(54) Title: DEVICE AND METHOD FOR AUTOMATIC CHANGE OF A DRILL BIT AND ROCK DRILLING EQUIPMENT PROVIDED WITH THE DEVICE

(57) Abstract:
A device for automatic changing of a drill bit (2) on a drill rod (5) for a drilling machine (4) which is supported by a feeder (3), which device comprises a bracket (6) for fastening to a forward portion of the feeder (3) and, attached to the bracket, a magazine (10) for...
(57) **Abstrait(suite)/Abstract(continued):**
drill bits (2), and a separate basket (9) for gathering up replaced drill bits (2) and comprises also a clamping means (14) for firmly clamping the drill rod (5) during a change of drill bit (2), whereby the device is pivoted upwards in front of a worn drill bit (2), which is unscrewed and gathered up in the basket (9), after which another drill bit from the magazine is screwed onto the drill rod.
Title: BIT CHANGER

Abstract: A device for automatic changing of a drill bit (2) on a drill rod (5) for a drilling machine (4) which is supported by a feeder (3), which device comprises a bracket (6) for fastening to a forward portion of the feeder (3) and, attached to the bracket, a magazine (10) for drill bits (2), and a separate basket (9) for gathering up replaced drill bits (2) and comprises also a clamping means (14) for firmly clamping the drill rod (5) during a change of drill bit (2), whereby the device is pivoted upwards in front of a worn drill bit (2), which is unscrewed and gathered up in the basket (9), after which another drill bit from the magazine is screwed onto the drill rod.
Device and method for automatic change of a drill bit and rock drilling equipment provided with the device

TECHNICAL FIELD

[0001] The present invention relates to a device for use in equipment for rock drilling and specifically in the replacement of a drill bit on a drill rod. The invention also relates to a method for replacing said drill bit on the drill rod.

STATE OF THE ART

[0002] Tunnelling and drifting operations in underground work and construction activities increasingly involve the use of specifically adapted mining machines.

[0003] The number and length of the drilled holes required in such operations vary with the cross-sectional area of the tunnel or drift and the type of rock. Drilling is now usually carried out with hydraulic drilling machines and there is a great deal of use of extension rods or pipes to form a longer drill rod with a replaceable drill bit at its tip.

[0004] Drill bits become worn and have to be replaced. The amount of drilling for which a given drill bit can be used before it has to be replaced depends on the characteristics of the rock. When the drill bit loses sharpness, its so-called drilling rate decreases. Achieving high productivity in drilling therefore involves taking into account the cost of replacing and/or regrinding drill bits and the amount of time required for changing a drill bit.

[0005] The changing of drill bits is generally carried out manually and is a time-consuming and troublesome operation. Moreover, it may also take place in unsafe rock which is liable to fail, making the operation not only time-consuming but also dangerous or unsafe. Sometimes the dimensions of a drilling unit may be such that it is difficult for operators from their normal working position to reach the place where the drill bit changing operation has to be done.

[0006] It would of course be an advantage if drill bits could be replaced automatically by means of some form of equipment. A solution involving an automatic bit changer has been tried on the market. Specification US 3 976 149 refers to an example of such an automatic bit changer. The type of bit changer therein presented has proved to have disadvantages because of comprising too many moving components and
therefore failing to withstand for long enough the very demanding environment in which it is used.

According to one aspect of the present invention, there is provided a device for automatic changing of a drill bit on a drill rod for a drilling machine supported by a feeder, wherein it comprises: a bracket for fastening to a forward portion of the feeder, a magazine for drill bits, and a separate basket for gathering up replaced drill bits, attached to the bracket, a clamping means for firmly clamping the drill rod and the respective drill bit during a change of drill bit.

According to still another aspect of the present invention, there is provided a method for automatically replacing a worn drill bit on a drill rod belonging to a drilling machine disposed on a feeder provided with the device as described above, comprising the steps of: the feeder drawing the drill rod back so that the worn drill bit is located in the clamping means, raising the pivotable element up against the forward portion of the feeder, the clamping means firmly gripping the worn drill bit, the drilling machine rotating the drill rod so that the worn drill bit is unscrewed, the feeder feeding the drill rod forward so that the worn drill bit falls into the basket, feeding the drill rod further forward until it abuts against and is aligned with a drill bit in a delivery position in the magazine, rotating the drill rod so that the new drill bit is screwed firmly onto the drill rod, lowering the pivotable element away from the feeder.

According to yet another aspect of the present invention, there is provided a computer readable medium having computer executable instructions, for controlling a change of drill bit, stored thereon for execution by one or more computers, that when executed implement the method described above.

According to a further aspect of the present invention, there is provided a rock drilling rig equipped with a feeder provided with the device described above.

[0007] An object of embodiments of the present invention is to provide a solution to the difficulties described above.
DESCRIPTION OF THE INVENTION

[0008] One aspect of the invention presents a device which has the characteristics as described above.

[0009] A further aspect of the invention is presented in the independent method claim.

[0010] Further embodiments of the invention are described in the dependent claims.

[0011] The device according to embodiments of the invention has very few moving parts, which makes it easy to use, robust and operationally reliable. It can tolerate powerful impacts and shocks without jeopardising its operational reliability.

[0012] Further advantages are of course that bit changing operations become considerably safer than previously in that the operator does not need to go to where the drill bit is situated. A further advantage is that used drill bits are automatically gathered up and can thereafter be passed on, e.g. for grinding.

LIST OF DRAWINGS

Fig. 1 depicts schematically a general view of a drilling rig with feeder, with a drilling machine mounted on it, and a circle indicating the location for the device depicted in the other drawings.

Fig. 2 depicts in perspective a device according to the invention fitted to the forward end of a feeder for a drilling machine, with the device's magazine for drill bits and a basket for replaced bits depicted in a lowered position.

Figs. 3a and 3b depict in perspective the device according to Fig. 1, but with the magazine and the associated basket in a raised position.
Fig. 4 depicts in perspective a clamping cylinder pertaining to the device according to Fig. 1, separated from the rest of the device.

DESCRIPTION OF EMBODIMENTS

[0013] A number of embodiments of the invention are described below with reference to the attached drawings.

[0014] A bit changer 1 of the kind according to the invention for automatic changing of a drill bit 2 on a drill rod is depicted in perspective in Fig. 2. The bit changer 1 is fitted to the forward end of a feeder 3 which supports a rock drilling machine 4 to which a drill rod 5 is connected, as illustrated in Fig. 2. The feeder 3 may itself be articulated suspended from a boom 101 fitted to a drilling rig 100, as illustrated in general terms in Fig. 1. The bit changer 1 is built around a bracket 6 which is adapted to being connectable to the forward end of the feeder 3.

[0015] The bracket 6 supports in its lower portion a shaft 7 running transversely relative to the direction of the drill rod 5. Two arms 8 situated on their respective sides of the bracket 6 are arranged for rotation relative to said shaft 7. These two arms 8 are each attached to diametrically opposite sides of a basket 9 which in this example is cylindrical. The function of the basket 9 is, as described below, to catch and temporarily store worn and replaced drill bits 2. The base surface of the basket, which faces outwards (i.e. in the drilling direction) from the feeder 3 when the bit changer is in a raised position, is in this example planar and serves as support for a magazine 10 for drill bits 2. The basket's walls may otherwise be perforated, as illustrated in the drawings. The basket 9 is thus separate from the magazine and comprises no moving parts.

[0016] New or reground drill bits 2 are intended to be stored in the magazine 10 in a straight column, i.e. in line, which means that the structure of the magazine 10 may closely resemble a rectangular parallelepiped in which drill bits 2 are acted upon by a spring urging them towards one end of the magazine 10, which means that the magazine 10 closely resembles a straight magazine of the type used with machine guns. The result is that a drill bit 2 out of a possible plurality of drill bits present in the magazine 10 will be constantly available for delivery at a short end of the magazine.
When a drill bit 2 is drawn from the magazine during a bit change, another drill bit 2, if there is one, is immediately caused to occupy the vacated position by the spring urging towards said short end all the drill bits 2 remaining in the magazine 10. This is illustrated in Fig. 3a.

[0017] The basket 9 and the magazine 10 are thus joined together by the arms 8 to form a rotatable element, herein called the pivotable element. In Figs. 3a and 3b the pivotable element is raised and abuts against the front of the bracket 6. In Fig. 2, in contrast, the pivotable element is lowered to be out of the way during drilling and also be better protected from damage. When the pivotable element is raised, an inner base surface of the basket 9 will abut against a mounting 11 fitted to the front of the bracket and preferably made of rubber, although it may of course be made of other material, e.g. steel. The outer and inner base surfaces of the basket 9 are each provided with a central hole larger in diameter than the drill bit 2 so that a drill bit from the magazine 10 can pass in through the outer base surface and proceed on through the inner base surface. A sleeve 13 extending outwards from the basket 9 connects to the hole in the inner base surface. When the pivotable element is raised up against the bracket 6, the basket 9 will be centred in the axial direction of the drill rod 5 by the sleeve 13 being accommodated and supported in a recess 12 in the mounting 11 which is adapted to the dimensions of the sleeve 13.

[0018] A clamping means 14 is mounted on the inside of the bracket. The clamping means 14 is intended to clamp the drill rod 5 and the respective drill bit 2 during a drill bit replacement operation. The clamping means 14 is depicted separately in Fig. 4.

[0019] The process of replacing a drill bit is described below:

1) When a drill bit 2 is worn and the operator intends to replace it, it is released when it is at the bottom of a drilled hole. If the striker hits the drill without rotation and the drill with the drill bit is pressed against the rock, the threaded connection between the drill bit and the drill will be loosened.

2) The drilling machine 4 is drawn back on the feeder 3 so that the drill bit 2 does at least not appreciably protrude outside the bracket 6. The drill rod 5 is gripped firmly by the clamping means 14. Rotating the drill rod 5 relative to the drilling machine 4 draws it firmly against the drilling machine.
3) The pivotable element comprising the basket and the magazine is raised up against the mounting 11 so that the sleeve 13 and a drill bit 2 which is at delivery position in the magazine 10 are aligned axially with the drill rod 5.

4) The drilling machine 4 is drawn back further on the feeder 3 so that the worn drill bit 2 is in line with the clamping means 14, followed by the drill bit 2 being clamped firmly by this clamping means. Rotation of the drill rod 5 by the drilling machine 4 in the opposite direction as compared with step 2) unscrews the drill bit.

5) The drill rod 5 is fed forward and hence pushes the worn drill bit 2 down so that the latter falls into the basket 9. A fallen worn drill bit 2 is illustrated inside the basket 9 in Fig. 3b.

6) The drill rod 5 continues to move forwards and meets a waiting drill bit 2 which is situated in the magazine 10 in a deliverable position and axially aligned with the drill rod 5. The drill rod 5 is rotated so that the new drill bit in the magazine 10 is screwed onto the drill rod.

7) The drill rod 5 with the new drill bit 2 is drawn back until the drill bit 2 is within the bit changer 1.

8) The pivotable element comprising the basket 9 and the magazine 10 is lowered to its lowered position.

9) The drilling machine 4 is ready for drilling with the new drill bit 2.

[0020] During the axial movements of the drill rod 5 which are involved in the above process, it is necessary to be able to control the drill rod's position in the axial direction. This is achieved by providing a longitudinal position sensor which measures the drill rod's position in the axial direction relative to a fixed point on the feeder 3, thereby enabling an operator to control the axial feed of the drill rod. It is of course possible with a drilling rig which has a control programme for not only the various steps described above involved in a drill bit change but also the detection and control of the drill rod's longitudinal movement to be programmed in the form of a drill bit change programme which may be initiated by an operator and thereafter automatically executes the various sequences of the bit change operation.
[0021] The bit changer 1 according to the description may take the form of a separate unit which can be mounted on existing feeders for drilling rigs on the market or be integrated with the feeder and be already available for a drilling rig at the time of supply.
CLAIMS:

1. A device for automatic changing of a drill bit on a drill rod for a drilling machine supported by a feeder, wherein it comprises:

   - a bracket for fastening to a forward portion of the feeder,

   - a magazine for drill bits, and a separate basket for gathering up replaced drill bits, attached to the bracket,

   - a clamping means for firmly clamping the drill rod and the respective drill bit during a change of drill bit.

2. A device according to claim 1, wherein the magazine and the basket are joined together to form an integrated element adapted to pivoting relative to the bracket so that this element can assume respective raised and lowered positions, whereby the pivotable element in the lowered position is lowered away from the forward portion of the feeder.

3. A device according to claim 1, wherein said magazine is a magazine for a row of unused drill bits which are fed one at a time to a delivery position as a result of a spring force acting upon the row of drill bits.

4. A device according to claim 3, wherein a drill bit situated in the delivery position is aligned with the drill rod when the pivotable element is in the raised position.

5. A method for automatically replacing a worn drill bit on a drill rod belonging to a drilling machine disposed on a feeder provided with the device according to claim 2, comprising the steps of:

   - the feeder drawing the drill rod back so that the worn drill bit is located in the clamping means,

   - raising the pivotable element up against the forward portion of the feeder,

   - the clamping means firmly gripping the worn drill bit,
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- the drilling machine rotating the drill rod so that the worn drill bit is unscrewed,

- the feeder feeding the drill rod forward so that the worn drill bit falls into the basket,

- feeding the drill rod further forward until it abuts against and is aligned with a drill bit in a delivery position in the magazine,

- rotating the drill rod so that the new drill bit is screwed firmly onto the drill rod,

- lowering the pivotable element away from the feeder.

6. The method according to claim 5, further comprising the steps of:

- before the worn drill bit is clamped firmly in the clamping means, drawing the drill rod back only so far that the worn drill bit is situated at the bracket, followed by the clamping means situated within the bracket firmly gripping the drill rod,

- the drilling machine rotating the drill rod so that the drilling machine and the drill rod are screwed firmly to one another.

7. The method according to claim 5 or 6, comprising the step of:

- before the drill rod is drawn out of a drilled hole for replacement of a worn drill bit, releasing the drill bit from the drill rod while it is still in the drilled hole.

8. The method according to claim 5, further comprising the step of:

- a longitudinal feed sensor detecting the position of the drill rod relative to the feeder.

9. A computer readable medium having computer executable instructions, for controlling a change of drill bit, stored thereon for execution by
one or more computers, that when executed implement a method according to claim 5.

10. A rock drilling rig equipped with a feeder provided with the device according to claim 1.

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Fig. 4