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(54) **DRILLING EQUIPMENT DEVICE ESPECIALLY ARRANGED FOR REAMING A BOREHOLE IN A
ROCK FORMATION AND METHOD OF REAMING A BOREHOLE IN A ROCK FORMATION**

BOHRAUSRÜSTUNG, INSBESONDERE ZUM AUSWEITEN EINES BOHRLOCHS IN EINER
GESTEINSFORMATION, UND VERFAHREN ZUM AUSWEITEN EINES BOHRLOCHS IN EINER
GESTEINSFORMATION

DISPOSITIF D'ÉQUIPEMENT DE FORAGE SPÉCIALEMENT CONÇU POUR ALÉSER UN TROU
DE FORAGE DANS UNE FORMATION ROCHEUSE ET PROCÉDÉ D'ALÉSAGE D'UN TROU DE
FORAGE DANS UNE FORMATION ROCHEUSE

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Description

[0001] The invention relates to a drilling equipment device for use when reaming a pilot hole in a rock formation, in which a drilling unit comprises a rotatable drill-bit structure fitted with roller cutters, which are arranged to break up the rock formation. The invention also relates to a method of reaming a pilot hole in a rock formation.

[0002] The development in recent years has led to an increased need for developing small hydro-electric power plants and new infrastructure arranged in rock formations. In both cases, there is a great need for cost-effective and environmentally correct solutions.

[0003] For small hydro-electric power plants, it is important that the interference in nature is minimized and that costs for building and future operation are low. New infrastructure with sewage, power cables and water supply through established housing areas and sensitive nature areas will now be difficult to implement. An obvious solution is to establish the infrastructure in boreholes in rock formations under the areas mentioned. During the establishing of such boreholes, it may be relevant first to establish a small pilot hole which is afterwards reamed to the final hole diameter.

[0004] Several technical solutions for carrying out the reaming are known. However, the methods are expensive and are technically limited in reach. A reaming unit is typically rotated by means of a rotating drill string through a predrilled hole. The drill string is subjected to great torsional forces that result in material fatigue and a short lifetime. The achievable hole length is limited because the torsion will become too great with a large drill-string length. Besides, torsion in a long rotating drill string gives large vibrations and varying stresses on the drilling device, hence reduced lifetime.

[0005] US 3399738 discloses a self-propelled drilling machine for drilling a pilot hole and reaming the pilot hole. In an initial phase, a fixed machine unit drives a drill string for drilling a pilot hole. Then the machine unit is reset for reaming the pilot hole by the machine unit being provided with a reaming drill bit which is rotated while the machine unit is moved gradually along the drill string in the pilot hole.

[0006] US2011/0079443 discloses a hole opener including a reaming section which is connected to and follows right behind a pilot drill bit. Cutting-element details in the reaming section are described in particular.

[0007] US4117895 A discloses a hole-opener and a hole-opener apparatus for enlarging a pilot hole of the inverted arcuate type, which bypasses an obstacle, the pilot hole having an entrance and terminal end, both ends usually being accessible to surface drilling equipment. During the enlarging of a straight portion a drill motor located on a ramp is rotating a pipe with a hole opener attached at its forward end. A swivel body is rotating with the hole opener and is provided with a pilot nose protruding from the hole opener and carrying at its forward end a swivel assembly screwed on the pilot nose. The swivel

may be connected to a tubular member and drill pipe or to a cable located in the pilot hole. The progress of the rotating hole opener is achieved by pushing the rotating pipe and/or pulling the drill pipe or the cable, the rotation of the hole opener being provided by the drill motor located outside the entrance of the enlarged (reamed) bore hole.

[0008] US3508620 A discloses a down reaming apparatus with an upper stabilizer and a lower stabilizer located in the pilot hole. A weighted cutter head is rotated with a drill string.

[0009] The invention has for its object to remedy or reduce at least one of the drawbacks of prior art or at least provide a useful alternative to the prior art.

[0010] The object is achieved through the features that are specified in the description below and in the claims that follow.

[0011] A drilling device with an electrically driven drill bit has been provided, in which the rotation of the drill bit is provided by electromotors, without a drill string, which is pulling the drill bit in the axial direction, rotating.

[0012] It has surprisingly been found that reaming equipment with an electrically operated drill head and a non-rotating drill string through a predrilled hole has great advantages as compared with the prior art.

[0013] A drilling device which is used in performing the reaming includes a rotating drill bit with rotating roller cutters that are pressed against a rock formation, thereby breaking particles loose. The rotation is driven by one or more motors, typically electromotors, through suitable gear transmissions. The power supply is effected via cables through the predrilled hole from the surface. Necessary pressure on the drill bit is provided by the drill string which is assembled from drill-string sections and is moved in the axial direction of the borehole by an axial drive, typically a hydraulic axial drive positioned on the surface. The rotational torque arising through the rotation of the drill bit is transmitted to the rock formation through supporting feet that are pressed against a surrounding borehole wall by means of hydraulic cylinders.

[0014] Drilled particles are transported out through the borehole behind the drilling device, for example by means of gravity through a sufficiently steep borehole, or they are flushed out with water if the borehole has a low gradient behind the drilling device.

[0015] In a first aspect, the invention relates more specifically to a drilling equipment device for use when reaming a pilot hole in a rock formation, in which a drilling unit includes a rotatable drill-bit structure fitted with roller cutters which are arranged to break up the rock formation, the rotatable drill-bit structure being connected to a non-rotatable drill string extending through the pilot hole and being connected to an axial drive outside the pilot hole and distant from the drilling unit, characterized by the non-rotatable drill string is axially displaceable, and the drill-bit structure and a connected housing are supported on a drill stem which is connected to an end portion of said drill string distant from the axial drive in a non-rotatable

tional manner, and wherein rotation of the housing and the drill-bit structure is provided by driving motors connected to the housing and the drill-bit structure via a gear system including gear wheels in mesh with a gear rim, and wherein the axial drive includes a carriage displaceable along a carriage guide which is pivotably connected to a bottom frame, the carriage being arranged to be connected to an engagement portion of a drill-string section.

[0016] The drill string may be sectioned, the drill-string sections being provided with rotationally rigid couplings.

[0017] Cables arranged for carrying energy and control signals may be arranged along the drill string.

[0018] A portion of the cables may be wound on one or more cable drums arranged at the axial drive.

[0019] In a second aspect, the invention relates more specifically to a method of reaming a pilot hole in a rock formation, characterized by the method including the following steps:

- placing a sectioned, non-rotatable drill string in the pilot hole with first and second end portions of the drill string projecting out of the pilot hole;
- providing a drilling unit comprising a rotatable drill-bit structure and a connected housing rotatable on a drill stem, driving motors connected to the housing and the drill-bit structure via a gear system including gear wheels in mesh with a gear rim;
- providing an axial drive outside the pilot hole, the axial drive including a carriage displaceable along a carriage guide which is pivotably connected to a bottom frame, the carriage being arranged to be connected to an engagement portion of a drill-string section;
- connecting the first end portion of the drill string to the drill stem of the drilling unit at an end of the pilot hole;
- connecting the second end portion of the drill string to the axial drive at an opposite end of the pilot hole;
- setting a drill bit arranged in the drilling unit in rotation by the driving motors; and
- displacing the drilling unit towards the opposite end of the pilot hole by means of the axial drive by displacing the axial drive along the carriage guide, thereby pressing the drill bit onto the rock formation to be cut.

[0020] The method may include the further step:

- centring the drilling unit in a reamed borehole by means of several supporting feet arranged on the periphery of the drilling unit.

[0021] In drilling operations that are carried out with a drilling device and a method of the kind described above, the drill string is typically subjected to a pull force of about 80 tonnes, whereas the torque to be absorbed by the supporting feet is typically about 2.5 tonne metres. With a diameter of a reaming hole of 1 metre and a friction

coefficient of about 0.5 in the abutment of the supporting feet against a borehole wall, a compressive force of about 10 tonnes against the borehole wall is required in order to absorb a torque of about 2.5 tonne metres. The axial pull force applied to the drill string by the axial drive will thereby be able to pull the drilling unit in the axial direction while the supporting feet are abutting against and sliding along the borehole wall. Alternatively, the supporting feet may be arranged on a structure which is connected in a rotationally rigid, but axially displaceable manner to the drilling unit, so that the supporting feet do not have to slide along the borehole wall during the axial displacement of the drilling unit, but are disengaged, pulled axially towards the drilling unit and set again during a halt in the drilling operation. In a further alternative, two sets of supporting feet may be used, acting independently of each other and alternating between abutment against the borehole wall and axial displacement. Thereby the drilling operation may run uninterruptedly while the torque is continuously absorbed by a set of non-moving supporting feet. The advantage of this is that the axial drive does not have to overcome the friction force between the supporting feet and the borehole wall. Moreover, the supporting feet are subjected to less wear.

[0022] In what follows, an example of a preferred embodiment is described, which is visualized in the accompanying drawings, in which:

Figure 1 shows a side view of a drilling device with a drilling unit and an axial drive connected to a drill string;

Figure 2 shows the drilling device viewed in the direction B according to figure 1;

Figure 3 shows the drilling device viewed in the direction A according to figure 1;

Figure 4 shows the drilling unit with a drill bit and a portion of a drill string in perspective;

Figure 5 shows a side view of the drilling unit;

Figure 6 shows an axial section A-A according to figure 5 through the drilling unit;

Figure 7 shows a radial section B-B according to figure 6 through a gear system;

Figure 8 shows a detail in a locking device for the steel string in perspective;

Figure 9 shows the axial drive in perspective;

Figure 10 shows a portion of the locking device for the drill string in perspective; and

Figure 11 shows a side view of the axial drive.

[0023] In figures 1-3, the reference numeral 1 indicates a rock formation in which a pilot hole 13 has been drilled, which is being reamed to a larger borehole 8 by means of a drilling device 2'. A drilling unit 2 is driven forwards in the axial direction of the borehole 8 by means of a sectioned drill string 4 extending through the pilot hole 13 and being connected to an axial drive 11. The transmission of energy and control signals to the drilling unit 2 is effected via cables 14 clamped to the drill string 4. The cables 14 are wound onto a cable drum 3 positioned on the surface. A control unit 7 includes the equipment necessary for controlling and operating the drilling device 2'.

[0024] Reference is now made to figures 4-7 in particular. The drilling unit 2 comprises a rotatable drill bit 12' which is provided, in a manner known *per se*, with roller cutters 12 with wear coating which are pressed against the rock formation while, at the same time, being set in rotation by the rotation of the drill bit 12'. The roller cutters 12 are attached to a drill-bit structure 15 which in turn is connected to an outer housing 16 supported with bearings 22 on an inner drill stem 21. The drill stem 21 projects from a centre opening in the drill bit 12' and is connected in a rotationally rigid manner to the drill string 4 through a coupling 45. The rotation of the drill-bit structure 15 and the outer housing 16 is provided by driving motors 18, typically electromotors, fixed to the drill stem 21 and connected to a gear system 17 including gear wheels 20 engaging a gear rim 19 connected to the outer housing 16. The cables 14 are extended in cut-outs through the drill stem 21 up to the driving motors 18.

[0025] To prevent the drilling unit 2 from rotating and, at the same, being centred in the borehole 8, supporting feet 23 have been fitted, which, by means of knee-joint linkages 24, 29, first and second supporting structures 25, 26 and a first linear actuator 27, can be pressed against the wall of the borehole 8.

[0026] The knee-joint linkages 24, 29 are connected to the first and second supporting structures 25, 26 via pivot joints 46. The first supporting structure 25 is connected to the first linear actuator 27, typically a hydraulic cylinder, which, through the first structure 25, which is displaceable in the direction of the second supporting structure 26, and the knee-joint linkages 24, 29 can exert a clamping force on the supporting feet 23. A spring 28 has been fitted between the supporting structures 25, 26 so that if the hydraulic pressure is uncontrolledly absent, the supporting feet 23 will retract to prevent the supporting feet 23 from being pressed against the rock formation 1 and impeding the withdrawal of the drilling unit 2 from the borehole 8.

[0027] The drill string 4 is formed from several drill-string sections 4a which are each connected to an adjacent drill-string section by means of a first coupling portion 39 and a corresponding coupling bolt (see in particular figures 4-6 and 8) of a second adjacent coupling portion 40. Each drill-string section 4a is provided, in an end portion, with an engagement portion 31 arranged to

lockingly engage with a locking device 36 arranged in the carriage-guide frame 10 (see figure 10).

[0028] Reference is now made to figures 8-11. To drive the drilling unit 2 in the axial direction of the borehole 8, an axial drive 11 is arranged, consisting of a bottom frame 9 connected through pivot joints 43 to a carriage-guide frame 10. To the carriage-guide frame 10, a carriage guide 33 is further connected, which is arranged to form a guide track for a carriage 5. The carriage-guide frame 10 is provided with a projecting frame portion 41 which is connected to the bottom frame 9 distant from the pivot joints 43 via second linear actuators 34, typically hydraulic cylinders, so that the carriage-guide structure 10 with the carriage guide 33 may be placed at a desired angle relative to the bottom frame 9.

[0029] To displace the carriage 5 along the carriage guide 33, two third linear actuators 6, typically hydraulic cylinders, are arranged, connected at their upper ends to the carriage 5 and at their lower ends to the carriage-guide frame 10. The carriage 5 may be connected to the drill string 4 via the coupling portion 39 of the drill-string section 4a.

[0030] When a section 4a of the drill string 4 is out of the pilot hole 13, the drill string 4 is locked by means of a locking device 36 arranged in the carriage-guide frame 10, which engages the engagement portion 31 of the adjacent, next drill-string section of the drill string 4. The locking device 36 is moved by means of a fourth linear actuator 35, typically a hydraulic cylinder.

[0031] When the locking device 36 is in its locked position, the upper section 4a of the drill string 4 is removed and the carriage 5 is run down and reconnected to the drill string 4 that is locked. The locking device 36 is released and the drill string 4 may be displaced further together with the drilling unit 2.

[0032] The sequence is repeated in the reverse order when the drilling unit 2 is to be displaced in the opposite direction out of the borehole 8.

Claims

1. A drilling equipment device (2') for use when reaming a pilot hole (13) in a rock formation (1), in which a drilling unit (2) comprises a rotatable drill-bit structure (15) fitted with roller cutters (12) which are arranged to break up the rock formation (1), the rotatable drill-bit structure (15) being connected to a non-rotatable drill string (4) extending through the pilot hole (13) and being connected to an axial drive (11) outside the pilot hole (13) and distant from the drilling unit (2), **characterized in that** the non-rotatable drill string (4) is axially displaceable, and the drill-bit structure (15) and an connected housing (16) are supported on a drill stem (21) which is connected to an end portion of said drill string (4) distant from the axial drive (11) in a non-rotational manner, and wherein rotation of the housing (16) and the drill-bit

structure (15) is provided by driving motors (18) connected to the housing (16) and the drill-bit structure (15) via a gear system (17) including gear wheels (20) in mesh with a gear rim (19), and wherein the axial drive (11) includes a carriage (5) displaceable along a carriage guide (33) which is pivotably connected to a bottom frame (9), the carriage (5) being arranged to be connected to an engagement portion (31) of a drill-string section (4a).

2. The device in accordance with claim 1, wherein the drill string (4) is sectioned, the drill-string sections (4a) being provided with rotationally rigid couplings (39, 40).

3. The device in accordance with claim 1, wherein cables (14) arranged for transmitting energy and control signals are arranged along the drill string (4).

4. The device in accordance with claim 3, wherein a portion of the cables (14) is wound on one or more cable drums (3) arranged at the axial drive (11).

5. A method of reaming a pilot hole (13) in a rock formation (1), **characterized in that** the method includes the following steps:

- placing a sectioned, non-rotatable drill string (4) in the pilot hole (13) with first and second end portions of the drill string projecting out of the pilot hole (13);

- providing a drilling unit (2) comprising a rotatable drill-bit structure (15) and a connected housing (16) rotatable on a drill stem (21), driving motors (18) connected to the housing (16) and the drill-bit structure (15) via a gear system (17) including gear wheels (20) in mesh with a gear rim (19);

- providing an axial drive (11) outside the pilot hole (13), the axial drive (11) including a carriage (5) displaceable along a carriage guide (33) which is pivotably connected to a bottom frame (9), the carriage (5) being arranged to be connected to an engagement portion (31) of a drill-string section (4a);

- connecting the first end portion of the drill string (4) to the drill stem (21) of the drilling unit (2) at an end of the pilot hole (13);

- connecting the second end portion of the drill string (4) to the axial drive (11) at an opposite end of the pilot hole (13);

- setting a drill bit (12') arranged in the drilling unit (2) in rotation by the driving motors (18); and
- displacing the drilling unit (2) towards the opposite end of the pilot hole (13) by means of the axial drive (11) by displacing the axial drive (11) along the carriage guide (33), thereby pressing the drill bit (12') onto the rock formation (1) to be

cut.

6. The method in accordance with claim 5, wherein the method includes the further step:

- centring the drilling unit (2) in a reamed bore-hole (8) by means of several supporting feet (23) arranged on the periphery of the drilling unit (2).

Patentansprüche

1. Eine Vorrichtung (2') für ein Bohrgerät zur Verwendung bei der Erweiterung einer Pilotbohrung (13) in einer Gesteinsschicht (1), in welcher eine Bohreinheit (2) eine rotierbare Bohrspitzen-Struktur (15) aufweist, welche mit Rollschneidern (12) ausgerüstet ist, welche ausgestattet sind, die Gesteinsschicht (1) aufzubrechen, wobei die rotierbare Bohrspitzen-Struktur (15) mit einem nicht rotierbaren Bohrstrang (4) verbunden ist, welcher sich durch die Pilotbohrung (13) hindurch erstreckt und welche mit einem axialen Antrieb (11) ausserhalb der Pilotbohrung (13) und entfernt von der Bohreinheit (2) verbunden ist, **dadurch gekennzeichnet, dass** der nicht rotierbare Bohrstrang (4) axial verschiebbar angeordnet ist, und dass die Bohrspitzen-Struktur (15) und ein verbundenes Gehäuse (16) auf einem Bohrgestänge (21) abgestützt sind, welches in nicht rotierbarer Weise mit einem Endanteil des besagten Bohrstrangs (4) entfernt vom axialen Antrieb (11) verbunden ist, und wobei die Rotation des Gehäuses (16) und der Bohrspitzen-Struktur (15) durch Antriebsmotoren (18) bewirkt wird, welche über ein Getriebesystem (17), welches Getrieberäder (20) im Eingriff mit einem Zahnkranz (19) aufweist, mit dem Gehäuse (16) und mit der Bohrspitzen-Struktur (15) verbunden sind, und wobei der axiale Antrieb (11) einen Wagen (5) aufweist, welcher entlang einer Wagenführung (33) verschiebbar ist, welche in schwenkbarer Weise mit einem unteren Rahmen (9) verbunden ist, wobei der Wagen (5) ausgestattet ist, an einen Eingriffsanteil (31) eines Bohrstrangabschnittes (4a) verbunden zu werden.

2. Vorrichtung gemäss Anspruch 1, wobei der Bohrstrang (4) in Abschnitte eingeteilt ist, wobei die Bohrstrangabschnitte (4a) mit drehfesten Kupplungen (39, 40) ausgestattet sind.

3. Vorrichtung gemäss Anspruch 1, wobei Kabel (14) zur Übertragung von Energie und von Kontrollsignalen entlang dem Bohrstrang (4) angeordnet sind.

4. Vorrichtung gemäss Anspruch 3, wobei ein Anteil der Kabel (14) auf eine oder mehrere beim axialen Antrieb (11) angeordnete Kabeltrommeln (3) aufgewickelt sind.

5. Verfahren zur Erweiterung einer Pilotbohrung (13) in einer Gesteinsschicht (1), **dadurch gekennzeichnet, dass** das Verfahren die folgenden Schritte aufweist:

- Platzieren eines in Abschnitte eingeteilten, nicht rotierbaren Bohrstrangs (4) in der Pilotbohrung (13), wobei erste und zweite Endanteile des Bohrstrangs aus der Pilotbohrung (13) hinausragen;
- Anordnen einer Bohreinheit (2), aufweisend eine rotierbare Bohrspitzen-Struktur (15) und ein verbundenes Gehäuse (16), welches auf einem Bohrgestänge (21) rotierbar sind, sowie Antriebsmotoren (18), welche mit dem Gehäuse (16) und der Bohrspitzenstruktur (15) über ein Getriebesystem (17) verbunden sind, welches Getrieberäder (20) im Eingriff mit einem Zahnkranz (19) aufweist;
- Anordnen eines axialen Antriebs (11) ausserhalb der Pilotbohrung (13), wobei der axiale Antrieb (11) einen Wagen (5) aufweist, der entlang einer Wagenführung (33) verschiebbar ist, welche in schwenkbarer Weise mit einem unteren Rahmen (9) verbunden ist, wobei der Wagen (5) ausgestattet ist, an einen Eingriffsanteil (31) eines Bohrstrangsabschnittes (4a) verbunden zu werden;
- Verbinden des ersten Endanteils des Bohrstrangs (4) mit dem Bohrgestänge (21) der Bohreinheit (2) an einem Ende der Pilotbohrung (13);
- Verbinden des zweiten Endanteils des Bohrstrangs (4) mit dem axialen Antrieb (11) an einem gegenüberliegenden Ende der Pilotbohrung (13);
- in-Drehung-Versetzen einer Bohrspitze (12'), welche in der Bohreinheit (2) angeordnet ist, durch die Antriebsmotoren (18); und
- Verschieben der Bohreinheit (2) zum gegenüberliegenden Ende der Pilotbohrung (13) hin durch den axialen Antrieb (11), durch Verschieben des axialen Antriebs (11) entlang der Wagenführung (33), wobei die Bohrspitze (12') auf die zu schneidende Gesteinsschicht (1) gedrückt wird.

6. Verfahren gemäss Anspruch 5, wobei das Verfahren ferner den folgenden Schritt aufweist:

- Zentrieren der Bohreinheit (2) in einem erweiterten Bohrloch (8) mittels mehrerer Stützfüsse (23), welche an der Peripherie der Bohreinheit (2) angeordnet sind.

Revendications

1. Un dispositif d'équipement de forage (2') destiné à être utilisé lors de l'alésage d'un avant-trou (13) dans une formation rocheuse (1), une unité de forage (2) comprenant une structure de trépan de forage rotatif (15) équipée de molettes (12) qui sont agencées pour rompre la formation rocheuse (1), la structure de trépan de forage rotatif (15) étant connectée à un train de tiges de forage non rotatives (4) s'étendant à travers l'avant-trou (13) et étant connectée à un entraînement axial (11) à l'extérieur de l'avant-trou (13) et à distance de l'unité de forage (2), **caractérisé en ce que** le train de tiges de forage non rotatives (4) peut être déplacé axialement, et la structure de trépan de forage (15) et un boîtier connecté (16) sont supportés sur une tige de forage (21) qui est connectée à une partie terminale du dit train de tiges de forage (4) à distance de l'entraînement axial (11) de manière non rotative, et dans lequel la rotation du boîtier (16) et de la structure de trépan de forage (15) est fournie par des moteurs d'entraînement (18) connectés au boîtier (16) et la structure de trépan de forage (15) à travers un système d'engrenages (17) incluant des roues d'engrenage (20) en maillage avec un bord d'engrenage (19), et dans lequel l'entraînement axial (11) inclut un chariot (5) pouvant être déplacé le long d'un guide de chariot (33) qui est connecté de manière pivotante à un cadre inférieur (9), le chariot (5) étant agencé pour être connecté à une partie d'enclenchement (31) d'une section de train de tiges de forage (4a).
2. Le dispositif selon la revendication 1, dans lequel le train de tiges de forage (4) est sectionné, les sections de train de tiges de forage (4a) étant munies de couplages rotativement rigides (39,40).
3. Le dispositif selon la revendication 1, dans lequel des câbles (14) disposés pour transmettre de l'énergie et des signaux de commande sont disposés le long du train de tiges de forage (4).
4. Le dispositif selon la revendication 3, dans lequel une partie des câbles (14) est enroulée sur un ou plusieurs tambours à câble (3) disposés au niveau de l'entraînement axial (11).
5. Un procédé d'alésage d'un avant-trou (13) dans une formation rocheuse (1), **caractérisé en ce que** le procédé inclut les étapes suivantes:
 - placer un train de tiges de forage non rotatif et sectionné (4) dans l'avant-trou (13) avec les premières et secondes parties terminales du train de tiges de forage projetant hors de l'avant-trou (13);
 - prévoir une unité de forage (2) comprenant une

structure de trépan de forage rotatif (15) et un boîtier (16) connecté pouvant être tourné sur une tige de forage (21), des moteurs d'entraînement (18) connectés au boîtier (16) et la structure de trépan de forage (15) à travers un système d'engrenages (17) incluant des roues d'engrenage (20) en maille avec un bord d'engrenage (19);

- prévoir un entraînement axial (11), en dehors de l'avant-trou (13), l'entraînement axial (11) incluant un chariot (5) pouvant être déplacé le long d'un guide de chariot (33) qui est connecté de manière pivotante à un cadre inférieur (9), le chariot (5) étant agencé pour être connecté à une partie d'enclenchement (31) de la section de train de tiges de forage (4a);
- connecter la première partie terminale du train de tiges de forage (4) à la tige de forage (21) de l'unité de forage (2) au niveau d'une extrémité de l'avant-trou (13);
- connecter la seconde partie terminale du train de tiges de forage (4) à l'entraînement axial (11) au niveau d'une terminaison opposée de l'avant-trou (13);
- mettre en rotation le trépan de forage (12') disposé dans l'unité de forage (2) par l'intermédiaire des moteurs d'entraînement (18); et
- déplacer l'unité de forage (2) vers la terminaison opposée de l'avant-trou (13) au moyen d'un entraînement axial (11) en déplaçant l'entraînement axial (11) le long du guide de chariot (33), ainsi plaçant le trépan de forage (12') sur la formation rocheuse (1) destinée à être coupée.

6. Le procédé selon la revendication 5, dans lequel le procédé inclut en outre l'étape suivante:

- centrer l'unité de forage (2) dans un trou de forage (8) alésé au moyen de plusieurs pieds de support (23) disposés sur la périphérie de l'unité de forage (2).

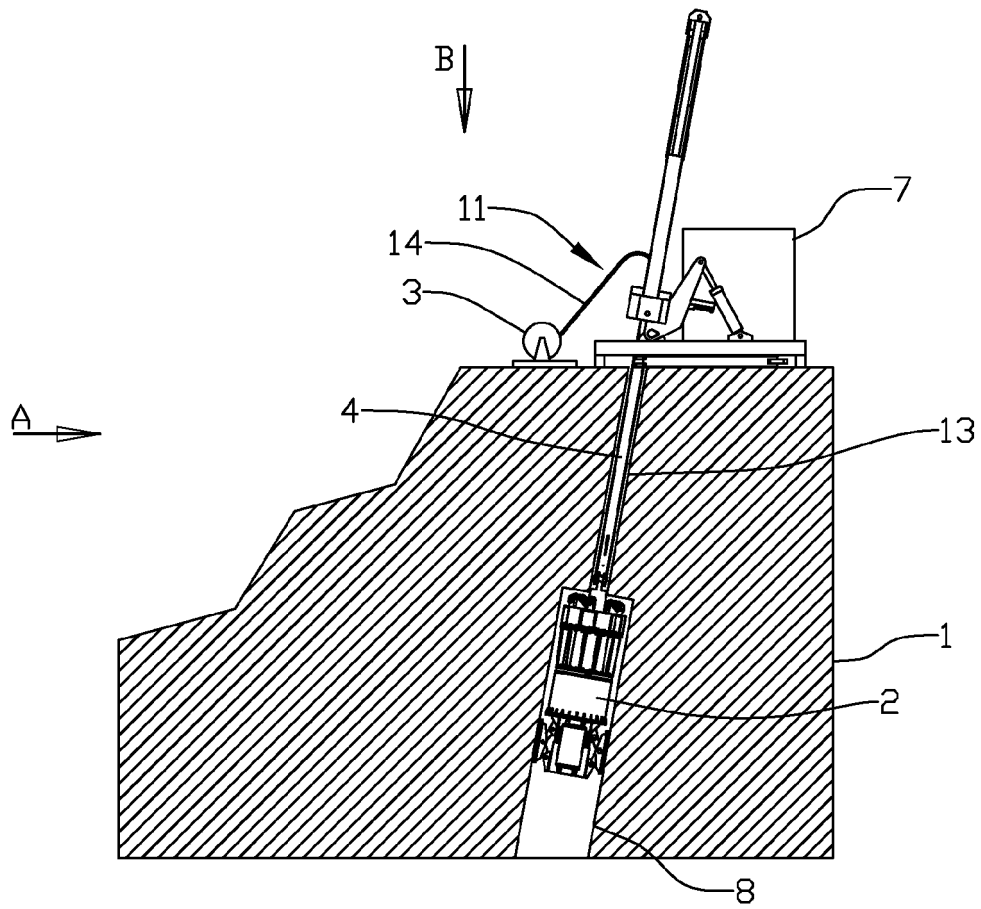


Fig. 1

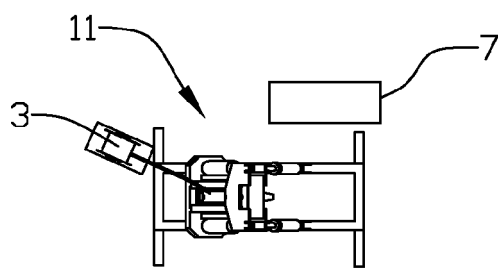


Fig. 2

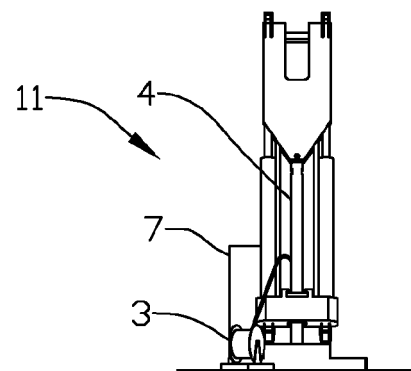


Fig. 3

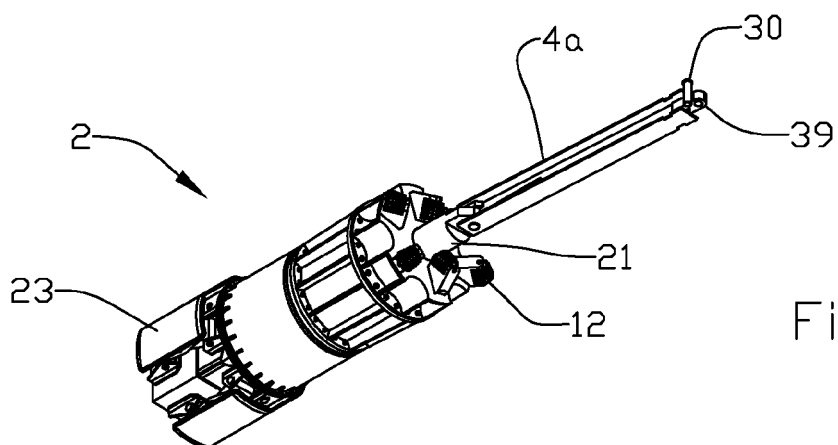


Fig. 4

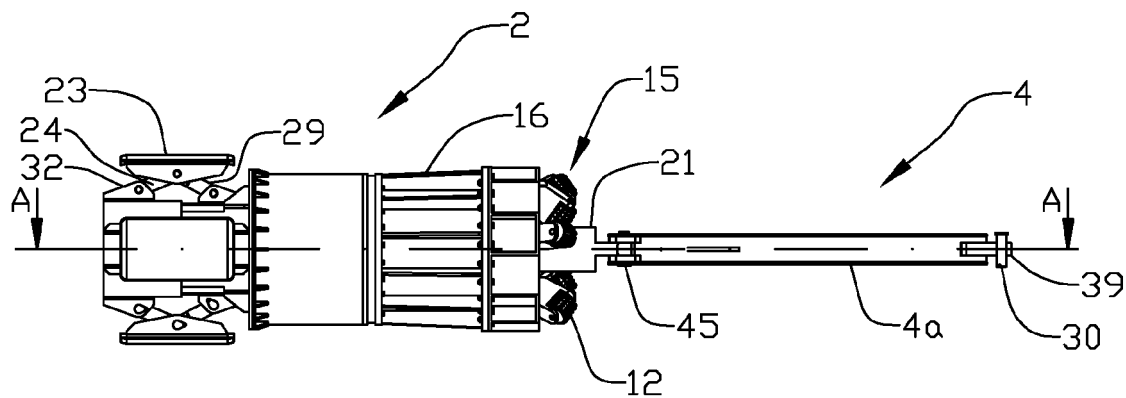


Fig. 5

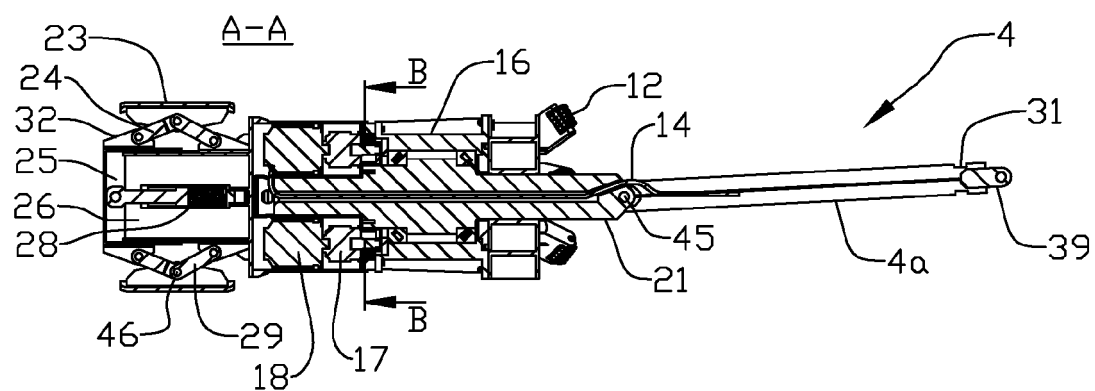


Fig. 6

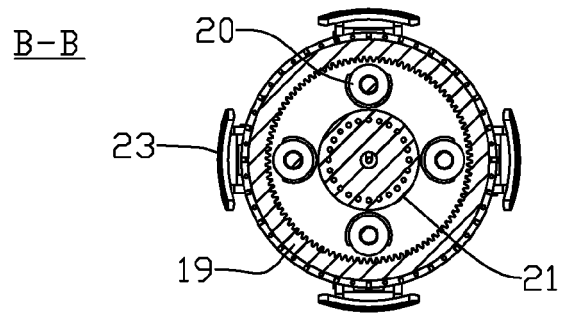


Fig. 7

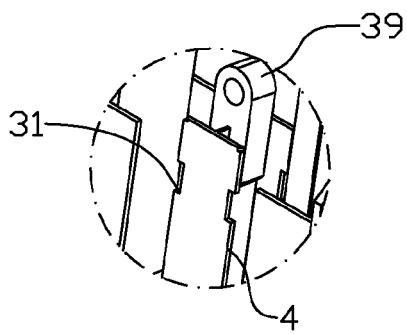


Fig. 8

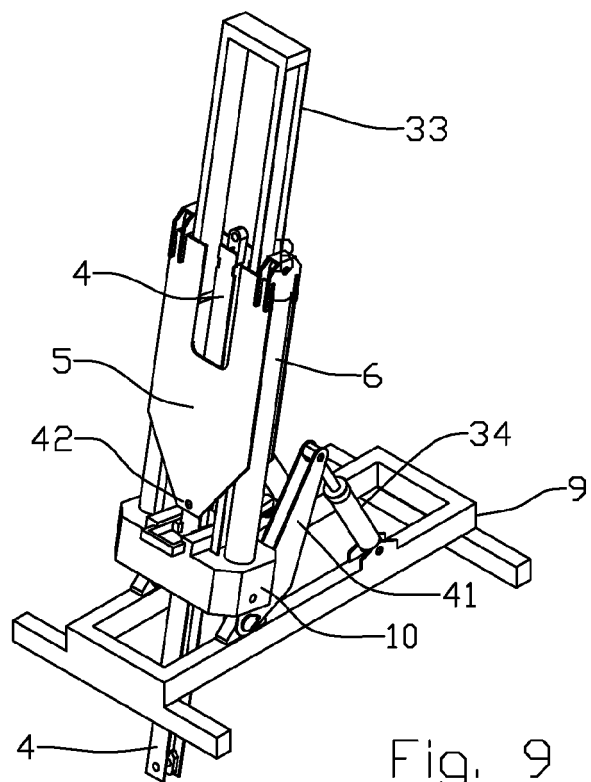


Fig. 9

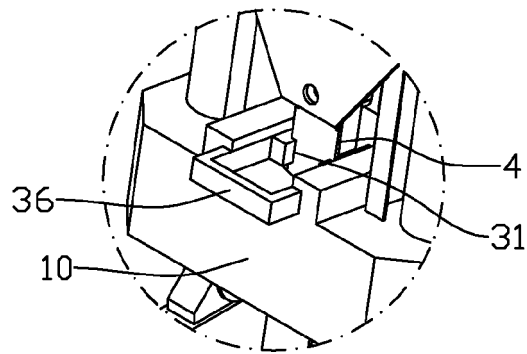


Fig. 10

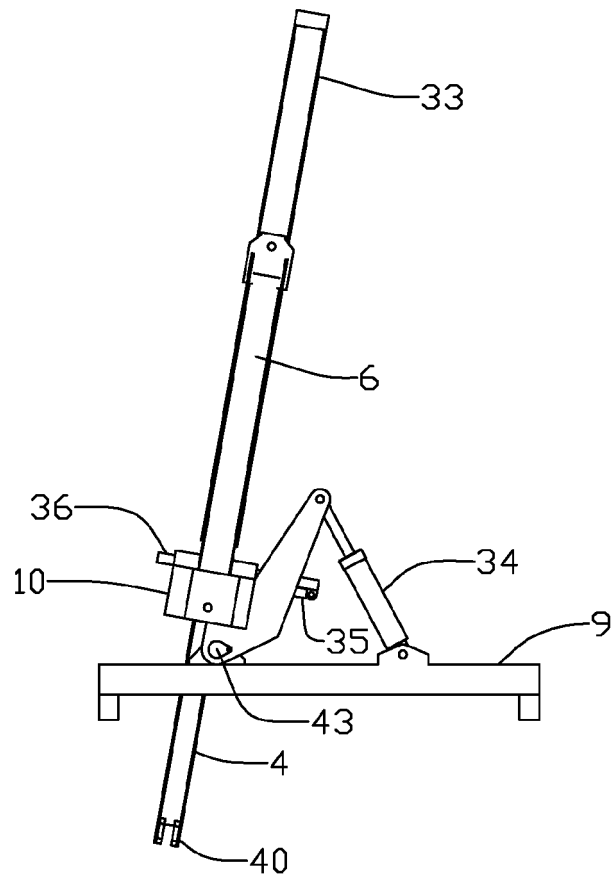


Fig. 11

REFERENCES CITED IN THE DESCRIPTION

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