United States Patent

[11] 3,552,505

[72] Inventors **Charles T. Thompson**
Dallas, Tex.;
Frank B. Kidd, New Iberia, La.; William R. Henry, Corpus Christi, Tex.

[21] Appl. No. **778,195**
[22] Filed **Nov. 22, 1968**
[45] Patented **Jan. 5, 1971**

[73] Assignee **American Coldset Corporation**
Teterboro, N.J.
a corporation of Texas

[54] **CORE BIT AND CORE CRUSHER APPARATUS**
15 Claims, 5 Drawing Figs.

[52] **U.S. Cl.** **175/57,** 175/398, 175/404
[51] **Int. Cl.** **E21b 9/16,** E21c 13/02
[50] **Field of Search** 175/333, 398, 400, 404, 213

[56] **References Cited**

UNITED STATES PATENTS

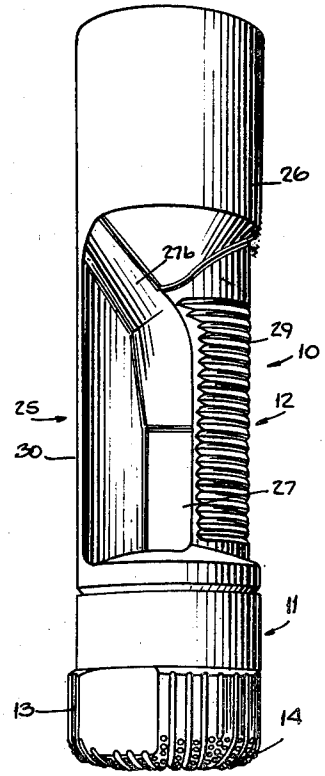
1,785,120	12/1930	Harding	175/333
1,785,405	12/1930	Candee et al.	175/404X
1,867,024	7/1932	Oliver	175/404X
2,520,517	8/1950	Taylor	175/400X
2,931,630	4/1960	Grady	175/330
3,215,215	11/1965	Kellner	175/404X

FOREIGN PATENTS

1,366,092	6/1964	France	175/404
900,099	7/1962	Great Britain	175/404

Primary Examiner—David H. Brown
Attorney—Kenyon & Kenyon, Reilly, Carr & Chapin

ABSTRACT: A well-boring apparatus is disclosed as including a core bit to cut material within a borehole in the form of a core during a well-drilling operation and a core crusher to crush the core material between the wall of the borehole and the core crusher. The core bit and core crusher also include passages for delivering fluid to the bottom of the borehole to serve as a cutting fluid for the core bit and to flush the core material from the cutting surfaces of the core bit.



PATENTED JAN 5 1971

3,552,505

SHEET 1 OF 2

Fig. 1.

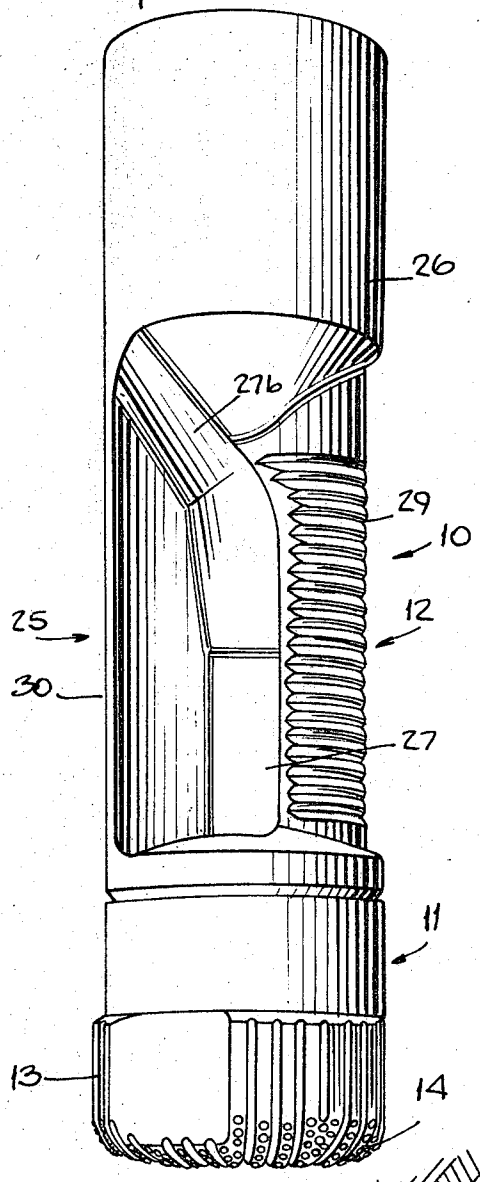


Fig. 2.

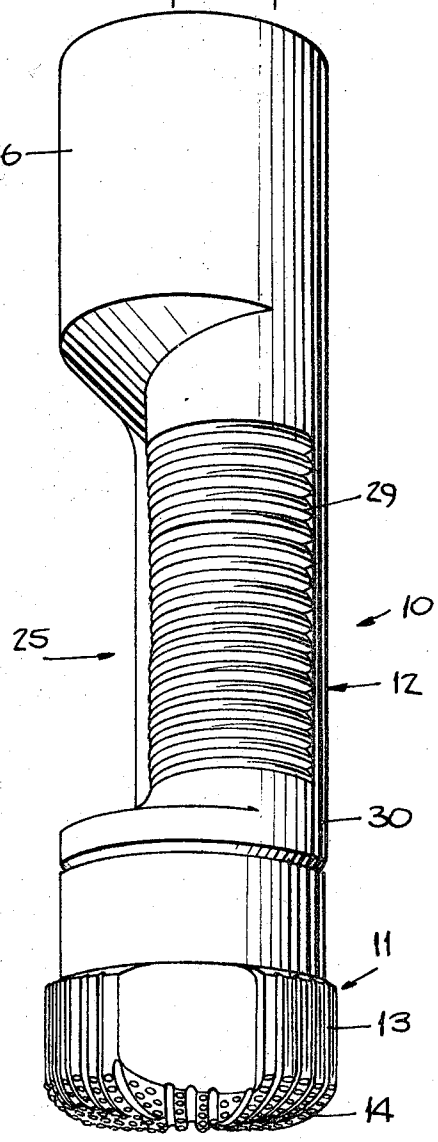
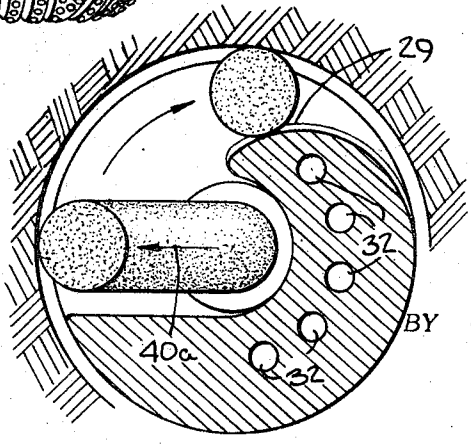


Fig. 3.



INVENTORS
CHARLES T. THOMPSON
FRANK B. KIDD
WILLIAM R. HENRY
BY
Kenyon & Kenyon
ATTORNEYS

PATENTED JAN 5 1971

3,552,505

SHEET 2 OF 2

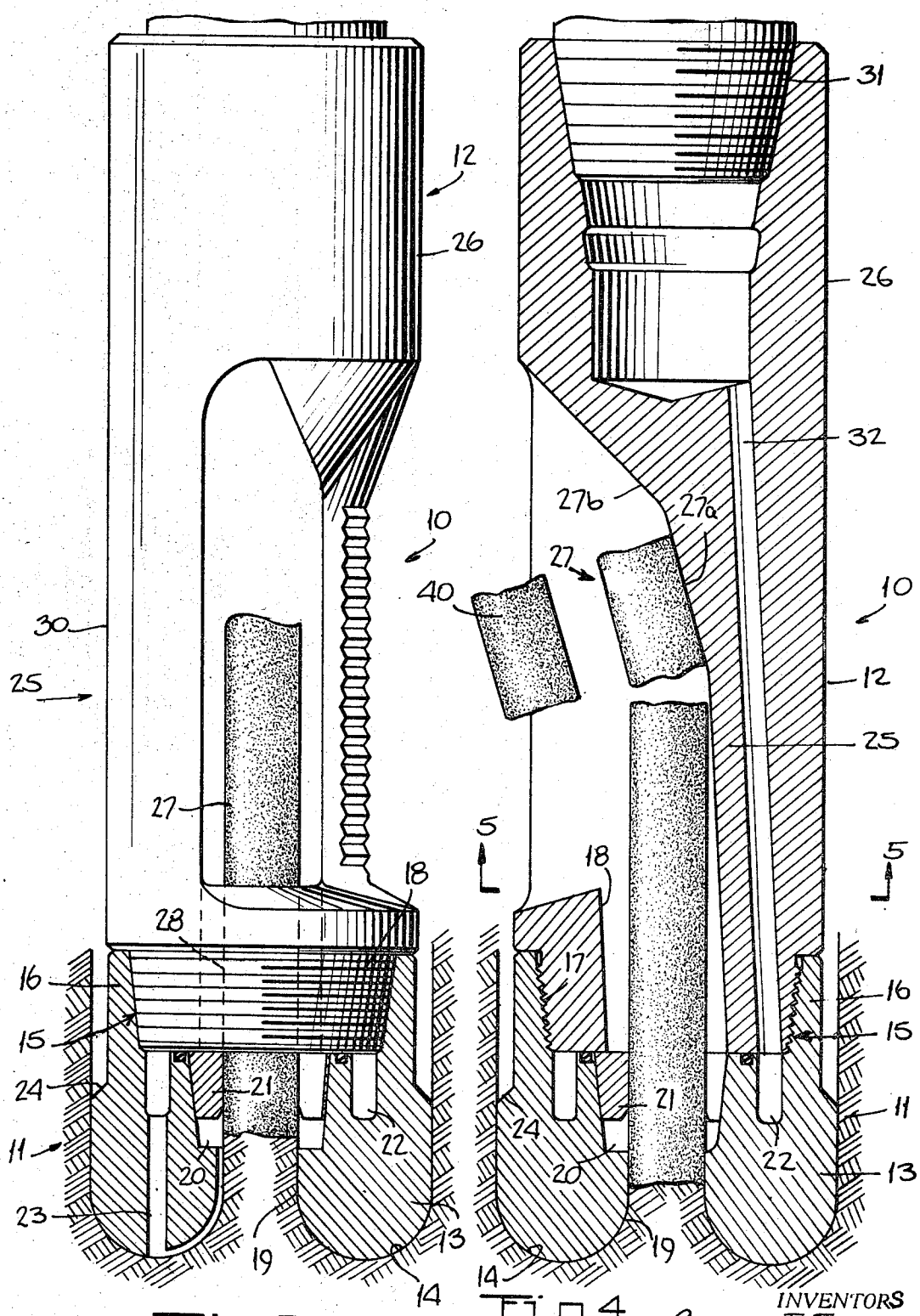


Fig. 3.

Fig. 4.

INVENTORS
CHARLES T. THOMPSON
FRANK B. KIDD
WILLIAM R. HENRY

BY Kenyon & Kenyon
ATTORNEYS

CORE BIT AND CORE CRUSHER APPARATUS

BACKGROUND OF THE INVENTION

This invention relates to a core bit and core crusher that can be used to perform a continuous well-drilling operation and in particular to apparatus that can continually crush core material that is generated during the drilling operation

In attempting to reach underground deposits, boreholes are drilled deep into the earth. Generally this is done by using a drill string to rotate a bit having a cutting surface on its lowest portion which is advanced into the earth. In cutting certain formations of underground strata, it is of advantage to use a core bit which has an angular cutting pattern at its face. Consequently a central core of material is formed within the core bit as it advances. A problem arises in breaking up and removing the core material as the bit advances downwardly.

DESCRIPTION OF THE PRIOR ART

With conventional core bits the core material being cut by the bit is not immediately crushed after it is cut from the center of the borehole but instead is forced into the bottom of the borehole, then outwardly around the core bit, and finally in an upward direction passing between the cutting elements of the core bit, the drill string rotating the core bit and the borehole wall. Such conventional core bits can become clogged with cuttings especially when the material being cut is soft. Of course if such core bits become clogged, it is necessary for the drilling apparatus to withdraw the drill string in order that the soft core material can be removed from the core bit.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide improved apparatus for drilling boreholes into the earth.

Still another object of the present invention is to provide a core bit and core crusher that can remove core material from a borehole and crush the core material after it has been generated in order that the core material cannot interfere with the operation of the core bit and core crusher.

A further object of the present invention is to provide a core bit and core crusher which can continuously drill a borehole and continuously flush away the core material from the face of the cutting surfaces of the core bit in order that it can continuously be crushed against the wall of the borehole by the core crusher.

Briefly, in accordance with the present invention, the foregoing and other objects are accomplished by utilizing a core bit attached to a core crusher with a central passage extending through the core bit and core crusher to receive core material which is being formed during the drilling operation by cutting surfaces on the core bit. The core crusher includes a relieved portion which has a sizing surface against which core material from the central passage of the core bit and core crusher is directed. Rotation of the core crusher crushes the core material between the sizing surface of the core crusher and the wall of the borehole. After crushing, the core material is passed upwardly along the shank portion of the core crushing device and along the drill string.

DESCRIPTION OF THE DRAWINGS

Other objects, aspects and features of the present invention will be apparent from the following description and drawings in which:

FIG. 1 is a perspective view of an embodiment of the present invention;

FIG. 2 is a perspective view of an embodiment of the invention taken at a position 90° from the position in which the view of FIG. 1 is taken;

FIG. 3 is a fragmentary vertical section view of an embodiment of the invention during a boring operation;

FIG. 4 is another cutaway fragmentary vertical section view of an embodiment of the present invention taken in a different plane from that of the view of FIG. 3; and

FIG. 5 is a horizontal section view taken along line 5–5 of FIG. 4.

DESCRIPTION OF PREFERRED EMBODIMENT

In FIGS. 1—4 of the drawings a core crusher assembly 10 in accordance with the present invention is seen to include a core bit 11 attached to a core crusher 12, the latter adapted to be rotated by a drill string. Core bit 11 includes a cutter head portion 13 which cuts the core material from the borehole during a drilling operation and which includes, as seen in FIGS. 1 and 2, a suitable cutting surface 14 including cutting elements such as diamonds. Core bit 11 is generally in the form of a hollow cylinder and includes FIGS. 3 and 4) a socket portion 15 in the interior of the bit at a location furthest away from cutter head portion 13. Annular shoulder 16 surrounding socket portion 15 is internally threaded to engage external threads 17 on stub 18 of core crusher 12 so the two members may be securely fastened to each other.

A central passage 19 extends from the center of the cutter head portion 13 of core bit 11 to the base portion of socket portion 15. Tapered annular recess 20 surrounds central passage 19 and extends outwardly from the base of socket portion 15 and surrounds a part of central passage 19. An annular member 21, such as a core blank or catcher, may be located in annular recess 20 immediately adjacent the base of socket portion 15. A core catcher will be utilized to retain core material which has not been crushed when the boring apparatus is raised from the bottom of the borehole. In some cases the core material is soft enough so this function is not necessary and when this occurs the core catcher can be replaces with a core blank. Of course, if it is known that the standing core will not interfere with movement of the boring apparatus on and off the borehole bottom, the bit can be constructed without a core catcher or core blank. An annular well 22 is located adjacent annular shoulder 16 and extends from the base of socket portion 15 into the interior of the cuttinghead portion of the core bit to communicate with a fluid passage 23 which extends to cutting surface 14. As can be seen in FIGS. 1—4, cutting head portion 13 of core bit 11 has a greater outside diameter than the outside diameter of annular shoulder 16, the latter extending to the periphery of cutting head portion 13 at tapered edge 24.

Core crusher 12 (FIGS. 3 and 4) is seen to be a generally cylindrically-shaped member including a male threaded stub portion 18 at one end, a central base portion 25 and an end shank portion 26. Central base portion 25 is seen to include a relieved portion which includes an open channel 27 which is in alignment with a central passage 28 of stub 18. Open channel 27 includes inclined plane surface 27*a* which leads to surface 27*b*, the latter extending to one surface of the crusher attachment. A sizing surface, such as a spiral cam 29, extends partially about the central base portion and is contiguous with surface 30 of base portion 25. As can be seen in FIG. 2, surface 30 and spiral cam 29 form an enclosed periphery of core crusher 12 and extend to either edge of channel 27.

A threaded inlet portion 31 (FIG. 4) in shank portion 26 of the core crusher communicates with a plurality of fluid passages 32 which extend about the cross section of the core crusher with one of the passages shown in FIG. 4. As can best be seen in FIG. 3, the outer surface of shoulder 16, the circumference of shank portion 26 and surface 30 all are approximately the same distance from an axis passing longitudinally through the geometric center of the combined core bit and core crusher.

When it is desired to commence well-boring operations, core bit 11 and core crusher 12 are threadedly engaged to one another, as seen in FIGS. 3 and 4, by having the male threads 17 on stub portion 18 of core crusher 12 engage the female threads located on the inside of annular shoulder 16. As the core crusher and the core bit are coupled to one another, fluid passages 32 of core crusher 12 are aligned with annular well

22 of core bit 11 to communicate therewith. The core bit and core crusher are then attached to a drill string in order to be rotated and driven into the earth. Drilling liquid is supplied to port 31. As the rotating core bit and core crusher descent into the earth, the core material will be cut from the borehole by rotating cutting surfaces 14 of the core bit. Since the cutting is performed with a hollow circular pattern, a core of material, as seen in FIGS. 3 and 4 is formed and extends into central passage 19 within core bit 11. The core being formed is guided to central passage 28 within stub portion 18 of core crusher 12. The core material then passes through open channel 27 and, if homogeneous, will stand until it is forced off the core crusher longitudinal axis by inclined plan surface 27*a* causing the core to break into increments, an increment 40 as seen in FIG. 4 to the left of channel 27. These increments transverse by centrifugal force to the periphery of the borehole as indicated by the movement of increment 40 along path 40*a* in FIG. 5. The rotation of the core crusher wedges the increment between the spiral cam 29 and the inside of the borehole as seen in FIG. 5. This process continues at regular, but intermittent, intervals. The broken core material then passes upwardly between the wall of the borehole and shank 26 since the shank has a smaller outside diameter than that of cutting head portion 13, which determines the diameter of the borehole.

As the crushing of core material takes place, drilling liquid is forced, under pressure, through inlet port 31 and passages 32 of core crusher 12 to annular well 22 of core bit 11. The fluid in annular well 22 of core bit 11 is directed, via passage 23, to cutting surfaces 14 of cutter head 13 where part of the fluid is passed about the external surface of the cutting head and part of the fluid passed through central passage 19 within the core bit. By having the liquid directed into the bore at the cutting surfaces of the core bit, all the material about the cutting surfaces of the core bit are flushed therefrom. Small cuttings are continuously generated and simultaneously flushed at the face of the bit to be carried by the fluid both internally and externally of the bit. The fluid that goes about the external surface of cutting head 13 flushes material from the periphery of the cutting head and as the fluid passes upwardly about the base portion and the shank of the core crusher, it assists in directing the crushed core material in an upward direction, past the core crusher and ultimately along the drill string.

It can thus be seen that the core bit and core crusher of the present invention will continuously crush the core material as it is formed at the face of the borehole. This procedure prevents large chunks of the core material from interfering with the rotation of the core bit and core crusher thus allowing a continuous drilling operation.

If it is desired to use a different core bit than the bit disclosed in FIGS. 1—4, core bit 11 may be unscrewed from core crusher 12 and a new core bit substituted therefor.

While a sizing surface consisting of a spiral cam has been disclosed it is of course obvious that other sizing surfaces could be used.

Having thus described the invention, it is not intended that it be so limited as changes may be readily made therein without departing from the scope of the invention. Accordingly, it is intended that the subject matter described above and shown in the drawings be interpreted as illustrative and not in a limiting sense.

We claim:

1. In combination with a core bit having a cylindrical body with an annular cutting head disposed on one end and a central axial passageway extending therethrough, said core bit being adapted for rotation in a predetermined direction about the axis thereof for generating a core of material in a drill hole, the improvement comprising a core crusher which includes:

a cylindrical member connected in axial alignment with the body of said core bit and having a relieved portion extending inwardly from the cylindrical surface thereof to adjacent the central axis of said cylindrical member and along the length thereof, one end of said relieved portion being in communication with the central passageway of said core bit, said relieved portion having:

a core-engaging surface extending adjacent the central axis of said cylindrical member along a portion of the length of said relieved portion, said core-engaging surface being moved adjacent the core of material as the core bit is rotated and advanced within the drill hole, with the core material extending through said central passageway and into said relieved portion, said core-engaging surface extending progressively outwardly toward the cylindrical surface of said cylindrical member in the direction of the other end of said relieved portion for deflecting the core of material toward the wall of the drill hole as the core bit is rotated and advanced within the drill hole; and

a core-sizing surface extending simultaneously outwardly and circumferentially from one side of said core-engaging surface adjacent the central axis of said cylindrical member for a portion of the length of said relieved portion, said core-sizing surface extending in a direction opposite to said predetermined direction of rotation and intersecting the cylindrical surface of said cylindrical member, whereby the core of material generated by said core bit as the core bit rotates and advances is sequentially deflected toward the wall of the drill hole by said core-engaging surface and crushed against the wall of the drill hole by said core-sizing surface.

2. The combination of claim 1 wherein said relieved portion extends through an arcuate portion of the cylindrical surface of said cylindrical member which subtends an obtuse angle, the remaining portion of said cylindrical member having a substantially continuous cylindrical surface extending from adjacent said relieved portion.

3. The combination of claim 1 in which said relieved portion further includes an open channel extending axially along a portion of the length of said relieved portion adjacent the central axis of said cylindrical member, the surface of said open channel providing said core-engaging surface, the end of said open channel adjacent said one end of said relieved portion being substantially in alignment with the central passageway of the core bit, whereby said channel is adapted to receive and direct the core material generated by said core bit.

4. The combination of claim 1 and further comprising means for transferring a liquid through said core crusher and said cutting head to the surface thereof to flush drilled material away from the cutting head both outwardly between the wall of the drill and the body of the core bit and inwardly between the wall of the central passageway and the surface of the core.

5. The combination of claim 4 wherein said core bit and said core crusher are threadedly connected to one another, whereby a worn core bit can be replaced without changing the core crusher.

6. The combination of claim 5 wherein:

the body of said core bit includes a female threaded portion;

said core crusher includes a male threaded portion on one end for detachably mating with the threaded portion of the body of said core bit and an additional female threaded portion on the other end thereof for connecting said core crusher to a drill stem; and

said cutting head of the core bit has the largest outside diameter of any part of said core bit and said core crusher.

7. The combination of claim 4 wherein said means for transferring a fluid through said core crusher and said core bit to said cutting head comprises:

said core bit and core crusher each having surfaces in an interfacing relationship, said core crusher having a port disposed in said interfacing surface and a flow passage extending therefrom;

said cutting head of said core bit having an outlet opening facing away from said core crusher; and

said core bit having an inlet opening in said interfacing surface in alignment with said port and an additional flow passage extending from said inlet opening to said outlet opening.

8. The combination of claim 7 wherein said inlet opening comprises an annular groove in the body of the core bit at said interfacing surface.

9. The combination of claim 1 in which said relieved portion further includes an open channel extending axially along a portion of the length of said relieved portion adjacent the central axis of said cylindrical member, the surface of said open channel providing a portion of said core engaging surface, the end of said open channel adjacent said one end of said relieved portion being substantially in alignment with the central passageway of the core bit, said core-engaging surface having a portion spaced apart from said channel end adjacent said one end of said relieved portion and inclined outwardly toward the periphery of said cylindrical member in the direction of the other end of said channel, whereby said outwardly inclined portion of said core-engaging surface is adapted to deflect and fracture the core material generated by said core bit.

10. The combination of claim 9 wherein said core-engaging surface further comprises an additional portion disposed between said outwardly inclined portion of said core-engaging surface and said other end of said channel, said additional portion being more sharply inclined with respect to the central axis of said cylindrical member for applying increased fracturing forces on the core of material not broken up by said outwardly inclined portion of said core-engaging surface.

11. The combination of claim 9 wherein said core-sizing surface has an inner extremity extending adjacent the length of said channel and an outer extremity extending adjacent the periphery of said cylindrical member, the clearance between said core-sizing surface at its inner extremity and the wall of the borehole being at least equal to substantially the diameter of said central axis passageway, whereby the clearance between said core-sizing surface and the wall of the borehole is adapted to receive and crush the core material therein.

12. The combination of claim 11 wherein said core-sizing surface comprises a spiral cam whose surface extends substantially from one end of said open channel to the other end thereof and has its minimum radius of curvature at said inner extremity.

13. The combination of claim 12 wherein said spiral cam has a radius of curvature at said outer extremity thereof substantially equal to the radius of curvature of the periphery of said cylindrical member.

14. The combination of claim 13 wherein said core-sizing surface of said spiral cam includes a plurality of parallel grooves extending in planes disposed at substantially right angles to the central axis of said cylindrical member and forming lands therebetween, said lands being adapted to increase the unit compressive load on the broken core of material during the core-crushing operation.

15. A method for removing a cylindrical core of material from a borehole, the core of material being produced by a core bit adapted to be rotated in a predetermined direction about the axis thereof and to be advanced along said axis in the direction of a cutting face thereof, said core bit having a central axial passageway extending therethrough for generating said cylindrical core, the method comprising the steps of:

continually maintaining a length of the cylindrical core extending from the cutting face through the axial passageway of the core bit substantially along the axis thereof, the end portion of the cylindrical core material opposite the cutting face being disposed beyond the end of the central axial passageway which is opposite the cutting face thereof;

rotationally deflecting the end portion of the cylindrical core material which is opposite said cutting face and which is beyond the end of the central axial passageway away from the axis of the core bit toward the wall of the borehole by the application of a rotating bending force to the periphery of the core of material to fracture the end portion transversely into increments and to release the same;

directing the released increments outwardly toward the wall of the borehole;

wedging the released increments between the core bit and the wall of the borehole to crush the core material; and

urging the crushed material to move between the wall of the borehole and the core bit in a direction extending away from the cutting face thereof.