing of the drilling device can draw aqueous liquid through a passage in the drilling device and out over the

cutting surfaces of the drill bit or mill. The resulting slurry, which is a stream of entrained cuttings then flows around the outside of the drilling device and up the tubing and is emitted into the conduit where it is diluted with aqueous liquid that is flowing to the surface through the conduit. Where the new wellbore section is a side-track or lateral wellbore, it is also envisaged that at least a portion of the cuttings may disentrain from the aqueous liquid and may be deposited in any rat hole of the existing wellbore, as described above.

Where the new wellbore section is a side-track or lateral well and the existing wellbore is provided with a casing which runs down through the selected location where the new wellbore section is to be drilled, it is generally necessary to mill a window through the casing before commencing drilling of the new wellbore section. Where the side-track or lateral well is to be drilled from a location in the conduit, the window is milled through the conduit and through the casing before commencing drilling of the new wellbore section. Where the casing and optionally the conduit is formed from metal, this may be achieved by lowering a whipstock to the selected location through the conduit. Suitably, the whipstock may be lowered to the selected location in the wellbore suspended from a cable, for example a conventional cable or a modified conventional cable, via a releasable connection means. The whipstock is then locked in place in the casing or the conduit via radially extendible gripping means, for example radially extendible arms. The whipstock is then released from the cable and the cable is pulled from the wellbore. A first drilling device comprising a mill is subsequently lowered to the selected location in the wellbore suspended from a cable, for example a conventional cable, modified conventional cable or a hybrid cable. However, it is also envisaged that the whipstock may be lowered to the selected location suspended from the first drilling device which, in turn, is suspended from a cable, for example a conventional cable, a modified conventional cable or a hybrid cable. Suitably, the whipstock may be suspended from the first drilling device via a releasable connection means. Once the whipstock is located in the region of the cased wellbore where it is desired to drill the side-track or lateral well, the whipstock is locked into place in the casing or the conduit as described above. The whipstock is then released from the first drilling device. By whipstock is meant a device having a plane surface inclined at an angle relative to the longitudinal axis of the wellbore which causes the first drilling device to deflect from the original trajectory of the wellbore at a slight angle so that the cutting

surfaces of the mill engage with and mill a window through the metal casing of the wellbore (or through the metal conduit and the metal casing). Preferably, the first drilling device is provided with an electrically operated traction means to assist in the milling operation. Once a window has been milled through the metal casing (or through the metal conduit and the metal casing), the first drilling device may be removed from the wellbore by pulling the cable out of the wellbore and/or by operating the traction means. A second drilling device comprising a conventional drill bit is then attached to the cable which is reinserted into the wellbore through the conduit. Where the cable is a conventional cable or modified conventional cable, it is preferred that the cable passes through a length of tubing which is in fluid communication with a fluid passage in the drilling device, as described above. The whipstock causes the second drilling device to deflect into the window in the casing (or the window in the conduit and casing) such that operation of the second drilling device results in the drilling of a side-track or lateral well through the desired zone of the formation. However, it is also envisaged that the casing (or the conduit and casing) at the selected location of the wellbore may be formed from a friable alloy or composite material such that a window may be formed in the casing (or the conduit and casing) using a drilling device comprising a conventional drill bit and the drilling device may then be used to drill the side-track or lateral well.

Where a whipstock is employed to deflect the drilling device, the whipstock may remain in the existing wellbore following completion of drilling of the new wellbore section. Where the new wellbore is a lateral well, the whipstock may be provided with a fluid by-pass to allow any produced fluid to flow to the surface from the existing wellbore through the conduit. Preferably, the whipstock is retrievable through the conduit. Thus, the whipstock may be collapsible, for example having retractable parts and being capable of being retrieved through the conduit when in its collapsed state, for example, by attaching a cable thereto and pulling the cable from the wellbore through the conduit.

In yet a further embodiment of the present invention there is provided a method of removing deposits of mineral scale, for example deposits of barium sulfate and/or calcium carbonate from the wall of the existing wellbore, for example, from the wall of the casing of a cased wellbore thereby increasing the diameter of the available bore hole. Thus, the drilling device may be lowered into the wellbore through the conduit suspended on a conventional cable, a modified conventional cable or a hybrid cable to a section of the

existing wellbore having mineral scale deposited on the wall thereof. Optionally, the drilling device may be used to remove mineral scale deposits from the wall of the conduit as the drilling device is being lowered into the wellbore through the return conduit. Suitably, the cuttings of mineral scale are diluted into the liquid that flows in the return

5 conduit directly to the surface. Preferably, the drilling device, that is used to remove mineral scale from the wall of the existing wellbore or from the conduit, is provided with upper and lower cutting surfaces. Thus, a drill bit or mill may be located on both the upper and lower ends of the drilling device. Preferably, the drill bit or mill that is located on the upper end of the device is positioned on the housing below a connector for the cable. By

10 providing a drill bit or mill on the upper end of the device, the mineral scale deposit may be removed from the wall of the existing wellbore upon raising the drilling device through the wellbore in addition to when lowering the device through the wellbore suspended on the cable. Preferably, an electrically operated traction means is provided below the upper drill bit or mill to assist in moving the drilling device upwardly through the wellbore. It is

15 envisaged that the drilling device may be moved upwardly and downwardly within the wellbore a plurality of times, for example, 2 to 5 times, in order to substantially remove the mineral scale deposit from the wall of the existing wellbore, for example, from the wall of the casing of a cased wellbore. Preferably, the drill bit or mill located on the lower end of the drilling device and optionally on the upper end of the drilling device is an expandable

20 drill bit. This is advantageous when the drilling device is used to remove mineral scale deposits from the wall of a cased wellbore as the diameter of the wellbore is generally significantly larger than the inner diameter of the conduit. Preferably, the drilling device may also be moved, a plurality of times, upwardly and downwardly within the conduit in order to substantially remove mineral scale deposits from the conduit. The device may be

25 left in the wellbore below a producing interval and be deployed, as required, to remove any mineral scale deposits that may build up on the wall of the existing wellbore and optionally on the wall of the conduit. Suitably, the mineral scale cuttings are removed from the aqueous liquid at the wellhead, using conventional cuttings separation techniques. However, it is also envisaged that at least a portion of the mineral scale cuttings may

30 disentrain from the liquid and may be deposited in any rat hole of the existing well, as described above.

During the subterranean drilling the tubing extends from above the entry of liquid in the conduit down to the drilling device and/or bottom hole assembly at the face being drilled from the first subterranean location. As the drilling progresses the face recedes and the tubing is moved down usually by traction means on the bottom hole assembly or drilling device acting on the well bore. To allow for this movement on drilling from the first to the second location, the top end of the tubing is preferably initially at a distance above the entry of liquid in the conduit at least equal to or preferably larger than the distance between the first and second locations. If required drilling may be stopped in order that a further section of tubing may be jointed to the top end in order that the top end is maintained above the entry of liquid in the conduit.

In its one aspect the present invention involves passing the liquid into the conduit of the apparatus. There is at least one such as 1 or 2 entry line for liquid into the apparatus from outside the apparatus which line may be at a non subterranean location, such as at the land surface from whence the casing extends, whether on dry land or the bed of a body of water such as a river, lake or sea bed. The entry line for liquid from outside the apparatus may be into the wellhead, which may be situated in said non-subterranean location. Thus in a particular embodiment of the invention, the apparatus comprises a well head itself comprising at least one entry line through which the liquid initially enters the apparatus. In the method and apparatus of the invention, there is at least one entry for the liquid in the conduit below the outlet second end of the tubing; there may be 1-3, e.g. 1 or 2 but preferably 1 such entry in the conduit. From the entry line (or lines), the liquid may pass to said entry (entries) for liquid in the conduit. The liquid may pass directly into the conduit via a pipe opening in that conduit below the outlet of the tubing, namely its second end, or the liquid may pass into the first annulus, and thence into the conduit at a location below the second end of the tubing. The entry for the liquid in the conduit below the second end of the tubing may be from said pipe, or from a hole/perforation in the conduit wall or at the bottom of the conduit which is capable of being in liquid contact with liquid in said first annulus.

In a first embodiment the liquid may be injected directly into the conduit in a pipe from outside the apparatus e.g. from the surface preferably via the wellhead. Alternatively it may be passed from outside the apparatus through a pipe or pipes, passing through the annulus, preferably into the annulus and longitudinally along the annulus from the surface

and thence into the conduit. The pipe, through which the liquid is injected into the conduit, has an end in the conduit, which end is nearer the drilling device than is the second end of the tubing; thus in use the pipe-end is below the second end. The pipe may pass through the conduit e.g. downwards and end below the conduit where it is surrounded by the casing. Preferably the pipe passes only partly through the conduit and ends inside it, but still below the second end. While the pipe usually passes axially through the conduit, its end point in a radial, or axial direction, whether upwards but preferably downwards in use, or any other direction. If desired the pipe end may be constant diameter, or flared with increasing diameter, optionally of diameter which increases linearly or increases at an increasing rate, such as a trumpet shape. Preferably the pipe passes substantially parallel to but spaced from the part of the tubing inside the conduit leading to the second end of the tubing.

The aspect of the invention involving direct entry of the liquid into the conduit is beneficial because the annulus can then be closed e.g. with a packer and the casing does not then contact the aqueous or organic liquid, thereby avoiding any possible harmful effects on the casing surface.

However the presence of the injection pipe inside the conduit increases congestion in it because of the presence there of the tubing as well, which may result in mechanical problems and flow problems, possibly impeding upward flow of the slurry of drill cuttings in the conduit.

Accordingly in a preferred second embodiment the liquid passes into the annulus first e.g. via the wellhead, passes down the annulus contacting its walls and thence into the conduit. This approach has the benefit over use of the pipe for direct injection into the conduit of no congestion or impedance of the flow in the conduit, encouraging efficient upward entrainment of the drill cuttings. The liquid may flow in the annulus to its bottom end, where the conduit stops and then divide into a first and a second stream. The first stream passes into the conduit, at a second annulus formed between the conduit wall and part of the tubing in the conduit leading to the tubing second end. The second stream passes in an opposed direction to the first stream passing around and/or beside the section of tubing towards its first end and the drill device. This approach can be especially valuable when an extension to an existing well bore, as distinct from a lateral or sidetrack well, is being drilled, as it requires minimum alteration to drilling apparatus.

In a more preferred third embodiment, the liquid, preferably an aqueous liquid passes through the first annulus between conduit and casing contacting the conduit outer wall and then through the conduit wall, the annulus being consequently closed off e.g. with a sealed packer further down. A benefit of this embodiment over the previous one with flow round the bottom of the conduit is that the location of the passage through the conduit wall can be varied at will, so it is especially valuable in the drilling of lateral and sidetrack wells. There is at least one conduit passage for the liquid through the conduit wall. When there is more than 1 conduit passage, e.g. 2-4 passages, they may be located longitudinally up the conduit, but preferably are located axially around the conduit; in all cases the conduit passage(s) are located in use below the second end of the tubing. The conduit passage may be a perforation but is preferably a slot or mandrel in the conduit. There may be only one conduit passage. But especially valuable are conduits with one first conduit passage to allow the passage of liquid and at least one other conduit passage; especially a series of them e.g. 1-6 conduit passages especially arranged longitudinally thereto, those other ones being closed. The closure may be permanent or maybe temporary with the conduit passages sealed but unsealable e.g. by mechanical or electromechanical means from the surface. The other conduit passages may have similar dimensions to each other and/or the first conduit passage, or may have an increasing cross section area progressively away from the second tubing end ie in use towards the surface. Advantageously the conduit with the open and closed conduit passages is a section of conduit usable for gas lift wells, in which, in a production well, gas is injected at the top of the production conduit in order to increase oil production rate from bore holes in low pressure oil bearing formations. Thus in a preferred combination with a production well, gas is passed through the production conduit with the conduit passages open to maximize oil production, then the production is stopped, all but the lowest of the conduit passages are closed temporarily, liquid, preferably aqueous liquid, is passed through that lowest conduit passages while a lateral bore hole is drilled or extended in an oil bearing formation, then the passage of water is stopped, the conduit passages unsealed and gas flow restarted and production restarted; this alternation between production and gas lift may be performed more than once. The sealing and unsealing of the conduit passages may be done mechanically or electrically. This preferred combination provides a method of producing hydrocarbons from a lateral or side track well in a subterranean oil bearing formation, which has been at

least partly drilled with an apparatus wherein the wall has a first conduit passage through which the liquid passes and at least one further conduit passage located more remote from said drilling device than said first conduit passage, each further conduit passage being sealed but capable of being unsealed e.g. with a movable sleeve, wherein after drilling the flow of liquid is stopped, said other conduit passage in said conduit are unsealed and gas is passed down said annulus through at least some of the conduit passages and other conduit passage in a gas lift operation to aid movement of oil from said formation into said well and thence into said conduit.

The passage(s) in the conduit may be a slot or other pre-shaped hole, rectilinear or curved e.g. circular, which pre-shaped hole may be coverable by a sliding sleeve, adapted to be moved between two locations allowing or denying passage of liquid through the conduit wall. Its movement may be controlled e.g. from the surface by mechanical or electrical means. The benefit of using a coverable single slot is that the apparatus can easily alternate between use in lateral drilling with the slot open and use in normal oil production without gas lift with the slot closed.

In the above discussion of the mode of use of the apparatus of the invention and of the method of the invention, emphasis has been placed on flows in which a first stream of liquid passes up the conduit while a second stream of that liquid passes around and beside the tubing towards the drilling device. The latter stream collects the drill cuttings into a slurry which passes inside the tubing towards its second upper end from whence it emanates into the first stream, to be entrained therein for carriage further e.g. to the surface. The volume ratios of the first to the second stream may be 50:1 to 1:1 preferably 25:1 to 5:1. There is usually a volume excess of the first over the second stream.

The first and second streams of liquid are usually formed by dividing main stream of liquid entering the apparatus in the entry line. In the first embodiment in which the entry line leads to a pipe opening directly in the conduit, the division into said streams occurs in the conduit at the outlet of said pipe. In the preferred second embodiment, in which the entry line is into the first annulus, the division into said streams can occur at the bottom of the conduit or as in the more preferred third embodiment in which the entry line is in the first annulus and the liquid passes from the annulus through conduit wall, the division into said streams occurs on entry into the conduit downstream of passage through the wall. In each case the second annulus between the tubing and the conduit is open for liquid flow in

the first and third embodiment, the flow of liquid being upwards above the entry in the conduit e.g. the perforation or slot and downwards below that entry. When the entry line for liquid is into the first annulus and the division of liquid into said streams occurs at the bottom of the return conduit, the flow of first stream of liquid is upwards up the second
5 annulus and the flow of second stream is downstream along beside the tubing inside the casing but no longer surrounded by the conduit and thence in the well bore to the drilling device.

When there is more than one entry line in the apparatus, one entry line, such as the pipe directly entering the conduit may provide the first stream and another entry line such
10 as one directly into the annulus may provide the second stream.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 represents a drilling apparatus according to a first embodiment of the invention

Fig.2 represents a drilling apparatus according to a second embodiment of the
15 invention

Fig.3 represents a drilling apparatus according to a third embodiment of the invention

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention will now be illustrated by reference to Figures 1 to 3.
20 Referring to Figure 1, an existing wellbore 1 penetrates through an upper zone 2 of a subterranean formation below which is zone 3 of the subterranean formation; zone 3 may be hydrocarbon or water bearing or devoid of both. A metal casing 4 is arranged in the existing wellbore 1 and is fixed to the wellbore wall by a layer of cement 5. A conduit 6 is positioned within the existing wellbore 1 and hangs from a wellhead 8. A packer 7 is
25 provided at the lower end of the casing 4 to seal the annulus 22 formed between the conduit 6 and the casing 4. The wellhead 8 at the surface provides fluid communication between the conduit 6 and a hydrocarbon fluid production facility (not shown) or drill cuttings separation facility (not shown) via a pipe 9 and also fluid communication between annulus 22 and a source of aqueous liquid via pipe 23. An expandable whipstock 10 is
30 passed through the conduit 6 and is locked in place in the casing 4 of the existing wellbore 1 via radially expandable locking means 11. A bottom hole assembly 12 comprising a remotely controlled electrically operated drilling device and pump is passed into the

existing wellbore through the conduit 6 suspended on a reinforced steel cable 13 comprising at least one electrical conductor wire or segmented conductor (not shown). The lower end of the reinforced steel cable 13 passes through a length of steel tubing 14 which is in fluid communication with a fluid passage (not shown) in the drilling device.

5 The drilling device is provided with an electrically operated steering means, for example, a steerable joint (not shown) and an electric motor (not shown) arranged to drive a means (not shown) for rotating drill bit 15 located at the lower end of the drilling device 12. The tubing 14 has a top end 16, which is above a perforation or slot 21 in conduit 6. Above the perforation or slot 21 in the conduit may be more perforations or slots (not shown) which
10 are closed but can be opened. The bottom hole assembly 12 is provided with electrically operated traction wheels or pads 17 which are used to advance the drilling device through a new wellbore section 18. The cable 13 passes through the interior of the steel tubing 14 to the bottom hole assembly.

The new wellbore section 18 is drilled using the bottom hole assembly 12 in the
15 manner described hereinafter, the new wellbore section extending from a window 19 in the casing 4 of the existing wellbore 1 into the zone 3 and being a side-track well or lateral well. During drilling of the new wellbore section 18, aqueous liquid such as water passes via pipe 23 into annulus 22 and hence through perforation 21 into conduit 6. Some of the aqueous liquid passes up towards end 16 of the tubing 14. In the reverse circulation mode,
20 the remainder of the aqueous liquid, which has passed through perforation 21 but then not upwards towards end 16, passes down conduit 6 and through the annulus 20 to the drill bit 15 to produce slurry of the drilling cuttings entrained in the aqueous liquid. The slurry is then passed through the passage in the drilling device and into the interior of the steel tubing 14 and is emitted into conduit 6 through tubing end 16, where after it leaves the
25 apparatus via well head 8.

A plurality of formation evaluation sensors (not shown) may be located: on the drilling device 12 in close proximity to the drill bit 15; on the end of the steel tubing 14 which is connected to the bottom hole assembly 12; along the lower end of the cable 13 that lies within the steel tubing 14; or along the outside of the steel tubing. The formation
30 evaluation sensors are electrically connected to recording equipment (not shown) at the surface via electrical wire(s) and/or segmented conductor(s) which extend along the length of the cable 13. Where sensors are located on the outside of the steel tubing, the sensors

may be in communication with the electrical wire(s) and/or segmented conductor(s) of the cable 13 via electromagnetic means. As drilling with the drilling device proceeds, the formation evaluation sensors are operated to measure selected formation characteristics and to transmit signals representing the characteristics via the electrical conductor wire(s) and/or segmented conductor(s) of the cable 13 to recording equipment at the surface (not shown).

A navigation system (not shown) for the steering means may also be included in the drilling device to assist in navigating the drilling device through the new wellbore section 18.

After drilling of the new wellbore section 18, the flow of aqueous liquid in annulus 22 may be replaced by a flow of gas to replace all the aqueous liquid above perforation 21. The steel tubing 14 may be expanded to form a liner for the new wellbore section 18 and the bottom hole assembly 12 may be retrieved by pulling the cable from the wellbore and/or by actuating the traction wheels or pads 17 such that the drilling device passes through the expanded steel tubing and the conduit 6.

Where the steel tubing is not expandable, the steel tubing may be provided with at least one radially expandable packer. The packer(s) may be expanded to seal the annulus formed between the steel tubing 14 and the new wellbore section 18 thereby forming a sealed liner for the new wellbore section 18. The pump located in the bottom hole assembly 12 may be disconnected from the drilling device and may be retrieved through the interior of the steel tubing 14.

The apparatus and general method of Fig 1 can be used in the drilling in a producing well of a lateral well in an oil bearing formation. They can also be used as described but with the respect to the drilling in a water injection well of a lateral well in a water bearing formation though in this latter case reference 3 denotes a water bearing zone and reference 6 represents a water injection conduit. After the drilling of the new well bore section 18, the flow of aqueous liquid in annulus 22 is stopped and injection water is passed via pipe into conduit 6 and into the formation in well bore section 18. They can also be used in the drilling of a dry well.

In a modification (not shown) of the apparatus and general method of Fig 1, the packer 7 and perforation or slot 21 are absent. The aqueous liquid flows down annulus 22 to the lower end of conduit 6. In the "reverse" mode operation some of the aqueous liquid

passes out of the bottom of annulus 22 and up into conduit 6 while the remainder passes into annulus 20 of the lateral bore to the bottom hole assembly 12 where an aqueous slurry of drilling cuttings is produced and is pumped along tubing 14 to be emitted from end 16 into aqueous liquid in conduit 6, and the mixture obtained is passed to the well head 8 up
5 conduit 6.

This modification without the packer 7 and perforation or slot 21 can also be used as illustrated in Fig 2 in the drilling of the bottom of a new wellbore, in particular a barren bore devoid of water and oil. In Fig 2 the same numbers mean the same as in Fig 1. Into the new wellbore 18 extends tubing 14 surrounding cable 13 and leading to bottom hole
10 assembly 12 having drill bit 15 and traction means 17 as well as fluid passages (not shown). The aqueous liquid flows down annulus 22, some passes up into conduit 6, and the remainder of the liquid passes to the drill bit 15 via annulus 20 and back with cuttings up tubing 14 into conduit 6 where it meets upward moving liquid from annulus 22 and the mixture obtained passed to the well head 8. If desired, not shown, conduit 6 in Fig 2 may
15 have a perforation or slot below the upper end 16 of tubing 14 and the bottom of conduit 6 may extend to meet the narrow section of well bore with which it makes a tight fit giving a substantially sealed joint.

Referring now to Fig 3, the same numbers mean the same as in Fig 1. In this modification, compared to Fig 1, perforation or slot 21 and line 23 are absent, but packer 7
20 is still present. There is also an entry line 24 in wellhead 8 for aqueous liquid which passes into and down conduit 6 through a tube 25. Tube 25 terminates in an outlet 26 which is below the upper end 16 of tubing 14. The mode of operation of the apparatus of Fig 3 is as described with respect to Fig 1 apart from the fact that the aqueous liquid in Fig 3 is passed
25 down line 24 and tube 25 and is emitted into conduit 6 directly from outside without passing through annulus 22 and perforation or slot 21, the route by which it reaches conduit 6 in Fig 1.

Claims:

1. Method of drilling a borehole from a first subterranean location to a second subterranean location, which method comprises
 - (i) passing liquid into an apparatus in at least one location, said apparatus comprising a casing (4) extending longitudinally inside a borehole, a conduit (6) extending longitudinally inside said casing, and capable of being in sealing relationship therewith, a first annulus (22) between said casing and said conduit, entry for said liquid in said conduit, tubing (14) having a first end present in said first location and a second end (16) present inside said conduit above said entry for liquid in said conduit, a remote controlled electrically powered drilling device (12) located in said first subterranean location and a remote controlled electrically powered pump;
 - (ii) passing a first stream of said liquid into said conduit below said second end;
 - (iii) passing a second stream of said liquid from inside the casing to said drilling device in said first location;
 - (iv) drilling said borehole in the presence of said liquid to produce a slurry of drill cuttings in said liquid;
 - (v) passing said slurry along said tubing from said first end to said second end where said slurry is emitted into said first stream of said liquid moving upwardly in said conduit from said entry.
2. A method according to claim 1, wherein the liquid enters the apparatus at a non-subterranean location.
3. A method according to claim 1, wherein the liquid passes into said first annulus and at least a part thereof passes into said conduit.
4. A method according to claim 3, wherein substantially all the liquid passes through the wall of the conduit.
5. A method according to claim 4, wherein the liquid passes into the conduit via at least one perforation or slot (21) in its wall.
6. A method according to claim 5, wherein the wall of the conduit (6) has a first perforation or slot (21) through which the liquid passes and at least one further perforation or slot located more remote from said drilling device than said first perforation or slot, each further perforation or slot being sealed but capable of being unsealed.

7. A method according to claim 4, wherein the liquid passes into the conduit via a slot in its wall, which slot is reversibly covered with a sliding sleeve.

8. A method according to claim 3, wherein the liquid divides into 2 streams, one passing up the conduit and the other passing towards the drill device.

5 9. A method according to claim 3, wherein the liquid passes through the first annulus to the bottom of the conduit, and divides into a first stream and a second stream, said first stream passing into the conduit to the second end of the tubing and said second stream passing around said tubing outside the conduit and to said drill device.

10 10. A method according to claim 1, wherein said liquid flows directly into said conduit, without access of said liquid into said annulus.

11. A method according to claim 1, wherein said borehole being drilled is a lateral or side track borehole from a main borehole.

12. A method according to claim 11, wherein the lateral or sidetrack borehole is in an oil bearing formation and the main borehole is a producing well.

15 13. A method according to claim 11, wherein the lateral or sidetrack borehole is in a water formation and the main borehole is a water injection well.

14. A method according to claim 1, wherein the borehole is drilled into a formation barren of water or oil.

20 15. A method of producing hydrocarbons from a lateral or sidetrack well in a subterranean oil bearing formation, which has been at least partly drilled by a method according to claim 6, wherein the flow of aqueous liquid is stopped, said other perforations or slots in said conduit are unsealed and gas is passed down said annulus through at least some of the perforation or slot and other perforations or slots in a gas lift operation to aid movement of oil from said formation into said well and thence into said conduit.

25 16. Apparatus for drilling a borehole from a first subterranean location to a second subterranean location, which apparatus comprises a casing (4) extending longitudinally inside a borehole, a conduit (6) extending longitudinally inside said casing, and capable of being in sealing relationship therewith, at least one entry line (23,24) for liquid into said apparatus, a first annulus (22) between said casing (4) and said conduit (6), at least one
30 entry for liquid in said conduit, a tubing (14) having a first end and a second end (16), a remote controlled electrically powered drilling device (12) and a remote controlled electrically powered pump, said drilling device and pump being capable of being in fluid

contact with said first end of said tubing (14), said second end (16) of said tubing (14) being inside said conduit (6) at a location more remote from said drilling device (12) than said entry for liquid in said conduit (6), wherein tubing (14) and first end and second end (16) thereof are adapted to provide two routes for liquid contact between said conduit (6) and said drilling device (12), said routes being respectively internally and externally of said tubing (14).

17. Apparatus according to claim 16, wherein the entry line (23) for liquid is into said first annulus (22), and said conduit (6) and said first annulus (22) are capable of being in liquid contact.

18. Apparatus according to claim 17, wherein the first annulus (22) comprises a packer (7) sealing it from liquid flow there through, and liquid contact between said conduit (6) and said first annulus (22) is through the wall of said conduit.

19. Apparatus according to claim 18, wherein said liquid contact is via at least one perforation or slot (21) in said wall of said conduit.

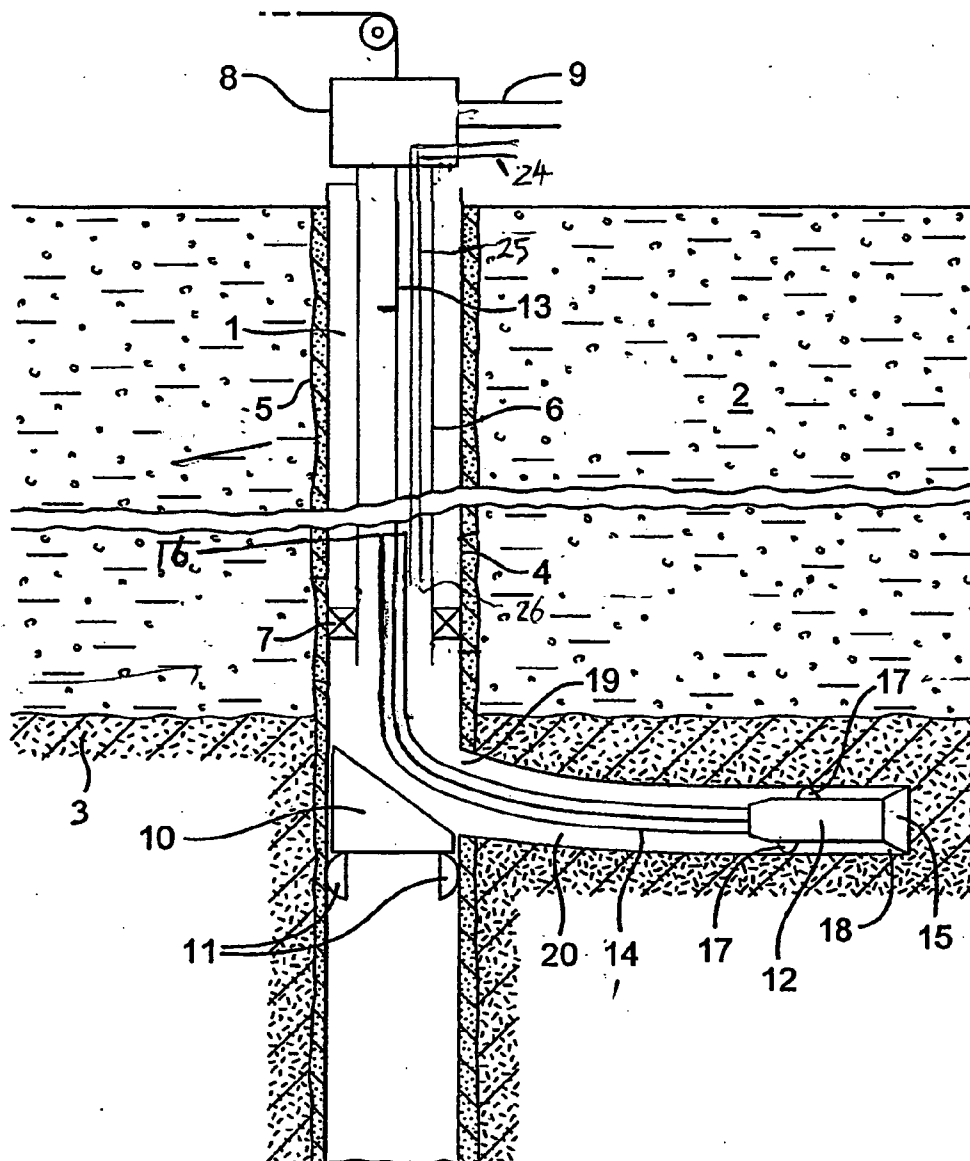
20. Apparatus according to claim 19, wherein said wall has a first perforation or slot (21) opened to provide said liquid entry and at least one further perforation or slot located more remote from said drilling device than said first perforation or slot (21) and each further perforation or slot are sealed but capable of being unsealed.

21. Apparatus according to claim 18, wherein said conduit (6) wall has a slot therein reversibly covered with a sliding sleeve capable of allowing or denying liquid contact through said wall of said conduit.

22. Apparatus according to claim 16, wherein said first annulus (22) and said conduit (6) are capable of being in liquid contact past the lower end of said conduit.

23. Apparatus according to claim 16, wherein said entry of liquid is a tube (25,26) entering said conduit (6) directly without access of said liquid to said first annulus (22).

Fig.3



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2008/001659

A. CLASSIFICATION OF SUBJECT MATTER

INV. E21B4/18 E21B7/00 E21B21/00 E21B41/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

E21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1 559 864 A (SCHLUMBERGER SERVICES PETROL [FR]; SCHLUMBERGER TECHNOLOGY BV [NL]; SC) 3 August 2005 (2005-08-03)	16
Y	column 35, paragraph 305 - paragraph 308; figure 22	1-15, 17-23
Y	WO 2004/011766 A (BP EXPLORATION OPERATING [GB]; XL TECHNOLOGY LTD [GB]; HEAD PHILIP [GB]) 5 February 2004 (2004-02-05) page 25, line 8 - line 18	1-15, 17-23
A	WO 00/75476 A (SHELL INT RESEARCH [NL]; SHELL CANADA LTD [CA]) 14 December 2000 (2000-12-14) page 9, line 22 - page 11, line 2	1, 16



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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Information on patent family members

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