PERCUSSION DEVICE OF ROCK BREAKING DEVICE AND METHOD FOR CONTROLLING PERCUSSION DEVICE

SCHLAGVORRICHTUNG FÜR EINE GESTEINSZERTRÜMMERUNGSVORRICHTUNG UND VERFAHREN ZUR STEUERUNG DER SCHLAGVORRICHTUNG

APPAREIL DE PERCUSSION ET DE CONCASSAGE DE ROCHES ET MÉTHODE DE CONTRÔLE DU DISPOSITIF DE PERCUSSION

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 MT NL NO PL PT RO RS SE SI SK SM TR

Priority: 07.06.2011 FI 20115550

Date of publication of application: 16.04.2014 Bulletin 2014/16

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Description

Background of the invention

[0001] The invention relates to a pressure medium-operated percussion device of a rock breaking device for providing impact pulses to a rock breaking tool, according to the preamble of claim 1. Such a percussion device is known from US 2003/0006052 A1.

[0002] The percussion device comprises a percussion piston, on the working pressure surfaces of which a pressure medium is directed to act, whereby the percussion piston moves back and forth in the impact and return directions. The work cycle of the percussion piston is controlled by a control valve that has positions for directing the pressure medium to act on the working pressure surfaces of the percussion piston and away from them. The control valve is a sleeve-like piece around the percussion piston.

[0003] Further, the invention relates to a method for controlling the work cycle of a percussion piston of a hydraulic percussion device.

[0004] The field of the invention is described in more detail in the preambles of the independent claims of the patent application.

[0005] Percussion devices intended to break rock have a percussion piston that moves back and forth and hits a tool or intermediate piece on the forward side of the percussion piston. Hydraulic percussion devices typically have a control valve that directs pressure medium flows to the working pressure surfaces of the percussion piston and away from them, thus, controlling the reciprocating movement or work cycle of the percussion piston. The position of the control valve is altered in relation to the position of the percussion piston by directing the pressure medium along pressure medium channels to the working pressure surfaces of the valve. Flanges on the percussion piston displace the pressure medium flow required to move the valve. It has been found that in controlling the control valve a large quantity of pressure medium is momentarily required and that leakage flows over the percussion piston flanges are high. Owing to these facts, the efficiency of conventional percussion devices is insufficient.

Brief description of the invention

[0006] It is an object of the present invention to provide a novel and improved percussion device of a rock breaking device as well as a method for controlling its work cycle.

[0007] The percussion device of the invention is defined by the features of claim 1, and characterised in that the percussion device comprises, in addition to a first impulse space in the impact direction, a second impulse space in the return direction, whereby an initial impulse for the alternating movement is provided to the control valve in both extreme positions.

[0008] The method of the invention is defined by the features of claim 8, and characterised by generating pressure pulses in a first impulse space in the impact direction and a second impulse space in the return direction, by using the pressure pulses to alter the position of the control valve in both extreme positions.

[0009] The idea is that the position of the percussion piston is detected in both travel directions, that is, in the impact and return directions, by means of pressure pulses generated in the impulse spaces. The pressure pulse provides the sleeve-like control valve an initial impulse in both extreme positions, that is, triggers a change in the valve position. Further, the percussion piston has an impact-direction impulse edge and a return-direction impulse edge that close the pressure connection to the impulse space, whereby the impulse space becomes momentarily a closed pressure space and a pressure pulse is generated. The pressure pulse affects one or more control valve pressure surfaces that are in the impulse space.

[0010] One advantage is that the present solution permits a simple and strong structure for detecting the position of the percussion piston in both impact and return directions. The pressure pulse is used to initiate a change in the position of the control valve. It is no longer necessary to control large pressure fluid volumes by means of percussion piston flanges to move the control valve. Efficiency can be improved, because it is possible to reduce leakage flows past the percussion piston edges. Edge or skirt leakage of a percussion piston is a significant single leakage in conventional percussion devices. It is also possible to reduce the leakages of the control valve. Further, as the pressure surfaces of the valve are in the impulse space, there is no need for long channels to transmit pressure pulses. Thus, pressure losses may be negligible. The structure also makes it possible to change the properties of the percussion device relatively easily by replacing the control valve.

[0011] The idea of an embodiment is that the outer rim of the percussion piston has one impulse flange located at the control valve. The impulse flange has an impact-direction impulse edge and a return-direction impulse edge. Further, there is at least one counter-flange on the inner rim of the control valve to define the impulse space in the axial direction. When the impulse edge arrives at the counter-flange during the movement of the percussion piston, the impulse space closes and a pressure pulse is generated.
The idea of an embodiment is that two counter-flanges are arranged on the inner rim of the control valve at an axial distance from each other. The advantage of this type of embodiment is that the stroke length may be longer than in solutions with just one counter-flange. Thus, it is possible to affect the stroke length of the percussion piston by the dimensioning of the axial distance between the two counter-flanges.

The idea of an embodiment is that on the outer rim of the percussion piston, there are two impulse flanges, namely an impact-direction impulse flange and a return-direction impulse flange. These flanges are located at the control valve at an axial distance from each other. Each impulse flange comprises an impulse edge. The inner rim of the control valve has at least one counter-flange that defines the impulse space in the axial direction and forms together with the impulse flange the impulse space into a closed impulse space.

The idea of an embodiment is that the outer rim of the control valve has a holding flange, the pressure surfaces of which may be acted on by a holding pressure. The holding pressure provides in the holding surface a holding force that keeps the valve in its extreme position. In addition, the holding pressure and surface may participate in moving the control valve after an initial impulse provided by a pressure pulse. The holding pressure may be a normal percussion circuit pressure.

The idea of an embodiment is that the effect of the pressure pulse on the control valve ends at the latest when the control valve has reached its new extreme position. The alternating movement of the control valve activates a holding force regardless of the movement position of the percussion piston, and the holding force keeps the control valve in the new extreme position until the next change.

The idea of an embodiment is that to generate a pressure pulse, the percussion piston is equipped with a narrow impulse flange and, further, the control valve is equipped with at least one narrow counter-flange. When the percussion piston moves toward its alternating position, the impulse flange passes the counter-flange, whereby a closed pressure space is formed that "opens" when the percussion piston continues its movement and the impulse flange moves away from the counter-flange.

The idea of an embodiment is that the impulse flange and counter-flange do not pass each other, but settle toward each other. Then, when a pressure pulse is generated, the control valve changes its position, as a result of which the percussion piston changes its travel direction.

The idea of an embodiment is that the percussion device comprises one or more start-up valves or start-up circuits. By means of the start-up valve, the control valve may be forced to a predefined extreme position for the purpose of starting a new work cycle of the percussion device. The percussion piston can also be forced by means of a start-up valve to a predefined position for start-up.

**Brief description of the figures**

Some embodiments will be explained in more detail in the attached drawings, in which

Figure 1 is a schematic side view of a rock drilling rig, in which the present percussion devices can be utilized,
Figure 2 is a schematic side view of a rock drilling unit, in which the present percussion devices can be utilized,
Figure 3 is a schematic side view of an excavator equipped with a breaking hammer, in which the present percussion devices can be utilized,
Figure 4 shows in a simplified manner steps and features related to the control of a percussion device,
Figure 5a is a schematic cross-sectional view of a basic structure of a percussion device, in which the control valve is equipped with one internal counter-flange and the outer rim of the percussion piston has one impulse flange,
Figure 5b is a schematic view of a detail of the structure of Figure 5a, and pressure surfaces related to a holding circuit,
Figure 6 is a schematic cross-sectional view of an alternative control valve and features related to its holding circuit,
Figure 7 is a schematic cross-sectional view of an embodiment of a percussion device, in which the control valve is equipped with two internal counter-flanges, and the percussion piston has one impulse flange,
Figure 8 is a schematic cross-sectional view of an embodiment of a control valve and features related to its holding circuit,
Figure 9 is a schematic cross-sectional view of a percussion device, in which the percussion piston is equipped with two impulse flanges and a channel that when closed permits the generation of a pressure pulse,
Figure 10 is a schematic cross-sectional view of a percussion device, in which the percussion piston is equipped with two impulse flanges and the frame of the percussion device has a channel that the percussion piston closes, thus, permitting the generation of a pressure pulse,
Figure 11 is a schematic cross-sectional view of a percussion device, in which the control valve controls the pressure medium in both the front and back spaces of the percussion piston, and
Figure 12 is a schematic cross-sectional view of a percussion device, in which the impact-direction impulse space is between the percussion piston and frame and the return-direction impulse space is between the percussion piston and control valve.
In the figures, some embodiments are shown in a simplified manner for the sake of clarity. Like reference numerals refer to like parts in the figures.

Detailed description of some embodiments

Figure 1 shows a rock drilling rig 1 that comprises a movable carrier 2 which is provided with one or more drilling booms 3. The drilling boom 3 is provided with a rock drilling unit 4 that comprises a feed beam 5 and a feed device 7, with which the rock drilling machine 6 may be moved on the feed beam 5 in the impact direction A and return direction B. The rock drilling unit 4 can be used to drill boreholes for excavating rock, or it can be used to drill boreholes for reinforcements set into the rock.

Figure 2 shows a rock drilling unit 4 that comprises a rock drilling machine 6, to the drill shank 8 of which a percussion tool 9 is attached with a drill bit 10 at its outermost end. The rock drilling machine 6 comprises a percussion device 11 to provide impact pulses to the drill shank 8 that, in turn, transmits the impact pulses through the drilling tool 9 to the rock 12 being drilled. At the same time, the rock drilling machine 6 is fed by means of the feed device 7 toward the rock, whereby the buttons on the drill bit 10 break the rock and a borehole 13 is formed. Typically, the rock drilling machine 6 also comprises a rotating device 14 for rotating the drill shank 8 and the attached drilling tool 9 around its longitudinal axis. The rock drilling machine 6 comprises a frame 15 that may be fastened to a carriage 16 arranged to be supported by the feed beam 5. The frame 15 of the rock drilling machine may have a space, into which the percussion device 11 and the related components are arranged.

Figure 3 shows an excavator 17 with a moveable carrier 2 and a boom 3 equipped with a breaking hammer 18. The breaking hammer 18 can be used to break boulders, rock, earth’s crust and the like. The breaking hammer 18 comprises a frame 19, inside which a percussion device 11 is arranged to provide impact pulses to a tool 20 that under the influence of the impact pulses penetrates the material 12 to be broken and breaks it.

The percussion devices, their various embodiments and feature combinations shown in the following Figures 4 to 12 can be used as percussion devices in rock drilling machines and breaking hammers of the type described above.

Figure 4 illustrates the steps related to the operation of a percussion device. The percussion device is started up by directing hydraulic pressure to it from a pump or a similar pressure source along pressure medium channels. The percussion device may be equipped with one or more start-up valves that forcibly control a control valve and percussion piston to a predefined position for the start-up of the percussion device. The pressure acting on the working pressure surfaces of the percussion piston of the percussion device makes the percussion piston perform a reciprocating movement according to its work cycle. The control valve directs the supply of pressure fluid to the pressure surfaces so that the motion of the percussion piston changes between the impact direction and return direction. The impulse flange or the like on the outer rim of the percussion piston and the counter-flange on the inner rim of the control valve define impulse spaces between the percussion piston and control valve in both travel directions, that is, impact direction and return direction. Further, the percussion piston has impulse edges in both travel directions. The impulse edges close the pressure connection to the impulse spaces when the percussion piston approaches its extreme positions. The closing of the pressure connection causes a sudden pressure increase, that is, a pressure pulse, in the closing impulse space. This pressure pulse acts on the pressure surfaces of the control valve in the impulse spaces. When a pressure pulse acts on the pressure surface of the control valve, an axial-direction force effect is generated to provide the control valve an initial impulse toward its opposite extreme position, that is, the pressure pulse initiates the alternating movement of the control valve. The control valve may alternate its position under the effect of the pressure pulse, or other pressures that move the valve to its new extreme position may be directed to the pressure surfaces of the control valve after its initial movement. In its extreme positions, the control valve is acted on by a holding pressure that generates holding forces in the pressure surfaces to keep the valve in place in its extreme positions. With the pressure pulse, the control valve is destabilized in its extreme position so that, in spite of the holding force, it begins its movement toward its opposite extreme position. When the valve has reached its new position, it remains there until the next pressure pulse. The percussion device continues its operation as long as pressure fluid pressure is directed to it.

Figure 5a shows the structure of a percussion device 11. The percussion device comprises a frame 21 that may essentially be a tubular elongated piece. The percussion device also comprises an elongated percussion piston 22 with a percussion surface 23 at its impact-direction A end to hit a shank or directly a tool, when the percussion piston 22 moves back and forth according to its work cycle. The percussion piston 22 comprises sections 22a to 22e of different diameters, whereby the percussion piston 22 has working pressure surfaces 24 and 25 to which pressure fluid pressure can be directed to act on so that the percussion piston moves in the desired travel direction. The first working pressure surface 24 is in a first working pressure space 26, that is, front space. A continuous pressure fluid pressure is directed from a pressure channel 27 to the working pressure space 26, whereby a force acts on the percussion piston 22 during the entire work cycle and endeavours to move it into the return direction B. The second working pressure surfaces 25 are in a second working pressure space 28, that is, back space, that is connected to a pressure channel 29 to provide the percussion movement A of the percussion piston and to a tank channel 30 to provide the return movement B. The
flow of the pressure fluid into and out of the working pressure space 28 is controlled by a control valve 31 that is an elongated sleeve-like piece arranged around the percussion piston 22 in a space formed in the frame 21. The control valve 31 moves axially back and forth between its extreme positions during the work cycle of the percussion device 11. When the control valve 31 moves into its return-direction B control position, it closes the pressure channel 29 and opens the tank channel 30. Correspondingly, when the control valve 31 moves to its left-side control position, it closes the tank channel 30 and opens the pressure channel 29. The second working pressure surfaces 25 are dimensioned to be clearly larger in surface area than the first working pressure surface 24, whereby the movements of the percussion piston 22 can be controlled by altering the pressure of the pressure fluid acting in the second working pressure space 28. The position change of the control valve 31 takes place in relation to the position of the percussion piston 22. The following discusses in more detail how to control the work cycle of the percussion piston 22, that is, the movement from the percussion point to the rear turning point and back, by means of the control valve 31.

[0027] The outer rim of the percussion piston 22 has an impulse flange 32 and the inner rim of the control valve 31 has a counter-flange 33. Further, a first, impact-direction A impulse space 34 and a second, return-direction B impulse space 35 are formed in the back space 28 when the percussion piston 22 approaches its extreme positions. Namely, at this point, the impulse flange 32 arrives at the location of the counter-flange 33. The impulse spaces 34 and 35 are annular spaces between the percussion piston 22 and control valve 31, and they are defined in the axial direction by the impulse flange 32 and counter-flange 33. The purpose of the impulse flange 32, counter-flange 33 and impulse spaces 34, 35 is to generate, as the percussion piston 22 approaches its extreme position, a pressure pulse that is used to alter the position of the control valve 31 and, consequently, to change the travel direction of the percussion piston 22.

[0028] The impulse flange 32 comprises axial surfaces K1 and K2 that make the impulse spaces smaller in the axial direction, when the percussion piston 22 moves toward them. When the percussion piston 22 moves in the return direction B, the impulse space 35 is made smaller not only by the surface K2, but also the working pressure surface 25. In Figure 5a, the surface K1 decreases the volume of the impulse space 34, when the piston moves in the impact direction A. Further, the impulse flange 32 is equipped with an impact-direction impulse edge S1 and a return-direction impulse edge S2. When the impulse edge S1 arrives at the counter-flange 33, it closes the pressure connection Y to the impulse space 34, after which no more pressure medium can flow from the impulse space 34 to the back space 28. The impulse space 34 then becomes a closed pressure space, and a pressure pulse is generated. Similarly, during the return movement B, the second impulse edge S2 in the percussion piston 22 arrives at the counter-flange 33 and closes the pressure connection Y, as a result of which the second impulse space 35 becomes a closed pressure space, and a pressure pulse is generated.

[0029] An impact-direction A pressure pulse acts on the front-end pressure surface 36 of the control valve 31, and a return-direction B pressure pulse acts on the back-end pressure surface 37 of the valve. The pressure surfaces 36 and 37 are in the impulse spaces 34 and 35. Between the pressure surfaces 36, 37 and the frame 21, there are openings 38, 39, so that the pressure pulse can act on the pressure surfaces. The pressure pulse can provide the initial trigger, with which the position change of the control valve 31 is started.

[0030] In Figure 5a, the control valve 31 is in its extreme position in the impact direction A, where the forces acting on its pressure surfaces keep it until a pressure pulse acts on its pressure surface 36 to provide the initial impulse to change its position in the return direction B. Thus, the pressure pulse destabilizes the position of equilibrium of the control valve at its end positions. The holding forces ensure that the valve is continuously synchronized to the movements of the percussion piston.

[0031] Further, the back end of the control valve 31 has on the outer rim of the valve a pressure surface 40, on which the pressure in the pressure channel 29 acts continuously. The pressure surfaces 36, 37, 40 are dimensioned in such a manner that holding forces act on the control valve 31 in its extreme positions. The dimensioning of the pressure surfaces is discussed in more detail in connection with Figure 5b.

[0032] Figure 5a further shows that the back end of the frame 21 may have an end sleeve 42 that may comprise one or more bearings 43 and one or more seals 44. Correspondingly, the impact-direction A side front end may have a similar end sleeve and a bearing 45 and seals 46. The sections between the seals 44, 46 and bearings 43, 45 may be connected to drain channels 47 to conduct possible leakage flows to the tank T.

[0033] Figure 5b shows the pressure surfaces A1 to A6 that affect the generation of holding forces. As can be seen in the figure, the control valve 31 has pressure surfaces of different sizes. The control valve 31 is not connected to any separate pressure channel for supplying holding pressure, but the pressure in the back working space 28 is utilized to generate the holding forces. In the back working space 28 of the percussion piston, the pressure varies during the work cycle, and this pressure variation is utilized in generating the impact-direction holding force FpA and return-direction holding force FpB.

[0034] When the control valve 31 is in the position according to Figure 5b, the back working space 28 is connected to the pressure channel 29, as a result of which the holding force FpA acts on the control valve, and its size may be calculated as follows:
wherein \( P \) is the pressure in the pressure channel 29, that is, the impact pressure, and \( T \) is the tank pressure. The pressure surfaces A5 and A6 on the counter-flange 33 are equal in size.

When the control valve 31 moves to its return-direction B extreme position under the effect of the pressure pulse, the pressure of the pressure channel 29 acts only on the pressure surface A2. The back working space 28 is connected to the tank channel 30, whereby its pressure acts on the pressure surfaces A4, A5, A6, and A3. Further, the pressure surface A1 is continuously connected to the tank channel 41. The size of the holding force \( F_{pB} \) acting on the control valve in this position can be calculated as follows:

\[
F_{pB} = P^2 + T^2 \cdot A_1 + A_2 = P^2 + T^2 \cdot A_1 + A_2
\]

in which case the surface areas A1 and A2 can be defined as follows:

\[
A_1 < \frac{P}{T} (A_3 - A_4 - A_2)
\]

\[
A_2 > \frac{T}{P} (A_3 - A_1 - A_4)
\]
the control valve 31 remains in its return-direction extreme position. The pressure of the impact pressure channel 60 acts through the channel 27 on the front working space 26 and pressure surface 24. Because the back working space 28 is connected to the tank, the percussion piston 22 moves in the return direction B. After this, the control valve 31 controls the work cycle of the percussion device 11.

[0039] The percussion device shown in Figure 7 differs somewhat in structure from the embodiments shown in the earlier figures, but the basic principle is the same with respect to the work cycle control. In Figure 7, the inner rim of the control valve 31 has two counter-flanges 33a and 33b at an axial distance from each other. This type of control valve 31 permits a longer stroke length for the percussion piston 22 than a solution with just one counter-flange that participates in the generation of the pressure pulse in both alternating positions of the percussion piston. Between the impact-direction counter-flange 33a and return-direction counter-flange 33b, there are channels 62 and 63, through which pressure medium is allowed to discharge from the space between the counter-flanges 33a, 33b. A return-direction pressure pulse is then generated only when the impulse edge S2 meets the counter-flange 33b and, correspondingly, an impact-direction pressure pulse is generated only when the impulse edge S1 meets the counter-flange 33a. The pressure pulse formed in the impulse space 35 acts on the pressure surface 37, and the valve 31 moves in the impact direction A, as a result of which the connections to the holding channel 50 and tank channels 30, 61 close and the connections to the channels 29 and 50 open. The back working space 28 is then under impact pressure that makes the percussion piston 22 begin an impact-direction A movement. When the impulse edge S1 in the percussion piston arrives at the counter-flange 33b, no closed pressure space is formed in the impact direction A side of the impulse flange 32, and the pressure can discharge through the opening 62 into the channel 50. Only after the impulse edge S1 meets the counter-flange 33a, the closed impulse space 34 is formed as is a pressure pulse that acts on the pressure surface 36 and pushes the valve 31 into the return direction. When the valve 31 moves under the effect of the pressure pulse in the return direction B, the holding pressure of the channel 50 acts on the holding surface 49 and the thus generated force participates in moving the valve 31 toward its extreme position. The start-up surface 59 does not participate in controlling the position of the control valve 31 during the work cycle of the percussion device.

[0040] When the control valve 31 is in the return-direction B extreme position, it is affected by a return-direction holding force that is formed when pressure acts on the holding surface 49. In the impact-direction A extreme position, pressure from the channel 29 acts on the entire surface area of the back end of the valve 31. Thus, Figure 7 shows a holding arrangement based on the combination of a separate holding surface and the pressure surface in the back space.

[0041] As in Figure 7, the control valve 31 shown in Figure 8 comprises two counter-flanges 33a, 33b and channels 62, 63 between them. Further, the control valve 31 of Figure 8 has holding surfaces 49a, 49b as well as pressure channels 50a, 50b and tank channels 51 a, 51 b leading to them as in Figure 6.

[0042] When in the situation shown in Figure 8, the percussion piston 22 moves in the impact direction A, the impulse flange S1 arrives at the counter-flange 33a and closes the pressure connection to the impulse space 34. A pressure pulse is then generated that acts on the pressure surface 36 in the impulse space 34. The sudden force effect caused by the pressure pulse in the return direction B overcomes the holding force formed by the holding surface 49a, and the valve 31 moves in the return direction B. As a result of this, the holding channel 50a closes, the tank channel 51a opens, and pressure is directed from the holding channel 50b to the holding surface 49b and the channels 51b and 62 close. Further, a connection opens from the channel 63 to the tank channel 64. A return-direction holding force is formed on the holding surface 49b to keep the valve 31 in its extreme position until the impulse edge S2 arrives at the counter-flange 33b. When the impulse flange 32 arrives at the counter-flange 33a during the return-direction B movement, no closed pressure space is formed on the return-direction side of the impulse flange 32, because the pressure can discharge from the channel 63 to the tank channel 64.

[0043] Figures 9 and 10 show two different situations of the percussion device 11, that is, above the centreline of the percussion piston 22, the percussion piston moves in the impact direction A, and below the centreline, the piston moves in the return direction B.

[0044] The structure of the control valve 31 of the percussion device 11 shown in Figure 9 corresponds to that shown in Figure 5a. The percussion piston 22 differs from all solutions presented above, because it is equipped with two impulse flanges, namely an impact-direction A impulse flange 32a and a return-direction B impulse flange 32b. Further, the percussion piston 22 has one or more channels 65, through which the pressure medium can flow between the front and back parts of the back working space 28. When the percussion piston 22 moves in the impact direction A and the impulse flange 32b arrives at the counter-flange 33, the pressure medium can flow along the channel 65 to the back of the impulse flange 32b. Correspondingly, when the percussion piston 22 moves in the return direction B and the impulse flange 32a arrives at the counter-flange 33, the pressure medium can flow along the channel 65 to the front of the impulse flange 32a. Owing to the channel 65, the pressure pulses are only generated when the percussion piston 22 approaches its alternating position.

[0045] In the upper situation shown in Figure 9, the percussion piston 22 has moved in the impact direction A so that the channel 65 has closed and the impulse flange 32a has arrived at the counter-flange 33. A closed impulse space 34 is then formed as well as a pressure pulse that acts on the pressure surface 36. The impulse space 34 has pressure
The percussion device 11 shown in Figure 10 closely corresponds in its basic construction to the percussion device shown in Figure 9. The difference is that the percussion piston 22 does not have the channel 65, and the channel 66 providing the corresponding function is in the frame 21. Further, the percussion piston 22 has grooves or similar sections 67, 68, through which the pressure medium can flow to the channel 66 and on to the other end of the back working space 28. The figure also shows means related to the generation of the pressure pulse, the operation of which corresponds to the principles shown in the earlier figures.

The percussion device 11 shown in Figure 11 differs from those described above in at least that the pressure is varied not only in the back working space 28, but also in the front working space 26. With the control valve 31, connections are opened and closed to the pressure channel 27 and tank channel 69. The control valve 31 has channels 70, 71 for connecting the working spaces 26, 28 to the tank channels 69, 30. In the situation shown in the figure, the control valve 31 is in the impact-direction A position, and pressure is fed from the pressure channel 29 to the back working space 28, and the front working space 26 is connected to the tank channel 69 through the channel 70. A pressure pulse then acts on the surface K1 in the front working space 26, and the percussion piston 22 moves in the impact direction A. The pressure in the back working space 28 also keeps the valve 31 in the impact-direction position. When the piston moves in the impact direction A, the impulse flange 32a and the impulse edge S1 thereon arrive at the counter-flange 33a in the valve 31 and close the pressure connection Y1, whereby a closed impulse space 34 and pressure pulse are formed. The pressure pulse acts on the pressure surface 36 in the impulse space 34 and creates an effect that moves the valve 31 toward the opposite extreme position. When the valve 31 moves to the right in the figure, a connection to the pressure channel 27 opens and the pressure acts on the pressure surface 34 and moves the valve toward the return-direction B position. The channel 70 closes the connection to the tank channel 69. The channel 71 opens the connection from the back working space 28 to the tank channel 30 and the valve 31 also closes the pressure channel 29. Impact pressure then acts in the front working space 26 and tank pressure in the back working space 28. The pressure acts on the pressure surface K1 in the front working space 26, whereby the percussion piston 22 moves in the return direction B. When the percussion piston 22 approaches its alternating position in the return direction, a pressure pulse is again generated and the position of the valve 31 changed according to the principle described above.

Figure 12 shows yet another percussion device 11 that has different impulse means in the impact direction A and return direction B. In the impact direction A, there is an annular impulse space 34 between the frame 21 and percussion piston 22. The percussion piston has a first impulse flange 32a with an impulse edge S1 that closes the impulse space 34. The second, return-direction B impulse space 35 is formed in an annular space between the percussion piston 22 and the sleeve-like control valve 31 in accordance with the principles described in this patent application. The inner rim of the control valve 31 has a counter-flange 33b and the back part of the percussion piston 22 has, at the location of the valve 31, a second impulse flange 32b with an impulse edge S2 and a front surface K2. The first impulse edge S1 closes the pressure connection Y1 from the impulse space 34 to a channel 72, whereby a pressure pulse is generated and transmitted along an impulse channel 73 in the frame 21 to a pressure surface 74 on the outer rim of the valve 31. A pressure pulse generated in the second impulse space 35 acts directly on the pressure surface 37 on the back surface of the control valve 31. Thus, Figure 12 shows a combination of two different impulse generation principles. The impulse spaces 34, 35 are located at an axial distance from each other in separate pressure spaces. The pressure surfaces of the control valve 31 are dimensioned in such a manner that holding forces act on the valve in its extreme positions in accordance with the principle shown in Figure 5b, for instance.

Figure 12 also shows a start-up valve 75, with which the control valve 31 can be forced to its return-direction B extreme position and the percussion piston 22 is made to move in the impact direction A. The start-up valve 75 has positions a and b. In position a, pressure is fed along the start-up channel 50 to the start-up surface 49 of the valve 31, whereby the valve moves in the return direction B. The back working space 28 is then connected to the tank channel 30 and the pressure channel 29 is closed. When the start-up valve 75 is moved to position b, pressure is connected to an impact pressure circuit 60, whereby the front working space 26 becomes pressurized and the percussion piston 22 begins its return-direction movement. After this, the work cycle of the percussion piston is controlled by means of the control valve 31.

It is also possible to supply start-up pressure to the channel 41 shown in Figures 5a, 5b, 9, and 10 by means of a start-up valve or circuit. During the normal work cycle of the percussion device, the channel 41 is connected to the tank with the letter T. The channels in the pressure line are marked with the letter P.

For practical reasons, the embodiments of the figures have not been described in detail and completely in every description of the figures, but the structures and operating principles shown in different figures may also be used to understand the embodiments in other figures.
Differing from the figures of this patent application, the return-direction end of the percussion piston 22 may move in the pressure space, in the pressure space of a pressure accumulator, for instance, in which case the return movement of the percussion piston charges pressure energy into the pressure accumulator which can then be used during the next stroke length.

In some figures, reference marking H indicates a long edge or skirt that is made possible by the construction of the invention. Thanks to a long sealing surface, leakages between the control valve 31 and frame 21 may be insignificant. The efficiency of the percussion device 11 is then good.

A pressure pulse is a sudden, impulse-like pressure having a higher pressure than the basic pressure and a short duration. A pressure pulse may have a high pressure and short time of effect. However, this type of pressure pulse may provide a change in the prevailing state, even if some other pressure and pressure surfaces were used in performing the change.

The drawings and the related description are only intended to illustrate the idea of the invention. The details of the invention may vary within the scope of the claims.

Claims

1. A pressure medium-operated percussion device of a rock breaking device arranged to provide impact pulses to a rock breaking tool, the percussion device (11) comprising:
   - a frame (21);
   - a percussion piston (22) that is during its work cycle arranged to move axially back and forth in the impact direction (A) and return direction (B), when the pressure medium acts on its working pressure surfaces (24, 25);
   - at least one pressure-controlled sleeve-like control valve (31) that is arranged around the percussion piston (22) and has positions for directing the pressure medium to act on at least one working pressure surface (25) of the percussion piston (22) and away from it for the purpose of controlling the work cycle of the percussion piston, the control valve (31) being equipped with pressure surfaces (36, 37) and the control valve being arranged to move between its extreme positions under the influence of the pressure medium acting on the surfaces;
   - at least one impulse space (34, 35) that comprises an annular space between the percussion piston (22) and control valve (31);
   - at least one surface (K1, K2) on the percussion piston (22) which defines the impulse space (34, 35) in the axial direction and reduces the volume of the impulse space as the percussion piston moves toward it;
   - the impulse space (34, 35) being in a pressure connection with at least one pressure surface (36, 37) of the control valve (31) located in the impulse space (34, 35);
   - and the impulse space (34, 35) having at least one pressure connection (Y1, Y2) for the flow of the pressure medium from the impulse space;
   - at least one impulse edge (S1, S2) on the percussion piston (22) for closing the pressure connection to the impulse space (34, 35), whereby the impulse space becomes a closed pressure space and a pressure pulse is generated;
   - the pressure pulse affecting the control valve (31) and providing its alternating movement an initial impulse toward its opposite extreme position; wherein the percussion device (11) comprises a first impulse space (34) in the impact direction (A), and the percussion piston (22) has impulse edges (S1, S2) in both travel directions (A, B);
   - characterized in that
     - the percussion device (11) further comprises a second impulse space (35) in the return direction (B); whereby the control valve (31) is provided an initial impulse of the alternating movement in both its extreme positions.

2. A percussion device as claimed in claim 1, characterized in that
   - the outer rim of the percussion piston (22) has an impulse flange (32) located at the control valve (31);
   - the impulse flange (32) comprises an impact-direction (A) impulse edge (S1) and a return-direction (B) impulse edge (S2); and
   - the inner rim of the control valve (31) has at least one counter-flange (33) that defines the impulse space (34, 35) in the axial direction and that is arranged to make together with the impulse flange (32) the impulse space (34, 35) a momentarily closed space.

3. A percussion device as claimed in claim 2, characterized in that
   - the inner rim of the control valve (31) has two counter-flanges (33a, 33b) at an axial distance from each other.
4. A percussion device as claimed in claim 1, characterized in that

the outer rim of the percussion piston (22) has an impact-direction (A) impulse flange (32a) and a return-direction (B) impulse flange (32b) located at the control valve (31) at an axial distance from each other;

the impact-direction impulse flange (32a) comprises an impact-direction impulse edge (S1) and the return-direction impulse flange (32b) comprises a return-direction impulse edge (S2); and

the inner rim of the control valve (31) has at least one counter-flange (33) that defines the impulse space (34, 35) in the axial direction and that is arranged to make together with the impulse flange (32a, 32b) the impulse space (34, 35) a momentarily closed space.

5. A percussion device as claimed in any one of the preceding claims, characterised in that

the effect of the pressure pulse on the control valve (31) ends at the latest when the control valve has reached its new extreme position; and

the alternating movement of the control valve (31) activates a holding force regardless of the movement position of the percussion piston (22), and the holding force keeps the control valve in the new extreme position until the next change.

6. A percussion device as claimed in claim 5, characterized in that

the outer rim of the control valve (31) has a holding flange (48), and the holding pressure acting on its pressure surfaces (49) is arranged to generate a holding force.

7. A percussion device as claimed in any one of the preceding claims, characterised in that

the impulse spaces (34, 35) are connected to each other via at least one channel (65, 66) that is in the frame (21) or percussion piston (22); and

the percussion piston (22) is arranged to close said channel (65, 66) before the impulse edge (S1, S2) closes the impulse space (34, 35).

8. A method for controlling a percussion device of a rock breaking device, the method comprising:

controlling by means of at least one pressure-controlled control valve (31) pressure medium in and out of at least one pressure space (26, 28) of a percussion piston (22) belonging to the percussion device (11) for the purpose of controlling the work cycle of the percussion piston (22);

moving the control valve (31) between its extreme positions in relation to the position of the percussion piston (22);

generating during the movement of the percussion piston (22) a pressure pulse by closing with the percussion piston (22) the pressure connection to at least one impulse space (34, 35) that comprises an annular space between the percussion piston (22) and the sleeve-like control valve (31) surrounding it; and

transmitting the pressure pulse to at least one pressure surface (36, 37) of the control valve (31) and providing with the pressure pulse an initial impulse to the alternating movement of the control valve toward the opposite extreme position;

characterised by

generating the pressure pulses in a first impulse space (34) in the impact direction (A) and a second impulse space (35) in the return direction (B); and

using the pressure pulses to change the position of the control valve (22) between its extreme positions.

9. A method as claimed in claim 8, characterised by

releasing the closure of the impulse space (34, 35) before the control valve (31) has reached its new extreme position, whereby the effect of the pressure pulse on the control valve ends;

activating, by the alternating movement of the control valve (31) and independent of the movement position of the percussion piston (22), a holding pressure to act on the at least one pressure surface of the control valve; and

keeping the control valve in the new extreme position by means of the holding pressure until the next change.

10. A method as claimed in claim 8 or 9, characterised by

generating the holding forces acting on the control valve (31) in its extreme positions by directing on its pressure surfaces a pressure that endeavours to keep the control valve (31) in its extreme position;

transmitting the pressure pulse to at least one pressure surface of the control valve (31) and deflecting the control valve from its extreme position by means of the force caused by the pressure pulse; and

finishing the transfer movement of the control valve (31) under the effect of the holding forces.

11. A method as claimed in any one of preceding claims 8 to 10, characterised by
directing to at least one pressure surface of the control valve (31) an adjustable pressure medium pressure to affect the travel rate of the control valve in the control direction that affects the return-direction (B) movement of the percussion piston (22); and adjusting the stroke length of the percussion piston (22) by affecting in said manner the travel rate of the control valve (31).

12. A method as claimed in any one of preceding claims 8 to 11, characterised by forcing the control valve (31) by means of a start-up valve (53, 75) to a predefined extreme position for the purpose of starting a new work cycle of the percussion device (11).

**Patentansprüche**

1. Mit Druckmedium betriebene Schlagvorrichtung einer Gesteinsbrechervorrichtung, die so eingerichtet ist, dass sie einem Gesteinsbrecherwerkzeug Schlagimpulse zuführt, wobei die Stoßvorrichtung (11) umfasst:

   einen Rahmen (21);
   einen Stoßkolben (22), der so eingerichtet ist, dass er sich während seines Arbeitszyklus in der Schlagrichtung (A) und der Rückkehrrichtung (B) axial hin- und her bewegt, wenn das Druckmedium auf seine Arbeitsdruckflächen (24, 25) wirkt;
   wenigstens ein druckgesteuertes Schieber-Steuerventil (31), das um den Stoßkolben (22) herum angeordnet ist und Positionen hat, in denen das Druckmedium so geleitet wird, dass es auf wenigstens eine Arbeitsdruckfläche (25) des Stoßkolbens (22) wirkt,
   und davon weggeleitet wird, um den Arbeitszyklus des Stoßkolbens zu steuern, das Steuerventil (31) mit Druckflächen (36, 37) versehen ist und das Steuerventil so eingerichtet ist, dass es sich unter dem Einfluss des auf die Flächen wirkenden Druckmediums zwischen seinen äußersten Positionen bewegt; wenigstens einen Impuls-Raum (34, 35), der einen ringförmigen Raum zwischen dem Stoßkolben (22) und dem Steuerventil (31) umfasst;
   wenigstens eine Fläche (K1, K2) an dem Stoßkolben (22), die den Impuls-Raum (34, 35) in der axialen Richtung begrenzt und das Volumen des Impuls-Raums verringert, wenn sich der Stoßkolben auf sie zu bewegt;
   wobei der Impuls-Raum (34, 35) in Druckverbindung mit wenigstens einer Druckfläche (36, 37) des Steuerventils (31) steht, die sich in dem Impuls-Raum (34, 35) befindet;
   und der Impuls-Raum (34, 35) wenigstens eine Druckverbindung (Y1, Y2) für den Fluss des Druckmediums aus dem Impuls-Raum aufweist;
   wenigstens eine Impuls-Kante (S1, S2) an dem Stoßkolben (22), mit der die Druckverbindung zu dem Impuls-Raum (34, 35) geschlossen wird, so dass der Impuls-Raum ein geschlossener Druckraum wird und ein Druckimpuls erzeugt wird;
   wobei der Druckimpuls das Steuerventil (31) beeinflusst und seiner abwechselnden Bewegung einen Anfangsimpuls auf seine entgegengesetzte äußerste Position zu verleiht;
   und die Stoßvorrichtung (11) einen ersten Impuls-Raum (34) in der Schlagrichtung (A) umfasst und der Stoßkolben (22) Impuls-Kanten (S1, S2) in beiden Bewegungsrichtungen (A, B) hat; **dadurch gekennzeichnet, dass**
   die Stoßvorrichtung (11) des Weiteren einen zweiten Impuls-Raum (35) in der Rückkehrrichtung (B) umfasst; so dass das Steuerventil (31) einen Anfangsimpuls der abwechselnden Bewegung an seinen beiden äußersten Positionen erhält.

2. Stoßvorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** der äußere Rand des Stoßkolbens (22) einen Impuls-Flansch (32) aufweist, der sich an dem Steuerventil (31) befindet; der Impuls-Flansch (32) eine Impuls-Kante (S1) in Schlagrichtung (A) sowie eine Impuls-Kante (S2) in Rückkehrrichtung (B) umfasst; und der innere Rand des Steuerventils (31) wenigstens einen Gegenflansch (33) aufweist, der den Impuls-Raum (34, 35) in der axialen Richtung begrenzt und der so angeordnet ist, dass er zusammen mit dem Impuls-Flansch (32) den Impuls-Raum (34, 35) zu einem vorübergehend geschlossenen Raum macht.

3. Stoßvorrichtung nach Anspruch 2, **dadurch gekennzeichnet, dass** der innere Rand des Steuerventils (31) zwei Gegenflansche (33a, 33b) in einem axialen Abstand zueinander hat.
4. Stoßvorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** der äußere Rand des Stoßkolbens (22) einen Impuls-Flansch (32a) in Schlagrichtung (A) sowie einen Impuls-Flansch (32b) in Rückkehrrichtung (B) hat, die sich an dem Steuerventil (31) in einem axialen Abstand zueinander befinden; der Impuls-Flansch (32a) in Schlagrichtung eine Impuls-Kante (S1) in Schlagrichtung umfasst und der Impuls-Flansch (32b) in Rückkehrrichtung eine Impuls-Kante (S2) in Rückkehrrichtung umfasst; und der innere Rand des Steuerventils (31) wenigstens einen Gegenflansch (33) aufweist, der den Impuls-Raum (34, 35) in der axialen Richtung begrenzt und der so angeordnet ist, dass er zusammen mit dem Impuls-Flansch (32) den Impuls-Raum (34, 35) zu einem vorübergehend geschlossenen Raum macht.

5. Stoßvorrichtung nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass**

   die Auswirkung des Druckimpulses auf das Steuerventil (31) spätestens dann endet, wenn das Steuerventil seine neue äußerste Position erreicht hat; und

   die abwechselnde Bewegung des Steuerventils (31) unabhängig von der Bewegungsposition des Stoßkolbens (22) eine Haltekraft aktiviert und die Haltekraft das Steuerventil bis zur nächsten Änderung in der neuen äußersten Stellung hält.

6. Stoßvorrichtung nach Anspruch 5, **dadurch gekennzeichnet, dass**

   der äußere Rand des Steuerventils (31) einen Halteflansch (48) hat und der auf seine Halteflächen (49) wirkende Haltedruck so eingerichtet ist, dass er eine Haltekraft erzeugt.

7. Stoßvorrichtung nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass**

   die Impuls-Räume (34, 35) über wenigstens einen Kanal (65, 66) miteinander verbunden sind, der sich in dem Rahmen (21) oder dem Stoßkolben (22) befindet; und

   der Stoßkolben (22) so eingerichtet ist, dass er den Kanal (65, 66) schließt, bevor die Impuls-Kante (S1, S2) den Impuls-Raum (34, 35) schließt.

8. Verfahren zum Steuern einer Stoßvorrichtung einer Gesteinsbrechervorrichtung, wobei das Verfahren umfasst:

   Leiten von Druckmedium mittels wenigstens eines druckgesteuerten Steuerventils (31) in wenigstens einen Druckraum (26, 28) eines zu der Stoßvorrichtung (22) gehörenden Stoßkolbens (22) hinein und aus ihm heraus, um den Arbeitszyklus des Stoßkolbens (22) zu steuern;

   Bewegen des Steuerventils (31) zwischen seinen äußersten Positionen in Bezug auf die Position des Stoßkolbens (22);

   Erzeugen eines Druckimpulses durch Schließen der Druckverbindung zu wenigstens einem Impuls-Raum (34, 35), der einen ringförmigen Raum zwischen dem Stoßkolben (22) und dem ihn umgebenden Schieber-Steuerventil (31) umfasst, mit dem Stoßkolben (22) während der Bewegung des Stoßkolbens (22); und

   Übertragen des Druckimpulses auf wenigstens eine Druckfläche (36, 37) des Steuerventils (31) und Erzeugen eines Anfangsimpulses für die abwechselnde Bewegung des Steuerventils auf die entgegengesetzte äußerste Position zu mit dem Druckimpuls; **gekennzeichnet durch**

   Erzeugen der Druckpulspe in einem ersten Impuls-Raum (34) in der Schlagrichtung (A) und einem zweiten Impuls-Raum (35) in der Rückkehrrichtung (B); sowie Nutzen der Druckimpulse, um die Position des Steuerventils (22) zwischen seinen äußersten Positionen zu ändern.

9. Verfahren nach Anspruch 8, **gekennzeichnet durch**

   Öffnen des Verschlusses des Impuls-Raums (34, 35), bevor das Steuerventil (31) seine neue äußerste Position erreicht hat, so dass die Auswirkung des Druckimpulses auf das Steuerventil endet;

   Aktivieren eines Haltedrucks, der auf die wenigstens eine Druckfläche des Steuerventils wirkt, durch die abwechselnde Bewegung des Steuerventils (31) unabhängig von der Bewegungsposition des Stoßkolbens (22); und

   Halten des Steuerventils in der neuen äußersten Position mittels des Halteledrucks bis zur nächsten Änderung.

10. Verfahren nach Anspruch 8 oder 9, **gekennzeichnet durch** Erzeugen der Haltekraft, die auf das Steuerventil (31) in seinen äußersten Positionen wirken, durch Richten eines Drucks auf seine Druckflächen, der versucht, das Steuerventil (31) in seiner äußersten Position zu halten;

    Übertragen des Druckimpulses auf wenigstens eine Druckfläche des Steuerventils (31) und Bewegen des Steuerventils aus seiner äußersten Position mittels der durch den Druckimpuls erzeugten Kraft; sowie

    Beenden der Übergangsbewegung des Steuerventils (31) unter der Wirkung der Haltekraft.
11. Verfahren nach einem der Ansprüche 8 bis 10, gekennzeichnet durch
Leiten eines regulierbaren Druckmedien-Drucks zu wenigstens einer Druckfläche des Steuerventils (31), um die Bewegungsgeschwindigkeit des Steuerventils in der Steuerrichtung zu beeinflussen, die die Bewegung des Stoßkolbens (22) in der Rückkehrrichtung (B) beeinflusst; und
Regulieren der Hublänge des Stoßkolbens (22) durch Beeinflussen der Bewegungsgeschwindigkeit des Steuerventils (31) auf diese Weise.

12. Verfahren nach einem der vorangehenden Ansprüche 8 bis 11, gekennzeichnet durch Drücken des Steuerventils (31) mittels eines Startventils (53, 75) an eine vorgegebene äußerste Position, um einen neuen Arbeitszyklus der Stoßvorrichtung (11) zu starten.

Revendications

1. Dispositif de percussion actionné par un milieu de pression d’un dispositif de rupture de roche, configuré de façon à délivrer des impulsions d’impact à un outil de rupture de roche, le dispositif de percussion (11) comprenant :
un bâti (21) ;
un piston de percussion (22), qui est configuré, durant son cycle de travail, de façon à se déplacer axialement vers l’avant et vers l’arrière dans la direction d’impact (A) et dans la direction de retour (B), lorsque le milieu de pression agit sur ses surfaces de pression de travail (24, 25) ;
au moins une vanne de commande en forme de manchon commandée par pression (31), qui est disposée autour du piston de percussion (22), et qui comporte des positions pour diriger le milieu de pression de façon à agir sur au moins une surface de pression de travail (25) du piston de percussion (22) et de façon à s’éloigner de celle-ci dans le but de commander le cycle de travail du piston de percussion, la vanne de commande (31) étant munie de surfaces de pression (36, 37), et la vanne de commande étant configurée de façon à se déplacer entre ses positions extrêmes sous l’influence du milieu de pression agissant sur les surfaces ;
au moins un espace d’impulsion (34, 35), qui comprend un espace annulaire entre le piston de percussion (22) et la vanne de commande (31) ;
au moins une surface (K1, K2) sur le piston de percussion (22), qui définit l’espace d’impulsion (34, 35) dans la direction axiale, et qui réduit le volume de l’espace d’impulsion lorsque le piston de percussion se déplace vers celle-ci ;
l’espace d’impulsion (34, 35) étant en liaison de pression avec au moins une surface de pression (36, 37) de la vanne de commande (31), disposée dans l’espace d’impulsion (34, 35) ;
et l’espace d’impulsion (34, 35) comportant au moins une liaison de pression (Y1, Y2) pour l’écoulement du milieu de pression à partir de l’espace d’impulsion ;
au moins un bord d’impulsion (S1, S2) sur le piston de percussion (22) pour fermer la liaison de pression vers l’espace d’impulsion (34, 35), grâce à quoi l’espace d’impulsion devient un espace de pression fermé, et une impulsion de pression est générée ;
l’impulsion de pression affectant la vanne de commande (31), et produisant son mouvement alternatif par une impulsion initiale vers sa position extrême opposée ;
dans lequel le dispositif de percussion (11) comprend un premier espace d’impulsion (34) dans la direction d’impact (A), et le piston de percussion (22) comporte des bords d’impulsion (S1, S2) dans les deux directions de déplacement (A, B) ;
caractérisé en ce que :
le dispositif de percussion (11) comprend de plus un deuxième espace d’impulsion (35) dans la direction de retour (B) ;
grâce à quoi la vanne de commande (31) se voit délivrer une impulsion initiale du mouvement alternatif dans ses deux positions extrêmes.

2. Dispositif de percussion selon la revendication 1, caractérisé en ce que :
le rebord extérieur du piston de percussion (22) comporte une bride d’impulsion (32) disposée au niveau de la vanne de commande (31) ;
la bride d’impulsion (32) comprend un bord d’impulsion (S1) de direction d’impact (A) et un bord d’impulsion
3. Dispositif de percussion selon la revendication 2, caractérisé en ce que :
le rebord intérieur de la vanne de commande (31) comporte deux contre-brides (33a, 33b) à une certaine distance axiale l'une de l'autre.

4. Dispositif de percussion selon la revendication 1, caractérisé en ce que :
le rebord extérieur du piston de percussion (22) comporte une bride d'impulsion (32a) de direction d'impact (A) et une bride d'impulsion (32b) de direction de retour (B), disposées au niveau de la vanne de commande (31) et à une certaine distance axiale l'une de l'autre ;
la bride d'impulsion de direction d'impact (32a) comprend un bord d'impulsion de direction d'impact (S1), et la bride d'impulsion de direction de retour (32b) comprend un bord d'impulsion de direction de retour (S2) ; et
le rebord intérieur de la vanne de commande (31) comporte au moins une contre-bride (33) qui définit l'espace d'impulsion (34, 35) dans la direction axiale, et qui est configurée de façon à faire, avec la bride d'impulsion (32a, 32b), de l'espace d'impulsion (34, 35) un espace momentanément clos.

5. Dispositif de percussion selon l'une quelconque des revendications précédentes, caractérisé en ce que :
l'effet de l'impulsion de pression sur la vanne de commande (31) s'achève au plus tard lorsque la vanne de commande a atteint sa nouvelle position extrême ; et
le mouvement alternatif de la vanne de commande (31) active une force de maintien quelle que soit la position de mouvement du piston de percussion (22), et la force de maintien maintient la vanne de commande dans la nouvelle position extrême jusqu'au changement suivant.

6. Dispositif de percussion selon la revendication 5, caractérisé en ce que :
le rebord extérieur de la vanne de commande (31) comporte une bride de maintien (48), et la pression de maintien agissant sur ses surfaces de pression (49) est configurée de façon à générer une force de maintien.

7. Dispositif de percussion selon l'une quelconque des revendications précédentes, caractérisé en ce que :
les espaces d'impulsion (34, 35) sont reliés entre eux par l'intermédiaire d'au moins un canal (65, 66) qui se trouve dans le bâti (21) ou le piston de percussion (22) ; et
le piston de percussion (22) est configuré de façon à fermer ledit canal (65, 66) avant que le bord d'impulsion (S1, S2) ne ferme l'espace d'impulsion (34, 35).

8. Procédé pour commander un dispositif de percussion d'un dispositif de rupture de roche, le procédé comprenant :
la commande, à l'aide d'au moins une vanne de commande commandée par pression (31), d'un milieu de pression vers l'intérieur et vers l'extérieur d'au moins un espace de pression (26, 28) d'un piston de percussion (22) appartenant au dispositif de percussion (11) dans le but de commander le cycle de travail du piston de percussion (22) ;
le déplacement de la vanne de commande (31) entre ses positions extrêmes vis-à-vis de la position du piston de percussion (22) ;
la génération, durant le mouvement du piston de percussion (22), d'une impulsion de pression par fermeture avec le piston de percussion (22) de la liaison de pression vers au moins un espace d'impulsion (34, 35) qui comprend un espace annulaire entre le piston de percussion (22) et la vanne de commande en forme de manchon (31) entourant celui-ci ; et
la transmission de l'impulsion de pression à au moins une surface de pression (36, 35) de la vanne de commande (31), et la production, avec l'impulsion de pression, d'une impulsion initiale pour le mouvement alternatif de la vanne de commande vers la position extrême opposée ;
caractérisé par :
la génération des impulsions de pression dans un premier espace d’impulsion (34) dans la direction d’impact (A) et dans un deuxième espace d’impulsion (35) dans la direction de retour (B) ; et l’utilisation des impulsions de pression pour changer la position de la vanne de commande (22) entre ses positions extrêmes.

9. Procédé selon la revendication 8, caractérisé par :

le relâchement de la fermeture de l’espace d’impulsion (34, 35) avant que la vanne de commande (31) n’ait atteint sa nouvelle position extrême, grâce à quoi l’effet de l’impulsion de pression sur la vanne de commande s’achève ;

l’activation, par le mouvement alternatif de la vanne de commande (31), et indépendamment de la position de mouvement du piston de percussion (22), d’une pression de maintien de façon à agir sur la surface de pression au nombre d’au moins une de la vanne de commande ; et

le maintien de la vanne de commande dans la nouvelle position extrême à l’aide de la pression de maintien jusqu’au changement suivant.

10. Procédé selon la revendication 8 ou 9, caractérisé par :

la génération des forces de maintien agissant sur la vanne de commande (31) dans ses positions extrêmes par le fait de diriger sur ses surfaces de pression une pression qui tente de maintenir la vanne de commande (31) dans sa position extrême ;

la transmission de l’impulsion de pression à au moins une surface de pression de la vanne de commande (31), et l’infléchissement de la vanne de commande à partir de sa position extrême à l’aide de la force provoquée par l’impulsion de pression ; et

l’achèvement du mouvement de transfert de la vanne de commande (31) sous l’effet des forces de maintien.

11. Procédé selon l’une quelconque des revendications 8 à 10 qui précèdent, caractérisé par :

le fait de diriger vers au moins une surface de pression de la vanne de commande (31) une pression de milieu de pression réglable pour affecter le taux de déplacement de la vanne de commande dans la direction de commande qui affecte le mouvement de direction de retour (B) du piston de percussion (22) ; et

le réglage de la longueur de course du piston de percussion (22) par le fait d’affecter de ladite manière le taux de déplacement de la vanne de commande (31).

12. Procédé selon l’une quelconque des revendications 8 à 11 qui précèdent, caractérisé par :

le fait de forcer la vanne de commande (31), à l’aide d’une vanne de démarrage (53, 75), vers une position extrême prédéfinie, dans le but de démarrer un nouveau cycle de travail du dispositif de percussion (11).
FIG. 3

Start-up of percussion device

Start-up valve

Percussion device work cycle wherein percussion piston moves back and forth

Impulse space is annular space between percussion piston and sleeve-like control valve

Closing pressure connection to impulse space, the volume of which the percussion piston decreases

Percussion piston with impulse edges

Sudden pressure increase in impulse space, pressure pulse to control valve

Both directions A and B

Triggering or initiation of position change of control valve with pressure pulse

Holding forces keep control valve at extreme position until new pressure pulse

Change of control valve position and percussion piston travel direction

FIG. 4
REFERENCES CITED IN THE DESCRIPTION

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