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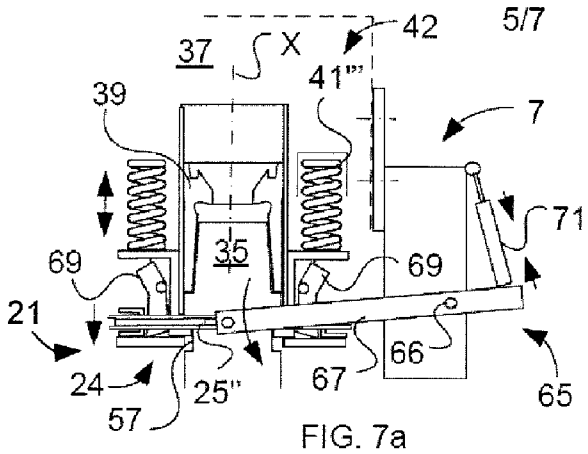

FIG. 7a

(57) Abstract: The invention relates to a method pertaining to a drilling arrangement (7) to grip a drill string means (36) for detaching a drill steel (35) from said drill string means (36). The method comprises the steps of providing holding of said drill string means (36), providing a drive head (20, 37) arranged at the drilling arrangement (7) a rotation to detach the drill steel (35) from the drive head (20, 37), providing an actuator means (42) to from an initial position (U) in an axial direction (X) displacing a gripping arrangement (21) in the direction from the drive head (20, 37), said providing of the actuator means (42) including spring actuation, and holding in a holding position by means of said gripping arrangement (21) a drill end arranged closest to the drive head (20, 37) and rotating the drill steel (35) from the remaining drill string means (36). 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 for performing the method.

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Drilling arrangement and method for holding a drill string

TECHNICAL FIELD

The present invention relates to a method pertaining to a drilling arrangement underground to grip a drill string means. 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.

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

BACKGROUND

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. Thus, avoiding having to turn the drilling equipment upside down and thereby avoiding cumbersome handling of the drilling equipment and problems with drill cuttings etcetera which can complicate the handling if falling down on the drilling equipment.

Existing technology thus means that a large amount of work is required. Known drilling arrangements means that the drill steel of the drill string is detached either manually or by means of bulky retaining structures arranged adjacent the drilling arrangement and in the drilling direction for holding the drill steel. Cumbersome and bulky structures of today require as said a large amount of work when drilling upwards. Drill cuttings can fall down in the drive head of the drilling arrangement which can cause shutdown.

Such handling to detach drill steel from each other and from the drive head of the drilling arrangement is thus time consuming and can according to prior art be dangerous for the operations staff.

US 6 230 590 describes a free standing gripping wrench for holding drill steel during upward drilling. EP 2 487 325 discloses a gripping claw for holding drill steel. US 5 012 878 describes one in a drive head integrated gripping wrench used to detach drill steel from each other.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a flexible drilling arrangement.

An object is to provide a drilling arrangement which is user friendly to use in a mine.

An object of the invention is to provide a new and advantageous method for a drilling arrangement for holding drill string means, in particular during raise boring, but it is not limited to such type of boring.

Another object of the invention is to provide a new and advantageous drilling arrangement for providing said method and an advantageous computer program pertaining to a drilling arrangement.

An object of the invention is to provide a semiautomatic drilling arrangement, comprising a hub or "wrench" for holding drill steel. One object is that it easily can be used for driving a reamer in a direction towards the drive head of the drilling arrangement regardless of bore hole direction, i.e. drilling upwards (Eng. box hole) will likewise be cost effectively performed.

A further object of the invention is to provide a drilling arrangement which is cost effective to use from a time and safety aspect.

A further object of the invention is to provide a drilling arrangement which is compact and easy to manufacture.

A further object of the invention is to provide a drilling arrangement which is reliable.

A further object of the invention is to provide a drilling arrangement and method, which is user friendly during the drilling procedure per se.

These objects have been achieved with a method pertaining to a drilling arrangement to grip a drill string means for detachment according to claim 1.

In one aspect of the present invention a method pertaining to a drilling arrangement for gripping a drill string means to detach a drill string from said drill string means is provided. The method comprises:

- providing holding of said drill string means;

- providing a rotation of the drive head arranged at the drilling arrangement to detach the drill steel from the drive head;

- providing an actuator means to displace, in an axial direction from an initial position, a gripping device in a direction from the drive head and to hold, in a holding position by means of said gripping device, a drill steel end arranged closest to the drive head; and

- rotating the drill steel from the remaining drill string means.

In this way, the actuator means can ensure that the gripping device is displaced in an axial direction from the drive head towards recesses for gripping the drill steel so that it can be held and rotated by an internally threaded body (chuck) of the drive head. Particularly advantageous is this during raise boring when drilling is done vertically upwards towards the ground surface. The method described herein thus allows a reliable functionality and the gripping device is guaranteed to be displaced, in a direction from an initial position at the drive head to a holding position, when restraining means of the gripping device is pushed into for this recessed recesses in the end of the drill steel by means of one about the rotational axis of the drive head arranged ring member actuable by a linkage arrangement.

In this way, an operator does not need to manually move the gripping device in a direction upwards for gripping one end of the drill steel for holding. A necessary upward movement of grips must be done in order to detach drill steel from each other. During for example raise boring for drilling two opposing holes or two holes oriented at an angle relative to each other in vertical direction this means a large amount of work.

A drill string means, also called drill string, suitably comprises one or a plurality of drill steels attached to each other and a drill bit.

According to one aspect of the present invention a method pertaining to a drilling arrangement to grip a drill string means for detaching a drill steel from said drill string means is provided. The method comprises:

- providing holding of said drill string means;

- providing a rotation of the drive head arranged at the drilling arrangement to detach the drill steel from the drive head;

- providing an actuator means to displace in an axial direction from an initial position a gripping device in a direction from the drive head, said providing of the actuator means comprising spring actuation, and to hold in a holding position by means of said gripping device a drill steel arranged closest to the drive head; and

- rotating the drill steel from the remaining drill string means.

According to one aspect of the present invention a method pertaining to a drilling arrangement to grip a drill string means for detaching a drill steel from said drill string means is provided. The method comprises:

- holding said drill string means;

- rotating a drive head arranged at the drilling arrangement to detach the drill steel from the drive head;

- axially displacing a gripping device from an initial position in a direction from the drive head, wherein said displacement comprises spring actuation;

- holding a drill steel end arranged closest to the drive head in a holding position, by said gripping device; and

- rotating the drill steel from the remaining drill string means.

Because the actuator means by means of spring actuation displaces the gripping device in axial direction a reliable operation can be provided. Spring actuation is preferably done by means of actuator means comprising spring means. The number of spring means can vary from a single one enclosing the drill steel to a plurality symmetrically arranged in peripheral extension. The spring means can consist of compression springs, tension springs, or combinations of these types.

The actuator means can comprise various types of spring assemblies. It can be spring pads, reverse dampers, lowering springs, electromagnetic spring devices and/or devices with pressurized fluid.

Preferably, the step of providing said actuator means for said displacement of the gripping device in the axial direction comprises operation by means of hydraulics and/or pneumatics.

This allows the drive head to be easily displaced with adjustable power and the power source in for example an already existing vehicle to be used.

Preferably the actuator means is supplemented with a linkage arrangement controlled by hydraulics or the like to, in engagement with a ring member surrounding the gripping device, bring the ring member down over said restraining means and displace these for engagement in recesses of the drill steel to be able to rotate the drill steel by means of the drive head and to detach this drill steel from a connecting retained drill steel.

The restraining means may comprise shoulders, blocks, wedges or similar restraining means arranged for moving in and out from the recesses of the drill steel.

Suitably, the step of providing said actuator means comprises insertion of restraining means in at least one recess of the drill steel. When the drill steel is rotated relative to the other drill steels for disassembling a detachment occurs.

Preferably, the step with the holding position also comprises providing said restraining means in engagement with a stop member of the gripping device during rotation of the drill steel from the remaining drill string means.

Thus, said ring element can be provided less bulky in the axial direction as the stop member prevents the ring element to come at the side of the restraining means whereby the ring element does not need to be made wider to always reach the restraining means. Since large forces on the restraining means are required for holding the drill steel it is important that the inner circumference of the ring element and the restraining means gets in position of the drill steel´s recesses.

The stop means can for example be a projecting flange portion of a housing arranged at the gripping device, also called edge flange.

By using restraining means that is pushed into the recess of the drill steel for holding, by means of the ring member provided in an optimal position, the ring element can be made as narrow as possible, at the same time the load distribution will be optimal, whereby the drilling arrangement can be provided less bulky.

The gripping device preferably comprises a hub. By means of circlip grooves in the hub, and in cooperation with a cylinder assigned to the actuator means and comprising a length sensor means, various types of brands of drill steel can be used for the drilling arrangement. Preferably, the length sensor means is programmed with predetermined length values so that an operator easily can input representative setting values in the control unit for the current drill steel, wherein the drilling arrangement thereby automatically adapts the positioning of the gripping device relative to recesses of the drill steel.

Alternatively, a detection means for detecting a position of a drill steel is used.

Thereby a user does not need to mine an unnecessarily large underground passage or drift to accommodate the drilling arrangement.

Preferably, the restraining means of the gripping device comprises shoulders and an over a pivot point journalled arm which in turn is actuated by the ring element which is pushed over and thus pushes in and holds the shoulders in the recess of the drill steel. In that the gripping device grips the drill steel and the gripping device has internal splines in engagement with external splines of a chuck arranged at the drive head and the external splines of the chuck are in engagement with internal splines of a drive unit of the drive head, the drill steel can be rotated. Due to a rotationally fixed transmission of power via splines a displacement in axial direction can be done. During detaching of the drill steel from the other drill string means, the drill steel will move from the drill string means wherein of course also the gripping device moves in the direction away from the drill string means and thus in the direction towards the drive head. During detaching of the drill steel said ring element is pushed, by means of the linkage arrangement, in a direction towards the drive head and away from the shoulders and opens these.

Preferably the method also comprises the step of adjusting, in axial direction, the gripping device together with a sealing member arranged at the gripping device, so that said sealing member does not come flush with said recess of the drill steel during drilling. The sealing device may be constituted by a sealing membrane, a sealing washer or the like.

In this way drill cuttings, such as dirt, water and rock residues, are prevented from entering the drive head via the recess in the drill steel when a user is reaming a pilot borehole or drills an upward hole during raise boring.

Said length sensor means arranged at the cylinder, which is arranged at the actuator means, (the length sensor means can for example be in the form of a position sensor built in the cylinder) allows the drilling arrangement to easily be controlled to arrange the sealing device so that it seals against recesses of different types of drill steels.

In this way an external sensor is not required.

Preferably, and in the case it appears necessary, a sensor is arranged at the drive head and based on the position of the recess of different types of drill steels relative to the thread of the drill steel the sensor can detect the current position of the recess relative to the chuck of the drive head in the axial direction and a control unit is preferably arranged to control the gripping device, comprising the sealing device, to always seal against the drill steel regardless where the recess is arranged on the current drill steel.

Preferably, the actuator means is arranged to displace the gripping device in a direction towards or in a substantial direction towards the gravitational force.

These objects have also been achieved by one in the introductory part defined drilling arrangement having the features disclosed in the characterizing part of claim 7.

According to one aspect of the present invention a drilling arrangement comprising a drive head for driving an internally threaded body, slidable in axial direction, and a gripping device, arranged rotationally fixed enclosing the body and displaceable in the axial direction, wherein said body being arranged for attaching and detaching drill string means, wherein an actuator means is arranged to, from an initial position, displace said gripping device in the axial direction in a direction from the drive head.

According to one aspect of the present invention a drilling arrangement comprising a drive head for driving an internally threaded body, slidable in axial direction, and a gripping device, arranged rotationally fixed enclosing the body and displaceable in the axial direction, wherein said body being arranged for attaching and detaching drill string means, wherein an actuator means is arranged to, from an initial position, displace said gripping device in the axial

direction in a direction from the drive head, wherein the actuator means comprises a spring means.

The internally threaded body can also be called chuck.

Thereby, a design of a compact non-bulky drilling arrangement is achieved. The drilling arrangement is particularly space-saving in the axial direction of the drive head, i.e. the dimension transverse for example the longitudinal extension of a mining drift. This in turn creates a cost efficient mining.

Thereby also a reliable drilling arrangement is achieved. The actuator means, such as a spring assembly, displaces the gripping device (comprising a hub axially displaceable on the chuck of the drive head) in an axial direction away from the drive head (from the initial position), i.e. towards the drill steel´s recess/-es associated to the drill end adjacent the drive head.

Due to such a structure also an opportunity to turn the drive head for driving of bore holes upwards is created, which occurs for example during raise boring. The actuator means is preferably arranged to displace the gripping device (the hub) in a direction towards or in substantial direction towards the gravitational force.

Preferably, the actuator means comprises at least one hydraulic actuator.

In this respect, the hub of the gripping device can be operated back by a control unit by means of a linkage arm arrangement.

Preferably, the gripping device comprises a ring element displaceable in the axial direction to drive a restraining means radially inwardly to provide a rotationally fixed connection between the gripping device and the drill steel. Suitably, an end portion of a linkage arrangement is in engagement with and journalled at the ring element, so that the actuation of the ring element in an axial direction is made against cam surfaces of restraining means in the form of for example rockers, so that the rockers in the radial direction are inserting restraining means in the form of, for example blocks in the recesses of the drill steel.

Preferably, the gripping device has a stop means for positioning the ring member in the axial direction relative to said restraining means.

Preferably, the hub of the gripping device has a flange portion acting as stop means. The flange portion is alternatively formed at the hub´s side facing away from the drive head.

During detaching of the drill steel´s second end (closest to the drilled borehole), the drill steel is enabled (by for example splines) to move towards the drive head, whereby the gripping device for obvious reasons follows this movement and thereby approaches the drive head.

The linkage arrangement connected to the ring element adapts to this movement and also the actuator means. The stop member in the form of the flange portion of the hub prevents during such a movement the ring element to come outside the area for actuation of said restraining means. Thus, the ring element in the axial direction does not need to be formed with a wide envelope surface, thereby enabling an axially non bulky drilling arrangement.

Alternatively, the actuator means has a spring element arranged at a linkage arrangement, which spring element initially moves the gripping device from its initial position. A cylinder comprising piston and piston rod is arranged to act on a shorter arm which in turn via said spring element acts on a longer arm supporting the gripping device. Suitably, said cylinder is arranged to pivot the shorter arm around a pivot point common with the longer arm to actuate, via said spring members, the gripping device in a disengaged position.

In this way a disengaging is provided, which result in a smooth and rigid actuation of the gripping device, especially during detaching of the drill steel from the next when the gripping device follows the drill steel in the direction towards the drive head. The spring member allows a free movement of the longer arm towards the shorter arm while the cylinder acts on the shorter arm to pivot back to its initial position.

Preferably, the gripping device comprises a sealing device having an inner circumference adapted to the diameter of the drill steel. Preferably, the drilling arrangement is provided with a control unit which controls the gripping device to position the sealing device in an alternative position around the drill steel other than in the area of the drill steel´s recess for said restraining means. This functionality is primarily used during reaming of boreholes.

The above 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 intended for mining.

According to one aspect of the invention a computer program for a drilling arrangement is provided to grip a drill string means for detaching a drill steel from said drill string means, wherein said computer program comprises a program code stored on a by a computer readable medium for performing the method steps of any of claims 1 to 6 when the computer program is run on an electronic control unit associated with the drilling arrangement.

Software that comprises program code for positioning the drilling arrangement can easily be updated or replaced. Further, various parts of the software can be replaced independently of each other. This modular configuration is advantageous from a maintenance perspective.

According to one aspect of the invention, a computer program product is provided comprising a program code stored on a by a computer readable medium for performing the method steps of any of claims 1 to 6 when a computer program is run on an electronic control unit associated with the drilling arrangement.

Other objects, advantages and new features of the present invention will be apparent to those skilled in the art in view of the following technical features and during practice of the invention. While the invention is described by the following claims, it should be noted that the invention is not limited to therein appended features, but additional embodiments and combinations of the described embodiments are possible. For example, the drilling arrangement per se can comprise a remote controlled vehicle transporting the equipment to the designated location. The vehicle can be arranged for autonomous control. For example, the communication link can be a physical line, such as an opto-electrical communication line, or a non-physical line such as a wireless connection, for example a radio or microwave link.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the present invention and further objects and advantages thereof, reference is now made to the following detailed description taken in conjunction with the accompanying drawings, wherein similar reference numbers refer to similar parts in the different figures, and in which drawings schematically:

Figure 1 shows a vehicle supporting a drilling arrangement according to an embodiment of the invention;

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

Figure 3 shows a gripping device of the drilling arrangement according to an embodiment of the invention;

Figures 4a to 4h show steps for detaching drill steel from a drill string according to an aspect of the invention;

Figure 5 shows an aspect of the invention wherein so called raise boring is performed;

Figures 6a to 6f show an aspect of the invention in more detail;

Figures 7a to 7c show an embodiment of the linkage arrangement;

Figure 8 a gripping device and actuator means according to an aspect of the invention;

Figures 9a to 9j show different aspects of the invention;

Figures 10a to 10b show flowcharts of methods according to different aspects of the invention; and

Figure 11 shows a control unit according to an embodiment of the invention.

DETAILED DESCRIPTION OF THE FIGURES

Details that are not of major importance for the invention are omitted in the drawings in order to clarify the figures. Corresponding details in different figures can be shown with different reference numbers.

With reference to Figure 1, a vehicle 1 is shown. The exemplified vehicle 1 is according to one embodiment a so called drilling rig 3 arranged for mining. The vehicle 1 is a motor vehicle with four wheels 5 and is provided with a drilling arrangement 7. The drilling arrangement 7 shown in Figure 1 is in the transport position to transport the drilling arrangement 7 to a position for drilling underground (for example mine, tunnel etc.).

Figure 2 shows the vehicle 1 in Figure 1 during the positioning of the drilling arrangement 7. The drilling arrangement 7 is arranged in position between two wall sections 9 of a space 11, wherein the drilling arrangement´s 7 extension is oriented in the borehole direction.

The vehicle 1 is, according to this embodiment, operator controlled by an operator (not shown) by means of a first control unit 100. A communication link between the drilling

arrangement 7 and the control unit 100 is shown by reference number 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 software to the first control unit 100 via the link L110 that is a part of an internal network in the vehicle 1.

The operator is operating four supporting legs 13 (only two are shown) to brace against said wall sections 9. A drive means 15, in the form of two double acting hydraulic cylinders 17, is coupled to the supporting legs 13. Between the hydraulic cylinders 17 is a motor unit 19 comprising gearbox and one at a drive head 20 arranged chuck (not shown) pivotally mounted by a pivot sector of 180 degrees. The operator operates the drive head 20 to pivot to a first end position, wherein the chuck is facing the location of the first borehole to be drilled, and the control unit 100 locks the drive head 20 in a first position. A first drill steel (not shown) is arranged in engagement by attachment with the chuck at one end and with a drill bit (not shown) at its other end. Mounting of the drill steel is done by the operator via the control unit 100. The control unit 100 thereafter provides, under the supervision of the operator, driving of the drill bit and continuously checks the hydraulic pressure both as regards of pressure applied to the hydraulic cylinders 17 and pressure that drives the rotation of the motor unit 19 of the drive head 20 for rotation of the drill bit. The control unit 100 thus controls the operation of the drilling arrangement 7 by means of control signals via the link L100. A second drill steel (not shown) is attached to the first drill steel and subsequent drill steels are attached as the drill bit works its way into the rock.

Mounting of drill steel (not shown) is done sequentially by the operator via the control unit. The control unit 100 continuously controls the driving of the drill bit and simultaneously checks the hydraulic pressure for the hydraulic cylinders 17 and the motor unit 19. During reaming of the borehole, the drill string is pulled in the direction of the drilling arrangement 7, whereby subsequent drill steels must be detached from the drill string one by one and also detached from the drive head´s 20 chuck. At each step of detachment of a drill steel (can also be a drill pipe or the like) for unfastening, the drill steel which is coupled to the drill steel which is closest to the drive head 20 is held. The drill steel that is to be removed and which is closest to the drive head 20 is first detached from the chuck. This is provided by that the drill steel, that is adjacent to it, is held rotationally fixed against the hole that is drilled by means of a gripping device 21. In this way, the chuck will during its rotation detach from the drill steel.

The rotational direction is opposite the rotational direction for drilling. This is followed by a step to detach the drive head 20 that is arranged closest to the drill steel from the adjacent drill steel. This is accomplished by holding, rotationally fixed in relation to the chuck, the drill steel adjacent the drive head 20 by means of locking means, so that the chuck during its rotation rotates this drill steel so that it detaches from the adjacent drill steel. Now when the drill steel closest arranged to the drive head 20 is free in its both ends, it is detached and the drive head 20 is moved to the free end of the subsequent drill steel and the chuck is attached. Reaming or making of the drill string continues, and the procedure is repeated until the last drill steel is detached.

Figure 3 shows in a perspective view a gripping arrangement 21 of a drilling arrangement 7 according to an embodiment of the invention. The gripping device 21 is built up of a hub housing 23 and one about this in the axial direction X slidable journalled ring element 25. The hub housing 23 comprises a central through hole 27 formed with internal splines 29. The hole 27 is fitted with a rotationally fixed and in the axial direction X slidable chuck (not shown) of a drive head (not shown) having external splines for engagement with the splines 29. The chuck is in turn journalled axially movable and rotationally fixed with its external splines in engagement with splines of a rotating drive means of the drive head, wherein the drive means is coupled to the drilling arrangement´s 7 gearbox (not shown). By means of circlip grooves (not shown) in the hub housing 23 together with a detection means (not shown) for detecting a position of a drill steel, various types of brands of drill steels can used for the drilling arrangement 7.

A linkage arrangement 31 is journalled about an axis Y extending transversely to the axial direction X. The linkage arrangement´s 31 function is to hold in position and guide the ring member 25 over the circumference of the hub housing 23 and via the ring element 25 actuate the displacement of the gripping device 21 along the drill steel (not shown) and act on the restraining means 33 of the gripping device to provide a rotationally fixed connection between the gripping device 21 and the drill steel.

The figures 4a to 4h schematically show steps for detaching the drill steel 35 from a drill string 36 according to one aspect of the invention. Figure 4a shows a drilling arrangement 7 clamped in a drift by means of a support leg 13 and hydraulics (not shown but merely indicated by the

dotted line). The drilling arrangement 7 comprises a drive head 37 for rotating an internally threaded chuck 39, slidable in an axial direction X, and a gripping device 21, surrounding the chuck 39 and arranged rotationally fixed and slidable in an axially direction X. The chuck 39 is designed for attachment and detachment of said drill steel 35. The gripping device 21 is journalled around the chuck 39 and an actuator means 42 in the form of a preloaded pressure spring 41 is arranged for actuation of a hub (not shown) of the gripping device 21. Figure 4a shows the drilling arrangement 7 rotating a drill string 36 for making a borehole 43. In this case the reaming is made by means of a reamer 45. The rotational direction for drilling is clockwise ME. Figure 4b shows a step wherein the drill steel 35' attached to said drill steel 35 is held by means of a locking means in the form of a wrench 47 which holds and supports the drill string 36 and the reamer 45. The chuck 39 is rotated counter clockwise MO and the drill steel´s 35 end 38, facing the drive head 37, is detached from the chuck 39. Figure 4c shows that the rotation is stopped and the preloaded compression spring 41 is arranged to from an initial position U (see Figure 4a) for the gripping device 21 adjacent the drive head 37, displace said gripping device 21 in a first direction from the drive head 37 along the axial direction X. In this way is achieved that the gripping device 21 in a reliable way is ensured to be pushed down over the recesses 51 of the drill steel´s 35 said end 38.

Figure 4d shows a step wherein the restraining means 33 of the gripping device 21 is forced into its respective recesses 51 to provide a rotationally fixed connection between the gripping device 21 and the drill steel 35. The chuck 39 is then rotated counter clockwise again, shown in Figure 4e, wherein the gripping device 21 detaches the drill steel 35 from said attached drill steel 35' holded by the wrench 47. During such a detachment, the drill steel 35 is pushed towards the drive head 37 and the splines of the type shown in Figure 3 allows displacement of the chuck 39 in axial direction towards the drive head 37. At the same time rotatably driving of the chuck 39 is done to provide rotation of the drill steel 35 and said detaching.

Figure 4f shows a step wherein a hydraulic (not shown) acts on the gripping device 21 in a direction towards the spring force of the preloaded spring 41 to displace the restraining means 33 in said direction X towards the drive head 37 after the restraining means has been pulled out from said recess 51. When the gripping device 21 has been displaced towards the drive head 37, the drill steel 35 can be removed, as shown in Figure 4g.

Figure 4h shows finally how the drilling arrangement 7 is positioned at a position adjacent the previously attached drill steel 35', which now is the first said drill steel. The chuck 39 is attached to the drill steel 35' and the reaming progresses a distance D corresponding to the length of a drill steel 35, 35'. The method is repeated from the step shown in Figure 4a.

Figure 5 shows an aspect of the invention wherein so called raise boring is performed. This embodiment refers to a step when the drilling arrangement 7 is turned with the chuck´s 39 thread facing upwards (for drilling from a drift underground in a direction towards the ground surface). Actuator means 42 in the form of two springs 41' ensures that the gripping device 21 is displaced in a direction from the drive head 37 to facilitate the locking of the gripping device 21 against the recesses 51 of the drill steel 35. A locking means in the form of a wrench 47' holds the drill string 36 and the reamer 45. The drilling arrangement 7 is suspended in a support device (not shown) comprising drive means (not shown) (such as hydraulics) for feeding the drive head 37 in the axial direction X. A pivoting mechanism 60 is arranged to pivot the drive head 180 degrees about an axis extending orthogonal to the axial direction X. The pivoting of 180 degrees is made from a first position, when the chuck´s 39 (also the drive head´s 37 or the drill steel´s 35) rotational axis corresponds to the axial direction X, to a second position when the chuck´s 39 rotational axis naturally also corresponds to the axial direction. This functionality in combination with said drilling arrangement 7 provides a very efficient raise boring. It is an advantage when said functionality and detaching of drills steel is done semi-automatically and a control unit 100 (shown in Figure 2) provides an operator controlled method. Both the gripping device 21 and the pivot mechanism 60 are then arranged for signal communication with the control unit 100. When the driving of the first borehole is finished, the drill steels 35, 35' succeeding each other are detached from each other. They are detached from each other with a rotational direction opposite the rotational direction (during drilling) of the drill string 36 under the supervision of the control unit 100. When the last drill steel has been detached from the chuck 39, the drive head 37 is pivoted (180 degrees) about an axis Y extending transverse the direction of the hydraulic cylinder´s (not shown) operation movement , i.e. transverse the direction of the borehole or transverse the longitudinal extension of the hydraulic cylinders. The pivoting is done from a position wherein the direction of the drive head´s 37 rotational axis, aligned with the longitudinal direction of the drill steel 35, corresponds to the direction or the extension of the hydraulic

cylinders. The drive head 37 is thus pivoted from a position wherein the axis of the drive head´s 37 rotational centre is parallel with said direction of the hydraulic cylinder´s operation movement. Thus, the operator operates the drive head 37 to pivot to a second end position, wherein the chuck 39 faces the position of the second borehole to be drilled, and the control unit 100 ensures locking of the drive head 37. A first drill steel (not shown) is attached to the chuck 39 again and a drill bit starts the driving of a second hole in another direction.

The figures 6a to 6f show an aspect of the invention in more detail. Figure 6a shows a drive head 37 comprising a chuck 39. The chuck 39 is rotatably fixed and slidably journalled in the drive unit 53 of the drive head 37. A spring assembly 41'' (only two springs are shown) of an actuator means 42 is arranged between said drive unit 53 and a gripping device 21 for active and direct acting on the housing 22 of the gripping device 21. The gripping device 21 comprises a hub 24 formed by at the chuck 39 in axial direction slidable and rotationally fixed journalled housing 22. The hub 24 has a stop means 40 in the form of an edge flange 40. The gripping device 21 further comprises a ring 25' formed with a groove 55, in which groove 55 a hinge member 57 is arranged to bring the ring 25' in the axial direction X. Figure 6a further shows a first drill steel 35 attached to the chuck 39. The drill steel 35 has two recesses 51. The recesses 51 are each formed with flat surfaces against which surfaces restraining means 33 in the form of blocks 59 can be arranged for locking and holding of the drill steel 35 by means of the gripping device 21. The ring 25' cooperates with the rocker arms 61 for actuating the blocks 59.

Figure 6b shows how the spring assembly 41'' of an actuator means 42 acts on the gripping device 21 in a direction toward the recesses 51. The drilling steel´s 35 thread facing the drive unit 53 is detached from the chuck 39. A linkage arrangement (not shown) is configured to act on the ring 25' in motion over the rocker arms 61 for inserting the blocks 59 in the recesses 51 of the drill steel, as shown in Figure 6c. In Figure 6c is also shown an initiated detachment of the drill steel 35 from the drill string´s other drill steels (not shown). The gripping device 21 is rotationally fixed and slidably connected to the chuck 39 via engagement means (such as splines) and holds the drill steel 35, which drill steel 35 rotates together with the gripping device 21 and the chuck 39 while the drill string´s 36 drill steel 35', closest to said drill steel 35, is locked by a locking means (such as the wrench 47 in Figure 4b). Figure 6d shows how the gripping device 21 is displaced in a direction towards the drive unit 53 together with the drill

steel 35 during detachment of the drill steel 35 from the drill string (not shown). The spring assembly 41'' will now be compressed (supported against the rotating part of the drive unit 53) and take a position for preloading. Such an automatically achieved preloading has by test procedures, performed by the applicant, proved to be effective during mining, because mechanisms for acting on the gripping device 21 thus can be manufactured less bulky than known drilling arrangements. It is advantageous with a non-bulky drilling arrangement during mining because mining of larger drifts is expensive. In Figure 6d is also shown according to this described embodiment how the blocks 59 are arranged in engagement with the recesses 51. At this holding position will, upon displacement of the drill steel 35 towards the drive unit 53, said edge flange 40 be arranged against the blocks 59 (or restraining means 33) whereby the ring 25' is held in position against the blocks 59 and does not slide off them. Since large forces are required for holding the drill steel 35 during separation of the drill steels from each other, it is important that the ring 25' abuts the rocker arms 61 in line with the blocks 59. This solution with the edge flange 40 guiding the ring 25' in position with the blocks 59, permits the ring 25' to be configured with a relatively small dimension, seen in the axial direction X, which in turn means that the drilling arrangement 7 can be provided less bulky than known drilling arrangements.

In Figure 6e is shown how the ring 25', after the detachment of the drill steel 35 from adjacent drill steels has been provided, is displaced up to a second edge 40' of the hub´s 24 housing 22 thereby detaching the blocks 59 from the recesses 51. A linkage arrangement (not shown), driven by pneumatic, engages and guides the gripping device 21 in the direction back, towards the drive unit 53, as shown in Figure 6f wherein the spring assembly 41'' is further pretensioned to its initial position U.

The figures 7a to 7c show one aspect of the invention, wherein it is shown a linkage arrangement 65 pivotally arranged about an axis 66 extending transverse to the axial axis X. According to this aspect, a link arm 67 guides a ring element 25'' over the two rocker arms 69 actuating these to pivot and to hold drill steel 35 by means of a hydraulic cylinder 71. The actuator means 42 in form of four springs 41''' (only two are shown) have previously displaced the gripping device 21 in the direction from the drive head 37. In this position, detachment of the drill steel 35 is initated by rotation of the chuck 39.

Splines on the surface of the chuck 39 are engaged with internal splines of the hub 24 of the gripping device. The linkage arrangement 65 follows in Figure 7b the movement of the drill steel 35 towards the drive head 37 because the drill steel 35, during detachment from an attached drill steel (such as 35' in Figure 4e), will move towards the drive head 37. In Figure 7c are shown as examples how the arm 67 of the linkage arrangement 65 pushes back the gripping device 21 towards the drive head 37 and thereby preloads the four springs 41''' to the initial position U. In this position, also the blocks 59 are free and the drill steel 35 can be detached from the drilling arrangement 7 manually or automatically by means of an operating arm (not shown).

Figure 8 shows a gripping device 21 according to a further embodiment of the invention. The gripping device 21 comprises a hub 24' having an internal central passage 27'. The passage 27' is formed with splines 29. A sealing device in the form of a sealing washer 73 is provided via the hub´s 24' side facing away from the drive head 37. The gripping device 21 is guided into position along the axial axis X so that the washer 73 is positioned tightly fitting at least next to a recess 51 of the drill steel 35.

Figure 9a schematically shows an actuator means 42 in the form of hydraulic cylinders H. Figure 9b schematically shows an actuator means 42 in the form of a combined spring element 41''' and pneumatic cylinders H.

Figure 9c schematically shows an actuator means 42 in the form of a centrally about the axial axis arranged resilient rubber bellow means 41'''' which for actuation on the gripping device 21 is pressurized. Figure 9d schematically shows an actuator means 42 comprising one of a tension spring 41''''' actuated lever 68.

Figure 9e schematically shows an actuator means 42 wherein a spring element 80 of a linkage arrangement 65 is arranged between a short arm K and a long arm L. A cylinder C comprising a piston and a rod is arranged for acting on the short arm C which in turn via the spring element 80 acts on the long L arm supporting the gripping device 21. From the initial position U, the first spring element 80, which presses the long arm L in the direction from the short arm K so that the gripping device 21 comes in position for engagement (not shown) around the drill steel (not shown), is first operated. Thereafter, the cylinder C is actuated to retract whereby the short arm K is rotated compressing the spring element 80. In this position shown in Figure

9f also the short arm K is disengaged from the long arm L whereby the gripping device 21 via the long arm L obtains a satisfactory degree of freedom of movement F along the axial direction X.

Figure 9g schematically shows an actuator means 42 comprising a linkage arrangement 65 and springs 41 according to one aspect of the invention. The linkage arrangement 65 comprises a first linkage arm 67 connected to a second linkage arm 70. A spring element 80 is arranged between the two linkage arms 67, 70. The first linkage arm 67 is connected to the gripping device 21 and a thereto provided ring element 25 and the second linkage arm 70 is in one of its ends connected to a hydraulic cylinder 71. The springs 41 ensure that the hub 24 of the gripping device 21 is moved in a direction from the drive head 37, whereby the first linkage arm 67 thus also is moved. The cylinder 71 is also connected via an ear S to the first linkage arm 67, so that when the cylinder 71 is pulled in a direction P1, the front end Ä of the first linkage arm 67 is moved in the opposite direction (see Figure 9h) . When the first linkage arm 67 is connected to the ring element 25, the ring element 25 will thereby be moved in a direction P3 from the drive head 37. When the hub 24 is stuck on a circlip SR on the chuck of the drive head 37", the second linkage arm 70 is “activated” by means of the cylinder 71, so that the second linkage arm 70 is moved towards the first linkage arm 67 and the spring element 80 is compressed. In this way, the spring element 80 pushes on the first linkage arm 67 and ensures that the ring element 25 is further pushed in a direction from the driving head 37. The ring element ensures in turn that retraining means (not shown) are positioned in the correct position. Figure 9i schematically shows how the said first linkage arm 67 has been decoupled from the second linkage arm 70 and the cylinder 71 acts on, in the direction P4, the second linkage arm 70, so that the spring element 80 is compressed and so that the ring element thereby by force is pressed over said retraining means.

The figures 9g to 9i thus schematically shows a cylinder 71 which is used for "activation" or "deactivation" of the gripping device 21 by movement of a ring element 25. The cylinder 71 is also used according to one aspect for positioning a sealing device in the form of a sealing membrane (reference 73 in Figure 8). Such positioning can result in a further movement of 20-30 mm for engagement against the envelope surface of the drill steel depending on the value entered in the control unit for the current used drill steel. A spring means 41 ensures that the gripping device 21 always is pressed against the ring member 25 until the gripping device 21 is

in the correct position on the chuck 39 of the drive head 37. Thereafter the second linkage arm 70 presses the first linkage arm 67, so that the restraining means are pushed into the drill string means. In that the ring element 25 is acted on by both the cylinder 71 and the spring element 80, and in conjunction with the second linkage arm 70, a "floating" function is provided. Thereby the gripping arrangement´s 21 height (in the axial direction X) is optimized. I.e. a ring element 25 with smaller dimension in the X direction can be provided because the ring element 25 will always be optimally positioned.

The first linkage arm 67 is actuated by the hydraulic cylinder 71 for displacement of the hub 24 in the direction from the drive head 37 by means of the ring element 25 coupled to the first linkage arm 67. A releasable interconnection between the hydraulic cylinder 71 and the first linkage arm´s 67 end facing away from the hub 24 provides a decoupling when the second linkage arm 70 via the first linkage arm 67 actively holds the hub 24 in position during detachment of the drill steel 35 from the adjacent drill steel 35'. It is especially important during said detachment to allow such decoupling to avoid disturbance of the hydraulic cylinder´s 71 contraction. The second linkage arm 70 also allows that a relatively large torque and thereby a positioning force can be applied to the ring element 25 for holding the rocker arms against the restraining means in the form of blocks and in abutment with an edge flange 40 of the gripping device 21.

One aspect could be that the second linkage arm 70 thus pushes the first linkage arm 67 and thereby the hub 24 in a direction away from the drive head 37 by abutment of the ring element 25 against the edge flange 40 (see Fig. 8) of the gripping device 21 and a spring element 80, arranged between the second linkage arm 70 and the first linkage arm 67, allows a smooth and resilient movement of the first linkage arm 67 in engagement with the ring member 25.

Figure 9j schematically shows a spring means 41 directly connected to a linkage arm 67 in the absence of a shorter arm (such as 70 in the previous Figure 9i). This is made possible by the cylinder´s 71 coupling (can be a push rod, an end of rod piston or cylinder ear) to the linkage arm end 67 is flexible, that is, i.e. at the position FL runs in an elongated hole of the cylinder´s cylinder ear.

Figure 10a shows a flow chart according to one aspect of the invention. The first step is the start. The method further comprises gripping pertaining to a drilling arrangement 7 a drill string means 36 for detaching a drill steel 35 from said drill string means 36. The method comprises the steps of providing holding 202 of said drill string means 36; providing the drive head 20, 37 arranged at the drilling arrangement 7 a rotation 203 to detach the drill steel 35 from the drive head 20, 37; providing an actuator means 42 to from an initial position in axial direction displace 204 a gripping device 21 in the direction away from the drive head 20, 37; and holding 205, in a holding position by means of said gripping device 21, a drill end arranged closest to the drive head 20, 37 and rotating 206 it from the remaining drill string means 36.

Figure 10b shows a flow chart wherein the method step 302 comprises providing holding of said drill string means 36, providing a drive head 20,37 arranged at the drilling arrangement 7 a rotation to detach the drill steel 35 from the drive head 20, 37, providing an actuator means 42 in order to from an initial position U in an axial direction X displace a gripping device 21 in a direction from the drive head 20, 37, and holding in a holding position, by means of said gripping device 21, a drill end arranged closest to the drive head 20, 37 and to rotate the drill steel 35 from the remaining drill string means 36.

Figure 11 shows a control unit according to an embodiment of the invention. Herein a chart of an embodiment of a device 400 is shown. The control units 100 and 110 described with reference to Figure 2 comprise according to this embodiment said device 400. The device 400 comprises a non-volatile memory 401, a data processing unit 402 and a read/write memory 403. The non- volatile memory 401 has a first memory portion 404, wherein a computer program P, such as an operating system, is stored for controlling the function of the device 400. Further, the device 400 comprises a bus controller, a serial communication port, I/O body, an A/D converter, a time and date input and transfer unit, an event counter and an interrupt controller (not shown). The non- volatile memory 401 also has a second memory part 405.

It is provided a computer program P comprising routines for detaching said drill steel 35 from the drill string 36 one after another in series according to an embodiment. The program P comprises routines for adjusting a hydraulic pressure of the actuator means 42 to in this respect adjust an axial force on the gripping device 21. The program P further comprises

routines to disengage the gripping device 21 to move from the drive head 37 and to change the rotational direction of the chuck 39 and to stop the rotation. Likewise, the program P comprises routines to position the drive head 37 at the free end of the drill string 36, attach the chuck 39, drive back the drill string 36 from the borehole, and grip the drill string 36 according to the method described herein. 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 406.

When it is described that the data processing unit 402 performs a specific function, it is to be understood that the data processing unit 402 performs a specific part of the program P which is stored in the memory 406, or a certain part of the programme P which is stored in the read/write memory 403. The data processing device 402 can communicate with a data port DP via a data bus 407. The non-volatile memory 401 is intended for communication with the data processing unit 402 via a data bus 408. The separate memory 406 is intended to communicate with the data processing unit 402 via a data bus 409. The read/write memory 403 is arranged to communicate with the data processing device 402 via a data bus 410. To the data port DP can for example links L100 and L101 be connected (see Figure 2).

When data is received on the data port DP, it is temporarily stored in the second memory portion 405. When the received input data has been temporarily stored, the data processing unit 402 is prepared to perform the execution of code in a manner as described above. According to one embodiment, signals received on the data port DP comprise information about a current hydraulic pressure of the hydraulic cylinder of the actuator means 42 and hydraulic pressure for the rotation of the drive head´s 37 provided rotation of the drill string 36 and provided opposite the rotation for detachment.

According to one embodiment, signals received on the data port comprises information about complete detaching of drill steel 35 or, during drilling, the current position of the recess of the drill steel 35 for positioning of sealing. Said information can be detected with suitable sensors or entered manually in the first control unit by means of a touch screen (not shown). The received signals at the data port of the DP can be used by the device 400 for controlling said hydraulic pressure based on the detected current values. Steps of the methods described are performed by the device by means of a data processing unit 402 that runs the program P

stored in the memory 406 or read/write memory 403 and when the device 400 is running said program said methods are executed.

The invention is specified by the following claims. It should be noted that the invention is not limited to the features in the claims, but additional embodiments and combinations of the described embodiments are possible. For example, the drilling arrangement per se can comprise a remote controlled vehicle transporting the equipment to the designated location. The vehicle can be arranged for autonomous control. For example, the communication link can be a physical line, such as opto-electric communication line, or a non-physical line such as a wireless connection, for example a radio or microwave link. Detaching of drill steel one after another can be done entirely automatically, semi-automatically or manually. The drilling can be raise boring or other reaming boring wherein you are trying to connect a space with two other spaces and the spaces are located in one plane, horizontally, vertically, or in between. The stop means can, in addition to being formed of a flange or an end edge of the gripping device, be formed of stop shoulders or protrusions of a hub comprised in the gripping device. Restraining means such as blocks or wedges are preferably dimensioned to fit the current recesses present in the drill steel for splicing. Actuator means can, in addition of consisting of springs or of a single spring, be formed of a motor-driven push rod to provide the movement in the axial direction. The motor drive can be electric, pneumatic or hydraulic. Likewise, a type of magnet means or electromagnet means can provide the initial displacement. For example, the initial displacement of the gripping device can likewise, starting from the initial position in a direction away from the drive head, be done both by spring force and by means of linkage arrangements actuated by hydraulic cylinder. The actuator means can be secured to the housing of the drive head, non-rotating about the rotational axis of the chuck and rotating together with the chuck and the gripping means about the rotational axis. The actuator means can be supported against the drive head´s gear box or drive house. It can likewise be attached to other foundations for supported driving of the gripping device in the direction from the drive head and from the initial position. The definition of the drill steel of the drill string can also be synonymous with drill pipe, "pipe", or the like. 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 for example, ventilation, material transport or a lift can be arranged.

Usually, an pilot hole is first drilled in a first direction from the drilling arrangement. Double-acting hydraulic cylinders are operated to feed a rotary drive head. This creates a pressure force which presses the drill bit in the direction from the drilling arrangement and a propulsion in the opposite direction to feed back the drill bit. This thrust can for example be used for reaming a further hole in the direction back to the drilling arrangement. The drill string has sections with drill steel, drill rods, drill pipes etc., which sections are built on or are removed by hand based on the feed direction.

The drill string has at one end a drill bit or the like for making holes. Upon retraction, drill steels are detached from each other one at a time. Various support mechanisms are available today to detach the drill steels from each other. Various means are available for attaching the drill steel against a drive head, such as clamping, bolting, magnetism etc.

Alternatively, the drilling arrangement according to an aspect of the invention can be remotely controlled, wherein an operator at a distance from the drilling arrangement, for example from the ground surface, can control the method to hold drill string means and to detach it from the drilling arrangement. According to another alternative, the drilling arrangement can be a remotely operated vehicle arranged with the drilling arrangement, wherein an operator remotely controls the vehicle to the place intended for drilling, drills and then back. According to another alternative, the drilling arrangement comprising a carrier can be autonomous, wherein an operator only needs to start the process and the process continues by itself to completion.

CLAIMS

1. Method pertaining to a drilling arrangement (7) to grip a drill string means (36) for detaching a drill steel (35) from said drill string means, comprising:

- providing holding of said drill string means (36);

- providing a drive head (20, 37) arranged at the drilling arrangement (7) a rotation to detach the drill steel (35) from the drive head (20, 37);

- providing an actuator means (42) to from an initial position (U) in an axial direction (X) displace a gripping device (21) in the direction from the drive head (20, 37), said providing of the actuator means (42) including spring actuation, and holding in a holding position by means of said gripping device (21) a drill steel end arranged closest to the drive head (20, 37); and

- rotating the drill steel (35) from the remaining drill string means (36).

2. The method according to claim 1, **wherein** the step of providing said actuator means (42) for said displacement of the gripping device (21) in the axial direction (X) includes actuation by means of hydraulic and/or pneumatic.

3. The method according to any of claims 1 or 2, **wherein** the step of providing said actuator means (42) includes inserting restraining means (33, 59) in at least one recess (51) of the drill steel (35).

4. The method according to claim 3, **wherein** the step of holding in a holding position also includes providing said restraining means (33, 59) in engagement with a stop member (40) of the gripping device (21) during rotation of the drill steel (35) from the remaining drill string means (36).

5. The method according to any of the preceding claims, **wherein** the method also comprises the step of in the axial direction (X) adjusting the gripping device (21) together with an at it arranged sealing device (73), so that during drilling said sealing device (73) does not come in level with a recess (51) of the drill steel (35).

6. The method according to of any preceding claims, **wherein** the actuator means (42) is arranged to displace the gripping device (21) in a direction towards or in a substantial direction towards the gravitational force.

7. Drilling arrangement comprising a drive head (20, 37) for driving an in axial direction (X) slidable internally threaded body (39) and a gripping arrangement (21) surrounding the body (39) arranged rotationally fixed and displaceable in the axial direction (X), said body (39) is arranged for attachment and detachment of drill string means (36), **characterized in that** an actuator means (42) is arranged to from an initial position (U) displace said gripping device (21) in the axial direction in direction from the driving head (20, 37), wherein the actuator means (42) comprises a spring means (41, 41', 41'', 41''', 41'''', 41''''').

8. The drilling arrangement according to claim 7, **wherein** the actuator means (42) comprises at least one hydraulic actuator (71, C, H).

9. The drilling arrangement according to claim 7 or 8, **wherein** the gripping device (21) comprises one in the axial direction (X) displaceable ring element (25, 25', 25'') to radially inwardly guide a restraining means (33, 59) to provide a rotationally fixed connection between the gripping device (21) and the drill steel (35).

10. The drilling arrangement according to claim 9, **wherein** the gripping device (21) has a stop means (40) for positioning the ring member (25, 25', 25'') in the axial direction (X) relative to said restraining means (33 , 59).

11. The drilling arrangement according to any of claims 7-10, **wherein** the gripping device (21) comprises a sealing device (73) having an internal circumference adapted to the diameter of the drill steel (35).

12. Vehicle comprising a drilling arrangement (7) according to any one of claims 7 to 11.

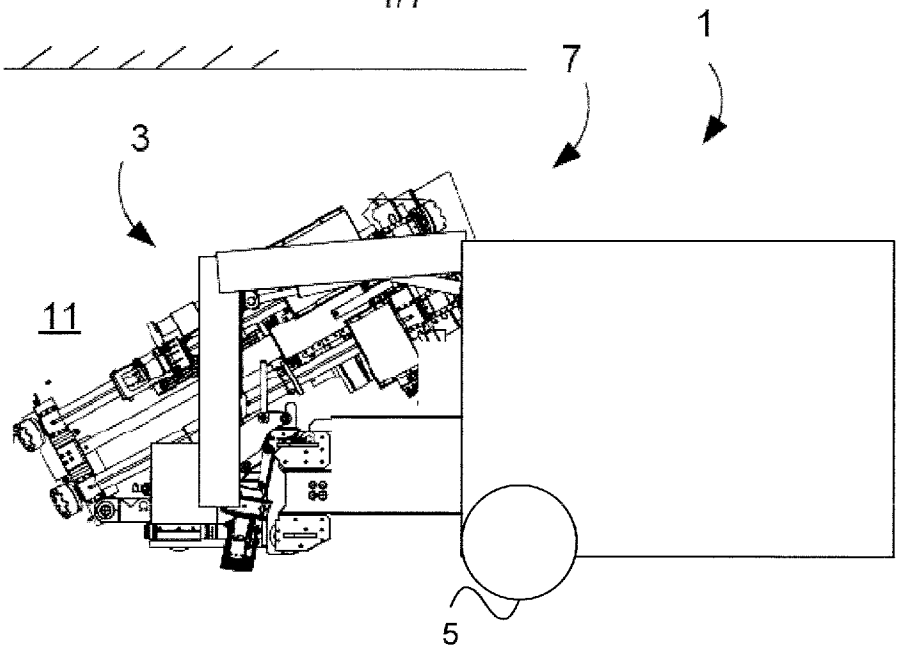
13. Vehicle according to claim 12, **wherein** the vehicle (1) is a drilling rig (3) intended for mining.

14. Computer program (P) pertaining to a drilling arrangement (7), comprising a drive head (20, 37) for driving one in an axial direction (X) slidable internally threaded body (39) and a gripping device (21), surrounding the body (39) arranged rotationally fixed and in the axial

direction (X) slidable, said body (39) is arranged for attachment and detachment of drill string means (36), an actuator means (42) is arranged to from an initial position (U) displace said gripping device (21) in a first direction from the drive head (20, 37), **wherein** the computer program (P) comprises a program code stored on a by a computer readable medium for performing the method steps according to any of claims 1 to 6 when the computer program (P) is run on an electronic control unit (100) associated with the drilling arrangement (7).

15. Computer program product comprising a program code stored on a by a computer readable medium for performing the method steps of any of claims 1 to 6 when a computer program (P) is run on an electronic control unit (100) associated with the drilling arrangement (7).

FIG. 1



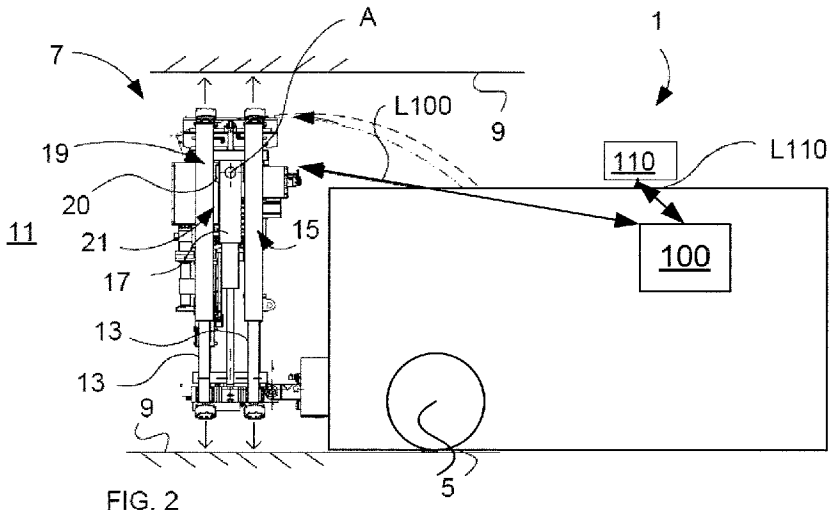
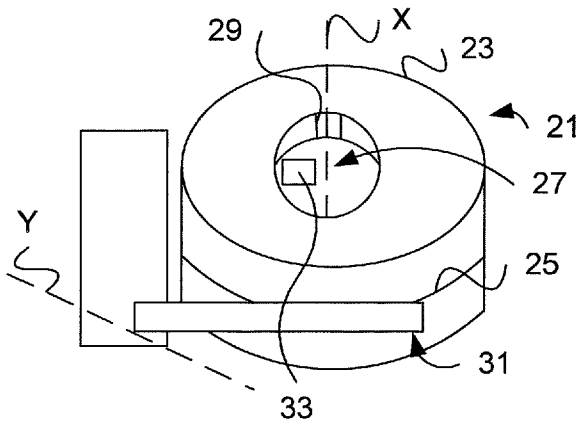


FIG. 2

Fig. 3



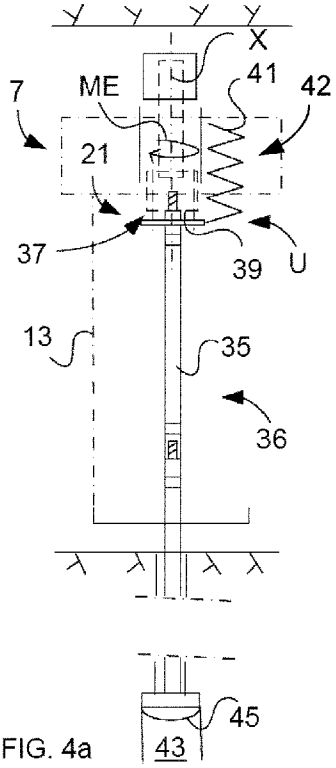


FIG. 4a

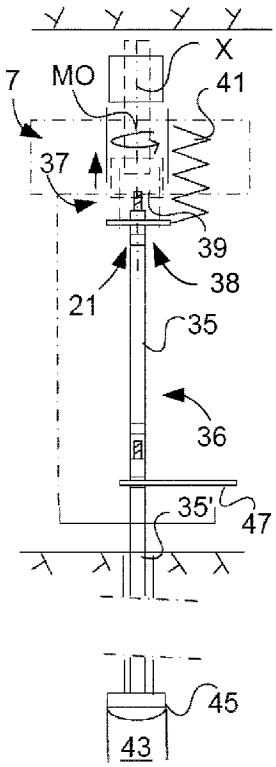


FIG. 4b

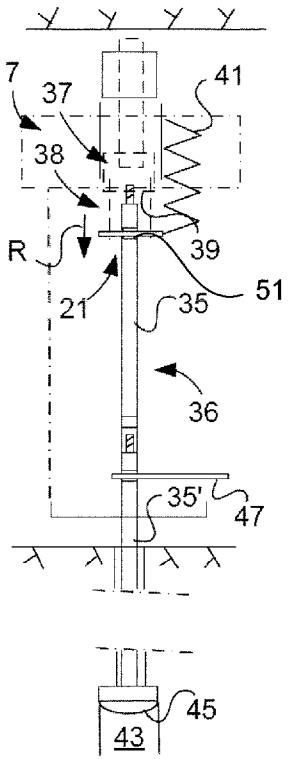


FIG. 4c

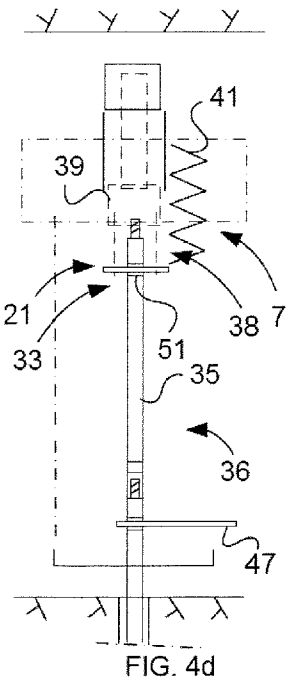


FIG. 4d

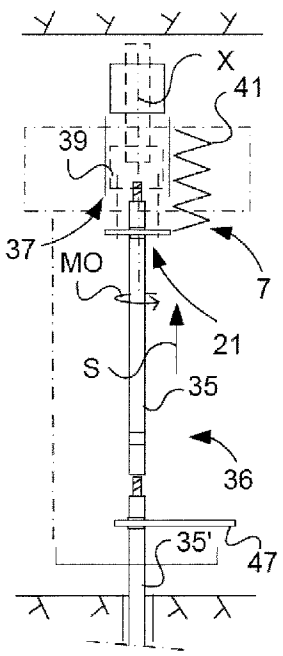


FIG. 4e

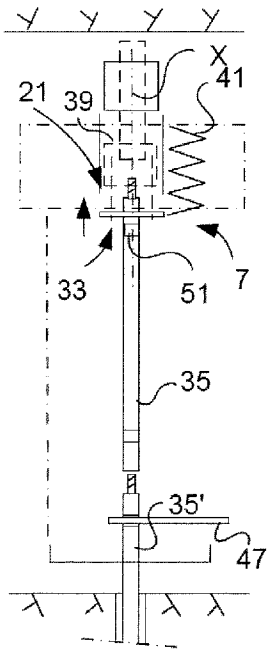


FIG. 4f

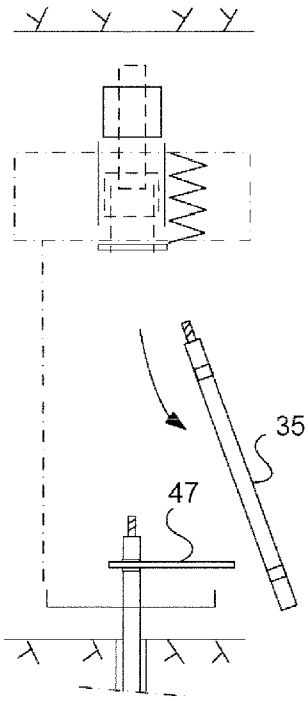


FIG. 4g

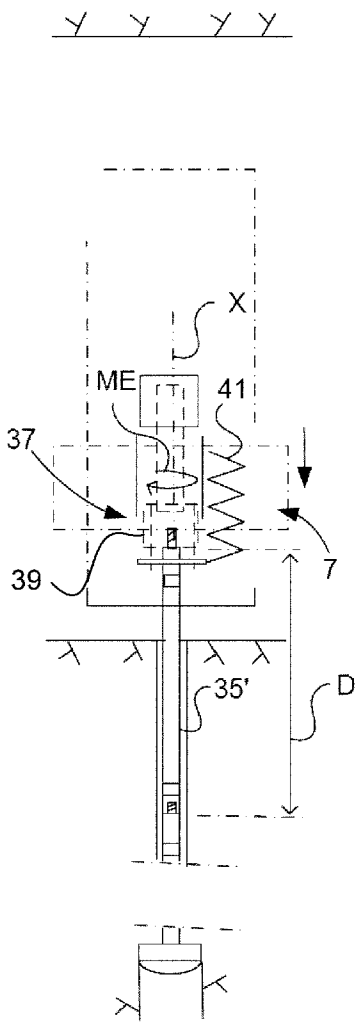


FIG. 4h

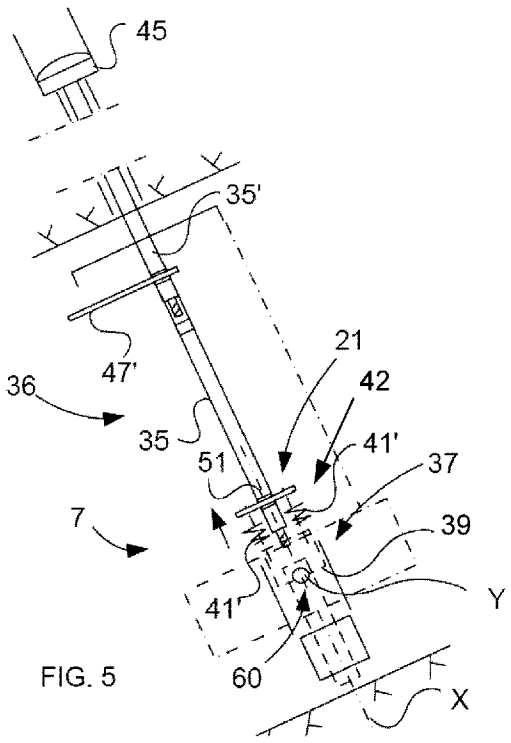


FIG. 5

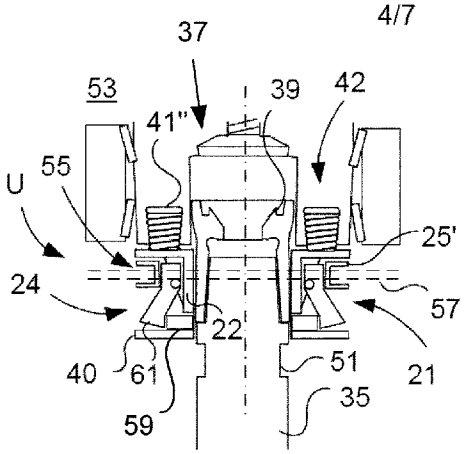


FIG. 6a

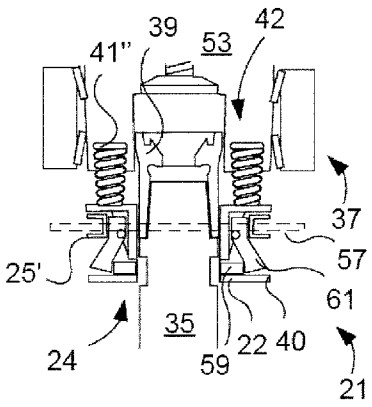


FIG. 6b

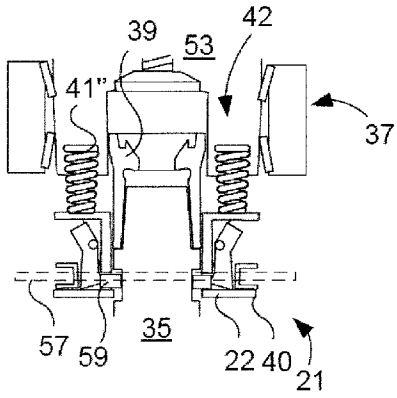


FIG. 6c

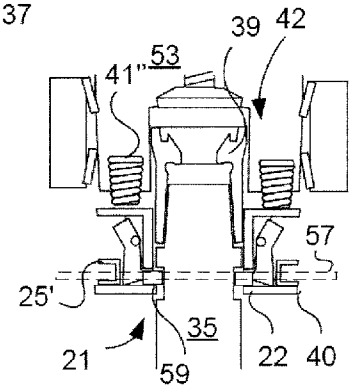


FIG. 6d

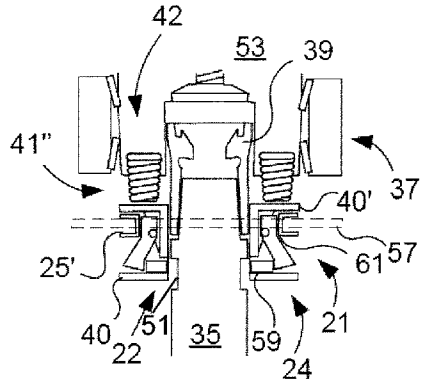


FIG. 6e

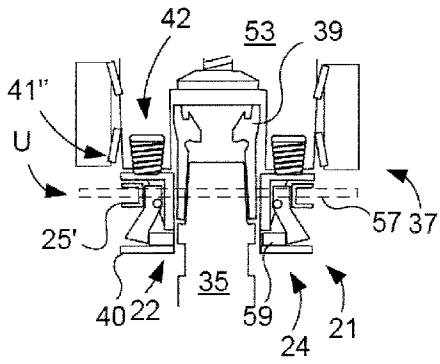


FIG. 6f

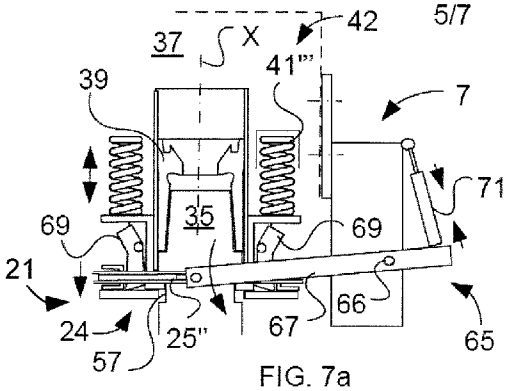


FIG. 7a

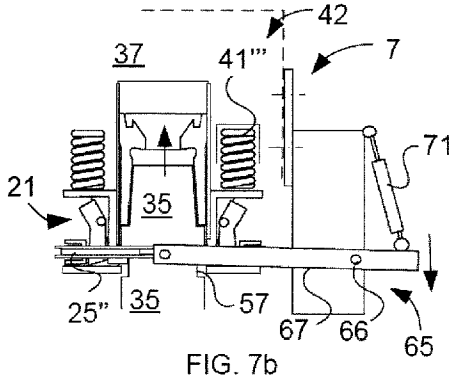


FIG. 7b

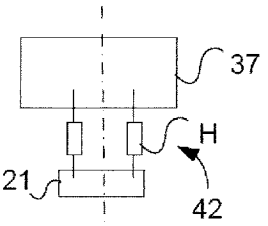


FIG. 9a

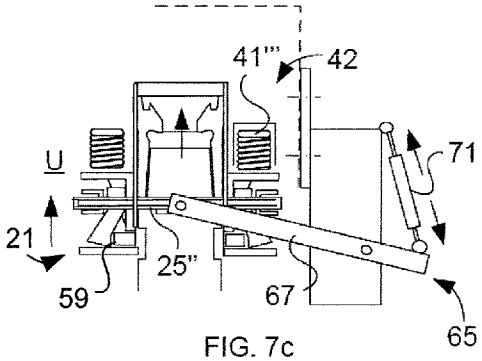


FIG. 7c

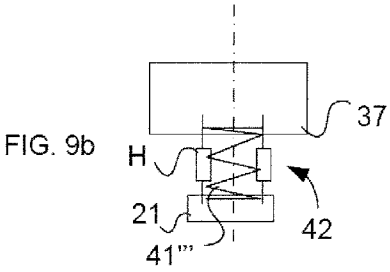


FIG. 9b

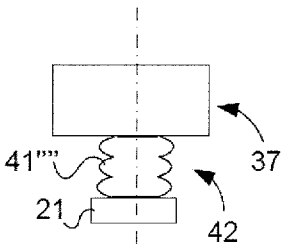


FIG. 9c

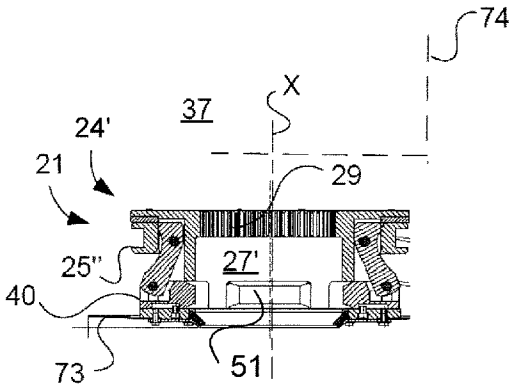


FIG. 8

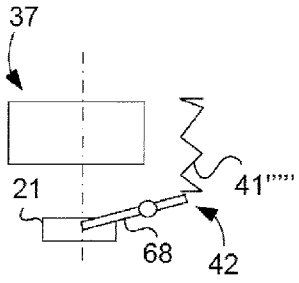


FIG. 9d

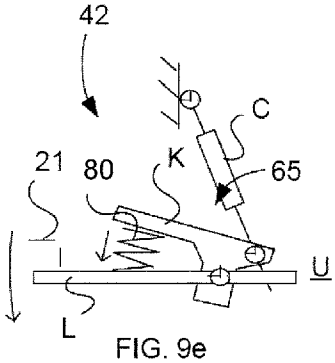


FIG. 9e

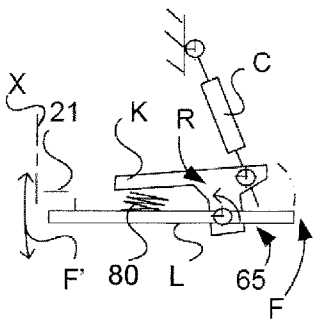


FIG. 9f

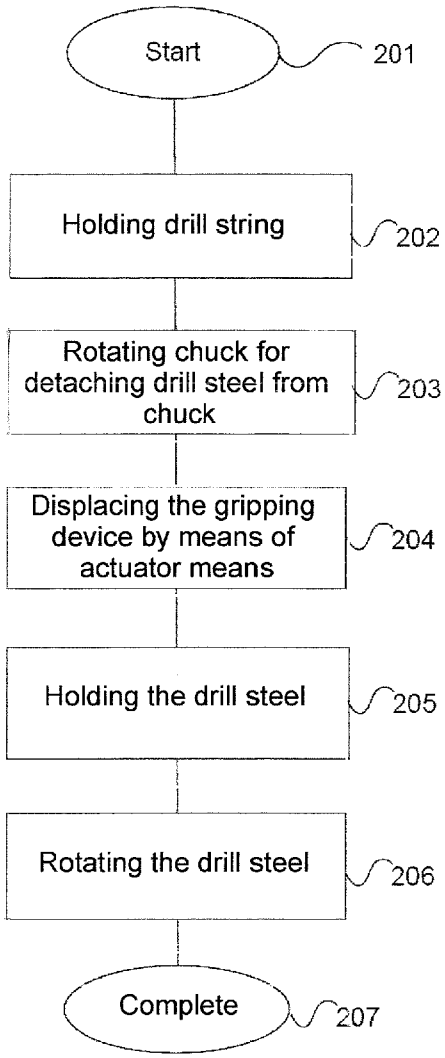


FIG. 10a

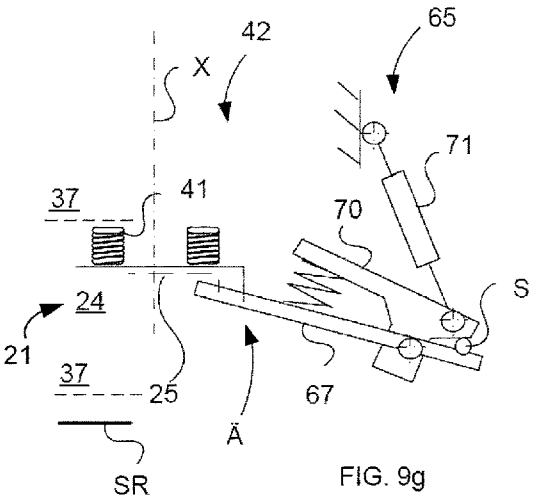


FIG. 9g

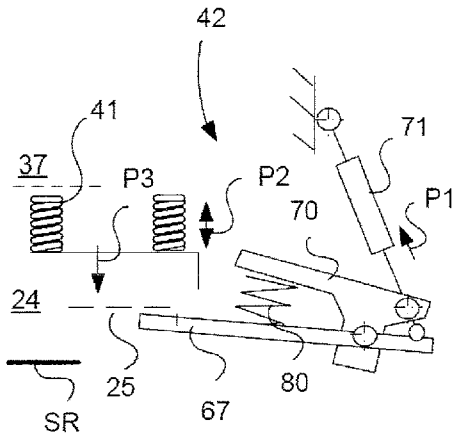


FIG. 9h

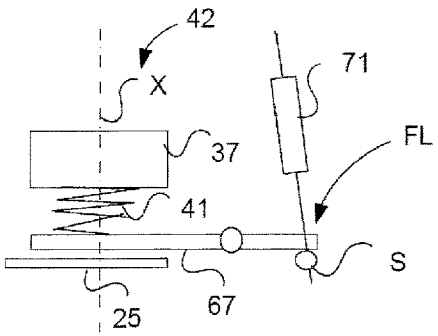


FIG. 9j

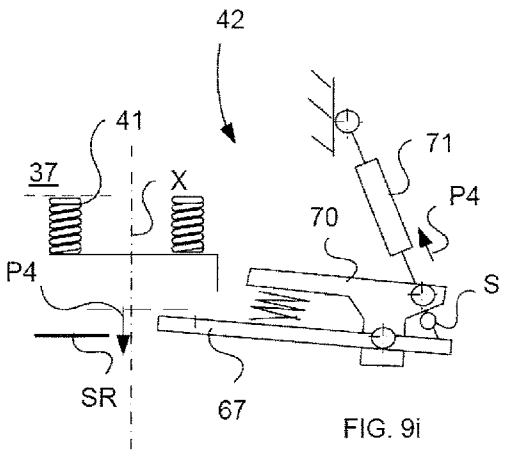


FIG. 9i

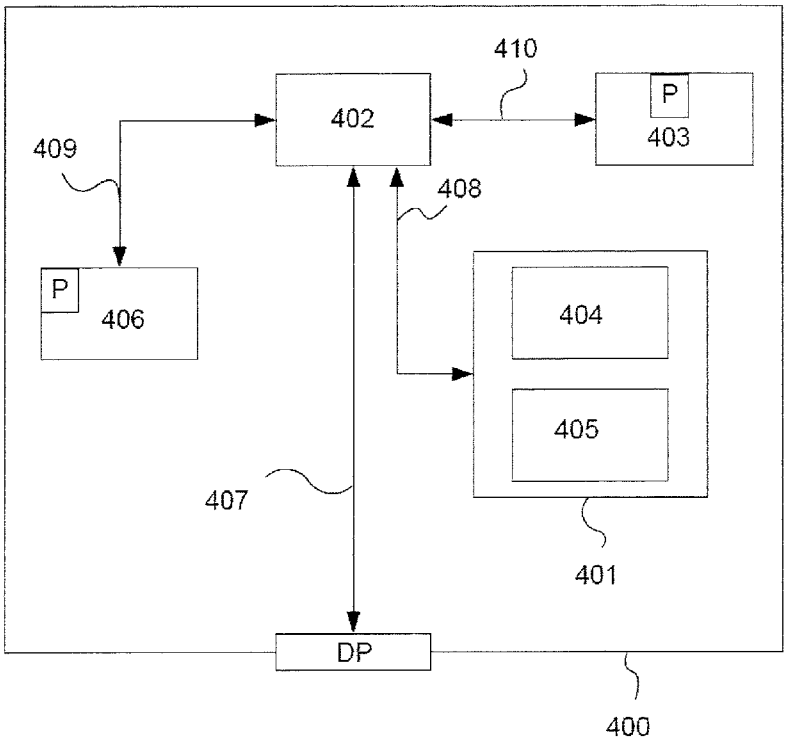


FIG. 11

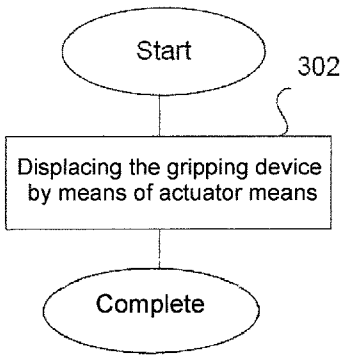


FIG. 10b