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(54) APPARATUS AND METHODS FOR USE WITH DRILLING FLUIDS

VORRICHTUNG UND VERFAHREN ZUR VERWENDUNG MIT BOHRFLÜSSIGKEITEN

APPAREIL ET PROCÉDÉS À UTILISER AVEC DES FLUIDES DE FORAGE

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(73) Proprietor: **Churchill Drilling Tools Limited**
Cove, Aberdeen AB12 3RY (GB)

(72) Inventor: **CHURCHILL, Andrew Philip**
Aberdeen AB12 3RY (GB)

(74) Representative: **Murray, David Craig**
Marks & Clerk LLP
Aurora Building
120 Bothwell Street
Glasgow G2 7JS (GB)

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Description

TECHNICAL FIELD

[0001] The invention relates to apparatus and associated methods for use with drilling fluid. In particular, but not exclusively, the invention relates to apparatus for conditioning of a drilling fluid for circulation downhole.

[0002] Certain embodiments relates to the apparatus and methods used when milling.

BACKGROUND

[0003] In downhole operations, such as in the drilling of bores to access subsurface reservoirs (e.g. oil and gas reservoirs), drilling fluids are used to, among other things, remove drill cuttings and to cool drill bits. Drilling fluid consists typically of a base liquid with various chemicals and powdered particles combined together in order to provide suitable properties to perform a particular down-hole operation. The base fluid is generally water or synthetic oil; and the powdered particles are usually clays (drilling fluid is often referred to as 'mud').

[0004] The various properties of the mud can be split into chemical and physical properties. For example, chemically the mud can be a particular acidity and salinity in order to minimize any chemical damage done by corroding metal parts down-hole or by dissolving/swelling various rock types through which the drilling is occurring. The clays suspended in the mud are generally there to provide the useful physical properties for the mud, including density, viscosity and gel strength. The density can provide a hydrostatic pressure overbalance on the fluid pressure in the rock, to prevent fluid flowing out of the surrounding formation and into the well (known as a kick, the precursor to a blow-out if left uncontrolled). The viscosity can influence the ability of the mud to lift drilled cuttings out of a well, for example, as the mud flows back up an annulus between the drill pipe and the hole or the casing. The gel strength influences the ability of the mud to 'set' when it is not flowing (drilling fluid is typically thixotropic), and can prevent the drilled cuttings from dropping back down the hole when the pumps are turned off (e.g. whilst making a connection or while tripping into or out of the well).

[0005] Another factor in lifting the cuttings out of the hole is the speed at which the mud is flowing to flush them up and then out of the well. If the mud is thick and viscous it will require much energy (by creating back-pressure) to pump it at high speeds. Mud pumps have pressure/power limits so if the mud is too thick, the mud is not pumped fast enough. Gel strength can also be linked to viscosity, generally the higher the viscosity the higher the gel strength can be.

[0006] Drilling fluid normally operates hot because down hole temperatures are typically 120-140°C (248-284°F) but can get over 200°C (392°F). So the drilling fluid acts like a heat exchanger between the hot rock and the cold surface temperature. Most mud is used for drilling, which tends to be a continuous operation with the mud circulating and in equilibrium, that is the mud properties are generally stable. When re-starting the mud pumps it is common to start the pumps slowly. This is known as 'breaking circulation' to allow the gel's strength some time to reduce. After longer periods of mud stagnation (e.g. after a trip), after breaking circulation, when starting to drill it is common to use a slightly lower flow rate as the mud is subject to shear thinning and warms up, and in order to prevent excess pressures on the hole and on the equipment. A driller can see this effect on his pump pressure gauge; the pressure gradually drops off as the mud thins to the correct circulating equilibrium.

[0007] Tight nozzles in the drill bit are used to jet the mud at the cutting face; this improves the rate of drilling penetration particularly in softer rocks. It is also known that that the nozzles assist in the shear thinning of the mud. However, this comes at a pressure/power/flow-rate cost to the mud pumps.

[0008] Sometimes a rig will simply circulate mud through the string, doing nothing really productive until the mud is judged to be sufficiently conditioned. Considerable rig time can be wasted 'circulating and conditioning' the mud; particularly in preparation for a milling operation, during which optimal drilling mud conditioning is critical for success. A mill will be used in circumstances where is it necessary to cut the metal casing, for example to form a window in the casing, or when a section of casing simply needs to be ground away. This is often achieved by rotating a tungsten carbide cutter or bit/mill onto the casing to turn the casing into metal shavings/swarf, which then need to be flushed out of the hole by the mud. Metal swarf is much denser than normal drilled rock, and has a tendency to clump, and thus the mud needs to be thicker and have a better gel strength to perform properly. Starting milling before the mud is not sufficiently thinned and capable of being pumped at a rate sufficient to carry the the swarf out of the bore is likely to lead to blockage of the annulus with swarf, and the mill and the associated string becoming stuck in the bore, resulting in considerable damage to equipment and considerable and very expensive delay.

[0009] This is particularly problematic when milling with extendable cutters: such cutters are often powered by a very tight nozzle which creates a differential pressure to push piston-actuated cutters outwards radially. This creates several problems for conditioning the mud. The tight nozzle significantly limits the possible flow-rate making the initial time for a complete drilling mud circulation (from surface through the drill string to the cutter, through the mill nozzles, and then back to surface through the annulus) very long indeed, also the string cannot be moved (particularly rotated) while this is occurring - otherwise milling will effectively start. The combination of the viscous drilling fluid used in milling operations and the long circulation time may require the drilling fluid to be circulated for an extended period, for example 18 hours or more, before the fluid has been sufficiently conditioned and its viscosity reduced to permit the circulation rate to be increased to a rate sufficient for milling to commence. This represents a very significant expense for the rig operator. Furthermore, the initial viscosity of the unconditioned drilling fluid places a high load on the fluid circulation apparatus, and it is not unknown for an operator to misjudge initial conditions and find that it simply is not possible to circulate the unconditioned fluid with the existing pumps and other equipment.

[0010] This background serves to set a scene to allow a skilled reader to better appreciate the following description. Therefore, none of the above discussion should necessarily be taken as an acknowledgement that that discussion is part of the state of the art or is common general knowledge. One or more aspects/embodiments of the invention may or may not address one or more of the background issues.

[0011] US4189243 (A) describes a mud shearing device for placement in the mud flow line in a well drilling operation which includes a series of inner pressure chambers surrounded by concentric outer chambers with jet discharge ports connecting each inner chamber with a respective outer chamber and an inlet aperture connecting each succeeding inner chamber with a preceding outer chamber.

[0012] WO2011142894 (A1) describes a system for conditioning drilling fluid which includes a conditioning device having a first conduit configured to receive the drilling fluid, a flow restriction disposed adjacent the first conduit, the flow restriction comprising a fluid inlet and a fluid outlet, an impact plate disposed downstream of the flow restriction, a first chamber disposed between the flow restriction and the impact plate, and a second chamber disposed downstream of the impact plate, wherein the first chamber is fluidly connected to the second chamber. A method for conditioning drilling fluid using a conditioning device, includes pumping a drilling fluid through a flow restriction, accelerating the drilling fluid into a mixing chamber, subjecting the drilling fluid to elongational shearing, decelerating the drilling fluid against an impact plate, subjecting the drilling fluid to impact shearing, and emptying drilling fluid from the mixing chamber.

[0013] US3136583 describes a well drilling mud conditioning apparatus and method where clogging at the inlet end of the suction line is prevented by fragmenting congealed or coagulated masses in advance of the inlet to said line to produce small size particles which will not clog the inlet, and thereafter mixing said particles with water by means of suitable agitating blades within the suction line inlet so as to insure a drilling fluid or mud of substantially uniform consistency prior to its delivery to the usual mud pump.

[0014] WO0120121 (A1) describes a system which may include a separator at the sea floor adjacent the wellhead, which separates solids above a predetermined size from the wellstream. The wellstream then enters one or more underwater pumps, which pump the wellstream to the surface. A crusher, as a separate unit, integrated in the separator or in the pump, receives the separated solids and reduces them to relatively small-sized particles. The small particles are then pumped or moved to the surface by the pumps utilized for pumping the wellstream to the surface or by a separate underwater pump. Alternatively, the separated solids are collected from the separator into a container, which container is then transported to the surface by a suitable method. Solids reaching the surface are removed to obtain filtered fluid, which after conditioning by conventional methods is pumped back into the wellbore as the drilling fluid.

SUMMARY

[0015] According to an aspect of the invention there is provided a method for facilitating a downhole operation, the method comprising:

providing a drilling fluid conditioning device in a proximal portion of a tubular string providing mounting for a cutting tool on a distal downhole portion of the tubular string;
circulating drilling fluid through the drilling fluid conditioning device and the tubular string to condition the drilling fluid;
removing the drilling fluid conditioning device from the string; and
circulating the conditioned drilling fluid through the tubular string and the cutting tool.

[0016] According to another aspect of the invention there is provided a drilling fluid conditioning device comprising a tubular body configured for incorporation in a proximal portion of a tubular string extending to a distal downhole location, the body configured to induce shear thinning of fluid passing therethrough.

[0017] According to a further aspect of the present invention there is provided apparatus comprising:

a tubular string providing mounting for a cutting tool on a distal end of the string; and
a drilling fluid conditioning device for coupling with the tubular string at a proximal end of the string,
wherein the drilling fluid conditioning device is removable from the tubular string prior to operation of the cutting tool.

[0018] Although reference is made primarily herein to the use of cutting tools, aspects of the invention may be utilised in relation to other downhole tools or devices.

[0019] Rather than physically removing the drilling fluid conditioning device from the string it also possible to modify the device to, for example, remove a flow restriction from the device, or redirected fluid around or past the device.

[0020] The drilling fluid conditioning device may be configured to induce shear thinning of fluid passing therethrough, for example by accelerating the fluid. Thus, if a drilling fluid is passed through the device the viscosity of the fluid decreases, and the fluid is more easily circulated.

[0021] The drilling fluid conditioning device may be incorporated in the circulation path for the drilling fluid only until the drilling fluid is judged to be suitably conditioned to permit a downhole operation to commence. Typically, the downhole operation will be a cutting operation, such as drilling, reaming or milling. By removing the conditioning device from the circulation path the losses associated with the device are also removed from the fluid circulation system, reducing the load placed on associated pumps and the like, and potentially permitting a higher fluid circulation rate to be achieved.

[0022] A bypass tool may be incorporated in the tubular string, typically towards the distal end of the string, such that the drilling fluid may bypass the cutting tool during initial circulation. This may facilitate initiation of circulation of more viscous fluids, as the circulating fluid bypasses the nozzles in the cutting tool, and may facilitate higher circulation rates to accelerate the heating of the drilling fluid to a desired level. The presence of an open bypass tool also allows the drilling fluid to be circulated without activating or actuating fluid-powered tools located below the bypass tool. Thus, for example, the presence of a bypass tool allows circulation of fluid at relatively high rates without activating a fluid pressure-actuated cutting tool with extendable cutting blades provided on the string below the bypass tool. This would allow the operator to rotate or reciprocate the string as the fluid is circulated, and further accelerate the conditioning of the fluid, safe in the knowledge that the cutters would not extend.

[0023] According to an aspect of the invention there is provided a drilling fluid apparatus and associated methods. The apparatus and methods may be useful to reduce the time to condition mud sufficiently, prior to starting a milling operation.

[0024] The apparatus may be configured to condition a drilling fluid to be supplied to a downhole assembly. The apparatus may comprise a conditioning device configured to thin the drilling fluid passing therethrough. The apparatus may be configured to be positioned at a surface region of a wellbore.

[0025] The conditioning device may be configured to induce a shear flow in the fluid. The conditioning device may be configured to induce a turbulent flow in the fluid. The conditioning device may be configured to induce an eddy current flow in the fluid. The conditioning device may be configured to stimulate, or generate, heating of the fluid. The conditioning device may be configured to provide a friction in the fluid. The conditioning device may be configured to provide an internal friction in the fluid. The conditioning device may be configured to provide an increased internal friction in the fluid. The conditioning device may be configured to provide an external friction with the fluid, such as a friction between the fluid and the apparatus, or between the fluid and a flowpath surface (e.g. a toolstring throughbore). The conditioning device may be configured to provide an increased external friction with the fluid.

[0026] Conditioning may comprise modifying the drilling fluid. Conditioning may comprise adapting the drilling fluid. Conditioning may comprise altering a physical property of the drilling fluid. Conditioning may comprise adjusting, or modifying, the viscosity of the drilling fluid. Thinning may comprise reducing a viscosity of the fluid.

[0027] The conditioning device may comprise a flow restrictor. The conditioning device may comprise a valve. The conditioning device may comprise a nozzle. The conditioning device may comprise a choke. The conditioning device may comprise a throttle. The conditioning device may comprise an inlet. The conditioning device may comprise an outlet. The outlet may comprise a reduced cross-sectional area relative to the inlet.

[0028] The conditioning device may be variable. The conditioning device may be adjustable. The conditioning device may be removable. The conditioning apparatus may be configured to permit selective positioning of the conditioning device. The conditioning apparatus may be configured to permit removal and/or replacement of the conditioning device without retrieval of a toolstring. The apparatus may be configured to provide downhole access, such as to a downhole tool, without requiring access through the conditioning device.

[0029] The conditioning device may be configured to induce a predetermined thinning of the fluid. The conditioning device may be configured to induce a predetermined relative thinning of the fluid. The conditioning device may be configured to induce a predetermined pressure differential in the fluid. The conditioning device may be configured to provide a predetermined relative acceleration of the fluid. The conditioning device may be configured to thin the fluid according to one or more characteristics of the fluid supplied to the conditioning device. The characteristic may comprise a velocity. The characteristic may comprise a temperature. The characteristic may comprise a viscosity.

[0030] The conditioning device may be configured to condition a substantially cold drilling fluid. The conditioning device may be configured to condition a substantially thick drilling fluid.

[0031] The conditioning device may be configured to receive the drilling fluid from a pump. The drilling fluid may be supplied to the conditioning device from the pump. The conditioning device may be configured to be located proximal to the pump. The conditioning device may be configured to be located proximal to a BOP. The conditioning device may be configured to be located proximal to a drill drive. The conditioning device may be configured to be located proximal to the surface region. The conditioning device may be configured to be located nearer to the surface region than to the downhole assembly. The conditioning device may be configured to be located distal to the downhole assembly.

[0032] The apparatus may comprise a plurality of conditioning devices. The plurality of conditioning devices may be arranged in parallel, and/or series (e.g. one after the other in the direction of flow). The plurality of conditioning devices may be configured to provide a sequential thinning of the fluid. The plurality of conditioning devices may be configured to provide a gradual thinning from an initial viscosity, uphole of a first device, to an exit viscosity downhole of a lowermost device.

[0033] The conditioning device may be configured to be located downhole of a drill drive. For example, the conditioning device may be configured to be located downhole of a surface drive, such as a rotary table or a topdrive.

[0034] The conditioning device may be configured to be located uphole of a drill drive. The conditioning device may be configured to be located upstream of a drill drive. The conditioning device may be configured to be located between a drill drive and the pump. For example, the conditioning device may be configured to be located between a surface drill drive, such as a rotary table or a topdrive, and the pump. The conditioning device may be configured to be located uphole of a toolstring.

[0035] The conditioning device may form part of a toolstring (e.g. integrally formed).

[0036] The apparatus may be configured to attach to a toolstring. The apparatus may be configured to be inline with a toolstring throughbore when in use. The apparatus may be configured to supply a conditioned fluid to a throughbore. The apparatus may be configured to supply the conditioned fluid to a throughbore directly from a conditioning device outlet. The apparatus may be configured to provide a substantially uninterrupted flow of fluid from the conditioning device outlet.

[0037] The apparatus may comprise a tubular. The conditioning device may be configured to be located at an upper portion of a toolstring; such as a drillstring or a milling string. The conditioning device may be configured to be located at an uppermost portion of a toolstring; such as in a tubular coupled to a surface drive.

[0038] The apparatus may be configured to condition a drilling fluid for a milling operation. The apparatus may be configured to condition a drilling fluid for a drilling operation. The drilling fluid may comprise a milling fluid. The drilling fluid may comprise a mud.

[0039] The apparatus may be configured for use with a milling tool. The apparatus may be configured for use with a bypass tool.

[0040] The apparatus may comprise a milling tool. The apparatus may comprise a bypass tool.

[0041] The apparatus may be configured for use with a reaming tool.

[0042] According to an aspect of the invention there is provided a method of conditioning a drilling fluid to be supplied to a downhole assembly.

[0043] The method may comprise positioning a drilling fluid apparatus comprising a conditioning device at a surface region of a wellbore.

[0044] The method may comprise passing a drilling fluid through the conditioning device.

[0045] The method may comprise thinning the drilling fluid that passes through the conditioning device.

[0046] The method may comprise pumping the drilling fluid from a fluid source, such as a mud tank, to the conditioning device.

[0047] The method may comprise passing the thinned fluid downhole through a drillstring to the downhole assembly.

[0048] The method may comprise passing the fluid through the conditioning device remotely from the downhole assembly.

[0049] The method may comprise passing the fluid through a substantial portion of the drillstring subsequent to passing through the conditioning device.

[0050] According to an aspect of the invention there is provided a conditioning device. The device may be configured to thin a drilling fluid passing therethrough, and may comprising:

an inlet portion; and
an outlet portion, the outlet portion being downhole of the inlet portion.

[0051] The outlet may provide a relative flow constriction, compared to the inlet portion.

[0052] The conditioning device may comprise an exit portion downhole of the outlet portion. The exit portion may be configured to provide a substantially unimpeded flow of fluid. The exit portion may comprise a throughbore to a toolstring. The exit portion may comprise a substantially full diameter toolstring throughbore.

[0053] According to an aspect of the invention there is provided a drilling fluid apparatus configured to condition a drilling fluid to be supplied to a downhole assembly; the apparatus comprising a conditioning device configured to thin the drilling fluid passing therethrough; and the apparatus configured to be positioned at a surface region of a wellbore.

[0054] According to an aspect of the invention there is provided a method of conditioning a drilling fluid to be supplied to a downhole assembly.

[0055] The method may comprise:

positioning a drilling fluid apparatus comprising a conditioning device at a surface region of a wellbore;
passing a drilling fluid through the conditioning device; and
thinning the drilling fluid that passes through the conditioning device.

[0056] The invention includes one or more corresponding aspects, embodiments or features in isolation or in various combinations whether or not specifically stated (including claimed) in that combination or in isolation. For example, it will readily be appreciated that features recited as optional with respect to the one aspect may be additionally applicable with respect to the other aspects without the need to explicitly and unnecessarily list those various combinations and permutations here (e.g. the conditioning device of one aspect may comprise features of any other aspect).

[0057] In addition, corresponding means for performing one or more of the discussed functions are also within the present disclosure.

[0058] It will be appreciated that one or more embodiments/aspects may be useful in conditioning a drilling fluid.

[0059] The above summary is intended to be merely exemplary and non-limiting.

BRIEF DESCRIPTION OF THE DRAWINGS

[0060] These and other aspects of the present invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 shows a schematic view of an apparatus in accordance with a first embodiment of the invention;
Figure 2 shows a cross-sectional view of a portion of the apparatus of Figure 1; and
Figure 3 shows a detail view of the cross-section of Figure 2; and
Figure 4 shows a schematic view of an apparatus in accordance with a second embodiment of the invention.

DETAILED DESCRIPTION OF THE DRAWINGS

[0061] Figure 1 shows a schematic view of apparatus 10 in accordance with an exemplary embodiment. In this example, the apparatus 10 is shown in use in preparation for a milling operation, and can be considered to be mounted to an upper portion 12 of a drill pipe string 14 at a proximal or surface region 16. Here, the surface region is a rig floor.

[0062] The drill pipe 14 extends into and through a bore 18, and may be, for example, 2,450 to 3,050 metres (8,000 to 10,000 feet) long. In the embodiment shown, the bore 18 is a cased hole, in which a metal bore-lining casing has been cemented in place. The drill pipe 14 has a milling tool 20 mounted at its lower or distal end, and which milling tool 20 forms part of a bottom hole assembly (BHA). The milling tool 20 has cutters 22 powered by a differential piston and including a pressure-differential creating nozzle to selectively extend the cutters 22 when milling is desired.

[0063] In use, the drill pipe 14 is rotated by a top drive 24 positioned above the apparatus 10. The drill pipe 14 transfers rotation from the top drive 24 to the milling tool 20. Drilling fluid (i.e mud) is pumped in from mud pumps (not shown) via a feed line 26 at the top drive 24. The mud is pumped through the apparatus 10, and through a conditioning device (as will be further described below), downhole through a central throughbore 28 of the drill pipe 14 to the milling tool 20.

[0064] The mud supplied to the apparatus 10 from the mud pumps is generally unconditioned when starting the pumps after an extended period of inactivity, or when initiating an operation using a fresh batch of drilling fluid, or when switching drilling fluids. Accordingly, the mud is initially relatively cold and thick. As the mud is pumped downhole, the apparatus 10 facilitates conditioning of the mud, as will be described in more detail with reference to Figures 2 and 3.

[0065] In the embodiment shown, the bore 18 is plugged with a cement plug 17.

[0066] Figure 2 shows a cross-sectional view of a portion of the apparatus 10 of Figure 1; and Figure 3 shows a detail view of the cross-section of Figure 2. The apparatus 10 is configured to facilitate conditioning of a drilling fluid prior to actuation of the milling tool 20. The apparatus 10 comprises a conditioning device 15 configured to thin the drilling fluid passing therethrough. The apparatus 10 is configured to be temporarily positioned in the drill string at the surface region 16 of the wellbore 18, at a proximal portion of the drill pipe string 14. The conditioning device 15 has a tubular body 40, which is a relatively short sub in the embodiment shown (facilitating manual handling), with a box (female) connection 42 at the top 44 and a pin (male) connection 46 at the bottom 48. The body 40 may thus be readily incorporated in a drill string. A throat 50 of the box connection has a short wider bore section 52 with a 30 degree taper at the end 54 to house and support a nozzle seat ring 56. The nozzle seat ring 56 has circumferential seals 58 in grooves 60 on its outer diameter to seal on the shorter wide bore section 52. The nozzle seat ring 56 has an internal bore 62 and a shoulder 64 to house and support a changeable nozzle 66. The nozzle 66 has seals 68 and grooves 70 on its outside to effect a seal to the internal bore 62 of the nozzle seat ring 56. In the embodiment shown, the nozzle 66 is made of case hardened steel. The case hardened steel helps to prevent abrasive damage of the high velocity mud. In alternative embodiments, the nozzle is made of tungsten carbide or a hard ceramic or a steel spray coated with tungsten carbide.

[0067] In use, mud can be pumped from the top 44 towards the nozzle 66, forcing the mud to speed up significantly as it passes through the nozzle 66. As the mud exits the nozzle 66, the mud flows out into a larger internal diameter 71 than the internal diameter of the nozzle 66, creating various eddy currents and swirls in its wake. This acceleration and subsequent vigorously turbulent situation causes the shearing effect which quickly conditions the mud (e.g. thins the mud for use). There is no obstruction, such as a metal member in the path of the mud exiting the nozzle 66. Accordingly, the significant energy can dissipate within the mud (without damaging further apparatus, such as metal components - e.g. drill bits, cutters, motors, etc.).

[0068] As will be appreciated, the apparatus 10 can improve, or speeds up, the time taken to shear/condition the mud. This is assisted by placing the apparatus 10/conditioning device 15 at the beginning of a mud circulating system, at or near the surface region 16, which also facilitates removal of the apparatus 10 from the string once the mud has been conditioned sufficiently to permit the downhole operation, in this example a milling operation, to commence.

[0069] In this example, conditioning of the drilling fluid is further facilitated by provision of a bypass tool 29 above the milling tool 20. The bypass tool 29 is operable to open bypass ports 30 to allow the mud to exit the drill pipe 14, with minimal restriction, into an annulus 32 between the drill pipe 14 and the bore 18, without having to pass through the milling tool 22 and the associated nozzles.

[0070] In use, the bypass ports 30 are initially opened to facilitate circulation of the drilling mud while the mud remains in an initial more viscous condition. Opening of the ports 30 also prevents radial extension of the cutters 22 before the mud has been suitably conditioned, allowing rotation and reciprocation of the string 14 without the cutters 22 engaging the casing.

[0071] Mud passed through the bypass tool 19 travels uphole in the annulus 32 to surface, where the mud is returned to the mud pumps via a flow line 34 to be treated or filtered and recirculated downhole, passing through the mud conditioning apparatus 10. The mud is subject to shear thinning on passing through the apparatus 10 and as the mud travels downhole, the mud temperature rises. As the mud returns uphole, the mud cools, but is generally still warmer on reaching the surface 16 than surface ambient temperature.

[0072] Once the mud has been circulated for a time through the string 14 incorporating the apparatus 10 and the open bypass tool 19 and is in the desired condition to allow milling to commence, the apparatus 10 is removed from the string 14 and the bypass ports 30 are closed. Subsequent circulation of mud will actuate the milling tool 20 and extend the cutters 22. When milling, the mud exits the drill pipe 14 through nozzles in the milling tool 20 to cool the cutters 22, assist removal of cuttings and swarf, and to transport the cuttings and swarf to the surface 16. The passage of the fluid through the milling tool nozzles also causes shear thinning of the fluid, thus assisting in maintaining the viscosity of the drilling fluid at a desirable level.

[0073] While incorporated in the string the conditioning device 15 does not restrict access to down-hole tools such as the bypass tool 19 or the milling tool 20, for example for activation by balls or darts, because the string may be broken below the apparatus 10 in conventional manner and the darts can be dropped from below the conditioning device 15.

[0074] Once the process of conditioning the mud has finished, and the mud is judged to be sufficiently conditioned to allow the miiling operation to commence, the apparatus 10 can be very quickly removed from the system. Consequently, the power usage and flow restriction associated with the apparatus 10 is eliminated. The absence of flow restrictions above the milling tool 20 is particularly useful in subsequent cleaning operations; the valve 19 may have relatively large unrestricted ports 30 so that at the end of the milling phase the tool 19 can be re-opened and used to pump fluid at a maximum flow rate to clean out all the swarf from the hole as quickly and efficiently as possible. Of course the milling operation may comprise a plurality of milling phases interspersed by clean-out phases, when the bypass tool 19 is employed to clear the annulus of swarf and other debris.

[0075] In the embodiment shown, the sub 40 has an NC50 connection, with a 17.8 cm (7 inch) OD and a 7.6 cm (3 inch) ID. The nozzle 66 shown has a 2.54 cm (1 inch) ID/Choke. Thus, the nozzle 66 shown has a ratio of 3:1 in diameter. The cross-sectional area is 9:1 and the kinetic energy increase at the choke is 81:1. A typical 10 pound per gallon mud (1.2sg) pumped at 500 gpm (1890LPM) would create a pressure drop of about 250 psi (1,724 kPa/17 bar). This is basically pure shearing energy. In the embodiment shown, the nozzle is configured for use with a mud pump rated to have about 27,579 kPa (4000psi) of usable pressure. In use, the apparatus 10 can reduce the time required to condition the mud sufficiently to allow milling to commence. For example, where an operation may otherwise require 18 hours circulation to condition the mud, the apparatus 10 may condition the mud sufficiently within 6 hours of circulation. Accordingly, the apparatus 10 can save considerable valuable rig time.

[0076] Here, the nozzle seat ring 56 has a tapered inlet 57. The nozzle 66 has a tapered inlet 67. The nozzle inlet 67 converges to a minimum inner diameter (ID/choke) before the diameter of the throughbore 28 sharply increases at a nozzle outlet 69.

[0077] The nozzle 66 is removable from the nozzle seat ring 56, through the box connection 42. Thus, if a different nozzle diameter is desired, the nozzle 66 can be removed and a different nozzle with a similar OD and different ID can be inserted into the nozzle seat ring 56. Likewise, if the nozzle 66 is damaged or needs replaced, a new nozzle can easily be inserted.

[0078] Figure 4 shows a schematic view of an apparatus 110 in accordance with a second embodiment of the invention. The apparatus 110 shown is generally similar to that shown in Figure 1; and as such like features share like reference numerals, incremented by 100. Accordingly, the apparatus 110 comprises a conditioning device 115 with a tubular body 140 and a nozzle 166. In the embodiment shown in Figure 4, the tubular body 140 is a sub comprising two additional nozzles 194, 196 in series with the first nozzle 166. Accordingly, the mud is sequentially sheared and thinned as it passes through the succession of nozzles 166, 194, 196. Because the conditioning device 115 is at/near surface 116, it can be quickly and easily installed or removed as required.

[0079] It will be appreciated that any of the aforementioned apparatus may have other functions in addition to the mentioned functions, and that these functions may be performed by the same apparatus.

[0080] The applicant hereby discloses in isolation each individual feature described herein and any combination of two or more such features, to the extent that such features or combinations are capable of being carried out based on the present specification as a whole in the light of the common general knowledge of a person skilled in the art, irrespective of whether such features or combinations of features solve any problems disclosed herein, and without limitation to the scope of the claims. The applicant indicates that aspects of the present invention may consist of any such individual feature or combination of features. It should be understood that the embodiments described herein are merely exemplary and that various modifications may be made thereto without departing from the scope of the invention. For example, in alternative embodiments (not shown), the apparatus may comprise a plurality of subs, each sub with a nozzle. The subs may be connected together, or may have spacer subs located therebetween. In an alternative embodiment (not shown) with a nozzle with a 1.9 cm (0.75") choke ID and a similar drill pipe ID would create a pressure drop of around 797psi (54 bar) with a typical 10 pound per gallon mud (1.2sg) pumped at 500 gpm (1890LPM). Similarly, a typical 10 pound per gallon mud (1.2sg) pumped at 500 gpm (1890LPM) would create a pressure drop in a nozzle with an ID of 2.24 cm (0.88 inches) of around 430psi (29.3 bar) .

[0081] In further embodiments, the nozzle/s could be installed within the circulating system of the rigs pipework; or as a bolt-on piece of kit to it as an addition to or a replacement for having the conditioning apparatus at the very top of the drill string near the drill floor.

Claims

1. A method for facilitating a downhole operation, the method comprising:

providing a drilling fluid conditioning device (15) in a proximal portion of a tubular string (14) providing mounting for at least one tool (20) on a distal downhole portion of the tubular string (14);
circulating drilling fluid along a fluid circulating flow path including the drilling fluid conditioning device (15) and the tubular string (14), to condition the drilling fluid;
reconfiguring the fluid circulating flow path to bypass at least a portion of the drilling fluid conditioning device (15); and
circulating conditioned drilling fluid through the tubular string (14) and the at least one tool (20).

2. The method of claim 1, comprising reconfiguring the fluid circulating flow path by removing the drilling fluid conditioning device (15) from the tubular string (14).

3. The method of any one of the preceding claims, comprising at least one of:

reconfiguring the fluid circulation flow path by directing drilling fluid along a flow path parallel to the drilling fluid conditioning device (15);
reconfiguring the fluid circulation flow path by reconfiguring the drilling fluid conditioning device (15).

4. The method of any one of the preceding claims, wherein the at least one tool (20) comprises at least one of:

a cutting tool;
a drill bit;
a reamer;
a mill, optionally,
wherein the at least one tool (20) is at least partially fluid pressure-actuated.

5. The method of any of the preceding claims, comprising at least one of:

circulating conditioned fluid through the at least one tool (20) and actuating the tool (20);
circulating conditioned fluid through nozzles in the at least one tool (20).

6. The method of any one of the preceding claims, wherein the drilling fluid conditioning device (15) at least one of:

induces shear thinning of fluid passing therethrough;
accelerates fluid passing therethrough;
decreases the viscosity of fluid passing therethrough;
is removed from the tubular string (14) when the drilling fluid is conditioned to a degree sufficient to permit operation of the at least one tool (20).

7. The method of any one of the preceding claims, comprising at least one of:

providing a plurality of drilling fluid conditioning devices (15) in the tubular string (14);
providing a bypass tool (29) in the tubular string (14) above the at least one tool (20);
circulating drilling fluid along a fluid circulating flow path including the drilling fluid conditioning device (15), the tubular string (14), and an open bypass tool (29), to condition the drilling fluid;
circulating drilling fluid through the tubular string (14) and through an open bypass tool (29) while rotating the string (14); circulating drilling fluid through the tubular string (14) and an open bypass tool (29) to clean the bore;
closing a bypass tool (29) located in the tubular string (14) above the at least one tool (20) and then actuating the at least one tool (20);

locating the drilling fluid conditioning device (15) in a surface portion of the tubular string (14).

8. The method of any one of the preceding claims, wherein the drilling fluid conditioning device (15) comprises at least one of:

a flow restrictor;
a nozzle (66).

9. The method of any one of the preceding claims, comprising at least one of:

locating the drilling fluid conditioning device (15) below a top drive (24);
locating the drilling fluid conditioning device (15) above a rotary table.

10. A drilling fluid conditioning device (15) comprising a tubular body (40) configured for incorporation in a proximal portion of a tubular string (14) extending to a distal downhole location, the body (40) configured to induce shear thinning of fluid passing therethrough.

11. The device of claim 10, wherein the drilling fluid conditioning device (15) is configured to at least one of:

induce shear thinning of fluid passing therethrough;
accelerate fluid passing therethrough;
decrease the viscosity of fluid passing therethrough; and optionally
wherein the tubular body (40) includes threaded end connectors.

12. The device of any one of claims 10 or 11, wherein the drilling fluid conditioning device (15) comprises at least one of:

a flow restrictor;
a nozzle (66), and optionally
wherein the drilling fluid conditioning device (15) is configured for at least one of:

location in a tubular string (14) below a top drive (24);
location in a tubular string (14) above a rotary table.

13. Apparatus comprising:

a tubular string (14) providing mounting for at least one tool (20) on a distal end of the string (14); and
a drilling fluid conditioning device (15) incorporated in the tubular string (14) at a proximal portion of the string (14),
wherein the drilling fluid conditioning device (15) is configured to be removable from the tubular string (14) prior to operation of the at least one tool (20).

14. The apparatus of claim 13, wherein the at least one tool (20) comprises at least one of:

a cutting tool;
a drill bit;
a reamer;
a mill, and optionally
wherein the at least one tool (20) is fluid pressure-actuated, further optionally wherein the at least one tool (20) has jetting nozzles.

15. The apparatus of any one of claims 13 or 14, wherein the drilling fluid conditioning device (15) is configured to at least one of:

induce shear thinning of fluid passing therethrough;
accelerate fluid passing therethrough;
decrease the viscosity of fluid passing therethrough.

16. The apparatus of any one of claims 13 to 15, comprising at least one of:

a plurality of drilling fluid conditioning devices (15);
a bypass tool (29) in the tubular string (14) above the at least one tool (20); optionally wherein the drilling fluid conditioning device (15) comprises at least one of:

a flow restrictor;
a nozzle (66).

17. The apparatus of any one of claims 13 to 16, wherein the drilling fluid conditioning device (15) is located in a surface portion of the tubular string (14), optionally wherein the drilling fluid conditioning device (15) is located in the tubular string (14) below a top drive (24), further optionally
wherein the drilling fluid conditioning device (15) is located in a tubular string (15) above a rotary table.

Patentansprüche

1. Verfahren zum Erleichtern eines Bohrlochbetriebs, wobei das Verfahren Folgendes umfasst:

Bereitstellen einer Bohrfluid-Konditioniervorrichtung (15) in einem proximalen Abschnitt eines Rohrstrangs (14), der eine Befestigung für mindestens ein Werkzeug (20) an einem dista-

len Bohrlochabschnitt des Rohrstrangs (14) bereitstellt;
Zirkulierenlassen von Bohrfluid entlang eines Fluidzirkulations-Strömungswegs,
einschließlich der Bohrfluid-Konditioniervorrichtung (15) und des Rohrstrangs (14), um das Bohrfluid zu konditionieren;
Neukonfigurieren des Fluidzirkulations-Strömungswegs, um mindestens einen Teil der Bohrfluid-Konditioniervorrichtung (15) zu umgehen; und
Zirkulierenlassen von konditioniertem Bohrfluid durch den Rohrstrang (14) und das mindestens eine Werkzeug (20).

2. Verfahren nach Anspruch 1, umfassend das Neukonfigurieren des Fluidzirkulations-Strömungswegs durch Entfernen der Bohrfluid-Konditioniervorrichtung (15) vom Rohrstrang (14).

3. Verfahren nach einem der vorstehenden Ansprüche, umfassend mindestens eines von Folgendem:

Neukonfigurieren des Fluidzirkulations-Strömungswegs durch Leiten von Bohrfluid entlang eines Strömungswegs, der zur Bohrfluid-Konditioniervorrichtung (15) parallel ist;
Neukonfigurieren des Fluidzirkulations-Strömungswegs durch Neukonfigurieren der Bohrfluid-Konditioniervorrichtung (15).

4. Verfahren nach einem der vorstehenden Ansprüche, wobei das mindestens eine Werkzeug (20) mindestens eines von Folgenden umfasst:

ein Schneidwerkzeug;
einen Bohrmeißel;
einen Räumer;
eine Mühle, wahlweise,
wobei das mindestens eine Werkzeug (20) mindestens teilweise fluiddruckbetätigt ist.

5. Verfahren nach einem der vorstehenden Ansprüche, umfassend mindestens eines von Folgendem:

Zirkulierenlassen von konditioniertem Fluid durch das mindestens eine Werkzeug (20) und Betätigen des Werkzeugs (20);
Zirkulierenlassen von konditioniertem Fluid durch Düsen in dem mindestens einen Werkzeug (20).

6. Verfahren nach einem der vorstehenden Ansprüche, wobei die Bohrfluid-Konditioniervorrichtung (15) mindestens eines von Folgendem ausführt:

eine Scherverflüssigung von dort hindurch strömendem Fluid bewirkt;
ein dort hindurch strömendes Fluid beschleunigt;
die Viskosität von dort hindurch strömendem Fluid verringert;
vom Rohrstrang (14) entfernt wird, wenn das Bohrfluid auf einen Grad konditioniert ist, der ausreichend ist, den Betrieb des mindestens einen Werkzeugs (20) zu ermöglichen.

7. Verfahren nach einem der vorstehenden Ansprüche, umfassend mindestens eines von Folgendem:

Bereitstellen einer Mehrzahl von Bohrfluid-Konditioniervorrichtungen (15) im Rohrstrang (14);
Bereitstellen eines Umgehungswerkzeugs (29) in dem Rohrstrang (14) über dem mindestens einen Werkzeug (20);
Zirkulierenlassen von Bohrfluid entlang eines Fluidzirkulations-Strömungswegs,
einschließlich der Bohrfluid-Konditioniervorrichtung (15), des Rohrstrangs (14) und eines offenen Umgehungswerkzeugs (29), um das Bohrfluid zu konditionieren;
Zirkulierenlassen von Bohrfluid durch den Rohrstrang (14) und durch ein offenes Umgehungswerkzeug (29), während der Strang (14) gedreht wird; Zirkulierenlassen von Bohrfluid durch den Rohrstrang (14) und ein offenes Umgehungswerkzeug (29), um die Bohrung zu reinigen;
Schließen eines Umgehungswerkzeugs (29), das in dem Rohrstrang (14) über dem mindestens einen Werkzeug (20) angeordnet ist, und dann Betätigen des mindestens einen Werkzeugs (20);
Anordnen der Bohrfluid-Konditioniervorrichtung (15) in einem Oberflächenabschnitt des Rohrstrangs (14).

8. Verfahren nach einem der vorstehenden Ansprüche, wobei die Bohrfluid-Konditioniervorrichtung (15) mindestens eines von Folgendem umfasst:

einen Strömungsbegrenzer;
eine Düse (66).

9. Verfahren nach einem der vorstehenden Ansprüche, umfassend mindestens eines von Folgendem:

Anordnen der Bohrfluid-Konditioniervorrichtung (15) unter einem oberen Antrieb (24);
Anordnen der Bohrfluid-Konditioniervorrichtung (15) über einem Drehtisch.

10. Bohrfluid-Konditioniervorrichtung (15) umfassend einen rohrförmigen Körper (40), der zur Aufnahme in einen proximalen Abschnitt eines Rohrstrangs (14) konfiguriert ist, der sich zu einer distalen Bohrlochposition erstreckt, wobei der Körper (40) eine

Scherverflüssigung von dort hindurch strömendem Fluid bewirkt.

11. Vorrichtung nach Anspruch 10, wobei die Bohrfluid-Konditioniervorrichtung (15) für mindestens eines von Folgendem konfiguriert ist:

Bewirken einer Scherverflüssigung von dort hindurch strömendem Fluid;
Beschleunigen von dort hindurch strömendem Fluid;
Verringern der Viskosität von dort hindurch strömendem Fluid; und wahlweise wobei der rohrförmige Körper (40) Gewindeendverbinder aufweist.

12. Vorrichtung nach einem der Ansprüche 10 oder 11, wobei die Bohrfluid-Konditioniervorrichtung (15) mindestens eines von Folgendem umfasst:

einen Strömungsbegrenzer;
eine Düse (66), und wahlweise
wobei die Bohrfluid-Konditioniervorrichtung (15) für mindestens eines von Folgendem konfiguriert ist:

Anordnung in einem Rohrstrang (14) unter einem oberen Antrieb (24);
Anordnung in einem Rohrstrang (14) über einem Drehtisch.

13. Einrichtung, umfassend:

einen Rohrstrang (14), der eine Befestigung für mindestens ein Werkzeug (20) an einem distalen Ende des Strangs (14) bereitstellt; und
eine Bohrfluid-Konditioniervorrichtung (15), die in dem Rohrstrang (14) an einem proximalen Abschnitt des Strangs (14) aufgenommen ist,
wobei die Bohrfluid-Konditioniervorrichtung (15) konfiguriert ist, von dem Rohrstrang (14) vor dem Betrieb des mindestens einen Werkzeugs (20) entfernbar zu sein.

14. Einrichtung nach Anspruch 13, wobei das mindestens eine Werkzeug (20) mindestens eines von Folgendem umfasst:

ein Schneidwerkzeug;
einen Bohrmeißel;
einen Räumer;
eine Mühle, und wahlweise
wobei das mindestens eine Werkzeug (20) fluiddruckbetätigt ist, ferner wahlweise wobei das mindestens eine Werkzeug (20) Sprühdüsen aufweist.

15. Einrichtung nach einem der Ansprüche 13 oder 14, wobei die Bohrfluid-Konditioniervorrichtung (15) für mindestens eines von Folgendem konfiguriert ist:

Bewirken einer Scherverflüssigung von dort hindurch strömendem Fluid;
Beschleunigen von dort hindurch strömendem Fluid;
Verringern der Viskosität von dort hindurch strömendem Fluid.

16. Einrichtung nach einem der Ansprüche 13 bis 15, umfassend mindestens eines von Folgendem:

eine Mehrzahl von Bohrfluid-Konditioniervorrichtungen (15);
ein Umgehungswerkzeug (29) in dem Rohrstrang (14) über dem mindestens einen Werkzeug (20); wahlweise
wobei die Bohrfluid-Konditioniervorrichtung (15) mindestens eines von Folgendem umfasst:

einen Strömungsbegrenzer;
eine Düse (66).

17. Einrichtung nach einem der Ansprüche 13 oder 16, wobei die Bohrfluid-Konditioniervorrichtung (15) in einem Oberflächenabschnitt des Rohrstrangs (14) angeordnet ist, wahlweise
wobei die Bohrfluid-Konditioniervorrichtung (15) im Rohrstrang (14) unter einem oberen Antrieb (24) angeordnet ist, ferner wahlweise
wobei die Bohrfluid-Konditioniervorrichtung (15) in einem Rohrstrang (15) über einem Drehtisch angeordnet ist.

Revendications

1. Procédé destiné à faciliter une opération de forage, le procédé comprenant :

le placement d'un dispositif de conditionnement de fluide de forage (15) dans une partie proximale d'une colonne tubulaire (14) afin de permettre le montage d'au moins un outil (20) sur une partie de forage distale de la colonne tubulaire (14) ;
la circulation d'un fluide de forage le long d'un trajet d'écoulement de circulation de fluide comprenant le dispositif de conditionnement de fluide de forage (15) et la colonne tubulaire (14), afin de conditionner le fluide de forage ;
la reconfiguration du trajet d'écoulement de circulation de fluide afin de contourner au moins une partie du dispositif de conditionnement de fluide de forage (15) ; et
la circulation du fluide de forage conditionné dans la colonne tubulaire (14) et le au moins un

outil (20).

2. Procédé selon la revendication 1, comprenant la reconfiguration du trajet d'écoulement de circulation de fluide en retirant le dispositif de conditionnement de fluide de forage (15) de la colonne tubulaire (14).

3. Procédé selon l'une quelconque des revendications précédentes, comprenant au moins l'un de ce qui suit :

la reconfiguration du trajet d'écoulement de circulation de fluide en orientant le fluide de forage le long d'un trajet d'écoulement parallèle au dispositif de conditionnement de fluide de forage (15) ;
la reconfiguration du trajet d'écoulement de circulation de fluide en reconfigurant le dispositif de conditionnement de fluide de forage (15).

4. Procédé selon l'une quelconque des revendications précédentes, dans lequel le au moins un outil (20) comprend au moins l'un de ce qui suit :

un outil de découpe ;
une mèche de forage ;
un aléseur ;
une fraise, en option,
dans lequel le au moins un outil (20) est au moins partiellement actionné par la pression de fluide.

5. Procédé selon l'une quelconque des revendications précédentes, comprenant au moins l'un de ce qui suit :

la circulation d'un fluide conditionné dans le au moins un outil (20) et l'actionnement de l'outil (20) ;
la circulation d'un fluide conditionné par le biais de buses dans le au moins un outil (20).

6. Procédé selon l'une quelconque des revendications précédentes, dans lequel le dispositif de conditionnement de fluide de forage (15), au moins :

induit un cisaillement du fluide qui passe à l'intérieur ;
accélère le fluide qui passe à l'intérieur ;
réduit la viscosité du fluide qui passe à l'intérieur ;
est retiré de la colonne tubulaire (14) lorsque le fluide de forage est conditionné à un degré suffisant pour permettre le fonctionnement du au moins un outil (20).

7. Procédé selon l'une quelconque des revendications précédentes, comprenant au moins l'un de ce qui suit :

le fait de prévoir une pluralité de dispositifs de conditionnement de fluide de forage (15) dans la colonne tubulaire (14) ;
le fait de prévoir un outil de dérivation (29) dans la colonne tubulaire (14) au-dessus du au moins un outil (20) ;
la circulation du fluide de forage le long d'un trajet d'écoulement de circulation de fluide comprenant le dispositif de conditionnement de fluide de forage (15), la colonne tubulaire (14), et un outil de dérivation ouvert (29), afin de conditionner le fluide de forage ;
la circulation du fluide de forage dans la colonne tubulaire (14) et dans un outil de dérivation ouvert (29) tout en faisant tourner la colonne (14) ; la circulation du fluide de forage dans la colonne tubulaire (14) et un outil de dérivation ouvert (29) afin de nettoyer le puits ;
la fermeture d'un outil de dérivation (29) situé dans la colonne tubulaire (14) au-dessus du au moins un outil (20), puis l'actionnement du au moins un outil (20) ;
le placement du dispositif de conditionnement de fluide de forage (15) dans une partie de surface de la colonne tubulaire (14).

8. Procédé selon l'une quelconque des revendications précédentes, dans lequel le dispositif de conditionnement de fluide de forage (15) comprend au moins l'un de ce qui suit :

un limiteur de débit ;
une buse (66).

9. Procédé selon l'une quelconque des revendications précédentes, comprenant au moins l'un de ce qui suit :

le placement du dispositif de conditionnement de fluide de forage (15) sous un entraînement supérieur (24) ;
le placement du dispositif de conditionnement de fluide de forage (15) au-dessus d'une table rotative.

10. Dispositif de conditionnement de fluide de forage (15) comprenant un corps tubulaire (40) configuré pour être intégré dans une partie proximale d'une colonne tubulaire (14) s'étendant jusqu'à un emplacement de forage distal, le corps (40) étant configuré pour induire un cisaillement du fluide qui passe à l'intérieur.

11. Procédé selon la revendication 10, dans lequel le dispositif de conditionnement de fluide de forage (15) est configuré pour au moins l'un de ce qui suit :

induire un cisaillement du fluide qui passe à

l'intérieur ;
accélérer le fluide qui passe à l'intérieur ;
réduire la viscosité du fluide qui passe à l'intérieur ; et, en option dans lequel le corps tubulaire (40) comprend des raccords d'extrémité filetés.

12. Procédé selon l'une quelconque des revendications 10 ou 11, dans lequel le dispositif de conditionnement de fluide de forage (15) comprend au moins l'un de ce qui suit :

un limiteur de débit ;
une buse (66), et, en option
dans lequel le dispositif de conditionnement de fluide de forage (15) est configuré pour au moins l'un de ce qui suit :

le placement dans une colonne tubulaire (14) sous un entraînement supérieur (24) ;
le placement dans une colonne tubulaire (14) au-dessus d'une table rotative.

13. Appareil comprenant :

une colonne tubulaire (14) permettant le montage d'au moins un outil (20) sur une extrémité distale de la colonne (14) ; et
un dispositif de conditionnement de fluide de forage (15) intégré à la colonne tubulaire (14) au niveau d'une partie proximale de la colonne (14), dans lequel le dispositif de conditionnement de fluide de forage (15) est configuré pour pouvoir être retiré de la colonne tubulaire (14) avant le fonctionnement du au moins un outil (20).

14. Appareil selon la revendication 13, dans lequel le au moins un outil (20) comprend au moins l'un de ce qui suit :

un outil de découpe ;
une mèche de forage ;
un aléseur ;
une fraise, et, en option
dans lequel le au moins un outil (20) est actionné par la pression de fluide, en option
dans lequel le au moins un outil (20) possède des buses d'éjection.

15. Appareil selon l'une quelconque des revendications 13 ou 14, dans lequel le dispositif de conditionnement de fluide de forage (15) est configuré pour au moins l'un de ce qui suit :

pour induire un cisaillement du fluide qui passe à l'intérieur ;
pour accélérer le fluide qui passe à l'intérieur ;
pour réduire la viscosité du fluide qui passe à l'intérieur.

16. Appareil selon l'une quelconque des revendications 13 à 15, comprenant au moins l'un de ce qui suit :

une pluralité de dispositifs de conditionnement de fluide de forage (15) ;
un outil de dérivation (29) dans la colonne tubulaire (14) au-dessus du au moins un outil (20) ; en option
dans lequel le dispositif de conditionnement de fluide de forage (15) comprend au moins l'un de ce qui suit :

un limiteur de débit ;
une buse (66).

17. Appareil selon l'une quelconque des revendications 13 à 16, dans lequel le dispositif de conditionnement de fluide de forage (15) est situé dans une partie de surface de la colonne tubulaire (14), en option
dans lequel le dispositif de conditionnement de fluide de forage (15) est situé dans la colonne tubulaire (14) sous un entraînement supérieur (24), en option
dans lequel le dispositif de conditionnement de fluide de forage (15) est situé dans une colonne tubulaire (15) au-dessus d'une table rotative.

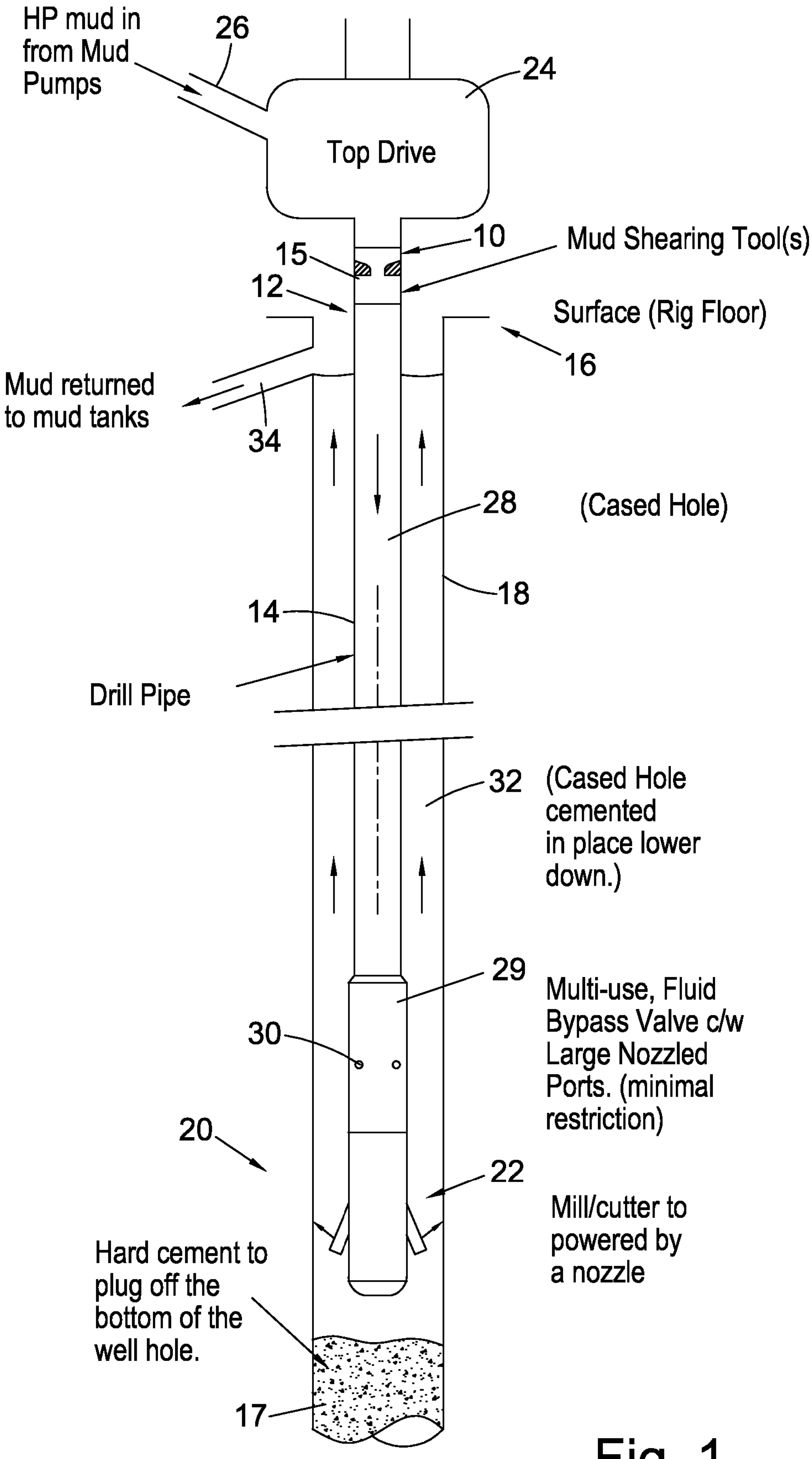
HP mud in from Mud Pumps
26
24
Top Drive
10
Mud Shearing Tool(s)
15
12
Surface (Rig Floor)
16
Mud returned to mud tanks
34
28
(Cased Hole)
18
14
Drill Pipe
32
(Cased Hole cemented in place lower down.)
29
Multi-use, Fluid Bypass Valve c/w Large Nozzled Ports. (minimal restriction)
30
20
22
Mill/cutter to powered by a nozzle
Hard cement to plug off the bottom of the well hole.
17

Fig. 1

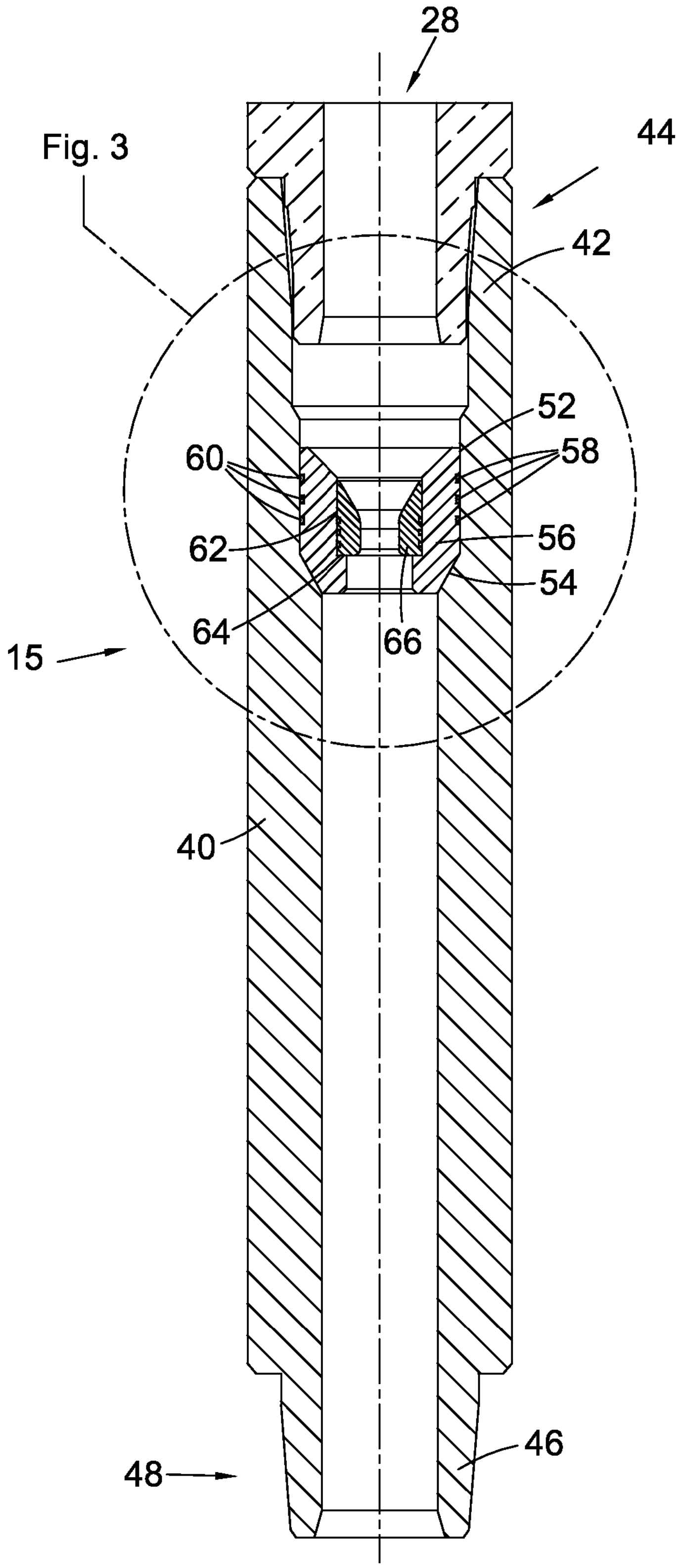

Fig. 2

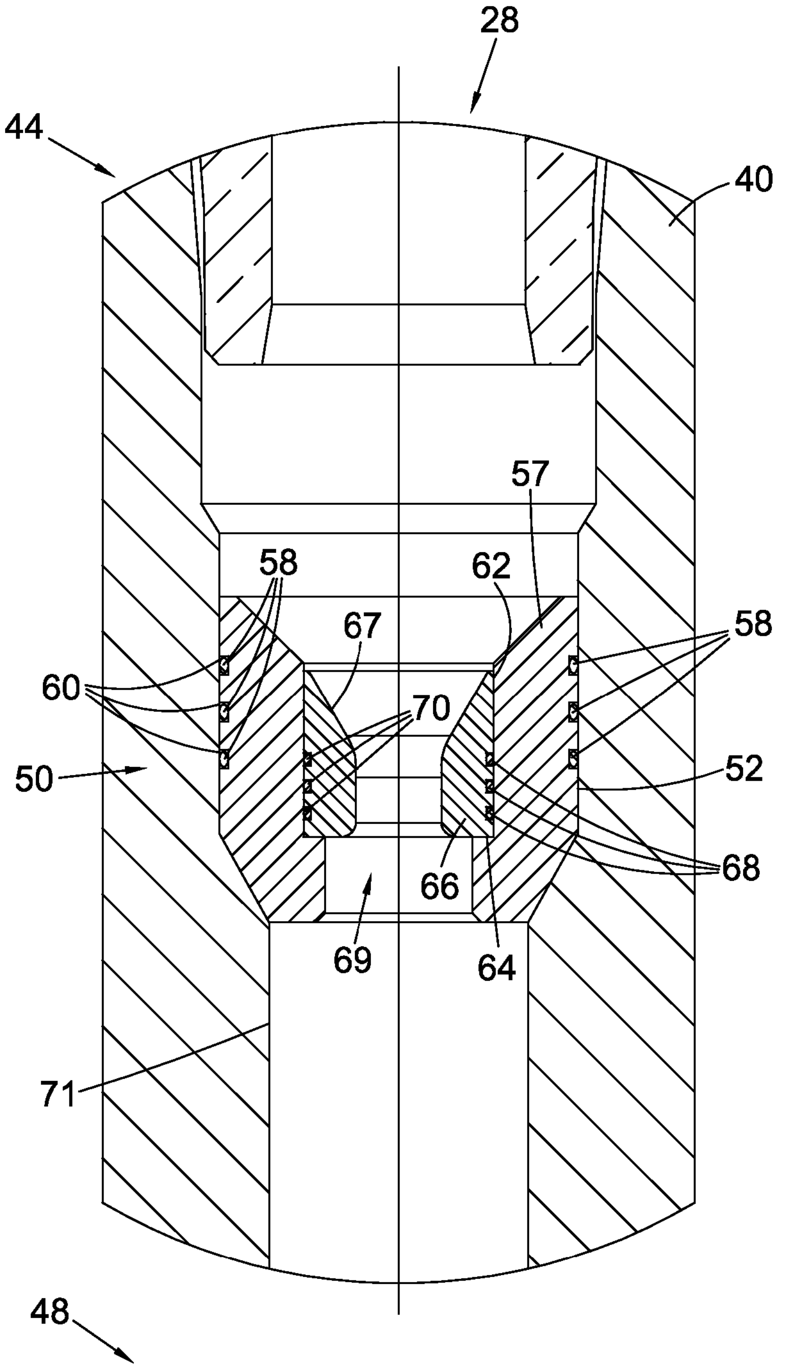

Fig. 3

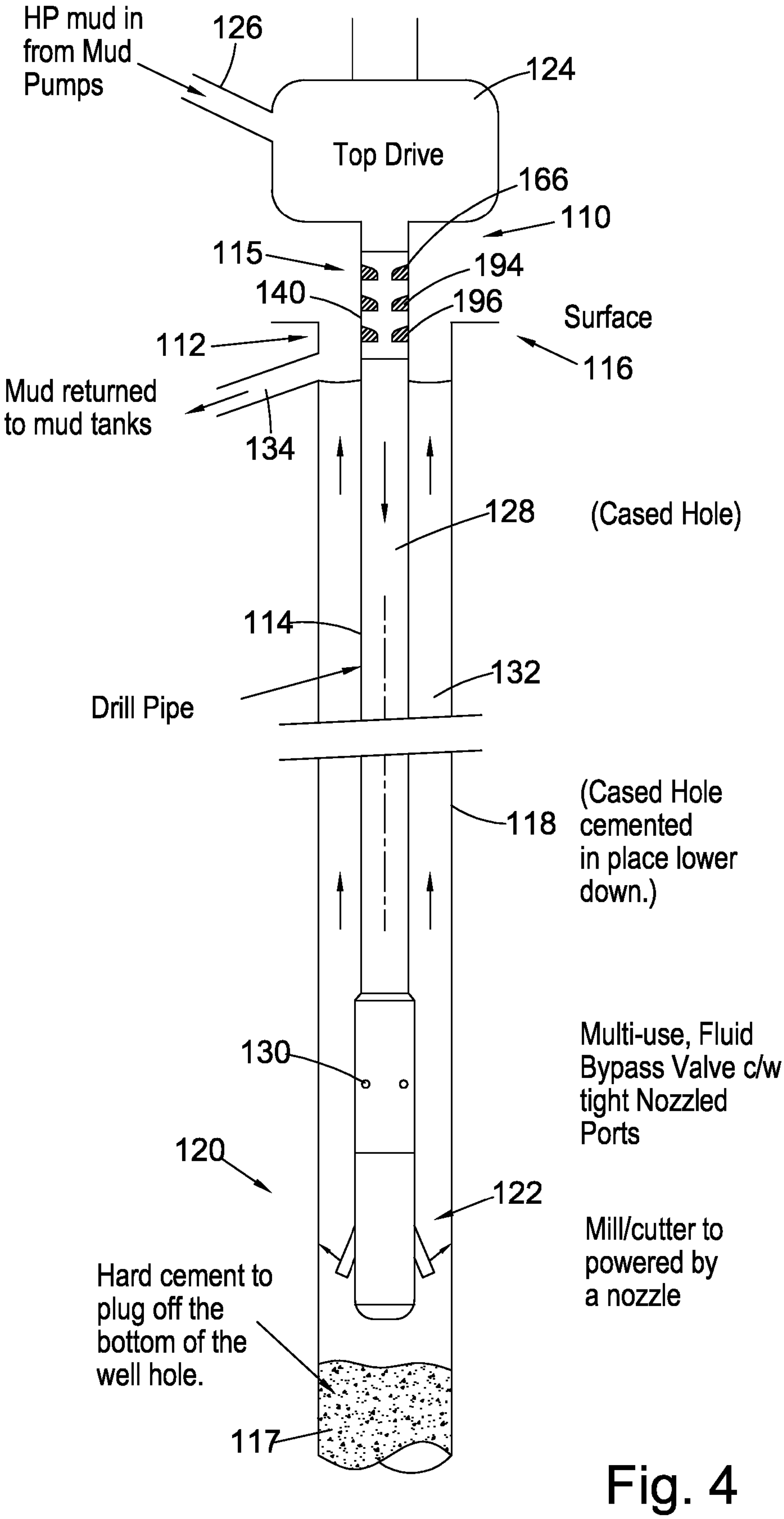
HP mud in from Mud Pumps
126
124
Top Drive
166
110
115
194
140
196
Surface
112
116
Mud returned to mud tanks
134
128
(Cased Hole)
114
132
Drill Pipe
118
(Cased Hole cemented in place lower down.)
130
Multi-use, Fluid Bypass Valve c/w tight Nozzled Ports
120
122
Mill/cutter to powered by a nozzle
Hard cement to plug off the bottom of the well hole.
117

Fig. 4

REFERENCES CITED IN THE DESCRIPTION

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- WO 2011142894 A1 **[0012]**
- US 3136583 A **[0013]**
- WO 0120121 A1 **[0014]**