US 20060113114A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2006/0113114 A1**

Jin et al. (43) **Pub. Date: Jun. 1, 2006**

(54) **DRILLING TOOL AND METHOD**

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(21) Appl. No.: **11/251,373**

(22) Filed: **Oct. 14, 2005**

Related U.S. Application Data

(63) Continuation-in-part of application No. PCT/CN04/00352, filed on Apr. 14, 2004.

(30) **Foreign Application Priority Data**

Apr. 15, 2003 (CN) 03244667.5

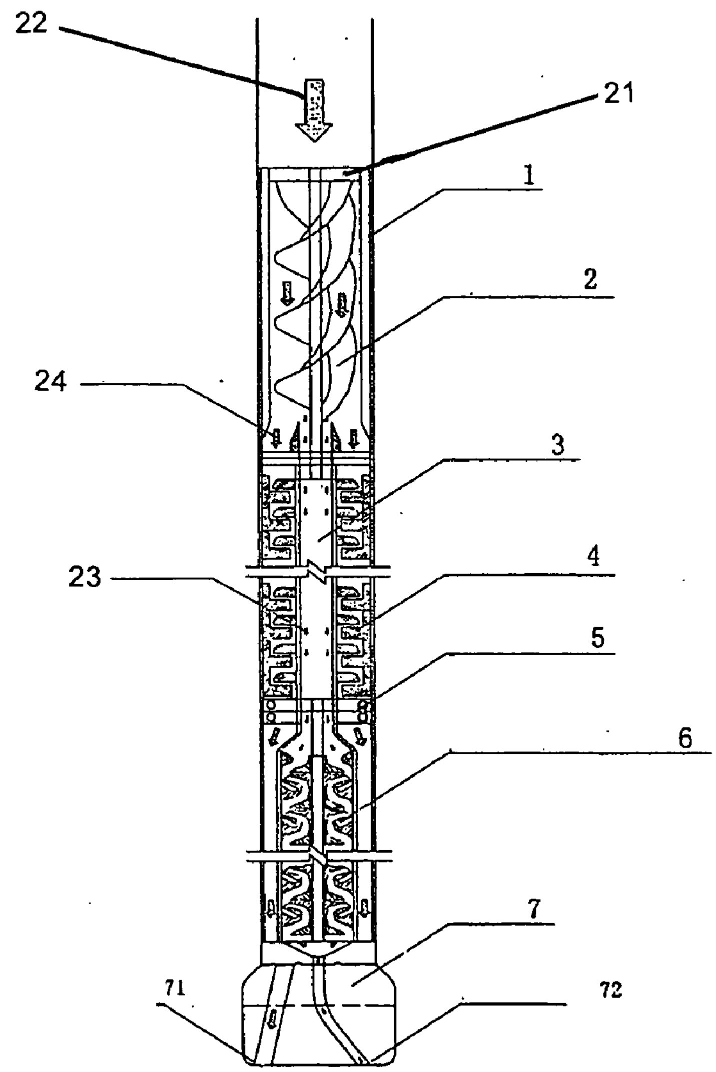
Publication Classification

(51) **Int. Cl.**
E21B 7/18 (2006.01)
E21B 4/00 (2006.01)

(52) **U.S. Cl.** **175/67**; 175/93; 175/107; 175/324

(57) **ABSTRACT**

A drill tool comprising a drill pipe having a turbine and a hydraulic pump, wherein drilling fluid is passed through the turbine and into the hydraulic pump through a hollow shaft in the drill pipe. The drill tool also includes a high pressure jet at a distal end of the drill pipe for discharging drill fluid at a pressure which is between 20 and 40 MPa greater than the ambient pressure of the drill hole.



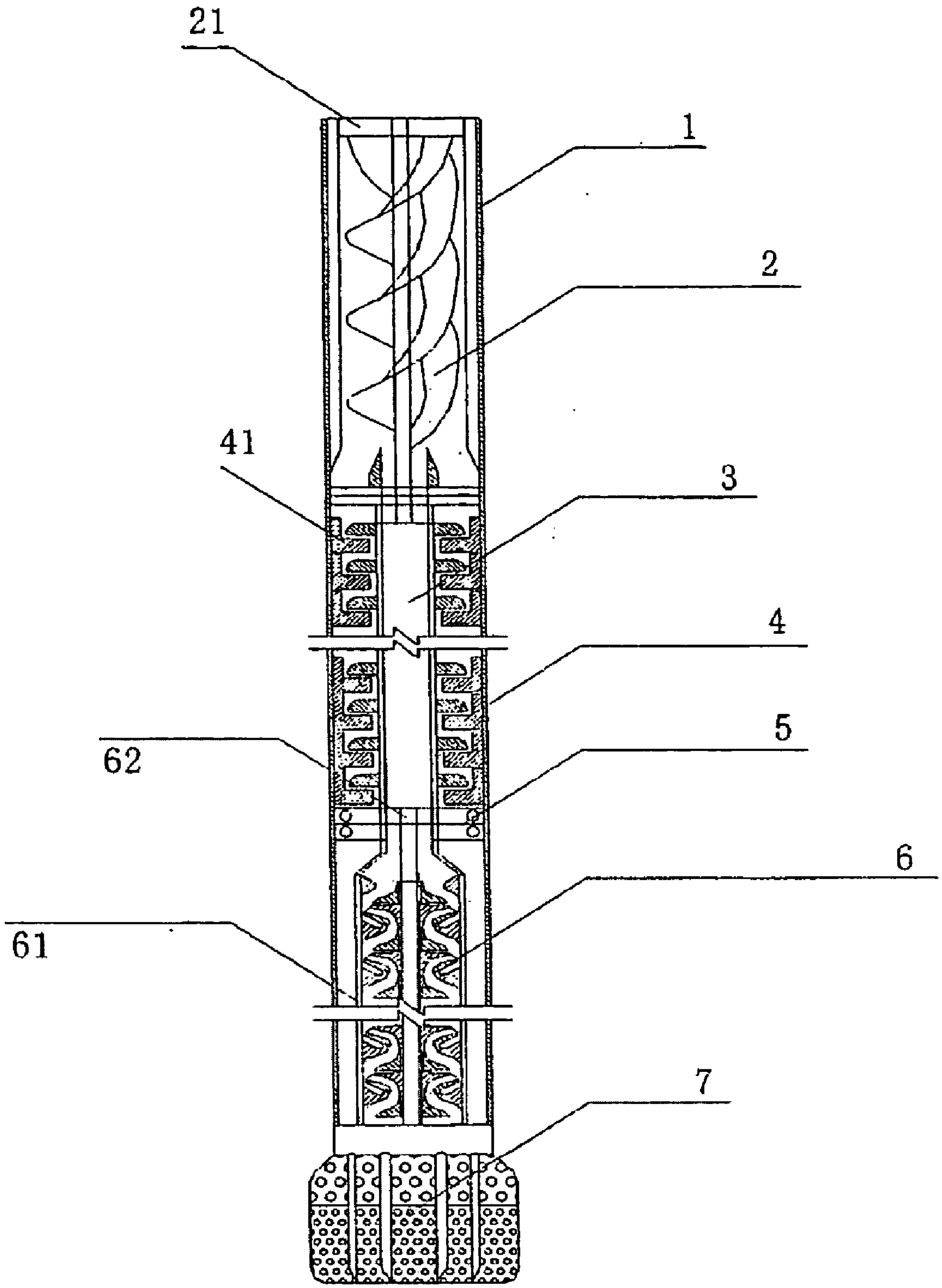


Fig. 1

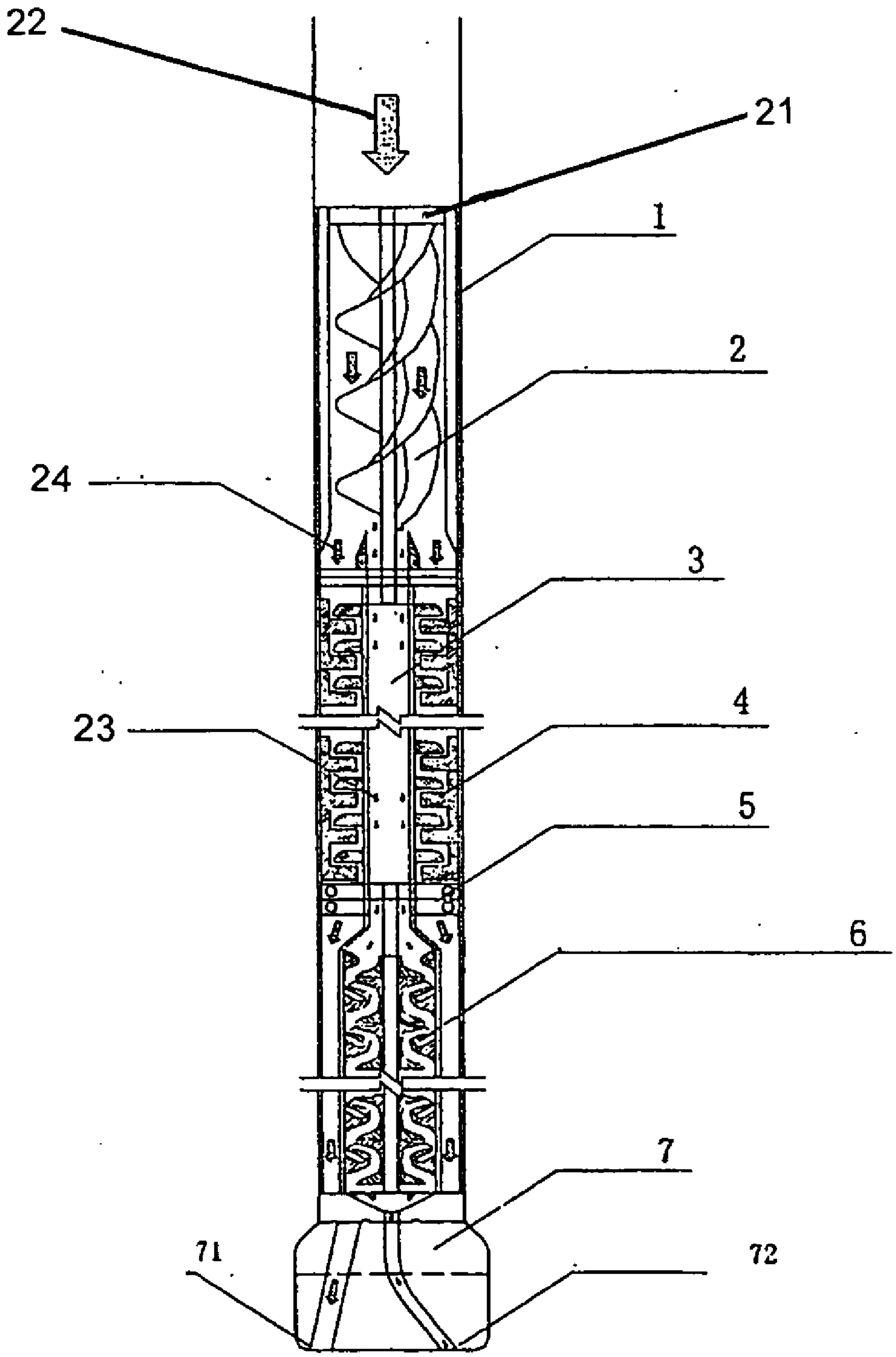
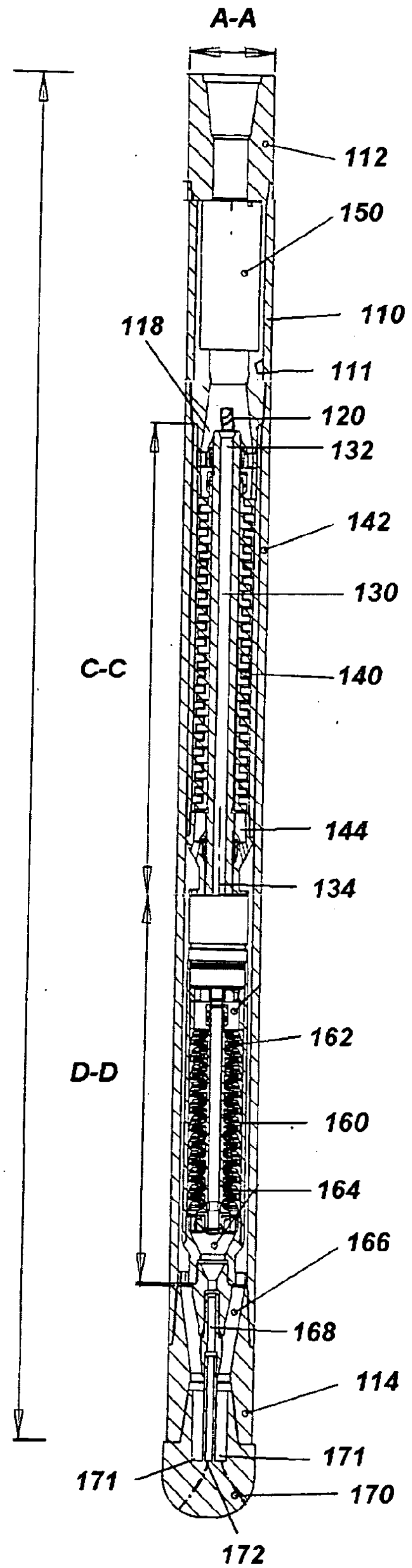


Fig. 2


A-A
112
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120
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C-C
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D-D
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Fig. 3

DRILLING TOOL AND METHOD

[0001] The present application is a continuation in part claiming priority from PCT International Patent Application No. PCT/CN2004/000352, filed Apr. 14, 2004, entitled "A DOWNHOLE-DRILLING TOOL WITH HIGH-PRESSURE AND CONTINUOUS-FLOW JET AND A METHOD FOR BREAKING THE ROCK," which claims priority from Chinese Patent Application No. 03244667.5, filed Apr. 15, 2003, having the same title. The entire disclosures of the foregoing applications are hereby incorporated by reference.

BACKGROUND

[0002] Chinese utility model ZL96207357.1 discloses a high-pressure downhole impulsive jet booster for a drilling tool driven by a two-stage turbocharger. The turbocharger is provided with a hydraulic cylinder mounted under the turbocharger (adjacent to the turbocharger is mounted a drilling fluid-driven piston pump). The drilling fluid passes through the turbine unit and enters the inlet of the nozzle after being boosted by the hydraulic cylinder. An impulsive high-pressure jet stream is then ejected from a nozzle for breaking rock being drilled. The jet stream pressure reaches 100-200 megapascals (MPa).

[0003] The impulsive jet booster disclosed in this document cannot create a continuously flowing high-pressure fluid stream, so that the rock breaking efficiency of this device is low. In addition, since the hydraulic cylinder of the disclosed device utilizes clearance sealing, the drill chips contained in the drilling fluid would have to be of a very small size. Therefore, the drilling fluid enters the high-pressure portion of the drilling tool only after being highly filtered. Moreover, when the hydraulic cylinder boosts the pressure of the drilling fluid, the space inside the cylinder is isolated from the outer drilling fluid, which results in low efficiency and may damage the cylinder itself.

[0004] Chinese Patent Application No. 89101781.X discloses a fluid pressure boosting device used in a drill pipe. This boosting device comprises a turbine unit and cannot supply a pressure high enough to break rock in a drill hole.

[0005] U.S. Pat. No. 4,819,745 discloses an impulsive jet device used in a drill pipe which includes a turbine unit. Under the turbine unit there is provided a directional valve which will close or open the outlet of the turbine unit, creating an impulsive jet stream. However this impulsive jet cannot provide a pressure high enough to break rock.

[0006] Chinese Patent Application No. 00250432.4 discloses a high-pressure jet downhole-drilling tool driven by a turbine unit, which is provided with a gear box to increase the rotation speed of a centrifugal pump in order to increase the drilling fluid pressure. This drilling tool cannot break rock effectively however and experiences significant wear.

SUMMARY

[0007] The use of high-pressure drilling fluid to break rock downhole has been explored previously. Some American oil companies, for example, have concluded that most of such rock would be broken when the pressure of drilling fluid is increased to 70-140 MPa. High-pressure water jets have also been used for cutting armor plate in some industries.

[0008] However, prior tests using high-pressure drilling fluids were performed under surface conditions and only simulated a two dimensional downhole confining pressure. As it is difficult to perform a three-dimensional test on the ground, a correct understanding of how rock is broken under realistic conditions was not previously obtained. The prior art teaches that the pressure of drilling fluid should be increased as much as possible to break rock. However, because the mechanism of rock breaking was not previously understood, prior methods of using high-pressure drilling fluid have not achieved the desired results.

[0009] The present invention relates to a downhole-drilling tool having a high-pressure, continuous-flow jet and a method of using such a drilling tool which overcomes problems encountered by prior drilling tools and improves the efficiency of breaking rock greatly.

[0010] The present method is believed to be achieved by creating a local negative pressure area near the rock at the well bottom of a drill hole through the use of a continuous high-pressure jet flow. In one embodiment, the present method comprises the following steps:

[0011] 1) providing a downhole-drilling tool comprising a high-pressure, continuous-flow jet and a drill pipe that is driven by a rotating disc on the ground or a top driving unit;

[0012] 2) providing a drilling fluid in the drilling tool, wherein a portion of the drilling fluid drives a multistage turbine to drive a multistage centrifugal pump or an axial flow pump, the turbine unit having multistage turbine sections as a drilling motor, and wherein the remaining drilling fluid flows through a hollow shaft directly into the multistage centrifugal pump or axial flow pump to increase the pressure of the drilling fluid to create a pressurized drilling fluid;

[0013] 3) discharging the pressurized drilling fluid into the well bottom through a special high-pressure jet nozzle of the drill bit, which is believed to generate a local negative pressure area near the rock at the well bottom by which the rock will be stretched and will come apart; and

[0014] 4) breaking the remaining non-broken rock using the drill bit by hydraulic and mechanical means.

[0015] After the drilling fluid is divided, the non-pressurized drilling fluid is used to drive the turbine, and such lower pressure fluid is discharged into the well bottom through a low-pressure jet nozzle to carry the cuttings to surface. Before the step of pressurizing the drilling fluid, a filter, such as a strainer, is used to filter the drilling fluid. The pressure of the filtered drilling fluid can be increased by 20-40 MPa by the centrifugal pump or axial flow pump.

[0016] The present drilling tool comprises a drill pipe driven by a ground rotary table or a top driving unit, a filter, a turbine, a centrifugal pump or an axial flow pump, a drill bit mounted on the bottom of the drill pipe, and both a high-pressure jet nozzle and a low-pressure jet nozzle on the drill bit. The filter, turbine unit, a thrust bearing and the centrifugal pump or axial flow pump are arranged in sequence in the drill pipe along the axis of the drill pipe inside the drill pipe. The turbine preferably has a hollow shaft for reducing the pressure loss of the drilling fluid. The filter is connected with the hollow shaft, and the shaft input end of the centrifugal pump or axial flow pump is connected with the output end of the hollow shaft.

[0017] One end of the hollow shaft is supported with a thrust bearing and the shaft of the centrifugal pump or axial flow pump is also supported by thrust bearing. The output end of the hollow shaft is preferably supported with a thrust bearing and the shaft input end of the centrifugal pump or axial flow pump is connected with the output end of the hollow shaft by the thrust bearing. The internal diameter of the hollow shaft is substantially aligned with the internal diameter of the housing of the centrifugal pump or axial pump. Further, a clearance, such as an annular space, is formed between the inner wall of the drill pipe and the outer wall of the centrifugal pump or axial flow pump. The high-pressure jet nozzle on the drill bit is connected with the centrifugal pump or axial flow pump. The low-pressure jet nozzle on the drill bit is adapted to generate a circulating return flow and is preferably in the drill bit.

[0018] The turbine unit is a multistage turbine, each stage of the turbine being connected serially on the hollow shaft. The turbine is comprised of multistage turbine sections. The centrifugal pump or axial flow pump is also preferably a multistage centrifugal pump or axial flow pump.

[0019] The filter can be a cyclone means comprising screw blades fixed on the inner wall of the drill pipe or screw blades fixed on a drive shaft. Alternatively, the filter can be a hollow mesh bucket, preferably one made of stainless steel and having holes in the range of 3.0-3.5 millimeters in diameter. In this embodiment, drilling fluid, i.e. a liquid, enters the mesh bucket through holes in the wall of the container, and fluid from which larger particles have been excluded enters the hollow shaft of the drill tool. The remaining fluid, generally comprising about 80% of the drilling fluid, continues into the turbine. The diameter of the mesh bucket is preferably slightly larger than diameter the diameter of the hollow shaft, though this is not mandatory. For example, the mesh bucket can have a height of 200 millimeters and a diameter of 70 millimeters.

[0020] According to Bernoulli's theorem, the sum of dynamic pressure and static pressure at any point in a fluid is zero and the pressure of the central fluid in a high-pressure jet stream may be decreased to the vapor pressure. It is believed that discharge of a high-pressure jet stream will generate a pressure differential in an area, where rock will be subject to tensile force and will either be broken or be made easier for a drill bit to cut it apart. Even if the rock is not broken, its strength would be reduced so that it can be more easily cut by a drill bit. In addition, the so-called pressure holding effect during the well drilling process is eliminated, thereby clearing debris in the drill hole, letting the drill bit contact new rock and avoiding breaking the same rock repeatedly. Thus, drilling speed is increased greatly.

[0021] The principle mentioned above is essentially different from prior drilling mechanisms used to break rock through boosting downhole fluid pressures. Such prior mechanisms aimed to break rock by means of the dynamic energy of a high-pressure jet, so that the high-pressure jet stream has to be designed to boost pressure up to 100-200 MPa with a correspondingly very small quantity of fluid discharge. The drilling fluid must also be highly purified. Conversely, in the present methods, the pressure of the high-pressure jet stream need only be about 20-40 Mpa. In this pressure range most rock can be broken easily. Moreover, the quantity of drilling fluid discharged is correspondingly relatively large, making the drilling tools used to accomplish this method more easily realized mechanically compared to prior art drilling tools.

[0022] In the present drilling tool, the turbine is used not for directly rotating the drill bit but for driving the multistage centrifugal pump or axial flow pump to boost the pressure of a portion of the drilling fluid. It should be noted that this portion of the drilling fluid first passes from the top of the turbine through the hollow shaft and then enters the multistage centrifugal pump or axial flow pump, thereby decreasing pressure loss and increasing the system's efficiency.

[0023] Since the invention utilizes the multistage centrifugal pump or axial flow pump to boost the pressure of the drilling fluid, the drilling fluid does not need to be as finely filtered as when drilling fluids are pressurized by a hydraulic cylinder. Moreover, the multistage centrifugal pump or axial flow pump can provide a continuously flowing high-pressure jet stream. In addition, since the thrust bearing of the present drilling tool can perfectly seal the drilling fluid without a rubber seal, the drilling tool is suitable for operation in a relatively high temperature situation.

[0024] The low-pressure nozzle of the present drilling tool is mounted adjacent the drill bit, preferably inside the cavity formed in the lower end of the drill pipe. The drilling fluid can flow with a maximum sectional area of fluid which causes the drilling fluid to have an easy and smooth return flow. This technical measure allows the drilling tool to utilize ground equipment and seals in general use for drilling tools. The high-pressure nozzle can be mounted on the drill bit and connected hermetically with the outlet of the multistage centrifugal pump or axial flow pump through a flow passage.

DRAWINGS

[0025] These and other features, aspects and advantages of the present invention will become better understood with regard to the following description, appended claims, and accompanying figures where:

[0026] **FIG. 1** is a schematic diagram showing the structure of one embodiment of the present drill tool.

[0027] **FIG. 2** is a schematic diagram showing fluid flow in the embodiment of the present drill tool shown in **FIG. 1**.

[0028] **FIG. 3** is a schematic diagram showing the structure of an alternative embodiment of the present drill tool.

[0029] All dimensions specified in this disclosure are by way of example only and are not intended to be limiting. Further, the proportions shown in these Figures are not necessarily to scale. As will be understood by those with skill in the art with reference to this disclosure, the actual dimensions of any device or part of a device disclosed in this disclosure will be determined by their intended use.

DESCRIPTION

Drilling Tool

[0030] As shown in **FIG. 1**, the present downhole-drilling tool comprises a drill pipe **1**, a filter **2** for the drilling fluid, a turbine unit **4** with a hollow shaft **3**, a thrust bearing **5** for supporting an output end of the turbine hollow shaft **3**, a multistage centrifugal pump or axial flow pump **6** driven by the turbine shaft **3**, and an intake **62** of the hydraulic pump **6**, which can be a centrifugal pump or axial flow pump, and which is sealingly connected with the turbine hollow shaft **3**. A drill bit **7** is connected to the lower end of the drill pipe **1**, and both a low-pressure jet nozzle **71** and a high-pressure jet nozzle **72** are mounted in the drill bit **7**. The drill pipe **1** is driven by a ground rotation table or a top driver, and the hollow shaft **3** is also used as the intake of the multistage centrifugal pump or axial flow pump.

[0031] The components of the present drilling tool are arranged sequentially inside the drill pipe **1** along its axial direction in order to cause the turbine unit **4** to drive the multistage centrifugal pump or axial flow pump **6**. The drilling fluid enters into the inlet **21** of the filter **2** and part of the filtered drilling fluid, for example, about 20%, passes from the top of the turbine **41** through the hollow shaft **3**. The fluid then enters the multistage centrifugal pump or axial pump **6** (as shown by the dotted line **FIG. 2**), and further is ejected from the high-pressure jet nozzle **72** after its pressure has been boosted by up to 20-40 MPa.

[0032] A large portion of the remainder of the drilling fluid, for example, about 80%, (as shown by the unbroken lines in **FIG. 2**) is driven to rotate by means of the turbine **41** and then passes through the annular space **9** between the drill pipe and the multistage centrifugal pump or axial flow pump **6**. This portion of the drilling fluid is ejected from the low-pressure jet nozzle **71** shown in **FIG. 2**. Because the present drilling tool has a hollow shaft **3**, the tool has advantages over prior art tools such as continuousness and high-efficiency.

[0033] According to the present method, rock in the well of a drill hole is broken with a downhole continuously flowing high-pressure jet stream. The present drilling tool can create such a jet stream as follows. The turbine unit **4** is used as a drill motor comprised of a multistage turbine section and a hollow shaft, with the turbine being rotated by the force of the drilling fluid, which also thereby drives the hollow shaft to rotate so as to create a rotating torque. A thrust bearing housing supporting the hollow shaft of the drill motor is fixed on the inner wall of the drill pipe, and the rotating torque of the hollow shaft is transmitted to the multistage centrifugal pump and axial flow pump **6** to drive the pump **6** to rotate. The multistage centrifugal pump or axial flow pump **6** boosts the drilling fluid coming from the motor hollow shaft and causes the drilling fluid to be ejected with a high pressure from the drill bit to strike rock downhole. The filtered drilling fluid forms a continuous injection with a certain pressure.

[0034] The filter for the drilling fluid, in one embodiment, can be a cyclone comprising screw blades fixed on the inner wall of the drill pipe. Each of the blades preferably has the same relatively large blade angle so that the drilling fluid will have a smaller pressure loss. The drilling fluid experiences a centrifugal rotation as it moves along the screw blades, which causes the particles with larger diameters in the drilling fluid to move along the outer circumference of the blades. The drilling fluid passing through the vane wheel of the motor and the annular space between the centrifugal pump and the drill pipe is ejected from the low-pressure jet nozzle of the drill bit. The drilling fluid flowing in the central portion is purified to a certain level and contains solid particles with a smaller diameter. This fluid passes through the hollow shaft of the drill motor and flows directly into the multistage centrifugal pump or axial flow pump, and after being boosted in pressure it is ejected from the high-pressure jet nozzle. This portion of the drilling fluid does not pass the motor turbine and has a very small pressure loss

[0035] The filter of the drilling fluid can be comprised of screw blades fixed on a drive shaft which is driven by the drill motor and rotates with a certain speed to purify the drilling fluid. Such a purifying means may obtain the same effect as the filtering process mentioned above. The direction of the screw blades should be in accordance with the direction of the motor turbine blade.

[0036] The shape of turbine blade should match the flow rate, flow speed and pressure drop of the drilling fluid passing through the turbine. After passing the filter, a portion of the clean drilling fluid passing through the upper inlet of the hollow shaft enters the hollow shaft. This portion of clean drilling fluid has a very small pressure drop since it does not pass through the turbine. It then flows through the outlet of the hollow shaft and enters into the multistage centrifugal pump or axial flow pump. The wall thickness of the hollow shaft, which is preferably about **10** millimeters, should ensure that the hollow shaft itself has the strength to meet torque transmission requirements, and the internal diameter should meet the flow rate requirements of the high-pressure jet stream.

Alternative Drilling Tool

[0037] An alternate embodiment of the present drilling tool is shown in **FIG. 3**. In this embodiment, the support and thrust bearing **150** is located adjacent the proximal end **142** of the turbine **140** toward the proximal end **112** of the drill pipe **110**. The turbine **140** and other components of the drill tool located distally of the turbine are thereby suspended from the support and thrust bearing **150**. This embodiment arrangement subjects the bearing **150** to less vibration than in the embodiment described above. The thrust bearing can be, for example, an SKF thrust bearing type QJ211, available from AB SKF, Göteborg, Sweden.

[0038] At the proximal end **142** of the turbine **140** is a filter **120**, which in this embodiment is preferably a mesh filter. Drilling fluid in the interior space **118** of the drill pipe **110** flows through the mesh, but larger particulates are excluded. The filter **120** is attached to the proximal end **132** of a hollow shaft **130** at the proximal end **142** of the turbine **140**. Preferably, the filter **120** and proximal end **132** of the hollow shaft **130** are adapted to allow approximately 20% of the drilling fluid to pass into the hollow shaft **130**, while the remaining 80% of the drilling fluid remains in the interior space **118** of the drill pipe **.110** between the inner wall **111** of the drill pipe **110** and the outer walls of other components within the drill pipe **110**. The hollow shaft is preferably made from a chromium-molybdenum alloy (e.g., 35CrMo).

[0039] The drilling fluid that passes through filter **120** proceeds through the hollow shaft **130**, exiting the hollow shaft **130** at a distal end **134** and entering an inlet of the hydraulic pump **160**. The use of such a hollow shaft increases the efficiency of the present drills. This drilling fluid passes into the hydraulic pump **160** at its proximal end **162**, and flows from the distal end **164** of the pump **160**

through a fluid passage **168** to the high-pressure nozzle **172**, where it is discharged into the drill hole. The high-pressure nozzle **172** is located at the distal end **114** of the drill pipe **110**, preferably adjacent to the drill bit **170**, which can be a PDC bit made by Sichuan Best. A plurality of high-pressure nozzles can be provided if desired. The hydraulic pump and turbine are both advantageously made from steel having a high chromium content.

[**0040**] The drilling fluid that does not pass through the filter **120** passes through the turbine **140**, exiting at the distal end **144** of the turbine **140**. This portion of the drilling fluid passes around the exterior of the hydraulic pump, i.e. between the inner wall **111** of the drill pipe **110** and the exterior wall of the pump **160**, and into a low-pressure fluid passage **166**. This passage **166** leads to one or more low-pressure nozzles **171**, which discharge this portion of the drilling fluid into the drill hole. Preferably, the drilling fluid discharged from the low-pressure nozzles is at a pressure of at least one MPa, preferably between about 5 and 10 MPa.

[**0041**] In a preferred embodiment, the drilling tool is approximately 10 meters long, i.e. along its long axis, shown by line B-B in **FIG. 3**. The diameter of the tool is about 170 millimeters (shown as line A-A in **FIG. 3**). The turbine in this embodiment is preferably about 1.6 meters in length along line C-C, and the hydraulic pump is about 5.3 meters in length, along line D-D in **FIG. 3**. This embodiment is adapted to be used with 8.5 inch drill bits.

Method of Using the Drilling Tools

[**0042**] The present drilling tools are preferably adapted to discharge drilling fluid from the high-pressure nozzle of the present drilling tools at a pressure of between about 20 and about 40 MPa above the ambient pressure at the nozzle. It has been determined that pressures in this range can break rock or facilitate the breaking in rock. While higher pressures can also be used, such higher pressures produce unacceptable wear in some circumstances and are associated with a higher rate of nozzle failure. Therefore, in a preferred embodiment the pressure of the drilling fluid discharged from the high-pressure nozzle or nozzles of the present drilling tools is in the range of 23-33 MPa.

[**0043**] In the present methods, the drill fluid is preferably discharged from the high-pressure outlet at a speed of between about 100 and 200 meters per second, and more preferably at about 150 meters per second. When fluid discharged at the foregoing speeds and/or pressures is insufficient to break rock in a particular instance, or where faster drilling is desired, the present drills can include mechanical drill bits to mechanically break rock or other material at the bottom of a drill hole.

[**0044**] As used herein, the term "comprise" and variations of the term, such as "comprising" and "comprises," are not intended to exclude other additives, components, integers or steps. The terms "a,""an," and "the" and similar referents used herein are to be construed to cover both the singular and the plural unless their usage in context indicates otherwise.

[**0045**] Although the present invention has been discussed in considerable detail with reference to certain preferred embodiments, other embodiments are possible. The steps disclosed for the present methods are not intended to be limiting nor are they intended to indicate that each step depicted is essential to the method, but instead are exemplary steps only. Therefore, the scope of the appended claims should not be limited to the description of preferred embodiments contained in this disclosure. All references cited herein are incorporated by reference to their entirety.

What is claimed is:

1. A method for breaking rock at the bottom of a drill hole, characterized in that a local negative pressure area is created near the rock by a high-pressure and continuous jet stream of drilling fluid.

2. The method of claim 1, characterized in that after the drilling fluid flows through a hollow shaft the drilling fluid is pressurized by a multistage centrifugal pump or an axial flow pump.

3. The method of claim 2, characterized in that the pressure of said pressurized drilling fluid is 20-40 MPa.

4. The method of claim 1, further comprising using a drill bit to mechanically break the rock.

5. The method of claim 1, characterized in that before pressurizing the drilling fluid, a filter is used for filtering the drilling fluid.

6. A method for breaking the rock comprising the following steps:

(a) providing the drilling fluid for a downhole-drilling tool with a high-pressure and continuous-flow jet by a drill pipe that is driven by a ground rotary table or a top driving unit;

(b) driving the drilling fluid by said the drilling tool, a portion of drilling fluid driving the multistage turbine sections rotary to drive a multistage centrifugal pump or an axial flow pump by using a turbine which has multistage turbine sections as a drilling motor, and the other portion of the drilling fluid flowing through a hollow shaft and directly flowing into the multistage centrifugal pump or axial flow pump to increase the pressure of the drilling fluid, said pressurized drilling fluid jetting the well bottom through a high-pressure jet nozzle of a drill bit to generate a local negative pressure area near the rock at the well bottom, in which the rock will be expanded and broken;

(c) breaking the non-broken rock using the bit in order to break the rock by hydraulic and mechanical means.

7. The method of claim 6, characterized in that the non-pressurized drilling fluid is used for driving the turbine unit, and then jets the well bottom through a low-pressure jet nozzle (**72**) of the bit to carry the cuttings to the surface.

8. The method of claim 6, characterized in that before the step of pressurizing the drilling fluid, a filter is used for filtering the drilling fluid.

9. The method of claim 6, characterized in that the filtered drilling fluid is increased to between 20 and 40 MPa by the centrifugal pump or axial flow pump.

10. A downhole-drilling tool with high-pressure and continuous-flow jet, comprising:

a drill pipe driven by a ground rotary table or a top driving unit,

a filter;

a turbine unit;

a centrifugal pump or an axial flow pump;

a drill bit mounted on the bottom of the drill pipe; and both a high-pressure jet nozzle and a low-pressure jet nozzle provided on the drill bit, wherein

the filter, the turbine unit, a thrust bearing, and the centrifugal pump or axial flow pump are arranged sequentially along the axis of the drill pipe inside the drill pipe, the turbine unit having a hollow shaft for reducing the pressure loss of drilling fluid, the filter being connected with the hollow shaft.

11. The downhole-drilling tool according to claim 10, characterized in that the shaft input end of the centrifugal pump or axial flow pump is connected with the output end of the hollow shaft.

12. The downhole-drilling tool according to claim 11, characterized in that the output end on the hollow shaft is supported with a thrust bearing and the shaft input end of the centrifugal pump or axial flow pump is connected with the output end on the hollow shaft by the thrust bearing.

13. The downhole-drilling tool according to claim 10, characterized in that the internal diameter of the hollow shaft is substantially aligned with the internal diameter of the housing of the centrifugal pump or axial pump.

14. The downhole-drilling tool according to claim 10, characterized in that an annular space is formed between the inner wall of the drill pipe and the outer wall of the centrifugal pump or axial flow pump.

15. The downhole-drilling tool according to claim 10, characterized in that the high-pressure jet nozzle on the drill bit is connected with the centrifugal pump or axial flow pump, the low-pressure jet nozzle on the drill bit is adapted to generate a circulating return flow and is mounted inside the cavity formed in the drill bit.

16. The downhole-drilling tool according to claim 10, characterized in that said turbine unit is a multistage turbine, each turbine stage being connected serially on said hollow shaft.

17. The downhole-drilling tool according to claim 10, characterized in that said centrifugal pump or axial flow pump is a multistage centrifugal pump or axial flow pump.

18. The downhole-drilling tool according to claim 10, characterized in that the filter is a cyclone means, which includes screw blades fixed on the inner wall of the drill pipe.

19. The downhole-drilling tool according to claim 10, characterized in that a filter of the drilling fluid is comprised of screw blades fixed on a drive shaft.

20. A method of drilling, comprising:

(a) providing a drill in a drill hole, the drill having a first fluid outlet adjacent the drill bit for discharging a drill fluid; and

(b) discharging the drill fluid from the first fluid outlet at a pressure which is between about 20 and about 40 MPa greater than the ambient pressure at the first fluid outlet

21. The method of claim 20, wherein the drill fluid is at a pressure which is between 23 and 33 MPa greater than the ambient pressure at the first fluid outlet.

22. The method of claim 20, wherein the drill fluid is discharged from the first fluid outlet at a speed of between about 100 and 200 meters per second.

23. The method of claim 22, wherein the drill fluid is discharged from the first fluid outlet at a speed of about 150 meters per second.

24. A drilling tool, comprising:

a drill pipe having a proximal end and a distal end, wherein the proximal end is in mechanical communication with a driving unit for rotating the drill pipe;

a turbine in the drill pipe, the turbine having a proximal end and a distal end;

a hydraulic pump in the drill pipe located distally with respect to the turbine, the hydraulic pump having a proximal end and a distal end and comprising an inlet at the proximal end;

a hollow shaft in the turbine having a proximal end and a distal end, wherein the hollow shaft extends from a proximal end of the turbine to the inlet of the hydraulic pump, wherein the hydraulic pump is in fluid communication with the proximal end of the turbine by means of the hollow shaft;

a drill bit on the distal end of the drill pipe; and

a high-pressure jet nozzle adjacent the drill bit, the nozzle being in fluid communication with the distal end of the hydraulic pump.

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