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

(72) Inventor: **LAINE, Juhani**
33311 Tampere (FI)

(74) Representative: **Sandvik**
Patents Department
Sandvik Mining and Construction Oy
Pihtisulunkatu 9
33330 Tampere (FI)

(54) TOOL BUSHING, ARRANGEMENT AND METHOD FOR LUBRICATING TOOL BUSHINGS

(57) A tool bushing of a breaking hammer, an arrangement for lubricating tool bushings of a breaking hammer, a breaking hammer, and a method of lubricating tool bushings of a breaking hammer. The tool bushing (8, 8a, 8b) is a sleeve-like piece comprising lubricating grooves (17) on its inner surfaces whereby lubricant is feedable through transverse lubricating channels (13) to the lubricating grooves for lubricating bearing surfaces on the inner surface. The lubricating grooves are arranged to form at least two local lubricated areas (La1, La2; La3, La4) opposing each other. The local lubricating areas have dedicated lubricating grooves which do not surround a periphery of the inner surface.

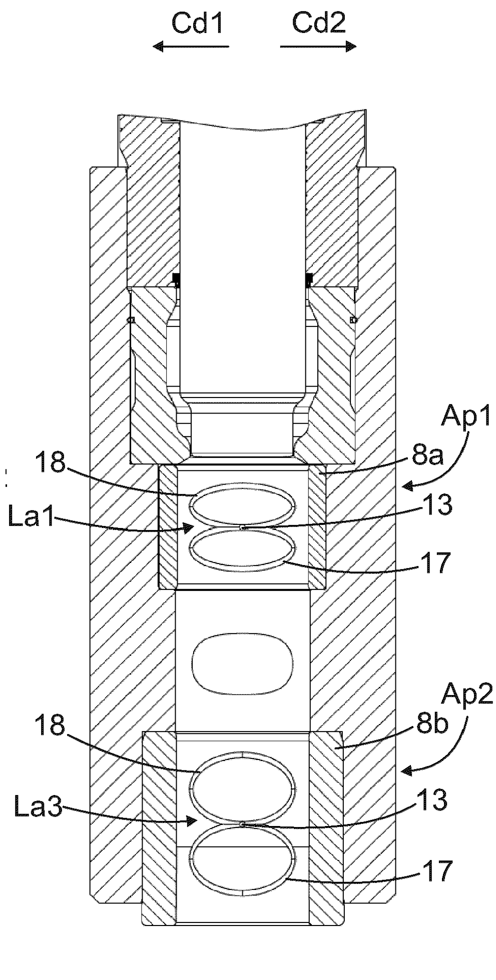

FIG. 8

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Description

Background of the invention

[0001] The invention relates to a tool bushing of a breaking hammer. The tool bushing is a sleeve-like piece which provides support for an axially movable breaking tool and comprises slide bearing surfaces on its inner surface. There are lubricating grooves on the inner surface for lubricating the bearing surfaces.

[0002] The invention further relates to an arrangement for lubricating tool bushings, to a breaking hammer, and further to a method of lubricating tool bushings of a breaking hammer.

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

[0004] Breaking hammers are used to break hard materials, such as rock, concrete, and the like. The breaking hammer comprises a percussion device for generating impact pulses to a breaking tool connectable to the breaking hammer. The tool is supported to a frame of the breaking hammer by means of one or more tool bushings, which are sleeve-like objects through which the tool passes and reciprocates during its operation. Inner surface of the tool bushing serves as slide bearing surface. Different lubricating arrangements and devices are designed for delivering lubricating to the slide bearing surfaces for controlling wear of the tool bushings. However, the known solutions have shown to include some drawbacks in proper delivery of lubricant and are thereby not capable to ensure sufficient lubrication on the slide bearing surfaces.

Brief description of the invention

[0005] An object of the invention is to provide a novel and improved tool bushing. A further object is to provide a novel and improved arrangement for lubricating tool bushings and a breaking hammer provided with such arrangement. An object is also to provide a novel an improved method lubricating tool bushings.

[0006] The tool bushing according to the invention is characterized by the characterizing features of the first independent apparatus claim.

[0007] The arrangement according to the invention is characterized by the characterizing features of the second independent apparatus claim.

[0008] The breaking hammer according to the invention is characterized by the characterizing features of the third independent apparatus claim.

[0009] The method according to the invention is characterized by the characterized features of the independent method claim.

[0010] An idea of the disclosed solution is that a tool bushing comprises transverse lubricating channels extending from an outer surface of the tool bushing to an inner surface. The lubricating channels are in fluid connection with lubricating grooves arranged on the inner surface. Lubricant can be fed from the outer surface side through the lubricating channels to the lubricating grooves for lubricating bearing surfaces on the inner surface. The lubricating channels on the inner surface of the tool bushing are arranged so that they form at least two local lubricated areas opposing each other. The at least two local lubricated areas are provided with dedicated lubricating grooves extending only at a limited area of the inner surface without surrounding a periphery of the inner surface.

[0011] In other words, the inner surface of the tool bushing comprises the at least two local lubricated areas on opposite sides of the inner surface, and transverse to the local lubricated areas there are opposite non-lubricated areas which are without any lubricating grooves. Thus, when examining the inners surface in a plane transverse to a length axis of the tool bushing, there are alternatively lubricated and non-lubricated areas .

[0012] In the tool bushing the inner surface or periphery is serving as a bearing surface and is intended to be towards an axially movable breaking tool to be supported, and the outer surface or periphery is intended to be facing a bushing housing in a body of the breaking hammer. The tool bushing is a non-rotating slide bearing component.

[0013] An advantage of the disclosed solution is that feeding of the lubricant can be directed only to critical areas on the inner surface of the bushing tool. Further, since the lubricating grooves do not surround the entire inner surface, the lubricant cannot escape from the critical bearing areas to non-critical bearing areas. In other words, flow of lubricant from heavily loaded bearing areas to areas with lower loading is decreased.

[0014] During the operation of the breaking hammer there typically exists heavy loadings to the breaking tool in the direction of a plane of a boom to which the breaking hammer is mounted in typical use cases. These loadings in the boom direction can be forwards and backwards, wherefore the heavily loaded areas exist in these two opposite main loading directions. When the tool bushing supporting the breaking tool is provided with the disclosed lubricated areas directed in the corresponding main loading directions, then proper lubrication can be ensured despite of the possible heavy loading situations. The lubricant provided for the tool bushing remains better at the heavily loaded bearing areas and ensures thereby longer service life for the tool bushing and the breaking tool.

[0015] A further advantage of the disclosed solution is that the lubricating grooves at the limited areas of the lubricated areas can be easily manufactured by means of modern machine tools, such as by means of lathes provided with rotating milling tools.

[0016] The disclosed tool bushings may also be retrofitted to the existing breaking hammers. In some cases there may be a need to slightly modify feeding of the lubricant to the tool bushing.

[0017] According to an embodiment, the tool bushing comprises at least one locking element for preventing the tool bushing to turn in relation to longitudinal axis of the tool bushing. The locking element may be for example an axial groove arranged on the outer surface of the tool bushing and a bushing housing may comprise a protruding locking element which is received by the axial groove.

[0018] According to an embodiment, the tool bushing may be an upper tool bushing or a lower tool bushing of the breaking hammer. This is the case when the breaking tool is supported to a frame of the breaking hammer by means of two separate tool bushings. The upper tool bushing is closer to an impact device of the breaking hammer and the lower tool bushing is at a front end part of the breaking hammer.

[0019] Alternatively, in some breaking hammer constructions there may be only one tool bushing for supporting the breaking tool. Then the single tool bushing is in accordance with this document. In the single tool bushing there are four local lubricated areas arranged in pairs at two axial positions or levels which are located at an axial distance from each other. Thus, it can be considered that an upper part of the single tool bushing corresponds to an upper tool bushing and a lower part corresponds to a lower tool bushing.

[0020] According to an embodiment, the local lubricated area is provided with at least one lubricating groove pattern comprising several lubricating groove sections with deviating directions on the inner surface. In other words, there is a lubricating groove pattern having desired shapes and deviating from a shape of simple straight line. The groove pattern may comprise one or more circular, oval, half circular, half oval, or any other continuous and closed shapes, for example.

[0021] Alternatively, the groove pattern may comprise straight or curved lines forming desired shapes. Then the groove pattern may have shapes resembling letters X, Z, H or W, for example.

[0022] The lubricating groove pattern, disclosed in the previous embodiments, is connected to one lubricating channel only, or it may be connected to two or even more lubricating channels.

[0023] According to an embodiment, the local lubricated area is provided with at least one straight or curved lubricating groove section extending on a periphery of the inner surface only a limited length. In other words, there may be one, two, three, or even more straight or curved groove sections one above each other in axial direction of the tool bushing and having limited length so that they are located only at the area of the local lubricated area and thereby do not surround the entire inner periphery. Each groove section is connected to at least one dedicated lubricating channel.

[0024] According to an embodiment, the disclosed solution relates also to a first arrangement for lubricating tool bushings of a breaking hammer. The arrangement comprises an upper tool bushing and a lower tool bushing arranged at an axial distance from each other and both comprising inner surfaces provided with at least one lubricating groove. There is at least one lubricating device for submitting lubricant through lubricating channels to the lubricating grooves of the upper tool bushing and the lower tool bushing for lubricating bearing surfaces between the breaking tool and inner surfaces of the upper and lower tool bushings. The upper tool bushing and the lower tool bushing are both in accordance with the features and embodiments disclosed in this document and they both comprise on their inner surfaces the mentioned two local lubricated areas opposing each other. Further, the lubricated areas of the upper tool bushing and the lower tool bushing have corresponding orientation in relation to central axis passing through the upper tool bushing and the lower tool bushing. Thereby a first lubricating area of the upper tool bushing and a third lubricating area of the lower tool bushing are facing in a same first main direction, and a second lubricating area of the upper tool bushing and the fourth lubricating area of the lower tool bushing are facing in a same second main direction. The at least one lubricating device is configured to feed lubricant simultaneously and in a diagonal manner to the lubricated areas of the upper tool bushing and the lower tool bushing, whereby the lubricating device is fed lubricant separately to the first lubricated area of the upper tool bushing and to the fourth lubricated area of the lower tool bushing, and separately to the second lubricated area of the upper tool bushing and to the third lubricated area of the lower tool bushing.

[0025] In other words, when the breaking tool is loaded either in the first main direction, or in the second main direction, diagonal loading is directed to the tool bushing setting, and the disclosed diagonal feeding of the lubricant ensures that the loaded bearing areas of the tool bushings are provided with proper lubrication.

[0026] According to an embodiment, the disclosed solution relates also to a second arrangement for lubricating tool bushings of a breaking hammer. The arrangement comprises only one tool bushing which is in accordance with the features disclosed in this document and comprises four local lubricated areas opposing each other in pairs and arranged on two axial positions so that a first lubricated area and a second lubricated area are opposing each other at a first axial position. At an axial distance from the first axial position is a second axial position wherein a third lubricated area is opposing a fourth lubricated area. The lubricated areas of the tool bushing have corresponding orientation in relation to central axis passing through the tool bushing, whereby a first lubricated area and a third lubricated area are facing in a same first main direction, and a second lubricated area and the fourth lubricated area are facing in a same second main direction. Further, one or more lubricating devices are configured to feed lubricant simultaneously and in a diagonal manner to the lubricated areas, whereby the lubricating device is configured to feed lubricant separately to the first lubricated area and to the fourth lubricated area, and separately to the second lubricated area and to the third lubricated area.

[0027] According to an embodiment, there are two diagonal lubricant feed circuits.

[0028] According to an embodiment, the lubricant is fed constantly to all four lubricated surfaces of the tool bushing setting during use of the breaking hammer.

[0029] According to an embodiment, the at least one lubricating device is configured to feed the lubricant with same pressure to all the lubricated areas.

[0030] According to an embodiment, same lubricant flow is fed to all the lubricated areas.

[0031] According to an embodiment, the lubricant is fed to the lubricant feed circuits in continuous flow.

[0032] According to an embodiment, the lubricating device provides batch type flow of the lubricant to the lubricant feed circuits.

[0033] According to an embodiment, the lubricating device provides cyclic or pulsating type flow of the lubricant to the lubricant feed circuits.

[0034] According to an embodiment, the lubricating device is an apparatus integrated to be part of the lubricating system and is mounted to the rock breaking hammer. The lubricating device can be automatically controlled or may be controlled remotely under control of an operator of the rock breaking hammer. The lubricating device may comprise one or more actuators and one or more fluid control elements.

[0035] According to an embodiment, the lubricating device is an apparatus mounted separately in relation to the rock breaking hammer. The lubricating device can be automatically controlled or may be controlled remotely under control of an operator of the rock breaking hammer. The separate lubricating device may be in continuous fluid connection with the lubricant feed circuits or may be selectively connected to the lubricant feed circuits for providing suitable lubricant batches to the lubricating system.

[0036] According to an embodiment, the arrangement comprises one combined lubricating device configured to feed the lubricant diagonally to the lubricated areas.

[0037] According to an embodiment, the combined lubricating device is arranged to feed the lubricant along two separate lubricating channels to the diagonal feed circuits.

[0038] According to an embodiment, the combined lubricating device comprises two separate lubricating circuits which are separately controllable.

[0039] According to an embodiment, the arrangement comprises a first lubricating device for feeding the lubricant diagonally to the first and fourth lubricated areas, and a second lubricating device for feeding the lubricant diagonally to the second and third lubricated areas.

[0040] According to an embodiment, the disclosed solution relates also to a breaking hammer comprising: a percussion device comprising a frame and an impact element arranged inside the frame; a breaking tool connectable to the percussion device and protruding from the frame; and an arrangement comprising an upper tool bushing and a lower tool bushing being arranged at an axial distance from each other and forming a tool bushing setting for supporting the breaking tool to the frame. Both tool bushings comprise inner surfaces provided with at least one lubricating groove. There is at least one lubricating device for submitting lubricant through lubricating channels to the lubricating grooves of the upper tool bushing and the lower tool bushing for lubricating bearing surfaces between the breaking tool and inner surfaces of the upper and lower tool bushing. The arrangement for providing the lubrication is in accordance with the features and embodiments disclosed in this document. The arrangement implements the disclosed diagonal feeding of the lubricant to the limited lubricated areas of the upper and lower tool bushings.

[0041] According to an embodiment, the disclosed solution relates also to a breaking hammer comprising a tool bushing arrangement with only one tool bushing which is provided with the four limited lubrication areas disclosed in this document and also diagonally lubricated as disclosed in this document.

[0042] According to an embodiment, the disclosed solution relates also to a method of lubricating tool bushings of a breaking hammer. The method comprises: submitting lubricant by means of at least one lubricating device through lubricating channels to lubricating grooves of an upper tool bushing and a lower tool bushing of a breaking hammer for lubricating bearing surfaces between a breaking tool and inner surfaces of the upper and lower tool bushings. The method further comprises submitting the lubricant only to limited lubricated areas provided on the inner surfaces of the upper and lower bushings thereby avoiding peripherical lubricant feeding. The method implements feeding of lubricant in a first lubricant feeding feature simultaneously and diagonally to a first lubricated area of the upper tool bushing and to a fourth lubricated area of the lower tool bushing which first and fourth lubricated areas are facing to opposite load directions of the breaking tool. The method implements also feeding the lubricant in a second lubricant feeding feature separately in relation to the first lubricant feeding feature. The method comprises feeding the lubricant in the second lubricant feeding feature simultaneously and diagonally to a second lubricated area of the upper tool bushing and to a third lubricated area of the lower tool bushing which second and third lubricated areas are facing to opposite load directions of the breaking tool.

[0043] In other words, the lubricant is fed diagonally to surface areas which are loaded due to the loadings directed to the breaking tool. The breaking tool is subjected during use of the breaking hammer to transverse forces causing diagonal loading to the tool bushings. There are typically relatively large tolerances between the inner surfaces of the tool bushings and the breaking tool, whereby the breaking tool can move laterally from its central position inside the tool bushings and thereby cause problems for the lubrication. In the disclosed solution the lateral movement of the breaking tool is taken into consideration and solved by utilizing the local limited lubricated areas and the diagonal lubricant feeding principle.

[0044] Further, impact pulses provided to the breaking tool by an impact device cause changes on cross sectional dimensions of the breaking tool when propagating as stress waves in the material of the breaking tool. Effects of the changes in the cross sectional directions to the lubrication of the breaking tool can also be compensated by means of the disclosed lubrication solution implementing the use of the limited lubricated areas and the diagonal lubrication feed flow to the lubricated areas.

[0045] According to an embodiment, the disclosed solution relates also to a method of lubricating at least one tool bushing of a breaking hammer. The method comprises: submitting lubricant by means of at least one lubricating device through lubricating channels to lubricating grooves of the at least one tool bushing for lubricating bearing surfaces between a breaking tool and inner surface of the at least one tool bushing. The method further comprises submitting the lubricant only to limited lubricated areas provided on the inner surface of the at least one bushing thereby avoiding peripherical lubricant feeding; feeding the lubricant in a first lubricant feeding feature simultaneously and diagonally to a first lubricated area which is located at an upper first axial position and to a fourth lubricated area which is located at a lower second axial position which first and fourth lubricated areas are facing to opposite load directions of the breaking tool; feeding the lubricant in a second lubricant feeding feature separately in relation to the first lubricant feeding feature; and feeding the lubricant in the second lubricant feeding feature simultaneously and diagonally to a second lubricated area which is located at an upper first axial position and to a third lubricated area which is located at a lower second axial position which second and third lubricated areas are facing to opposite load directions of the breaking tool.

[0046] According to an embodiment, the method further comprises feeding the lubricant in the first and second lubricant feeding feature to the lubricated areas which are directed to the load directions defined by a plane passing on central axis a boom to which the breaking hammer is mounted.

[0047] According to an embodiment, the method further comprises using slide bearing grease as the lubricant. Further, the disclosed lubricating system is designed for treating the slide bearing grease.

[0048] According to an embodiment, the slide bearing grease is a special grease developed for slide bearings and it has high viscosity compared to other typical lubricants such as lubricant oil. The viscosity of the slide bearing grease is over 300 mm^2/s, typically 300 - 600 mm^2/s.

[0049] Further, the lubricant is of non-circulating type of lubricant. In the breaking hammer lubricant oil and circulation lubrication cannot be used since the lubricant will get dirty due to rock dust and other impurities during the use. The circulation of the lubricant would clog the feed lines and would cause damage to the lubricating system.

[0050] The above-disclosed embodiments can be combined to form desired solutions provided with necessary features disclosed.

Brief description of the figures

[0051] Some embodiments are described in more detail in the accompanying drawings, in which

- Figure 1 is a schematic side view of an excavator, which is provided with a breaking hammer,
- Figure 2 is a schematic and sectional side view of a lower part of a breaking hammer,
- Figures 3 and 4 are schematic and sectional side views of a lower part of a breaking hammer and illustrate loadings directed to tool bushings,
- Figure 5 is a schematic diagram of a lubricating arrangement comprising one common lubricating device and two lubricating circuits,
- Figure 6 is a schematic diagram of a lubricating arrangement comprising two dedicated lubricating devices and lubricating circuits,
- Figures 7 and 8 are schematic and sectional side views showing upper and lower tool bushings provided with elliptical lubricating grooves,
- Figure 9 is a schematic and partly sectional side view of a lower tool bushing,
- Figures 10 and 11 are schematic and sectional side views of a lower part of a breaking hammer provided with an integrated tool bushing comprising diagonally arranged lubricated areas, and
- Figure 12 is a schematic and partly sectional side view of the tool bushing shown in previous Figures 10 and 11.

[0052] For the sake of clarity, the Figures show some embodiments of the disclosed solution in a simplified manner. In the Figures, like reference numerals identify like elements.

Detailed description of some embodiments

[0053] Figure 1 shows a breaking hammer 1 arranged on a free end of a boom 2 in a working machine 3, such as an excavator. Alternatively, the boom 2 may be arranged on any movable carriage or on a fixed platform of a crushing apparatus, for example. The breaking hammer 1 comprises a percussion device 4 for generating impact pulses. The breaking hammer 1 may be pressed by means of the boom 2 against material 5 to be broken and impacts may be simultaneously generated with the percussion device 4 to a tool 6 connected to the breaking hammer 1. The tool 6 transmits the impact pulses to the material 5 to be broken. The percussion device 4 may be hydraulic, whereby it may be connected to the hydraulic system of the working machine 2. Alternatively, the percussion device 4 may be electrically or pneumatically powered. The impact pulses may be generated in the percussion device 4 by means of a percussion element, such as percussion piston, that may be moved back and forth in the impact direction and return direction under the influence of hydraulic fluid. Further, the breaking hammer 1 may comprise a protective casing 7, inside which the percussion device 4 may be located. At a lower end of the breaking hammer, i.e., at the tool side end, are one or two tool bushings 8 for bearing the tool 6 to a frame of the breaking hammer. The breaking hammer 1 is also provided with an arrangement for lubricating slide bearing surfaces between the tool 6 and the one or more tool bushings 8. The tool bushings and the lubricating arrangement are in accordance with the solutions disclosed in this document.

[0054] Figure 1 further shows main directions Md1 and Md2 in the direction of a plane of the boom 2. During the use of the breaking hammer 1 loadings directed to the tool bushings 8 are greater in the main directions Md1, Md2 compared to cross directions Cd1 and Cd2 of the boom 2. This will be explained in further detail in Figures 3 and 4.

[0055] Figure 2 discloses a structure of a lower end part of a breaking hammer 1. A percussion device 4 comprises a percussion piston 9 arranged to move to and fro relative to a frame 10 of the percussion device 4. An impact surface 11 of the percussion piston or element 9 is arranged to strike an upper end of a tool 6. The tool 6 is allowed to move a limited axial distance in during the use. The tool 6 is locked in place relative to the frame 10 by means of transverse locking pins 12. The tool 6 is supported to the frame 10 by means of an upper tool bushing 8a and a lower tool bushing 8b arranged at an axial distance from each other. The tool bushings 8a, 8b serve as changeable slide bearing elements between the tool 6 and the frame 10. Rotation of the lower tool bushing 8b around central axis of the tool 6 may be prevented by means of a pin 14. The pin 14 also locks the lower tool bushing 8b in axial direction. The upper tool bushing 8a is arranged between the frame 10 and a structure of the percussion device 4 whereby its axial ends may be clamped to prevent rotation of the upper tool bushing 8a. This way, the tool bushings 8a, 8b with specially directed and formed lubricating areas can be in kept in their designed positions during the use. The tool bushings 8a, 8b are provided with transverse lubricating channels 13 extending from outer surfaces of the tool bushings 8a, 8b to their inner surfaces. Lubricant, which is lubricating grease, can be fed to the lubricating channel 13 from one or more lubricating devices.

[0056] Figures 3 and 4 illustrate loadings directed to tool bushings 8a and 8b during the use of a breaking hammer 1. Load1 and Load2 in main directions Md causes relative movement between a tool 6 and tool bushings 8a, 8b supported to a frame 10. This is because inner diameters of the tool bushings 8a, 8b are dimensioned to be greater than an outer diameter of the tool 6 i.e., there are clearances in this type of slide bearings to allow fluent axial movement for the tool 6. Because of the mentioned relative movement there exist diagonal contact areas and clearance areas between outer surfaces of the tool 6 and inner surfaces of the tool bushings. As can be noted, relative positions of the contact areas and the clearance areas depend on the direction of the loadings Load1 and Load2. The contact areas are critical for wearing of the tool bushings 8a, 8b. In the disclosed solution lubricant is forced separately to the contact areas. By means of specially designed lubricating groove configurations, the fed lubricant is also kept at the contact areas to thereby provide proper lubrication.

[0057] Figures 5 and 6 disclose two alternative lubrication arrangements which both comprise two separate lubricating circuits 14a, 14b for directing lubricant to lubricated areas La1 - La4 formed on inner surfaces of tool bushings 8a, 8b. The lubricated areas La1 - La4 of the upper tool bushing 8a and the lower tool bushing 8b have corresponding orientation in relation to central axis 15 passing through the upper tool bushing and the lower tool bushing. Then a first lubricated area La1 of the upper tool bushing 8a and a third lubricated area La3 of the lower tool bushing 8b are facing in a same first main direction Md1, and a second lubricated area La2 of the upper tool bushing 8a and a fourth lubricated area La4 of the lower tool bushing 8b are facing in a same second main direction Md2. Lubricant is fed simultaneously and in a diagonal manner to the lubricated areas La1 - La4, as it is shown by means of crossing arrows D. Then lubricant is fed separately via the first lubricating circuit 14a to the first lubricated area La1 of the upper tool bushing 8a and to the fourth lubricated area La4 of the lower tool bushing 8b, and separately via the second lubricating circuit 14b to the second lubricated area La2 of the upper tool bushing 8a and to the third lubricated area La3 of the lower tool bushing 8b.

[0058] In Figure 5 there is one lubricating device Ld for feeding the lubricant to both lubricating circuits 14a, 14b. The lubricating device Ld may comprise two separately controllable feed ports 16a, 16b. The lubricating device Ld may be controlled under control of a control device Cd or it may be manually controlled. Further, the lubricating device Ld may comprise an actuator for executing the lubricant feed, or the operation may be manual. The lubricant may be slide bearing grease.

[0059] In Figure 6 there are two separate lubricating devices Ld1 and Ld2 connected to separate lubricating circuits 14a, 14b.

[0060] Figures 7 and 8 disclose a tool bushing arrangement wherein an upper tool bushing 8a and a lower tool bushing 8b are both provided with lubricating grooves 17 on their inner surfaces. The lubricating grooves 17 are in connection with transverse lubricating channels 13 and are so formed that they can keep the fed lubricant at lubricated areas La1 - La4. The inner surfaces of the tool bushings comprise two local lubricated areas La1, La2 and La3, La4 opposing each other, and each provided with dedicated lubricating grooves 17 extending only at a limited area of the inner surface. For example, the groove 17 do not surround a periphery of the inner surface, which can be clearly seen in Figure 8, wherein the breaking machine is seen in a main direction Md2. The lubricating grooves 17 can form a shape of an ellipse, for example. In Figure 8 the lubricated areas La1 and La3 both comprise two elliptical shapes 18 of the lubricating grooves and the lubricating channels 13 between the elliptical forms. The fed lubricant can flow in the lubricating grooves and spread effectively to the lubricated areas La1 and La3. This way escape of the lubricant to surfaces with greater clearances shown in Figures 3 and 4 can be decreased. As can be noted shapes of the lubricant groove configurations may be slightly different on the upper tool bushing 8a and on the lower tool bushing 8b. In some cases the lubricant groove shapes may be totally different from each other if improved lubrication effect is thereby achieved.

[0061] Lubricant feed is arranged diagonally D to the lubricated areas La1 - La4 in accordance with the principles disclosed in Figures 5 and 6.

[0062] Figure 9 discloses a lower tool bushing 8b provided with round shaped or elliptically shaped lubricating grooves on its inner surface.

[0063] Figures 10 and 11 disclose a breaking device 1 which differs from the one shown in Figures 7 and 8 in that only one integrated tool bushing 8 is implemented. The tool bushing 8 comprises lubricated areas La1 - La4 and transverse lubricating channels 13 for executing lubricant feed on limited areas between a tool and inner surfaces of the tool bushing 8. The lubricated areas La1 - La4 comprise lubricating grooves 17 which are arranged to form X shaped configurations 19 shown in Figure 11. Lubricant feed is arranged diagonally D to the lubricated areas La1 - La4 in accordance with the principles disclosed in Figures 5 and 6. A locking pin 12 can lock the tool as well as prevent rotation of the tool bushing 8 so that the lubricated areas La1 - La4 remain in their designed directions facing towards main directions Md1 and Md2. Further, at a lowermost end the tool bushing 8 there may be a sealing 20 for sealing a clearance between the tool and the inner surfaces of the tool bushing 8.

[0064] Figure 12 discloses an integrated tool bushing 8 provided with X shaped configurations 19 formed of lubricating grooves 17.

[0065] In Figures 5,6,8 and 10 - 12 first axial positions Ap1 and second axial positions Ap2 are shown in connection with double tool bushing solutions and single tool bushing solutions. The local lubricated areas La1 - La4 are arranged in pairs at these two axial positions Ap1 and Ap2 lubricant is fed utilizing separate and diagonal lubricant feedings.

[0066] The drawings and the related description are only intended to illustrate the idea of the invention. In its details, the invention may vary within the scope of the claims.

Claims

1. A tool bushing (8, 8a, 8b) of a breaking hammer (1) for supporting an axially movable breaking tool (6) to a frame (10) of the breaking hammer (1);

   wherein the tool bushing (8, 8a, 8b) is a sleeve-like piece comprising an outer surface, an inner surface and an axial length;
   and wherein the tool bushing (8, 8a, 8b) comprises at least one transverse lubricating channel (13) extending from the outer surface to the inner surface and being in connection with at least one lubricating groove (17) on the inner surface whereby lubricant is feedable from the outer surface side to the inner surface side of the tool bushing (8, 8a, 8b) for lubricating bearing surfaces on the inner surface;
   characterized in that
   the inner surface of the tool bushing (8, 8a, 8b) comprises at least two local lubricated areas (Lal, La2; La3, La4) opposing each other, wherein the local lubricated areas are provided with dedicated lubricating grooves (17) extending only at a limited area of the inner surface without surrounding a periphery of the inner surface.

2. The tool bushing as claimed in claim 1, **characterized in that**
   the local lubricated area (La1 - La4) is provided with at least one lubricating groove pattern comprising several lubricating groove sections with deviating directions on the inner surface.

3. The tool bushing as claimed in claim 1, **characterized in that**
   the local lubricated area (La1 - La4) is provided with at least one straight or curved lubricating groove section extending on a periphery of the inner surface only a limited length.

4. An arrangement for lubricating tool bushings (8a, 8b) of a breaking hammer (1),
   wherein the arrangement comprises:

   an upper tool bushing (8a) and a lower tool bushing (8b) arranged at an axial distance from each other and both comprising inner surfaces provided with at least one lubricating groove (17);
   at least one lubricating device (Ld) for submitting lubricant through lubricating channels (13) to the lubricating grooves (17) of the upper tool bushing (8a) and the lower tool bushing (8b) for lubricating bearing surfaces between the breaking tool (6) and inner surfaces of the upper and lower tool bushings (8a, 8b);
   characterized in that

the upper tool bushing (8a) and the lower tool bushing (8b) are both in accordance with the previous claims 1 - 3 and both comprise the mentioned two local lubricated areas (Lal, La2; La3, La4) opposing each other;
the lubricated areas (Lal, La2; La3, La4) of the upper tool bushing (8a) and the lower tool bushing (8b) have corresponding orientation in relation to central axis (15) passing through the upper tool bushing (8a) and the lower tool bushing (8b), whereby a first lubricated area (La1) of the upper tool bushing (8a) and a third lubricated area (La3) of the lower tool bushing (8b) are facing in a same first main direction (Md1), and a second lubricated area (La2) of the upper tool bushing (8a) and the fourth lubricated area (La4) of the lower tool bushing (8b) are facing in a same second main direction (Md2);
and wherein the at least one lubricating device (Ld) is configured to feed lubricant simultaneously and in a diagonal manner (D) to the lubricated areas (La1 - La4) of the upper tool bushing (8a) and the lower tool bushing (8b), whereby the lubricating device (Ld) is configured to feed lubricant separately to the first lubricated area (La1) of the upper tool bushing (8a) and to the fourth lubricated area (La4) of the lower tool bushing (8b), and separately to the second lubricated area (La2) of the upper tool bushing (8a) and to the third lubricated area (La3) of the lower tool bushing (8b).

5. An arrangement for lubricating a tool bushing (8) of a breaking hammer (1),

wherein the tool bushing (8) comprises an inner surface provided with at least one lubricating groove (17);
and wherein the arrangement comprises at least one lubricating device (Ld) for submitting lubricant through at least one lubricating channel (13) to the lubricating groove (17) for lubricating bearing surfaces between the breaking tool (6) and inner surface of the tool bushing (8) ;
characterized in that
the tool bushing (8) is in accordance with the previous claims 1 - 3 and comprises four local lubricated areas (Lal, La2; La3, La4) opposing each other in pairs and arranged on two axial positions (Ap1, Ap2) so that a first lubricated area (La1) and a second lubricated area (La2) are opposing each other at a first axial position (Ap1), and at an axial distance from the first axial position (Ap1) is a second axial position (Ap2) wherein a third lubricated area (La3) is opposing a fourth lubricated area (La4);
and wherein the lubricated areas (Lal, La2; La3, La4) of the tool bushing (8) have corresponding orientation in relation to central axis (15) passing through the tool bushing (8), whereby a first lubricated area (La1) and a third lubricated area (La3) are facing in a same first main direction (Md1), and a second lubricated area (La2) and the fourth lubricated area (La4) are facing in a same second main direction (Md2);
and wherein the at least one lubricating device (Ld) is configured to feed lubricant simultaneously and in a diagonal manner (D) to the lubricated areas (La1 - La4), whereby the lubricating device (Ld) is configured to feed lubricant separately to the first lubricated area (La1) and to the fourth lubricated area (La4), and separately to the second lubricated area (La2) and to the third lubricated area (La3).

6. The arrangement as claimed in claim 4 or 5, **characterized in that**
the at least one lubricating device (Ld) is configured to feed the lubricant with same pressure to all the lubricated areas (La1 - La4).

7. The arrangement as claimed in any one of the preceding claims 4 - 6, **characterized in that**
the arrangement comprises one combined lubricating device (Ld) configured to feed the lubricant diagonally (D) to the lubricated areas (La1 - La4).

8. The arrangement as claimed in claim 7, **characterized in that**
the combined lubricating device (Ld) comprises two separate lubricating circuits (14a, 14b) which are separately controllable.

9. The arrangement as claimed in any one of the preceding claims 4 - 6, **characterized in that**
the arrangement comprises a first lubricating device (Ld1) for feeding the lubricant diagonally (D) to the first and fourth lubricated areas (Lal, La4), and a second lubricating device (Ld2) for feeding the lubricant diagonally (D) to the second and third lubricated areas (La2, La3) .

10. A breaking hammer (1), comprising:

a percussion device (4) comprising a frame (10) and an impact element (9) arranged inside the frame (10);
a breaking tool (6) connectable to the percussion device (4) and protruding from the frame (10);
and an arrangement comprising at least one tool bushing (8, 8a, 8b) for supporting the breaking tool (6) to the frame (10);
the at least one tool bushing (8, 8a, 8b) comprises an inner surface provided with at least one lubricating groove (17);

and at least one lubricating device (Ld) for submitting lubricant through lubricating channels (13) to the lubricating grooves (17) of the at least one tool bushing (8, 8a, 8b) for lubricating bearing surfaces between the breaking tool (6) and inner surface of the at least one tool bushing (8, 8a, 8b);
characterized in that
the arrangement is in accordance with claims 4 to 9 and is provided with the diagonal (D) feeding of the lubricant to the limited lubricated areas (La1 - La4) of the at least one tool bushing (8, 8a, 8b).

11. A method of lubricating at least one tool bushing (8, 8a, 8b) of a breaking hammer (1),
wherein the method comprises:

submitting lubricant by means of at least one lubricating device (Ld) through lubricating channels (13) to lubricating grooves (13) of the at least one tool bushing (8, 8a, 8b) for lubricating bearing surfaces between a breaking tool (6) and inner surface of the at least one tool bushing (8, 8a, 8b);
characterized in
submitting the lubricant only to limited lubricated areas (La1 - La4) provided on the inner surface of the at least one bushing (8, 8a, 8b) thereby avoiding peripherical lubricant feeding;
feeding the lubricant in a first lubricant feeding feature simultaneously and diagonally to a first lubricated area (La1) which is located at an upper first axial position (Ap1) and to a fourth lubricated area (La4) which is located at a lower second axial position (Ap2) which first and fourth lubricated areas (Lal, La4) are facing to opposite load directions of the breaking tool (6);
feeding the lubricant in a second lubricant feeding feature separately in relation to the first lubricant feeding feature;
and feeding the lubricant in the second lubricant feeding feature simultaneously and diagonally to a second lubricated area (La2) which is located at an upper first axial position (Ap1) and to a third lubricated area (La3) which is located at a lower second axial position (Ap2) which second and third lubricated areas (La2, La3) are facing to opposite load directions of the breaking tool (6) .

12. The method according to claim 11, **characterized by** feeding the lubricant in the first and second lubricant feeding feature to the lubricated areas (La1 - La4) which are directed to the load directions defined by a plane passing on central axis a boom (2) to which the breaking hammer (1) is mounted.

13. The method according to claim 11 or 12, **characterized by**
using slide bearing grease as the lubricant.

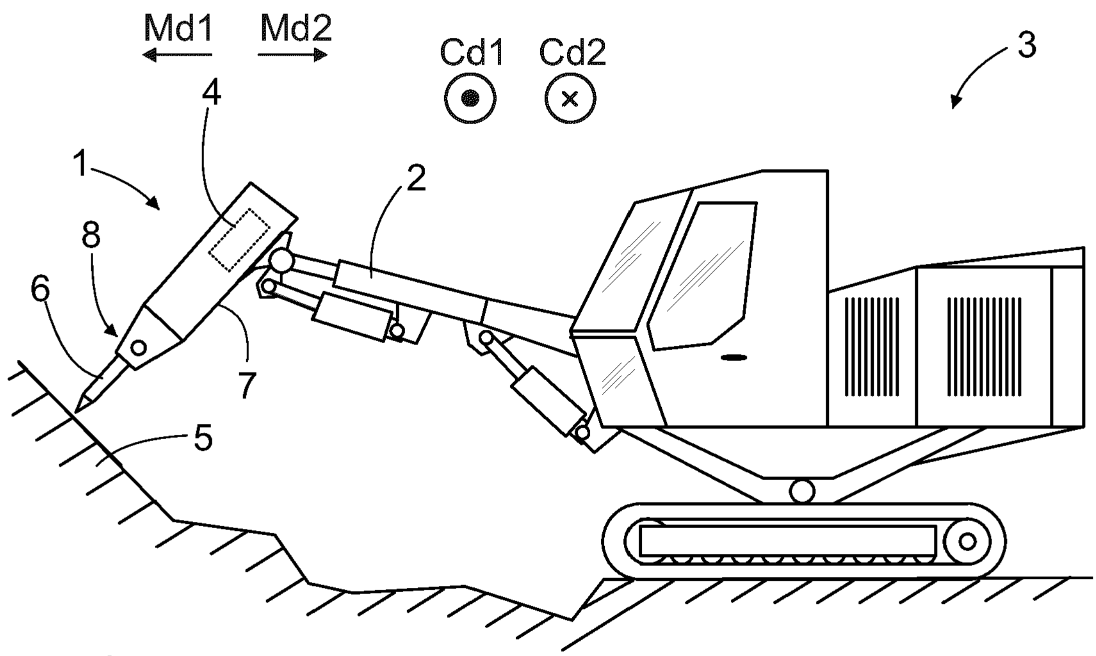

FIG. 1

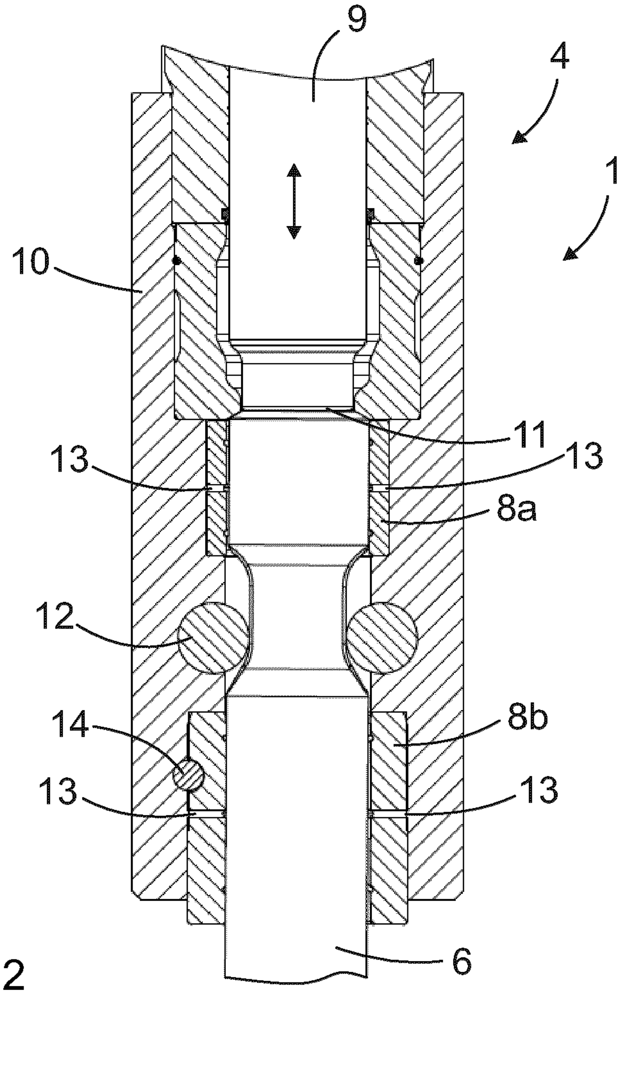

FIG. 2

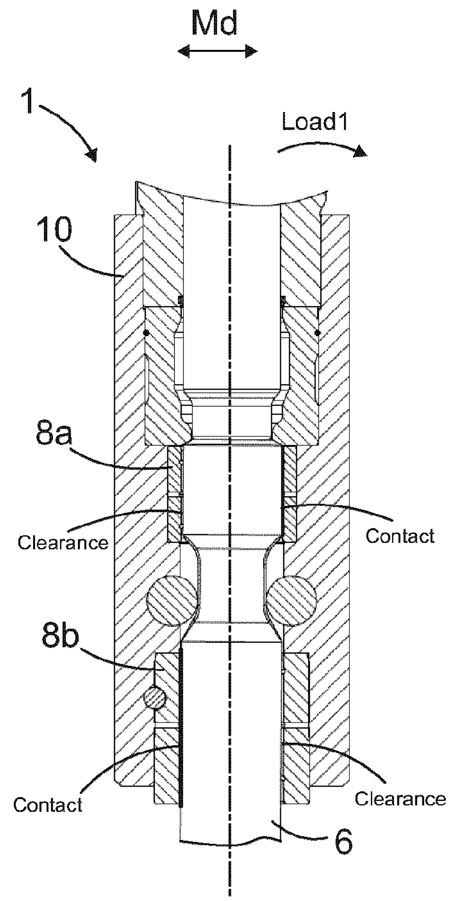

FIG. 3

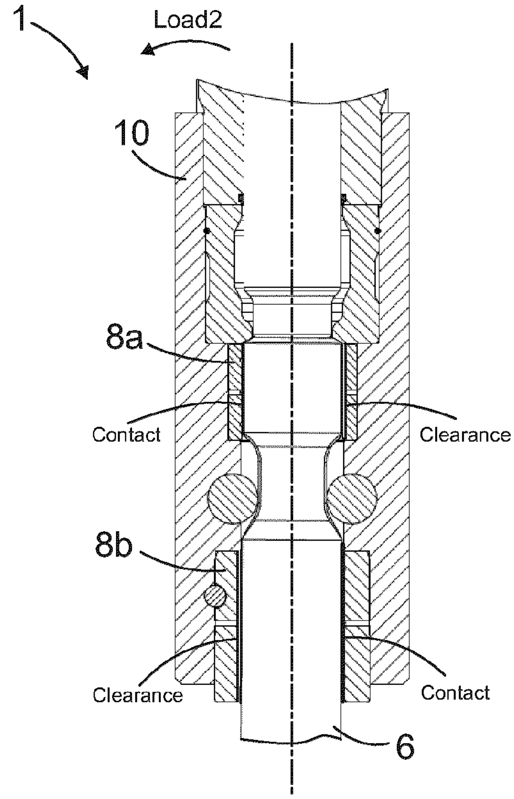

FIG. 4

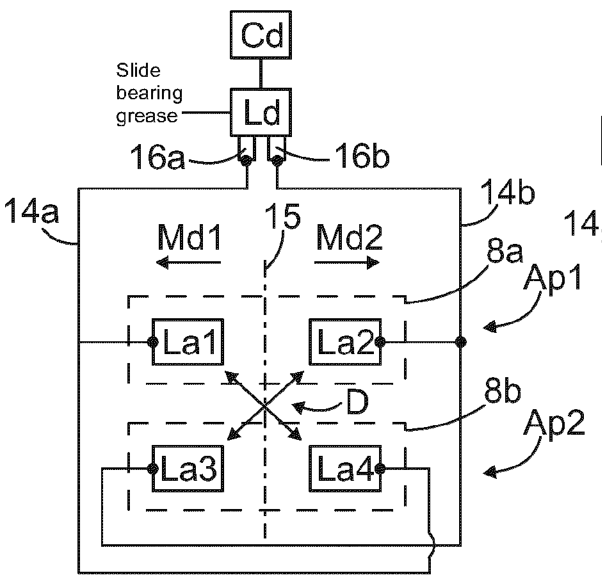

FIG. 5

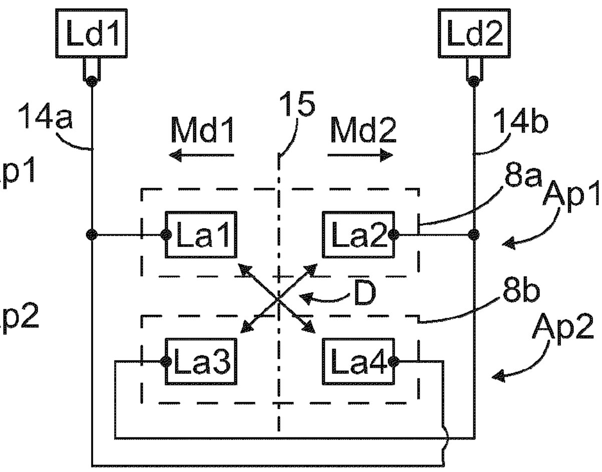

FIG. 6

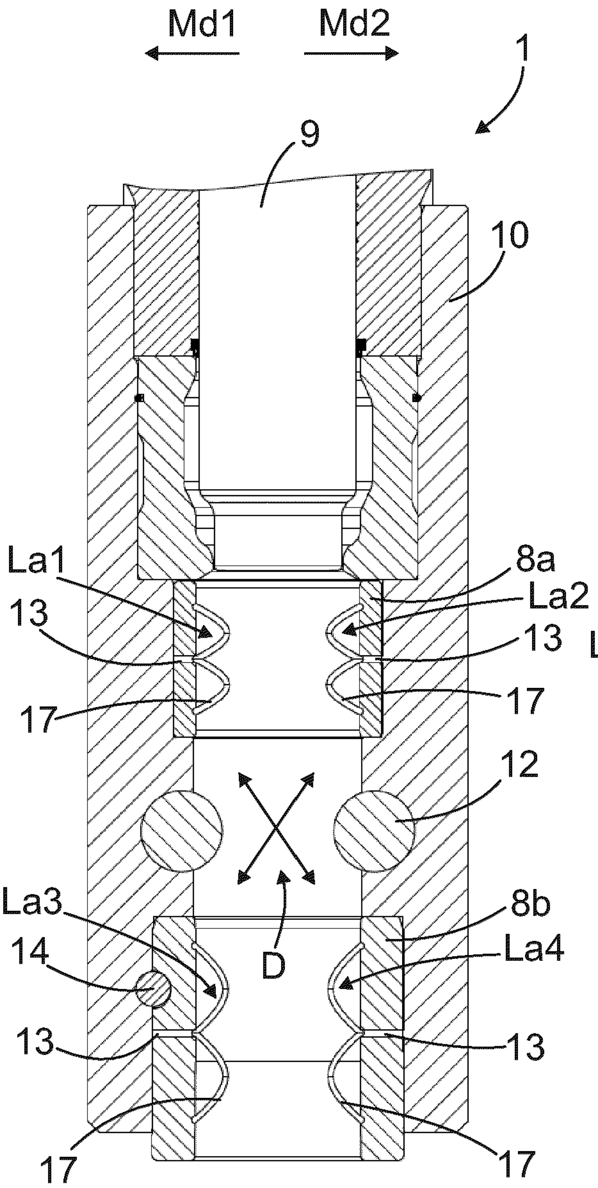
Md1
Md2
1
9
10
La1
8a
La2
13
13
17
17
12
D
La3
8b
La4
14
13
13
17
17

FIG. 7

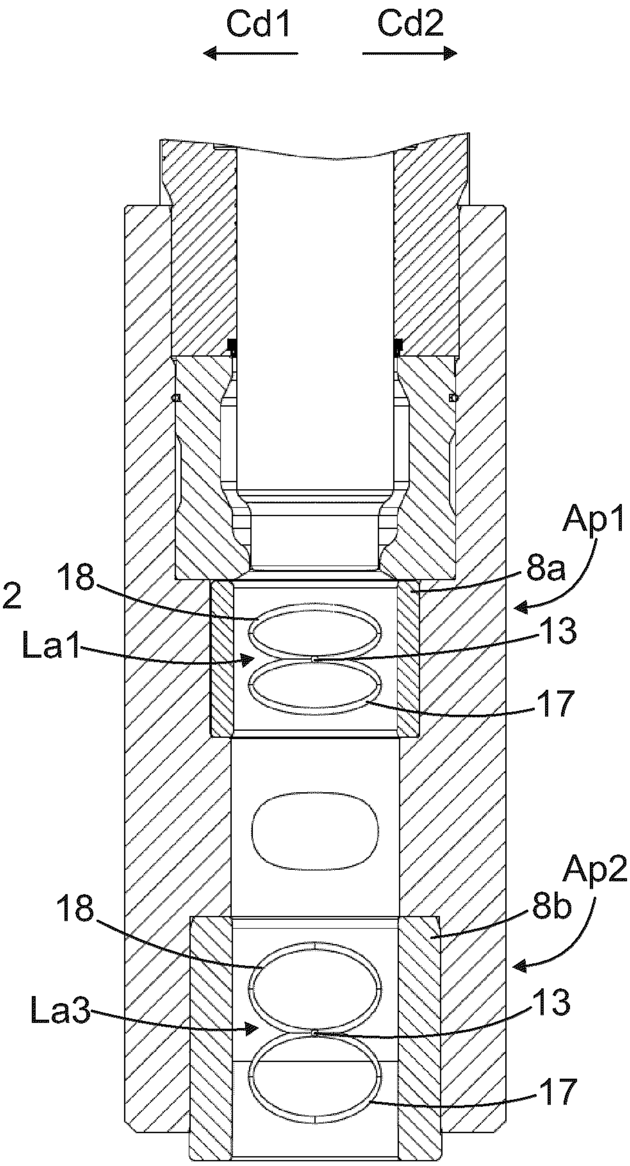
Cd1
Cd2
Ap1
18
8a
La1
13
17
Ap2
18
8b
La3
13
17

FIG. 8

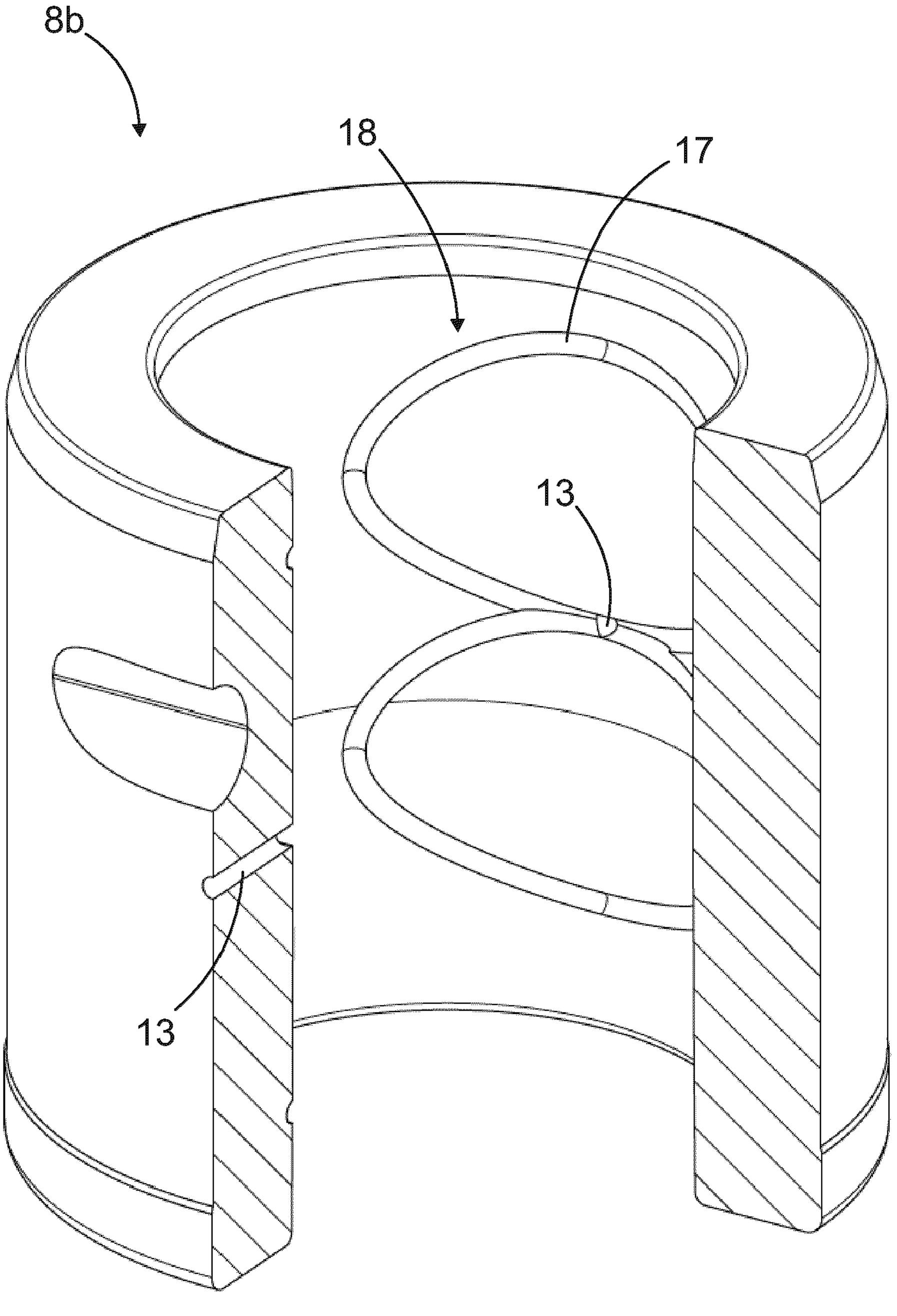

FIG. 9

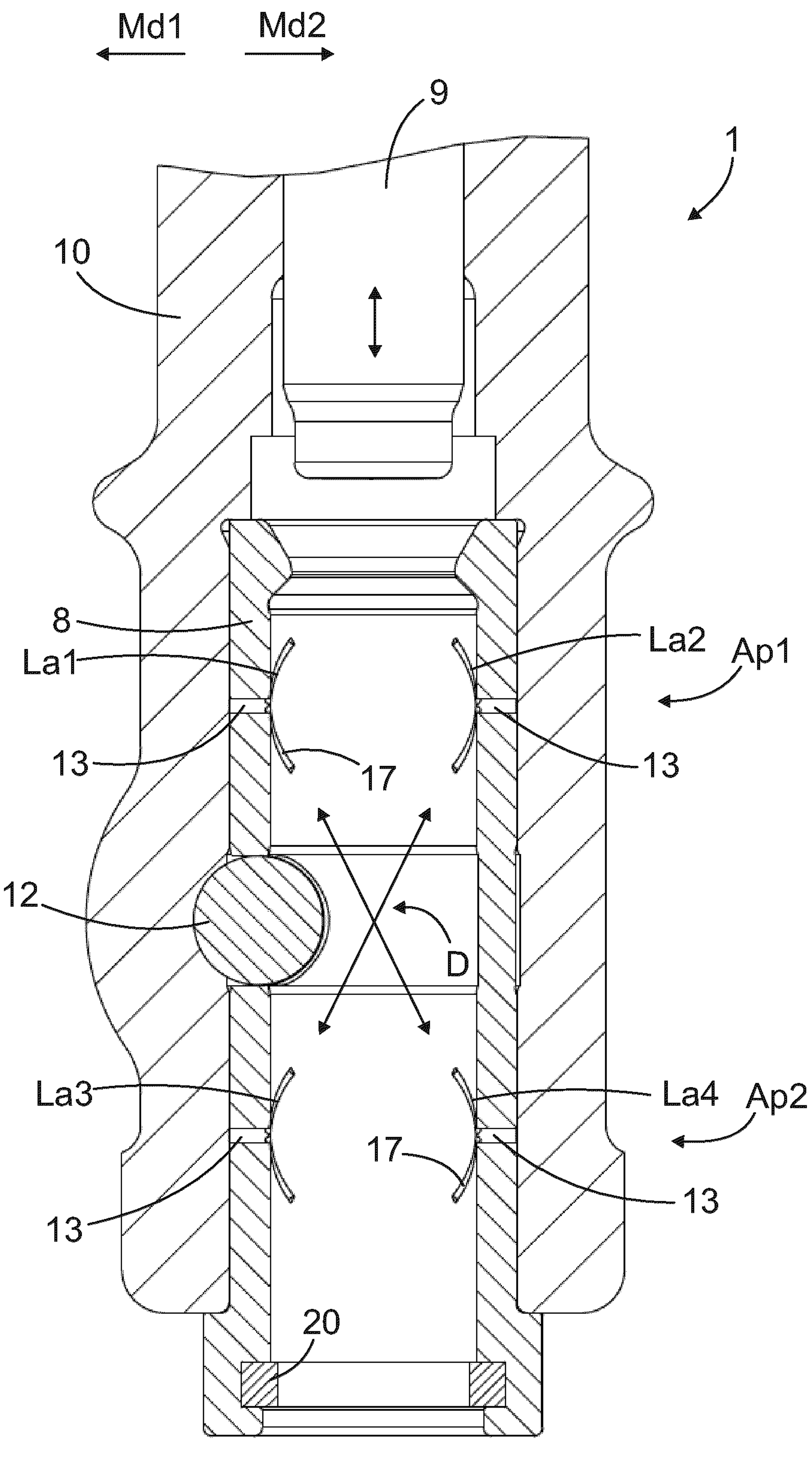

FIG. 10

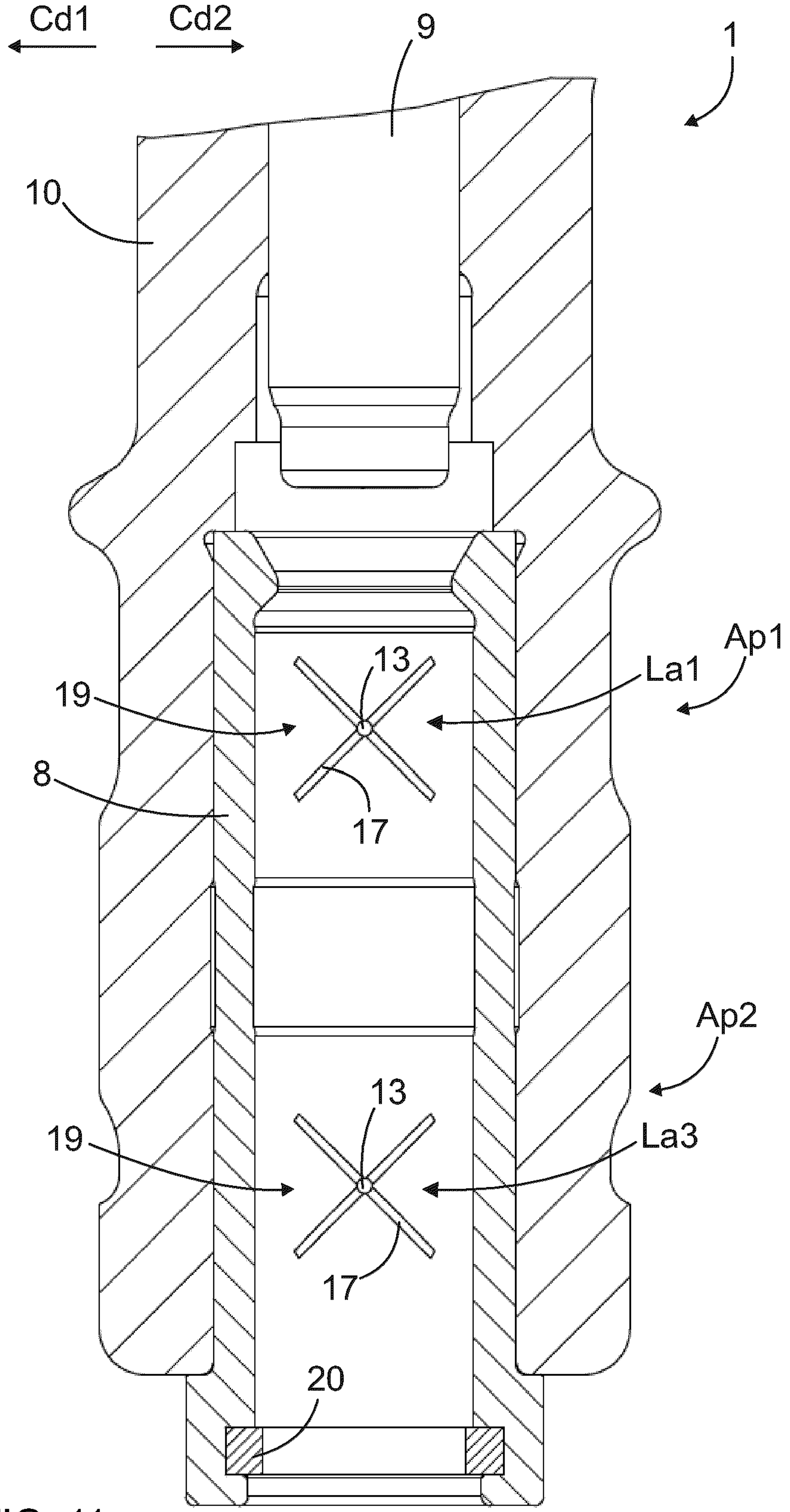

FIG. 11

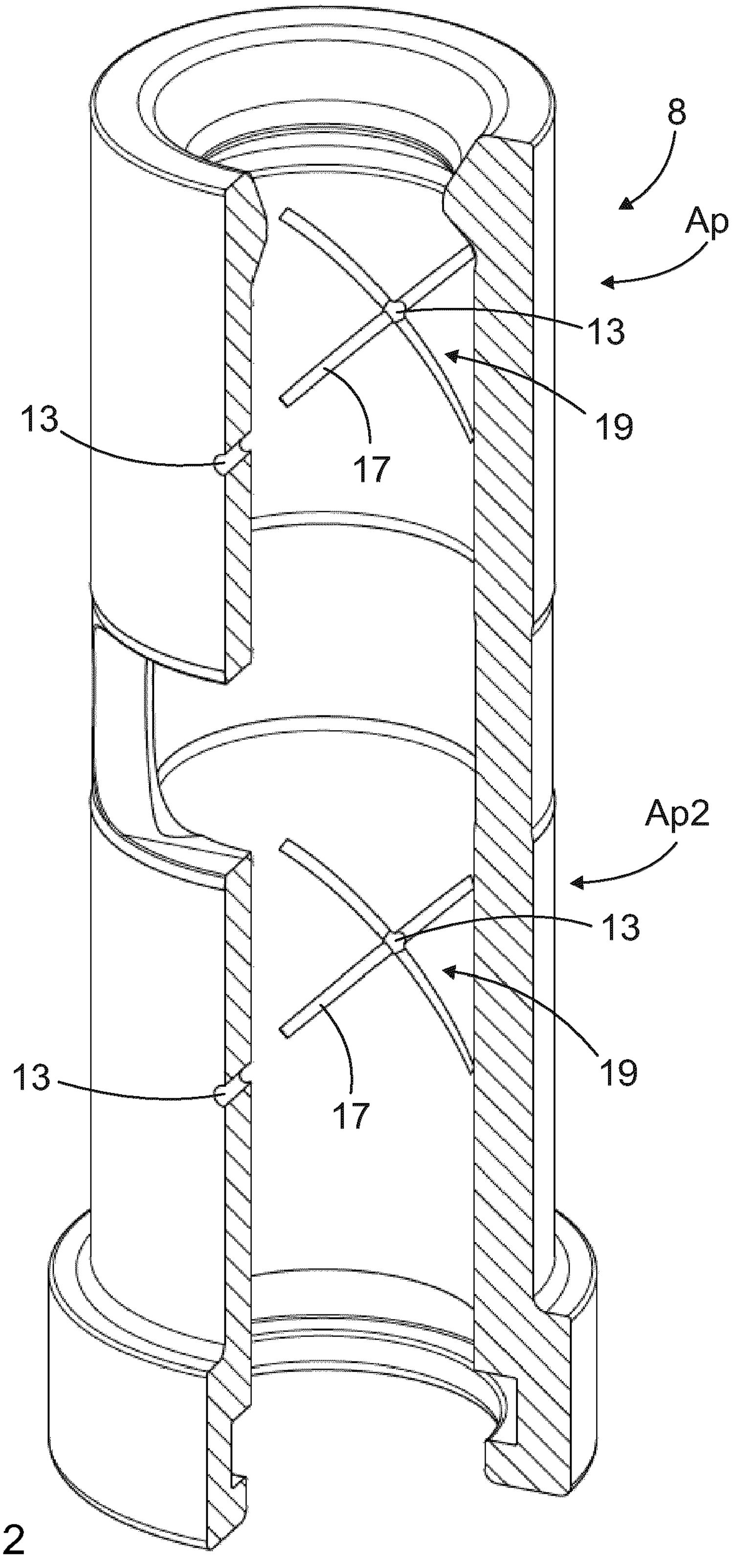

FIG. 12

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EUROPEAN SEARCH REPORT

Application Number
EP 23 21 6184

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	CN 216 948 499 U (BEILITE MACHINERY CO LTD) 12 July 2022 (2022-07-12) * the whole document * -----	1-13	INV. B25D17/08 B25D17/26
A	KR 2018 0130662 A (SON YOUNG HOON [KR]) 10 December 2018 (2018-12-10) * abstract * * paragraphs [0001], [0006] * * paragraph [0188] - paragraph [0208] * * figures 1,2,4,5 * -----	1-13	
			TECHNICAL FIELDS SEARCHED (IPC)
			B25D E02F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	10 June 2024	Baumgärtner, Ruth

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CATEGORY OF CITED DOCUMENTS

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10-06-2024

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
CN 216948499 U	12-07-2022	NONE	
KR 20180130662 A	10-12-2018	NONE	

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