Rod changer for a rock drill

A rock drill system includes a rotatable carousal adapted to hold a plurality of drill rods. A carousal driver is in communication with the rotatable carousal. The carousal driver includes a driver gear and a driven gear. Both the driver gear and the driven gear are coated with a self-lubricating/anti-corrosive layer comprising a metal-containing composition and a fluorine-containing resin. The rock drill system also includes a rod gripper for positioning a drill rod under a rock drill. Another rock drill system of similar design is provided in which the rod gripper includes one or more pivot pins that are coated with a self-lubricating/anti-corrosive layer comprising a metal-containing composition and a fluorine-containing resin.

Figure 1A
Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] In at least one aspect, the present invention is related to an improved rod changer for a drill.

2. Background Art

[0002] Construction and mining drills are used to drill deep holes in hard materials such as rock. Such drills use a plurality of rods to extend the deep to which drilling is to proceed. Rods are sequentially loaded to extend the drilling depth when necessary. A rod changer is typically used to handle adding or taking rods or pipes out of the drill string.

[0003] A rod changer serves three functions in a drilling operation. The first function is to add more rods or pipes in line with the drill string. The second function is to remove rods or pipes from the drill string. The third function is to store rods or pipes for use. There are several different techniques used to position rods or pipes in and out of the drill string, each of which has a rod indexing mechanism and another mechanism to swing rods or pipes into or out of the drill string. Regardless of the techniques used, there are pivot and locking mechanisms that typically have pivot points thereby requiring lubrication to aid in movement or to prevent corrosion from making such movements difficult. Experience has shown that these pivot and locking mechanisms are not properly maintained resulting in equipment lock up and failure.

[0004] Accordingly, there is a need for rock drill components with improved wear resistance requiring minimal maintenance.

SUMMARY OF THE INVENTION

[0005] The present invention solves one or more problems of the prior art by providing, in at least one embodiment, a rock changer for a rock drill system. The rod exchanger of this embodiment includes a rotatable carousal adapted for holding a plurality of drill rods. A carousal driver is in communication with the rotatable carousal. The carousal driver includes a driver gear and a driven gear. Both the gear and the driven gear are coated with a self-lubricating/anti-corrosive layer comprising a metal-containing composition and a fluorine-containing resin.

[0006] In another embodiment, a rod changer for a rock drill system is provided. The rock drill system includes a rotatable carousal adapted for holding a plurality of drill rods. A carousal driver is in communication with the rotatable carousal. The carousal driver includes a driver gear and a driven gear. The rock drill system also includes a rod gripper for positioning a drill rod under a rock drill. The rod gripper includes one or more pivot pins that are coated with a self-lubricating/anti-corrosive layer comprising a metal-containing composition and a fluorine-containing resin.

In still another embodiment, a rock drill system is provided. The rock drill system includes a rod exchanger for a rock drill. The rod exchanger includes a pivot pin and locking mechanism adapted for holding a plurality of drill rods. A carousal driver is in communication with the rotatable carousal. The carousal driver includes a driver gear and a driven gear. The rock drill system also includes a rod gripper for positioning a drill rod under a rock drill. The rod gripper includes one or more pivot pins that are coated with a self-lubricating/anti-corrosive layer comprising a metal-containing composition and a fluorine-containing resin. During operation, the rod exchanger adds or removes rods or pipes to the drill string so that the driver may move the drill bit deeper. After drilling to a desired depth, the rod exchanger sequentially removes the rods or pipes while the drill bit is retracted.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] Exemplary embodiments of the present invention will become more fully understood from the detailed description and the accompanying drawings, wherein:

[0009] FIGURES 1A and 1B provide a flowchart illustrating operation of a rod changer of an embodiment of the invention;

[0010] FIGURE 2 is a perspective view of a rod changer used to exchange rods for a rock drill;

[0011] FIGURE 3A is a side view of a clamp jaw pin;

[0012] FIGURE 3B is an end view of a clamp jaw pin;

[0013] FIGURE 4A is a side view of a swing cylinder jaw pivot pin;

[0014] FIGURE 4B is an end view of a swing cylinder jaw pivot pin;

[0015] FIGURE 5A is a side view of a swing cylinder base mount pin;

[0016] FIGURE 5B is an end view of a swing cylinder base mount pin;

[0017] FIGURE 6A is a side view of a clamp cylinder base mount pin;

[0018] FIGURE 6B is an end view of a clamp cylinder base mount pin;

[0019] FIGURE 7A is a side view of an arm pivot pin;

[0020] FIGURE 7B is an end view of an arm pivot pin;

[0021] FIGURE 8 is a bottom view of a carousal driver used in an embodiment of a rod changer.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0022] Reference will now be made in detail to presently preferred compositions, embodiments and methods of the present invention, which constitute the best
modes of practicing the invention presently known to the inventors. The Figures are not necessarily to scale. However, it is to be understood that the disclosed embodiments are merely exemplary of the invention that may be embodied in various and alternative forms. Therefore, specific details disclosed herein are not to be interpreted as limiting, but merely as a representative basis for any aspect of the invention and/or as a representative basis for teaching one skilled in the art to variously employ the present invention.

[0023] Except in the examples, or where otherwise expressly indicated, all numerical quantities in this description indicating amounts of material or conditions of reaction and/or use are to be understood as modified by the word “about” in describing the broadest scope of the invention. Practice within the numerical limits stated is generally preferred. Also, unless expressly stated to the contrary: percent, “parts of,” and ratio values are by weight, the description of a group or class of materials as suitable or preferred for a given purpose in connection with the invention implies that mixtures of any two or more of the members of the group or class are equally suitable or preferred; description of constituents in chemical terms refers to the constituents at the time of addition to any combination specified in the description, and does not necessarily preclude chemical interactions among the constituents of a mixture once mixed; the first definition of an acronym or other abbreviation applies to all subsequent uses herein of the same abbreviation; and, unless expressly stated to the contrary, measurement of a property is determined by the same technique as previously or later referenced for the same property.

[0024] It is also to be understood that this invention is not limited to the specific embodiments and methods described below, as specific components and/or conditions may, of course, vary. Furthermore, the terminology used herein is used only for the purpose of describing particular embodiments of the present invention and is not intended to be limiting in any way.

[0025] It must also be noted that, as used in the specification and the appended claims, the singular form “a,” “an,” and “the” comprise plural referents unless the context clearly indicates otherwise. For example, reference to a component in the singular is intended to comprise a plurality of components.

[0026] Throughout this application, where publications are referenced, the disclosures of these publications in their entireties are hereby incorporated by reference into this application to more fully describe the state of the art to which this invention pertains.

[0027] With reference to Figures 1A and 1B, a flow chart illustrating the operation of the rod changer is provided. Rock drill system 10 includes rock drill 12 and rod changer 14. Rock drill 12 may use rotation and/or hammering action for drilling. Driver 13 provides the necessary rotation and/or hammering motion. Rod changer 14 includes rod holder sections 16, 18 that are pivotal about axis 20. Rod holder sections 16, 18 are carousals that hold rods 22, 24, 26. Rock drill 12 is movably mounted on feed arm 28. Rod changer 14 also includes carousel driver 30, which rotates rod sections 16, 18. Specifically, carousel driver 30 allows indexing of rod holder sections 16, 18 at set positions. Rock drill system 10 also includes drill bit 32. During operation, drill bit 32 is driven downward along direction d1. Rod changer 14 is also mounted on feed arm 28.

[0028] After traversing a maximum distance, rock drill 12 is retracted to position 34 so that a rod (or pipe) may be positioned into location 36 thereby allowing a greater depth to be drilled. As used herein the term “rod” refers to both rods and pipes. In step a), rod 22 is grabbed by rod grippers 42, 44 which then pivots such that rod 22 is positioned under rock drill 12, as shown in step b). Rod grippers 42, 44 are then pivoted away in step c), leaving rod 22 positioned under rock drill 12 thereby increasing the depth to which rock drill 12 can drill. In step d), drilling to this greater depth is continued. The introduction of additional rods proceeds in a similar fashion. For example, in step e), rock drill 12 is retracted to position 34 so that another rod may be introduced. The carousel is indexed so that rod 24 is in the rod gripper 42 and 44 accept position. Rod grippers 42, 44 grab rod 24 and then pivot inward in step f) so that rod 24 is positioned under rock drill 12. In step g), rod grippers 42, 44 release rod 24 and pivot away, leaving rod 24 positioned under rock drill 12. Couple 46 is used to connect rod 22 to rod 24.

[0029] With reference to Figures 2-7, schematics of a rod gripper and components therein are provided. Advantageously, one or more of the components of the rod gripper that are susceptible to wear and/or corrosion are coated with a thin layer of a self-lubricating-anti-corrosive layer set forth below. Sometimes herein, the self-lubricating-anti-corrosive layer is simply referred to as the self-lubricating layer. Figure 2 is a perspective view of a rod gripper used to exchange rods for a rock drill. Figure 3A provides a side view of clamp jaw pin 56 while Figure 3B provides an end view of clamp jaw pin 56. Figure 4A provides a side view of swing cylinder jaw pivot pin 58 while Figure 4B provides an end view of swing cylinder jaw pivot pin 58. Figure 5A provides a side view of swing cylinder base mount pin 60 while Figure 5B provides an end view of swing cylinder base mount pin 60. Figure 6A provides a side view of clamp cylinder base mount pin 61 while Figure 6B provides an end view of clamp cylinder base mount pin 61. Figure 7A provides a side view of arm pivot pin 62 while Figure 7B provides an end view of arm pivot pin 62. Rod grippers 42, 44 each include jaw 50, which includes jaw sections 52, 54. Jaw section 54 pivots about swing cylinder jaw pivot pin 58 to open and close. Jaw pivot pin 58 is a component that is susceptible to wear and corrosion during operation of the rock drill. Therefore, in a variation of the present invention, pivot pin 58 is coated with a thin layer of the self-lubricating-anti-corrosive layer set forth. Jaw section 54 swings in and out by means of clamp jaw pin 56. Similarly, clamp jaw pin 56 is also a component that is susceptible to wear.
and/or corrosion. Therefore, in a variation of the present invention, clamp jaw pin 56 is coated with a thin layer of the self-lubricating/anti-corrosive layer set forth below.

[0030] Still referring to Figures 2-7, jaw 50 grabs the rods when a rod is positioned under the rock drill as set forth above. Rods are positioned under the rock drill by pivoting about swing cylinder base mount pin 60, clamp cylinder base mount pin 61, and arm pivot pin 62 via the movement of actuator 64 along directions d3. Individually, each of swing cylinder base mount pin 60, clamp cylinder base mount pin 61, and arm pivot pin 62 are susceptible to wear and/or corrosion. Therefore, in other variations, one or more of swing cylinder base mount pin 60, clamp cylinder base mount pin 61, and arm pivot pin 62 are coated with a thin layer of the self-lubricating/anti-corrosive layer set forth below.

[0031] With reference to Figure 8, a bottom view of driver 30 set forth above is provided. Driver 30 includes driver gear 70 and driven gear 72. A motor (not shown) moves driver gear 70 causing movement of driven gear 72. Driven gear 72 is in mechanical communication with rod holder sections 16 and 18. Therefore, rotation of driven gear 72 causes rod holder sections 16 and 18 to rotate thereby allowing each rod to be selected as set forth above. Notches 74 allow accurate positioning of driven gear 72 and its associated rod holder section 16. This, in turn, allows accurate positioning of the rods. Each of driver gear 70 and driven gear 72 are susceptible to wear and/or corrosion. Therefore, in a variation of the present invention, driver gear 70 and driven gear 72 are each independently coated with a self-lubricating/anti-corrosive layer as set forth below.

[0032] In an embodiment of the present invention, components of rod changer 14 susceptible to wear and corrosion are coated with a self-lubricating/anti-corrosive layer. The self-lubricating/anti-corrosive layer comprises a metal-containing composition and a fluorine-containing resin. The metal-containing composition may be a metal, a metal oxide, or combinations thereof. Examples of suitable metals include nickel, aluminum, stainless steel, silver, gold or copper. Aluminum oxide is an example of a suitable metal oxide. In one variation, the self-lubricating/anti-corrosive layer is made by electroplating metal plating, and in particular, electroless nickel plating. In a particularly useful variation, a nickel layer is deposited on the component and then infused with a fluorine-containing resin to form a nickel-fluoropolymer layer (e.g., a fluoropolymer or a fluorohydrocarbon resinous material). The metal-containing composition may be applied by thermal spraying or by vacuum techniques such as evaporation, sputtering, LPCVD. Voids are impregnated with a fluoropolymer. The fluoropolymer may be applied by any method known to those skilled in the art. For example, the fluoropolymer may be formed by chemical deposition methods or by a spray of polymeric particle with subsequent heat treatment. Excess fluoropolymer on the surface of the nickel layer is optionally removed by chemical etching or by physical removal.

[0034] In a refinement of the invention, the self-lubricating/anti-corrosive layer has a thickness from about 0.0001 inches to about 0.01 inches. In another refinement, the self-lubricating/anti-corrosive layer has a thickness from about 0.0008 inches to about 0.001 inches. In another refinement, the self-lubricating/anti-corrosive layer has a coefficient of friction from about 0.05 to about 0.3. In another refinement, the self-lubricating/anti-corrosive layer has a coefficient of friction from about 0.1 to about 0.2. In still another refinement, the self-lubricating/anti-corrosive layer has a coefficient of friction of about 0.15.

[0035] While embodiments of the invention have been illustrated and described, it is not intended that these embodiments illustrate and describe all possible forms of the invention. Rather, the words used in the specification are words of description rather than limitation, and it is understood that various changes may be made without departing from the spirit and scope of the invention.

Claims

1. A rod exchanger for a rock drill, the rod exchanger comprising:

   a rotatable carousal adapted for holding a plurality of drill rods;

   a carousal driver in a communication with the rotatable carousal, the carousal driver comprising a driver gear and a driven gear, the driver gear and the driven gear each coated with a self-lubricating/anti-corrosive layer comprising a metal-containing composition and a fluorine-containing resin; and

   a rod gripper for positioning a drill rod under a hammer component of a rock drill.

2. The rod exchanger of claim 1 wherein the self-lubricating/anticorrosive layer has a coefficient of friction of about 0.15.

3. A rod exchanger for a rock drill, the rod exchanger
comprising:

- a rotatable carousel adapted for holding a plurality of drill rods;
- a carousel driver in communication with the rotatable carousel; and
- a first rod gripper for positioning a drill rod under a rock drill, the rod gripper having one or more pivot pins that are coated with a layer comprising a metal-containing composition and a fluorine-containing resin.

4. The rod exchanger of claim 3 further comprising a second rod gripper that cooperates with the first rod gripper to position a drill rod under a rock drill.

5. The rod exchanger of claim 4 wherein the first rod gripper and the second rod gripper each independently include a first jaw section, a second jaw section, and a swing cylinder jaw pivot pin, the first jaw section and the second jaw section pivoting about the swing cylinder jaw pivot pin being coated with a layer comprising a metal-containing composition and a fluorine-containing resin.

6. The rod exchanger of claim 5 wherein the first rod gripper and the second rod gripper each independently further comprise at least one additional component for positioning rods under a rock drill, the additional components being coated with a layer comprising a metal-containing composition and a fluorine-containing resin.

7. The rod exchanger of claim 7 wherein the additional components are a cylinder base mount pin, clamp cylinder base mount pin, and arm pivot pin.

8. The rod exchanger of claim 5 further comprising a clamp jaw pin by which the second jaw section of the first rod gripper and the second rod gripper swings and out of a position for clamping rods.

9. The rod exchanger of claim 1 or claim 3 wherein the self-lubricating/anti-corrosive layer has thickness from about 0.0001 inches to about 0.01 inches.

10. The rod exchanger of claim 1 or claim 3 wherein the self-lubricating/anti-corrosive layer has a coefficient of friction from about 0.01 to about 0.2.

11. The rod exchanger of claim 10 wherein the nickel-fluoropolymer layer includes a nickel layer having a plurality of voids, the fluorine-containing resin being disposed within the voids.

12. The rod exchanger of claim 1 or claim 3 wherein the self-lubricating/anti-corrosive layer has thickness from about 0.0008 inches to about 0.01 inches.

13. A rock drill comprising:

   - a drill bit;
   - a driver for moving the drill bit in a rotating and/or hammering motion;
   - a rod exchanger for adding and removing rods or pipes to a drill string, the rod exchanger including;
   - a rotatable carousel;
   - a carousel driver in communication with the rotatable carousel, the carousel driver comprising a gear and a driven gear, the gear and the driven gear each coated with a self-lubricating/anti-corrosive layer comprising a metal-containing composition and a fluorine-containing resin; and
   - a first rod gripper for positioning a drill rod under a rock drill, the rod gripper having one or more pivot pins that are coated with a layer comprising a metal-containing composition and a fluorine-containing resin.
REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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