United States Patent

Lichte

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[54] LARGE DIAMETER BIT WITH A REPLACEABLE STEM

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[52] **U.S. Cl.** **175/53**, 175/334

[51] **Int. Cl.** **E21c 23/00**

[58] **Field of Search** 175/53, 334, 335, 391

[56] **References Cited**

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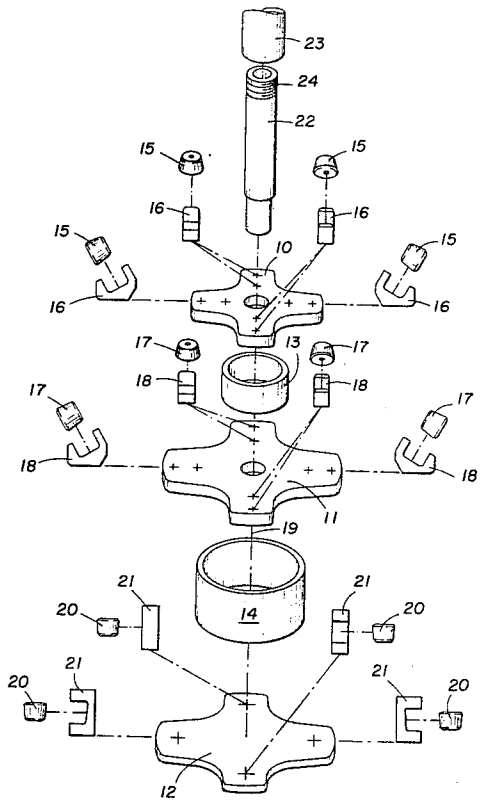
[57] **ABSTRACT**

A bit for drilling a large diameter hole has a replaceable stem. The body of the bit includes a multiplicity of stages around a central axis. The bit is attached to the drill column by a replaceable stem connected to the main body of the bit and the body of the bit includes a series of plates separated by a series of hollow support elements.

8 Claims, 3 Drawing Figures



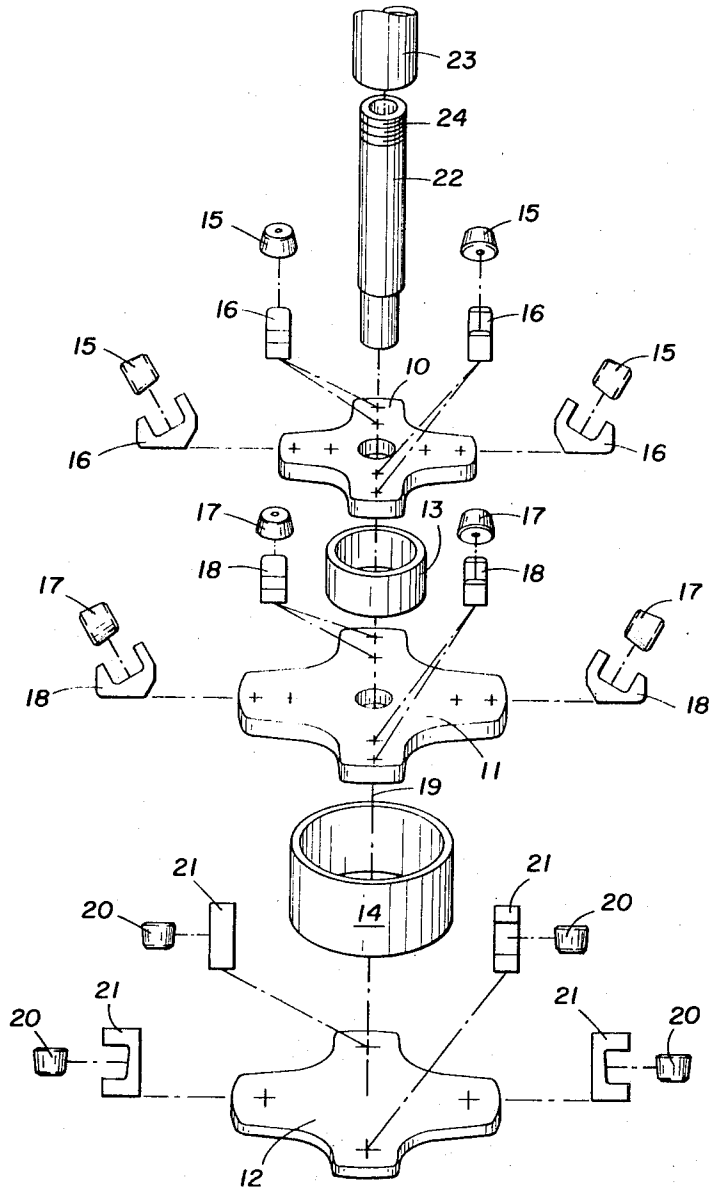


FIG. 1

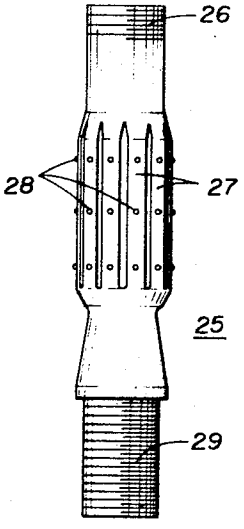


FIG. 2

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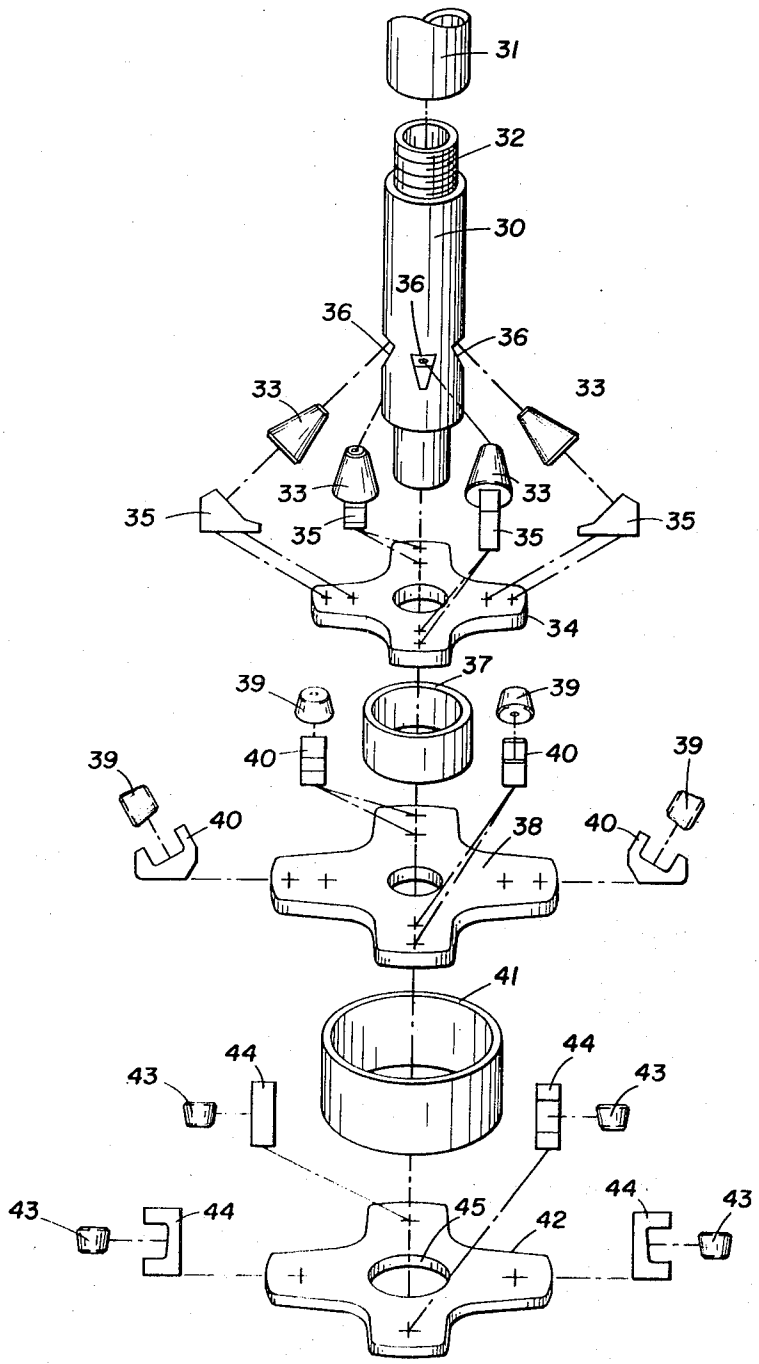

FIG. 3

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LARGE DIAMETER BIT WITH A REPLACEABLE STEM

BACKGROUND OF THE INVENTION

This invention relates to the art of earth boring and more particularly to a rotary bit for drilling large diameter holes.

The drilling of a large diameter hole may be accomplished by drilling a small pilot hole through the formations from a first location to an opening at a second location and subsequently enlarging the hole to the desired size by a reaming operation. After the pilot hole is completed, the pilot bit is removed and a large diameter bit attached to the drill column. As the large diameter bit is rotated and moved along the pilot hole it enlarges the pilot hole to the desired size.

The large diameter bit has a central body made up of a plurality of stages, each stage having a larger diameter than the previous stage. Individual cutters are mounted on each stage for disintegrating the formations as the bit is rotated and moved along the pilot hole. The bit is attached to a rotary drill column by a stem mounted along the central axis of the bit.

DESCRIPTION OF THE PRIOR ART

The prior art is represented by U. S. Pat. No. 3,220,494 to R. E. Cannon et al., patented Nov. 30, 1965, wherein a pilot hole is enlarged to the desired size by rotating and drawing a large diameter bit upward along the pilot hole. This operation places a great amount of wear and stress upon the large diameter bit; consequently, a need exists for a large diameter bit that will stand up under severe drilling conditions. It is desirable to keep the cost of the bit as low as possible. In order to do this, the amount of high cost materials used in the bit should be held to a minimum. The process of manufacturing the bit should be carried out in the most economical manner possible and the lifetime of the bit should be long.

The large diameter bit should have a large mass in order to include adequate strength and rigidity. It must operate smoothly, without excessive vibrations and should tend to follow the pilot hole. Cutters should be positioned in a way that will inherently preserve a balanced mass and also cancel the drilling forces by balancing one force against another. A carefully balanced bit will exhibit a longer life and will drill a true hole. Prior art bits have only been partially successful in accomplishing these objectives. Assuming that it was possible to produce a perfect bit, the bit would still have to drill a heterogeneous rock formation and the bit body and stem would be subjected to great loads with high shock. The stem functions as a pilot to guide the bit along the pilot hole and is subjected to severe abrasive wear, high tensile and torque loads, and high bending stresses during drilling.

Although the prior art bits have included replaceable cutters, they have not provided a replaceable stem. Because of the stress, wear and other abuses encountered by the stem, its life is shorter than that of the body. This results in high drilling costs because bits must be discarded due to stem failure even though the body of the bit is still in working condition. In addition, it is impossible to change the size of the stabilizer portion on the stem of prior art bits in order to correct undersized stabilizer conditions because attempts to weld the stem material results in discontinuities and subsequent stem failure.

Manufacturing costs of prior art bits have been high because more high cost materials were used than was necessary to combat wear and stress. The manufacture of bits of the prior art required complicated and expensive joining procedures. In addition, the manufacture of prior art bits included complicated alignment procedures for the stem and various other elements with the necessity of subsequent machining operations.

SUMMARY OF THE INVENTION

The present invention provides a large diameter bit for reaming a pilot hole into a large diameter hole by rotating and drawing the large diameter bit along the pilot hole. The tremendous stress and wear encountered in the reaming operation causes some elements to wear out much earlier than

others, notably the cutters and stem. The bit of the present invention allows the elements that have a relatively short lifetime to be replaced, thereby extending the lifetime of the bit and reducing cost. The stem is replaceable as well as individual cutters; this allows the elements that receive the greatest stress and wear to be readily replaced. The relatively short lifetime of the individual cutters results from their nearly constant contact with the formations and the consequent exposure to wear and abuse. The stem also contacts the formations and receives a great deal of wear and abuse. One embodiment of this invention includes a stabilizer section on the replaceable stem. This stabilizer is approximately the same diameter as the pilot hole and consequently is exposed to a great deal of stress. When the stem and stabilizer reach the end of their useful lifetime, they may be removed and a new stem and stabilizer inserted in their place.

Other factors enter into limiting the useful life of the stem. One of these factors is the tremendous stresses encountered by the stem. The stem absorbs a large amount of stress because it is the single link between the drill column and the body of the bit. All energy from the rotary equipment is transmitted to the bit through the stem. Generally the pilot hole tends to wander which results in a series of curves over the length of the pilot hole. As the large diameter bit is drawn along the pilot hole the drilling geometry changes. This results in a tremendous amount of stress being transmitted to the stem when the large diameter bit is being drawn through the curves. The outside radius of the large diameter bit may be many times greater than the radius of the pilot hole, therefore, the moment developed is great. When resistance is encountered by cutters located on the outer radius of the bit, as when drilling along a curve, it causes increased stress on the stem. It can be appreciated that changes in formations encountered complicates the abovementioned conditions and adds to the drilling difficulties.

Consequently, the stem must be constructed of material that will stand up under these conditions. Such material is expensive and any reduction in the amount of this material in the bit results in a cost savings. The bit of this invention allows separate processing for the body of the bit and the stem. The stem may be manufactured from high strength material whereas the body may include low strength and therefore less expensive materials. Manufacturing costs of the bit of this invention are also less than in the prior art because the joining and alignment procedures are less.

The bit of this invention consists of a multiplicity of stages. Each stage is of an increasingly larger diameter and carries a multiplicity of cutters thereby insuring that all portions of the formations will be acted upon to form the large diameter hole. In addition, the graduated stages provide stability to the bit during drilling and prevent wandering. The individual cutters are mounted on plates that are centered and extend perpendicular to the central axis of the bit. The plates are separated by hollow support sections. The stem is removably attached to the first stage along the central axis of the bit. The multiplicity of stages gives the body of the bit a degree of stiffness not found in bits of the prior art.

It is therefore an object of this invention to provide a bit for boring a large diameter hole that has a replaceable stem.

It is a further object of the present invention to provide a bit for boring a large diameter hole that is more efficient and economical than those of the prior art.

It is a still further object of the present invention to provide a large diameter bit that will perform better than those of the prior art.

It is a still further object of the present invention to provide a large diameter bit that is less expensive than those of the prior art.

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

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is an exploded view of a bit of this invention.

FIG. 2 shows another embodiment of the replaceable stem of this invention.

FIG. 3 shows another embodiment of a bit of this invention.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to FIG. 1, a series of plates **10**, **11** and **12** are separated by hollow cylindrical sections **13** and **14**. Plates **10**, **11** and **12** are firmly affixed to sections **13** and **14** by suitable means such as welding or a series of bolts.

The first drilling stage includes a series of four cutters **15** mounted in a corresponding series of saddles **16**. The saddles **16** are firmly affixed to plate **10**. While four saddles and cutters are shown for illustration purposes, it is to be understood that a different number of saddles and cutters may be used without departing from the invention. The basic requirement is that the bit remain balanced. The cutters **15** are rolling cutters and are removably mounted in saddles **16**. An example of this type of cutter is shown in U. S. Pat. No. 3,203,492 to C. L. Lichte, patented Aug. 31, 1965.

The second drilling stage includes a series of four cutters **17** mounted in a corresponding series of saddles **18** similar to the cutter and saddle arrangement described in conjunction with the first drilling stage. The cutters **17** are mounted at a greater distance from the central axis **19** than are cutters **15** of the first drilling stage in order to insure that all portions of the formations are disintegrated.

The third drilling stage is similar to the previous two drilling stages except that cutters **20** and saddles **21** are mounted a greater distance from the central axis. Thus it can be seen that the bit provides a number of drilling stages, each stage progressively increasing in diameter. As the bit is rotated and drawn along a pilot hole the pilot hole is enlarged in diameter to the desired size. It can be appreciated that additional stages may be added to the bit to produce an even larger diameter hole.

Plates **10**, **11** and **12** and cylindrical elements **13** and **14** provide strength and stiffness to the bit without requiring the high strength and therefore expensive materials used in the stem **22**. It can also be appreciated that the bit of this invention places a greater portion of the mass of the bit near the drilling surfaces than bits of the prior art and is consequently a better performing bit. The bit must maintain its alignment and shape during drilling because any change would create an unbalanced condition and consequently introduce damaging stresses. The bit of this invention accomplishes this objective and provides a stronger and more reliable bit than those of the prior art.

The large diameter bit is attached to a rotary drilling column **23** in order to enlarge a pilot hole. Stem **22** includes conventional means, such as a threaded connection **24**, for connecting the bit to drilling column **23**. Stem **22** extends into the bit and is attached thereto. The stem **22** may be firmly attached to the body of the bit by suitable means such as welding. For example, stem **22** may be welded to plates **11** and **12** thereby firmly affixing it to the body of the bit. When the stem **22** is to be replaced, the welds may be cut and stem **22** removed. Other suitable means of removably attaching the stem to the main bit body are contemplated. For example, the stem **22** may have a threaded section that mates with threads on one of the plates, or the stem **22** may be bolted to the body of the bit.

The bit of this invention provides a substantial cost savings because the amount of high strength, high cost materials required is less than in prior art bits. The stem **22**, may be processed separate from the main body and subsequently attached which reduces manufacturing costs by eliminating the complicated joining and alignment processes. In addition, the main body of the bit may be used to enlarge different sized pilot holes by using a stem with a diameter that matches that of the pilot hole.

Referring now to FIG. 2, another embodiment of the replaceable stem is shown in general at **25**. Stem **25** includes means **26** for connection to the drill column and a stabilizer section **27**. The stabilizer section **27** insures that the bit follows the pilot hole and prevents the bit from moving around as drilling progresses. Stabilizer section **27** receives most of the wear from engagement with the pilot hole. A multiplicity of compacts **28** may be inserted on stabilizer section **27** to receive the wear and to insure continuity in drilling. Stem **25** may be attached and removed from the main body of the bit by a threaded connection **29** or by other suitable means such as those previously explained in connection with FIG. 1.

Referring now to FIG. 3, another embodiment of the bit of this invention is shown. A removable stem **30** may be attached to a rotary drill column **31** by threaded connection **32**. A first drilling stage includes a series of four cutters **33**. The cutters **33** are supported by stem **30** and plate **34**. Mounted on plate **34** are four support elements **35**. Elements **35** support one end of roller cutters **33**. The other end of roller cutters **33** is supported by four support elements **36** mounted on stem **30**. Plate **34** fits on stem **30** and is welded thereto or attached thereto by other suitable means. A hollow support element **37** is attached to plate **34** and a plate **38** is attached to the other end of hollow support element **37**. Stem **30** is also attached to plate **38** by welding or some other suitable means. Plate **38** supports cutters **39** mounted in saddles **40**. A second hollow support element **41** is attached to plate **38** and a plate **42** is attached to the other end of hollow support element. Plate **42** supports a series of cutters **43** mounted in a corresponding series of saddles **44**. Plate **42** includes an opening **45** to provide access to the connection between stem **30** and plate **34**. This allows the stem **30** to be easily attached and removed from the body of the bit.

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

1. A bit for enlarging a pilot hole into a large diameter hole by disintegrating the earth formation surrounding the pilot hole comprising:

a main bit body including a multiplicity of drilling stages for contacting and disintegrating the earth formation surrounding the pilot hole wherein said multiplicity of drilling stages consist of a multiplicity of plates separated by and attached to a multiplicity of hollow support elements and a multiplicity of saddles with cutters mounted in said saddles, said saddles and cutters mounted on said plates; and

a stem for extending through said pilot hole that is removably connected to at least two drilling stages of said main bit body.

2. The bit of claim **1** including first means for removably connecting said stem to one of said multiplicity of plates and second means for removably connecting said stem to another of said plates.

3. The bit of claim **2** including stabilizer means connected to said stem for contacting said pilot hole and stabilizing said bit.

4. A bit for enlarging a pilot hole by disintegrating the formations surrounding the pilot hole, said bit to be attached to a rotary drill column, comprising:

a main bit body including

a first plate,

a second plate,

a first hollow support element connected to and separating said first and second plates,

a multiplicity of cutter means for disintegrating the formations, said multiplicity of cutter means mounted on said first and second plates, and

a stem removably connected to both of said plates, for attaching said bit to said rotary drill column.

5. The bit of claim **4** including:

a third plate,

a second hollow support element connected to and separating said second and third plates, and

a multiplicity of cutter means for disintegrating the formations mounted on said third plate.

6. The bit of claim 5 including an opening in said third plate to provide access to said second plate.

7. The bit of claim 5 including:

at least one additional plate with cutter means mounted thereon and at least one additional hollow element.

8. The bit of claim 7 wherein said stem includes a stabilizer section with an enlarged diameter.

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