



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
12.08.2020 Bulletin 2020/33

(51) Int Cl.:
E21B 19/22^(2006.01)

(21) Application number: **19156375.8**

(22) Date of filing: **11.02.2019**

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

(72) Inventors:
• **VERHO, Samuli**
33311 Tampere (FI)
• **KOKKONEN, Annukka**
33311 Tampere (FI)

(74) Representative: **Sandvik**
Sandvik Mining and Construction Oy PL 100
Patent Department
33311 Tampere (FI)

(71) Applicant: **Sandvik Mining and Construction Oy**
33311 Tampere (FI)

(54) **DETERMINING A LENGTH OF A DRILL HOLE DRILLED BY A CONTINUOUS ROD**

(57) A drilling arrangement, a mine drilling machine and a method. The arrangement comprises a drill bit (3) arranged in a hollow, flexible and rotatable drill rod (2). The arrangement comprises (100) a feed beam (4) comprising a feed unit (1) for feeding said drill rod (2) in a drill

hole, and a first sensor (6) arranged at the feed beam (4) for monitoring position of the drill bit (3) or the drill rod (2), and a second sensor (12) arranged for measuring length of the hole.

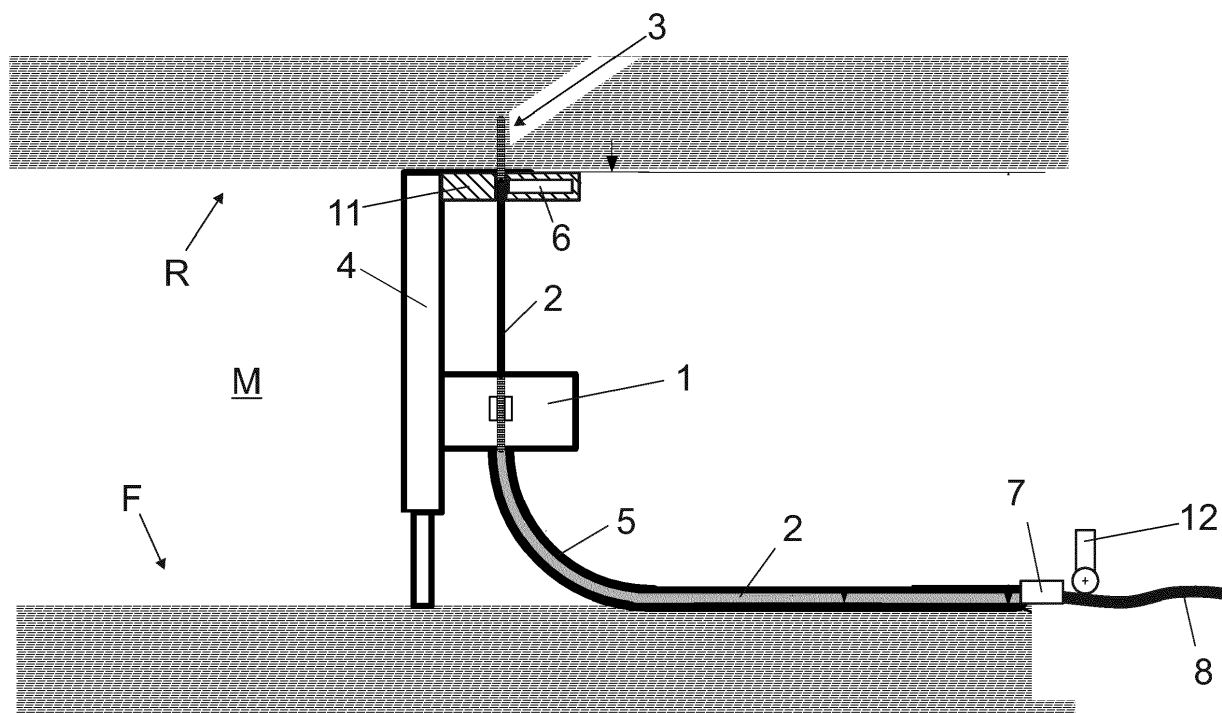


Fig. 1

Description

BACKGROUND

[0001] The invention relates to an arrangement for determining position of a drill bit of 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 position of drill bit both inside and outside of the hole. The position should be known to measure length of drilled hole and to detect when bit has been retracted from the hole. Accurate length of the hole is critical for success of the bolting process, especially when using refabricated fixed length bolts. Also retraction of the drill bit needs to be ensured in the automated drilling cycle to prevent the drill rod breaking when positioning the arrangement. If the drill bit is not secured during movements of the arrangement it may hit the rock causing the major breakage of the drill rod or the drill bit itself.

BRIEF DESCRIPTION

[0007] Viewed from a first aspect, there can be provided an arrangement for determining position of a drill bit of a mine drilling machine, the drill bit being arranged in a hollow, flexible and rotatable drill rod, the arrangement comprising a feed beam comprising a feed unit for feeding said drill rod in a drill hole, wherein the arrangement further comprises a first sensor arranged at the feed beam for monitoring position of the drill bit or the drill rod, and a second sensor arranged for measuring length of the hole.

[0008] Thereby an arrangement for precise monitoring of position of drill bit both inside and outside of the hole 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 into a rock, comprising using a drill bit arranged in a hollow, flexible and rotatable drill rod, rotating the drill rod and the drill bit therewith by a rotation unit, feeding the drill bit into the rock by said rotation unit, monitoring the drill bit or drill rod by a first sensor arranged at the feed beam, and measuring by a second sensor length of the hole.

[0011] Thereby a method for precise monitoring of position of drill bit both inside and outside of the hole 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 first sensor is arranged at the front of the feed beam. An advantage is that that an immediate detection of the drill bit retracted from the hole may be achieved.

[0014] In one embodiment, the arrangement comprises a flushing medium hose connected to the drill rod, the flushing medium hose arranged for providing flushing medium in the drill rod, wherein the second sensor is arranged to measure length of the flushing medium hose passing the second sensor. An advantage is that the hose may provide precise measurement of the hole length.

[0015] In one embodiment, the arrangement comprises 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, the second sensor thus arranged for measuring unrotating flushing medium hose. An advantage is that the precision of the measurement may be improved.

[0016] In one embodiment, the feed beam comprises a rod holder arranged at a front end of the feed beam for supporting the drill rod, and the first sensor being arranged in said rod holder. An advantage is that the rod holder provides a protected site for the sensor at the very end of the feed beam.

[0017] In one embodiment, a guiding element is arranged between the feed unit and the second sensor to bend the drill rod. An advantage is that the course of the drill rod in the arrangement may be optimized.

[0018] 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.

[0019] In one embodiment, the arrangement comprises a control unit arranged to receive signals from the sensors, and to control the actuators moving the drill rod based on said signals. An advantage is that a fluent movement of the drill rod may be achieved.

[0020] In one embodiment, the control unit is arranged to change feed speed of the drill rod based on signals received from the second sensor. An advantage is that a safe and economical way of use of the drill rod and the drill bit may be achieved.

[0021] In one embodiment, the control unit is arranged to slow down retracting feed speed of the drill rod when the second sensor is indicating the drill bit is about to leave the drill hole. An advantage is that the first sensor may detect the position of the drill bit even more accurate.

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 an arrangement for determining position of a drill bit of a mine drilling machine 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 drilling machine,

Figure 4 is a schematic side view of a detail of an arrangement, 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 an arrangement for determining position of a drill bit of a mine drilling machine and method in partial cross-section.

[0025] The 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 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 rotation 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 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.

[0033] In an embodiment, the flushing medium connector 7 enables the flushing medium hose 8 to remain unrotating while the drill rod 2 is rotating.

[0034] In an embodiment, a guiding element 5, such as a guiding tube, is arranged to guide the drill rod 2. 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.

[0035] 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.

[0036] In an embodiment, the guiding element 5 comprises a series of guiding loops or rings etc.

[0037] 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.

[0038] The arrangement 100 comprises a sensor arrangement for monitoring position of the drill bit 3 both inside and outside of the hole. According to an aspect, the sensor arrangement comprises a first sensor 6 arranged at the feed beam 4 for monitoring position of the drill bit 3 or drill rod 2, and a second sensor 12 arranged for measuring length of the hole.

[0039] In an embodiment, the first sensor 6 is arranged at the front of the feed beam 4. In the embodiment shown in Figure 1, the first sensor 6 lies in the rod holder 11.

[0040] The first sensor 6 is able to detect when the drill rod 2 and the drill bit 3 are retracted away from the hole. In an embodiment, the first sensor 6 is arranged to give just information "yes" or "not" if the drill rod 2 and the drill

bit 3 are retracted away from the hole or not.

[0041] The first sensor 6 may be e.g. an induction sensor, a mechanical sensor, a capacitive sensor, a magnetic sensor, an ultrasonic sensor, etc.

[0042] It is to be noted that in some embodiments the first sensor 6 may comprise plurality of sensors. All said sensors may be of same type, or alternatively different types of sensors. An advantage is that reliability of the monitoring of the drill rod 2 or the drill bit 3 may be enhanced.

[0043] In an embodiment, the second sensor 12 is arranged to measure length of the flushing medium hose 8. For this purpose, length value of the sensor is automatically reset to zero when starting the hole drilling. Then, the flushing medium hose 8 passing the second sensor 12 is measured, the length of which corresponds to the length of the hole and the position of the drill bit 3. This embodiment is especially advantageous in combination with embodiments where the flushing medium connector 7 enables the flushing medium hose 8 to remain unrotating while the drill rod 2 is rotating. This combination may assure highly exact measuring of length of the hole.

[0044] In an embodiment, the second sensor 12 comprises a measuring wheel that is connected to an encoder, a resolver, a potentiometer, etc.

[0045] A control unit 10 (shown in Figure 3) receives signals from the sensors 6, 12 and controls the actuators moving the drill rod 2 based on said signals. In an embodiment, the control unit 10 is arranged to change feed speed of the drill rod 2 based on signals received from the second sensor 12, for instance to slow down retracting feed speed of the drill rod 2 when the second sensor 12 is indicating the drill bit 3 is about to leave the drill hole.

[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 unconformity 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 mine drilling machine.

[0056] The mine drilling machine 22 comprises at least one drilling arrangement provided with the arrangement 100 for determining position of a drill bit.

[0057] The mine drilling machine 22 may comprise a boom 3 that is provided with the drilling arrangement. 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.

[0058] The mine drilling machine 22 may comprise not only drilling arrangement(s), but also other type of mining equipment.

[0059] The arrangement 100 for determining position of a drill bit is provided with a control unit 10 as described earlier in this description. In the embodiment shown in Figure 4, the control unit 10 is arranged in the mine drilling machine 22.

[0060] The control unit may control not only the feed speed of the drill rod 2 as described above, but also movements of the boom 3 and the drilling arrangement, etc.

[0061] Figure 4 is a schematic side view of a detail of an arrangement.

[0062] As described above in connection with Figure 1, the feed beam 4 comprises a rod holder 11 arranged at a front end of the feed beam for supporting the drill rod 2, and the first sensor 6 is arranged in said rod holder 11.

[0063] In an embodiment, the rod holder 11 is provided with at least one contact bracket 13. In the drilling site, the contact bracket 13 makes contact with the rock K to be drilled. When drilling, the bracket(s) 13 keep(s) the rod holder 11 at a distance from the rock K. This makes it possible to arrange the first sensor 6 on a front surface of the rod holder 11. This provides an advantage that the first sensor is accessible for maintenance work etc.

[0064] Figure 5 illustrates a method for drilling a hole into a rock. The method comprises using 501 a drill bit 3 arranged in a hollow, flexible and rotatable drill rod 2, rotating 502 the drill rod 2 and the drill bit 3 by a rotation unit 1, feeding 503 the drill rod into the rock by said rotation unit, monitoring 504 the drill bit 3 or drill rod 2 by a first sensor 6 arranged at the feed beam (4), and measuring by a second sensor 12 length of the hole.

[0065] In an embodiment, the method comprises providing flushing medium in the drill rod 2 by a flushing medium hose 8 connected to the drill rod 2, measuring the length of the hole by monitoring the flushing medium hose 8 by the second sensor 12, and measuring length of the flushing medium hose 8 passing said second sensor 12.

[0066] In an embodiment of the method, it is slowed down retracting feed speed of the drill rod 2 when the second sensor 12 is indicating the drill bit 3 is about to leave the drill hole.

[0067] In an embodiment of the method, the hole is drilled in a continuous way.

[0068] 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.

[0069] 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

[0070]

- | | |
|---|---------------------------|
| 1 | feed unit |
| 2 | drill rod |
| 3 | drill bit |
| 4 | feed beam |
| 5 | guiding element |
| 6 | first sensor |
| 7 | flushing medium connector |
| 8 | flushing medium hose |
| 9 | contact element |

- | | |
|----|-----------------------|
| 10 | control unit |
| 11 | rod holder |
| 12 | second sensor |
| 13 | contact bracket |
| 14 | boom |
| 19 | tube |
| 20 | corrugated cut |
| 21 | spiral baseline |
| 22 | mine drilling machine |
| 23 | boom |

100 arrangement

501- 504 method steps

- | | | |
|----|---|-------|
| 15 | F | floor |
| | K | rock |
| | M | mine |
| | R | roof |

20

Claims

1. An arrangement (100) for determining position of a drill bit of a mine drilling machine,

- the drill bit (3) being arranged in a hollow, flexible and rotatable drill rod (2), the arrangement comprising (100)
 - a feed beam (4) comprising a feed unit (1) for feeding said drill rod (2) in a drill hole,

wherein the arrangement (100) further comprises

- a first sensor (6) arranged at the feed beam (4) for monitoring position of the drill bit (3) or the drill rod (2), and
 - a second sensor (12) arranged for measuring length of the hole.

2. The arrangement as claimed in claim 1, wherein the first sensor (6) is arranged at the front of the feed beam (4).

3. The arrangement as claimed in claim 1 or 2, comprising

- a flushing medium hose (8) connected to the drill rod (2), the flushing medium hose (8) arranged for providing flushing medium in the drill rod (2), wherein
 - the second sensor (12) is arranged to measure length of the flushing medium hose (8) passing the second sensor (12).

4. The arrangement as claimed in claim 2 or 3, 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), and wherein the first sensor (6) is arranged in said rod holder (11).

5. The arrangement as claimed in any of claims 3 - 4, comprising 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, the second sensor (12) thus arranged for measuring unrotating flushing medium hose (8). 5
6. The arrangement as claimed in any of the preceding claims, wherein a guiding element (5) is arranged between the feed unit (1) and the second sensor (12) to bend the drill rod (2). 10
7. The arrangement as claimed in claim 6, wherein the guiding element (5) comprises a guiding tube.
8. The arrangement as claimed in any of the preceding claims, comprising a control unit (10) arranged to receive signals from the sensors (6, 12), and to control the actuators moving the drill rod (2) based on said signals. 20
9. The arrangement as claimed in claim 8, wherein the control unit (10) is arranged to change feed speed of the drill rod (2) based on signals received from the second sensor (12). 25
10. The arrangement as claimed in claim 9, wherein the control unit (10) is arranged to slow down retracting feed speed of the drill rod (2) when the second sensor (12) is indicating the drill bit (3) is about to leave the drill hole. 30
11. A mine drilling machine comprising a drilling arrangement (100) according any one of the preceding claims. 35
12. A method for drilling into a rock, comprising 40
 - using a drill bit (3) arranged in a hollow, flexible and rotatable drill rod (2),
 - rotating the drill rod (2) and the drill bit (3) therewith by a rotation unit (1), 45
 - feeding the drill bit (3) into the rock by said rotation unit (1),
 - monitoring the drill bit (3) or drill rod (2) by a first sensor (6) arranged at the feed beam (4), 50
 - and
 - measuring by a second sensor (12) length of the hole.
13. The method as claimed in claim 12, comprising 55
 - providing flushing medium in the drill rod (2) by a flushing medium hose (8) connected to the

drill rod (2),

- measuring the length of the hole by monitoring the flushing medium hose (8) by the second sensor (12), and

- measuring length of the flushing medium hose (8) passing said second sensor (12).

14. The method as claimed in claim 12 or 13, comprising slowing down retracting feed speed of the drill rod (2) when the second sensor (12) is indicating the drill bit (3) is about to leave the drill hole.

15. The method as claimed in any one of claims 11 - 14, comprising drilling the hole in a continuous way.

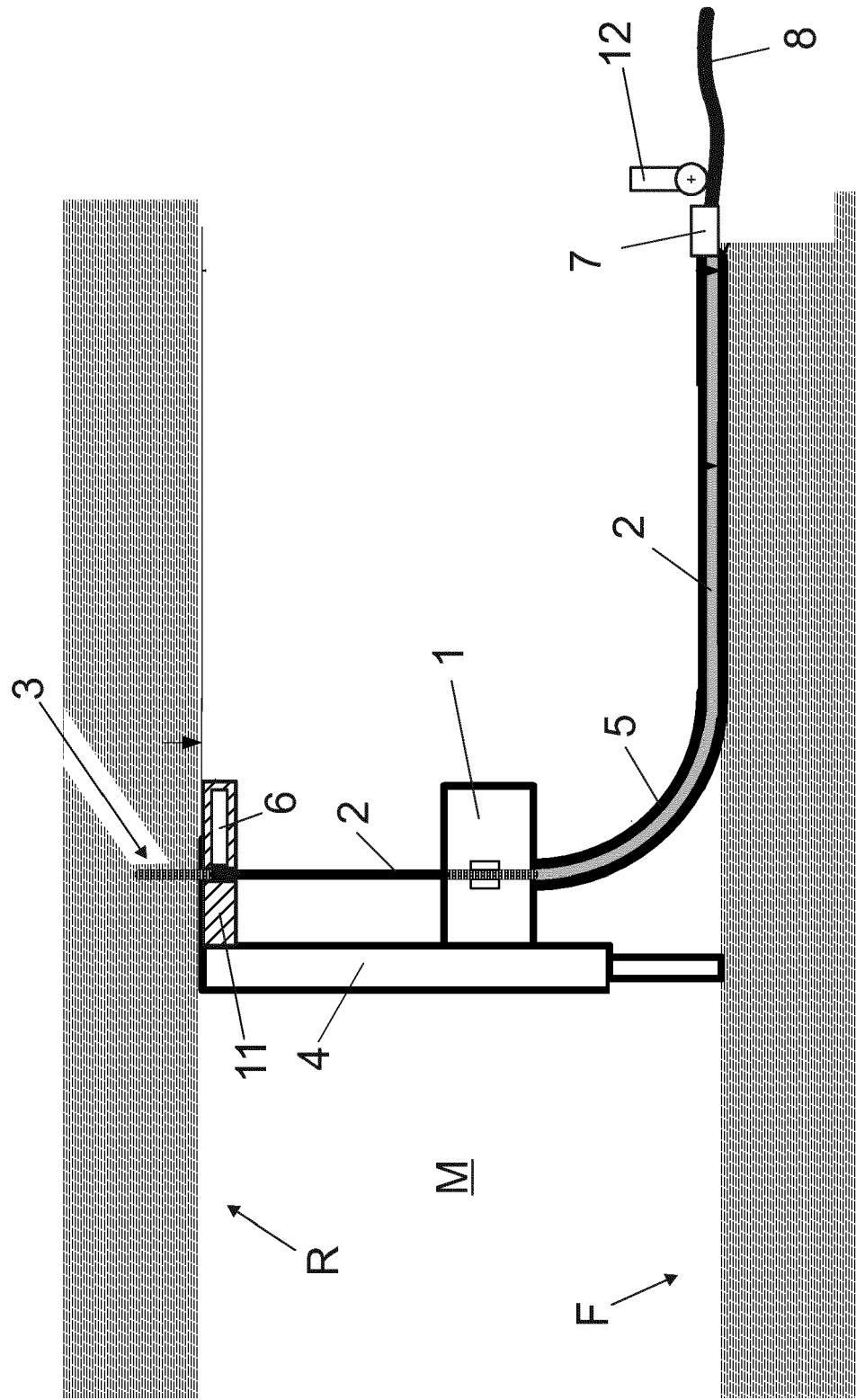
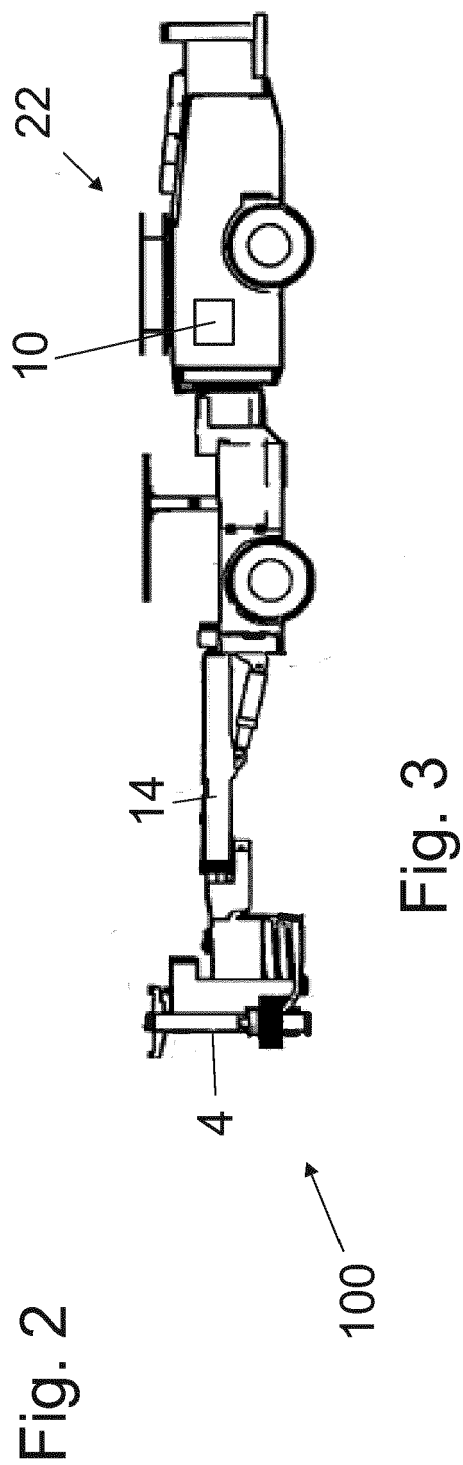
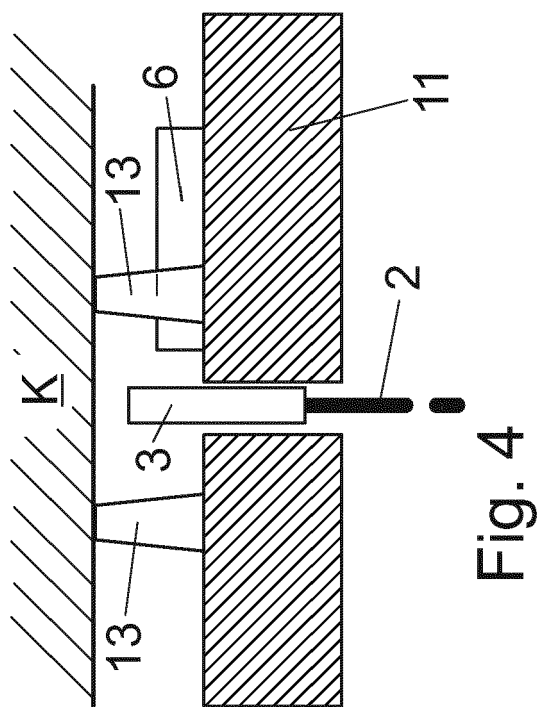
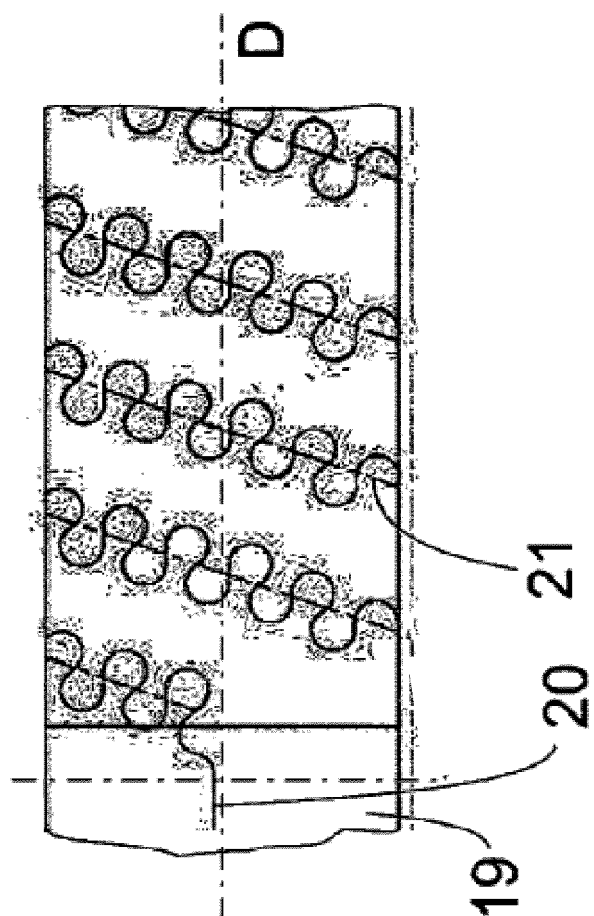


Fig. 1



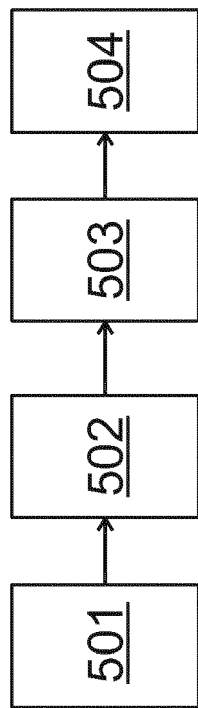


Fig. 5



EUROPEAN SEARCH REPORT

Application Number
EP 19 15 6375

5

10

15

20

25

30

35

40

45

50

55

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 3 837 592 A (THIERY J ET AL) 24 September 1974 (1974-09-24)	1-6,8-15	INV. E21B19/22
Y	* column 2, line 41 - column 4, line 35; figures 1-3 *	7	
Y	US 3 563 436 A (REYNARD REMI ET AL) 16 February 1971 (1971-02-16) * figures 1-3 *	7	
A,D	EP 2 896 780 A1 (SANDVIK MINING & CONSTR OY [FR]) 22 July 2015 (2015-07-22) * the whole document *	7	
A	US 3 872 932 A (GOSSELIN JEAN-CHARLES) 25 March 1975 (1975-03-25) * the whole document *	1-15	
A	US 3 658 138 A (GOSSELIN JEAN CHARLES) 25 April 1972 (1972-04-25) * the whole document *	1-15	
A	US 2002/170711 A1 (NUTH DAVID [CA]) 21 November 2002 (2002-11-21) * the whole document *	1-15	TECHNICAL FIELDS SEARCHED (IPC)
A	WO 2007/026111 A1 (PSL ENERGY SERVICES LTD [GB]; FOUBISTER JOHN WILLIAM [GB]) 8 March 2007 (2007-03-08) * page 2, line 23 - page 3, line 3 *	1-15	E21B
A	US 2014/262340 A1 (BEDDOES RICHARD [CA] ET AL) 18 September 2014 (2014-09-18) * figures 6,6a,7,7a *	1-15	
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 31 July 2019	Examiner Beran, Jiri
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 19 15 6375

5

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

31-07-2019

10

15

20

25

30

35

40

45

50

55

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 3837592 A	24-09-1974	CA 982529 A	27-01-1976
		DE 2262758 A1	28-06-1973
		FR 2165322 A5	03-08-1973
		GB 1410368 A	15-10-1975
		IT 972581 B	31-05-1974
		JP S4871702 A	28-09-1973
		JP S5525101 B2	03-07-1980
		NL 7217690 A	26-06-1973
		US 3837592 A	24-09-1974

US 3563436 A	16-02-1971	CS 150595 B2	04-09-1973
		DE 1758968 A1	08-04-1971
		ES 155343 U	16-03-1970
		FR 1583175 A	24-10-1969
		GB 1242103 A	11-08-1971
		SE 346353 B	03-07-1972
		US 3563436 A	16-02-1971

EP 2896780 A1	22-07-2015	CA 2936262 A1	23-07-2015
		CL 2016001779 A1	09-12-2016
		EP 2896780 A1	22-07-2015
		EP 3094808 A1	23-11-2016
		PE 11142016 A1	29-10-2016
		PL 3094808 T3	31-05-2019
		RU 2629296 C1	28-08-2017
		WO 2015106859 A1	23-07-2015
		WO 2015107145 A1	23-07-2015

US 3872932 A	25-03-1975	NONE	

US 3658138 A	25-04-1972	BE 749366 A	01-10-1970
		CA 927375 A	29-05-1973
		DE 2021232 A1	12-11-1970
		FR 2037007 A1	31-12-1970
		GB 1284149 A	02-08-1972
		JP S5025404 B1	23-08-1975
		NL 7006264 A	03-11-1970
		US 3658138 A	25-04-1972

US 2002170711 A1	21-11-2002	CA 2444657 A1	31-10-2002
		US 2002170711 A1	21-11-2002
		WO 02086287 A2	31-10-2002

WO 2007026111 A1	08-03-2007	NONE	

US 2014262340 A1	18-09-2014	US 2014262340 A1	18-09-2014

EPO FORM P0459

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

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- EP 2896780 A [0006]