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(54) ROCK BOLTING RIG AND METHOD FOR ROCK REINFORCING

(57) A bolting rig and method for rock reinforcing. The bolting rig (1) comprises a movable carrier (2), a bolting boom (3) mounted to a boom mounting point (16), and a bolting unit (4) mounted to the bolting boom. There is also

a cable reel arrangement (9) which comprises a cable reel (18) loaded with would cable (26). The cable reel arrangement is located at a front part of the carrier and is in front of the boom mounting point.

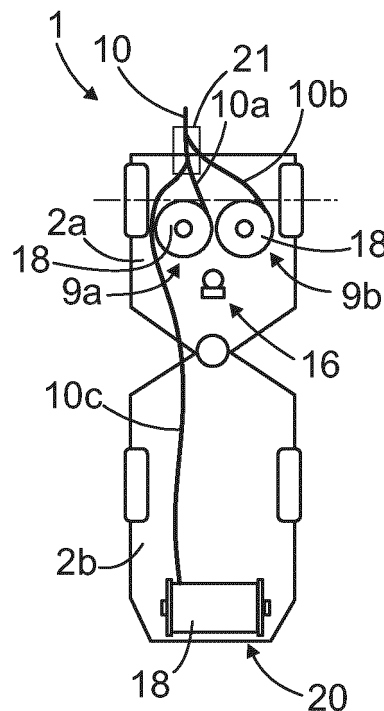


FIG. 4

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Description

Background of the invention

[0001] The invention relates to rock bolting rig for installing cable bolts to drill holes for reinforcing a rock surface.

[0002] The invention further relates to a method for reinforcing rock surfaces.

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

[0004] In mines, construction sites and at other work areas exists a need to reinforce rock surfaces and to thereby ensure their safety and suitability for the intended purposes. A common method for rock reinforcement is rock bolting. In such reinforcement system several rock bolts are fastened in drilled holes by grouting material. In this way rock layers are bonded together so that the risk for collapse is reduced. There are several different rock bolt types and methods for installing the rock bolts. One known and widely used rock bolt is a cable bolt. However, the present solutions for installing the cable bolts have shown to contain some disadvantages.

Brief description of the invention

[0005] An object of the invention is to provide a novel and improved solution for installing cable bolts for reinforcing rock surfaces.

[0006] The bolting rig according to the invention is characterized by the characterizing features of the independent apparatus claim.

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

[0008] An idea of the disclosed solution is that a rock bolting rig comprises a carrier, at least one bolting boom mounted to a boom mounting point on the carrier, and at least one bolting unit mounted to a distal end portion of the bolting boom. There are also one or more cable reel arrangements for storing wound cable and a cable feed device for feeding the cable from the cable reel arrangement to the bolting unit under guidance of a guide arrangement. Furthermore, the cable reel arrangement is located in front of the boom mounting point. In other words, the cable reel arrangement is located at a front part of the carrier when examined in the operating direction.

[0009] An advantage of the disclosed solution is that stability of the bolting rig is improved when the cable reel arrangement is located at a front part of the carrier. This is because of the fact that at a rear part of the bolting rig there are typically heavy weight components and apparatuses, and also the bolting rigs have typically relatively long rear overhangs. Thus, the cable reel arrangement at the front can balance the carrier.

[0010] A further advantage is that distance between the cable reel arrangement and the bolting unit may be

relatively short whereby feeding of the cable is easy.

[0011] According to an embodiment, position of the cable reel arrangement is independent of the operation of the bolting boom. Thus, the cable reel is not located on the bolting boom of the bolting unit. When the cable reel arrangement does not move together with the bolting boom, the structure may be simpler, and weight of the cable does has no influence on movements of the bolting boom.

[0012] According to an embodiment, the bolting rig may be provided with a rock bolt storing and handling apparatuses in addition to the cable feed capability. Thus, the bolting rig may comprise a dual system allowing mounting either rock bolts or cable reinforcements. There may be a rock bolt magazine for storing the rock bolts and a handling arrangement for picking the rock bolts from the magazine.

[0013] According to an embodiment, the bolting boom is mounted to a support frame fastened on the carrier and protruding vertically from an upper surface of the carrier. The bolting boom may be connected on a side surface facing towards the operating direction by means of a joint system.

[0014] According to an embodiment, the bolting unit comprises a cutter for cutting the cable. Thus, cable bolts are formed by cutting the cable after being inserted into the drill hole.

[0015] According to an embodiment, the guide arrangement comprises at least one feed tube for guiding the cable inside the feed tube from the cable reel arrangement to the bolting unit.

[0016] According to an embodiment, the cable reel arrangement comprises a cable reel on which the cable is wound, and wherein the cable reel is rotatable in relation to vertical rotating axis. In other words, the rotatable cable reel is in horizontal or predominantly horizontal orientation. An advantage of the horizontally orientated cable reel is that center of gravity is located at a lower level compared to the vertically orientated cable reel and this is beneficial regarding stability of the bolting rig. Further, the horizontally orientated cable reel has improved availability whereby change, handling and service measures are easy to execute.

[0017] According to an embodiment, the cable reel may be slightly slanted from the horizontal orientation for facilitating the cable feeding process. Magnitude of the slanting is limited. Thereby, also in that case one end surface of the cable reel is facing downwards towards a driving surface and an opposite end surface is facing upwards. In known bolting rigs the cable reels are rotated around horizontal rotation axis and end surfaces of the cable reel are facing in opposite lateral directions.

[0018] The cable reel may be tilted a limited amount in a vertical direction in relation to a tilting joint by means of a tilting actuator.

[0019] According to an embodiment, the cable reel arrangement is located in front of the carrier. In other words, the cable reel arrangement is located at a distance

from the frontmost end of the carrier. An advantage of this embodiment is that there is no need to reserve space on the carrier for the cable reel arrangement. Then layout of the carrier is easier to design.

[0020] According to an embodiment, the cable reel arrangement has an operational position wherein it is positioned underneath the bolting boom during the bolting. Then it is advantageous that the cable reel has horizontal orientation and takes thereby only little space in vertical direction.

[0021] According to an embodiment, the cable reel arrangement is located in front of a front axle of the carrier. Then the cable reel arrangement may be located in front of the carrier, or it may be entirely, or partly located on a frontmost part of the carrier.

[0022] According to an embodiment, the carrier is wheeled and comprises a front axle and a rear axle. The cable reel arrangement is in front of the boom mounting point which is located between the front and rear axles of the carrier. In other words, the cable reel arrangement may be located entirely or partly between the front and rear axles.

[0023] According to an embodiment, the cable reel arrangement is supported to the carrier movably by means of at least one turning join and turning actuator. In other words, position of the cable reel arrangement is changeable in relation to the carrier.

[0024] According to an embodiment, the cable reel arrangement is movable at least in lateral direction of the carrier. Then the cable reel arrangement can be moved from the operational position to a side of the carrier wherein more space is available and wherein it is easier to execute change of the cable reel and needed handling and service operations.

[0025] According to an embodiment, the cable reel arrangement is movable in vertical direction relative to the carrier. This vertical movement possibility may be alternatively or in addition to the lateral direction movement. An advantage of the vertical direction movement feature is that height level of the cable reel arrangement can be adjusted so that cable feeding to the bolting unit is fluent. The vertical movement may also be implemented when changing the cable reel, for example.

[0026] According to an embodiment, the cable reel arrangement is supported to a handling arm connected to a front part of the carrier and configured to protrude from the carrier in longitudinal direction of the carrier. In other words, the handling arm supports the cable reel arrangement at a distance from the front part of the carrier. An advantage of this embodiment is that there is no need for space and support structures for the cable reel arrangement on upper surfaces of the carrier. Further, the handling arm and the provided distance from the carrier facilitates change of the cable reel and maintenance operations.

[0027] According to an embodiment, a first end of the handling arm is connected to the front part of the carrier by means of one or more joints whereby the handling arm

and the cable reel arrangement, located at a second end portion of the handling arm, can be moved in a versatile manner. This way work of the operator of the bolting rig can be made easier, safer, and more productive.

[0028] According to an embodiment, a first end of the handling arm is connected at the front part of the carrier at a transverse distance from a longitudinal center line of the carrier. The handling arm may be mounted at a mounting point being at a maximum transverse distance from the center line. Then the handling arm can be turned into a transport position wherein it is directed transversally or substantially transversally relative to the longitudinal direction of the carrier. Thereby the handling arm and the cable reel arrangement at its distal end portion does not increase length of the carrier and does not form visual obstructions when driving and positioning the bolting rig.

[0029] Further, the handling arm can be turned to desired angle orientations in relation to the carrier whereby it allows the cable reel arrangement to be positioned during the bolting operation into a desired position relative to the bolting unit. When the handling arm mounting is located close to a side of the carrier, it has sufficient lateral reach when being turned to one side of the carrier for cable reel change, for example.

[0030] According to an embodiment, the cable reel arrangement comprises a cable cassette and a cable reel is arranged inside the cable cassette forming a surrounding and supporting structure for the cable reel on which the cable is wound. In other words, the cable cassette is able to receive the cable reel inside a protective outer casing and the cassette has support means allowing the rotating movement of the cable reel. An advantage of the cable cassette is that it can protect the cable reel at harsh operating environment from falling rock material, dirt and moisture thereby increasing operational reliability.

[0031] According to an embodiment, the cable reel is a changeable component that can be arranged inside the cable cassette. Then an empty cable reel can be easily removed from the cable cassette and substituted by a new cable reel on which desired amount of cable is wound. The cable reels can be delivered to the bolting site as pre-wound units. The cable reels can be wound at separate facilities outside the bolting site, or they can be submitted as ready for use units by a cable supplier.

[0032] According to an embodiment, the cable cassette comprises quick locking elements for the coupling of the cable reel. The coupling can also be automated so that unmanned change of the cable reel is possible.

[0033] According to an embodiment, the cable reel arrangement is a changeable unit. Then the cable cassette and the cable reel inside it can be easily removed and replace as one entity. This way the cable reel arrangement can be removed when it is not needed, and the removal is also possible for maintenance purposes, for example.

[0034] According to an embodiment, the cable reel arrangement is arranged at distal end portion of a hand-

ling arm which is mounted to a front end of the carrier. Between the cable reel arrangement and the handling arm are quick coupling elements facilitating easy and quick removal and recoupling.

[0035] According to an embodiment, the cable reel arrangement is provided with the cable feed device for feeding the cable. In other words, the cable reel arrangement is a structurally and operationally independent module which is able to feed the cable from the cable reel arranged inside the cable cassette.

[0036] According to an embodiment, the cable reel arrangement comprises a rotating device for rotating the cable reel inside the cable cassette. The rotating device may provide the cable reel at least an assisting rotation movement which is enough together with the feed of the cable to make the cable reel to rotate and allow the cable to be unwound from the cable reel.

[0037] According to an embodiment, the bolting rig may comprise a feed device mounted in connection with the bolting unit or the bolting boom. Further, it possible to use several feed devices. Thus, there may be a first feed device in connection with the cable reel arrangement and a second feed device in connection with the bolting unit. The first feed device may subject trust forces to the cable and the second feed device may subject draw forces to the cable.

[0038] It has been noted that it is usually beneficial to direct draw forces to the cable being fed. Then the cable can be fed with lower forces compared to solutions wherein only trust forces are implemented.

[0039] According to an embodiment, the bolting rig comprises two or more cable reels. Then the guide arrangement comprises a branched guide element allowing cable feeding selectively from one of the cable reels one at a time. In other words, the embodiment allows to feed cable from two or more separate cable reels and thereby improves reliability of operation. If one cable reel fails or cable runs out, then another cable reel can be activated.

[0040] According to an embodiment, the disclosed cable reel arrangement serves as a main cable reel and one or more additional cable reels can be placed elsewhere, such to a rear part or middle part of the carrier. A back reel and a middle reel can then serve as reserve cable reels.

[0041] According to an embodiment, the branched guide element has Y-shaped configuration and comprises two receiving branches and one delivery branch. The cables can be fed selectively from the alternative cable reels through the receiving branches towards the delivery branch which is connected to a feed tube or another type of guide element for directing the cable to the bolting unit.

[0042] According to an embodiment, the disclosed solution can also be implemented in a rock drilling rig intended mainly to drill blast holes on surfaces of rock cavities, or face surfaces of tunnels and mine corridors. Then a drilling boom may be provided with a bolting unit,

or alternatively the rock drilling rig may be provided with a bolting boom equipped with the bolting unit. In this respect the term "bolting rig" also refers to the rock drilling rig which is provided with the disclosed cable bolting solution.

[0043] According to an embodiment, the disclosed solution also relates to a method for rock reinforcing. The method comprises: using a bolting rig comprising a carrier, a bolting boom, a bolting unit and a cable reel; drilling a drill hole to the rock surface by means of a rock drilling machine of the bolting unit; feeding grouting material into the drill hole; feeding from the cable reel the cable bolt to the drill hole by means of a feed device; and cutting the cable bolt outside the drill hole. The method further comprises supporting the cable reel at a front part of the carrier an operating the cable reel independently in relation to the bolting boom.

[0044] The above disclosed embodiments may be combined in order to form suitable solutions having those of the above features that are needed.

Brief description of the figures

[0045] Some embodiments are described in more detail in the accompanying drawings, in which

Figure 1 is a schematic side view of a bolting rig installing cable bolts to a rock surface,

Figures 2 - 4 are schematic top views of bolting rigs with different layouts,

Figure 5 is a schematic side view of a front part of a bolting rig provided with a cable reel arrangement arranged movably in front of a carrier; and

Figure 6 is schematic top view of a front part of a bolting rig provided with a handling arm for moving a cable reel arrangement.

[0046] 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

[0047] Figure 1 discloses a bolting rig 1 comprising a movable carrier 2 and at least one bolting boom 3 at a free end portion of which is a bolting unit 4 for installing cable bolts 5 inside drilled holes 6. The bolting unit 4 may comprise a rock drilling unit 7 for drilling the drill holes 6, or alternatively, the drill holes 6 may be already drilled. The bolting unit 4 comprises needed devices 8 for feeding, cutting, and tensioning the cable bolt 5, as well as for mounting needed accessories, such as anchors and surface plates. On the carrier 2 is a cable reel arrangement 9 for storing wound cable. There is also a guide arrangement 10 for guiding the cable from the cable reel arrangement 9 to the bolting unit 4. The guide arrangement 10 may be a tubular element, for example.

[0048] The cable reel arrangement 9 comprises a rotatable cable reel 11. In Figure 1 the cable reel 10 is arranged horizontally to a rear end portion of the carrier 2 and thereby shows a prior art solution in this regard.

[0049] The bolting rig 1 further comprises a grouting system, which is not disclosed in Figure 1 for clarity reasons. Typically, the grouting system comprises a grout storage, a grout feed device, and a hose reel for injecting grout material to the drill hole 6. The disclosed devices and systems can be controlled under control of one or more control units CU, automatically or together with an operator of the bolting rig 1.

[0050] Figure 1 further discloses that the bolting rig 1 may be used to mount the cable bolts 5 to ceiling surfaces 12 of a rock space. Alternatively, or in addition to, the rock reinforcement can be done to wall surfaces 13, face surfaces and any other rock surfaces which need to be reinforced. The bolting rig 1 is operated at a work site in an operating direction OD and can also be moved and positioned in a reverse direction RD.

[0051] Figures 2 - 4 disclose bolting rigs 1 wherein carriers 2 are frame steered and comprise front frames 2a and rear frames connected to each other by means of steering joints 14. The front frames 2a and the rear frames 2b are provided with tires 15. Cable reel arrangements 9 are mounted to the front frame parts 2a wherein it is also located boom mounting points 16 for supporting bolting booms 3. For clarity reasons, Figure 2 shows the bolting boom 3 partly and with broken lines, and in Figures 3 and 4 the bolting boom is not disclosed. The boom mounting point 16 comprises a frame, a support surface or any other firm structure capable of supporting the bolting boom 3. The boom mounting point 16 is facing towards an operating direction OD. In Figures 2 - 4 it is shown in a simplified manner that joints 17 for coupling the bolting booms may be located on surfaces facing towards the operating direction OD. Alternatively, the bolting booms can be mounted on top of the structures of the boom mounting points 16. The cable reel arrangements 9 are mounted on the carriers 2 and are located in front of the boom mounting points 16.

[0052] In Figure 2 the cable reel arrangement 9 comprises a cable reel 18 rotatable in relation to vertical rotating axis. The cable reel arrangement 9 is located at an area between a front most part of the front frame 2a and the boom mounting point 16.

[0053] In Figure 3 the cable reel arrangement 9 comprises a cable reel 18 rotatable in relation to horizontal rotating axis. The cable reel arrangement 9 is mainly located in front of a front axle 19 of the front frame 2a.

[0054] In Figure 4 there are two adjacent cable reel arrangements 9a, 9b with cable reels 18 rotatable in relation to vertical rotating axis. The cable reel arrangements 9 are located between a front axle 19 of the front frame 2a and the boom mounting point 16. However, it is possible to mount the cable reel arrangements 9a, 9b alternatively in front of the front axle 19. It is also possible to arrange the cable reel arrangements 9a, 9b one after

each other in the direction of the operating direction OD. In some cases, number of the cable reel arrangements may be three or even larger.

[0055] Figure 4 further discloses, that the bolting rig 1 may be provided with an additional cable reel arrangement 20 mounted to the rear frame 2b. Thus, there may be one or more cable arrangements 9a, 9b in front of the boom mounting point 16 and one or more additional cable reel arrangements 20 located behind the boom mounting point 16. Then a guide arrangement 10 is provided with a branched guide element 21 for connecting several guide branches 10a, 10b and 10c and allowing cable feeding selectively from one of the cable reels 18 one at a time.

[0056] Figure 5 discloses a rock drilling rig 1 wherein a cable reel arrangement 9 is supported to a handling arm 22 connected to a front part of a carrier 2 and configured to protrude from the carrier 2 in longitudinal direction of the carrier 2. Then the cable reel arrangement 9 can be moved in relation to turning joints 23, 24 by means of one or more turning actuators, which are not shown for clarity reasons. Figure 5 shows by means of arrows that the cable reel arrangement 9 can be lifted and lowered, as well as tilted and moved in sideways.

[0057] Further, the cable reel arrangement 9 comprises a cable cassette 25 inside which is arranged a cable reel 18. The cable reel 18 is a changeable object which can be changed to a new one when a cable 26 runs out.

[0058] In order to feed the cable 26 there may be a cable feed device 27 in connection with the bolting unit 4. The cable feed device 27 may be part of a bolting device 28 of the bolting unit 4, or it may be a separate device connected to the bolting unit 4. In addition to, or alternatively, the cable reel arrangement 9 may be provided with a cable feed device 27a. The cable feed device 27 can drag the cable 26 and the cable feed device 27a can push the cable 26.

[0059] Further, the bolting unit 4 is provided with a cutting device 29 for cutting the cable after being inserted into the drilled hole. A system 30 for feeding grouting material or resin injection material is disclosed only in simplified manner. The system 30 delivers the grouting material to the bolting unit 4 by means of a hose 31 or tubes. The operation of the bolting process can be controlled under control of a control unit CU.

[0060] Figure 6 discloses a bolting rig 1 wherein a cable reel arrangement 9 is mounted to a handling arm 22 so that the cable reel arrangement 9 can pick up a full cable reel 18a from a first side and can place an empty cable reel 18b to a second side. Then handling of cable reels can be efficient and safe when there is no need to operate under a bolting boom 3 by means of any external transport vehicles and apparatuses.

[0061] The disclosed handling arm 22 allows the cable reel arrangement 9 to be moved into a transport position close to the carrier 2 and also allows the cable reel arrangement 9 to be moved in accordance with the position and orientation of the bolting boom 3 and the

bolting unit 4 so that the cable feeding can be enhanced.

[0062] Figure 6 further discloses that the cable reel arrangement 9 may comprise a cable feed device 27a. There may also be a rotation device 28 for rotating a cable reel 18 inside a cable cassette 25 and to thereby assist the feeding of the cable 26.

[0063] 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 rock bolting rig (1) for installing cable bolts (5) to drill holes (6) for reinforcing a rock surface, wherein the bolting rig (1) comprises:

a carrier (2) movable in an operating direction (OD) and an opposite reverse direction (RD);
at least one bolting boom (3) mounted to a boom mounting point (16) on the carrier (2) and configured to face towards the operating direction (OD);

at least one bolting unit (4) mounted to a distal end portion of the bolting boom (3);

at least one cable reel arrangement (9) supported on the carrier (2) and being capable of storing wound cable (26);

at least one cable feed device (27, 27a) for feeding the cable from the cable reel arrangement (9) to the bolting unit (4); and

a guide arrangement (10) for guiding the cable (26) from the cable reel arrangement (9) to the bolting unit (4);

characterized in that

the cable reel arrangement (9) is located in front of the boom mounting point (16).

2. The bolting rig as claimed in claim 1, **characterized in that**

the cable reel arrangement (9) comprises a cable reel (18) on which the cable (26) is wound, and wherein the cable reel (18) is rotatable in relation to vertical rotating axis (V).

3. The bolting rig as claimed in claim 1 or 2, **characterized in that**

the cable reel arrangement (9) is located in front of the carrier (2).

4. The bolting rig as claimed in claims 1 - 3, **characterized in that**

the cable reel arrangement (9) is supported to the carrier (2) movably by means of at least one turning join (22, 23) and turning actuator.

5. The bolting rig as claimed in any one of the preceding claims 1 - 4, **characterized in that** the cable reel arrangement (9) is supported to a handling arm (22) connected to a front part of the carrier (2) and configured to protrude from the carrier (2) in longitudinal direction of the carrier (2).

6. The bolting rig as claimed in any one of the preceding claims 1 - 5, **characterized in that** the cable reel arrangement (9) comprises a cable cassette (25) and a cable reel (18) is arranged inside the cable cassette (25) forming a surrounding and supporting structure for the cable reel (18) on which the cable (26) is wound.

7. The bolting rig as claimed in any one of the preceding claims 1 - 6, **characterized in that** the cable reel arrangement (9) is provided with the cable feed device (27a) for feeding the cable (26).

8. The bolting rig as claimed in any one of the preceding claims 1 - 7, **characterized in that**

the bolting rig (1) comprises at least two cable reels (18); and

the guide arrangement (10) comprises a branched guide element (21) allowing cable feeding selectively from one of the cable reels (18) one at a time.

9. A method for rock reinforcing, wherein the method comprises:

using a bolting rig (1) comprising a carrier (2), a bolting boom (3), a bolting unit (4) and a cable reel (18);

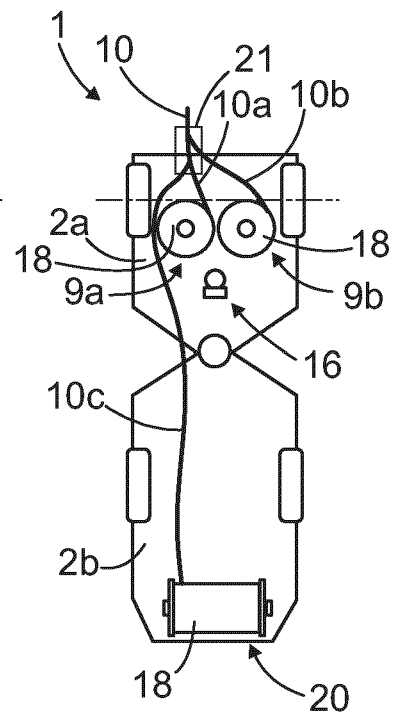
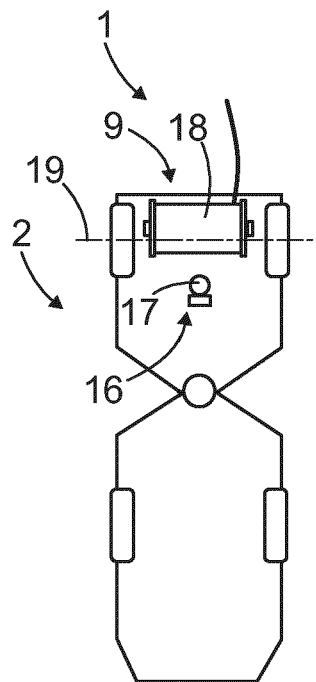
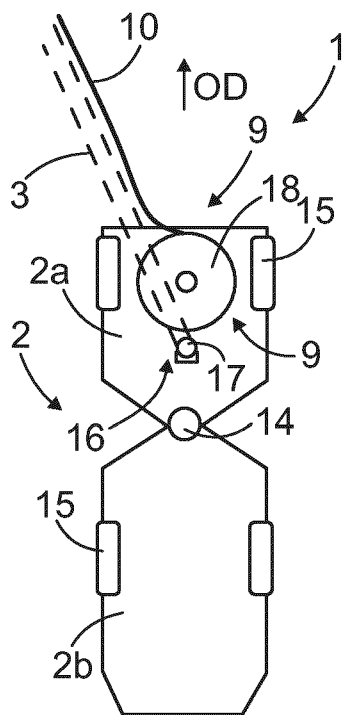
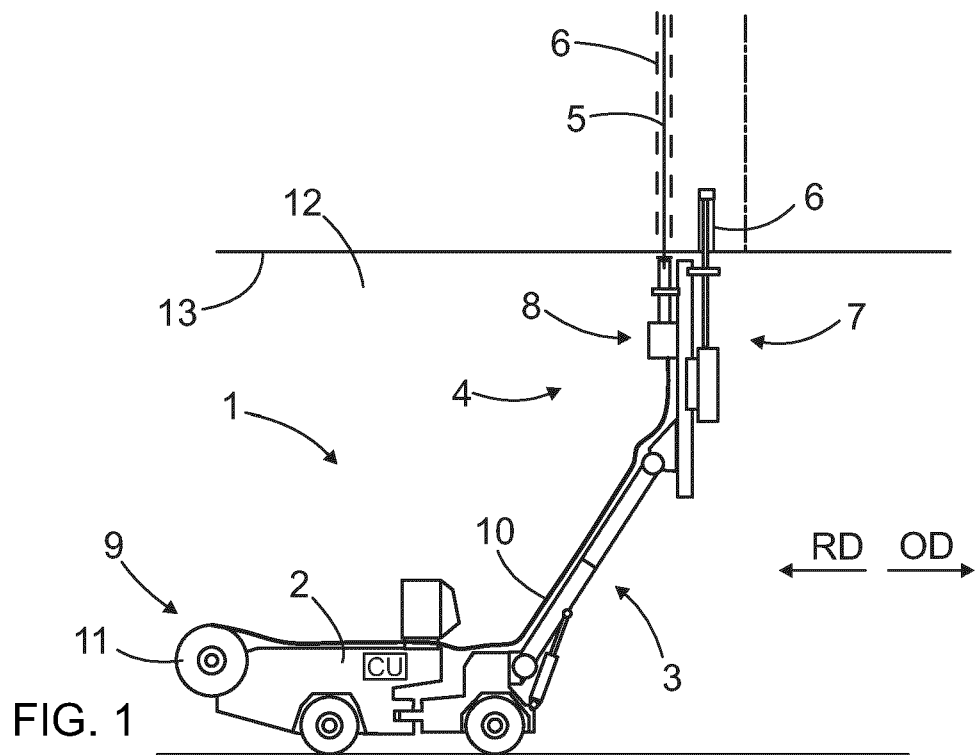
drilling a drill hole (6) to the rock surface by means of a rock drilling machine (7) of the bolting unit (4);

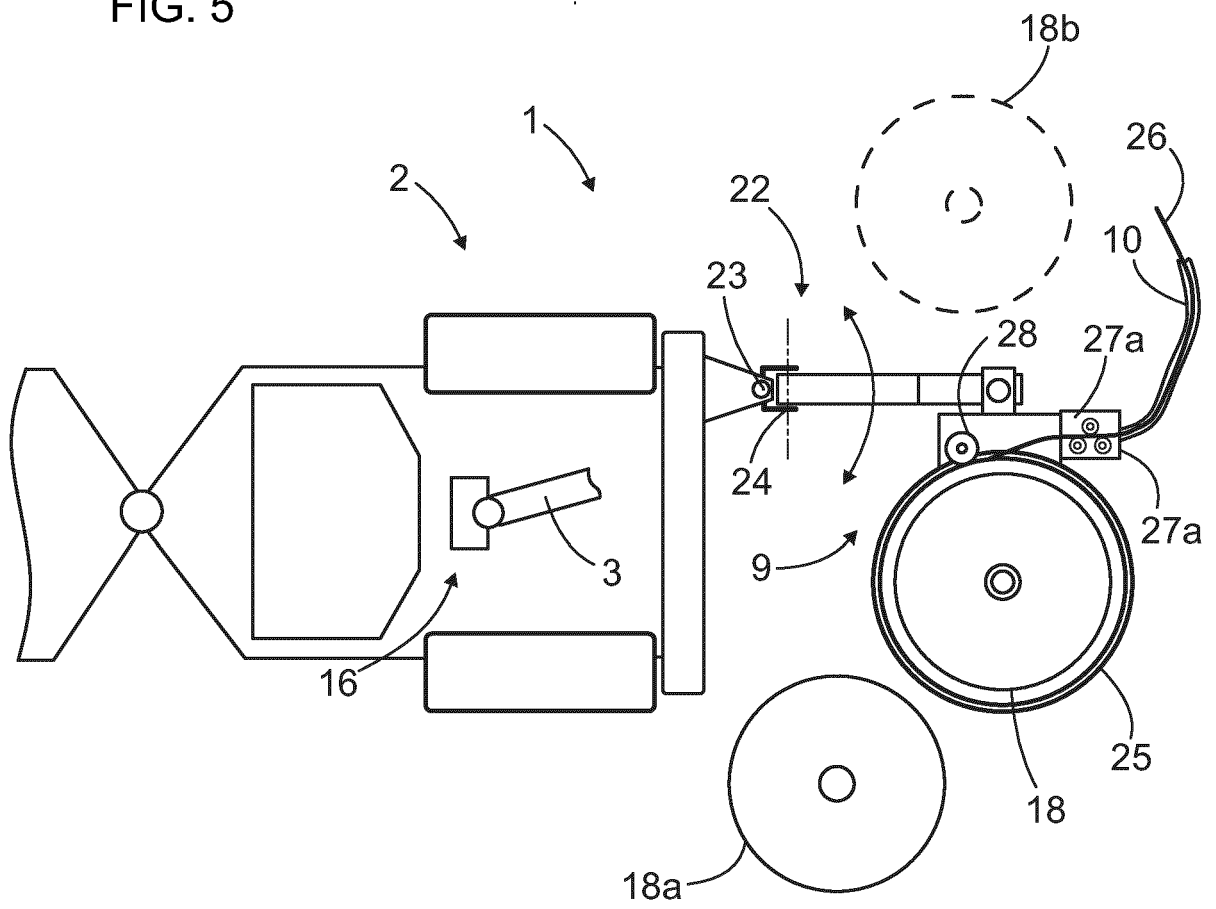
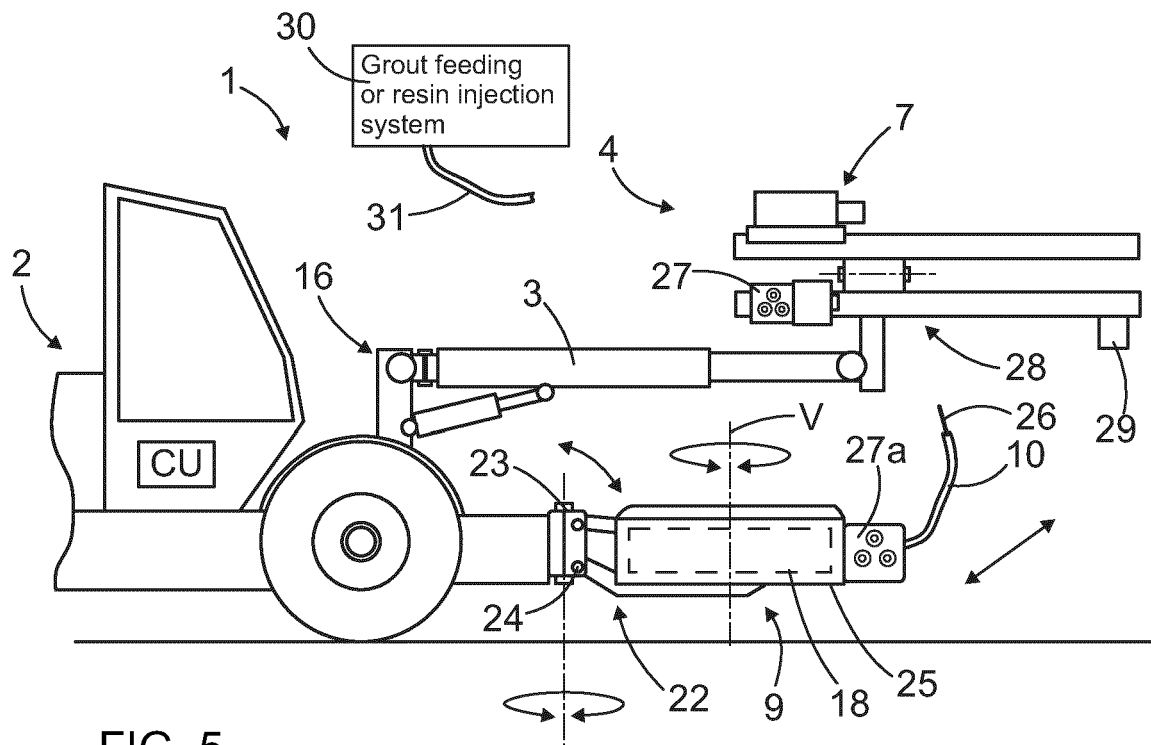
feeding grouting material into the drill hole (6);
feeding from the cable reel (18) a cable bolt (5) to the drill hole (6) by means of a feed device (27, 27a);

cutting the cable bolt (5) outside the drill hole (6);

characterized by

supporting the cable reel (18) at a front part of the carrier (2) and operating the cable reel (18) independently in relation to the bolting boom (3).







EUROPEAN SEARCH REPORT

Application Number

EP 24 21 1965

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			TECHNICAL FIELDS SEARCHED (IPC)
			E21D
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
The Hague		15 April 2025	Jucker, Chava
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO.

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