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(54) **APPARATUS FOR ROD HANDLING, ROCK DRILLING UNIT AND METHOD**

(57) An apparatus for handling drilling rods, a rock drilling unit and a method of handling drilling rods. The apparatus (36) comprises a rod feeder (13) and a swing device (11) which co-operate and move drilling rods (2) between a pick-up position (14) and a drilling center (10) defined by a rock drilling machine (7) of the drilling unit (1). The rod feeder and the swing device are separate devices which are independently controllable.

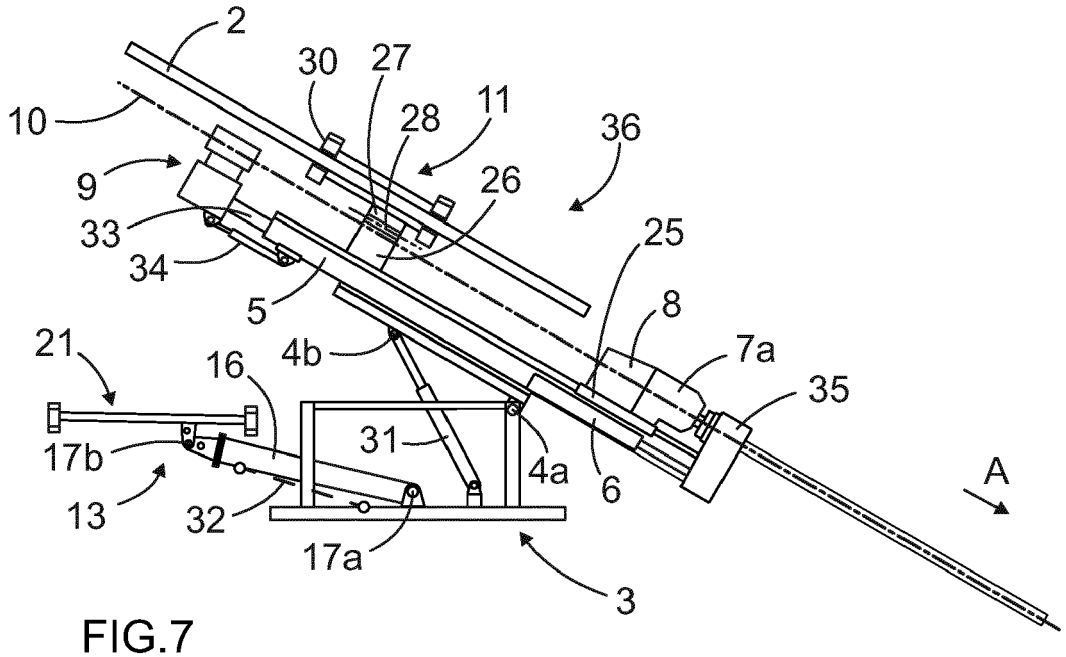

FIG.7

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Description

Background of the invention

[0001] The invention relates to an apparatus for handling rods in rock drilling and especially in core drilling.

[0002] The invention further relates to a rock drilling unit and a method of handling rock drilling rods.

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

[0004] Core drilling is executed for investigating rock ground at a distance in order to determine conditions for extracting minerals. Thus, core drilling is used for exploration drilling purposes and construction work. During core drilling, aiming to extract a drill core, it is often drilled to very great depths and distances. As an example, it is common to drill holes over thousands of meters. During rock drilling of such long drill holes, it is necessary to join a plurality of drilling components such as drilling rods for forming a drill string. A drill bit, which is located at a distal end of the drill string, needs to be changed regularly, several times for every hole, typically after every 30 - 50 meters, which means that the entire drill string needs to be disassembled and assembled 15 - 20 times for each drill hole. Traditionally handling of the drilling components is done manually. Nowadays the core drilling devices are more and more provided with rod handling apparatuses for moving drilling rods and other drilling components between a pick-up position and a drilling center of the rock drilling machine. However, the known handling devices have shown to contain some disadvantages.

Brief description of the invention

[0005] An object of the invention is to provide a novel and improved apparatus for rod handling. The invention further relates to a novel and improved rock drilling unit and method of handling rods.

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

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

[0008] The method according to the invention is characterized by the charactering features and steps of independent method claim.

[0009] An idea of the disclosed solution is that the rock drilling unit, which is intended especially for exploration drilling, may be provided with an apparatus for handling drilling rods and other elongated drilling components. The apparatus comprises a rod feeder for moving the drilling rods between a pick-up position and an intermediate position, and a swing device for moving the drilling rods between the intermediate position and a drilling center. The mentioned rod feeder and swing device are separate units so that they can be moved independently relative to each other. In other words, the rod feeder and the swing device are not integrated into one physical entity, but instead, they are separately operable devices.

[0010] An advantage of the disclosed solution is that handling of the drilling rods may be quickened when the swing device and the rod feeder may be driven independently and may thereby execute handling tasks simultaneously. This way the drill string may be assembled and disassembled quicker than by using the known apparatuses.

[0011] In this patent application the used terms drilling component and drilling rod include elongated drilling tools such as drilling tubes and solid rod type elements. The terms further include water swivel rods, inner tubes and retrieval elements, such as wire line retrieval tools, which are implemented in core and sample drilling.

[0012] According to an embodiment, the swing device and the rod feeder comprise dedicated frames and dedicated actuators for executing their independent movements. Thanks to this, the swing device and the rod feeder may be mounted relatively freely relative to each other, which has positive impact on the layout of the drilling unit. A further advantage of the embodiment is that construction and operation of the dedicated devices may be designed according to their special needs.

[0013] According to an embodiment, movement of the rod feeder has no influence to the swing device and correspondingly movement of the swing device has no influence to the rod feeder. Thus, the rod feeder and the swing device are separate units which can be moved independently.

[0014] According to an embodiment, the rod feeder and the swing device are separate units without direct physical connection between them.

[0015] According to an embodiment, direction of movements of the rod feeder and the swing device are transversal relative to each other.

[0016] According to an embodiment, the rod feeder is configured to execute only turning movements. Thus, the rod feeder reciprocates only in one single movement direction.

[0017] According to an embodiment, the drilling unit has a vertical first plane and the rod feeder has a vertical second plane. The second vertical plane of the rod feeder is configured to be constantly parallel relative to the first vertical plane during movement of the rod feeder.

[0018] According to an embodiment, the rod feeder is configured to be turned relative to at least one first turning axis and the swing device is configured to be turned relative to at least one second turning axis. The first turning axis and the second turning axis are perpendicular relative to each other.

[0019] According to an embodiment, the swing device has a fixed mounting and the only movement of the swing device is transversal turning movement relative to the drilling center.

[0020] According to an embodiment, the rod feeder comprises at least two arms connected to each other by means of at least one connecting joint axis, which con-

necting joint is perpendicular to the drilling axis. A first arm is connected to a base structure of the drilling unit by means of a rotational joint axis, which is transversal to the drilling axis. At a distal end of a second arm is a gripping device or gripper, which may be turned relative to the second arm around a rotational joint axis, which is transversal to the drilling axis. Thus, the basic mechanism of the rod feeder may comprise two arms and three rotational joints, as well as actuators to carry out the movements.

[0021] According to an embodiment, the rod feeder comprises at least one extendable arm for adjusting operative length of the device. In other words the rod feeder may comprise one linear joint enabling a so called zoom feature.

[0022] According to an embodiment, location of the pick-up position is adjustable by adjusting movement control of the rod feeder. Mechanism of the rod feeder allows its gripping device to be driven in a versatile manner into desired position and height which is beneficial for effective and ergonomic handling.

[0023] According to an embodiment, the apparatus is controlled by means of at least one control unit and the location of the pick-up position is programmable. The rod feeder may have a large reach area inside which one or more pick-up positions may be determined at desired locations. An advantage of this embodiment is that the position of the pick-up position may be selected by taking into account available free space around the drilling unit, location of a rod storage and desires of an operator. Height from the ground may also be determined and stored.

[0024] According to an embodiment, orientation of the drilling component at the pick-up position is adjustable by adjusting movement control of the rod feeder whereby it is easy to take into account personal desires and ergonomic issues of different operators.

[0025] According to an embodiment, the apparatus comprises one or more control units. Then, orientation of the drilling component at the pick-up position is controlled by means of the control unit. Thus, the desired orientation and exact position may be easily re-programmed. Alternatively, the desired positions and orientations of the pick-up positions may be taught and stored in a memory device. Updating of such programmed and taught pick-up positions is easy.

[0026] According to an embodiment, the apparatus comprises at least one control unit which is configured to determine position and orientation of the intermediate position and the pick-up position. In other words, the intermediate position and the pick-up position are both imaginary positions which are not limited by means of any mechanical limiting elements. This way, the position and orientation are freely selectable. The control unit is configured to control the rod feeder to move between the defined intermediate position and pick-up position.

[0027] According to an embodiment, the rock drilling unit comprises one or more sensors, scanners or corresponding measuring devices for sensing pose of the rock drilling unit. The sensing data is transmitted to at least one control unit, which is configured to determine position and orientation of the current position and is configured to determine position and orientation of the intermediate position on the basis of the detected position and orientation in order to carry out transport of the rods between the intermediate position and the drilling axis.

[0028] According to an embodiment, one drill rod may be hold at the intermediate position by means of the rod feeder while the swing device is handling another drill rod. This way the swing device may be operable with a rod while a gripping device of the rod feeder is occupied by another rod. Thus, the rod feeder may provide the apparatus with an intermediate storage.

[0029] According to an embodiment, the rod feeder is configured to receive and supply the drilling rod at the pick-up position in horizontal or substantially horizontal orientation. This embodiment may be implemented for example when the drilling rods are stored on horizontal racks or supports.

[0030] According to an embodiment, the rod feeder is configured to receive and supply the drilling rod at the pick-up position in vertical or substantially vertical orientation. In narrow mine spaces it may be easier to store and handle the drilling components which are orientated vertically. The drilling components may also be stored in vertical direction inside a rod storage.

[0031] According to an embodiment, between the intermediate position and the pick-up position is a horizontal distance when viewed in the direction of the drilling center, whereby the pick-up position is located horizontally at rearward end portion of the drilling unit.

[0032] According to an embodiment, the rod feeder and the swing device are both provided with at least one dedicated gripper for gripping the rods.

[0033] According to an embodiment, each of the dedicated grippers of the rod feeder and the swing device comprise at least two jaws, which are located at a distance from each other when seen in longitudinal direction of the drilling component being handled.

[0034] According to an embodiment, the swing device may comprise grippers which are based on roller-like gripping elements. These elements may be an alternative solution to jaw-like grippers. The roller-like gripping elements may be not only moved relative to each other but also be rotated so that they may also be enabled in threading of the drilling components. In that case, the roller-like gripping elements may serve as an integrated threading unit whereby no separate threading unit elsewhere in the drilling unit is needed. An advantage of such a combination swing device is that the apparatus has fewer devices, may be smaller in size and also lighter in weight.

[0035] According to an embodiment, the rod feeder may be configured to serve as an intermediate rod storage at the intermediate position. Then one rod may be stored on the dedicated grippers of the rod feeder. This

way, the rod feeder may bring the next drilling component to the intermediate rod storage, wherein it may wait for the swing device to become vacant.

[0036] According to an embodiment, the rod feeder is mountable on either longitudinal side of the rock drilling unit. An advantage of this embodiment is that the same construction may be used for right- and left-hand implementations, whereby need for two different rod feeders with different handedness is not needed. In other words, the rod feeder may have a symmetrical structure, whereby it may be a more universal and versatile device. The same applies also for the swing device, which may have a symmetrical structure so that it may be mounted on either sides of the feed beam.

[0037] According to an embodiment, the swing device is supported to the drilling unit and the rod feeder is supported directly to the base structure. The apparatus may comprise one common base structure, or alternatively, dedicated base structures for drilling unit and the rod feeder. The base structure may be designed to be supported against the ground and may comprise a frame structure made of steel bars or tubes, for example.

[0038] According to an embodiment, the swing device is mounted to a slide element so that it may be moved in longitudinal direction of the feed beam. The mentioned slide element may be supported directly to the feed beam or to an additional fastening beam mounted to the feed beam and being parallel to the feed beam. The longitudinal movement of the slide element and the swing device may be synchronized to longitudinal movements of the threading unit.

[0039] According to an embodiment, the swing device is mounted longitudinally immovably to the feed beam of the drilling unit or to an additional fastening beam mounted to the feed beam and being parallel to the feed beam. This way the mounting may be firm and the structure of the mounting may be simple.

[0040] According to an embodiment, directions of movement paths of the rod feeder and the swing device are transverse relative to each other. The rod feeder is arranged to be moved predominantly in front - rear direction whereas the swing device is arranged to move predominantly in transverse direction. Thus, the basic movements of the devices are easy to handle and no complicated joints and movement control are needed. The simple movements may be fast, which has positive impact on effectivity.

[0041] According to an embodiment, the rod feeder and the swing device have both only one dedicated function and they are separately controllable units. Thus, the rod feeder and the swing device may be devices which are designed for special purposes without any need for compromises. This way their effectivity and durability, for example, may be improved.

[0042] According to an embodiment, the rock drilling unit comprises at least one control unit. The control unit is configured to control the rod handling apparatus to move according to its work cycle simultaneously and independently relative to the operation of the threading unit. This way the threading unit and the rod handling apparatus may be driven simultaneously, which increases the performance of the handling of the drilling components. The control unit may comprise a processor which is configured to execute a software designed to control the operation of the apparatus. The control device may be located in connection to the apparatus or it may be located externally of the apparatus.

[0043] According to an embodiment, the rod feeder is an independently movable device, which is movable simultaneously with the swing device. The ability for simultaneous movements of these two devices has a significant impact on improved efficiency for the rod handling procedure. In other words, multitasking of the co-operating rod feeder and the swing device quickens loading and removing drilling components to and from the drill string.

[0044] According to an embodiment, the apparatus comprises a control unit which is configured to control the rod handling device, the threading device and the alignment device to perform multiple operational functions at the same time.

[0045] According to an embodiment, the threading unit is located at an extension of the feed beam. An advantage of this embodiment is that at the rear end of the feed beam may be an extension part, which offers proper support for the threading unit. A further advantage is that at the rear of the feed beam there is sufficiently free space for arranging the threading unit and it does not cause any visibility problem to an operator.

[0046] According to an embodiment, the threading unit is integrated in the swing device. Means for executing threading may be combined with gripping means of the swing device or they may be arranged separately in connection to the swing device.

[0047] According to an embodiment, the rod handling apparatus is configured to co-operate with at least one rod manipulator for feeding drilling rods automatically from a rod storage to the pick-up position and correspondingly for removing the rods from the pick-up position automatically to the rod storage. The rod manipulator may comprise an articulated arm system or it may be an industrial robot. Alternatively, or in addition to, the rod manipulator may comprise one or more transport tracks for moving the drilling rods and components. The rod storage may be a separate mobile unit, which may be positioned at a drilling site, or alternatively, the storage may be a separate unit being integrated to be part of the rock drilling unit. The rod storage may be dimensioned to receive dozens of drilling components, and typically up to 100 - 200 components, sometimes even more than 350 components.

[0048] According to an embodiment, the rock drilling machine of the drilling unit is a rotation device or a rotation head. Thus, the rod handling apparatus is implemented in rotational drilling.

[0049] Let it be mentioned, that regarding the steps of

handling the elongated drilling components, such as drilling rods, it is assumed in this patent application that one or several drilling rods have already been drilled into the rock and the last rod, which is partly drilled into the rock, is penetrating through the rock drilling machine so that a rearward end of the partly drilled rod is exposed. The solution disclosed in this patent application is for adding or removing drilling rods to a drill rod string comprising several drilling rods.

[0050] 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

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

Figure 1 is a schematic view of a rock drilling unit provided with an apparatus for handling elongated drilling tools,

Figure 2 is a schematic view of a rod feeder arranged to turn around turning axis and configured to transfer drilling components from a horizontal pick-up position to an intermediate position adjacent to a feed beam of a rock drilling unit,

Figure 3 is a schematic view of a rod feeder provided with a vertical pick-up position which is located at rear side area of the drilling unit,

Figure 4 is a schematic view of a rod feeder provided with a vertical pick-up position which is located at front side area of the drilling unit,

Figure 5 is a schematic view of a rod feeder configuration of which is an articulated boom comprising several arms and joints,

Figure 6 is a schematic view of a swing device configured to move drilling components between an intermediate position of a rod feeder to a drilling center of a rock drilling machine,

Figure 7 is a schematic side view of a rock drilling unit provided with an apparatus for handling drilling components;

Figures 8 and 9 are schematic views of a rock drilling unit provided with an apparatus for handling drilling components; and

Figure 10 is a schematic diagram showing transfer steps of drilling rods and means for executing the movements.

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

Detailed description of some embodiments

[0053] Figure 1 shows in a highly simplified manner principle of a rock drilling unit 1 provided with an apparatus 36 for handling elongated drilling rods 2 or corresponding drilling components. The drilling unit 1 is supported on a base structure 3 by means of turning joints 4a and 4b so that position and orientation of the drilling unit 1 can be changed. The drilling unit 1 may comprise a feed beam 5, a feed device 6, a rock drilling machine 7, an alignment device 8 and a threading unit 9. The rock drilling machine 7 may be a rotating device 7a, which is configured to rotate drilling rods 2 and tools at a drilling center 10. The rock drilling machine 7 is supported on a feed beam 5 and is moved by means of the feed device 6. The alignment device 8 is located at a rear end portion of the rock drilling machine 7 and is configured to align new rods to be in with the drilling centre 10. The alignment device 8 may comprise transversally movable roller elements, for example. The threading device 9 may be located at a rear end portion of the feed beam 5 and is configured to rotate the rod in order to open and close screw joints between successive rods.

[0054] In connection with the drilling unit 1 is a swing device 11, which may be supported directly to the feed beam 5, or alternatively to a fastening beam 12, which is parallel to the feed beam 5. On both sides of the drilling unit 1 may be such fastening beams, whereby the swing device 12 may be mounted on either left or right side of the drilling unit 1.

[0055] A rod feeder 13 may also be supported to the base structure 3. The rod feeder 13 is configured to move the rods between a pick-up position 14 and an intermediate position 15. In Figure 1 gripping means of the rod feeder 13 are positioned to the intermediate position 15. The pick-up position 14 is located at rear area of the rod feeder and at lower vertical height. The rod feeder 13 comprises at least one arm 16, which is connected to the base structure 3 by means of a turning joint 17a for turning the arm 16 relative to the base structure 3. At a distal end portion of the arm 16 may be a turning joint 17b for turning a gripping device of the rod feeder 13 relative to the arm 16. Turning axis of the joints 4a, 4b, 17a and 17b may be transversal to the direction of the drilling center 10.

[0056] The rods 2 may be stored to a rod storage 18. The rods 2 may be moved from the rod storage 18 to the pick-up position 14 manually by an operator 19 or there may be an industrial robot, a manipulator or any other device or mechanism for executing the transfer.

[0057] The rod feeder 13 is configured to move the rod 2 from the pick-up position 14 to the intermediate position 15 wherefrom the rod is picked by the swing device 11. The swing device 11 comprises turning joints 20a, 20b allowing the swing device 11 to be turned in transverse direction relative to the drilling axis 10. The swing device 11 may move the rod 2 from the intermediate position 15 to the drilling axis 10 where it may be aligned and become connected to the previous rod. As can be noted, the drilling unit 1 provided with the swing device 11 and the rod feeder 13 are physically separate devices. Moreover, the rod feeder 13 and the swing device 11 may be controlled separately. The control of the devices 1, 11 and 13 may

be done under control of a control unit CU. When the swing device 11 has gripped the rod 2 and begins to move it away from the intermediate position 15, the rod feeder 13 may instantly initiate new handling process for a next rod.

[0058] Figure 2 discloses movements of a rod feeder 13. The rod feeder 13 comprises an arm 16, which may be extendable and may be connected to a base structure 3 by means of a turning joint 17a so that the rod feeder 13 may be turned on a vertical plane, which is parallel to a drilling centre 10 of a rock drilling unit 1. Thus, the rod feeder 13 may be moved back and forth and may be without any sideward movements. At a distal end of the arm 16 is a gripping device 21, which may comprise an elongated frame 22 and two or more gripping elements 23, such as gripping jaws or rollers, for gripping a rod 2 at a longitudinal distance from each other. The gripping device 21 may be turned around a turning joint 17b so that orientation of the gripping device 21 may be adjusted. Thereby, the rod feeder 13 may be positioned to an intermediate position 15 which is defined by the position and orientation of the drilling unit 1. And further, the rod feeder 13 may be positioned to a pick-up position 14 which may be located at rear of the drilling unit 1 and may have horizontal orientation and desired vertical height so that it is easy for an operator 19 to feed and remove rods. So, figure 2 discloses both the intermediate position 15 and the pick-up position 14.

[0059] In Figure 3 the rod feeder 13 may be substantially the same as in Figure 2 but now the pick-up position 14 has a vertical orientation at the rear area of the drilling unit. Further, in Figure 4 the pick-up position 14 also has a vertical orientation but is located at a frontal area of the drilling unit. As can be noted, the position and orientation of the pick-up position 14 may be adjusted according to personal demands of the operator and according to available free space around the drilling device. Safe areas for manual handling of the rods to and from the pick-up position 14 may be locate at front or rear areas relative to the drilling unit 1. The pick-up position 14 is reachable from vertical on rear side to vertical on front side. In Figures 2 - 4 drilling direction is indicated by a reference A.

[0060] Figure 5 discloses a rod feeder 13 comprising two arm parts 16a, 16b connected to each other by means of a joint 17c. The arm 16 may be connected to a base structure by means of a turning support 24 so that the rod feeder 13 may also be turned laterally, whereby the configuration of the rod feeder 13 may resemble a robotic arm system or an industrial robot. Alternatively, the arm 16 may be arranged to be moved in one vertical plane in a similar manner as the embodiments shown in Figures 2 and 3, and may thereby have simpler configuration and control. Further, one or more arm parts 16a, 16b may comprise a zoom system for adjusting their lengths. In order to improve clarity turning actuators are not shown in Figures 1 - 5.

[0061] Figure 6 is a highly simplified presentation of a swing device 11. As it is mentioned above, the swing device 11 is configured to move the drilling rods 2 or other elongated drilling components between the intermediate position 15 of the gripping device 21 of the rod feeder and the drilling center 10 of the rock drilling machine 7. The swing device 11 may be mounted on the fastening beam 12 which is located on a side of the feed beam 5. The rock drilling machine 7 is mounted on a carriage 25, which is movable in longitudinal direction of the feed beam 5. The swing device 11 may comprise two arms 26 and 27 connected to each other by means of a turning joint 28 and connected to the fastening beam 12 by means of a turning joint 29. At a distal end of the arm system is a gripping device 30 or gripper, by means of which the swing device 11 may grip the rods 2. For clarity reasons the gripping device is shown in a simplified manner. As can be noted, the swing device 11 is moved together with the feed beam 5 whereas the gripping device 21 of the rod feeder is not physically linked to the feed beam 5. Therefore, positioning measures are required to place the gripping system of the rod feeder 13 at a reach of the swing device 11 and to be parallel with the drilling centre 10 or line.

[0062] Figure 7 discloses a rock drilling unit 1, which is provided with a swing device 11 and rod feeder 13 for moving rods 2 between a pick-up position 14 and a drilling center 10. Basic features of these devices have already been disclosed above. However, Figure 7 further discloses an actuator 31, such as a cylinder, for moving the feed beam 5, and an actuator 32, such as a cylinder, for moving the rod feeder 13 relative to the common base structure 3. The actuator 32 is shown in a simplified manner. At an extension of the rear end of the feed beam 5 is located movably the threading unit 9. The threading unit 9 may slide along a support beam portion 33 when being moved by means of an actuator 34, such as a cylinder. Figure 7 further shows that the alignment device 8 may be located at a rear end side of the rotating device 7a. The alignment device 8 and the rotating device 7a may both be supported on the carriage 25, which is moved by means of the feed device 6, such as a cylinder. At a front end of the feed beam 5 a front guide 35 for supporting the rod 2 may be arranged.

[0063] Figures 8 and 9 show the above disclosed apparatus in more detail and in two different view angles.

[0064] Figure 10 illustrates transfer steps of drilling rods and components. The rods 2 are moved from a storage or storage position 36 to the pick-up position 14 either by the operator 19, manipulator or robot. The rods 2 may be moved from the pick-up position 14 to the intermediate position 15 by means of the rod feeder 13, and further be moved to the drilling centre 10 by means of the swing device 11. On the drilling centre 10 the rods 2 may be moved by means of the threading unit 9 and the feed device 6. When the drill string is disassembled then the rods 2 are moved in an opposite direction, of course. Operation of the disclosed devices may be controlled by means of the control unit CU, which may comprise a processor, a software program and a memory device. Control

parameters, programs and commands may be fed by means of an input device, and further, sensing data of sensors may be transmitted to the control unit. The control unit may generate control commands for actuators moving the disclosed devices independently for executing the needed handling processes.

[0065] 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. An apparatus (36) for rod handling, which is mountable in connection to a rock drilling unit (1) and wherein the apparatus (36) is configured to move rock drilling rods (2) between at least one pick-up position (14) and a drilling center (10) of the rock drilling unit (1);
   the apparatus (36) comprising:

   a rod feeder (13) for moving the drilling rods (2) between the pick-up position (14) and an intermediate position (15),
   a swing device (11) for moving the drilling rods (2) between the intermediate position (15) and the drilling center (10); and
   at least one gripper for gripping the rods (2);
   characterized in that
   the rod feeder (13) and the swing device (11) are separate units, which are movable independently relative to each other.

2. The apparatus as claimed in claim 1, **characterized in that**
   direction of movements of the rod feeder (13) and the swing device (11) are transversal relative to each other.

3. The apparatus as claimed in claim 1 or 2, **characterized in that**
   the swing device (11) has a fixed mounting and the only movement of the swing device (11) is transversal turning movement relative to the drilling center (10).

4. The apparatus as claimed in any one of the previous claims 1 to 3, **characterized in that**
   the rod feeder (13) comprises at least two arms (16a, 16b) connected to each other by means of at least one connecting joint (17c) axis of which connecting joint is perpendicular to the drilling axis (10).

5. The apparatus as claimed in any one of the preceding claims 1 to 4, **characterized in that**
   location of the pick-up position (14) is adjustable by adjusting movement control of the rod feeder (13).

6. The apparatus as claimed in any one of the preceding claims 1 - 5, **characterized in that**
   the rod feeder (13) and the swing device (11) are both provided with at least one dedicated gripper (21, 30) for gripping the rods (2).

7. The apparatus as claimed in any one of the preceding claims 1 - 6, **characterized in that**
   the apparatus (36) is mountable on either longitudinal side of the rock drilling unit (1).

8. A rock drilling unit (1), comprising:

   a feed beam (5);
   a rock drilling machine (7) supported on the feed beam (5) and comprising at least a rotating device (7a) for rotating drilling rods (2);
   a feed device (6) for moving the rock drilling machine (7) longitudinally on the feed beam (5);
   an alignment device (8) for aligning a new rod (2) on the drilling center (10) with a previous rod (2) passing through the rock drilling machine (7);
   a threading unit (9) arranged to be movable on the drilling center (10) and configured to rotate the new rod and to simultaneously feed the new rod relative to the previous rod;
   an apparatus (36) for rod handling, wherein the apparatus (36) is configured to move the rods (2) between at least one pick-up position (14) and the drilling center (10), and wherein the apparatus (36) comprises a rod feeder (13) and a swing device (11);
   and wherein the rock drilling unit (1) is supported to a base structure (3);
   characterized in that
   the apparatus (36) for rod handling is according to any one of the preceding claims 1 to 7; and further
   the swing device (11) is supported to the drilling unit (1) and the rod feeder (13) is supported directly to the base structure (3).

9. The rock drilling unit according to claim 8, **characterized in that**
   the apparatus (36) comprises at least one control unit (CU); and
   the control unit (CU) is configured to control the rod handling apparatus (36) to move according to its work cycle simultaneously and independently relative to the operation of the threading unit (9).

10. The rock drilling unit according to claim 8 or 9, **characterized in that**
    the apparatus (36) comprises at least one control unit (CU);
    the control unit (CU) is configured to determine position and orientation of the intermediate position (15) and the pick- up position (14), which are both

imaginary positions without being mechanically limited; and
the control unit (CU) is configured to control the rod feeder (13) to move between the determined intermediate position (15) and pick-up position (14).

11. The rock drilling unit according any one of the preceding claims 8 - 10, **characterized in that**
the threading unit (9) is located at an extension of the feed beam (5).

12. The rock drilling unit according to any one of the preceding claims 8 to 11, **characterized in that**
the rod handling apparatus (36) is configured to cooperate with at least one rod manipulator for feeding drilling rods (2) automatically from a rod storage (18) to the pick-up position (14) and correspondingly for removing the rods (2) from the pick-up position (14) automatically to the rod storage (18).

13. A method of handling drilling rods in core drilling wherein drill holes are drilled by means of a rock drilling unit (1) comprising a feed beam (5) and a rock drilling machine (7),
the method comprising:

moving the rods (2) between at least one pick-up position (14) and an intermediate position (15) by means of a rod feeder (13);
moving the rods (2) between the intermediate position (15) and a drilling center (10) defined by the rock drilling machine (7) by means of a swing device (11); and
moving the swing device (11) and the rod feeder (13) along movement paths which are transversal relative to each other;
characterized by
using in rod handling physically and operationally separate devices as the swing device (11) and the rod feeder (13);
and moving the swing device (11) and the rod feeder (13) simultaneously and independently along their transversal movement paths.

14. The method according to claim 13, **characterized by**
detecting position and orientation of the rock drilling unit (1) by means of at least one sensing device; and
determining position and orientation of the intermediate position (14) on the basis of the detected position and orientation of the rock drilling unit (1).

15. The method according to claim 13 or 14, **characterized by**
holding one drill rod (2) at the intermediate position (15) by means of the rod feeder (13) while the swing device (11) is handling another drill rod (2).

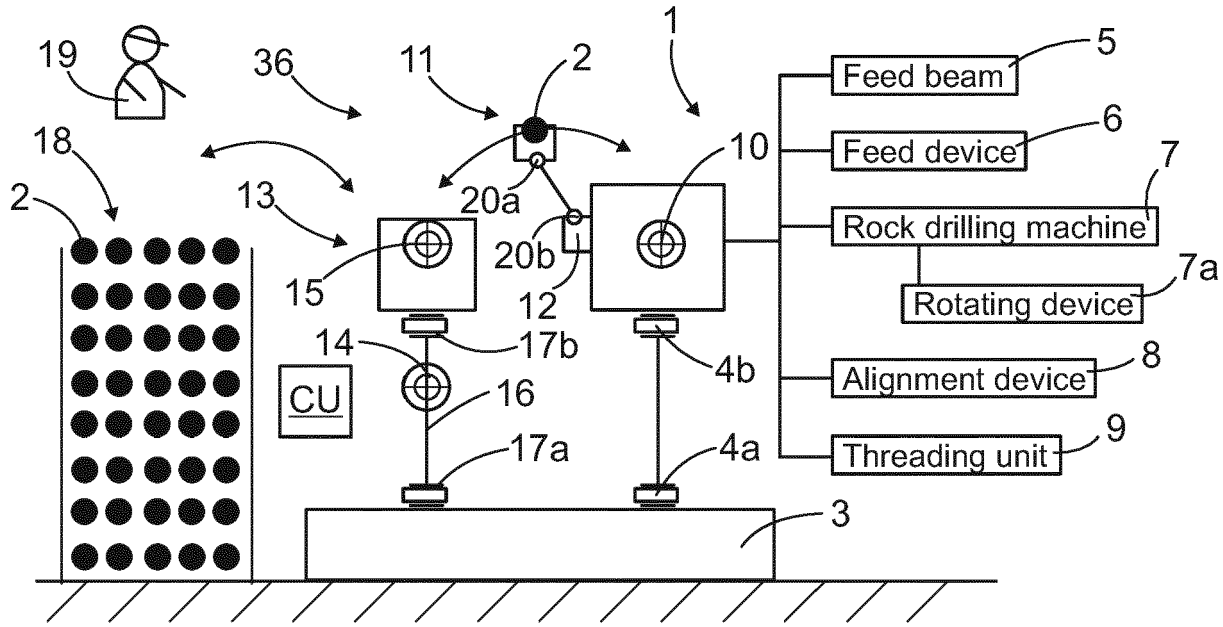

FIG. 1

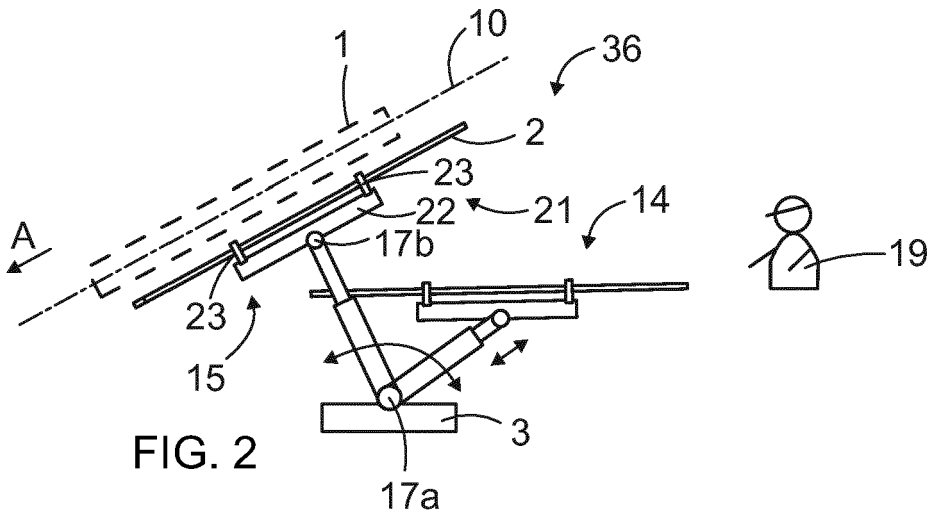

FIG. 2

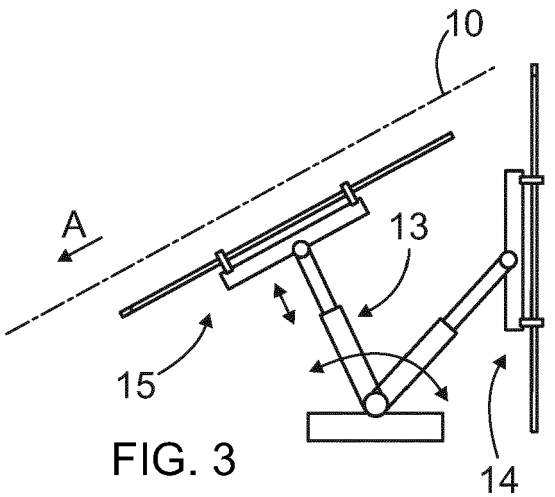

FIG. 3

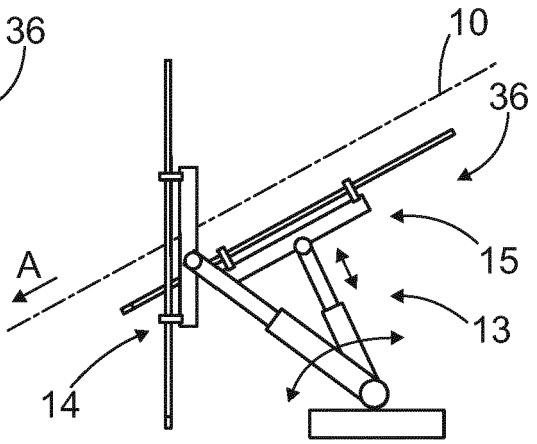

FIG. 4

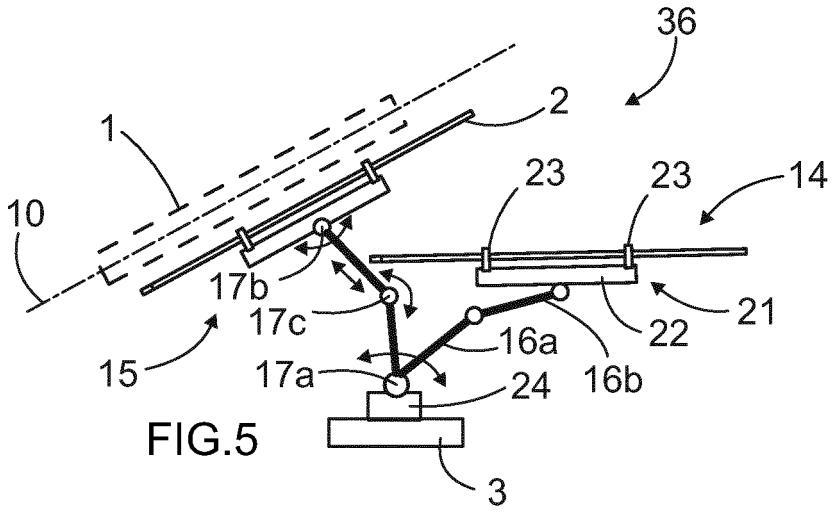

FIG.5

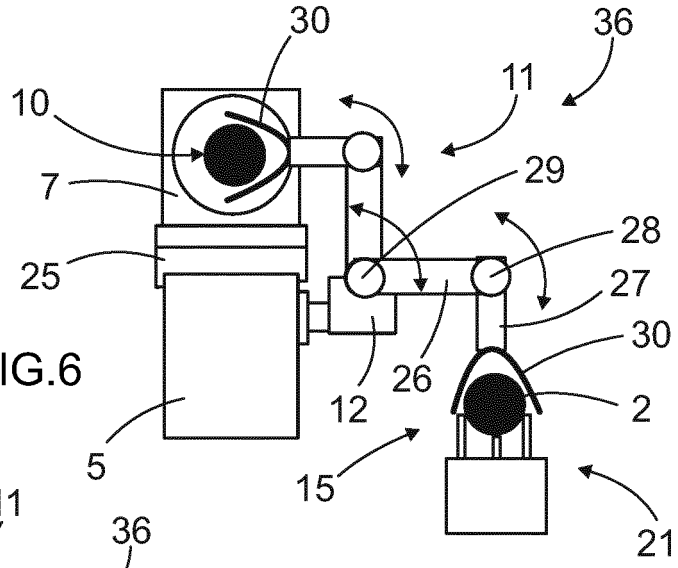

FIG.6

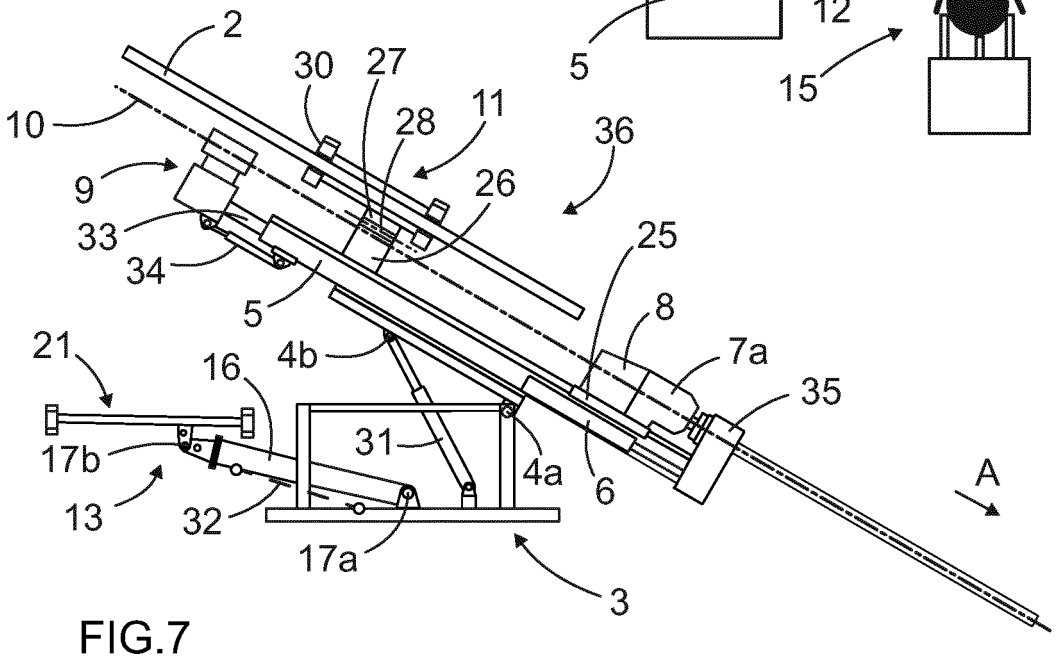

FIG.7

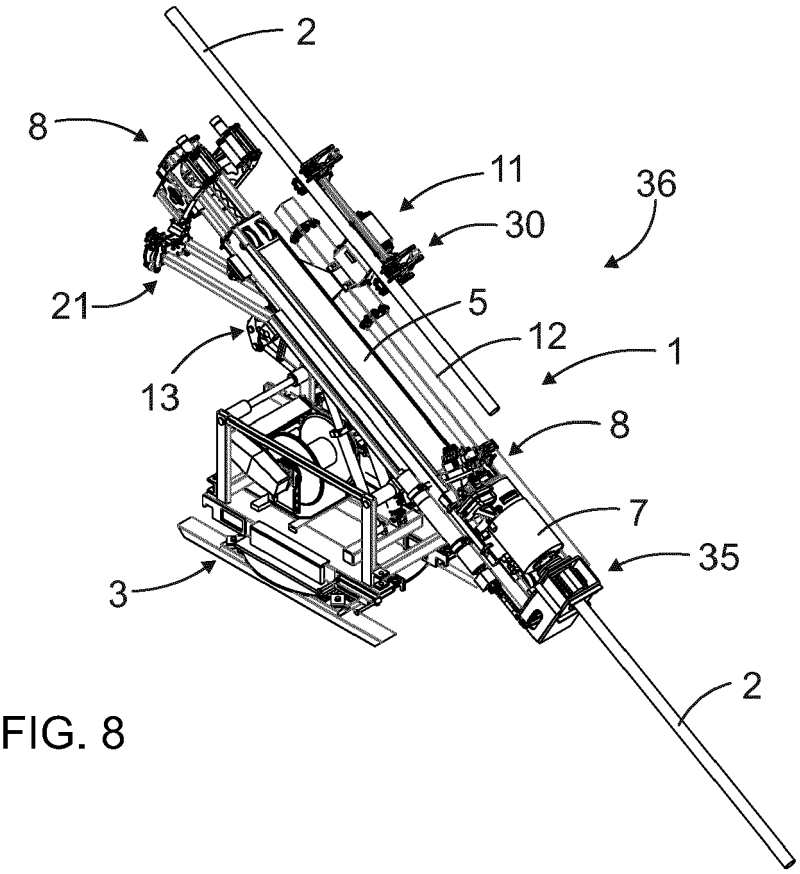

FIG. 8

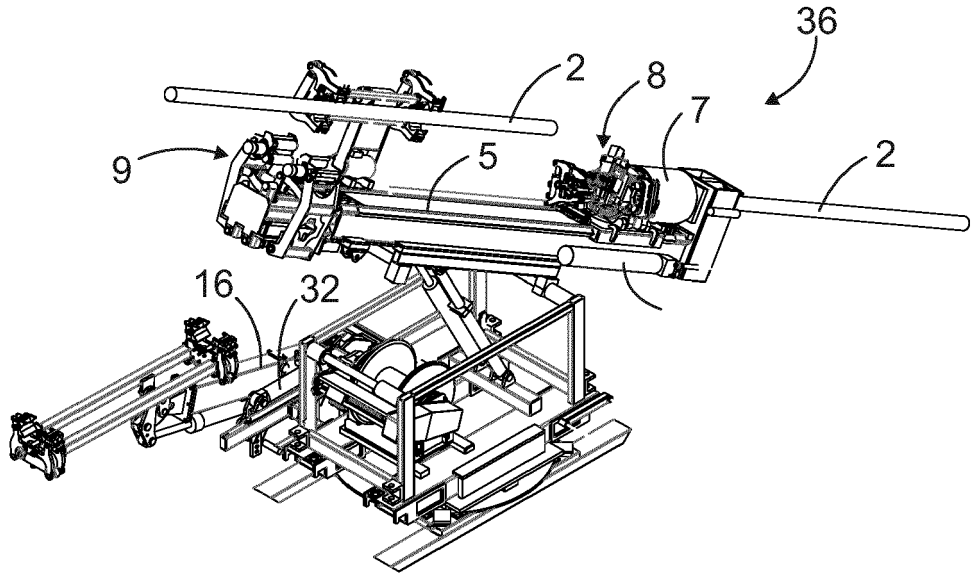

FIG. 9

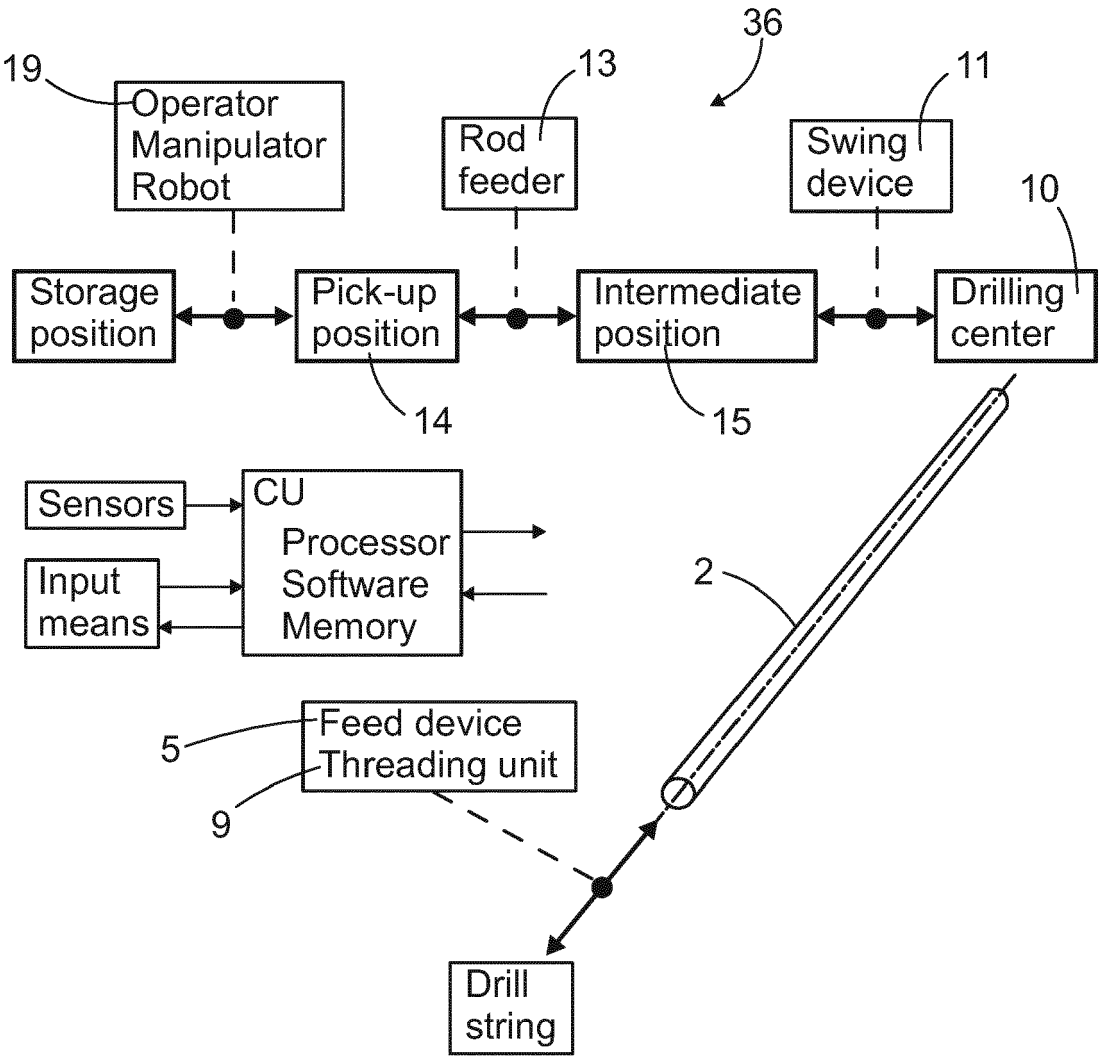
36
19
Operator
Manipulator
Robot
13
Rod
feeder
11
Swing
device
10
Storage
position
Pick-up
position
Intermediate
position
Drilling
center
14
15
Sensors
CU
Processor
Software
Memory
Input
means
2
5
Feed device
Threading unit
9
Drill
string

FIG. 10

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EUROPEAN SEARCH REPORT

Application Number
EP 18 15 4331

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Place of search	Date of completion of the search	Examiner
The Hague	25 July 2018	Dantinne, Patrick

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