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

(11) EP 2 955 319 A1

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
16.12.2015 Bulletin 2015/51

(51) Int Cl.:
E21B 21/08 *(2006.01)* ***E21B 7/02*** *(2006.01)*

(21) Application number: **14172341.1**

(22) Date of filing: **13.06.2014**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(71) Applicant: **Sandvik Mining and Construction Oy**
33330 Tampere (FI)

(72) Inventor: **Miikkulainen, Tatu**
33330 Tampere (FI)

(54) **Arrangement and method for feeding flushing fluid**

(57) The invention relates to a flushing system and a method of controlling feeding of flushing fluid. The flushing system (14) comprises a pump unit (15) for feeding pressurized flushing fluid to a feed duct (16) connected to a rock drilling machine (5). Flow rate of the flushing fluid to be fed is controlled by controlling pumping of the flushing fluid. The flow rate is determined by means of one or more sensing device.

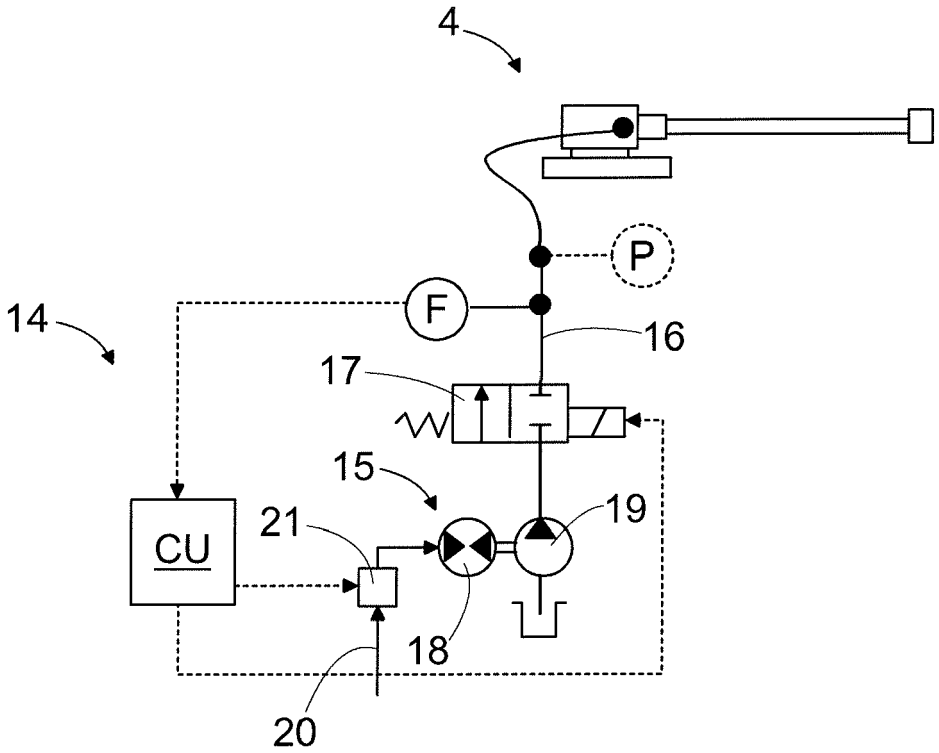


FIG. 2

EP 2 955 319 A1

Description

Background of the invention

[0001] The invention relates to a flushing system of a drilling unit. The flushing system comprises a pump unit for feeding pressurized flushing fluid needed in drilling. The flushing system further comprises means for conveying the flushing fluid and means for controlling feeding of the flushing fluid.

[0002] The invention further relates to a method of controlling feeding of flushing fluid in a flushing system of a rock drilling rig.

[0003] The field of the invention is defined more specifically in the preambles of the independent claims.

[0004] In mines and at other work sites, rock drilling machines are used for drilling bore holes into rock surfaces. The rock drilling machine comprises a rotating device for rotating a drilling tool during drilling. Flushing systems have been developed for feeding flushing fluid through the tool to the drill bit and further to the bottom of the drill hole. In some solutions flow of flushing fluid is adjusted by means of adjusting valves, which are designed especially for the purpose. However, these known flushing systems have some drawbacks.

Brief description of the invention

[0005] An object of the invention is to provide a novel and improved flushing system and a method of controlling feeding of flushing fluid of a rock drilling unit.

[0006] The flushing system according to the invention is characterized in that the pump unit is a variable flow rate pump unit provided with adjusting means allowing flow rate of the flushing fluid to be varied; and the control unit is configured to determine flow rate of the flushing fluid on the basis of the received sensing data, and the control unit is further configured to control the flow rate of the fed flushing fluid by adjusting the supplied pressure of the pump.

[0007] The method according to the invention is characterized by controlling flow rate of the flushing fluid by adjusting pressure supplied by the pump unit; directing the flushing fluid through at least two valves being operationally parallel and having flow paths which are different in size; and selecting opening and closing of the at least two valves in response to magnitude of the produced volume flow of the pump unit.

[0008] An idea of the disclosed solution is that flushing fluid is fed from a pump unit to a drilling unit for flushing drilling cuttings away from a bore hole being drilled. Flow rate flowing to the drilling unit is adjusted by controlling pumping of the flushing fluid.

[0009] An advantage of the disclosed solution is that adjustable needle valves or corresponding adjusting elements are not needed in the flushing system. Instead, the needed adjustments may be executed by controlling the pumping. The flushing flow may be adjusted accurately and the operation of the system is easy to control. The disclosed solution may allow a simple and reliable configuration to be utilized in the flushing system.

[0010] According to an embodiment, a feed duct of the flushing system is provided with one or more valves. The valve is without any adjusting means allowing adjusting the flow being fed through the valve. Thus, the valve is on/off -type having only two positions, namely an open position and a closed position. This type of valve is easy to control, reliable and inexpensive.

[0011] According to an embodiment, the flushing system comprises at least a first feed duct and a second feed duct, which are operationally parallel relative to each other. The first feed duct is provided with a first valve and a first throttle. Correspondingly, the second feed duct is provided with a second valve and a second throttle. The first throttle and the second throttle both have orifices, which differ in size. Further, the first valve and the second valve are independently controllable, whereby the valves may be opened and closed separately and simultaneously. The control unit is configured to control opening and closing of the first valve and the second valve according to the operation of the drilling unit. In this embodiment flushing flow may be directed through one or more suitable valves by controlling opening and closing of simple on/off - valves arranged in the feed ducts. The system is simple and requires no expensive components. It should be noted that the number of the parallel feed ducts may be three, four or even more, and the feed ducts are provided with the disclosed valves, throttles and differing orifice sizes.

[0012] According to an embodiment, the flushing system comprises two or more parallel feed ducts provided with valves. The valves are operationally parallel and have flow paths which are different in size. Flow rate of the flushing system is adjusted by controlling a pump. Flushing fluid flow is directed through the two or more valves so, that opening and closing of valves is controlled in response to magnitude of the supplied volume flow of the pump unit.

[0013] According to an embodiment, at least one feed duct of the flushing system is provided with a control valve and a throttle. The throttle is an integrated element of the valve. Thus, the throttle is a constructive part of the structure of the valve whereby no separate throttle element or device is needed. The structure may then be compact.

[0014] According to an embodiment, at least one feed duct of the flushing system is provided with a control valve and means for throttling flow of the feed duct. The valve may comprise a control element, such as a control spindle, which may be moved in order to influence to flow through the valve. The control element may be moved between closing and opening positions. Further, one or more preset intermediate positions may be determined for the control element so that when the control element is at the intermediate positions, different throttling is achieved. Thus, instead of several valves, different preset throttling may be achieved by means of a single valve.

The control element may comprise one intermediate position whereby two different throttling may be achieved, for example.

[0015] According to an embodiment, at least one feed duct of the flushing system is provided with a control valve and a throttle. The throttle is a separate element relative to the valve. Thus, the valve and the throttle may both be simple standard hydraulic components. Valves and throttles having different properties may be combined in order to find a desired combination.

[0016] According to an embodiment, flow rate determination is performed by means of a pressure difference measurement. Thus, at least one feed duct of the flushing system is provided with means for throttling flow of the feed duct. At least one throttle may be arranged in the at least one feed duct, wherein the throttle causes a pressure drop. Pressure drop over the throttling is sensed or measured and this data is used for determining flow rate in the observed feed duct. The produced data may be transmitted to a control unit of the flushing system. The pressure difference measurement is a reliable measuring principle and requires no expensive measuring devices. Pressure sensors are durable and easily mountable.

[0017] According to an embodiment, the flushing system comprises at least one first pressure sensing device for detecting pressure of the flushing fluid acting before the throttle, and correspondingly at least one second pressure sensing device for detecting pressure of the flushing fluid acting after the throttle. The sensed pressure data is transmitted to a control unit of the flushing system. The control unit is configured to determine a pressure difference caused by the throttle in the feed duct. The control unit is further configured to determine the flow rate of the flushing fluid on the basis of the detected pressure difference. The produced data on the flow rate may be utilized for controlling a pump of the flushing system in order to control the flow rate of the flushing fluid.

[0018] According to an embodiment, the flow rate is determined by means of one or more flow meters. The produced data is utilized for controlling a pump of the flushing system. In this embodiment at least one feed duct of the flushing system is provided with at least one flow meter for determining the flow rate of the flushing fluid.

[0019] According to an embodiment, produced flow rate of a feed duct is adjusted by adjusting operating speed of the pump. The pump may be driven by an electrical motor. Operating speed of the pump is adjusted in order to adjust the produced flow of the flushing fluid. Rotational speed of the electric motor may be adjusted by means of an adjusting device.

[0020] According to an embodiment, produced flow rate of a feed duct is adjusted by adjusting operating speed of the pump. The pump is driven by an electrical motor and the speed of the motor is adjusted by means of a frequency converter. The frequency converter allows an accurate control of rotational speed. Further, the frequency converter is a reliable component.

[0021] According to an embodiment, produced flow rate of a feed duct is adjusted by adjusting operating speed of the pump. The pump is driven by means of a hydraulic motor.

[0022] According to an embodiment, the pump of the flushing system is a pump provided with fixed displacement, such as a centrifugal pump or a gear pump. The produced pressure of the pump is adjusted by adjusting rotational speed of the pump. The pump with fixed displacement has simple and durable structure and is inexpensive and easy to control.

[0023] According to an embodiment, the pump is a variable displacement pump allowing flow rate of the flushing fluid to be varied. Displacement capacity i.e. amount of fluid may be varied by adjusting pumping elements of the pump.

[0024] According to an embodiment, the flushing system is provided with an air-mist flushing feature. Then the flushing system may comprise one or more compressors for producing compressed air for the flushing. The system further comprises a water pump arranged to produce pressurized water for the flushing. The produced pressurized flushing water and the pressurized flushing air may be mixed in a feed duct in order to produce air-mist. The flushing system comprises a control unit, which is configured to control the operation of the compressor and the water pump. The air-mist flushing system may be an optional system, which may be used when needed. Thus, in the optional system the flushing may be executed using liquid flushing or air-mist flushing depending on flushing need. The water pump may be arranged to produce needed water flows for the normal liquid flushing and the air-mist flushing. Further, when the flushing system comprises both flushing types, there may be two feed ducts or lines, which are dimensioned for different flow rates. Thus, the system may comprise a liquid flushing feed duct to be utilized in liquid flushing and having a greater cross section as compared to an air-mist flushing feed duct. In the liquid flushing a great amount of flushing fluid is typically used and in the air-mist flushing the flow rate may be substantially smaller.

[0025] According to an embodiment, the flushing system is provided with an air-mist flushing feature. The system comprises a compressor for producing needed pressurized air flow. Operational speed of the compressor may be controlled by means of a control unit. The compressor may be driven by an electrical motor and rotation speed of the electrical motor is controlled. The speed of the electrical motor may be controlled by means of a frequency converter in order to adjust production of the compressed air. An advantage of this solution is that the compressor may be controlled accurately and by using reliable control system.

[0026] According to an embodiment, the flushing system is provided with an air-mist flushing feature. The system comprises a compressor for producing needed pressurized air flow. The compressor may be driven by a hy-

draulic motor and rotation speed of the motor is controlled by means of a control unit.

[0027] According to an embodiment, the flushing system comprises one or more control units for controlling feed of the flushing fluid. The control unit may comprise one or more processing devices for implementing the control. The control unit may be provided with one or more predetermined control principles for the operation of the flushing system. The control principle may be stored in memory storage of the control unit or it may be retrieved from an external data source. The control unit is configured to determine control parameters in the processing device on the basis of the received sensing data and the control principle. The sensing data may be received from one or more sensing devices arranged to measure and detect properties of the fed flushing fluid. The predetermined control principle may be configured to control feeding of the flushing fluid by utilizing a flow control principle, which is disclosed in this patent application. Another control principle may be configured to monitor drilling procedure on the basis of the sensed data. Further still, an alternative control principle may be configured to detect failures in the flushing system.

[0028] According to an embodiment, the flushing system comprises a control unit and one or more control principles to be executed in the control unit. An optional control principle may be designed to detect clogging of flushing fluid apertures of a drill bit of a drilling tool. The drill bit may be provided with several narrow fluid channels into which rock material may enter during drilling and cause the apertures to clog. The clogging causes sudden increase in flow resistance, since the flushing fluid is not escaping the drill bit. Then the flow of flushing fluid decreases and pressure in the feed duct increases. The control unit may then detect that the clogging occurs. The clogging may be detected by monitoring the flow and pressure prevailing in the feed duct.

[0029] According to an embodiment, the flushing system comprises a control unit and one or more control principles to be executed in the control unit. An optional control principle may be designed to detect cracks and cavities in the material being drilled. Pressure in the feed duct may decrease suddenly when a drill bit of drilling tool enters a cavity. That is because the flushing fluid may then escape freely from the drill bit to a space surrounding the drill bit instead of flowing to a narrow space between the drilling tool and the drilled bore hole. When the drilling tool enters the cavity in the rock material flow resistance of the flushing fluid decreases. Also, when the drilled rock material has cracks or is fragmented, the flushing fluid may flow to voids in the rock material, whereby the flow resistance of the flushing fluid may decrease. Then the flow of flushing fluid increases and pressure in the feed duct decreases. The control unit may then detect the change in the drilling conditions. The system may monitor the flow and pressure prevailing in the feed duct.

[0030] According to an embodiment, pressure of the flushing fluid is set as high as possible. A maximum pressure rate is defined by a structure of a drill-ing machine. One or more pressure sensors or pressure sensing devices may be utilized to detect pressure of the flushing fluid acting in the drilling machine. The maximum pressure rate tolerated by the drilling machine is known by the control unit, whereby the control unit may control the pump unit to produce a pressure close to the predefined maximum pressure. Flushing of drilling cuttings may be improved by using as high pressure as possible. In addition to pressure, also flow of the flushing fluid may be increased, whereby total flushing capacity is increased.

[0031] According to an embodiment, the flushing fluid is water.

[0032] According to an embodiment, the rock drilling machine of the drilling unit is a down-the-hole (DTH) drilling machine comprising a rotating unit and a percussion unit arranged at opposite ends of a tool. The disclosed flushing system and method may be applied in DTH -drilling.

[0033] According to an embodiment, the rock drilling machine of the drilling unit is a rotary drilling machine comprising a rotating unit. The rotary drilling machine is without any percussion device. The disclosed flushing system and method may be applied in rotary drilling.

[0034] According to an embodiment, the rock drilling machine of the drilling unit is a top hammer drilling machine comprising a rotating device and a percussion device located at a rear end of the tool. The disclosed flushing system and method may be applied in rotary drilling.

[0035] According to an embodiment, the disclosed flushing system is utilized in surface drilling.

[0036] According to an embodiment, the disclosed flushing system is utilized in underground drilling.

[0037] The above-disclosed embodiments can be combined in order to form suitable solutions provided with necessary features disclosed.

Brief description of the figures

[0038] Some embodiments are described in more detail in the accompanying drawings, in which

Figure 1 is a schematic side view of a rock drilling rig provided with a drilling unit and a flushing system,
Figure 2 is a schematic diagram of a flushing system,
Figure 3 is a schematic diagram of a flushing system provided with means for an air-mist flushing in addition to normal liquid flushing, and
Figure 4 is a schematic graph showing different control situations of a flushing system.

[0039] For the sake of clarity, the figures show some embodiments of the disclosed solution in a simplified manner. In the figures, like reference numerals identify like elements.

Detailed description of some embodiments

[0040] Figure 1 shows a rock drilling rig 1, which comprises a movable carrier 2 and a drilling boom 3 connected movably to the carrier 2. At a distal end of the boom 3 is a drilling unit 4, which comprises a drilling machine 5. The drilling machine 5 may comprise a shank 6 at a front end of the rock drilling machine 5 for connecting a tool 7. The tool 7 may comprise one or more drill rods 8 and a drill bit 9 located at a distal end of the tool 7. The tool 7 may comprise a flushing channel leading to the drill bit 9. The drilling machine 5 further comprises a rotating device 10 for rotating the shank 6 and the tool 7 connected to the shank 6. The drilling machine 5 may also be provided with a percussion device for generating impact pulses to the tool 7. The drilling unit 4 may further comprise a feed beam 11 on which the drilling machine 5 may be supported. The drilling machine 5 may be moved on the feed beam 11 by means of a feed device 12.

[0041] At a drilling site, one or more drill holes 13 are drilled with the drilling unit 4. The drill holes 13 may be drilled in a vertical direction, as shown in Figure 1, or in a horizontal direction. During drilling rock material is detached by means of the drill bit 9. Produced drilling cuttings needs to be removed from the drill hole 13. Therefore the rock drilling rig 1 is provided with a flushing system 14, which comprises a pump unit 15 for feeding pressurized flushing fluid by means of a feed duct or hose 16 to the drilling machine 5. The drilling machine 5 may comprise a flushing housing around the shank 6 so that the flushing fluid may enter to a longitudinal flushing channel of the tool 7. Thus, the flushing fluid may flow through the tool 7 towards the drill bit 9. The drill bit 9 is provided with flushing apertures allowing the flushing fluid to finally escape from of the drill bit 9. In the drill hole 13 the flushing fluid pushes the drilling cuttings towards a mouth of the drill hole 13. During drilling a need for flushing may vary because of executed drilling efficiency or rock material being drilled, for example. Amount of flushing may be adjusted accurately and fast when using flushing system disclosed in this patent application.

[0042] Figure 2 discloses in a simplified manner a flushing system 14 comprising a pump unit 15, a valve 17, a flow meter F, a feed duct 16 and a control unit CU. The pump unit 15 comprises a power device 18, which is arranged to drive a pump 19 for producing pressurized flushing fluid flow to the feed duct 16. The valve 17 is arranged in the feed duct 16 for controlling feeding of the flushing fluid. The valve 17 may be on/off type allowing only opening and clos-ing the feed duct 16. The valve 17 is opened when the flushing fluid is fed, and closed when no need for flushing exists. Flow rate of the flushing fluid may be sensed by means of the flow meter F and the sensing data may be transmitted to the control unit CU. Based on the received sensing data the control unit CU may control pumping of the flushing fluid. The power device 18 may be a hydraulic motor connected to a hydraulic system 20. The pumping unit 15 may comprise an adjusting device 21 allowing rotational speed of the hydraulic motor and the pump 19 to be adjusted. The control unit CU may control the adjusting device 21 and the valve 17. Alternatively, the power device 18 may an electrical motor and the adjusting device 21 may be a frequency converter. Further, the feed duct 16 may be provided with an optional pressure sensing device P for detecting prevailing pressure of the feed duct 16. The pressure sensing data may also be transmitted to the control unit CU. Thanks to the pressure sensing data, it is possible to set the pressure of the flushing fluid as high as tolerated by the drilling unit 4. The pressure data may also utilized for detecting changes in the rock material being drilled.

[0043] Figure 3 discloses a flushing system 14, which is provided with a liquid flushing system and an air-mist flushing system. The air-mist system comprises a compressor 22, which may be driven by means of a power device 23, such as an electrical motor, hydraulic motor or diesel engine. Supply of pressurized air may be adjusted by means of an adjusting device 24, which may be a frequency converter, for example. The produced air flow of the compressor 22 may be conveyed through an air feed duct 25 to a feed duct 16 wherein the air mixes with the flushing fluid. In the air-mist flushing amount of flushing fluid is smaller than in a normal liquid flushing. A control unit CU may control opening and closing of an air valve 17C, adjusting device 24 and a small sized valve 17A of a feed duct 16a in order to produce desired air-mist flushing.

[0044] In Figure 3 the flushing fluid system 14 comprises two parallel feed ducts 16a and 16b, which are provided with control valves 17A and 17B. The control valves 17A and 17B may have orifices which have mutually different size. The control valve 17A may be utilized in air-mist flushing as disclosed above. The control valve 17B may be utilized in liquid flushing alone or in combination with the control valve 17A. The valves 17A and 17B may be opened and closed according to the produced flow, whereby different operational combinations of the valves may be utilized for scaling the flow path in response to the supplied flow. The control valves 17A and 17B may be provide with throttles 25a and 25b, or alternatively the throttles may be individual components arranged in parallel feed ducts 16a and 16b. The control valves 17A and 17B may be on/off type valves since adjusting of the flushing system is based on adjustment of the pump unit 15.

[0045] In Figure 3 flow rate determination is based on a pressure difference measurement utilizing pressure sensors P1 and P2. Thus, the feed duct 16 is provided with means for throttling flow of the feed duct. The throttle 25a, 25b causes a pressure drop. Pressure drop over the throttling is sensed or measured by means of pressure sensors P1, P2 and this data is used for determining flow rate in the feed duct 16. The adjusting device 21 may be controlled on the basis of the detected flow rate. The control unit CU also selects opening and closing of valves 17A and 17B according to the need. Control principles, algorithms and an additional data may be input to

control unit by means of a user interface UI.

[0046] The flushing system 14 may also differ from the one disclosed in Figure 3. In an alternative solution more than two operationally parallel feed duct portions and valves may be utilized. Further, the flow rate may be detected by means of a flow meter instead of pressure difference measurement. The pump unit 15 may also be hydraulically driven as it is shown in Figure 2.

[0047] Figure 4 illustrates three different scales of flows. Reference is made to the flushing system of Figure 3 comprising valves 17A and 17B in the feed duct. A lowermost curve A relates to a situation when only valve 17A is open, curve in the middle relates to a situation when only valve 17B open, and further an uppermost curve A + B shows a situation when both valves 17A and 17B are open. Depending on the flow rate the control unit opens and closes the valves 17A and 17B.

[0048] The drawings and the related description are only intended to illustrate the idea of the invention. In its details, the invention may vary within the scope of the claims.

Claims

1. A flushing system of a drilling unit,
wherein the drilling unit (4) comprises a drilling machine (5) and a tool (7) connectable to the drilling machine (5);
and the flushing system (14) comprising:

a pump unit (15) for feeding pressurized flushing fluid, wherein the pump unit (15) comprises a pump (19) and a power device (18) for driving the pump (19);
at least one feed duct (16) for feeding the pressurized flushing fluid from the pump (19) to the drilling machine (5);
at least one valve (17) in the feed duct (16) for controlling flow of the flushing fluid conveyed to the drilling machine (5);
at least one sensing device arranged to measure at least one property of the fed flushing fluid;
at least one control unit (CU) for controlling the feed of the flushing fluid in response to a sensing data received from the at least one sensing device;
characterized in that
the pump unit (15) is a variable flow rate pump unit (15) provided with adjusting means allowing flow rate of the flushing fluid to be varied; and
the control unit (CU) is configured to determine flow rate of the flushing fluid on the basis of the received sensing data, and the control unit (CU) is further configured to control the flow rate of the fed flushing fluid by adjusting the supplied pressure of the pump (19).

2. The flushing system as claimed in claim 1, **characterized in that**
the valve (17) is of on/off -type without adjusting means.

3. The flushing system as claimed in claim 1 or 2, **character-i** z e d in that
the control unit (CU) comprises at least one processing device;
the control unit (CU) comprises at least one predetermined control principle for the operation of the flushing system; and
the control unit (CU) is configured to determine control parameters in the processing device on the basis of the received sensing data and the control principle.

4. The flushing system as claimed in any one of the preceding claims 1 to 3, **characterized in that**
the flushing system (14) comprises at least a first feed duct (16a) and a second feed duct (16b), which are operationally parallel relative to each other;
the first feed duct (16a) is provided with a first valve (17A) and a first throttle (25a);
the second feed duct (16b) is provided with a second valve (17B) and a second throttle (25b);
the first throttle (25a) and the second throttle (25b) have orifices, which differ in size;
the first valve (17A) and the second valve (17B) are independently controllable; and
the control unit (CU) is configured to control opening and closing of the first valve (17A) and the second valve (17B) according to the operation of the drilling unit (4).

5. The flushing system as claimed in claim 4, **characterized in that**
the throttle (25a, 25b) is an integrated element of the valve (17A, 17B).

6. The flushing system as claimed in claim 4, **characterized in that**
the throttle (25a, 25b) is a separate element relative to the valve (17A, 17B).

7. The flushing system as claimed in any one of the preceding claims 1 to 6, **characterized in that**
at least one throttle (25a, 25b) is arranged in the at least one feed duct (16a, 16b), wherein the throttle (25a, 25b) causes a pressure drop;
the flushing system (14) comprises at least one first pressure sensing device (P1) for detecting pressure of the flushing fluid acting before the throttle (25a, 25b);
the flushing system (14) comprises at least one second pressure sensing device (P2) for detecting pressure of the flushing fluid acting after the throttle (25a, 25b);

the sensed pressure data is transmitted to the control unit (CU);
the control unit (CU) is configured to determine a pressure difference caused by the throttle (25a, 25b); and
the control unit (CU) is further configured to determine the flow rate of the flushing fluid on the basis of the detected pressure difference.

8. The flushing system as claimed in any one of the preceding claims 1 to 6, **characterized in that**
the at least one feed duct (16) is provided with at least one flow meter (F) for determining the flow rate of the flushing fluid.

9. The flushing system as claimed in any one of the preceding claims 1 to 8, **characterized in that**
the pump (19) is driven by an electrical motor;
operating speed of the pump (19) is adjusted in order to adjust the produced flow of the flushing fluid; and
rotational speed of the electric motor is adjusted by means of an adjusting device (21).

10. The flushing system as claimed in claim 9, **characterized in that**
the pump (19) is a fixed displacement pump; and
the supplied pressure of the pump is adjusted by adjusting rotational speed of the pump (19).

11. The flushing system as claimed in claim 9 or 10, **characteri z e d in that**
the adjusting device (21) is a frequency converter.

12. The flushing system as claimed in any one of the preceding claims 1 to 11, **characterized in that**
at least one pressure sensing device (P) is arranged to detect pressure of the flushing fluid acting in the drilling machine (5);
the pressure of the flushing fluid is adjusted by adjusting the pump (19);
a maximum pressure rate tolerated by the drilling machine (5) is set to the control unit (CU); and
the control unit (CU) is arranged to control the pump unit (15) to supply a pressure close to the predefined maximum pressure.

13. The flushing system as claimed in any one of the preceding claims 1 to 12, **characterized in that**
the flushing system (14) is provided with an air-mist flushing system; the flushing system (14) comprises at least one compressor (22) for supplying compressed air for the flushing;
the pump (19) is a water pump arranged to supply pressurized water for the flushing;
the supplied pressurized flushing water and the pressurized flushing air are mixed in the feed duct (16), whereby air-mist is produced; and
the control unit (CU) is arranged to control the operation of the compressor (22).

14. The flushing system as claimed in claim 13, **characteri z e d in that**
the compressor (22) is driven by a second electrical motor (23); and operational speed of the second electrical motor (23) is controlled by means of a second frequency converter (24) in order to adjust flow rate of the compressed air.

15. A method of controlling feeding of flushing fluid of a flushing system of a rock drilling unit,
the rock drilling unit (4) comprising a drilling machine (5) and a tool connectable to the drilling machine (5); and the method comprises:

pressurizing flushing fluid by means of at least one pump unit (15) and conveying the pressurized flushing fluid to the drilling machine (5) through at least one feed duct (16);
controlling the feeding of the flushing fluid by means of at least one valve (17) arranged in the feed duct (16);
monitoring the fed flushing fluid by means of at least one sensing device; and
controlling flow rate of the flushing fluid according to the monitoring;
characterized by
controlling flow rate of the flushing fluid by adjusting pressure supplied by the pump unit (15);
directing the flushing fluid through at least two valves (17A, 17B) being operationally parallel and having flow paths which are different in size; and
selecting opening and closing of the at least two valves (17A, 17B) in response to magnitude of the supplied volume flow of the pump unit (15).

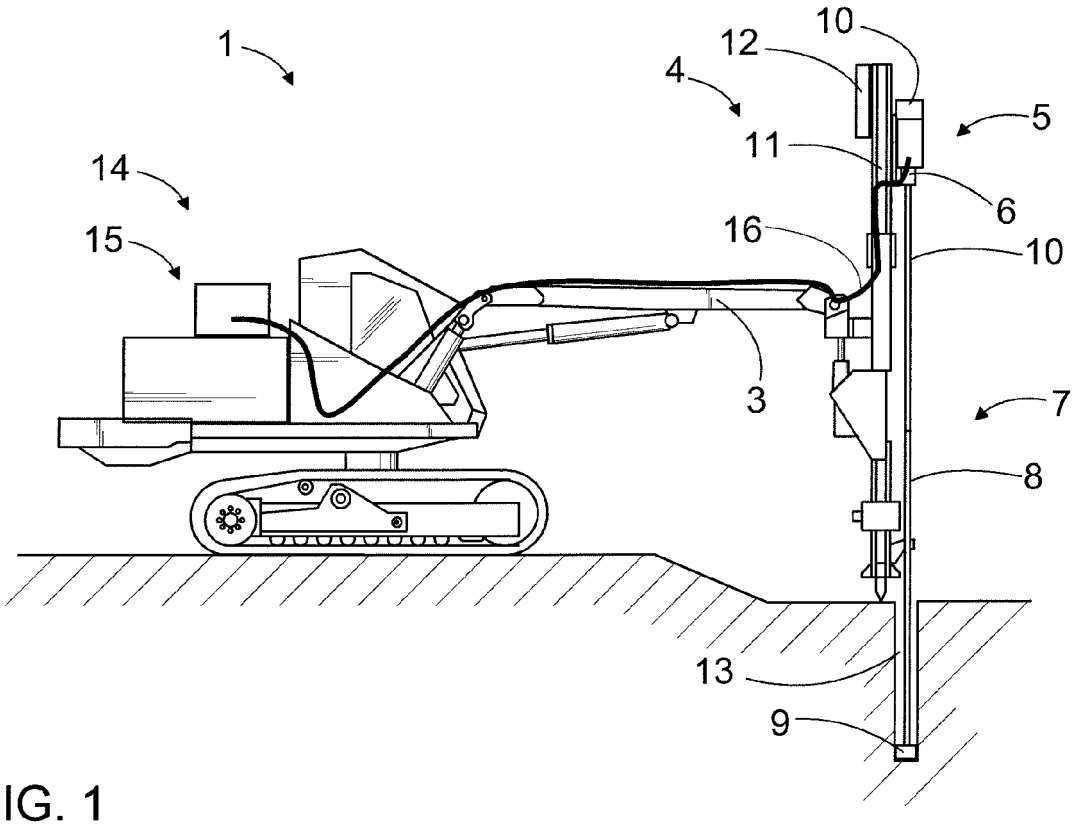


FIG. 1

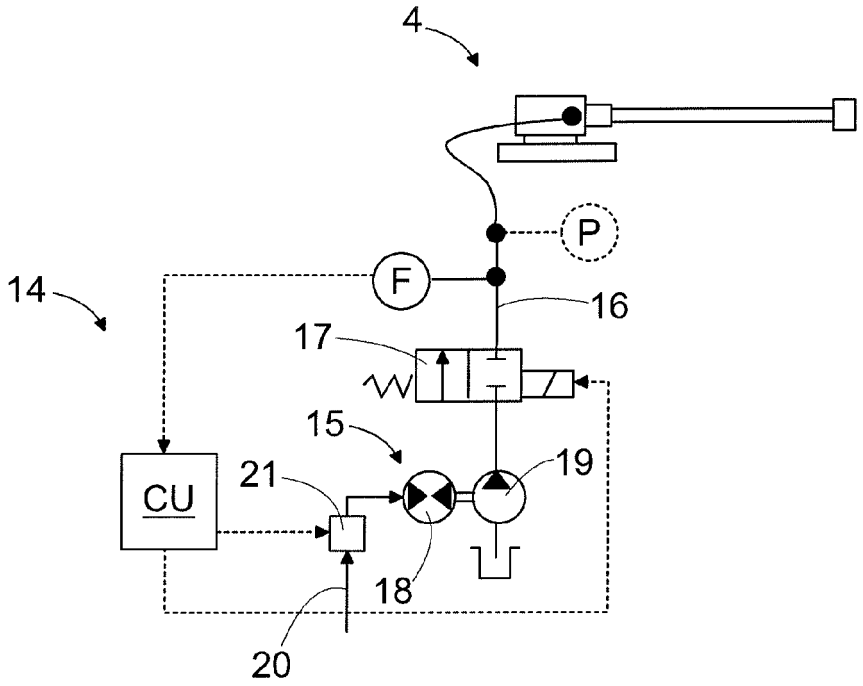


FIG. 2

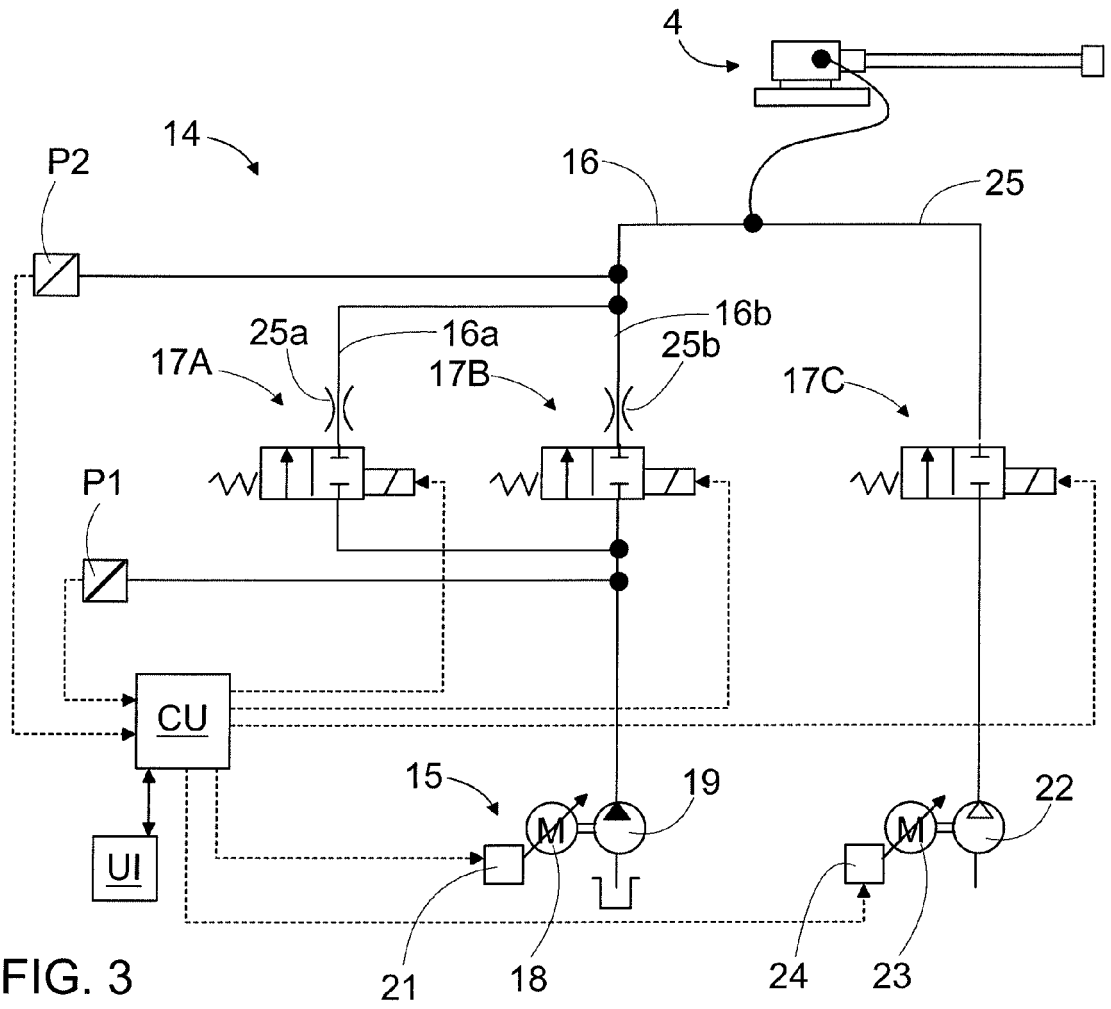

4
14
P2
16
25
16b
25a
16a
25b
17A
17B
17C
P1
CU
UI
15
19
22
M
M
21
18
24
23

FIG. 3

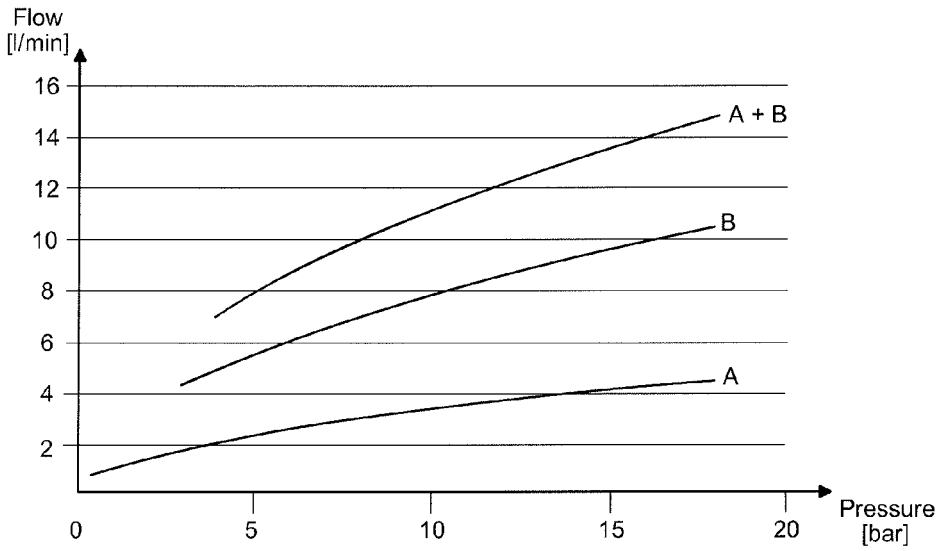

Flow
[l/min]
16
14
12
10
8
6
4
2
A + B
B
A
0
5
10
15
20
Pressure
[bar]

FIG. 4

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 14 17 2341

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	US 2012/048620 A1 (HOPWOOD FERGUS [US] ET AL) 1 March 2012 (2012-03-01) * paragraph [0022] - paragraph [0032]; claim 1; figures 1-3 *	1,3, 8-12,15 2,13,14	INV. E21B21/08 E21B7/02
Y	WO 03/071096 A1 (SANDVIK TAMROCK OY [FI]; UITTO VESA [FI]) 28 August 2003 (2003-08-28) * paragraph [0019] - paragraph [0021]; figures 1,2 *	2	
Y	GB 1 437 442 A (ROCK FALL CO LTD) 26 May 1976 (1976-05-26) * page 1, line 54 - page 2, line 20; figure 1 *	13,14	
X	WO 2007/122288 A1 (SANDVIK MINING & CONSTR OY [FI]; SORMUNEN TAPANI [FI]; SALONEN MARKUS) 1 November 2007 (2007-11-01) * paragraph [0014] - paragraph [0016]; figure 1 *	1,15	
			TECHNICAL FIELDS SEARCHED (IPC)
A	WO 2007/138170 A1 (SANDVIK MINING & CONSTR OY [FI]; SALONEN MARKUS [FI]) 6 December 2007 (2007-12-06) * abstract; figures 1,2 *	1-15	E21B
A	WO 2004/065761 A1 (SANDVIK TAMROCK OY [FI]; MUONA JOUKO [FI]; NIEMI JAAKKO [FI]; OSARA JU) 5 August 2004 (2004-08-05) * claim 1; figures 1-5 *	1-15	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	21 November 2014	Strømmen, Henrik

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 14 17 2341

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

21-11-2014

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2012048620 A1	01-03-2012	NONE	
WO 03071096 A1	28-08-2003	AU 2003247349 A1	09-09-2003
		FI 20020352 A	23-08-2003
		SE 0401983 A	05-08-2004
		US 2005006143 A1	13-01-2005
		WO 03071096 A1	28-08-2003
		ZA 200406565 A	14-06-2005
GB 1437442 A	26-05-1976	CA 1002514 A1	28-12-1976
		FI 217074 A	20-01-1975
		FR 2238031 A1	14-02-1975
		GB 1437442 A	26-05-1976
WO 2007122288 A1	01-11-2007	AU 2007242714 A1	01-11-2007
		CN 101427002 A	06-05-2009
		EP 2010750 A1	07-01-2009
		FI 20065252 A	22-10-2007
		JP 5396267 B2	22-01-2014
		JP 2009534556 A	24-09-2009
		KR 20090007344 A	16-01-2009
		RU 2008144778 A	27-05-2010
		US 2009071715 A1	19-03-2009
		WO 2007122288 A1	01-11-2007
		ZA 200808954 A	25-11-2009
WO 2007138170 A1	06-12-2007	EP 2021580 A1	11-02-2009
		FI 20065369 A	02-12-2007
		WO 2007138170 A1	06-12-2007
WO 2004065761 A1	05-08-2004	AT 356275 T	15-03-2007
		AU 2004206070 A1	05-08-2004
		DE 602004005162 T2	13-12-2007
		EP 1590551 A1	02-11-2005
		FI 20030115 A	25-07-2004
		US 2006120892 A1	08-06-2006
		WO 2004065761 A1	05-08-2004

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82