FORCE PULSE SHAPING MEMBER FOR PERCUSSION TOOL

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Field of Search..................173/133, 134, 135, 104, 105; 175/320

References Cited

UNITED STATES PATENTS

3,044,448 7/1962 Curtis et al. ........................................ 173/105

3,368,634 2/1968 Lear........................................... 173/105

3,382,932 5/1968 Wise........................................... 173/135

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ABSTRACT

A member comprising the shank or an integral shank-drill rod for a percussion rock drill and having a force-deflection or stiffness characteristic similar to the effective stiffness of the earth formation to be penetrated. The member is adapted to be removably inserted into the rock drill in blow-receiving relationship with a reciprocating hammer element. The member is also operable to be a rotation transmitting means for rotating an extension drill string.

7 Claims, 4 Drawing Figures
BACKGROUND OF THE INVENTION

The disclosure of U.S. Pat. No. 3,382,932 to B. A. Wise teaches that essentially all earth formations being penetrated by local crushing or shearing in the bore hole exhibit a force-deflection characteristic or stiffness. The Wise patent also reaches that, by providing a so-called spring member in a percussion rock drill, a force pulse may be transmitted to the earth formation which results in more desirable energy transfer to the formation and, accordingly, greater penetration rates. This spring member as disclosed in the Wise patent preferably has a stiffness characteristic similar to that of the effective stiffness of the formation to be penetrated and develops a force pulse having a shape, when graphically plotted as a function of time, which also results in lower stress levels imposed on the drill rod and coupling members.

Following the teaching of the above-mentioned patent the necessary dimensions of a force pulse shaping member for most percussion rock drills, including the drill disclosed in the Wise patent, result in a member which is a substantially slender rod located in blow-receiving relationship with the drill hammer element. However, the pulse shaping spring of Wise is positioned entirely within the drill housing and thereby substantially lengthens the drill structure proper. This elongation of the drill is undesirable in that it makes the drill considerably heavier and more bulky. Furthermore, for rock drills which are movably mounted on elongated feed supports, lengthening of the drill itself requires a longer and heavier support. Conversely, if the drill support is not lengthened, the effective feed length of the support is reduced and shorter sections of extension drill rod are required to be used for deep hole drilling. Short drill rod sections require more frequent operations for adding or subtracting drill rods to an extension drill string with the attendant increase in time required to complete the operation of drilling a hole.

Since the force pulse shaping member itself is highly stressed and is likely to incur a structural failure, it follows that, with the force pulse shaping member housed entirely within the drill, a catastrophic failure may easily cause damage to the drill itself and in any event requires considerable time to be replaced as the drill itself must be substantially disassembled.

SUMMARY OF THE INVENTION

The present invention provides for a force pulse shaping member for a percussion tool such as a fluid operated rock drill or the like wherein said member comprises a separate shank or an integral section of a one-piece drill rod. In accordance with the present invention a force pulse shaping member is provided which is removable insertable into one end of a percussion rock drill in blow-receiving relationship with a reciprocating hammer element. The force pulse shaping shank member may be adapted at the opposite end to include means for releasably coupling said member to a force transmitting means comprising an extension drill string made up of a plurality of rods coupled end to end and including a forming penetrating bit. Alternatively, the force pulse shaping member of the present invention may comprise an integral shank-drill rod for use in drilling holes where extension members are not required.

Contrary to prior teaching in the art of force pulse shaping the present invention also provides a pulse shaping member which is operable to be a torque transmitting coupling for rotating a percussive drill string.

The principal object of the present invention is to provide a force pulse shaping member as suggested by Wise which can be advantageously used with more conventional percussion rock drills without altering the drill structure itself, but yet providing improved penetration rates and longer life for drill string members. By incorporating a pulse shaping member as a shank or an integral shank-drill rod the drill housing is not required to be lengthened as with prior art, internally positioned, force pulse shaping members. Accordingly, the weight and structural complexity of the drill are not increased. Furthermore, by providing the pulse shaping member whose length becomes part of the useful drill rod length, deeper holes may be drilled in a single traversal of feed support mounted drills, and with lighter hand positioned tools such as feed leg drills as well. An additional advantage of the present invention also resides in the fact that should a structural failure be encountered with the force pulse shaping shank, said shank may be quickly replaced. Moreover, a catastrophic structural failure of such a shank member is not likely to cause damage to the drill proper as a substantial portion of the highly stressed force pulse shaping section is not housed within the drill.

FIG. 1 is a longitudinal view, partially sectioned, of a fluid operated percussion rock drill including the force pulse shaping member of the present invention.

FIG. 2 is a transverse section view taken along the line 2—2 of FIG. 1.

FIG. 3 is a side elevation of an exemplary mobile rock drill unit utilizing the present invention.

FIG. 4 is a view of an alternate embodiment of the present invention comprising an integral shank-drill rod member including a formation penetrating bit.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the present invention a force pulse shaping member or so-called spring comprises a separate shank portion for a fluid operated percussion rock drill. The essential subject matter for determining the stiffness characteristic and the dimensional relationships for the force pulse shaping shank herein disclosed may be found in the disclosure and teaching of U.S. Pat. No. 3,382,932 to B. A. Wise. Although the embodiments of a shank disclosed herein are utilized in an otherwise substantially conventional fluid operated rock drill, it is contemplated that the teaching of the present invention may be applied to the general type of percussion tool disclosed in the Wise patent as well as other types of percussion tools which operate to deliver repeated impact blows to a force-transmitting means.

Referring to FIG. 1, a pressure fluid operated percussion rock drill is illustrated and generally designated by the numeral 10. The rock drill 10 is of a type which includes a housing 12 having a cylindrical bore 14 therein. A hammer element 16 disposed in the bore 14 is operable in response to the alternate valving of pressure fluid, such as compressed air, to chambers 18 and 20 formed in the bore 14, to reciprocate rapidly therein. A pressure fluid distributing valve 22 forms one end of the bore 14 and is operable to receive pressure fluid, from a supply not shown, and alternately valve quantities of said fluid to the chambers 18 and 20 in a manner well known.

The drill 10 is also characterized by motor means 24 drivably connected to a rotatable chuck member 26 by means of a drive shaft 28 and a pinion 30, the latter drivably engaged with gear means 32 formed on the chuck member 26 by means of a drive shaft The chuck member 26 is rotatably housed in the forward part 42 of the drill housing 12. The chuck member 26 includes a light fitting sleeve 34 which nonrotatably journals a member 36 by means of complementary splines 40 and flutes 38 located on the segment 39 of the member 36 (see FIG. 2). The member 36 is removably insertable through the opening 43 into the chuck member 26 and is retained in the chuck member by means of a retainer 44.

The member 36 is commonly known in the art of percussion rock drills as a shank. The shank 36 is primarily an end portion of a force-transmitting means which usually includes one or more elongated rodlike members threadedly coupled in end-to-end relationship to form an extension drill string. Addi-
tionally, the shank 36 includes a surface 46 operable to receive percussion blows from the hammer element 16. Furthermore, the shank 36 is operable to be a torque transmitting member for transmitting rotational motion to the coupled rod sections for rotating a rock penetrating bit member attached to the opposite end of the aforementioned extension drill string.

For convenience in handling the drill 10 and to make practical the additional of drill rods to lengthen the extension drill string the shank 36 is designed to extend beyond the forward housing part 42 of the drill no more than is necessary to provide for the coupling threads 48. The shank 36 has a somewhat elongated section 50 which is desirably interposed between the shoulder 52 adjacent the threads 48 and a retaining collar 54, the latter comprising means operable to engage the retainer 44 to prevent unwanted displacement of the shank from the chuck member 26. The dimensions of the elongated section 50 may be determined from the procedure disclosed in U.S. Pat. 3,382,932 regarding spring stiffness and cross-sectional area of a force pulse shaping member. The shank 36 also includes a cleansing fluid passage 56 including a portion 58 for telescopically receiving a cleansing fluid tube 60. Due to the fact that the shank 36 must, in effect, act as a compression spring, it is desirably made of a high strength elastic material such as an alloy steel or titanium alloy.

Referring to Fig. 3 a typical mobile rock drill unit is shown generally designated by the numeral 62. The unit 62 includes a crawler-type undercarriage 64 and a movable positioning member 66 to which is attached an elongated drill support 68. The drill 10 is slidably mounted on the support 68 and is operable to be fed reversely therealong by suitable means, not shown.

In Fig. 3 the drill 10 is engaged with an extension drill string 70 comprising elongated drill rods 72 releasably coupled together and to the shank 36 by a cooperating internal and external threaded portions such as shown in Fig. 1 wherein the external threads 48 are engaged with an internal threaded portion 74 on the rod 72. The distal end of the drill string 70 has coupled thereto a bit 76 operable to penetrate an earth formation 78 to form a hole 80 in response to the transmission of force pulses form the drill through the drill string 70. As shown in Fig. 3, the lower end of the drill support 68 includes a drill rod guide 82 commonly known as a centralizer. The centralizer 82 rotatably journals the rod 72 and may be one of several well-known types.

Referring to Fig. 4 an integral shank-drill rod member is illustrated and generally designated by the numeral 86. The shank-drill rod member 86 is commonly known as a single pass rod and is used in applications wherein sufficient hole depth is obtained with one traversal of the drill 10 along the support 68. Such integrally formed shank-drill rods are also widely used in lightweight portable rock drills used in underground mining and the like. The shank-drill rod member 86 comprises a force pulse shaping and transmitting means having a section 88 formed in accordance with the teaching of the aforementioned U.S. Pat. No. 3,382,932 to provide a force deflection characteristic similar to that of the formation to be penetrated. The member 86 also includes a segment 90 including flutes 92 and a retaining collar 94 whereby the member 86 may be inserted in the chuck member 26 of the drill 10 in the same manner as the shank 36. The shank-drill rod member 86 also includes a surface 96 operable to be in blow-receiving relationship with the hammer element 16, and a cleansing fluid passage 98 leading to openings 100 (not shown) adjacent a formation penetrating bit 102. As shown in Fig. 4 the bit 102 is integrally formed as part of the shank-drill rod member 86 with the exception of the replaceable insert 104. However, the end opposite the blow-receiving end of the member 86 could also be provided with a tapered or threaded portion for removable coupling a detachable bit thereto in a manner well known.

It is contemplated that the shank-drill rod member 86 could be desirably formed of an elastic material such as alloy steel initially made up of separate segments 90 and 106, the latter comprising drill rod and the force pulse shaping section 88. The segments 90 and 106 could be separately formed and joined by so-called friction welding at the transverse interface 108 to thereby enjoy the benefits of the teaching of U.S. Pat. No. 3,295,613 to F. R. Anderson.

A particularly advantageous aspect of incorporating the force pulse shaping member into the shank 36 or the integral shank-drill rod 86 may be noted from the drawing in that additional effective drill string length is obtained by providing for the force pulse shaping section to be positioned substantially at the interior of the drill 10. That is, each traversal of the drill 10 down the support 68 is limited only by the engagement of the forward part of the drill casing 42 with the centralizer 82. Accordingly, if the force pulse shaping member was housed entirely within the drill casing the effective length of each traversal along the support would be less than is obtained with the present invention due to the fact that the length of the drill itself would have to be increased.

A further advantage of the present invention resides in the fact that although the provision of a force pulse shaping member in a percussion drill string results in more efficient energy transfer to the rock formation and lower stresses in the extension drill rods and couplings, the pulse shaping member itself becomes highly stressed. Therefore, should the force pulse shaping shank 36 or the integral shank drill rod 86 incur a structural failure, it may be quickly replace without disassembly of the drill 10 and furthermore it is unlikely that any damage to the drill would result from such a failure as the highly stressed force pulse shaping section is located substantially outside of the drill structure.

What is claimed is:

1. In a percussion tool for delivering impact blows to a load such as an earth formation or the like:
   a housing including a chuck member rotatably mounted in said housing;
   a reciprocable hammer element;
   force transmitting means including a formation penetrating bit portion operable to transmit percussive blows from said hammer element to said load; and,
   an elastic member comprising a shank portion of said force transmitting means located between said hammer element and said load for delivering force pulses from said hammer element to said force transmitting means and having a stiffness similar to the effective stiffness of said load, said shank portion having one end connected to said force transmitting means, and the opposite end of said shank portion is removable insertable in said chuck member whereby said shank portion is journaled by said chuck member nonrotatably with respect to said chuck member.

2. The invention set forth in claim 1 wherein:
   said shank portion includes a surface on said opposite end operable to be in blow-receiving contact with said hammer element.

3. The invention set forth in claim 1 wherein:
   said shank portion comprises a torque-transmitting coupling between said percussion tool and said force transmitting means.

4. In a percussion tool for delivering impact blows to a load such as an earth formation or the like:
   a reciprocable hammer element;
   force transmitting means including a formation penetrating bit portion operable to transmit percussive blows from said hammer element to said load;
   an elastic member comprising a shank portion of said force transmitting means located between said hammer element and said load for delivering force pulses from said hammer element to said force transmitting means and having a stiffness similar to the effective stiffness of said load, said shank portion including means at one end for releasably connecting said shank portion to said force transmitting means;
said tool including receiving means for receiving the opposite end of said shank portion, said shank portion being removably insertable in said receiving means;
said tool including retaining means for removably retaining said shank portion in said receiving means; and,
means on said shank portion engageable with said retaining means.

5. The invention set forth in claim 1 wherein:
said shank portion includes a section interposed between said means engageable with said retaining means and said one end having a stiffness similar to the effective stiffness of said load.

6. The invention set forth in claim 5 wherein:
said section of said shank is substantially exterior of said tool when said shank is retained in said tool.

7. In a percussion tool for delivering impact blows to a load such as an earth formation or the like; a reciprocable hammer element; force transmitting means including a formation penetrating

bit portion operable to transmit percussive blows from said hammer element to said load; an elastic member comprising a shank portion of said force transmitting means located between said hammer element and said load for delivering force pulses from said hammer element to said force transmitting means and having a stiffness similar to the effective stiffness of said load;
said tool including receiving means for receiving one end of said shank portion, said shank portion being removably insertable in said receiving means;
said shank portion including an elongated integral segment of said force transmitting means comprising a percussion drill rod; and said shank portion including a section interposed between said drill rod segment and said one end having a stiffness similar to the effective stiffness of said load.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,640,351 Dated February 8, 1972

Inventor(s) Merton W. Coyne and Dieter K. Palauro

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 10, change "reaches" to -- teaches --.
Column 2, line 62, place a period after "26" and delete "by means".
Column 2, line 63 delete "of a drive shaft".
Column 3, line 9, change "additional" to -- addition --.
Column 5, line 8, change "1" to -- 4 --.

Signed and sealed this 28th day of November 1972.

(SEAL)
Attest:
EDWARD M. FLETCHER, JR. Attesting Officer
ROBERT GOTTSCALCK Commissioner of Patents