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(54) **DRILLING ARRANGEMENT, DRILLING MACHINE AND METHOD**

(57) A drilling arrangement, a mine drilling machine and a method. The arrangement comprises a hollow, flexible and rotatable drill rod (2), a feed unit (1) for rotating said drill rod (2), a feed beam (4) arranged to support the feed unit (1) and comprising a feed unit (1) for feeding said drill rod (2), and flushing medium hose (8) connected to the drill rod (2). A flushing medium connec-

tor (7) connects the flushing medium hose (8) to the drill rod (2), enabling the flushing medium hose (8) remaining unrotating while the drill rod (2) is rotating. The arrangement (100) further comprises an auxiliary feed unit (3) arranged to contact with the flushing medium hose (8) for moving the drill rod (2) by pushing or pulling said flushing medium hose (8).

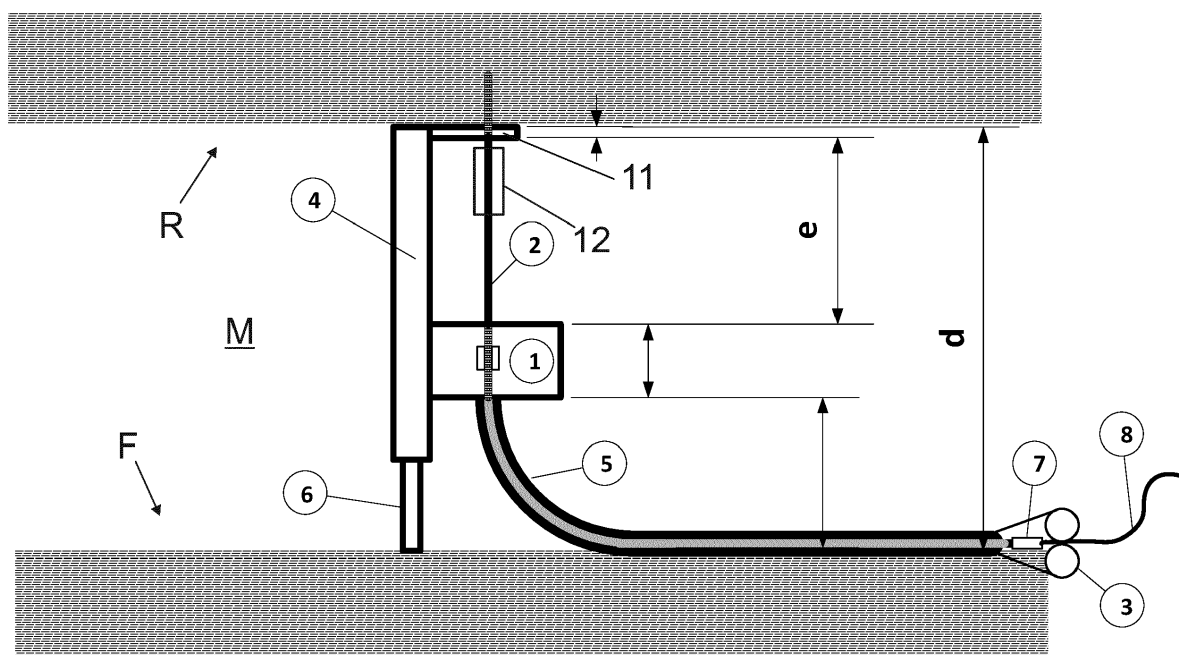


Fig. 1

Description

BACKGROUND

[0001] The invention relates to a drilling arrangement for a mine drilling machine.

[0002] The invention further relates to a mine drilling machine.

[0003] The invention still further relates to a method for drilling a hole into a rock.

[0004] The need for continuous drilling arises especially in the low profile (LP) and extra low profile (XLP) mines where rock support is a critical part of the process. The height of the mine gallery may be as low as 1.2 meters. Due to the rock conditions it is necessary to install up to 2-6 meter long rock reinforcement bolts to the roof of the mine.

[0005] Since the drilled length required is much longer than the height of the mine, currently extension drilling by adding rods is used. Adding rods takes time, lowers the efficiency of the process and risks persons when adding rods are often done by hand. Due to the space restriction a mechanic rod handler has not been seen feasible or as effective as manual handling.

[0006] A document EP2896780 discloses a flexible drill rod for continuous drilling, in which adding of rods may be avoided. However, there are some aspects regarding sliding of the drill rod that could be improved or developed further.

BRIEF DESCRIPTION

[0007] Viewed from a first aspect, there can be provided a drilling arrangement for a mine drilling machine, comprising a hollow, flexible and rotatable drill rod, a feed unit for rotating said drill rod, a feed beam arranged to support the feed unit and comprising a feed unit for feeding said drill rod, a flushing medium hose connected to the drill rod arranged for providing flushing medium in the drill rod, a flushing medium connector connecting the flushing medium hose to the drill rod, the connector enabling the flushing medium hose remaining unrotating while the drill rod is rotating, wherein the arrangement further comprises an auxiliary feed unit arranged to contact with the flushing medium hose for moving the drill rod by pushing or pulling said flushing medium hose.

[0008] Thereby an arrangement providing smooth sliding of the drill rod may be achieved.

[0009] Viewed from a second aspect, there can be provided a mine drilling machine comprising the drilling arrangement described above.

[0010] Viewed from a still further aspect, there can be provided a method for drilling a hole into a rock, comprising using a hollow, flexible and rotatable drill rod, rotating the drill rod by a feed unit, feeding the drill rod into the rock by said feed unit, providing flushing medium in the drill rod in a rear end thereof by using a flushing medium hose, keeping the flushing medium hose unrotating, and

moving the drill rod by pushing or pulling the flushing medium hose.

[0011] Thereby a method for smooth sliding of the drill rod may be achieved.

[0012] The arrangement and the method are characterised by what is stated in the characterising parts of the independent claims. Some other embodiments are characterised by what is stated in the other claims. Inventive embodiments are also disclosed in the specification and drawings of this patent application. The inventive content of the patent application may also be defined in other ways than defined in the following claims. The inventive content may also be formed of several separate inventions, especially if the invention is examined in the light of expressed or implicit sub-tasks or in view of obtained benefits or benefit groups. Some of the definitions contained in the following claims may then be unnecessary in view of the separate inventive ideas. Features of the different embodiments of the invention may, within the scope of the basic inventive idea, be applied to other embodiments.

[0013] In one embodiment, the auxiliary feed unit comprises a contact element being a rotating roll or an endless chain or belt. An advantage is that a simple means for moving the flushing medium hose may be achieved.

[0014] In one embodiment, the auxiliary feed unit is also arranged, on demand, to pull the flushing medium hose in direction opposite to the pushing direction. An advantage is that a rod holder provided with gripping means for gripping to the drill rod may be omitted, and stroke length of the drill rod may be extended.

[0015] In one embodiment, the auxiliary feed unit is arranged to move the flushing medium hose in the same direction as the feed unit is feeding said drill rod. An advantage is that tolerances in the structure of the flexible drill rod may be minimized, and thus the sliding of the drill rod may be smoothened effectively.

[0016] In one embodiment, the arrangement comprises a control unit arranged to control the moving force of the auxiliary feed unit exerting to the flushing medium hose. An advantage is that a fluent movement of the drill rod may be achieved.

[0017] In one embodiment, the feed beam comprises a rod holder arranged at a front end of the feed beam for supporting the drill rod, the rod holder being without a drill rod engaging element. An advantage is that the rod holder may have very compact dimensions in direction of the drill rod, and thus length of effective drilling stroke may be increased.

[0018] In one embodiment, a guiding element is arranged between the feed unit and the auxiliary feed unit to bend the drill rod. An advantage is that the course of the drill rod in the arrangement may be optimized.

[0019] In one embodiment, the guiding element comprises a guiding tube. An advantage is that the drill rod is not only guided but also protected inside the tube.

[0020] In one embodiment, a front guiding element is provided in front side of the feed unit for supporting the

drill rod. An advantage is that the guiding of the drill rod is maximized and the bending/twisting of the rod is prevented. Said bending may occur due to high torque peaks during drilling. Overbending may break the drill rod.

[0021] In one embodiment, the flushing medium connector comprises a first end attached to the drill rod, and a second end attached to the hose and arranged coaxially with the first end. An advantage is that a simple and reliable structure of the flushing medium connector may be achieved.

BRIEF DESCRIPTION OF FIGURES

[0022] Some embodiments illustrating the present disclosure are described in more detail in the attached drawings, in which

Figure 1 is a schematic side view of a drilling arrangement and method in partial cross-section,

Figure 2 is a schematic view of a flexible drill rod,

Figure 3 is a schematic side view of a flushing medium connector,

Figure 4 is a schematic side view of a drilling machine, and

Figure 5 illustrates a method for drilling a hole.

[0023] In the figures, some embodiments are shown simplified for the sake of clarity. Similar parts are marked with the same reference numbers in the figures.

DETAILED DESCRIPTION

[0024] Figure 1 is a schematic side view of a drilling arrangement and method in partial cross-section.

[0025] The drilling arrangement 100 is arranged in a mine M comprising floor F and roof R. The drilling arrangement 100 is shown in drilling a hole on the roof R. However, it is to be noted that the drilling arrangement 100 may also be used for drilling the floor or walls of the mine M.

[0026] The height d of the mine is very low, such that the mine M may be called as low profile or extra low profile mine. Therefore, a flexible drill rod 2 is used in the arrangement 100. The flexible drill rod 2 is also hollow and rotatable drill, a feed unit 1 being arranged for rotating said drill rod 2. In the front end of the drill rod 2 there is arranged a drill bit (not shown).

[0027] The drilling arrangement 100 further comprises a feed beam 4 arranged to support a feed unit 1 that feeds and rotates the drill rod 2 in the hole being drilled.

[0028] In an embodiment, the feed unit 1 comprises a rotation chuck (not shown) that may grip tightly to the drill rod 2 when the feed unit 1 starts rotating and pushing the drill rod 2 into the hole, such that the torque and the

thrust are transmitted to the drill rod 2 and further to the drill bit.

[0029] In an embodiment, the feed beam 4 comprises a rod holder 11 arranged at a front end of the feed beam for supporting the drill rod 2.

[0030] A flushing medium hose 8 is connected to the drill rod 2 and arranged for providing flushing medium in the drill rod 2. In an embodiment, the flushing medium is liquid, such as water. In another embodiment, the flushing medium is gas or gas mixture, such as air. In still another embodiment, the flushing medium is a mixture of liquid and gas, such as water and air.

[0031] The flushing medium hose 8 has a bendable structure.

[0032] A flushing medium connector 7 connects the flushing medium hose 8 to the drill rod 2. The connector allows flushing medium to flow from the flushing medium hose 8 to the drill rod 2, and enables the flushing medium hose 8 to remain unrotating while the drill rod 2 is rotating. The structure of the connector is described more detailed in connection with Figure 3.

[0033] In an embodiment, a guiding element 5, such as a guiding tube, is arranged between the feed unit 1 and the auxiliary feed unit 3. The guiding element 5 may bend the drill rod 2. This facilitates that the drill rod 5 may be fed to the feed beam 4 in a direction that may be e.g. at least essentially parallel with the floor F or roof R of the mine, and then turned towards e.g. said floor F or roof R.

[0034] In an embodiment, the guiding tube has a fixed shape, e.g. it is always changing the direction of the drill rod 2 in a same way. In another embodiment, the shape of the guiding tube may be changed or adjusted.

In an embodiment, the guiding element 5 comprises a series of guiding loops or rings etc.

[0035] In an embodiment, the feed beam 4 comprises a rod holder 11 arranged at a front end of the feed beam for supporting the drill rod 2.

[0036] In an embodiment, a front guiding element 12 is provided in front side of the feed unit 1 for supporting the drill rod 2 after the feed unit 1.

[0037] The arrangement 100 further comprises an auxiliary feed unit 3 that is arranged to contact with the flushing medium hose 8. The auxiliary feed unit 3 moves the drill rod 2 in its axial direction by pushing or pulling the flushing medium hose 8.

[0038] The auxiliary feed unit 3 has a contact element 9 that is arranged in contact with the flushing medium hose 8. The contact element 9 transmits power to the flushing medium hose 8 by e.g. frictional forces.

[0039] In an embodiment, the contact element 9 comprises a rotating roll or a pair of rolls arranged on different sides of the flushing medium hose 8.

[0040] In another embodiment, the contact element 9 comprises an endless chain or belt, or a pair of such chains or belts arranged on different sides of the flushing medium hose 8.

[0041] In still another embodiment, the contact ele-

ment 9 comprises at least one rotating roll and at least one endless chain or belt arranged on different sides of the flushing medium hose 8.

[0042] The auxiliary feed unit 3 may be driven e.g. electrically, pneumatically or hydraulically.

[0043] The auxiliary feed unit 3 is arranged, on demand, to push the flushing medium hose 8 in the same direction as the feed unit 1 is feeding the drill rod, i.e. towards the hole to be drilled. Pushing the flushing medium hose 8 in the same direction as the feed unit 1 facilitates fluent movement of the rod 2 sliding through the guiding element 5, if any. Said pushing towards the hole also facilitates fluent movement between the rod 2 and the feed unit 1 when the feed unit 1 is moved backwards for a new drilling stroke.

[0044] Alternatively, the auxiliary feed unit 3 may be arranged to pull the flushing medium hose 8 and the drill rod 2 therewith in an opposite direction, away from the hole. Thanks to this, extracting the drill rod 2 from hole may be at least partly, or even totally, taken care of by the auxiliary feed unit 3.

[0045] The auxiliary feed unit 3 makes it possible to realize the rod holder 11 without any drill rod engaging element, simplifying the structure of the rod holder 11. The rod holder 11 may thus be very thin, which in turn extends the effective drilling stroke e.

[0046] **Figure 2** is a schematic view of a flexible drill rod. The drill rod 2 may comprise a tube 19 and at least one corrugated cut 20 extending through the wall of the tube 19 in a transverse direction thereof, in other words in a direction transverse to the longitudinal axis D of the drill rod 2. The corrugated cut 20 extends at each point substantially radially through the tube wall from the outside of the tube to the inside of the tube.

[0047] In an embodiment, each corrugated cut 20 have a substantially spiral baseline 21 extending in a circulating manner around the tube 19 in the direction of longitudinal axis D from the direction of a first end of the drill rod to a direction of a second end of the drill rod.

[0048] Each corrugated cut 20 may be arranged to deviate from its baseline 21 on both sides of the baseline 21 forming a cut of a substantially corrugated shape. The baseline 21 is not a physical part of the corrugated cut 20, but a virtual line on both sides of which the corrugated cut extends at each portion of the drill rod 2.

[0049] The corrugated cut 20 may comprise curved portions of one or several radiuses. The corrugated cut 20 may also comprise straight portions connecting the curved portions. In different embodiments, the straight portions may be substantially parallel to the direction of the baseline 21, substantially perpendicular to the direction of the baseline 21 and/or arranged at an angle with respect to the baseline 21. This corrugated cut 20 may then spiral along the tube 19. In other words, the corrugated cut 20 may circulate around the drill rod 2, more particularly around the longitudinal axis D of the drill rod 2.

[0050] According to an embodiment, the shape of the corrugated cut 20 is of a teardrop-like shape.

[0051] By providing such a corrugated cut 20 on a rigid drill rod 2, the drill rod 2 may be made at the same time flexible, such that bending of the drill rod 2 is enabled in a transverse direction of the drill rod 2, and rigid, such that transmitting torque and thrust needed for drilling is enabled.

[0052] In an embodiment, the bending radius of the tube 19 is less than 1 meter, and preferably under 0.5 meter. This enables bending the drill rod 2 also at low drilling spaces and achieving an optimal amount of uninterrupted drilling at any circumstances using as much of the available drilling height as possible.

[0053] The corrugated cut 20 may be formed by laser cutting and/or high pressure water jet cutting.

[0054] The corrugated cut 20, even though very narrow, causes un-conformity and discontinuity on the outer surface of the drill rod 2. As a consequence, it may occur that the drill rod 2 slightly sticks or freezes in the feed unit or in the guiding element(s). In other words, moving or sliding of the drill rod 2 through the feed unit or the guiding element(s) is not smooth, which has a negative effect to the drilling process. Additionally, the drill rod or the feed unit or the guiding element may be damaged or even broken due to said sticking or freezing. The auxiliary feed unit 2 eliminates or at least decreases this problem by pushing the corrugated cut 20 as narrow as possible and thus levelling out the outer surface of the drill rod 2.

[0055] **Figure 3** is a schematic side view of a flushing medium connector. The connector 7 comprises a first end 13 attached to the back end of the drill rod 2, and a second end 14 attached to the flushing medium hose 8 and arranged coaxially with the first end 13. The ends 13, 14 are provided with corresponding fastening elements 16, 17 for receiving the drill rod and the flushing medium hose, respectively. A channel 18 extends through the connector 7 in direction of the longitudinal axis X thereof for passing flushing medium from the hose 8 to the drill rod 2.

[0056] Between the ends 13, 14 there is a rotary connection element 15. This element attaches the ends 13, 14 together and allows their mutual rotation around their common longitudinal axis X. In an embodiment, the rotary connection element 15 is unrotatably attached to one of the ends 13, 14, and thus, it may rotate only in respect to another of said ends. In another embodiment, the rotary connection element 15 is rotatably attached to both of the ends 13, 14.

[0057] **Figure 4** is a schematic side view of a mine drilling machine. The mine drilling machine 22 comprises at least one drilling arrangement 100 discussed in this description.

[0058] The mine drilling machine 22 may comprise a boom 3 that is provided with the drilling arrangement 100. This particular type of a mine drilling machine 22 is especially suitable for tunnels and other drilling spaces of limited height, such as low profile mines.

[0059] The mine drilling machine 22 may comprise not only drilling arrangement(s) 100 described in this descrip-

tion, but also other type of mining equipment.

[0060] The drilling arrangement 100 is provided with a control unit 10 arranged to control the auxiliary feed unit 3. In the embodiment shown in Figure 4, the control unit 10 is arranged in the mine drilling machine 22.

[0061] The control unit may control the moving force of the auxiliary feed unit 3 exerted to the flushing medium hose 8, speed of the pushing or pulling in terms of absolute values and/or in relation to the movements of the feed unit 1, etc.

[0062] Figure 5 illustrates a method for drilling a hole into a rock. The method comprises using 501 a hollow, flexible and rotatable drill rod, rotating 502 the drill rod 2 by a feed unit, feeding 503 the drill rod into the rock by said feed unit, 504 providing flushing medium in the drill rod in a rear end thereof by using a flushing medium hose, keeping 505 the flushing medium hose unrotating, and moving 506 the drill rod by pushing or pulling the flushing medium hose.

[0063] In an embodiment of the method, the drill rod is pulled, at demand, in direction opposite to the pushing direction.

[0064] In an embodiment of the method, it is controlled the force the auxiliary feed unit exerts to the flushing medium hose.

[0065] In an embodiment of the method, the hole is drilled in a continuous way.

[0066] The invention is not limited solely to the embodiments described above, but instead many variations are possible within the scope of the inventive concept defined by the claims below. Within the scope of the inventive concept the attributes of different embodiments and applications can be used in conjunction with or replace the attributes of another embodiment or application.

[0067] The drawings and the related description are only intended to illustrate the idea of the invention. The invention may vary in detail within the scope of the inventive idea defined in the following claims.

REFERENCE SYMBOLS

[0068]

1	feed unit
2	drill rod
3	auxiliary feed unit
4	feed beam
5	guiding element
6	stinger
7	flushing medium connector
8	flushing medium hose
9	contact element
10	control unit
11	rod holder
12	front guiding element
13	first end of connector
14	second end of connector
15	rotary connection element

16	first fastening element
17	second fastening element
18	connector channel
19	tube
20	corrugated cut
21	spiral baseline
22	mine drilling machine
23	boom
100	drilling arrangement
501- 506	method steps
d	height of mine
D	longitudinal axis of drill rod
e	effective drilling stroke
F	floor
M	mine
R	roof
X	longitudinal axis of connector

Claims

1. A drilling arrangement (100) for a mine drilling machine, comprising

- a hollow, flexible and rotatable drill rod (2),
- a feed unit (1) for rotating said drill rod (2),
- a feed beam (4) arranged to support the feed unit (1) and comprising a feed unit (1) for feeding said drill rod (2),
- a flushing medium hose (8) connected to the drill rod (2) arranged for providing flushing medium in the drill rod (2),
- a flushing medium connector (7) connecting the flushing medium hose (8) to the drill rod (2), the connector enabling the flushing medium hose (8) remaining unrotating while the drill rod (2) is rotating, wherein the arrangement (100) further comprises
- an auxiliary feed unit (3) arranged to contact with the flushing medium hose (8) for moving the drill rod (2) by pushing or pulling said flushing medium hose (8).

2. The arrangement as claimed in claim 1, wherein the auxiliary feed unit (3) comprises a contact element (9) being a rotating roll or an endless chain or belt.

3. The arrangement as claimed in any of the preceding claims, wherein the auxiliary feed unit (3) is also arranged, on demand, to pull the flushing medium hose (8) in direction opposite to the pushing direction.

4. The arrangement as claimed in any of the preceding claims, wherein the auxiliary feed unit (3) is arranged to move the flushing medium hose (8) in the same direction as the feed unit (1) is feeding said drill rod

- (2).
- controlling the force the auxiliary feed unit (3) exerts to the flushing medium hose (8).
5. The arrangement as claimed in any of the preceding claims, comprising a control unit (10) arranged to control the moving force of the auxiliary feed unit (3) exerting to the flushing medium hose (8). 5
6. The arrangement as claimed in any of the preceding claims, wherein the feed beam (4) comprises a rod holder (11) arranged at a front end of the feed beam for supporting the drill rod (2), the rod holder (11) being without a drill rod engaging element. 10
7. The arrangement as claimed in any of the preceding claims, wherein a guiding element (5) is arranged between the feed unit (1) and the auxiliary feed unit (3) to bend the drill rod (2). 15
8. The arrangement as claimed in claim 7, wherein the guiding element (5) comprises a guiding tube. 20
9. The arrangement as claimed in any of the preceding claims, wherein a front guiding element (12) is provided in front side of the feed unit (1) for supporting the drill rod (2). 25
10. The arrangement as claimed in any of the preceding claims, wherein the connector (7) comprises a first end (13) attached to the drill rod (2), and a second end (14) attached to the hose (8) and arranged coaxially with the first end (13). 30
11. A mine drilling machine comprising a drilling arrangement (100) according any one of the preceding claims. 35
12. A method for drilling a hole into a rock, comprising
- using a hollow, flexible and rotatable drill rod (2), 40
 - rotating the drill rod (2) by a feed unit (1),
 - feeding the drill rod (2) into the rock by said feed unit (1),
 - providing flushing medium in the drill rod (2) in a rear end thereof by using a flushing medium hose (8), 45
 - keeping the flushing medium hose (8) unrotating, and
 - moving the drill rod (2) by pushing or pulling the flushing medium hose (8). 50
13. The method as claimed in claim 12, comprising
- at demand, pulling the drill rod (2) in direction opposite to the pushing direction. 55
14. The method as claimed in claim 12 or 13, comprising
15. The method as claimed in any one of claims 12 - 14, comprising
- drilling the hole in a continuous way.

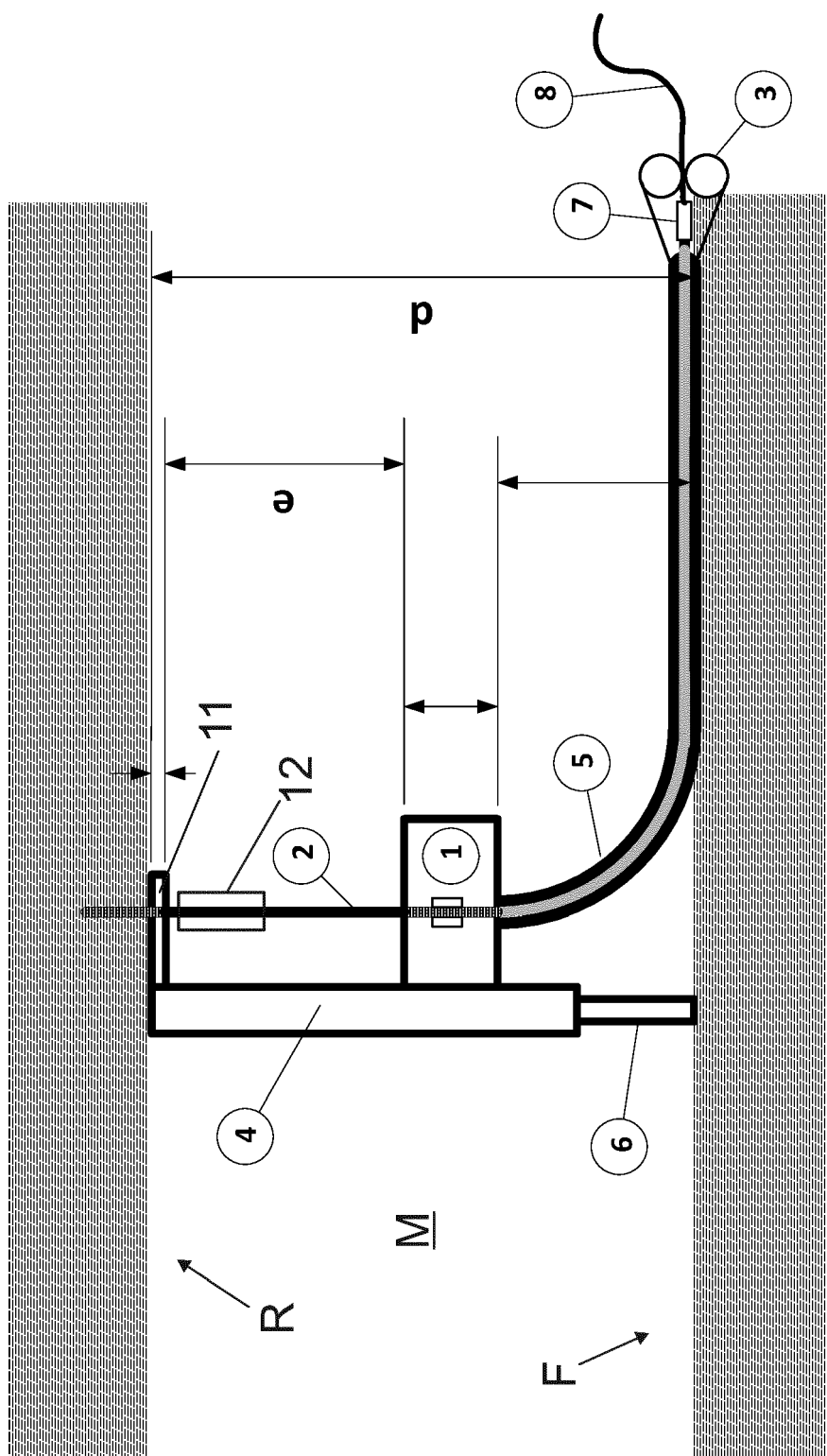


Fig. 1

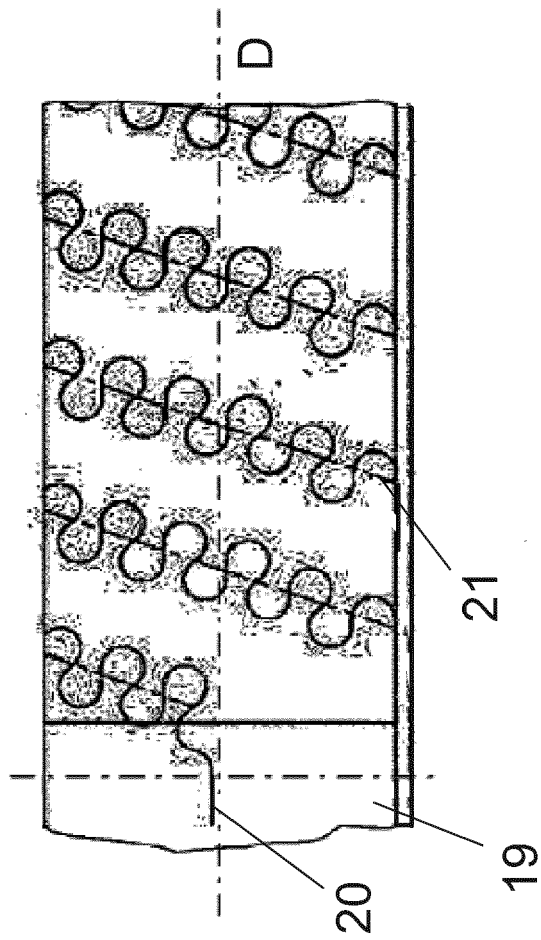


Fig. 2

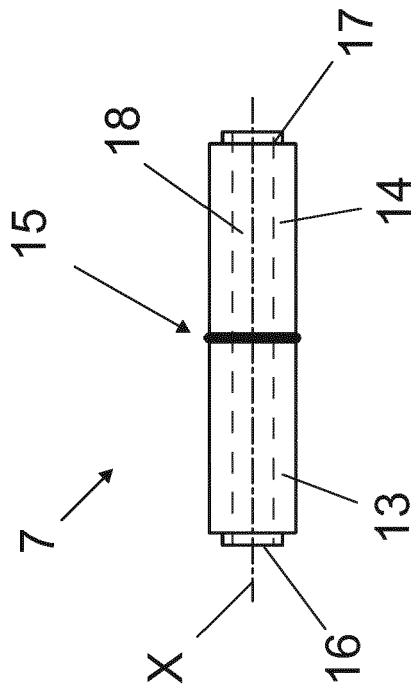


Fig. 3

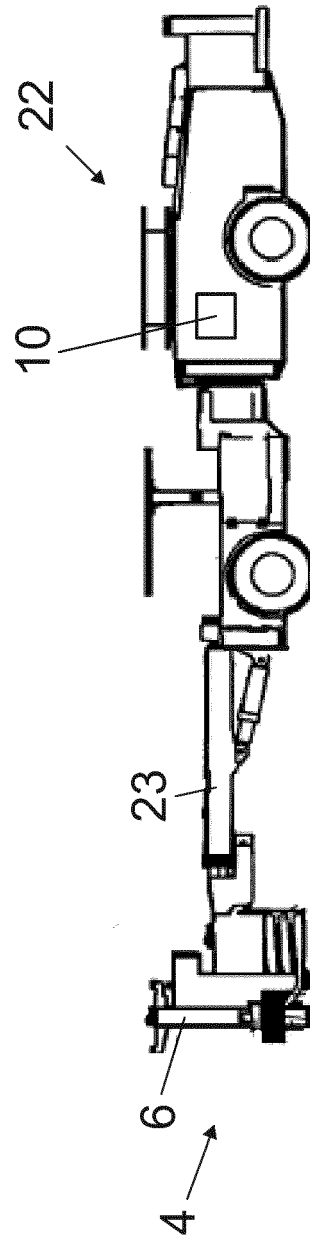


Fig. 4

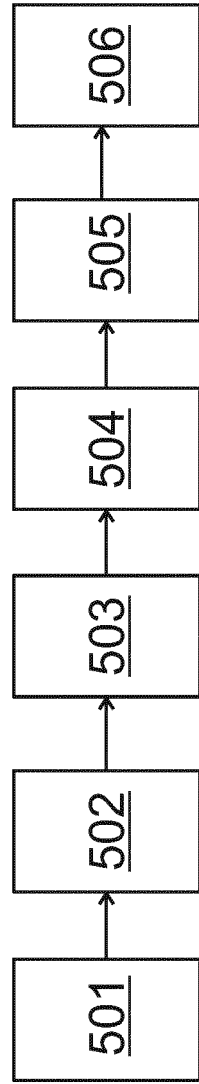


Fig. 5



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Application Number
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