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(54) **DRILLING ARRANGEMENT AND METHOD PERTAINING TO THE DRILLING ARRANGEMENT**

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(56) References cited:
**ES-A1- 2 367 492**
**US-A- 3 220 494**
**US-A- 3 490 546**
**US-A- 3 857 451**
**US-A- 4 067 398**



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## Description

### TECHNICAL FIELD

**[0001]** The present invention relates to a method pertaining to a drilling arrangement underground. The invention also relates to a drilling arrangement and a computer program product comprising program code for an electronic control unit associated with the drilling arrangement to perform the method.

**[0002]** The invention can relate to the manufacturing industry for mining equipment and to the mining industry in general, but is not limited to this.

### BACKGROUND

**[0003]** Today's technology to drill in rocks underground sometimes requires that an operator have to move his drill rig from the drift where it is currently located, to another drift above in order to be able to drill downwards. That way you avoid cumbersome handling of the drilling equipment upside down. Today's technology also means that when an operator, after having drilled in a first direction, shall change the orientation of the drilling equipment to drill in a second direction, he is forced to handle cumbersome and bulky retaining structures. These retaining structures for holding the drilling equipment thus causes a large amount of work in the case where an operator turns the drilling equipment to drill in a second direction. Today's technology thus causes a large amount of work. Structures of today for underground drilling also lack flexibility and are space consuming.

**[0004]** Known drilling arrangements means that the derrick often has to be transported to larger spaces or even up to ground level to be adjusted or turned. Known drilling arrangements also involve the use of cranes to change the extension of the drive member support device relative to the drive head of the drive member and the feed member. All such handling to change the orientation of the drive member relative to the extension of the drive member support device is time consuming and can be dangerous for the operating personnel.

**[0005]** US 3 220 494 discloses a drilling arrangement comprising a vehicle, known as a carrier, coupled to a drilling equipment. The drilling equipment comprises a derrick mounted on a base in a fixed position against the rock. The drilling equipment further comprises a rotation and feed structure for driving a borehole in a first direction from a first space. Should an operator want to drill a borehole in a second direction to a second space located above him, he has to dismantle the drilling equipment for transportation to said second space and from there drill downwards back to the first space. This is time consuming and results in a lack of flexibility.

**[0006]** US 3 857 451 A discloses an invertible drilling arrangement which includes an end frame at each of its ends which is adapted for connection to a ground emplaced mounting structure.

ES 2 367 492 A1 discloses a drilling arrangement arranged on the vertical column which can be rotated 360° about an axis perpendicular to the feed direction, in relation to the vertical column.

### SUMMARY OF THE INVENTION

**[0007]** An object of the present invention is to provide a new and advantageous method pertaining to a drilling arrangement.

**[0008]** An object of the invention to provide a non-bulky drilling arrangement.

**[0009]** An object is to provide a flexible drilling arrangement.

**[0010]** Another object of the invention is to provide a new and advantageous drilling arrangement for driving a first borehole between at least a first and a second space, and an advantageous computer program pertaining to a drilling arrangement.

**[0011]** A further object of the invention is to provide a drilling arrangement which is cost effective to use with regard to time and safety aspects.

**[0012]** A further object of the invention is to provide a drilling arrangement which is easy to manufacture and which can be provided cost effectively.

**[0013]** A further object of the invention is to provide a drilling arrangement and a method that is user friendly.

**[0014]** These objects are achieved with a method for positioning a drilling arrangement according to the method steps specified in claim 1.

**[0015]** According to one aspect of the present invention a method pertaining to a drilling arrangement is provided, the drilling arrangement comprising a drive member support device for fixing a drive member arranged at a drilling arrangement, wherein the drive member operates in a direction, the method comprising:

- providing a drive head with an axis of rotation adapted for engagement with a drill string means;
- providing the drive head pivotally about an axis of rotation extending transverse said direction;
- pivoting the drive head from a first fixed end position where the axis of rotation of the drive head is parallel to said direction and the drive member drives the drive head in a first direction, to a second fixed end position where the axis of rotation of the drive head is parallel to said direction and the drive member drives the drive head in a second direction which directions are opposite.

**[0016]** According to an aspect of the present invention a method pertaining to a drilling arrangement is provided, the drilling arrangement comprising a drive member support device for fixing a drive member arranged at the drilling arrangement, wherein the drive member operates in a direction, the method comprising:

- providing a drive head with an axis of rotation adapted for engagement with a drill string means, wherein the drive head is arranged to cooperate with a feed member operating in respectively a first and a second direction;

- providing the drive head pivotable relative the drive member support device and the feed member about an axis of rotation extending transverse said direction;

- pivoting the drive head from a first fixable end position where the axis of rotation of the drive head is parallel to said direction and the feed member drives the drive head in the first direction, to a second fixable end position where the axis of rotation of the drive head is parallel to said direction and the feed member drives the drive head in the second direction, which directions are opposite.

**[0017]** This way, a flexible method and a space-saving drilling arrangement is achieved.

**[0018]** This way, a cost-effective and from a work environment aspect more favourable method is also achieved. A derrick arranged in a first space for driving a drill bit in a first direction can advantageously flexibly be used for driving the drill bit in a second direction. In one case, the setting of the derrick (fixation in the drift) may be maintained and said second direction is drilled in a direction opposite the first direction. In another case, the derrick may be somewhat loosened and turned into proper alignment, be fixed and the drive head is pivoted 180 degrees so that drilling in the second direction may be performed in a different direction from the first space, but not necessarily in line with the first direction.

**[0019]** The drive member preferably comprises the drive head and the double-acting feed member, wherein the drive head is pivotally arranged at the feed member. Thus, the drive member is preferably also double-acting and the direction in which the drive member operates is the same as the direction in which the feed member operates.

**[0020]** The method preferably includes pivoting the drive head 180 degrees about said axis.

**[0021]** The definition relating to said pivot of the drive head about the axis extending transverse the operation movement of the drive member and thus the feed member includes the axis of rotation of the drive head being pivoted from a first position where the axis of rotation has an extension which is parallel to the direction of said operation movement, to a second position where the axis of rotation has an extension which is parallel to the direction of said operation movement.

**[0022]** Alternatively, said drill string means is completely or partly disengaged from the drive head after driving a first borehole.

**[0023]** Said drill string means is suitably provided in engagement with said drive head for driving a second borehole.

**[0024]** Said boreholes are suitably driven by means of successive feedings in said first respectively second direction.

**[0025]** The first borehole is preferably driven between a first space where the drilling arrangement is positioned and a second space, and the second borehole is driven between the first space and a third space.

**[0026]** The drilling arrangement may hereby advantageously be used at reaming, raise boring or at other drilling where, from a first space, two aligned drilled holes shall be made.

**[0027]** The both respective holes preferably end in a second respectively third space.

**[0028]** The step to pivot the drive head about the axis is alternatively achieved by means of a motor or semi-manually.

**[0029]** This way, the method may be performed by control of a control unit operated by an operator and coupled computer.

**[0030]** The step to pivot the drive head about the axis is preferably achieved manually.

**[0031]** The drive head is suitably pivoted about two lockable end positions.

**[0032]** The respective end position is preferably locked with bolts between the feed member and the drive head.

**[0033]** Locking these end positions is alternatively performed by said control unit and locking wedges or similar locking members are controlled to lock the drive head in position.

**[0034]** These objects are also achieved by a drilling arrangement defined in the introduction having the features specified in the characterizing part of claim 5.

**[0035]** According to an aspect of the present invention a drilling arrangement for mining is provided, the drilling arrangement comprising a drive member support device for fixing a drive member arranged at the drilling arrangement, wherein the drive member operates in a direction, and a drive head with an axis of rotation adapted for engagement with a drill string means, where:

the drive head is pivotally arranged to pivot about an axis of rotation extending transverse said direction between a first and a second end position,

in the first end position, the axis of rotation of the drive head is arranged parallel to said direction and the drive member is arranged to drive the drive head in a first direction,

in the second end position, the axis of rotation of the drive head is arranged parallel to said direction and the drive member is arranged to drive the drive head in a second direction, and

the directions are opposite, wherein the drilling arrangement allows drilling in the two opposite directions.

**[0036]** According to an aspect of the present invention a drilling arrangement for mining is provided, the drilling arrangement comprising a drive member support device for fixing a drive member arranged at the drilling arrangement, wherein the drive member operates in a direction, and a drive head with an axis of rotation adapted for engagement with a drill string means, wherein the drive head is arranged to cooperate with a feed member operating in a respectively first and a second direction, where:

the drive head is pivotally arranged relative the drive member support device and the feed member, to pivot about an axis of rotation extending transverse said direction between a first and a second end position,

in the first end position, the axis of rotation of the drive head is arranged parallel to said direction and the feed member is arranged to drive the drive head in a first direction,

in the second end position, the axis of rotation of the drive head is arranged parallel to said direction and the feed member is arranged to drive the drive head in a second direction, and

the directions are opposite, wherein the drilling arrangement allows drilling in the two opposite directions.

**[0037]** An alternative denomination of said drilling arrangement is herein rock drilling arrangement.

**[0038]** Said first end position may be a fixable end position. Said first end position may be a fixable position. Said first end position may be a lockable position.

**[0039]** Said second end position may be a fixable end position. Said second end position may be a fixable position. Said second end position may be a lockable position.

**[0040]** This way, a drilling arrangement is achieved which cost-efficiently can drill two holes in opposite directions from a common space. Hereby is also achieved that the drilling arrangement may be used in small spaces without having to go backwards back to larger spaces in order to use the drive member support device. The drive member support device may be bracing legs with support plates arranged to brace against the walls of the space. The bracing legs are then designed to support the feed member (such as hydraulic cylinders, pneumatic cylinders etc.). The feed member feeds/drives the drive head and the drill string means comprising drill steel and drill bit in the direction of the bore hole. To turn a drilling arrangement in such a small space requires a great effort and often involves disassembling of the different components.

**[0041]** The drive head is preferably coupled to a drive motor through a gearbox, which together form a pivotable unit.

**[0042]** Hereby is achieved an integrated unit which is user friendly to operate.

**[0043]** A pivot member is preferably arranged between the drive head and the feed member.

**[0044]** The pivot member alternatively comprises a distance piece arranged between a feed member in the form of a feed cylinder, and the base of the drive head on both sides of the base. The distance pieces each have a pivot pin. The respective distance piece is screwed to the housing of the feed cylinder. The pivot pin is in turn fitted into a bearing mounted at said base. Recesses are suitably arranged at the base for accommodation of stop flanges held against and retaining said pivot pins at their respective bearing.

**[0045]** This way may the base easily be slid in between the bearings and be screwed by means of bolting during mounting.

**[0046]** The pivot member alternatively comprises at least one pivot pin rigidly mounted at the feed member and said drive head may be journally attached at it.

**[0047]** A drilling arrangement may hereby be user friendly mounted in a space where first bracing legs and feed members are applied in position after which the drive head (chuck) with or without rotation unit (motor and gearbox) is pivotally mounted on suitably two pins, each pin being mounted on a feed member.

**[0048]** Said feed member and drive head are both suitably arranged to be driven by pressurized fluid.

**[0049]** This allows, for example, a vehicle's hydraulics or thereby connected pressure source to be used, whereby great feed power (feeding of drill string back and forth) and drill power (rotation) may be achieved.

**[0050]** Said in the first respective second direction operating feed member preferably comprises at least two double-acting cylinders, between which the drive head is removably attached and is pivotable between two lockable end positions. Said lockable end positions are suitably provided by means of a set of bolts.

**[0051]** According to an aspect of the invention the drilling arrangement has a flexible and robust design that also is reliable and easy to use. In such aspect few mechanical adjustments are needed to position the drilling arrangement in position to drill a second hole in the opposite direction to a first hole, which position is common for both holes.

**[0052]** At the drilling arrangement, the drive head may thereby be pivotable relative to the drive member support device and the feed member (feed cylinders) to easily drill a second opposite hole. It is therefore required, according to an aspect of the invention, only a relatively simple programming of the control unit for controlling the operation of the drilling arrangement. Such a control unit positions the drilling arrangement, provides pressing of the bracing legs against the space walls, provides pivoting of the drive head to chosen position, control and regulation of feed pressure both in terms of feeding the drill string in the direction of the borehole and in terms of

rotation of the drill string.

**[0053]** The foregoing objects are also achieved by a vehicle comprising the drilling arrangement, which vehicle may be a motor vehicle. The vehicle may be a drilling rig adapted for mining.

**[0054]** According to an aspect of the invention a computer program is provided for positioning the drilling arrangement, where said computer program comprises a program code stored on a computer readable medium for performing the method steps according to any of the claims 1 to 4 when the computer program is executed by said electronic control unit associated with the drilling arrangement.

**[0055]** According to an aspect of the invention a computer program pertaining to a drilling arrangement is provided, where said computer program comprises a program code stored on a computer readable medium for performing the method steps according to any of the claims 1 to 4 when the computer program is executed by said electronic control unit associated with the drilling arrangement.

**[0056]** According to an aspect of the invention a computer program pertaining to a drilling arrangement is provided, where said computer program comprises a program code for performing the method steps according to any of the claims 1 to 4 when the computer program is executed by said electronic control unit associated with the drilling arrangement.

**[0057]** According to an aspect of the invention a computer program for positioning the drilling arrangement is provided, where said computer program comprises a program code for performing the method steps according to any of the claims 1 to 4 when the computer program is executed by said electronic control unit associated with the drilling arrangement.

**[0058]** According to an aspect of the invention a computer program pertaining to a drilling arrangement is provided, the drilling arrangement comprising a drive member support device supporting a drive member comprising a drive head, which cooperates with a in respectively a first and a second direction operating feed member at said drive member, a pivot member arranged between the drive head and the feed member allowing pivoting of the drive head about an axis extending transverse the direction of the operation movement of the drive member and the feed member, wherein the computer program comprises a program code stored on a computer readable medium for performing the method steps according to any of the claims 1 to 4 when the computer program is executed by an electronic control unit associated with the drilling arrangement.

**[0059]** Software comprising program code for positioning the drilling arrangement may easily be updated or replaced. Further, various parts of the software may be replaced independently of each other. This modular configuration is advantageous from a maintenance perspective.

**[0060]** According to an aspect of the invention a computer program product is provided comprising a program code stored on a computer readable medium for performing the method steps according to any of the claims 1 to 4 when a computer program is executed by an electronic control unit associated with the drilling arrangement.

**[0061]** Further objects, advantages and novel features of the present invention are apparent from for a skilled person following technical features and at practice of the invention. While the invention is as specified by the following claims, it should be noted that the invention is not limited to therein specified features, but additional embodiments and combinations of described embodiments are possible. For example, the drilling arrangement per se may comprise a remote controlled vehicle transporting the equipment to the designated location. The vehicle may be adapted for autonomous control. For example, a communication link may be a physical line, such as an opto-electric communication line, or a non-physical line such as a wireless connection, for example a radio or microwave link.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0062]** For a more complete understanding of the present invention and further objects and advantages thereof, reference is now made to the following detailed description to be read together with the accompanying drawings, wherein same references refer to the same parts in the various figures, and in which schematically:

Figure 1 illustrates a vehicle carrying a drilling arrangement according to an embodiment of the invention;

Figure 2 illustrates the vehicle in Figure 1 during positioning of the drilling arrangement;

Figure 3 illustrates a drive head at a drilling arrangement according to an embodiment of the invention;

Figures 4a to 4d illustrate examples of pivot joints according to different aspects of the invention;

Figures 5a to 5c illustrate a drive member support device for supporting a drive member comprising a drive head according to a further aspect of the invention;

Figures 6a to 6b illustrate a drilling arrangement according to an embodiment of the invention;

Figure 7 illustrates a drilling arrangement according to a further embodiment of the invention;

Figures 8a-8c illustrate a pivot mechanism according to an embodiment of the invention;

Figures 9a to 9c illustrate flowcharts for methods ac-

cording to different aspects of the invention; and

Figure 10 illustrates a control unit according to an embodiment of the invention.

DETAILED DESCRIPTION OF THE DRAWINGS

**[0063]** Details of no significant meaning for the inventive idea are omitted from the drawing in order to clarify the figures.

**[0064]** Referring to Figure 1, a vehicle 1 is shown. De exemplified vehicle 1 is according to an embodiment a so called mining machine 3 adapted for mining. The vehicle 1 is a motor vehicle with four wheels 5 and is provided with a drilling arrangement 7 with possibility to make two raise holes at one and the same position of the drilling arrangement 7. The drilling arrangement 7 is shown in Figure 1 in a transport position for transportation to the position for drilling boreholes (not shown) from a first space 9, such as a tunnel or a drift. The drilling may be performed upwards or downwards. The drilling may even be performed to the sides. The drilling may on the whole be performed in an optional direction. The drilling rig 3 shown in Figure 1 is flexible and space-saving.

**[0065]** Figure 2 illustrates the vehicle 1 in Figure 1 during positioning of the drilling arrangement 7 in the first space 9. The drilling arrangement 7 is placed in position between two wall sections 8 of the space 9 wherein the extension of the drilling arrangement 7 is oriented in the direction of the borehole to be drilled.

**[0066]** The vehicle 1 is, in this embodiment, operator controlled by an operator (not shown) by a first control unit 100. A communication link between the drilling arrangement 7 and the control unit 100 is shown by reference numeral L100. A second control unit 110 is arranged for communication with the first control unit 100 and is an external control unit and is used to load the software to the first control unit 100 via the link L110 which is part of an internal network of the vehicle 1.

**[0067]** The operator operates four support legs 11 (only two are shown) (of a drive member support device) to brace against said wall section 8. A drive member 13 comprising feed member 14 in the form of two double-acting hydraulic cylinders 15, is coupled to the support legs 11. The drive member 13 further comprises a motor unit 17 (shown in detail in Figure 3) comprising a gearbox, a drive head and a chuck (not shown), pivotally mounted between the hydraulic cylinders 15. The operator actuates the motor unit 17 to pivot to a first end position, wherein a chuck (not shown) of the motor unit 17 faces the position of the first borehole to be drilled, and the control unit 100 ensures locking of the motor unit 17. A first drill steel (not shown) is arranged in engagement with the chuck at one end and its other end a drill bit (not shown). Mounting of the drill steel is performed by the operator via the control unit 100. The control unit 100 then provides, under the supervision of the operator, driving of the drill bit and continuously controls the hydraulic pressure both in terms of pressure applied to the hydraulic cylinders 15 and the pressure that drives the rotation of the motor unit 17 for rotating the drill steel with the drill bit. The control unit thus controls the operation of the drilling arrangement by means of control signals via the link L100. A second drill steel is attached to the first drill steel and subsequent drill steels are attached as the drill bit works its way into the rock.

**[0068]** When the driving of the first borehole is done, the drill steel is loosened from the chuck. The support legs 11 are detached and the motor unit 17 with the drive head is pivoted 180 degrees about an axis of rotation or pivot axis (A in Figure 4a) extending transverse the direction R, in Figure 4a, of the operation of the drive member 13 and thus the hydraulic cylinders 15 and/or transverse the extension of the hydraulic cylinders 15, to a second position. The definition relating to said pivot of the drive head about the axis extending transverse the operation movement of the feed member, includes the axis of rotation of the drive head (see reference 22 in Figure 3 and Figure 4a) being pivoted between two end positions where the extension 22 of the axis of rotation is parallel to the direction of said operation movement R in both end positions. The drive head is thus pivotable relative the feed member 14.

**[0069]** The operator thus operates the motor unit 17 to pivot to a second end position, wherein the chuck is facing towards the position for a second borehole to be drilled, and the control unit 100 ensures locking of the motor unit 17 in this end position. The first drill steel and the drill bit are again attached to the chuck, wherein the mounting of the drill still once again is performed by the operator via the control unit 100. The control unit 100 then provides, under the supervision of the operator driving of the drill bit for making the second hole. The control unit 100 controls at the same time the hydraulic pressure of the hydraulic cylinders 15 and the motor unit 17.

**[0070]** Figure 3 illustrates the motor unit 17 having the driving head 19. The motor unit 17 according to this embodiment is an integrated unit for rotating the drill steel and drill bit and the reaming head (not shown). The motor unit 17 comprises a gearbox 21 which in turn is in driving engagement with the chuck. The motor unit 17 is arranged for signal communication with the control unit (not shown). The axis of rotation 22 of the drive head 19 is the axis around which the drive head during operation rotates the drill string (drill steel and drill bit/reamer).

**[0071]** Figure 4a illustrates an embodiment of the drilling arrangement 7 comprising a drive member 13 operating along a first and a second direction R illustrated by arrows . The drive member 13 includes a drive head 19, arranged for engagement with the feed member 14 in the form of two hydraulic cylinders 15 arranged to operate in a first P respectively second direction P'. The direction R corresponds to (is parallel to) the axis of rotation 22 of the drive head 19 and the directions P and P' in which the feed member 14 operates. The drive head 19 is pivotally mounted between the hydraulic cylinders 15 about

an axis of rotation or pivot axis A extending transverse said direction R. The axis A extends in turn through two pins 23, each rigidly mounted on respective hydraulic cylinder 15. Corresponding recesses 24 on flanges 25 at the drive head 19 receive said pins. The drive head 19 may be pivoted 180 degrees relative to the feed member 14 between a first end position 26 and a second end position 28. At said first end position 26 drilling is performed in the direction P. At said second end position 28 drilling is performed in the direction P'. The drive head 19 is in Figure 4a locked in the second end position 28. Bolts 27 are screwed in for the purpose corresponding bores at the drive head 19 and thus locks the drive head 19 at the feed member 14 in the form of the hydraulic cylinders 15.

**[0072]** Figure 4b illustrates an example of a pivot member 37 in the form of a pivot joint 29, wherein the bearing between the drive head and the feed member (not shown) is achieved by ball bearings 31 sealed by a respective plate 33. For manual fitting of the drive head 19 between the feed members (not shown) shims 35 are mounted at the bearing.

**[0073]** Figure 4c illustrates an example of a pivot member 37 in the form of a pivot joint 29, wherein the pin 23 is fixed to a housing 35' of a drive head 19. This pivot joint 29 is also formed as a swivel joint wherein the hydraulic pressure, intended for a hydraulic motor (not shown) for rotating the drill steel, may be transferred from a pressure source (not shown) via feed members 14 without the need for hydraulic hoses.

**[0074]** Figure 4d illustrates an example of pivot members 37, which arranged between the drive head 19 and the feed member 14 in the form of a hydraulic cylinder 15, allows the drive head 19 to pivot about a pivot axis A extending transverse the direction of the movement of the feed member 14. A spacer 39, which has a pivot pin 23, is during mounting screwed to said feed cylinder 15. The pivot pin 23 in turn is fitted into a bearing 41, which is mounted to a base 43 supporting the drive head 19. Recesses 45 of the base 43 are arranged for housing stop flanges 47 retaining said pivot pins 23 at the respective bearing 41. In this way the base 43 may during mounting easily be slid in between the bearings 41 and be screwed by means of bolts. This means an easy service of the drilling arrangement 7 while the cylinders 15 of the feed member can remain in their positions in the case of the base 43 of the drive head 19 being mounted or dismounted

**[0075]** Figures 5a to 5c illustrate a drive member support device 49 for supporting a drive member 13 comprising a drive head 19 according to a further aspect of the invention. Figure 5a shows that the drive member support device 49 is formed as a rigid frame 51 which is anchored with strong bolts to the rock tunnel floor of a first space 9'. The frame 51 supports the drive member 13 comprising feed members 14 in the form of a rack 53 and a pinion 55. A drive head 19 is pivotally and removably mounted at the feed member 14, the drive head 19 having an electric drive motor 57. A drill string 59 with drill steel and drill bit 61 is attached to the drive head 19 and the feed member 14 is driven in the direction of the arrow P by an electric motor acting on the pinion 55 engaging the rack 53. This way, the drill string 59 with the drill bit 61 drive a pilot hole until a second space is reached 9". Figure 5b shows that the drill bit 61 is replaced with a reaming head 63 when it is free in the second space 9", whereupon the feed member 14 pulls the drill string 59 in the direction P' back to the first space 9' while the electric drive motor 57 rotates the reaming head 63. In Figure 5c is shown that after the reaming head 63 has been driven to the first space 9', the drive head 19 is pivoted approximately 180 degrees, the drill steel is remounted and as is the drill bit 61. The feed member 14 now feeds according to the arrow P', the rotating drill bit 61 in the direction P' towards a third space 9"', where the drill bit 61 will be replaced with a reaming head 63 for reaming a second hole back to the first space 9'.

**[0076]** The figures 6a to 6b illustrate a drilling arrangement 7 according to a further embodiment of the invention. According to this embodiment, the drilling arrangement 7 is arranged in a tunnel for driving a first hole at first in a first direction and then for driving a second hole in a second direction, which method is also shown with a flow chart represented in figure 9b. A remote controlled vehicle 1 has been operated to position selected parts of the drilling arrangement 7 so that a couple of meter deep holes can be drilled from the tunnel in the radial direction. The motor vehicle 1 is remote controlled to position the drilling arrangement 7 in selected positions along the extension of the tunnel. The vehicle 1 is then remote controlled to carry out the drilling arrangement 7 and the radial holes are applied with explosives for blasting and expansion of the tunnel.

**[0077]** Figure 7 illustrates a drilling arrangement 7 according to a further embodiment, wherein the drilling arrangement 7 is positioned for drilling two nearly horizontal holes 65. To facilitate pivoting of the drive head 19 in tight areas the drive motor 57' is applied for rotation of the drill string 59 near the tunnel wall 10 of the first space 9'. Feed members in the form of hydraulics (not shown) affect, through a drill string fastening, the drill string 59 for feeding in opposite directions, that is, back and forth, driving a drill bit 61.

**[0078]** Figures 8a-8c illustrate a pivot member 37 in the form of a pivoting mechanism 69 according to one embodiment. Figure 8a shows a drive head 19 in a first end position V1. A semi-circular coulisse (a plate with semi-circular curvature having grooves for a cable) 71 is rigidly attached to the drive head 19. Bearing is provided by slide bearings (not shown) arranged by the axis of the coulisse. A pull wire 73 is applied with its one end coupled to a distal portion of the coulisse 71 and partly overlying the coulisse 71. When the drive head 19 is to be pivoted 180 degrees the locking in the end position is disengaged and the drive head 19 takes, with the help of its own weight, the position shown in Figure 8b. The pull wire 73

is tensioned by means of a traction device 75 rigidly attached to an envelope surface of a feed member 14 in the form of a feed cylinder 15, which during drilling may act feeding. The feed cylinder 15 is thereby used as aid to pivot the drive head 19 to its second end position for locking. The other end position V2 is shown in Figure 8c.

**[0079]** Figure 9a shows a flow chart according to one aspect of the invention. The first step 200 involves starting. Step two 202 comprises positioning the drilling arrangement 7. Subsequently a third step 203 involves fixing the drill support or a drive member support device 49 for supporting a drive member 13 of the drilling arrangement. Thereafter is provided a locking 204 of a drive head 19 of a motor unit 17 of the drive member 13 in a first end position. The locking is performed against a feed member 14 of the drive member 13, such as hydraulics or other double acting feeders. The drive head 19 is arranged for engagement with the feed member 14 operating in respectively a first and a second direction. Thereafter, a first pilot hole is driven with pressure 205, by providing drill string means (such as drill steel, drill bit 61 etc.) in engagement with said drive head 19 driven by the feed member 14 in a direction for driving the first borehole. Thereafter, a reaming 206 is achieved in the opposite direction, by means of the feed member operating in the opposite direction. Thereafter, when the driving of the first borehole is completed, the drill string 59 is detached from the drive head 19 and the drive head 19 is pivoted in step 207 by 180 degrees about an axis extending transverse the direction of the operation of the feed member 14 and is locked. Thereafter, a second pilot hole is driven with pressure 208, by drill string means (such as drill steels, drill bit 61 etc.) being provided in engagement with said drive head 19 for driving the second borehole. Thereafter, the pilot hole is reamed 209 by feeding in the opposite direction. Thereafter, the drill support 210 is detached so that the drive member 13 can be moved in the first space. Thereafter, rearrangement or completion 211 is selected. Would rearrangement be selected the method starts over with step two and the procedure is repeated.

**[0080]** Of course, in another aspect of the invention the drive member support device 49 may be detached (the support legs 11), and the whole drilling equipment (including drive member support device 49, that is, the derrick 7 of the drilling arrangement) is adjusted a bit in the drift and is oriented to drill a second hole in a second direction, which does not correspond to the opposite direction, but may correspond to any direction. For example, the derrick could be turned (as seen in the extension of the drift) 10 degrees and be re-braced against the rock and then the operator turns the drive head about the pivot axis A 180 degrees. In this way, a flexible drilling arrangement 7 is achieved.

**[0081]** Figure 9b shows a flow chart according to one aspect of the invention. The first step involves starting 300. Step two 302 comprises positioning the drilling arrangement 7. Subsequently a third step 203 involves fixing the drill support or a drive member support device 49 for supporting a drive member 13 of the drilling arrangement 7. Thereafter is achieved a locking of a drive head 19 of a motor unit 17 of the drive member 13 in a first end position 304. The locking is performed against a feed member 14 of the drive member 13, such as hydraulics or other double acting feeders. Thereafter, a first hole is driven 305 by feed pressure on a rotating drill bit. Thereafter, when the driving of the first borehole is completed, the drill bit 61 is fed back in the direction towards the drive head 19, the drill string is disengaged from the drive head 19 and the drive head 19 is pivoted 180 degrees to a second end position 306 about an axis extending transverse to the direction of the operation of the feed member 14 and is locked. Thereafter, a second hole is driven 307. When the hole has been drilled and the drill string and drill bit are disconnected, the drill support 308 is detached and the drilling arrangement 7 is transported away.

**[0082]** Figure 9c illustrates an aspect of the invention. The method begins with start 401. A drive member 13 having hydraulics 15 and drive head 19 is provided. The hydraulics 15 cooperates with the drive head 19 to rotate the drill bit 61 and to drive this in a direction from or to the drilling arrangement 7. In a step 402, between drillings in two opposite directions, the drive head 19 is pivoted 180 degrees. Last step 403 is completion. Step 402 thus includes providing a drive member support device 49 for supporting a drive member 13 arranged at the drilling arrangement 7, providing a drive head 19 on said drive member 13, the drive head 19 being arranged for engagement with one of a first and second direction P, P' operating feed member 14, providing drill string means 59 engaged with said drive head 19, pivoting the drive head 19 about an axis A extending transverse the direction of the operating movement of the feed member 14.

**[0083]** The definition relating to said pivoting of the drive head 19 about axis A extending transverse the direction of the operating movement of the feed member includes the axis of rotation of the drive head being pivoted between two end positions, where the extension of the axis of rotation is parallel to the direction of said operating movement in both end positions.

**[0084]** Figure 10 illustrates a control unit 100 according to an embodiment of the invention. Herein, a diagram of an embodiment of a device 500 is shown. The control units 100 and 110 described with reference to Figure 2 comprise according to this embodiment said device 500. The device 500 comprises a non-volatile memory 501, a data processing unit 502 and a read/write memory 503. The non-volatile memory having a first memory portion 504, wherein a computer program P, such as an operating system, is stored for controlling the function of the device 500. Further, the device 500 comprises a bus controller, a serial communications port, I/O means, an A/D converter, a date-time input and transmission unit, event counters and an interruption controller (not shown). The non-volatile memory 501 also has a second memory part

505.

**[0085]** There is provided a computer program P comprising routines to fix said drilling arrangement 7 in a first space 9' according to an embodiment. The program P comprises routines to adjust the hydraulic pressure of the drive member support device 49 to hereby regulate a clamping force acting on the rock wall of the space 9'. The program P further comprises routines to lock the drive head 19 in a first end position, first affecting a drive motor for pivoting the drive head 19 and then inserting wedges into the housing of the drive head 19 for locking. The program P is in this embodiment stored in an executable manner or in a compressed manner in a memory and/or in a read/write memory.

**[0086]** When it is described that the data processing unit 502 performs a specific function, it is understood that the data processing unit 502 performs a specific part of the program P which is stored in the memory, or a certain part of the program stored in the read/write memory 503. The data processing unit 502 may communicate with a data port 515 via a data bus 506. The non-volatile memory 501 is adapted for communication with the data processing unit 502 via a data bus 507. A separate memory 509 is adapted to communicate with the data processing unit 502 via a data bus 510. The read/write memory 503 is arranged to communicate with the data processing unit 502 via a data bus 511. To the data port 515 may e.g. links L100 and L10 be connected (see Figure 2).

**[0087]** When data is received on the data port 515 it is temporarily stored in the second memory portion 505. When the received input data is temporarily stored, the data processing unit 502 is prepared to perform the execution of code in a manner as described above. According to an embodiment, the signals received on the data port 515 comprise information about a current hydraulic pressure of the hydraulic cylinders of the feed member 14.

**[0088]** According to an embodiment, the signals received on the data port 515 comprise information about drill steel detached from the chuck, pivoting of the drive head 180 degrees, locking of the drive head 19 and attachment of a first drill steel. Said information can be measured with suitable means or be manually fed into the first control unit 100 by a suitable communication means, such as a touch screen. The received signals on the data port 515 may be used by the device 500 for controlling a hydraulic pressure of the drive member device 49 appropriately.

**[0089]** Parts of the methods described herein may be performed by the device 500 with the help of the processing unit 110 that runs the program P stored in memory or read/write memory 503. When the device 500 runs the program P, the herein described methods are executed.

**[0090]** The invention is specified by the following claims. It shall however be pointed out that the invention is not limited to the features specified in the claims, but additional embodiments and combinations of described embodiments are possible. For example, the drilling arrangement per se may comprise a remote controlled vehicle transporting the equipment to the designated location. The vehicle may be adapted for autonomous control. For example, the communication link may be a natural line, such as opto-electric communication line, or a non-physical line such as a wireless connection, for example a radio or microwave link. The pivoting of the drive head may be performed around 180 degrees and is taken into consideration given the force vector of the drilling arrangement or drilling angle or application for drilling. The pivoting of the drive head may be fully automated. The drilling may relate to raise boring or other reaming drilling where you are looking to connect a space with two other spaces and the spaces are located in one plane, horizontally, vertically, or in between. Today, a technique for boring tunnels called raise boring is used. Raise boring is often used for driving boreholes such as shafts and/or raises between a first, second and third space. With raise boring spaces in different levels or horizontally lying spaces in a mine can be connected for communication, wherein ventilation, material transport or lift can be arranged. Usually, a pilot hole is first drilled in a first direction from the drilling arrangement. The often heavy feed pressure required can be achieved by a derrick of the drilling arrangement being clamped by means of for example bracing legs pressing support plates (grippers) against the walls of the first space.

**[0091]** For example, a drilling arrangement may be arranged for so-called raise boring where the driving (the drive member feeds a rotating drive head or chuck with compressive force) is performed in a first step by means of a drill bit for drilling of pilot holes and thereafter the driving is turned (the drive member feeds the rotating drive head or chuck with tractive force) in a second step by means of a reaming head in the opposite direction. By utilizing this in place determined push-pull function of the derrick where you only need to pivot the drive head for the new driving of the drill in the opposite direction (or after appropriate adjustment of the derrick, in any other direction), there is no need to turn the entire drilling arrangement, which otherwise is time consuming.

**[0092]** Double acting hydraulic cylinders are operated to push a rotating drive head (comprising a chuck) in the first direction affecting a drill string comprising a drill bit arranged at its outermost end. This creates a feed force (pressure) that pushes the drill bit in said first direction. Once the drill bit has reached its target and is free in the second space, the drill bit is exchanged to a reaming head, after which the drill string by means of the double-acting hydraulic cylinders is pulled in the opposite direction and a traction force is transferred to the reaming head which reams the hole to the final diameter. The drill string may have sections with drill steels, drill rods, drill pipes, etc., which sections are added or removed subsequently based on feed direction.

**[0093]** The definition of the direction of the operation movement of the feed member 14 is the direction in which, for example, hydraulic cylinders drive/feed the

drive head of the drilling arrangement for drilling boreholes. The operation movement of the feed member is performed in a direction substantially parallel to the axis of rotation of the drive head.

**[0094]** The definition of pivoting the drive head about a pivot or rotation axis extending transverse the direction in which the feed member operates, or feed the drive head, means that the drive head is pivoted from a first to a second end position. These two end positions are such that when the drive head is locked in these end positions, the axis of rotation of the drive head will extend parallel to (or at least substantially to) said direction in which the feed member operates.

**[0095]** Alternatively, the drilling arrangement according to an aspect of the invention may be remotely controlled, wherein an operator at a distance from the drilling arrangement, for example from the ground surface, may control the process of pivoting the drive head. According to another alternative, the drilling arrangement may be a remotely controlled vehicle arranged with the drilling arrangement, wherein an operator remotely controls the vehicle to the position intended for drilling, drills and then back. In another alternative, the drilling arrangement comprising a carrier may be autonomous, wherein an operator only needs to start the process and the process continues by itself to termination.

## Claims

1. Method pertaining to a drilling arrangement (7) comprising a drive member support device (49) for fixing a drive member (13) arranged at the drilling arrangement (7), wherein the drive member (13) operates in a direction (R), the method comprising:

   - providing a drive head (19) with an axis of rotation (22) adapted for engagement with a drill string means (59), wherein the drive head (19) is arranged to cooperate with a feed member(14; 15) operating in respectively a first (P) and a second (P') direction;
   **characterized by**
   - providing the drive head (19) pivotable relative the drive member support device (49) and the feed member (14; 15) about an axis of rotation (A) extending transverse said direction (R);
   - pivoting the drive head from a first fixable end position (V1; 26) where the axis of rotation (22) of the drive head is parallel to said direction (R) and the feed member (14; 15) drives the drive head (19) in the first direction (P), to a second fixable end position (V2; 28) where the axis of rotation (22) of the drive head is parallel to said direction (R) and the feed member (14; 15) drives the drive head (19) in the second direction (P'), where the directions (P) and (P') are opposite.

2. Method according to claim 1, **wherein** the step of pivoting the drive head (19) is performed 180 degrees about said axis (A).

3. Method according to claim 1 or 2, **wherein** a first borehole is driven between a first space (9') where the drilling arrangement (7) is positioned and a second space (9"), and a second borehole is driven between the first space (9') and a third space (9"').

4. Method according to any of claims 1 to 3, **wherein** the step of pivoting the drive head (19) about the axis (A) is achieved by a motor or manually or semi-manually.

5. Drilling arrangement (7) for mining comprising a drive member support device (49) for fixing a drive member (13) arranged at the drilling arrangement (7), wherein the drive member (13) operates in a direction (R), and a drive head (19) with an axis of rotation (22) adapted for engagement with a drill string means, wherein the drive head (19) is arranged to cooperate with a feed member (14; 15) operating in respectively a first (P) and second (P') direction, **characterized in that**:

   the drive head (19) is pivotally arranged relative the drive member support device (49) and the feed member (14; 15) for rotation about an axis of rotation (A) extending transverse said direction (R) between a first (V1; 26) and a second end position (V2; 28),
   in the first end position (V1; 26), the axis of rotation (22) of the drive head is arranged parallel to said direction (R) and the feed member (14; 15) is arranged to drive the drive head (19) in the first direction (P),
   in the second end position (V2; 28), the axis of rotation (22) of the drive head is arranged parallel to said direction (R) and the feed member (14;, 15) is arranged to drive the drive head (19) in the second direction (P'), and
   the directions (P) and (P') are opposite, wherein the drilling arrangement allows drilling in the two opposite directions.

6. Drilling arrangement according to claim 5, **wherein** the drive head (19) is coupled to a drive motor (17, 57) via a gearbox, which together constitute a pivotable unit.

7. Drilling arrangement according to claim 5 or 6, **wherein** said feed member (14) and the drive head (19) both are arranged to be driven by pressurized fluid.

8. Drilling arrangement according to any of claims 5-7, **wherein** a pivot member (29, 37, 69) is arranged

between the drive head (19) and the feed member (14; 15).

**9.** Drilling arrangement according to claim 8, **wherein** the pivot member (29, 37, 69) comprises at least a pivot pin (23) rigidly mounted to the feed member (14) and said drive head (19) may be journally attached thereto.

**10.** Drilling arrangement according to any of claims 5-9, **wherein** said feed member (14) operating in respectively the first and the second direction (P, P') comprises at least two double-acting cylinders (15) between which the drive head (19) is removably attached and is pivotable between two lockable end positions (26, 28).

**11.** Drilling arrangement according to claim 10, **wherein** said lockable end positions (26, 28) are provided by a set of bolts.

**12.** Vehicle comprising a drilling arrangement according to any of claim 5 to 11.

**Patentansprüche**

**1.** Verfahren betreffend eine Bohranordnung (7) umfassend eine Antriebselementunterstützungsvorrichtung (49) zum Fixieren eines an der Bohranordnung (7) angeordneten Antriebselements (13), wobei das Antriebselement (13) in einer Richtung (R) arbeitet, wobei das Verfahren umfasst:

- Bereitstellen eines Antriebskopfes (19) mit einer Drehachse (22), die zum Eingriff mit einem Bohrstrangmittel (59) ausgelegt ist, wobei der Antriebskopf (19) dazu angeordnet ist, mit einem Vorschubelement (14; 15) zusammenzuwirken, das in jeweils einer ersten (P) und einer zweiten (P') Richtung arbeitet;

**gekennzeichnet durch:**

- Bereitstellen des Antriebskopfes (19) schwenkbar relativ zur Antriebselementunterstützungsvorrichtung (49) und zum Vorschubelement (14; 15) um eine Drehachse (A), die sich quer zu der Richtung (R) erstreckt;
- Schwenken des Antriebskopfes von einer ersten fixierbaren Endposition (V1; 26), in welcher die Drehachse (22) des Antriebskopfes parallel zu der Richtung (R) ist und das Vorschubelement (14; 15) den Antriebskopf (19) in die erste Richtung (P) antreibt, in eine zweite fixierbare Endposition (V2; 28), in welcher die Drehachse (22) des Antriebskopfes parallel zu der Richtung (R) ist und das Vorschubelement (14; 15) den Antriebskopf (19) in die zweite Richtung (P') antreibt, wo die Richtungen (P) und (P') entgegengesetzt sind.

**2.** Verfahren nach Anspruch 1, **wobei** der Schritt des Schwenkens des Antriebskopfes (19) um 180 Grad um die Achse (A) durchgeführt wird.

**3.** Verfahren nach Anspruch 1 oder 2, **wobei** ein erstes Bohrloch zwischen einem ersten Raum (9'), wo die Bohranordnung (7) angeordnet ist, und einem zweiten Raum (9") angetrieben wird, und ein zweites Bohrloch zwischen dem ersten Raum (9') und einem dritten Raum (9"') angetrieben wird.

**4.** Verfahren nach einem der Ansprüche 1 bis 3, **wobei** der Schritt des Schwenkens des Antriebskopfes (19) um die Achse (A) durch einen Motor oder manuell oder halbmanuell erreicht wird.

**5.** Bohranordnung (7) für den Bergbau umfassend eine Antriebselementunterstützungsvorrichtung (49) zum Fixieren eines an der Bohranordnung (7) angeordneten Antriebselements (13), wobei das Antriebselement (13) in einer Richtung (R) arbeitet, und einen Antriebskopf (19) mit einer Drehachse (22), die zum Eingriff mit einem Bohrstrangmittel ausgebildet ist, wobei der Antriebskopf (19) dazu angeordnet ist, mit einem Vorschubelement (14; 15) zusammenzuwirken, das in jeweils einer ersten (P) und zweiten (P') Richtung arbeitet, **dadurch gekennzeichnet, dass:**

- der Antriebskopf (19) relativ zur Antriebselementunterstützungsvorrichtung (49) und zum Vorschubelement (14; 15) schwenkbar angeordnet ist, um um eine Drehachse (A), die sich quer zu der Richtung (R) erstreckt, zwischen einer ersten (V1; 26) und einer zweiten Endposition (V2; 28) zu drehen,
- in der ersten Endposition (V1; 26), die Drehachse (22) des Antriebskopfes parallel zu der Richtung (R) angeordnet ist, und das Vorschubelement (14; 15) dazu angeordnet ist, den Antriebskopf (19) in die erste Richtung (P) anzutreiben,
- in der zweiten Endposition (V2; 28), die Drehachse (22) des Antriebskopfes parallel zu der Richtung (R) angeordnet ist, und das Vorschubelement (14; 15) angeordnet ist, um den Antriebskopf (19) in die zweite Richtung (P) anzutreiben, und

die Richtungen (P) und (P') entgegengesetzt sind, wobei die Bohranordnung ein Bohren in den beiden entgegengesetzten Richtungen ermöglicht.

**6.** Bohranordnung nach Anspruch 5, **wobei** der An-

triebskopf (19) über ein Getriebe an einen Antriebsmotor (17, 57) gekoppelt ist, welche zusammen eine schwenkbare Einheit bilden.

**7.** Bohranordnung nach Anspruch 5 oder 6, **wobei** das Vorschubelement (14) und der Antriebskopf (19) beide eingerichtet sind, um von einer unter Druck stehenden Flüssigkeit angetrieben zu werden.

**8.** Bohranordnung nach einem der Ansprüche 5-7, **wobei** ein Schwenkelement (29, 37, 69) zwischen dem Antriebskopf (19) und dem Vorschubelement (14; 15) vorgesehen ist.

**9.** Bohranordnung nach Anspruch 8, **wobei** das Schwenkelement (29, 37, 69) mindestens einen Drehzapfen (23) umfasst, der an dem Vorschubelement (14) fest montiert ist, und der Antriebskopf (19) in einer gelagerten Weise an diesem befestigbar ist.

**10.** Bohranordnung nach einem der Ansprüche 5-9, **wobei** das Vorschubelement (14), das in jeweils der ersten und der zweiten Richtung (P, P') arbeitet, mindestens zwei doppeltwirkende Zylinder (15) umfasst, zwischen denen der Antriebskopf (19) lösbar befestigt ist und zwischen zwei verriegelbaren Endpositionen (26, 28) schwenkbar ist.

**11.** Bohranordnung nach Anspruch 10, **wobei** die verriegelbaren Endpositionen (26, 28) durch einen Satz Schrauben vorgesehen sind.

**12.** Fahrzeug umfassend eine Bohranordnung nach einem der Ansprüche 5 bis 11.

**Revendications**

**1.** Procédé relatif à un dispositif de forage (7) comprenant un dispositif de support d'élément d'entraînement (49) pour fixer un élément d'entraînement (13) disposé sur le dispositif de forage (7), dans lequel l'élément d'entraînement (13) fonctionne dans une direction (R), le procédé comprenant :

- fournir une tête d'entraînement (19) avec un axe de rotation (22) adaptée pour s'engager avec un moyen de train de forage (59), la tête d'entraînement (19) étant agencée pour coopérer avec un élément d'alimentation (14; 15) fonctionnant dans respectivement une première (P) et une deuxième (P') direction ;

**caractérisé par**

- la fourniture de la tête d'entraînement (19) pouvant pivoter par rapport au dispositif de support d'élément d'entraînement (49) et à l'élément d'alimentation (14; 15) autour d'un axe de rotation (A) s'étendant transversalement à ladite direction (R) ;
- le pivotement de la tête d'entraînement à partir d'une première position finale (V1; 26) dans laquelle l'axe de rotation (22) de la tête d'entraînement est parallèle à ladite direction (R) et l'élément d'alimentation (14; 15) entraîne la tête d'entraînement (19) dans la première direction (P), vers une deuxième position finale pouvant être fixée (V2; 28) dans laquelle l'axe de rotation (22) de la tête d'entraînement est parallèle à ladite direction (R), et l'élément d'alimentation (14; 15) entraîne la tête d'entraînement (19) dans la deuxième direction (P'), dans laquelle les directions (P) et (P') sont opposées.

**2.** Procédé selon la revendication 1, **dans lequel** l'étape de pivotement de la tête d'entraînement (19) est réalisée à 180 degrés autour dudit axe (A).

**3.** Procédé selon la revendication 1 ou 2, **dans lequel** un premier trou de forage est entraîné entre un premier espace (9') dans lequel le dispositif de forage (7) est positionné et un deuxième espace (9"), et un deuxième trou est entraîné entre le premier espace (9 ') et un troisième espace (9"').

**4.** Procédé selon l'une quelconque des revendications 1 à 3, **dans lequel** l'étape de pivotement de la tête d'entraînement (19) autour de l'axe (A) est réalisée par un moteur ou manuellement ou semi-manuellement.

**5.** Dispositif de forage (7) pour l'exploitation minière, comprenant un dispositif de support d'élément d'entraînement (49) pour fixer un élément d'entraînement (13) agencé au niveau du dispositif de forage (7), dans lequel l'élément d'entraînement (13) fonctionne dans une direction (R), et la tête d'entraînement (19) avec un axe de rotation (22) adaptée pour s'engager avec un moyen de colonne de forage, dans lequel la tête d'entraînement (19) est agencée pour coopérer avec un élément d'alimentation (14; 15) fonctionnant dans respectivement une première (P) et deuxième (P') direction, **caractérisé en ce que**:

la tête d'entraînement (19) est agencée de manière pivotante par rapport au dispositif de support d'élément d'entraînement (49) et à l'élément d'alimentation (14; 15) pour tourner autour d'un axe de rotation (A) s'étendant transversalement à ladite direction (R) entre une première (V1; 26) et une deuxième position finale (V2; 28), dans la première position finale (V1; 26), l'axe de rotation (22) de la tête d'entraînement est disposé parallèlement à ladite direction (R), et

l'élément d'alimentation (14; 15) est agencé pour entraîner la tête d'entraînement (19) dans la première direction (P),
dans la deuxième position finale (V2; 28), l'axe de rotation (22) de la tête d'entraînement est disposé parallèlement à ladite direction (R), et l'élément d'alimentation (14; 15) est agencée pour entraîner la tête d'entraînement (19) dans la deuxième direction (P'), et
les directions (P) et (P') sont opposées, le dispositif de forage permettant un forage dans les deux directions opposées.

**6.** Dispositif de forage selon la revendication 5, **dans lequel** la tête d'entraînement (19) est couplée à un moteur d'entraînement (17, 57) par l'intermédiaire d'une boîte de vitesses, qui constituent ensemble une unité pivotante.

**7.** Dispositif de forage selon la revendication 5 ou 6, **dans lequel** ledit élément d'alimentation (14) et la tête d'entraînement (19) sont tous les deux agencés pour être entraînés par un fluide sous pression

**8.** Dispositif de forage selon l'une quelconque des revendications 5 à 7, **dans lequel** un élément de pivotement (29, 37, 69) est agencé entre la tête d'entraînement (19) et l'élément d'alimentation (14; 15).

**9.** Dispositif de forage selon la revendication 8, **dans lequel** l'élément de pivotement (29, 37, 69) comprend au moins une broche de pivotement (23) montée rigidement sur l'élément d'alimentation (14) et ladite tête d'entraînement (19) peut y être attachée de manière à palier.

**10.** Dispositif de forage selon l'une quelconque des revendications 5 à 9, **dans lequel** ledit élément d'alimentation (14) fonctionnant respectivement dans les première et deuxième directions (P, P') comprend au moins deux cylindres à double effet (15) entre lesquels la tête d'entraînement (19) est fixée de manière amovible et peut pivoter entre deux positions finales verrouillables (26, 28).

**11.** Dispositif de forage selon la revendication 10, **dans lequel** lesdites positions finales verrouillables (26, 28) sont fournies par un jeu de boulons.

**12.** Véhicule comprenant un dispositif de forage selon l'une quelconque des revendications 5 à 11.

FIG. 1

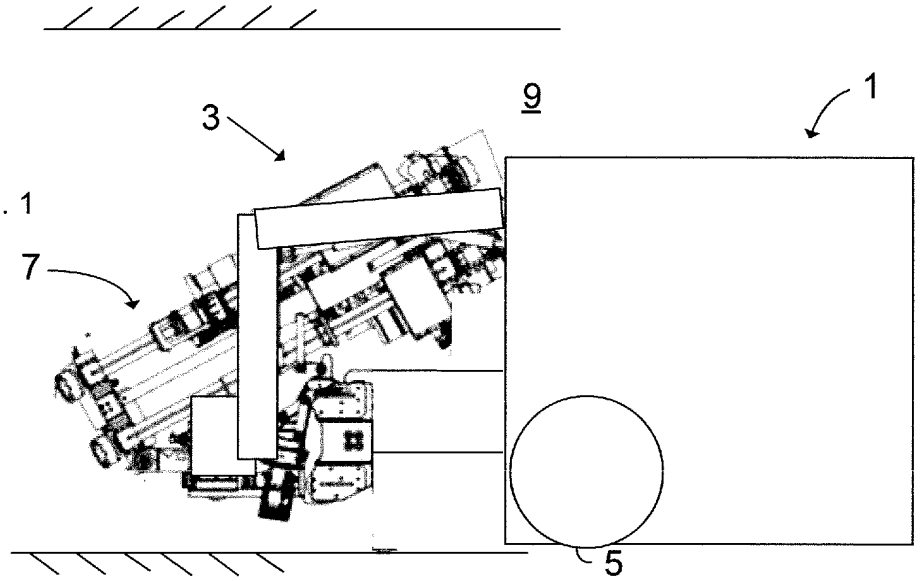
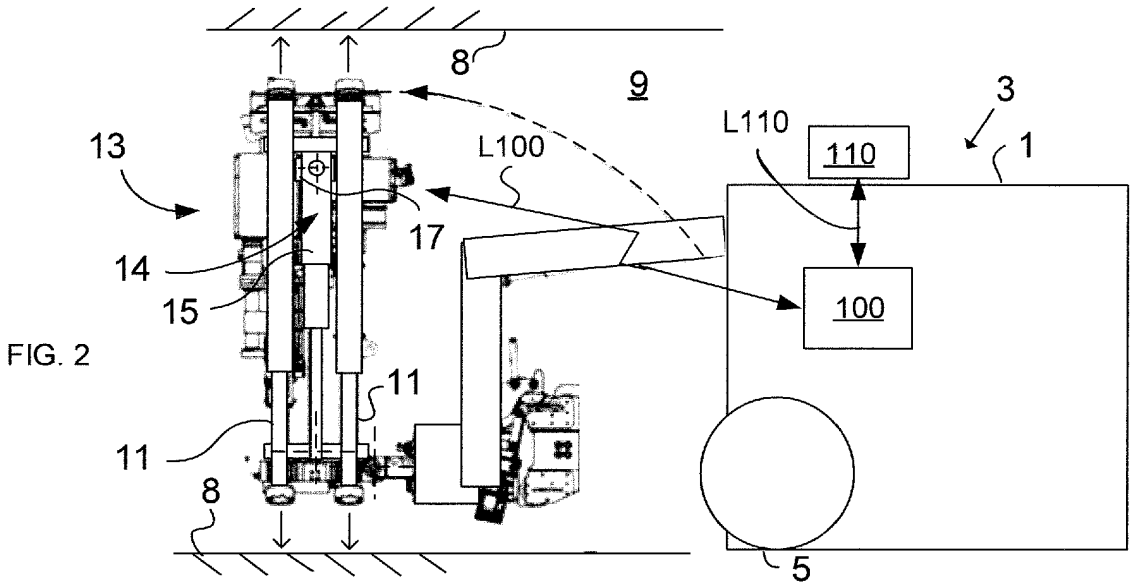



FIG. 2



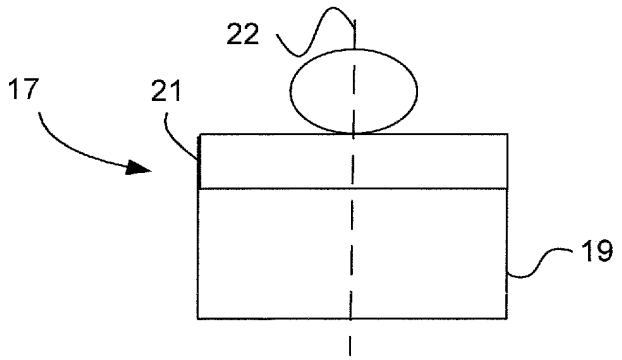




FIG. 3

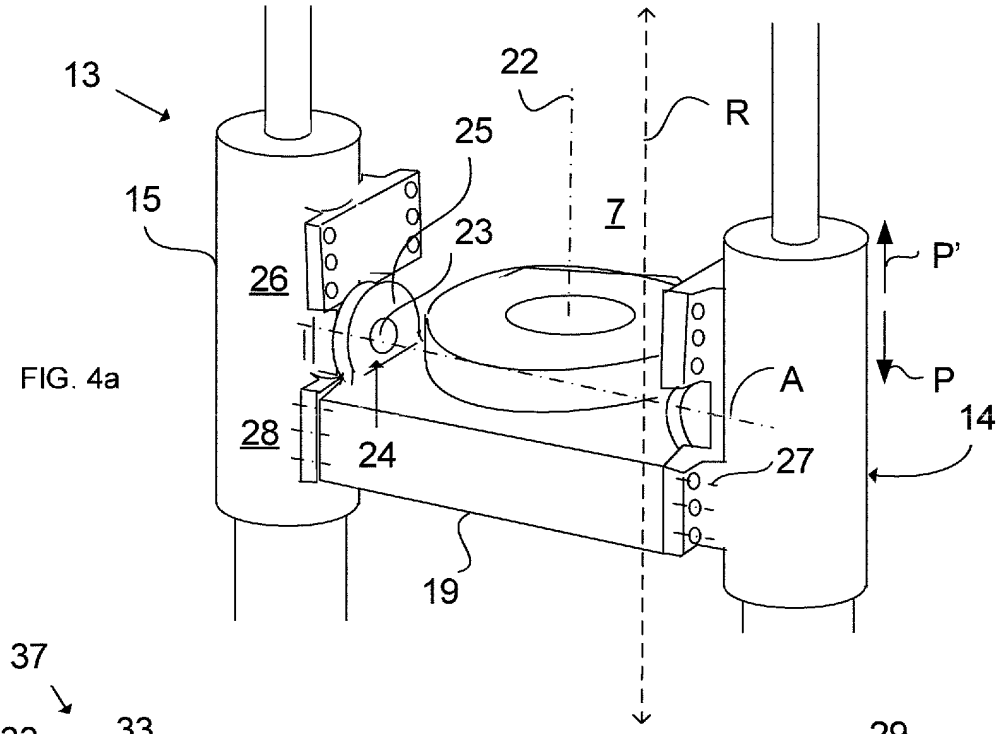



FIG. 4a

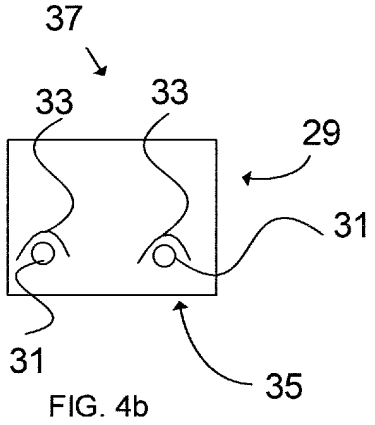



FIG. 4b

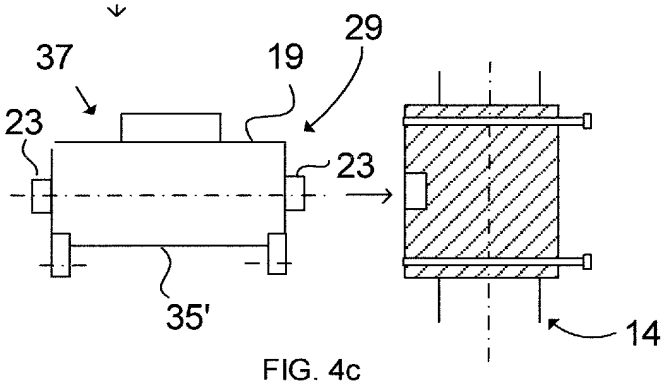



FIG. 4c

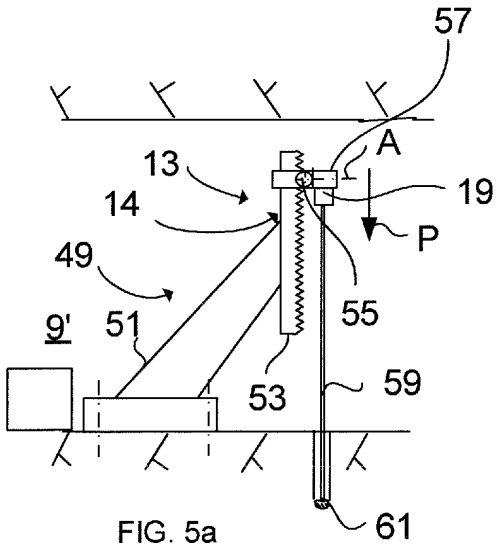



FIG. 5a

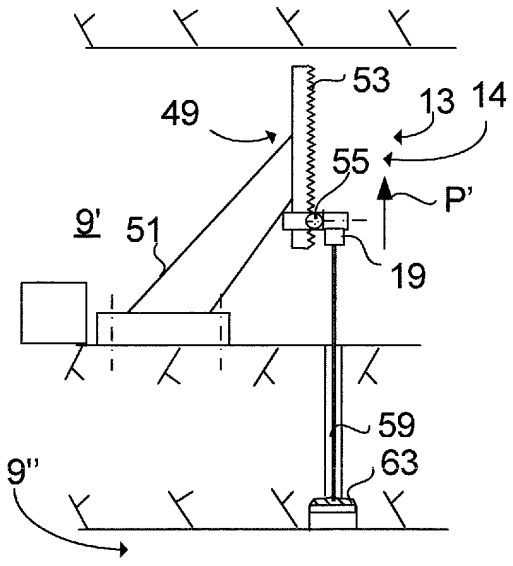



FIG. 5b

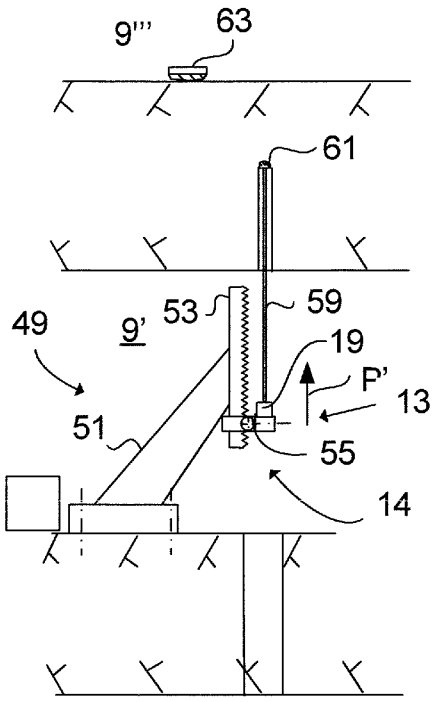



FIG. 5c

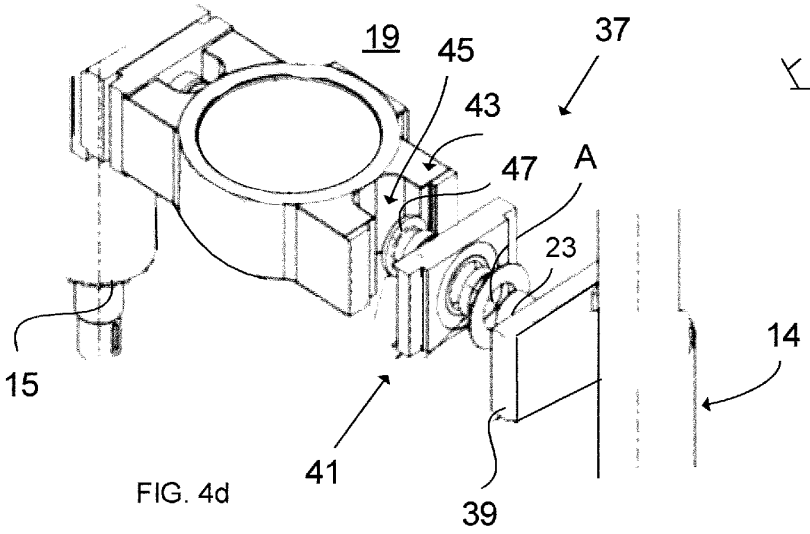



FIG. 4d

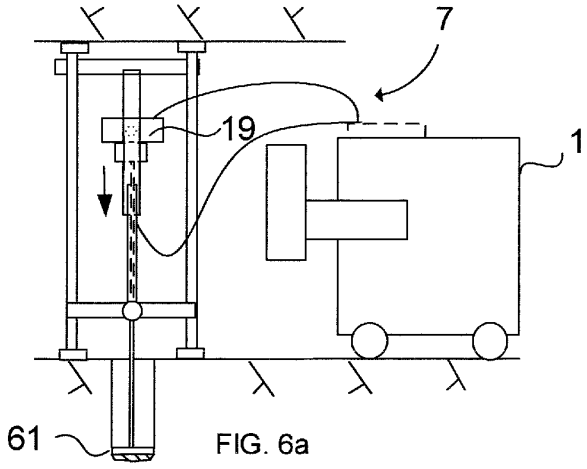



FIG. 6a

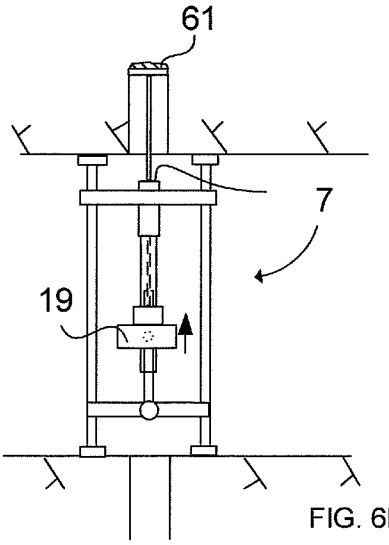



FIG. 6b

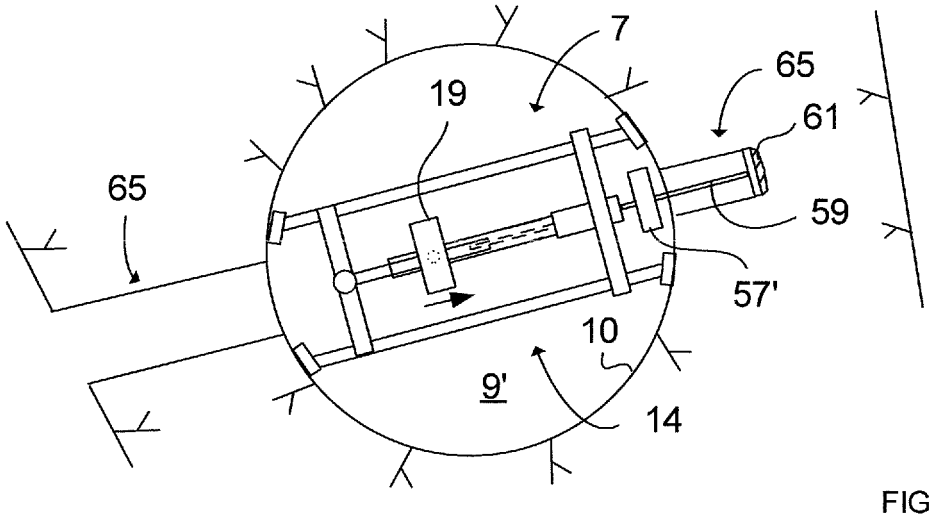



FIG. 7

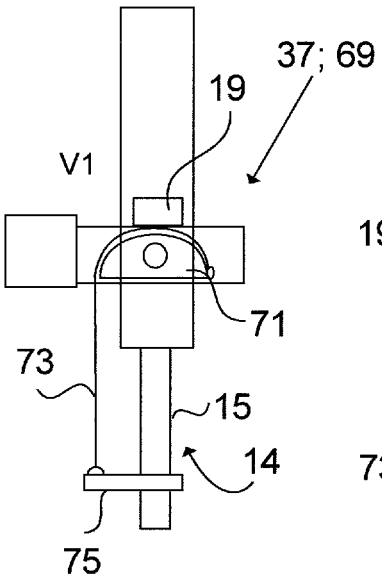



FIG. 8a

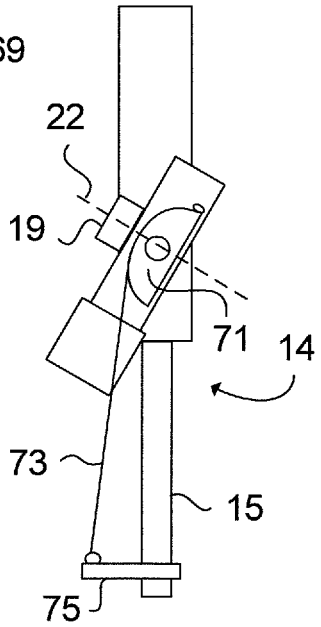



FIG. 8b

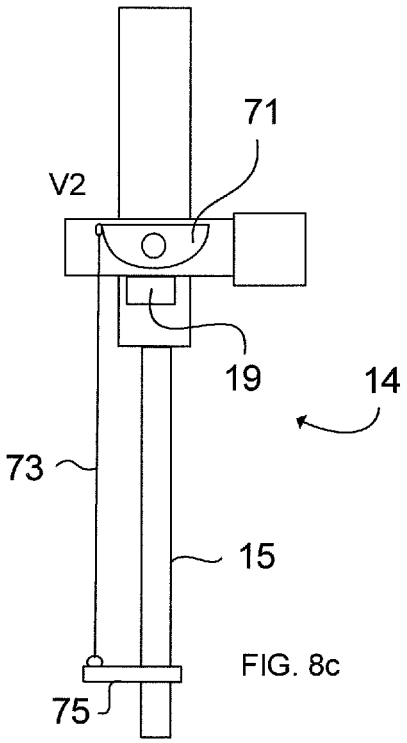



FIG. 8c

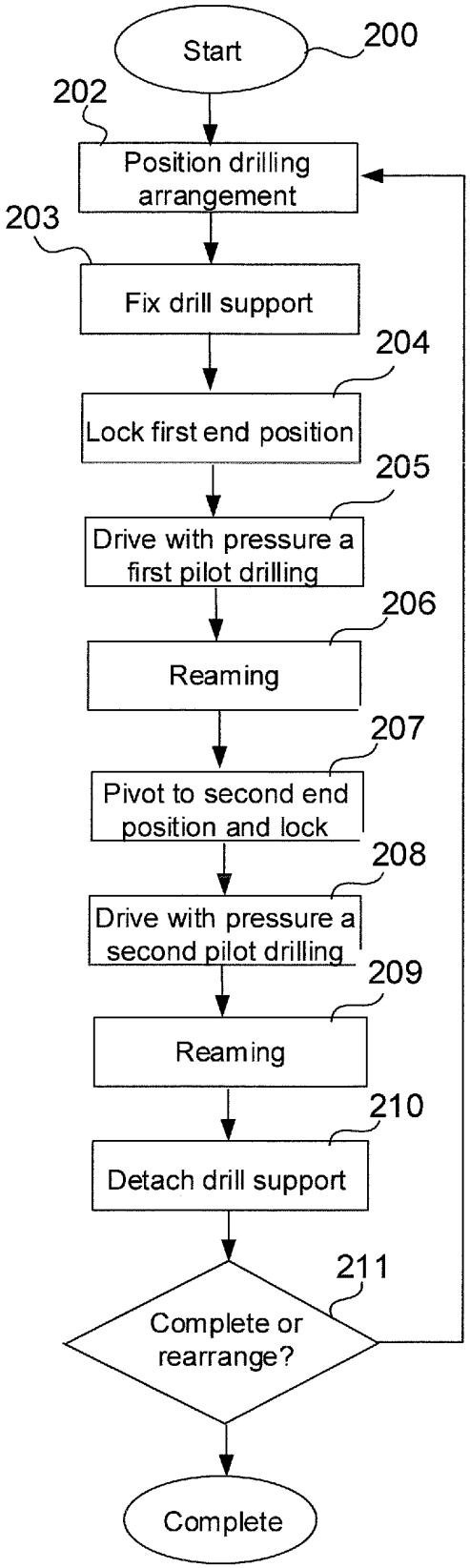

Start
200
202
Position drilling arrangement
203
Fix drill support
204
Lock first end position
205
Drive with pressure a first pilot drilling
206
Reaming
207
Pivot to second end position and lock
208
Drive with pressure a second pilot drilling
209
Reaming
210
Detach drill support
211
Complete or rearrange?
Complete

FIG. 9a

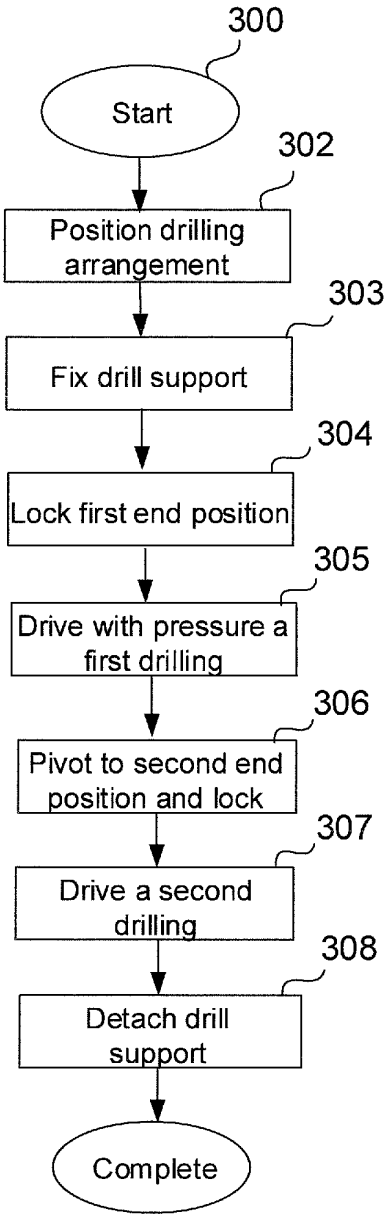

300
Start
302
Position drilling arrangement
303
Fix drill support
304
Lock first end position
305
Drive with pressure a first drilling
306
Pivot to second end position and lock
307
Drive a second drilling
308
Detach drill support
Complete

FIG. 9b

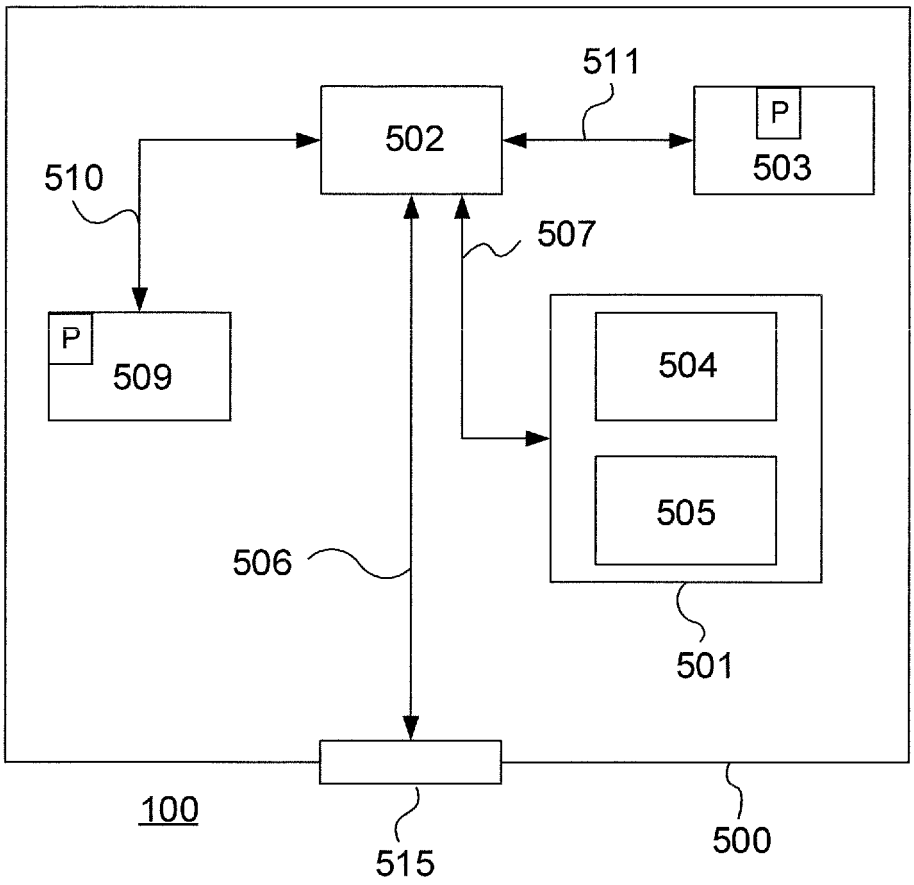
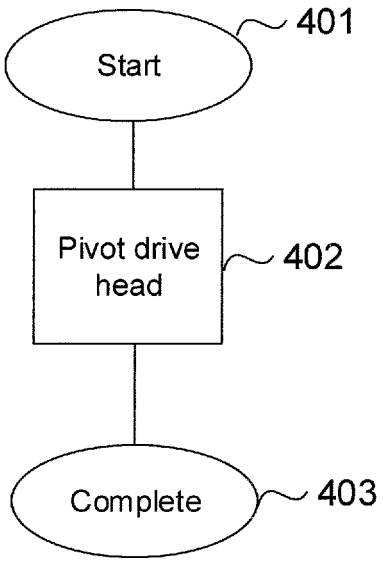

511
502
P
503
510
507
P
509
504
505
506
501
100
515
500

FIG. 10

FIG. 9c


401
Start
Pivot drive head
402
Complete
403

## REFERENCES CITED IN THE DESCRIPTION

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

### Patent documents cited in the description


- US 3220494 A **[0005]**
- US 3857451 A **[0006]**
- ES 2367492 A1 **[0006]**