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(54) BOLTING RIG AND METHOD FOR ROCK REINFORCING

(57) A bolting rig and method for rock reinforcing. The bolting rig (1) comprises a bolt storage (12) supported at a front part of a carrier (2) and being movable to a pick-up position (PP). A bolting unit (4) comprises a bolt rack (11)

and is positioned to the pick-up position for replenishing several rock bolts (5) simultaneously from a delivery plane (16) of a bolt storage.

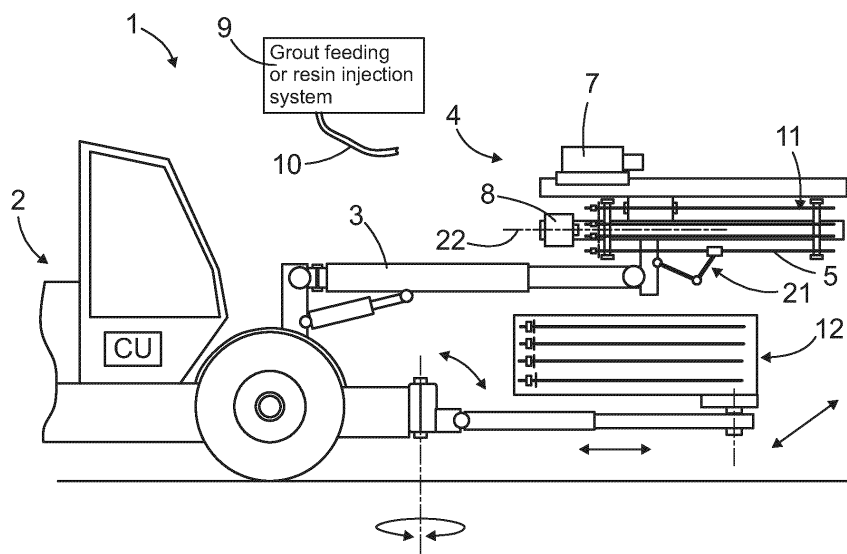


FIG. 5

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Description

Background of the invention

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

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

[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, bolting rigs, and methods for installing the rock bolts. However, the present solutions for handling the rock bolts at work sites 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 handling and installing rock 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 bolt storage is supported to a carrier of a bolting rig and is movable in front of the carrier. The bolt storage can be moved to a desired pick-up position which is located in front of the carrier in an operational direction. A bolt rack is mounted to bolting unit and comprises a plurality of parallel storage places for receiving several rock bolts. A control unit can control movement of a bolting boom for positioning the bolt rack to the pick-up position in response to the data on position and orientation of the bolt storage.

[0009] In other words, the bolt storage is part of the bolting rig and can be moved to a desired pick-up position at the front area of the carrier. Further, the bolt rack of the bolting unit is moved to the pick-up position for collecting new rock bolts from the bolt storage positioned to the pick-up position. Thus, for replenishing the bolt rack, the bolt storage and the bolt rack are both moved to the pick-up position under control of the control unit and are matched at the pick-up position for executing pick-up of the rock bolts.

[0010] An advantage of the disclosed solution is that the bolt storage is located away from the carrier, whereby

layout of the carrier can be designed more freely. In other words, the bolt storage requires no space on the carrier.

[0011] A further advantage is that since there is not a fixed physical pick-up position, it is possible to select or define the pick-up position in accordance with operational efficiency, available space in the operational direction, collision avoidance, bolting boom kinematics, and possible other issues. Because there is not the fixed or pre-determined pick-up position, any suitable position can serve as the pick-up position. Thereby, the solution improves operational flexibility. The pick-up position can be selected on the fly during the operation.

[0012] Further, sideways stability, especially turning stability, of the bolting rig can be improved. It is possible to move the bolt storage to its outmost placement within a turning radius and to thereby balance possible sideways tipping.

[0013] The control unit controlling operation of the rock bolting rig, and its actuators, is provided with sensing data on movements of the bolting boom, bolting unit, and the bolt storage, and can generate needed position data to move the bolt storage to any desired position in front of the carrier, can define position data for the selected pick-up position, and can move the bolt rack to the determined pick-up position.

[0014] According to an embodiment, the bolt rack is configured to pick-up several rock bolts at the same time from the bolt storage. Then all storage places of the bolt rack are replenished simultaneously and by implementing single pick-up action. This way the filling of the bolt rack is quick and effective.

[0015] According to an embodiment, number of the storage places in the bolt rack is 2 - 6, preferably 4. The bolt rack can be considered to be an intermediate bolt storage between the actual bolt storage and a bolt feed device of the bolting unit.

[0016] According to an embodiment, the bolt rack is a static component mounted immovably to the bolting unit and being without any handling device for moving the rock bolts from the bolt storage to the bolt rack. Then there are no handling arms, manipulators, robot arms, or corresponding apparatuses in the bolt rack or in connection with the bolt rack. There are only gripping members in the bolt rack for holding the rock bolts which are offered for it on the bolt storage. The gripping members may be spring load actuated, or there may be jaws operated by one or more actuators.

[0017] According to an embodiment, the disclosed solution provided with the bolt storage and the bolt rack is configured to handle pre-assembled rock bolts which are provided with tension nuts and bearing plates. The bearing plate is also known as an anchor plate and a washer. The pre-assembly of the rock bolts can be done at the work site or somewhere else. Further, the pre-assembly may be executed manually, or alternatively, by means or mechanized or automated apparatuses.

[0018] According to an embodiment, the disclosed solution provided with the bolt storage and the bolt rack

is configured to handle non-assembled rock bolts i.e., steel bars or threaded bars which are without bearing plates. In this case, assembly of the bearing plates can be done at the bolting unit, for example. In some cases the stored steel bars may be without the tension nuts and the bearing plates whereby the assembly includes mounting of the nuts and the plates.

[0019] According to an embodiment, the bolting rig comprises at least one rock bolt component storage on the carrier. Then there may be a first component storage for steel bars, a second component storage for the tension nuts, and a third component storage for the bearing plates. The first component storage may be located at the front part of the carrier and may be orientated transversally in relation to longitudinal axis of the carrier. Then the stored steel bars are close to the bolt storage and handling is facilitated.

[0020] According to an embodiment, the bolting rig may be provided with a cable bolt feed and handling apparatus in addition to the disclosed rock bolt storing and handling arrangement. Thus, the bolting rig may comprise a dual system allowing mounting either rock bolts or cable reinforcements.

[0021] According to an embodiment, the bolting unit comprises a rock drilling machine, or alternatively the bolting rig may comprise a separate drilling boom with a rock drilling unit.

[0022] According to an embodiment, the bolting rig may also relate to a rock drilling rig configured to drill blast holes or any other type of drill holes by means of a drilling boom, and wherein the rock drilling rig is further provided with the disclosed bolting boom, bolting unit and bolt storage. Then it is possible, for example, to implement the disclosed solution in a tunneling rig configured to primary execute face drilling.

[0023] According to an embodiment, the bolt storage supported to the carrier is movable at least in lateral direction of the carrier whereby the bolt storage is movable in addition to the pick-up position to at least one refilling position which is located laterally outside the front of the carrier. In other words, the refilling position is located elsewhere than below the bolting boom facing towards the operational direction. Then the bolt storage can be moved away from a normal operating area of the bolting boom whereby the replenish can be done safely. The normal operating area is typically a sector-like shaped area and is defined by reach of the bolting boom. The refilling position can be defined outside this area wherein no collision with the bolting boom and the bolting unit is possible.

[0024] According to an embodiment, the refilling position is located on a side of the carrier. At the side of the carrier more space is available, and it is easier to execute needed handling operations.

[0025] According to an embodiment, the bolt storage is movable in vertical direction relative to the carrier in addition to the lateral direction movement. An advantage of the vertical direction movement feature is that height

level of the bolt storage can be adjusted so that the bolt retrieval executed by means of the bolt rack and operated by the bolting boom is fluent. The vertical movement may also be implemented when reloading the bolt storage, for example.

[0026] According to an embodiment, the bolt storage is supported to a handling arm connected to a front part of the carrier and being movable horizontally and vertically by means of at least one turning joint and at least one turning mechanism. In other words, the handling arm allows to move the bolt storage in a versatile manner to different pick-up positions and replenishing positions.

[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 bolt storage, 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. Length of the handling arm may also be structured to be adjustable.

[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 bolt storage at its distal end portion does no 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 bolt storage 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 refilling the bolt storage, for example.

[0030] In one alternative solution the handling arm may be located at a mounting point being at the center line of the carrier.

[0031] According to an embodiment, the bolt storage may be supported to guide rails and can slide on the guide rails to one or more pick-up position in front of the carrier. A further possibility is to support a body of the bolt storage by means of one or more joints directly to a front end of the carrier so that the bolt storage can be turned at a front area of the carrier to different pick-up and replenishing positions.

[0032] According to an embodiment, mounting of the bolt storage comprises quick coupling means whereby the bolt storage is a changeable unit. In other words, the bolt storage can be removed and remounted quickly and easily. This facilitates for example maintenance measures, and if the bolt storage fails, it can be substituted with a new one.

[0033] According to an embodiment, the bolt storage is a pre-filled unit and when becoming empty, it is substituted with a new prefilled bolt storage. The pre-filling of the removed bolt storage can be executed outside the work site at good and safe conditions. Use of the changeable prefilled bolt storages improves efficiency and safety of the refilling measures.

[0034] According to an embodiment, bolt storage can be moved to side and away from the bolting area by means of the movable handling arm. Then the change of the bolt storage can be done also during the bolting operation and without a need to enter under the bolting boom. Further, the change of the bolt storage can be done by means of a transport vehicle, such as a forklift, for example.

[0035] According to an embodiment, the bolt storage further comprises support elements for supporting the rock bolts in several adjacent rows wherein each row comprises a plurality of successive rock bolts. There is also a delivery plane on one side of the bolt storage transverse to longitudinal direction of the rock bolts. At least one feed arrangement is arranged to move the rock bolts inside the bolt storage towards the delivery plane so that the delivery plane is provided with several parallel rock bolts accessible by the bolt rack. In other words, the bolt storage dispenses several rock bolts simultaneously on the delivery plane for the bolt rack movable close to the delivery plane. The feed arrangement dispenses the rock bolts by moving them along linear movement paths.

[0036] According to an embodiment, the feed arrangement is configured to move the delivery plane a distance further from a basic structure of the bolt storage. Thereby, the movement of the delivery plane can serve as a fine positioning movement towards the bolt rack coarse positioned close to the delivery plane. In other words, the final positioning movements at the pick-up position can be done by means of the feed arrangement moving the delivery plane towards the bolt rack. This way the feed arrangement may not only move the rock bolts inside the bolt storage but also assist the positioning measures at the pick-up position.

[0037] According to an embodiment, the bolt storage comprises physical guide elements on the side of the delivery plane for guiding the bolt rack when positioning the bolt rack and the bolt storage relative to each other. The physical guide elements facilitate and quicken the final positioning phase.

[0038] According to an embodiment, the feed arrangement comprises a scissors mechanism actuated by means of one or more actuators, whereby the bolt storage may comprises a scissor lift type mechanism for moving the rock bolts towards the delivery plane. The scissors mechanism may be actuated by means of a pressure fluid cylinder or motor, for example. An advantage of the scissors mechanism is a simple, reliable and inexpensive structure.

[0039] According to an alternative embodiment, the feed arrangement comprises a platform, support table

or any other movably arranged structure that can be moved linearly by means of one or more actuators, such as pressure fluid cylinders or motors.

[0040] According to an embodiment, each support element comprises at least two support arrangements arranged at a distance from each other when seen in longitudinal direction of the rock bolts whereby stability of the rock bolts inside the bolt storage is ensured.

[0041] According to an embodiment, the support elements comprise vertically orientated slots configured to receive several transverse rock bolts one above each other. The delivery plane is located on a vertical upper surface of the bolt storage. In other words, there are several rock bolts stacked to each slot. The delivery plane is located on an upper surface of the bolt storage i.e., at free ends of the slots and is accessible by the bolt rack in vertical direction. Thus, in this embodiment the bolt storage dispenses the rock bolts in the vertical direction and simultaneously by means of several laterally adjacent slots. The bolt rack retrieves the several dispensed rock bolts from a top layer of the bolt storage.

[0042] According to an embodiment, the slots are defined by vertically orientated bars, or alternatively there are one or more vertical support plates provided with the vertically orientated slots in their structures.

[0043] According to an embodiment, the support elements are horizontally directed parallel brackets provided with support surfaces on their vertical upper surfaces whereby each of the support elements is configured to support several laterally adjacent and horizontally directed rock bolts. The delivery plane is located at a vertical side of the bolt storage being located at a side of distal ends of the brackets. In other words, the delivery plane is located at free ends of the horizontal brackets and is thereby accessible by the bolt rack in the horizontal direction. Thus, in this embodiment the bolt storage dispenses the laterally adjacent rock bolts in horizontal direction and simultaneously on several support elements arranged one above another.

[0044] According to an embodiment, the control unit is configured to determine the pick-up position in response to provided data on planned work cycle of the rock bolting measures to be executed at a work site. In other words, the control unit considers bolting plans, bolt locations and number of rock bolts to be installed, bolting order, bolting sequences, and other available bolting data when determined suitable position for filling the bolt rack from the bolt storage. Then the control unit can pre-position the bolt storage close to the bolting unit so that it is quick to execute the filling of the bolt rack. This way, the disclosed system can prepare for the forthcoming refilling of the bolt rack. An advantage of this embodiment is that the pick-up of the rock bolts from the bolt storage interrupts the actual bolting measures for as short time as possible or does not cause any interrupt.

[0045] According to an embodiment, the control unit is configured to estimate the need for filling the bolt rack in manually controlled or computer aided bolting. Then the

control unit can determine position of the bolting unit and number of remaining rock bolts in the bolt rack and can control the system to pre-position the bolt storage close to the bolting unit or any other suitable pick-up position for providing fluent refilling of the bolt rack.

[0046] According to an embodiment, the bolt storage comprises a gripping mechanism for gripping at least one pre-loaded bolt assembly and for holding the bolt assembly in the bolt storage. In other words, the bolt storage is configured to receive one or more bolt assemblies each provided with a plurality of rock bolts. Implementation of the bolt assemblies quicken the refilling of the bolt storage.

[0047] According to an embodiment, the bolt assembly is a bolt clip, or magazine, which is filled with several rock bolts, and which comprises a casing or support structure inside which the rock bolts are filled. The bolt storage may comprise several separate adjacent spaces and each of them is capable of receiving one bolt clip. For example, when the bolt rack comprises intermediate storage places for four rock bolts, then the bolt storage comprises four adjacent bolt clips each being arranged to feed the rock bolts to a delivery plane of the bolt storage. The bolt storage may comprise one common feed arrangement for feeding the rock bolts to the delivery plane, or alternatively, the bolt clips may be provided with dedicated feed arrangements.

[0048] According to an embodiment, the bolt assembly is a bolt bunch wherein a plurality of rock bolts are connected to each other so that the bolt bunch can be handled in one piece at least when filling the bolt storage with one single bolt bunch in one go. The gripping mechanism can grip ends of the bolt bunch, for example. The gripping mechanism may comprise end plates provided with protrusions for supporting ends of the rock bolts of the bolt bunch. Further, the bolt storage may comprise several parallel brackets provided with support surfaces on their upper surfaces whereby each of the brackets is configured to support several laterally adjacent rock bolts. The brackets may be supported to turnable support poles which are located between the end plates and can be turned to operational position wherein they can provide support for the stored rock bolts and to a rest position wherein they are turned away and do not hamper the gripping of a new bolt bunch. The bolt bunch may be tied by means of strips, or there may be other coupling and supporting elements, which are to be removed when the bolt bunch is set properly to the bolt storage. The tie strips can be removed after the brackets are turned to their operational positions where the rock bolts are supported on upper support surfaces of the brackets.

[0049] 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 bolt storage supported to the carrier; drilling a drill hole to the rock surface by means of a rock drilling machine; feeding grouting material into the drill hole; and feeding a rock

bolt to the drill hole by means of a feed device of the bolting unit. The method further comprises: providing the bolting unit with a bolt rack for intermediate storing several rock bolts to the bolt unit; moving the bolt storage at an operational area of the bolting boom and in front of the carrier to a desired pick-up position; actuating the bolting boom for moving the bolt rack to the pick-up position for replenishing the bolt rack with several rock bolts; positioning the bolt rack and the bolt storage in relation to each other at the pick-up position for matching several storage places of the bolt rack with several rock bolts accessible on the bolt storage; and clamping by means of the bolt rack several rock bolts simultaneously.

[0050] According to an embodiment, the method further comprises dispensing simultaneously several parallel rock bolts to a delivery plane of the bolt storage by means of at least one feed arrangement of the bolt storage.

[0051] According to an embodiment, the method further comprises moving the bolt storage in front of the carrier by means of a handling arm for positioning the bolt storage to several pick-up positions and to at least one replenishing position or refilling position wherein rock bolts are loaded to the bolt storage.

[0052] According to an embodiment, the method further comprises replenishing the bolt storage by loading simultaneously several rock bolts to the bolt storage implementing bolt clips or bolt bundles.

[0053] 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

[0054] 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 rock bolts to a rock surface,

Figure 2 is a schematic top view of a bolting rig provided with a movable bolt storage arranged to a front part of a carrier,

Figure 3 is a schematic top view of a bolting rig wherein a bolt storage is moved to a transport position,

Figure 4 is a schematic top view of a front part of a bolting rig wherein a bolt storage is moved to a refilling position,

Figure 5 is a schematic side view of a front part of a bolting rig provided with a handling arm for moving a bolt storage,

Figure 6 is a schematic side view of a part of a bolt storage comprising quick couplings means for connecting the bolt storage removably to a handling arm,

Figure 7 is a schematic side view of a bolt storage and a bolt rack configured to pick-up rock bolts from a delivery plane,

Figure 8 is a schematic side view of a scissor me-

chanism -type feed arrangement configured to dispense rock bolts inside a bolt storage towards a delivery plane,

Figure 9 is a schematic side view of a bolt storage provided with horizontally oriented support elements, and a pre-loaded bolt assembly to be gripped by the support elements,

Figure 10 is a schematic side view of a bolt storage having a vertically oriented delivery plane and a bolt rack positioned adjacent to the bolt storage,

Figure 11 is a schematic side view of a bolt storage comprising gripping means for gripping a pre-loaded bolt assembly, and

Figure 12 is a schematic side view of a front part of a bolting rig provided with a component storage orientated transversally in relation to a carrier.

[0055] 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

[0056] 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 rock 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 bolting head 8, or a bolt feed device, for feeding the rock bolt 5. The bolting head 8 is connected to grout feed system 9 so that grout material can be fed through the rock bolt 5 to the drill hole 6. Therefore, the bolting head 8 is connected to a grout feed hose 10. Any known grouting material can be implemented. The bolting head 8 is also capable to pretension the rock bolt 5 by screwing a tension nut arranged to the rock bolt 5. Further, the bolting unit 4 is provided with a bolt rack 11 for holding one or several rock bolts 5 close to the bolting head 8. There is a mechanism for moving the rock bolts 5 from the bolt rack 11 to a bolting line defined by the bolting head 8. For clarity reasons the moving mechanism is not shown. The bolting rig 1 also comprises a bolt storage 12 for storing a plurality of rock bolts 5. The bolt storage 12 is supported to the carrier 2 and is arranged movably in front of the carrier 2. Then the bolt storage 12 can be moved to a pick-up position PP which is located in front of the carrier 2 in the operational direction OD. When the bolt storage 12 is positioned to the pick-up position PP, the bolt rack 11 can also be positioned to pick-up position PP for collecting new rock bolts 5 from the bolt storage 12. The movements of the bolt storage 12 and the bolting unit 4 may be controlled under control of a control unit CU, so that the bolt storage 12 and the bolt rack 11 can be positioned automatically to the pick-up position PP. Location and orientation of the pick-up position PP can be defined case by case and on the fly during bolting

operation. Thus, several different pick-up positions PP may be implemented when executing a bolting plan, such as a fanlike bolt pattern 13.

[0057] As can be seen, the bolt storage 12 is mounted to an articulated handling arm 14 and can be moved below the bolting boom 3 at an operational front area in a versatile manner.

[0058] Figure 2 discloses by means of arrows possible movements of a bolt storage 12. A handling arm 14 may comprise several turning joints 15a, 15b, 15c and also a linear joint 15d for extending and shortening the handling arm 14. The handling arm 14 may be mounted close to one lateral side of a carrier 2, or it may be located elsewhere at the front of the carrier. The bolt storage 12 may comprise a delivery plane 16 on its upper surface and a bolt rack can be positioned to the delivery plane 16 for picking up several rock bolts simultaneously from the bolt storage 12. In Figure 2 four parallel rock bolts 5 are available on the delivery plane 16 for the pick-up, but the number of rock bolts 5 can be designed case by case. The rock bolt 5 comprises a rod 17, a bearing plate 18 and a tension nut 19. Pre-assembled rock bolts 5 can be fed manually one by one to the bolt storage 12, or a bolt clip or bundle of several rock bolts 5 can be inserted into the bolt storage 12 by means of a loading apparatus, or alternatively picking the bolt clip by means of the bolt storage 12. The bolt storage 12 can be moved to side of the operational area whereby the loading is easy and safe to execute and does not hamper the actual bolting process.

[0059] Figure 3 discloses a bolt storage 12 in a transport position so that it is located close to a carrier 2. For clarity reasons a bolting boom is not shown.

[0060] Figure 4 shows that a bolt storage 12 is moved to a refilling position RP which is located on a side of a carrier 2. Then the refilling position RP is located outside an operation area whereby loading of new rock bolts 5 is facilitated. The rock bolts 5 can be assembled on the side of the carrier 2, and also a pre-loaded bolt assembly 20 can be utilized to replenish the bolt storage 12.

[0061] Figure 5 discloses a front part of a bolting rig 1. Main features of the solution are already discussed in connection with previous Figures 1 - 4. However, a manipulator or mechanism 21 for moving rock bolts 5 from storage places of a bolt rack 11 to a bolting line 22 of the bolting unit 4 is further disclosed. The mechanism 21 may be, for example, a robot arm as it is shown in Figure 5, or it may be a linearly movable handling arm, as it is shown in Figure 12. In both Figures 5 and 12 the mechanism 21 is shown in a simplified manner.

[0062] Figure 6 discloses that a frame structure 23 of a bolt storage 12 may comprise quick couplings means 24 for connecting the bolt storage 12 removably to a handling arm 14 configured to move the bolt storage 12. The handling arm 14 is shown in a simplified manner for clarity reasons. The quick coupling means 24 may comprise upwards protruding rigid pins 25 and vertical openings 26 in the frame 23 for receiving the pins 25 when the handling arm 14 and a connecting adaptor 27 is moved verti-

cally in relation to the frame 23. After the fixed pins 25 are coupled, then laterally moving pins 28 are locked to lateral openings 29 by means of actuators 30. An advantage is that pre-loaded bolt storages 12 can be implemented when removal of an empty bolt storage and connection of a new bolt storage is easy and quick to execute at a bolting site. The disclosed quick coupling means 24 may be utilized also when coupling a cable bolt reel to the handling arm 14 instead of using the bolt storage 12.

[0063] Figure 7 discloses a bolt storage 12 comprising several vertical support elements 31 for forming vertically orientated slots 32 for receiving several rock bolts 5 one above each other. In Figure 7 there are four parallel slots 32 but the number of slots can be designed as needed. A delivery plane 16 is located on a top surface i.e., on a vertical upper surface of the bolt storage 12. The rock bolts 5 are arranged in four adjacent rows 33 and four parallel rock bolts 5 are simultaneously accessible on the delivery plane 16 for a bolt rack 11 comprising the same amount of storage places 34. The storage places 34 may be provided with grippers 35, such as gripping jaws, for gripping to rods 17 of the rock bolts 5. The bolt rack 11 may be mounted for example to a side surface of a feed beam 36 on which a bolting head is movable. The bolting rack 11 can be positioned towards the delivery plane 16 by moving a bolting unit and the feed beam 36 being part of the bolting unit. The bolt storage 12 comprises a feed arrangement 37 for moving the rock bolts 5 inside the slots 32 towards the delivery plane 16 so that the delivery plane 16 is provided with several parallel rock bolts 5 accessible by the bolt rack 11. The feed arrangement 37 may comprise a feed element 38 such as a feed plate for moving the rock bolts 5 inside the bolt storage 12. The feed element 38 is actuated by means of a feed actuator 39, such as a fluid operated cylinder. The upwards movement of the feed element 38 can be utilized also when executing gripping of the rock bolts 5 by means of the bolt rack 11.

[0064] Figure 8 discloses an example of a feed arrangement 37 being of a scissors lift type. A feed element 38 can be moved linearly when a feed actuator 39 is operated. Mechanism of the feed arrangement 37 comprises a linkage mechanism.

[0065] Figures 9 and 10 disclose a bolt storage 12 provided with horizontally oriented support elements 31. The support elements 31 may be horizontally directed parallel brackets provided with support surfaces on their vertical upper surfaces whereby each of the support elements 31 can support several laterally adjacent and horizontally directed rock bolts 5. Thus, there are several rows 33 of rock bolts 5 one above each other. There may be two sets of support elements 31 at a horizontal distance from each other so that there is a free space between the support element sets allowing thereby a bolt rack 11 to be moved between the sets when collecting the rock bolts 5. This is shown in Figure 11. In this solution a delivery plane 16 is located at a vertical side of

the bolt storage 12. When the bolt rack 11 collects rock bolts 5 from the delivery plane 16, position of the delivery plane 16 adjusts laterally. However, there may be a feed arrangement for moving the remaining rock bolts 5 towards ends of the support elements 31 and then the delivery plane 16 is located at a side of distal ends of the support elements 31. The bolt storage 12 may also comprise a gripping mechanism 40 for gripping a pre-loaded bolt assembly 20 and for holding the bolt assembly 20 in the bolt storage 12. In Figure 9 the gripping mechanism 40 is shown in broken lines for clarity reasons.

[0066] The bolt assembly 20 may be a bolt bunch 41 wherein a plurality of rock bolts 5 are connected to each other so that the bolt bunch 41 can be handled in one piece. There may be strips 42 surrounding the bolt bunch 41 and spacers 43, or other pieces or material, for providing suitable spaces wherein the support elements 31 of the bolt storage 12 can be pushed. The disclosed solution is only one possible embodiment of the pre-loaded bolt assembly 20 that can be handled by means of the bolt storage 12. In Figure 10 the bolt assembly 20 is loaded inside the bolt storage 12 and the strips 42 and the spacers 43 are removed either manually, or automatically by means of a suitable mechanized apparatus.

[0067] Figure 11 discloses a gripping mechanism 40 which comprises end plates 44 provided with protrusions 45 for supporting ends of the rock bolts 5 of a pre-loaded bolt assembly 20. The end plates 40 can be moved towards and away from each other for executing a gripping operation.

[0068] Figure 12 discloses that at a front part of a carrier 2 of a bolting rig 1 may be a component storage 46 for storing a plurality of rods 17 of rock bolts 5. The component storage 46 is orientated transversally in relation to the carrier 2. Further, in Figure 12 a bolt storage 12 is mounted slidably on a guide bar 47 or corresponding support element allowing linear movement for the bolt storage. The guide bar 47 may be telescopically extendable and it may be connected to the carrier 2 and to the bolt storage 12 by means of one or more joints.

[0069] The devices and systems disclosed in this document can be controlled under control of one or more control units CU automatically, or together with an operator of the bolting rig 1. The control unit CU comprises a processor configured to execute a control program. The bolting boom 3 and the bolting unit 4 may be provided with sensors providing the control unit CU with needed position data. Also, the handling arm 12 and the bolt storage 12 may be provided with sensors for generating position sensing data for the control unit CU. Alternatively, or in addition to, there may be one or more positions scanning devices or other measuring apparatuses for generating position and orientation data for the control unit CU and thereby assisting the control unit CU for positioning the bolt rack 11 to the bolt storage 12.

[0070] 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 rock bolts (5) to drill holes (6) for reinforcing a rock surface, wherein the bolting rig (1) comprises:

a movable carrier (2);
 at least one bolting boom (3) mounted on the carrier (2) and facing towards an operational direction (OR);
 at least one bolting unit (4) mounted to a distal end portion of the bolting boom (3) and configured to feed the rock bolt (5) into the drill hole (6);
 a bolt rack (11) mounted to the bolting unit (4) and being capable of holding at least one rock bolt (5);
 at least one bolt storage (12) for storing a plurality of rock bolts (5) and being supported to the carrier (2);
 at least one pick-up position (PP) wherein the rock bolts (5) are configured to be loaded from the bolt storage (12) to the bolt rack (11) under control of at least one control unit (CU);
 and wherein the pick-up position (PP) determines position and orientation of the bolt storage (12);
characterized in that
 the bolt storage (12) supported to the carrier (2) is arranged movably in front of the carrier (2) and is movable to the pick-up position (PP) which is located in front of the carrier (2) in the operational direction (OR);
 the bolt rack (11) comprises a plurality of parallel storage places (34) for receiving several rock bolts (5);
 and wherein the control unit (CU) is configured to control movement of the bolting boom (3) for positioning the bolt rack (11) to the pick-up position (PP) in response to the data on position and orientation of the bolt storage (12).

2. The bolting rig as claimed in claim 1, **characterized in that**
 the bolt storage (12) supported to the carrier (2) is movable at least in lateral direction of the carrier (2) whereby the bolt storage (12) is movable in addition to the pick-up position (PP) to at least one refilling position (RP) which is located laterally outside the front of the carrier (2).
3. The bolting rig as claimed in claim 2, **characterized in that**
 the bolt storage (12) is supported to a handling arm (14) connected to a front part of the carrier (2) and

being movable horizontally and vertically by means of at least one turning joint (15a - 15c) and at least one turning mechanism.

4. The bolting rig as claimed in any one of the preceding claims 1 - 3, **characterized in that**
 mounting of the bolt storage (12) comprises quick coupling means (24) whereby the bolt storage (12) is a changeable unit.
5. The bolting rig as claimed in any one of the preceding claims 1 - 4, **characterized in that** the bolt storage (12) further comprises:
 support elements (31) for supporting the rock bolts (5) in several adjacent rows (33) wherein each row (33) comprises a plurality of successive rock bolts (5);
 a delivery plane (16) on one side of the bolt storage (12) transverse to longitudinal direction of the rock bolts (5);
 and at least one feed arrangement (37) for moving the rock bolts (5) inside the bolt storage (12) towards the delivery plane (16) so that the delivery plane (16) is provided with several parallel rock bolts (5) accessible by the bolt rack (11).
6. The bolting rig as claimed in claim 5, **characterized in that**
 the support elements (31) comprise vertically orientated slots (32) configured to receive several transverse rock bolts (5) one above each other;
 and the delivery plane (16) is located on a vertical upper surface of the bolt storage (12).
7. The bolting rig as claimed in claim 5, **characterized in that**
 the support elements (31) are horizontally directed parallel brackets provided with support surfaces on their vertical upper surfaces whereby each of the support elements (31) is configured to support several laterally adjacent and horizontally directed rock bolts (5);
 and the delivery plane (16) is located at a vertical side of the bolt storage (12) being located at a side of distal ends of the brackets.
8. The bolting rig as claimed in any one of the preceding claims 1 - 7, **characterized in that**
 the control unit (CU) is configured to determine the pick-up position (PP) in response to provided data on planned work cycle of the rock bolting measures to be executed at a work site.
9. The bolting rig as claimed in any one of the preceding

claims 1 - 8, **characterized in that**

the bolt storage (12) comprises a gripping mechanism (40) for gripping at least one pre-loaded bolt assembly (20) and for holding the bolt assembly (20) in the bolt storage (12) .

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10. 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 bolt storage (12) supported to the carrier (2);
drilling a drill hole (6) to the rock surface by means of a rock drilling machine (7);
feeding grouting material into the drill hole (6);
and feeding a rock bolt (5) to the drill hole (6) by means of a bolting head (8) of the bolting unit (4);
characterized by
providing the bolting unit (4) with a bolt rack (11) for intermediate storing of several rock bolts (5) to the bolt unit (4);
moving the bolt storage (12) at an operational area of the bolting boom (3) and in front of the carrier (2) to a desired pick-up position (PP);
actuating the bolting boom (3) for moving the bolt rack (11) to the pick-up position (PP) for replenishing the bolt rack (11) with several rock bolts (5);
positioning the bolt rack (11) and the bolt storage (12) in relation to each other at the pick-up position (PP) for matching several storage places (34) of the bolt rack (11) with several rock bolts (5) accessible on the bolt storage (12);
and clamping by means of the bolt rack (11) several rock bolts (5) simultaneously.

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11. The method as claimed in claim 10, **characterized by**

dispensing simultaneously several parallel rock bolts (5) to a delivery plane (16) of the bolt storage (12) by means of at least one feed arrangement (24) of the bolt storage (12).

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12. The method as claimed in claim 10 or 11, **characterized by**

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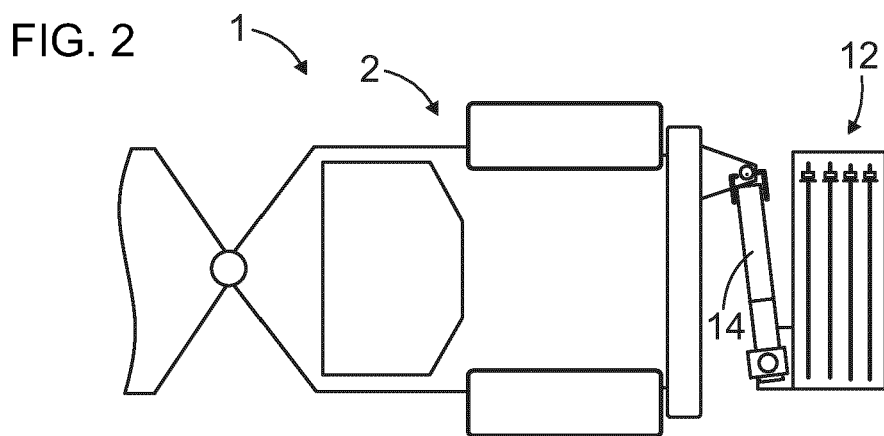
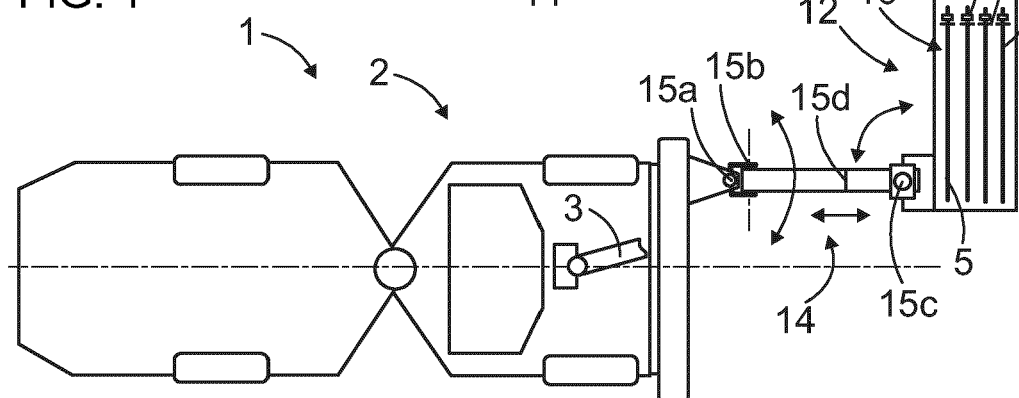
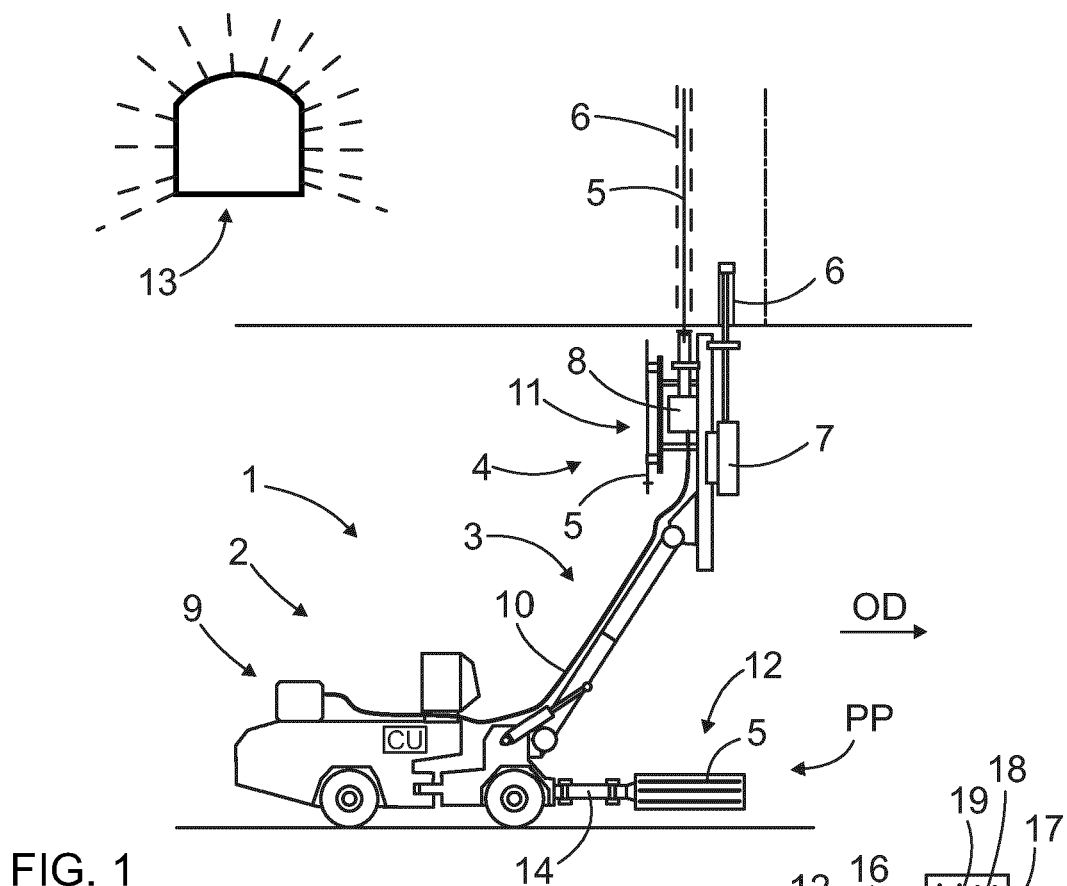
moving the bolt storage (12) in front of the carrier by means of a handling arm (14) for positioning the bolt storage (12) to several pick-up positions (PP) and to at least one replenishing position (RP) wherein rock bolts (5) are loaded to the bolt storage (12).

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13. The method as claimed in any one of the preceding claims 10 - 12, **characterized by**

replenishing the bolt storage (12) by loading simultaneously several rock bolts (5) to the bolt storage (12) implementing bolt clips or bolt bundles.

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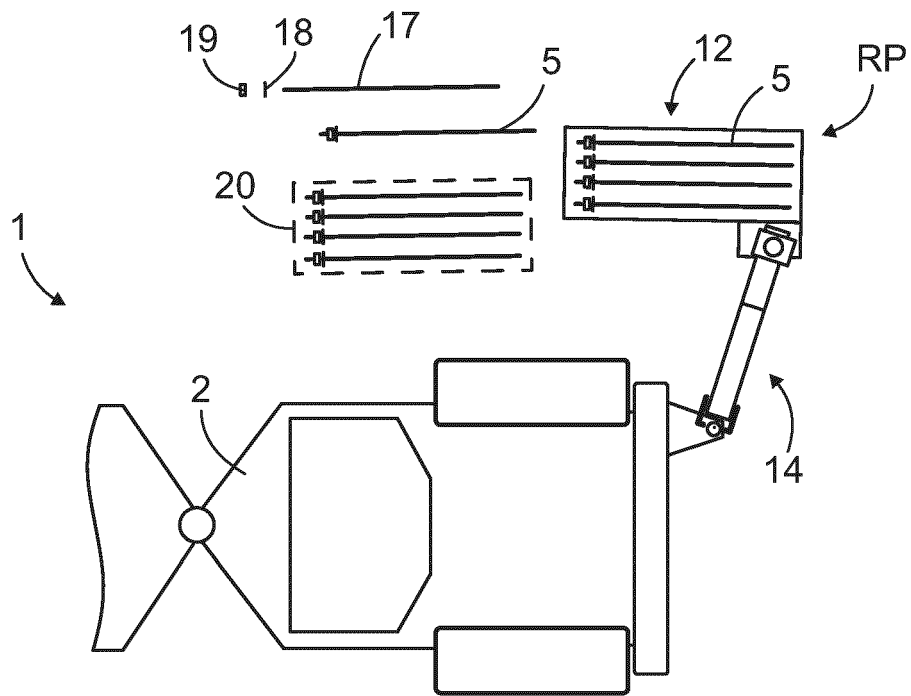


FIG. 4

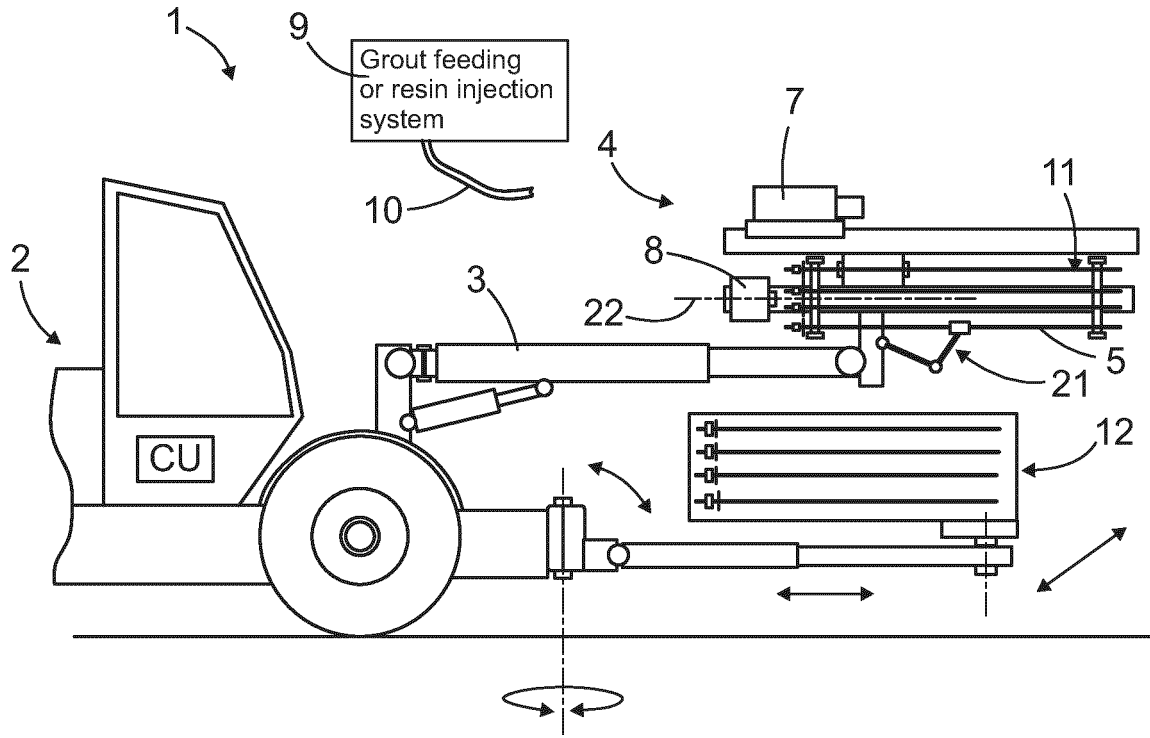


FIG. 5

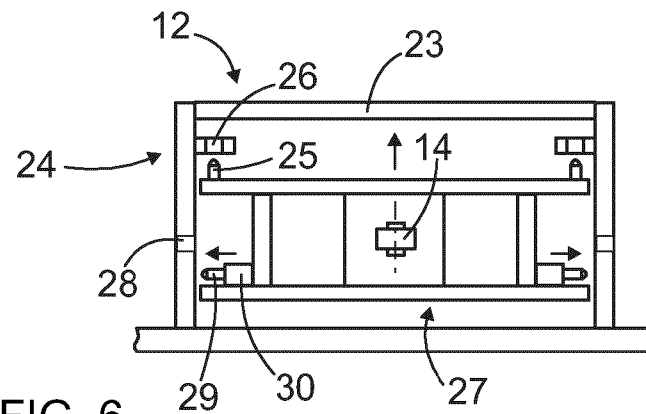


FIG. 6

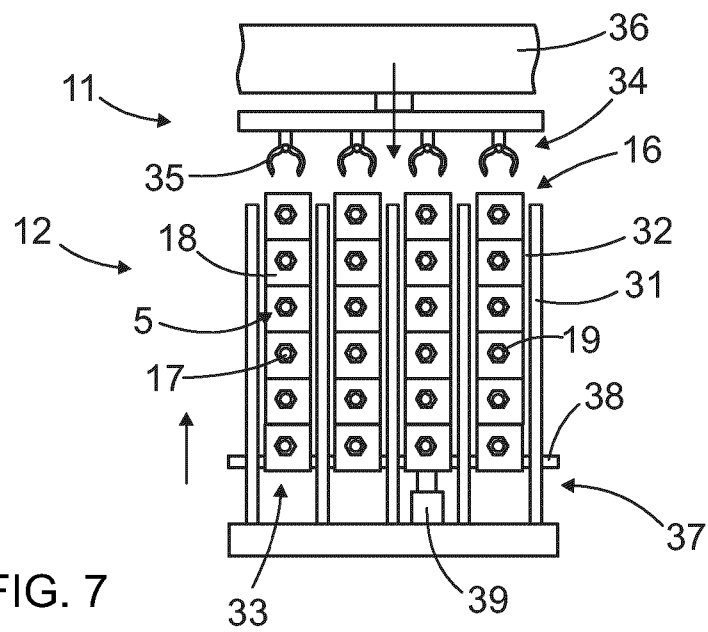


FIG. 7

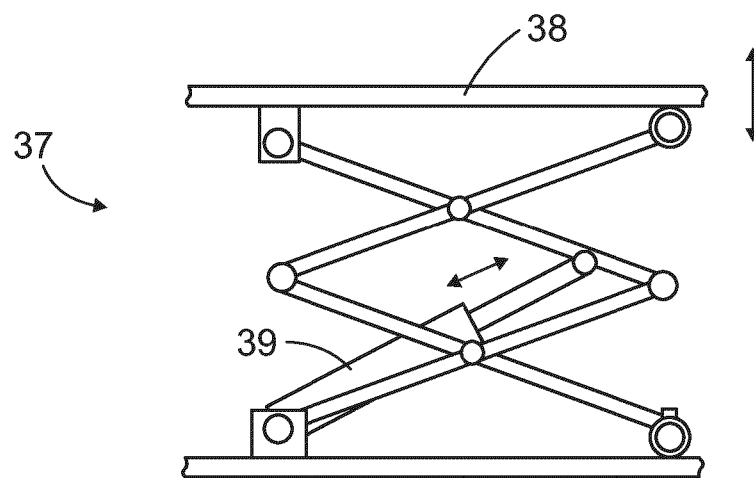
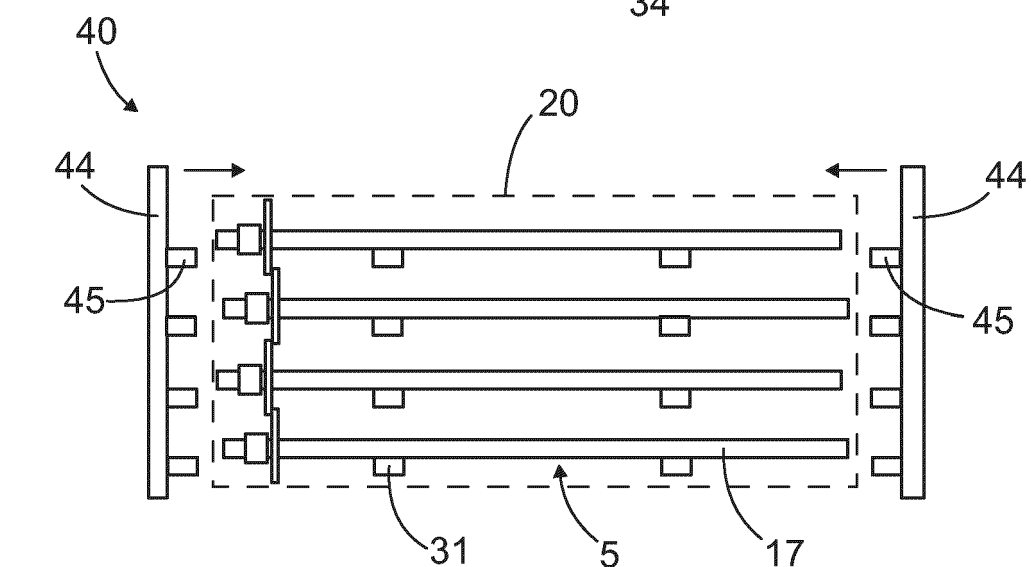
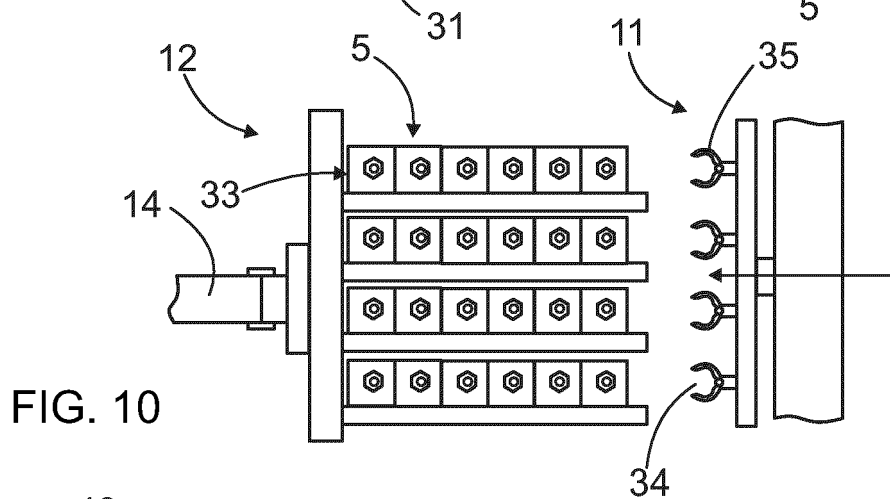
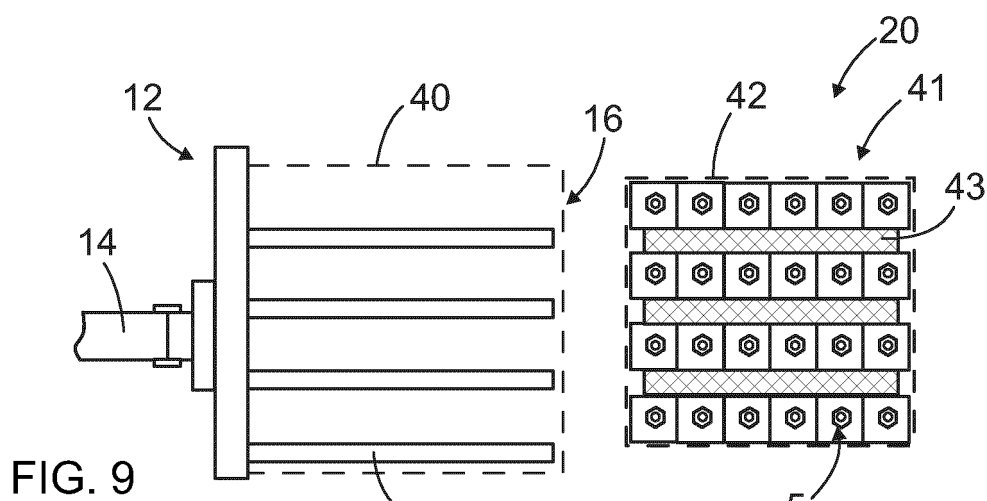


FIG. 8



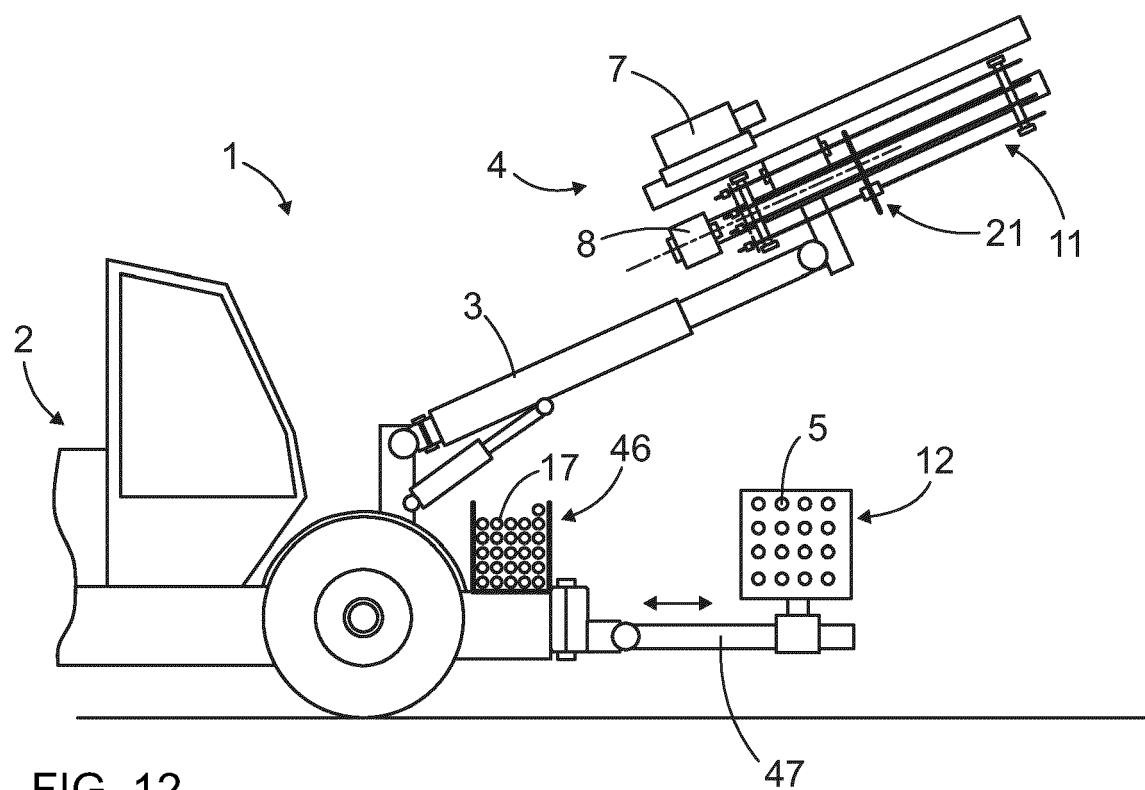


FIG. 12



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The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
The Hague		23 April 2025	Hustedt, Bernhard
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