

United States Patent

Conn

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[54] LARGE DIAMETER BIT FOR SHALLOW ANGLE HOLES

[72] Inventor: William M. Conn, Dallas, Tex.

[73] Assignee: Dresser Industries, Inc., Dallas, Tex.

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[52] U.S. Cl. 175/53, 175/391, 175/408

[51] Int. Cl. E21c 23/00, E21d 3/00

[58] Field of Search 175/53, 391, 408, 406

[56] References Cited

UNITED STATES PATENTS

1,139,529	5/1915	Hughes	175/408
3,231,029	1/1966	Winberg	175/53

1,571,309	2/1966	Wall	175/408
1,996,322	4/1935	Carlson	175/408
2,598,518	5/1952	Dufilho	175/408
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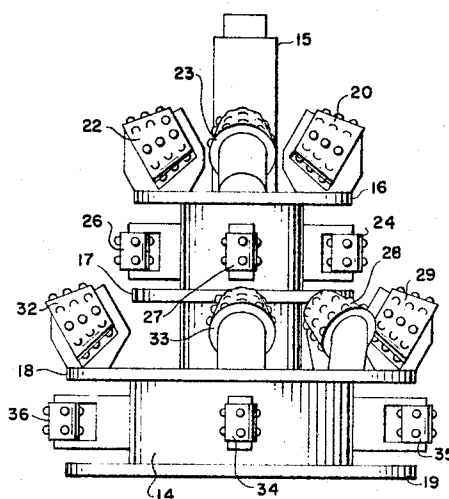
Primary Examiner—James A. Leppink

Attorney—Robert W. Mayer, Thomas P. Hubbard, Jr., Daniel Rubin, Raymond T. Majesko, Roy L. Van Winkle, William E. Johnson, Jr. and Eddie E. Scott

[57] ABSTRACT

A bit for enlarging a pilot hole into a large diameter hole includes a plurality of drilling stages surrounding a central shaft. Integral stabilization sections are included after each drilling stage.

6 Claims, 3 Drawing Figures



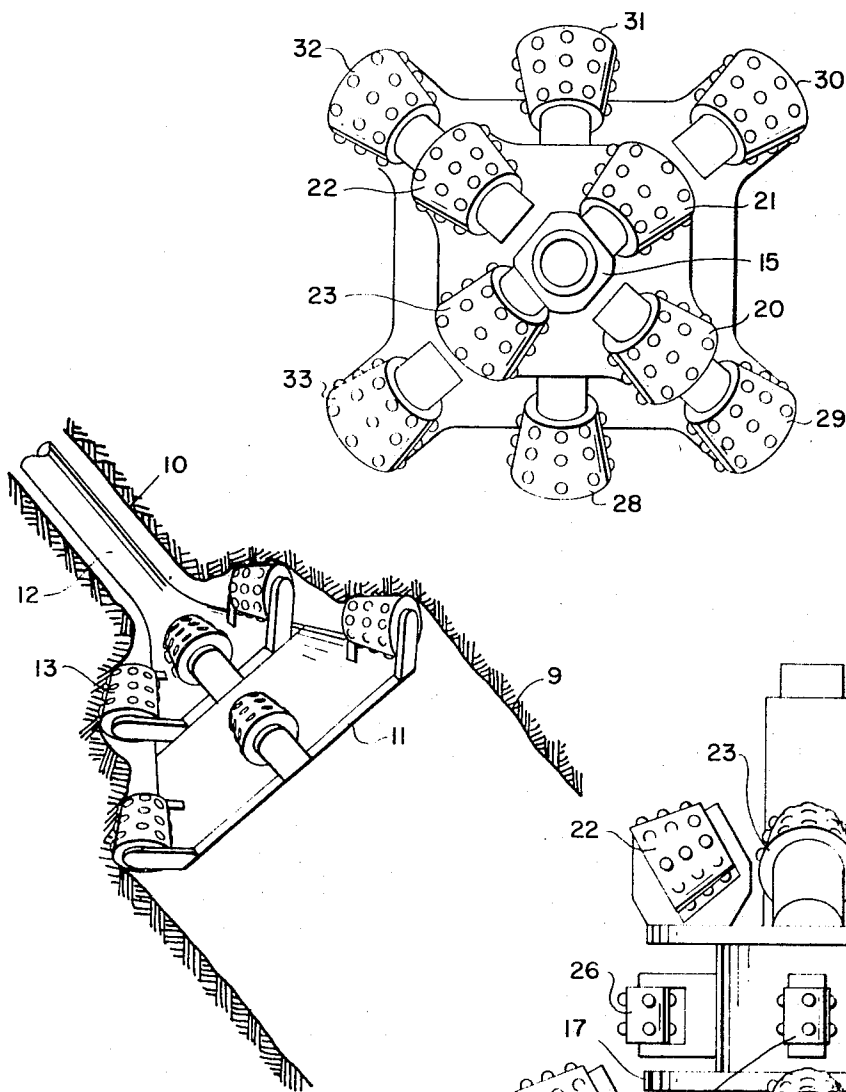


FIG. 3

FIG. 1

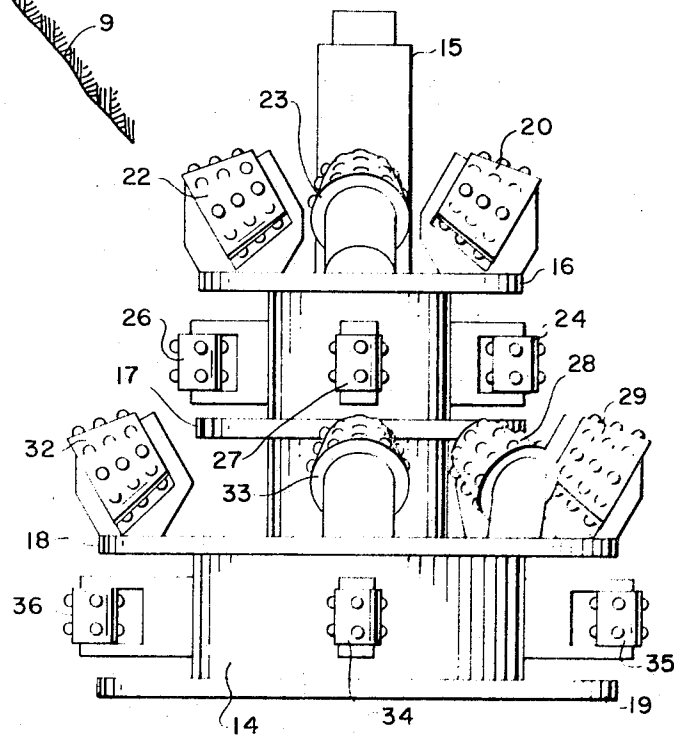


FIG. 2

INVENTOR
WILLIAM M. CONN

Eddie E. Scott

ATTORNEY

LARGE DIAMETER BIT FOR SHALLOW ANGLE HOLES

BACKGROUND OF THE INVENTION

This invention relates to the art of earth boring and more particularly to an improved large diameter bit for drilling shallow angle holes. A shallow angle hole may be defined generally as a hole having an angle of less than 45° with a horizontal plane.

The drilling of a large diameter hole may be accomplished by drilling a small pilot hole through the formation from a first location to an opening at a second location and subsequently enlarging the hole to the desired size by a reaming operation. The bit of this invention is generally used for enlarging the pilot hole into a large diameter hole. The bit of this invention is especially useful wherein the pilot hole is at a shallow angle.

This bit is the type of bit generally referred to as "raise bits" because of their extensive use in boring raise holes between levels of an underground mine. The term "raise" may have been applied to this type of operation because the pilot hole was drilled from one level of a mine down to another level and the hole enlarged by a raising operation on the upward pass. The bit of this invention may be used for boring raise holes and in other operations wherein a large diameter hole is desired. This may include boring either up or down.

Many strict requirements are imposed upon a bit to be used in boring large diameter holes. The bit must be a balanced, high performance apparatus that is rugged and will perform for a long period of time. It is desirable to have a majority of the elements wear out at about the same time without premature failure of any one element. Bits of this type generally use replaceable cutters located and spaced so that on rotation of the bit every portion of the hole being drilled will be acted upon by one or more of the cutters to disintegrate the formation. This insures that almost the entire wear in drilling takes place on the cutters rather than on the main bit body. The cutters are readily replaceable thereby allowing the life of the bit to be extended by replacing individual cutters.

DESCRIPTION OF THE PRIOR ART

A brief summary of the prior art may be obtained by reference to U. S. Pat. No. 3,220,494 to R. E. Cannon et al., patented Nov. 30, 1965. A large diameter hole is obtained by drilling a relatively small pilot hole and subsequently enlarging the pilot hole to the desired size by rotating and hydraulically raising a raise cutter head along the pilot hole.

A number of drilling problems are encountered with large diameter bits of the prior art. Among the problems are those described in U. S. Pat. No. 3,231,029 to Douglas F. Winberg et al., patented Jan. 25, 1966. When the large diameter bit is boring through formations wherein a relatively hard material is on one side of the raise hole, such as rock, and a relatively soft material, or void, is on the other side of the hole, the cutter is unevenly loaded and is urged by the harder material toward the softer material or void. This subjects the drill stem to a lateral component of force in addition to the torsional forces encountered. This results in an unstabilized and inefficient drilling operation. The hole drilled tends to wander from the straight line.

The problems mentioned above are aggravated and additional problems introduced when the pilot hole extends at a shallow angle. The large diameter bit is subjected to new forces and the existing forces are greater when boring a shallow angle hole. The weight of the bit causes it to drift off to the low side of the hole. The gage row of cutters can dig into the bottom side of the hole thus introducing additional and undesirable forces. The new forces may be damaging to the working parts of the bit such as the gage row cutters and compacts. The torque requirements are increased when the additional forces are introduced to the bit. The hole drilled by the large diameter bit tends to deviate from a straight line.

SUMMARY OF THE INVENTION

The bit of the present invention facilitates the boring of a straight line shallow angle large diameter hole. The bit of this invention has a plurality of drilling stages with each drilling stage having a series of cutters surrounding a central shaft. Consecutive stages progressively increase in diameter thereby allowing the pilot hole to be enlarged to the desired size. The staged configuration provides a stabilizing effect and reduces wandering of the bit as drilling proceeds. Integral stabilization sections are included after each drilling stage to help support the weight of the large diameter bit body and reduce the extraneous forces encountered in boring a shallow angle hole. This prevents the gage row of cutters from digging into the bottom side of the hole thus maintaining stabilization and concentricity of the reamed hole to the pilot hole. The lifetime of the individual cutters is extended as is the lifetime of the entire bit. The torque required to rotate the bit is reduced and the hole drilled by the improved bit is closer to a straight line.

It is therefore an object of the present invention to provide an improved large diameter bit for boring a shallow angle hole.

It is a further object of the present invention to provide stabilization to a large diameter bit.

It is a still further object of the present invention to provide a bit that will maintain concentricity of the reamed hole to the pilot hole.

It is a still further object of the present invention to provide a smooth drilling operation and longer bit and cutter life.

It is a still further object of the present invention to reduce the torque required to rotate a large diameter bit in a shallow angle hole.

The above and other objects and advantages will become apparent from the consideration of the following detailed description when taken in conjunction with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 shows a pilot hole being enlarged by a reaming operation wherein the pilot hole is at a shallow angle.

FIG. 2 shows an embodiment of the present invention.

FIG. 3 is a top view of the bit shown in FIG. 2.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to FIG. 1, a pilot hole 10 extending at a shallow angle is shown being enlarged into a large diameter hole 9 by a large diameter bit 11. Large diameter bit 11 is rotated and moved along the pilot hole 10 by a rotary drill rig (not shown) located above. The force to rotate and move the bit 11 along the pilot hole 10 is transmitted by a rotary drill string 12. The weight of the bit 11 tends to cause the reamed hole to vary from a straight line. Concentricity of reamed hole to pilot hole is not maintained and the drilling operation is inefficient. As the inner cutters 13 encounter the lower side of the hole, they tend to dig into the formations and introduce extraneous forces. A greater amount of torque is required to rotate bit 11. The various elements of bit 11 are subjected to greater stresses and consequently their useful lifetime is shortened.

Referring now to FIG. 2, a large diameter earth boring bit is shown. This bit may be used to enlarge a pilot hole into a large diameter hole wherein the pilot hole is at a shallow angle. The large diameter bit 14 includes a central stem 15 surrounded by a multiplicity of drilling stages. The stem 15 is connected to a rotary drill string by threaded connection or other means well known in the art. A series of plates 16, 17, 18 and 19 are mounted concentrically around stem 15. The plates 16, 17, 18 and 19 support a multiplicity of cutting stages and stabilization stages. The first drilling stage includes four rolling cutters 20, 21, 22 and 23 mounted in individual saddles, said saddles attached to plate 16. The saddles allow cutters 20, 21, 22 and 23 to be easily removed and new cutters inserted. An example of a removable cutter and saddle system is shown in U. S. Pat. No. 3,203,492 to C. L. Lichte, patented Aug. 31, 1965.

Mounted immediately below the first drilling stage is a stabilization stage. This stabilization stage provides support for the weight of the bit in a shallow angle hole and helps insure concentricity of reamed hole to pilot hole. Four individual rolling members 24, 25, 26 and 27 are positioned below cutters 20, 21, 22 and 23. The axes of rolling members 24, 25, 26 and 27 are substantially parallel to the axis of stem 15 and to the central axis of the bit 14. The individual rolling members may be cutters mounted in saddles attached to bit 14. The rolling members may be removably mounted in such saddles to facilitate replacement.

Immediately below the stabilization stage is a second cutting stage. This second cutting stage includes six rolling cutters 28, 29, 30, 31, 32 and 33 removably mounted in individual saddles as explained in connection with the first cutting stage.

Mounted immediately below the second drilling stage is another stabilization stage including four rolling members 34, 35, 36 and 37. These rolling members provide stabilization to the bit and support the weight of the bit in a shallow angle hole. The axes of individual rolling members 34, 35, 36 and 37 are substantially parallel to the axis of stem 15 and to the central axis of the bit 14. The rolling members may be cutters removably mounted in saddles attached to the bit 14.

Referring now to FIG. 3, a top view of the bit shown in FIG. 2 demonstrates how the bit when rotated and hydraulically moved along the pilot hole will produce a large diameter hole. As the bit 14 is rotated, the individual cutters contact and disintegrate the formations. The cutting surfaces of the individual cutters must traverse the entire surface of the hole being bored and the saddles and other portions of the bits must not contact the formations being drilled. It can be appreciated that additional drilling stages may be included in order to provide an even larger diameter bit. In order to support the weight of the bit and to insure concentricity of reamed hole to pilot hole, the additional drilling stages should be supported by rolling members.

The first drilling stage includes cutters 20, 21, 22 and 23. Two of these cutters 21 and 23 are in close proximity to stem 15, whereas the other two cutters 20 and 22 are positioned a greater distance from stem 15. The second drilling stage includes two cutters 28 and 31 that are positioned closer to stem 15 than the remaining four cutters 29, 30, 32 and 35. The arrangement of cutters insures that all portions of the formations will be disintegrated to form the large diameter hole. It can be appreciated that other combinations, sizes and arrangements of cutters may be provided without departing from the scope of this invention.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A bit for enlarging a small diameter hole into a large diameter hole by disintegrating the formations surrounding the small diameter hole, said bit to be connected to a rotary drill string that extends through the small diameter hole with the central axis of said bit aligned with the central axis of said rotary drill string, comprising:

a main bit body having a diameter larger than the diameter of the small diameter hole, said main bit body having a central axis that establishes the central axis of said bit;

means on the central axis of said main bit body for connecting said main bit body to the rotary drill string;

rolling cutter means mounted on said main bit body with the axis of rotation of said rolling cutter means inclined to the central axis of said main bit body for contacting and disintegrating the earth formations surrounding the small diameter hole at a first distance from the bit central axis;

and

rolling stabilization means mounted on said main bit body with the axis of rotation of said rolling stabilization means substantially parallel to the central axis of said main bit body for contacting the formations at substantially said first distance from the bit central axis and supporting a portion of the weight of the bit and providing stabilization to said bit.

2. The bit of claim 1 wherein said rolling stabilization means include a multiplicity of individual rolling members mounted on said main bit body for contacting the formations at substantially said first distance from the bit central axis and supporting a portion of the weight of the bit and stabilizing the bit, the axis of rotation of said rolling members being substantially parallel to the central axis of said main bit body.

3. A bit for enlarging a shallow angle pilot hole into a large diameter hole by disintegrating portions of the formations surrounding the pilot hole, said bit to be connected to a rotary drill string that extends through the shallow angle pilot hole with the central axis of the rotary drill string being generally concentric with the central axis of the pilot hole, comprising:

a central shaft with a central axis that forms a bit central axis;

a connection on said central shaft for connecting said central shaft to the rotary drill string with the central axis of said central shaft aligned with the central axis of said rotary drill string;

first rolling cutter means connected to said central shaft for contacting and disintegrating the formations surrounding the pilot hole at a first distance from the bit central axis, the axis of rotation of said first rolling cutter means inclined to the bit central axis;

rolling stabilization means positioned below said first cutter means for contacting the formations at substantially said first distance from the bit central axis and supporting a portion of the weight of the bit and stabilizing the bit, the axis of rotation of said rolling stabilization means being substantially parallel to the bit central axis; and

second rolling cutter means connected to said central shaft for contacting and disintegrating the formations surrounding the pilot hole at a second distance from the bit central axis, the axis of rotation of said second rolling cutter means inclined to the bit central axis.

4. The bit of claim 3 wherein said rolling stabilization means include a multiplicity of individual rolling members mounted below said first rolling cutter means for contacting the formations at substantially said first distance from the bit central axis and stabilizing the bit and supporting a portion of the weight of the bit, the axis of rotation of said rolling members being substantially parallel to the bit central axis.

5. The bit of claim 6 including additional rolling stabilization means for stabilizing and supporting a portion of the weight of the bit, positioned below said second cutter means at substantially said second distance from the bit central axis, the axis of rotation of said additional rolling stabilization means substantially parallel to the bit central axis.

6. The bit of claim 5 wherein said additional rolling stabilization means include a multiplicity of individual rolling members mounted below said second rolling cutter means for contacting the formations at substantially said second distance from the bit central axis and stabilizing the bit and supporting a portion of the weight of the bit, the axis of rotation of said rolling members being substantially parallel to the bit central axis.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,659,660 Dated May 2, 1972

Inventor(s) William M. Conn

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

Column 4, claim 5, line 51, change "6" to --4--.

Signed and sealed this 23rd day of January 1973.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents