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(54) Percussion device

(57) The invention relates to a pressure liquid-operated percussion device (1) comprising a body (2), a piston cylinder (3) in the body (2) and a percussion piston (4) moving in the piston cylinder (3) in its longitudinal direction in a reciprocating manner by the action of pressure liquid, at a first end of the piston cylinder (3), a first pressure liquid space (5) and a first pressure surface (7) of the percussion piston in the first pressure liquid space (5), at the other end of the piston cylinder (3), a second pressure liquid space (6) and in the percussion piston a second pressure surface (8) in a second pressure liquid space (6). In the pressure liquid-operated percussion device, when the percussion piston (4) continues its movement in the first direction towards the second pressure liquid space (6), the volume of the first pressure liquid space (5) expands (5), whereby the pressure of the pressure liquid in the first pressure liquid space (5) decreases.

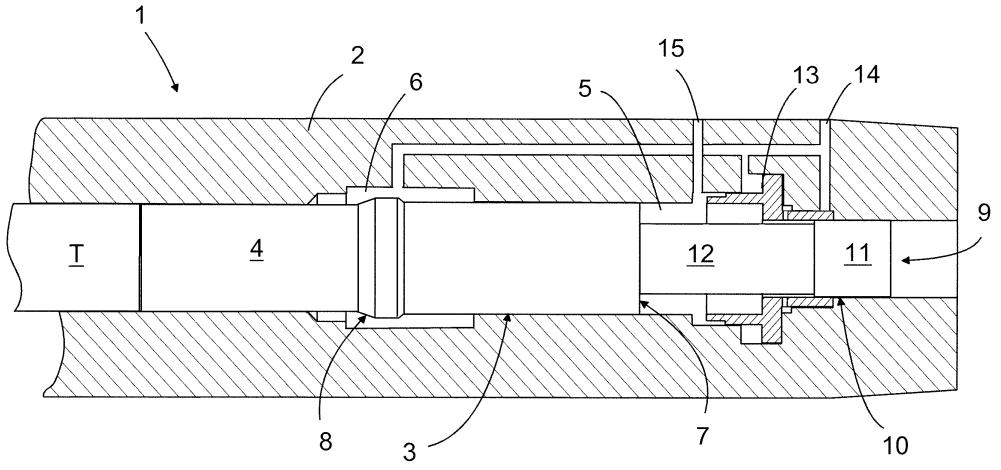

FIG. 1

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Description

BACKGROUND OF THE INVENTION

[0001] This invention relates to a pressure liquid-operated percussion device comprising
a body, a piston cylinder in the body and a percussion piston moving in the piston cylinder in its longitudinal direction in a reciprocating manner by the action of pressure liquid,
at a first end of the piston cylinder, a first pressure liquid space and a first pressure surface of the percussion piston in the first pressure liquid space,
at the other end of the piston cylinder, a second pressure liquid space and in the percussion piston a second pressure surface in a second pressure liquid space,
pressure liquid channels for supplying pressure liquid to and from the percussion piston,
the percussion piston having at its first end starting from the first pressure surface, an extension extending through the first pressure liquid space, the extension having at a distance from the first pressure space, a cylinder-shaped control surface with a diameter smaller than that of the outer diameter of the first pressure surface, the control surface moving in a control space with a diameter equal to the control surface; and at least one groove between the first pressure surface and a control surface, along which the pressure liquid is able to flow between the first pressure surface and the control surface,
a control valve for controlling the pressure liquid flow at least to the first pressure liquid space and away from it, whereby during the operation of the percussion device, at least one pressure surface of the percussion piston is affected by the pressure of the pressure liquid to move the percussion piston,
wherein the control valve is under the influence of a pushing force which tends to move the control valve to one direction, and the control valve has a control surface which is affected by a pressure of a pressure liquid creating a control force against the pushing force in such a way that in order to move the percussion piston to a first direction towards the second pressure liquid space, the control valve moved to its first position.

[0002] In common percussion devices the control valve is typically controlled by control edges in the percussion piston. The control edges in the piston connects either a high pressure or a low pressure to the operation surfaces of the control valve and therefore the valve changes its position and directs the pressure liquid to suitable operational surfaces of the percussion piston.

[0003] The control edges of the piston have been placed typically between the front and rear liquid spaces of the piston. This leads to a situation where in the percussion system has several high and low pressure spaces next to each other. This leads to multiple leaks between the spaces and lowers the operation efficiency of the percussion device.

[0004] It has been a tendency to go to higher percussion frequencies. As a result the stroke length of the percussion piston decreases and correspondingly the distances between the high and low pressure spaces decrease. Because of shorter leak gaps the leaks increase and thus the efficiency of the percussion device is further decreased. The problem has been tried to be solved with impulse valves. In these solutions the position of the valve is controlled by so called impulse chambers.

[0005] In these solutions a control edge of the percussion piston closes a liquid space to a closed chamber. When the percussion piston moves towards the chamber a high impulse pressure is created in the chamber. When this high impulse pressure affects the operation surface of the control valve it causes the valve to move and to change its.

[0006] A similar solution is also partly used in traditional percussion devices for changing the position of the control valve at the end return movement.

[0007] The impulse valve solutions make the starting of the percussion operation difficult and in practice a separate starting system has been needed.

BRIEF DESCRIPTION OF THE INVENTION

[0008] The object of the invention is to provide a solution, in which a valve position is made to change more efficiently.

[0009] The percussion device of the invention is **characterized in that**
a pressure liquid supply channel to the first pressure liquid space is connected to the control space,
a pressure liquid discharge channel is connected to the first pressure liquid space at a distance from the pressure liquid supply channel towards the second pressure liquid space,
while the percussion piston is moving to its first direction, the control surface of the extension of the percussion piston, when coming to the pressure liquid supply channel leading to the first pressure liquid space, closes the channel, whereby the first pressure liquid space is formed into a closed space,
when the percussion piston continues its movement in the first direction the volume of the first pressure liquid space expands, whereby the pressure of the pressure liquid in the first pressure liquid space decreases, and
the first pressure liquid space is connected to the control surface of the control valve in such a way that when the pressure decreases in the first pressure liquid space, the control valve moves under the influence of the pushing force from its first position to a second position and makes the percussion piston move to its second direction towards the first pressure liquid space.

[0010] The basic idea of the invention is that the position change of the control valve is done by changing the pressure acting on the control surface of the control valve so that the pressure acting on the control valve decreases by increasing the volume in the first pressure liquid space, whereby the control force is able to push the control valve

to a second position to change the movement direction of the percussion piston.

[0011] The solution of the invention provides the advantage that the efficiency of the percussion device improves. The construction of the valve is simple and very compact. Further, the construction of the percussion piston and valve have considerably fever gaps for the pressure liquid to leak from than in known percussion devices. This leads to better efficiency of the whole percussion construction.

[0012] Further, an advantage of the solution is that the length of the leaking gaps is not affected by the striking length of the piston, whereby it is possible to design a high-frequency percussion device without increasing the leaks too much.

[0013] Yet another advantage of the solution is that the length of movement of the valve is very short in comparison with the known solutions. This is because the valve can be designed to have an underlap (negative overlap). Therefore the power required to move the valve is considerably smaller than with known solutions.

[0014] Further, the solution does not require a special start system but this percussion device starts operating automatically when the pressure is supplied to the device.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] In the following, the invention will be described in greater detail in connection with the attached drawings, in which

Figure 1 is a schematic view of an embodiment of the percussion device,

Figure 2 is a detailed view of the embodiment of the percussion device in Figure 1,

Figures 3a to 3f present schematically the operation of the piston and the control valve of the percussion device in Figure1,

Figures 4a and 4b present two other embodiments of the percussion device,

Figure 5 presents still another embodiment of the percussion device, and

Figure 6 presents still another embodiment of the percussion device.

DETAILED DESCRIPTION OF SOME EMBODIMENTS OF THE INVENTION

[0016] Figure 1 shows schematically a percussion device 1 having a body 2. In the body 2, there is a piston cylinder 3, and a percussion piston 4 moves in the piston cylinder 3 in a reciprocating manner by the action of pressure liquid.

[0017] At the first end of the piston cylinder 3, there is a first pressure liquid space 5 and at the other end of the piston cylinder 3, there is a second pressure liquid space 6. The percussion piston 4 has in the first pressure liquid space a first pressure surface 7 and in the second pressure liquid space 6 a second pressure surface 8. Further, the percussion piston 4 has an extension 9 starting from the first pressure surface 7 and extending through the first pressure liquid space 5 to a control space 10. The extension 9 has at a distance from the first pressure surface 7 a cylinder-shaped control part 11.

[0018] Between the control part 11 and the first pressure surface 7, there is a groove 12. The groove 12 may be, as described in Figure 1, part of the extension 9 having a smaller diameter than that of the control part 11. It also may be a groove manufactured between the control part 11 and a first pressure surface 7. There may be one or more grooves of this type between the control part and the first pressure surface. This embodiment is presented in Figure 6.

[0019] Further, around the extension 9, there is a cylindrical control valve 13. A pressure liquid supply channel 14 is connected to the edge of the control space 10 and a liquid discharge channel 15 at a distance from the supply channel 14 towards the second pressure liquid space 6 for leading pressure liquid away from the first pressure liquid space 5. The control valve 13 is located between the supply channel 14 and discharge channel 15 so that in a first position of the control valve 13, it closes the discharge channel 15 and opens the supply channel 14 so that the percussion piston 4 moves towards the second pressure liquid space and in the second position, the control valve 13 opens the liquid discharge channel 15 and closes the liquid supply channel 14. The control valve has an underlap (negative overlap). So if the valve moves from its end position (position 1), it partly closes the supply channel 14 and partly opens the discharge channel 15. Normally, this would lead to a hydraulic short circuit, i.e. pressure fluid would be free to flow from high pressure to low pressure, but in this case the short circuit is prevented by the control part 11.

[0020] In this embodiment, a shank or a tool T is located in front of the percussion piston on the side of the second pressure liquid space so that when the percussion piston 4 moves to the left in the figure, it strikes the shank or the tool at the end of the movement.

[0021] Figure 2 presents schematically an enlargement of the construction of the control valve 13 and the percussion piston 4. The control valve 13 has a first cylindrical part 16 with the same inner diameter as the control part 11 of the extension of the percussion piston 4 and a second cylindrical part 17 towards the second pressure liquid space from the first cylindrical part 16. The second cylindrical part has the same inner diameter as the piston cylinder 3.

[0022] In the position shown in Figure 2, the control valve 13 is in its first position, in which the first cylindrical part 16 has opened the connection from the liquid supply channel 14 to the first pressure liquid space 5 and closed the connection from the first pressure liquid space 5 to the discharge channel 15. Between the control valve 13 and the body 2, there is a control space 18 which is con-

nected to the first pressure liquid space 5 through a control channel 19. In the control space 18, there is always substantially the same pressure as in the first pressure liquid space 5. In the position shown in Figure 2, the pressurized liquid flows via the supply channel 14 to the first pressure liquid space 5 and affects through the control channel 19 a control surface 20 in the control space 18.

[0023] The control valve 13 has a force surface 21 in a force chamber 22. The force chamber 22 is connected via a liquid channel 23 to the pressure liquid supply channel 14 so that during the operation of the percussion device there is always a high pressure in the force chamber 22, which creates a pushing force which tends to push the control valve 13 into its second position away from the second pressure liquid space 6.

[0024] Figures 3a - 3f present the operation of the percussion device shown in Figure 1.

[0025] In this embodiment, a high supply liquid pressure prevails during the operation of the percussion device all the time in the second pressure liquid space 6. The high pressure in the second pressure liquid space 6 creates a force pushing the percussion piston 4 towards the first pressure liquid space 5. The first pressure surface 7 in the first pressure liquid space 5 has a larger area than the second pressure surface 8 in the second pressure liquid space. When a high supply pressure also prevails in the first pressure liquid space 5, the force pushing the percussion piston 4 towards the second pressure liquid space is greater than the force pushing the percussion piston 4 towards the first pressure liquid space 5 because of the difference of the areas of the first and second pressure surfaces and, therefore, the percussion piston moves towards the second pressure liquid space 6.

[0026] In Figure 3a, the percussion piston 4 has already started moving to its first direction towards the second pressure liquid space 6. The control valve 13 is in its first position closing the discharge channel 15. A high pressure prevails in the force chamber 22, the first pressure liquid space 5 and the control space 18.

[0027] Figure 3b presents a situation where the control part 11 of the extension 9 has entered the edge of the first cylindrical part 16 of the control valve 13 and has closed the liquid supply channel 14. The percussion piston 4 still continues to move towards the second pressure liquid space 6. Because of the difference of the diameters of the first pressure surface 7 and the control part 11, the volume of the first pressure liquid space increases during the rest of the movement of the percussion piston 4. As a result, the high pressure in the first pressure liquid space 5 decreases rapidly and may even turn to negative pressure or vacuum for a short time.

[0028] Since in the control space 18, there is substantially the same pressure as in the first pressure liquid space 5, the control force acting on the control surface 20 decreases simultaneously with the decrease of the pressure, and the pushing force created by the high pressure in the force chamber 22 is able to push the control valve 13 from its first position to its second position on the left as shown in Figure 3c.

[0029] Figure 3c shows the situation when the percussion piston 4 has ended its movement to the first direction and the control valve 13 has changed its position. In the embodiment of Figure 1 the movement of the percussion piston 4 has ended to an impact of the percussion piston 4 against the end of the shank.

[0030] When the control valve 13 moves to its second position it opens the connection from the first pressure liquid space 5 to the discharge channel 15. At the same, it closes the liquid supply channel 14, which is necessary for the return movement of the percussion piston 4. Since in the control space 18, there is substantially the same pressure as in the first pressure liquid space 7, the control force acting on the control surface 20 decreases simultaneously with the decrease of the pressure, and the pushing force created by the high pressure in the force chamber 22 is able to push the control valve 13 from its first position to its second position on the left as shown in Figure 3c.

[0031] Figure 3d presents a situation during the return movement of the percussion piston 4. In this situation, the control part 11 has moved away from the control valve 13 and would have opened the connection from the first pressure liquid space 5 to the liquid supply channel 14. However, the control valve 13 has closed the connection and no high pressure liquid can flow to the first pressure liquid space 5.

[0032] Figure 3e presents a situation in which the first pressure surface has reached the edge of the second cylindrical part 17 of the control valve 13 and has closed the connection from the first pressure liquid space 5 to the discharge channel 15. When the percussion piston 4 continues to move to its second direction to the right in the figure, the first pressure liquid space 5 is a closed space and because of the differences in the diameters of the first pressure surface 7 and the control part 11, the volume of the first pressure liquid space decreases and the pressure of the liquid in the first pressure liquid space 5 increases quite rapidly. As a result the force acting on the control surface 20 in the control space 18 increases rapidly and pushes the control valve 13 to its first position on the left as shown in Figure 3f. The control valve has an underlap (negative overlap). While the valve moves from its second position to its first positions, both supply channel and discharge channels are simultaneously open. Normally this would lead to a hydraulic short circuit, i.e. pressure fluid would be free to flow from high pressure to low pressure, but in this case the short circuit is prevented by the edge of the first pressure surface 7. The underlap (negative overlap) is more than half of the stroke length of the control valve 13.

[0033] Figure 3f presents a situation when the control valve 13 has moved to its first position. High pressure liquid flows from the supply channel 14 to the first pressure liquid space 5, and the percussion piston 4 starts again to move to its first direction towards the second

pressure liquid space 6.

[0034] Figures 4a and 4b show a different embodiment of the percussion device. The control valve 13 is cylindrically shaped and located around the percussion piston 4. However, its diameter is larger than the diameter of the percussion piston, and it is in no contact with the percussion piston 4 or the control part 11 of the extension 9 of the percussion piston 4. The operation of this embodiment is substantially the same as described in figures 3a to 3f, but the percussion piston 4 and the control part 11 close the liquid supply channel 14 and the liquid discharge channel 15 without any cooperation of the surfaces of the control valve 13. Figure 4a does not show the way to create a force F to push the control valve to its second direction, but it has been depicted with an arrow F. The force may be created in the same way as described in Figures 3a to 3f, or another way to create a force maybe used. Thus, the force may be created by using a spring, a pressure accumulator, or any suitable way known in the art.

[0035] In Figure 4a, the tool or the shaft T is to the left in the figure and the percussion piston 4 strikes its end at the end of its movement in the first direction towards the second pressure liquid space 6.

[0036] Figure 4b presents a similar construction as Figure 4a, but in this solution the tool or the shank T has been situated at the other end of the percussion device, whereby the percussion piston strikes at the end of the tool or shank T at the end of its movement in the second direction towards the first pressure liquid space 5.

[0037] Figure 5 presents still another embodiment of the percussion device.

[0038] In this embodiment, the control valve is not a cylindrical valve around the percussion piston 4 but a separate valve located on the side of the piston cylinder 3. Otherwise it operates as the control valves of the other embodiments and changes its position at the end of the movements as has been described in connection with Figures 3a - 3f.

[0039] Figure 6 presents still another embodiment of the percussion device. In Figure 6, only part of the percussion piston 4 has been shown.

[0040] In this embodiment, the extension 9 of the percussion piston 4 has the same diameter along its whole length from the first pressure surface 7 to the end of the extension 9. However, between the control part and the first pressure surface 7, there are one or more grooves 12 which have been machined to the extension 9 so that pressure liquid may flow along each groove 12 between the control part 11 and the first pressure surface 7. The form and a depth of the grooves 12 may vary.

[0041] The invention has been explained in the specification and shown in the drawings only by way of example by means of the embodiments, and it may vary within the definitions of the claims. The tool or the shank may be at either end of the percussion piston. The different details shown in the figures and explained in the specification may be applied to other embodiments within scope of the claims.

Claims

1. A pressure liquid-operated percussion device comprising

a body (2), a piston cylinder in the body (2) and a percussion piston (4) moving in the piston cylinder (3) in its longitudinal direction in a reciprocating manner by the action of pressure liquid,

at a first end of the piston cylinder (3) , a first pressure liquid space (5) and a first pressure surface (7) of the percussion piston (4) in the first pressure liquid space (5),

at the other end of the piston cylinder (3) , a second pressure liquid space (6) and in the percussion piston (4) a second pressure surface (8) in a second pressure liquid space (6),

pressure liquid channels for supplying pressure liquid to and from the percussion piston (4),

the percussion piston (4) having at its first end starting from the first pressure surface (7), an extension (9) extending through the first pressure liquid space (5), the extension (9) having at a distance from the first pressure liquid space, a cylinder-shaped control surface with a diameter smaller than that of the outer diameter of the first pressure surface (7), the control surface moving in a control space with a diameter equal to the control surface; and at least one groove between the first pressure surface (7) and a control surface, along which the pressure liquid is able to flow between the first pressure surface (7) and the control surface,

a control valve (13) for controlling the pressure liquid flow at least to the first pressure liquid space (5) and away from it, whereby during the operation of the percussion device, at least one pressure surface of the percussion piston (4) is affected by the pressure of the pressure liquid to move the percussion piston (4) ,

wherein the control valve (13) is under the influence of a pushing force which tends to move the control valve (13) to one direction, and the control valve (13) has a control surface which is affected by a pressure of a pressure liquid creating a control force against the pushing force in such a way that in order to move the percussion piston (4) to a first direction towards the second pressure liquid space (6), the control valve (13) moved to its first position,

characterized in that

a pressure liquid supply channel to the first pressure liquid space (5) is connected to the control space,

a pressure liquid discharge channel is connected to the first pressure liquid space (5) at a distance from the pressure liquid supply channel towards the second pressure liquid space (6),

while the percussion piston (4) is moving to its first

direction, the control surface of the extension (9) of the percussion piston (4) , when coming to the pressure liquid supply channel leading to the first pressure liquid space (5), closes the channel, whereby the first pressure liquid space (5) is formed into a closed space,
when the percussion piston (4) continues its movement in the first direction the volume of the first pressure liquid space (5) expands, whereby the pressure of the pressure liquid in the first pressure liquid space (5) decreases, and
the first pressure liquid space (5) is connected to the control surface of the control valve (13) in such a way that when the pressure decreases in the first pressure liquid space (5), the control valve (13) moves under the influence of the pushing force from its first position to a second position and makes the percussion piston (4) move to its second direction towards the first pressure liquid space (5).

2. The percussion device of claim 1, **characterized in that** the supply liquid channel is connected to the second pressure liquid space (6) so that there is a high supply liquid pressure all the time during the operation of the percussion device.

3. The percussion device of claim 1 or 2, **characterized in that** the pushing force is created by the pressure of the supply liquid affecting a pushing surface positioned opposite the control surface of the control valve (13).

4. The percussion device of any one of claims 1 to 3, **characterized in that** the control valve (13) is a cylindrical valve positioned around the the percussion piston (4).

5. The percussion device of claim 4, **characterized in that** the control valve (13) is positioned in the piston cylinder (3) around the extension (9) of the percussion piston (4).

6. The percussion device of claim 5, **characterized in that** there is a control space between the body (2) and the control valve (13), that the control space is connected to with the first pressure liquid space (5) and that the control surface of the control valve (13) is in the control space away from the second pressure liquid space (6).

7. The percussion device of claim 6, **characterized in that** the control valve (13) is located between the pressure liquid supply channel and the pressure liquid discharge channel.

8. The percussion device of any of the claims 1 to 7, **characterized in that** there is an underlap (negative overlap) more than half of the stroke length of the control valve (13).

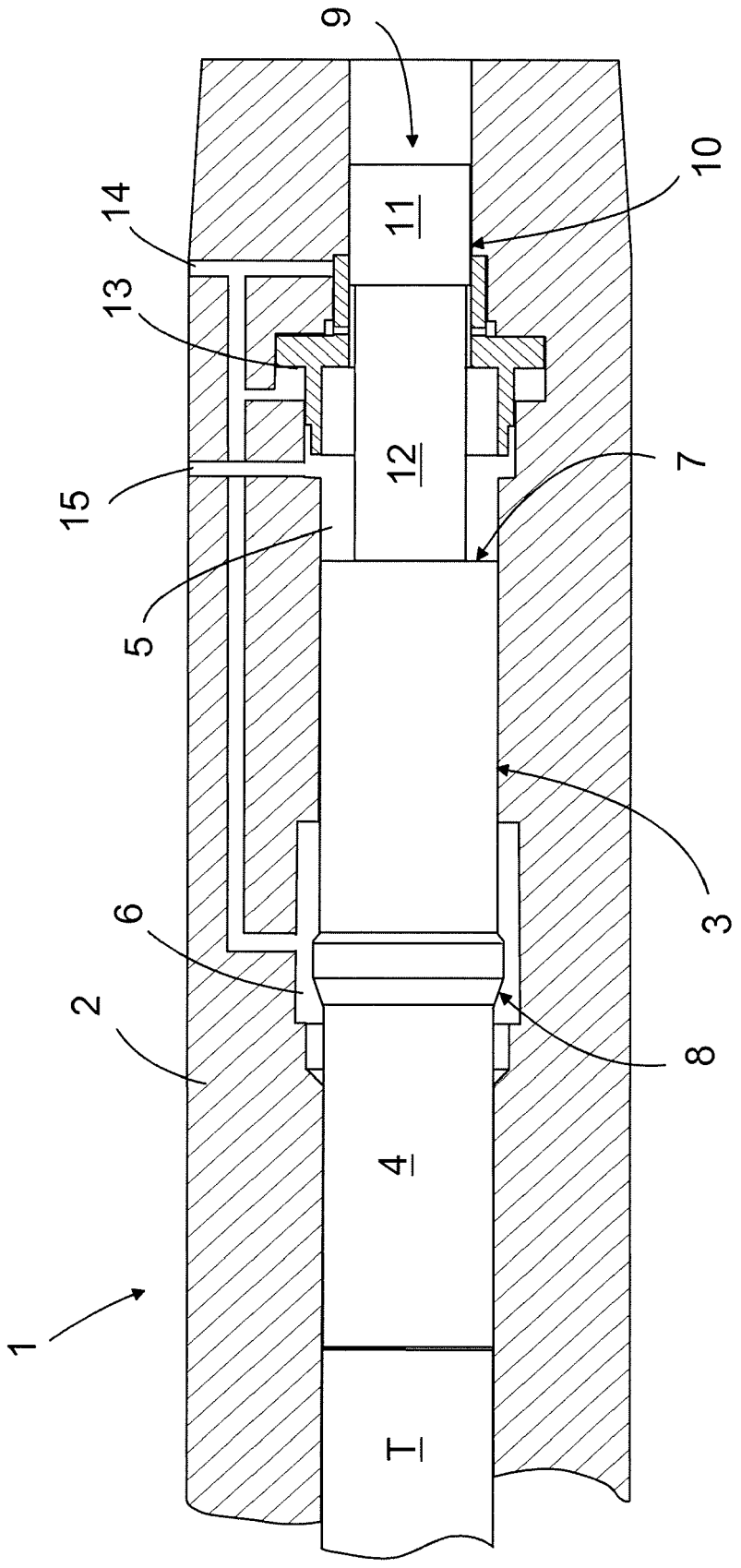

FIG. 1

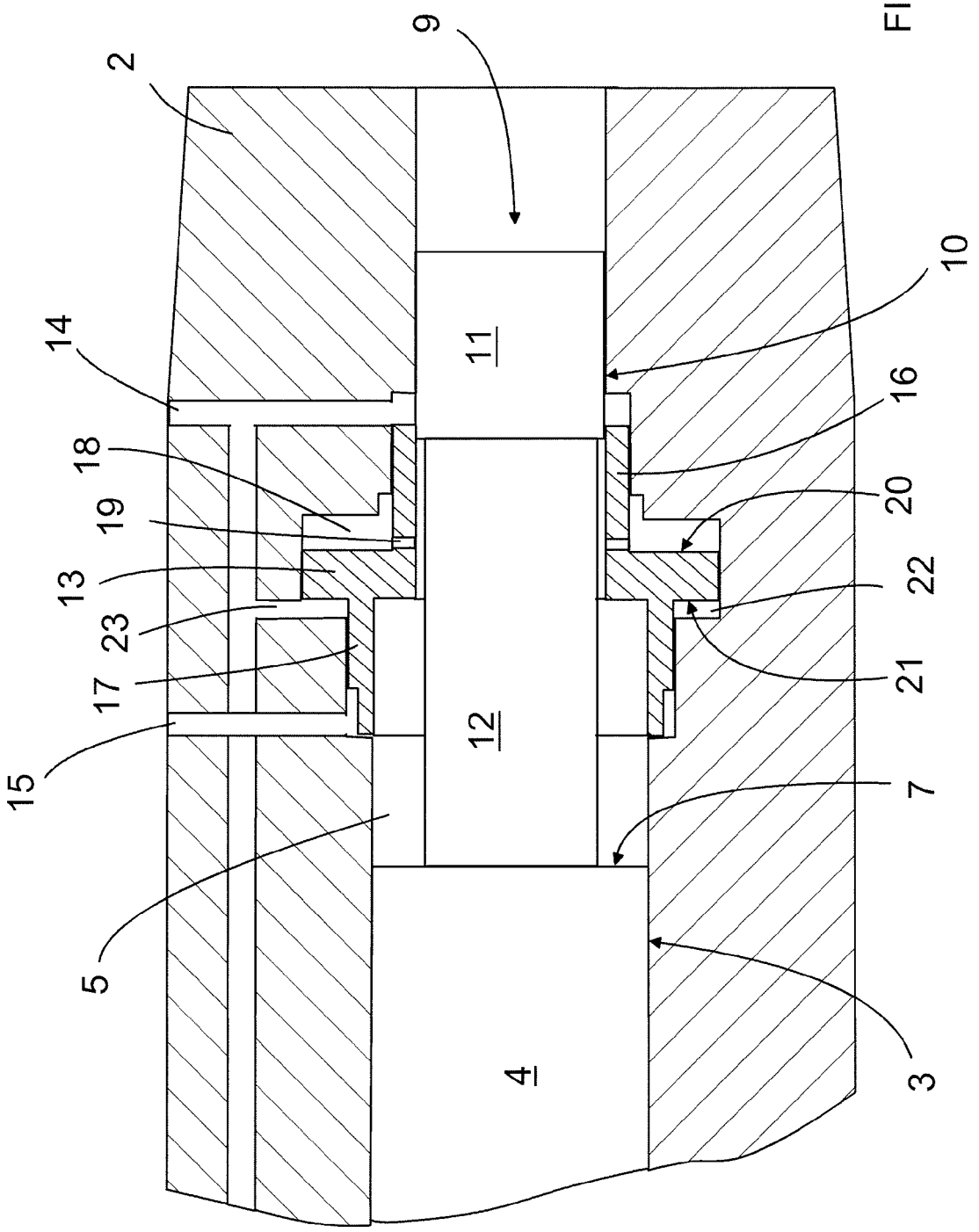

FIG. 2

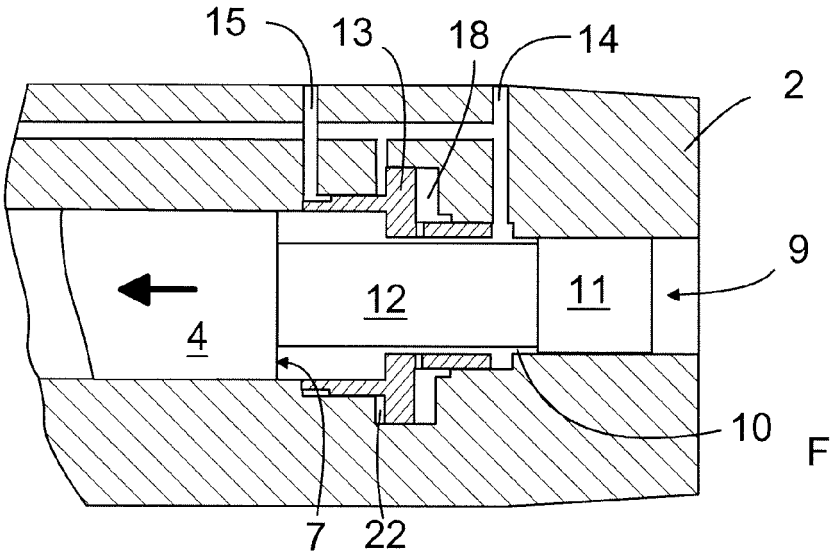

FIG: 3a

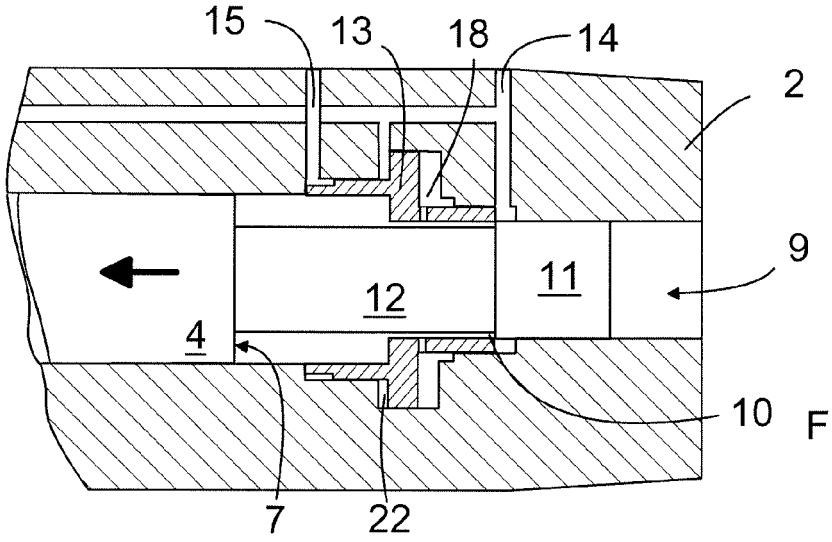

FIG: 3b

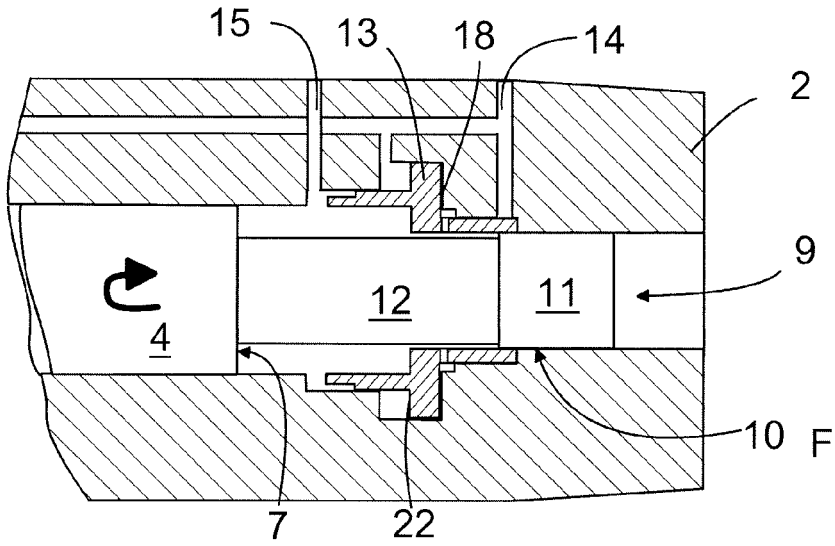

FIG: 3c

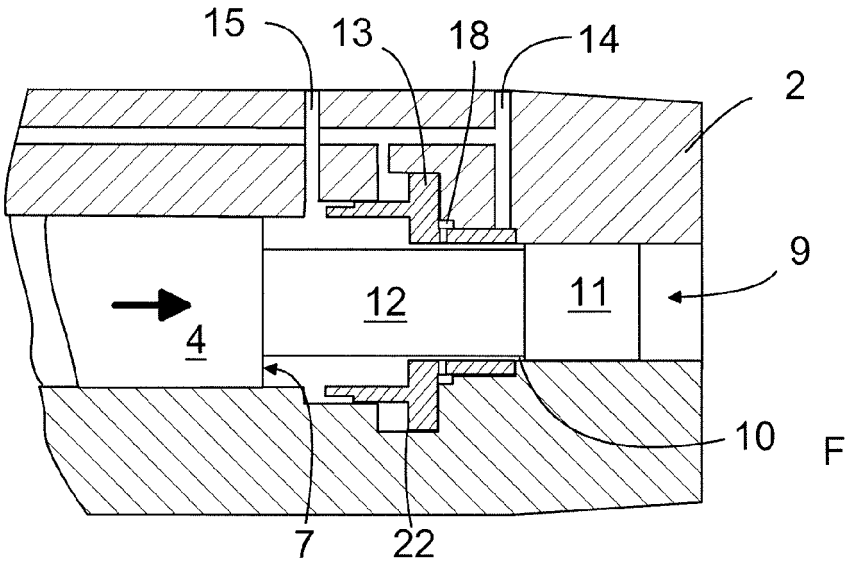

FIG: 3d

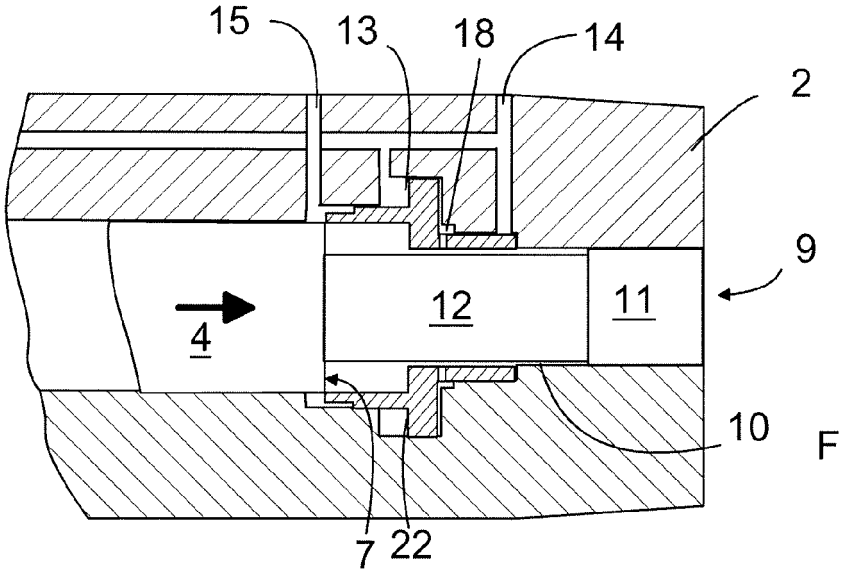

FIG: 3e

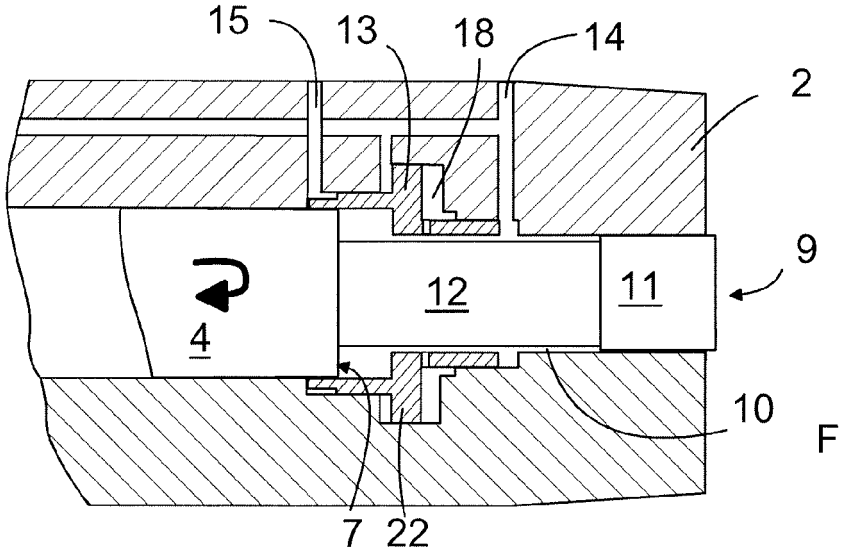

FIG: 3f

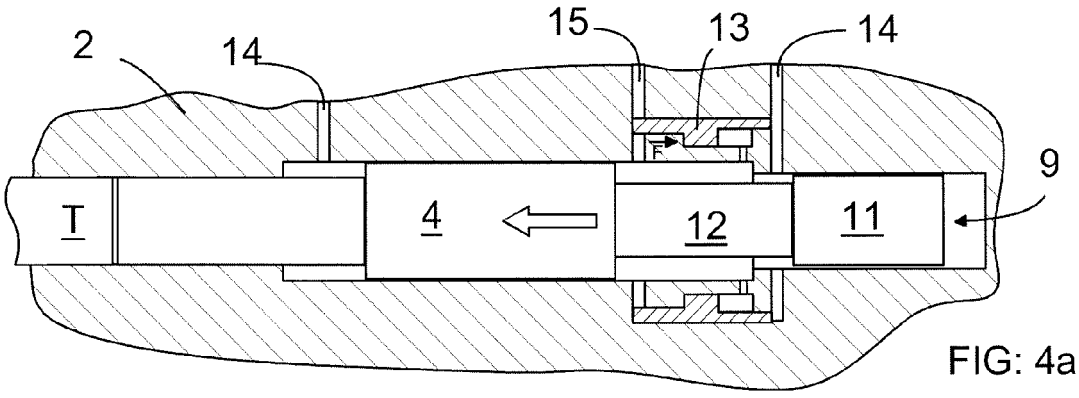

FIG: 4a

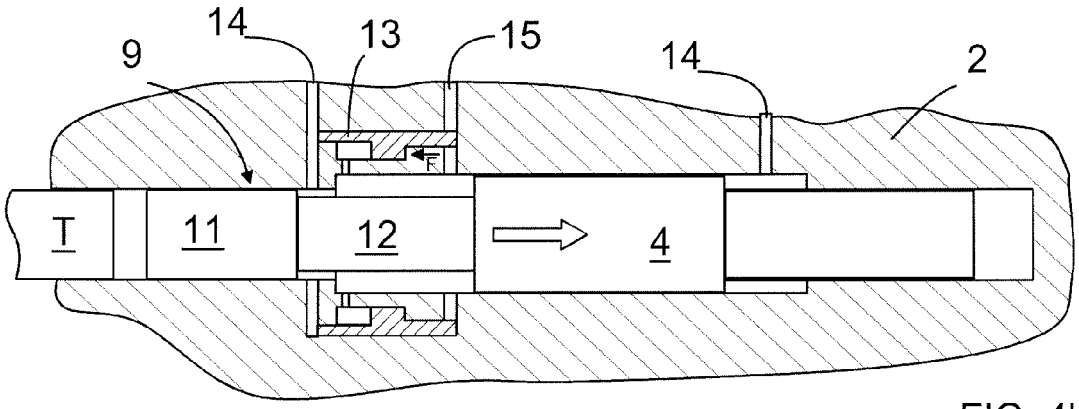

FIG: 4b

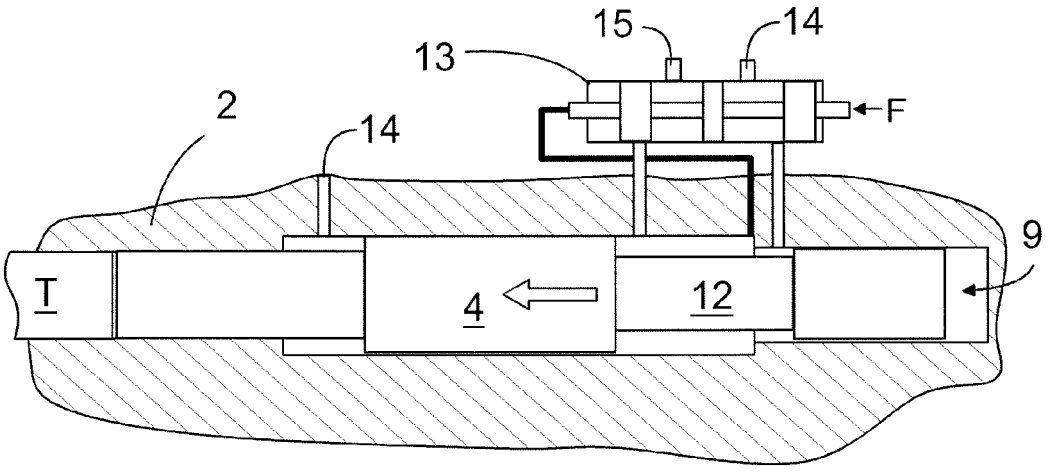

FIG: 5

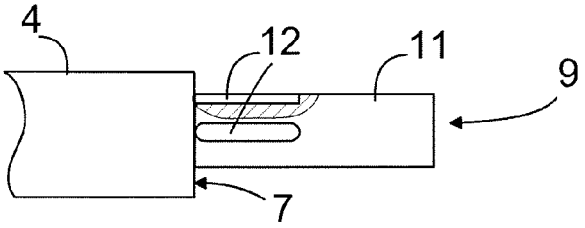

FIG: 6

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EUROPEAN SEARCH REPORT

Application Number
EP 13 18 9850

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	US 4 070 949 A (SALMI PEKKA M) 31 January 1978 (1978-01-31) * column 1, paragraph 1; figures 1-2 * -----	1-8	INV. B25D9/18 B25D9/20
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TECHNICAL FIELDS SEARCHED (IPC)

B25D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	6 February 2014	Coja, Michael

CATEGORY OF CITED DOCUMENTS

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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 13 18 9850

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