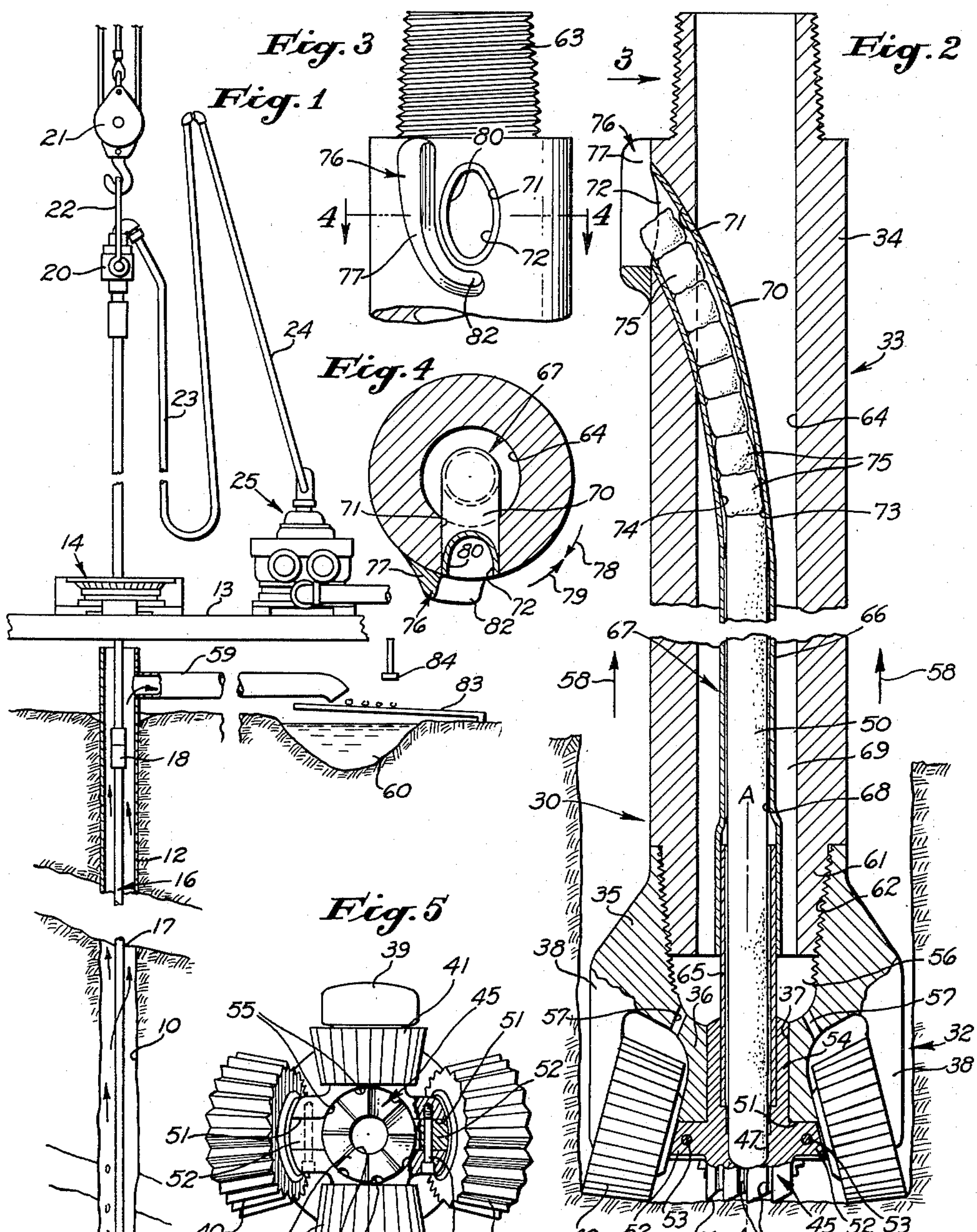
Aug. 29, 1950 H. A. TAYLOR 2,520,517

APPARATUS FOR DRILLING WELLS

Filed Oct. 25, 1946 3 Sheets-Sheet 1



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Filed Oct. 25, 1946 3 Sheets-Sheet 2

Fig. 6

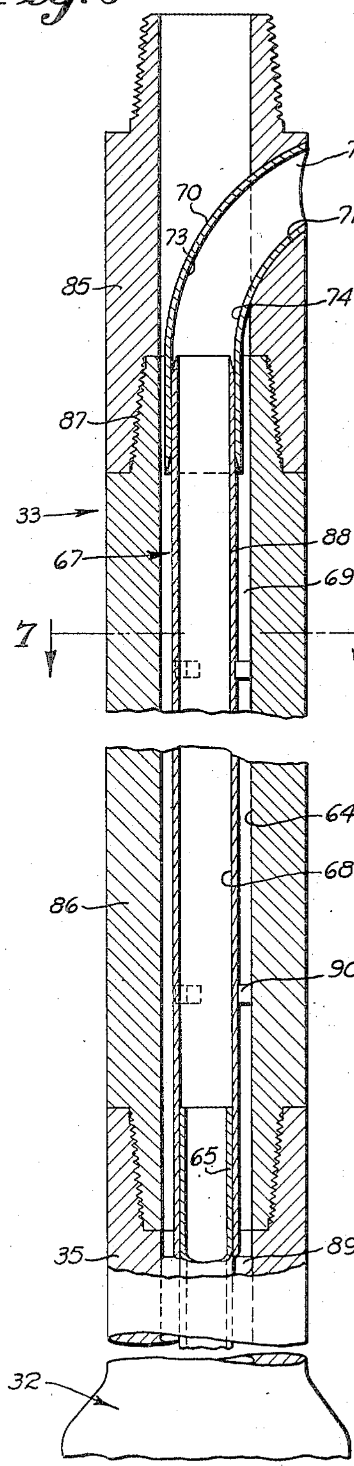


Fig. 7

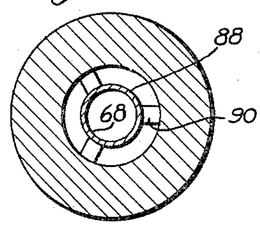
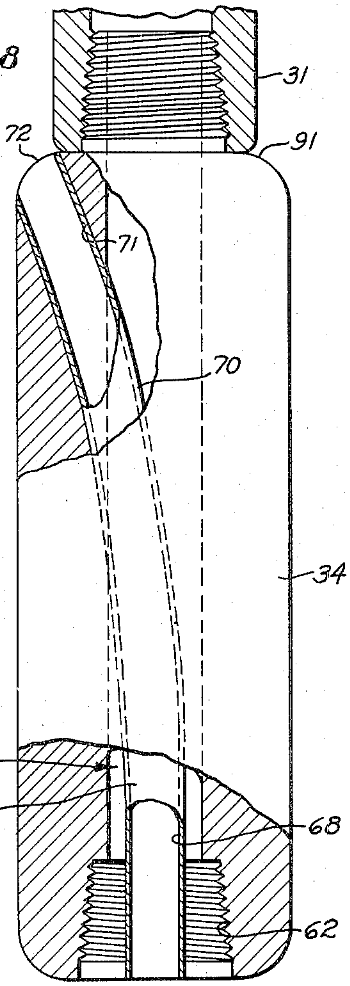


Fig. 8



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Filed Oct. 25, 1946 3 Sheets-Sheet 3

Fig. 9

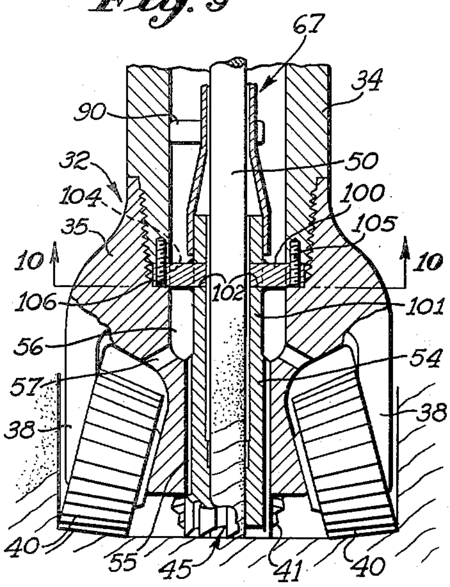


Fig. 11

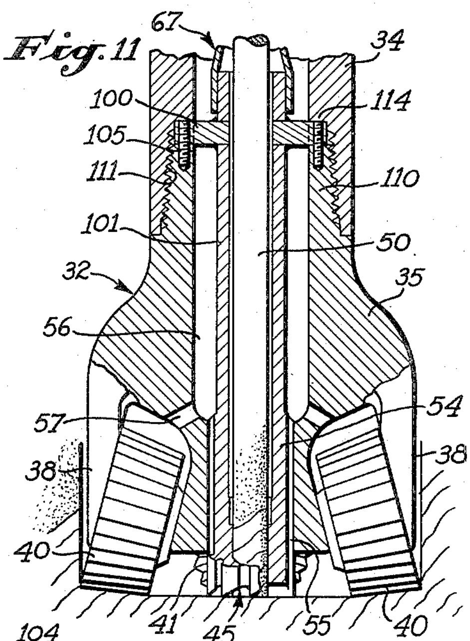


Fig. 10

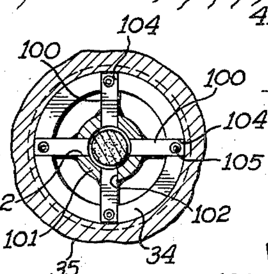


Fig. 12

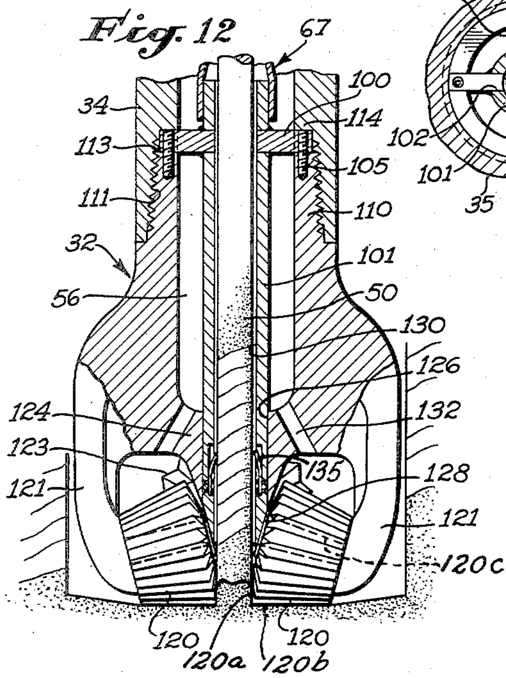
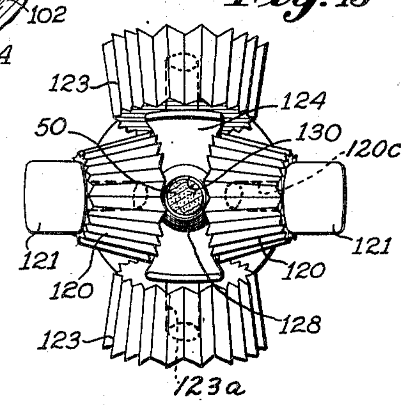


Fig. 13



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Patented Aug. 29, 1950

2,520,517

UNITED STATES PATENT OFFICE

2,520,517

APPARATUS FOR DRILLING WELLS

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Application October 25, 1946, Serial No. 705,691

17 Claims. (Cl. 255—72)

1

My invention relates to well drilling and, more particularly, to a novel drilling apparatus suited to obtain core sections during continued drilling and/or a residual or filamentary core upon withdrawal of the drilling bit for inspection, repair, or replacement.

The present invention contemplates cutting into the earth in an annular zone to leave a central core portion which is maximized in length by being progressively disintegrated into core particles, and it is an object of the invention to provide an improved drilling structure for accomplishing this.

By the term "disintegrating," I have reference to a subdivision of the central core portion into core particles, irrespective of the size thereof. Such core particles may be relatively small sand-like or cutting-like particles, as when the core portion is substantially completely disintegrated, or they may be in the form of larger masses, hereinafter termed core sections, which are severed, broken, or otherwise removed from the central core portion, being of substantial size but representing more than a mere temporarily compacted mass of cuttings from a bit. Such core specimens give particularly valuable data concerning subterranean strata including geological age, slope and character of subterranean strata, etc.

The present invention contemplates that the core particles, resulting from the progressive disintegration of the central core portion during continued drilling, shall be discharged to the exterior of the drilling structure and preferably into a column of fluid moving upward in the well. For example, it is common practice to drill wells by use of a rotary bit during the time that a high-density drilling mud is forced into the zone of the cutters to carry upward in the well the cuttings. In the preferred practice of the present invention, the core particles are discharged into the rising drilling mud and, if of substantial size, can be separated therefrom at the top of the well to provide a continuous coring method giving valuable information as to subterranean strata during continued drilling. It is an object of the present invention to provide an improved drilling system for accomplishing this.

The invention also contemplates a drilling structure having a central passage to receive the central core portion. Disintegration of this core portion preferably takes place a substantial but constant distance above the cutting elements, whereby the lower end of such a central passage contains a filamentary core. By use of the present invention, this core can be severed or detached from the earth's strata preparatory to lifting the drilling structure, and can be carried upward with the drilling structure when withdrawn for inspection, repair, or replacement. It is an object of the present invention to provide an improved apparatus for obtaining a residual filamentary core from a heavy duty drilling structure when withdrawn from the well.

2

Another object is to provide a novel telescoping interconnection between a bit and a drive unit; also, to provide a drive unit in which a tubular member is disposed to receive the core portion as drilling progresses.

If the disintegration of the central core portion breaks core sections therefrom, it is desirable that these be discharged into the rising fluid in such manner as to minimize abrasion thereof by the fluid. If such core sections are discharged from a rapidly rotating drilling structure into a body of fluid which is not rotating or rotating at lower velocity than the drilling structure, the fluid may unduly erode a core section extending into the fluid body. It is an object of the present invention to avoid undue abrasion at this point, as by deflecting the fluid from the immediate vicinity of the core passage from which the core sections issue.

Further objects of the invention lie in the provision of a novel rotary bit for cutting in an annular zone to leave a central core portion; also, to provide a structure in which fluid can be delivered to the cutters in an advantageous manner.

Further objects and advantages of the invention will be evident from the following description of exemplary embodiments.

Referring to the drawings:

Fig. 1 is a utility view, showing diagrammatically well drilling equipment employing one form of the invention;

Fig. 2 is a vertical cross-sectional view of the drilling structure of Fig. 1;

Fig. 3 is a side view of the upper end of the drilling structure of Fig. 2, taken as indicated by the arrow 3;

Fig. 4 is a horizontal sectional view, taken along the line 4—4 of Fig. 3;

Fig. 5 is a bottom view of the drilling structure of Fig. 2;

Fig. 6 is a vertical sectional view of an alternative embodiment of the invention employing a removable tubular member;

Fig. 7 is a horizontal cross-sectional view, taken along the line 7—7 of Fig. 6;

Fig. 8 is a side view, partially in section, of a further alternative embodiment;

Figs. 9 and 10 are sectional views of an alternative embodiment, Fig. 10 being taken along the line 10—10 of Fig. 9;

Fig. 11 is a vertical sectional view of another embodiment; and

Fig. 12 is a vertical sectional view and Fig. 13 is a bottom view of a further alternative embodiment.

Referring particularly to Fig. 1, the invention is shown as being used to drill a well or bore 10 in the earth to penetrate strata suggested at 11, a portion of the well being shown cased by a casing 12. Derrick floor 13 carries the usual rotary drilling table 14 turned by a suitable power source, not shown, to rotate a drill column 16 formed of sections of drill pipe 17 coupled by joints 18. At the upper end of the drill column 16 is the usual swivel 20, the lowering of the drill column being controlled by the position of a travelling block 21 connected to the swivel through a bail 22. The upper end of the drill column is supplied with a fluid, such as a high-density drilling mud, to move downward therethrough and carry the cuttings upward in the well. This fluid may be supplied at high pressure and very considerable volume through hose 23 and pipe 24 by a circulating pump 25.

The drilling structure 30 of the invention is secured to the lower end of the drill column 16, as by a collar 31. Essentially, the drilling structure 30 includes a bit 32 and a drive unit 33, here shown as a drill collar or sub 34 detachably connected to the collar 31.

The bit 32 is shown as including a body 35 having a depending head 36 having a central opening 37. The body 35 has two diametrically opposite arms 38 and two additional diametrically opposite arms 39. In the space between each of the arms 38 and the depending head 36 is a peripherally-toothed frusto-conical gage cutter 40 rotating on a suitable pin, not shown, extending between the arms and the head. Similarly, between each arm 39 and the depending head 36 is a peripherally-toothed frusto-conical mill cutter 41, similarly journalled on a pin, not shown. The innermost portions of the two mill cutters 41 are preferably spaced a distance substantially corresponding to the diameter of the central opening 37, as best shown in Fig. 5. As the bit 32 turns, the cutters 40, 41 rotate on their respective pins and revolve relative to the central axis A—A of the bit, which axis coincides with the axis of the central opening 37. During rotation of the bit 32, the cutters 40 and 41 cut into the earth in an outer annular zone, the gage cutters 40 deepening the bore in the outer portion of such zone and determining the well diameter, while the mill cutters 41 cut into the earth in the inner portion of such outer annular zone and, in the absence of other cutting elements, would leave a core portion of a diameter substantially equal to that of the central opening 37.

In this embodiment of the invention, additional core-cutting means is provided, comprising a core-cutting element 45 detachably extending into the central opening 37. The lower end of this core-cutting element provides teeth 46 which terminate opposite or somewhat above or below the lower portions of the cutters 40, 41. These teeth are disposed around a central passage 47 of the core-cutting element 45 and cut into the earth in an inner annular zone within the previously mentioned outer annular zone to leave a central core portion 50 which extends upward in the central passage 47.

The core-cutting element 45 is detachably connected to the body 35 in any suitable manner. As shown, the lower end of the depending head 36 provides diametrically opposite cavities 51, and the core-cutting element 45 carries arms 52 extending snugly therein and retained by pins 53. The upper end of the core-cutting element 45 comprises a neck 54 extending into the central opening 37, the neck forming essentially a part of the bit body when the core-cutting element 45 is secured in place.

The inner surface of this opening 37 preferably cooperates with the outer surface of the neck 54 to provide a downwardly-directed passage means for jetting drilling mud or other fluid at high velocity toward the bottom of the well, preferably near the junction of the inner and outer annular zones, respectively penetrated by the teeth 46 and by the cutters 40, 41. In the preferred construction, the inner wall of the central opening 37 is cylindrical and engages snugly the outer wall of the neck 54. However, this outer wall provides longitudinal grooves around its periphery, these grooves facing the wall of the central opening 37 and cooperating therewith in defining a plurality of passages 55, best shown in Fig. 5. The upper ends of these passages communicate with a chamber 56 of the bit so that the drilling mud or other fluid in this chamber under high pressure will be jetted downward through the passages 55 to impinge on the floor of the well and aid the drilling operation, either by a hydraulic cutting, similar to that effected in hydraulic mining, or by directing the cutting fluid in the immediate vicinity of the teeth 46 to facilitate the cutting action and remove cuttings. Similiary, high-pressure drilling mud or other fluid may flow from the chamber 56 through four small passages 57, respectively directed toward the upper portions of the cutters 40 and 41 to wash the cuttings therefrom and facilitate the cutting action thereof. As in the usual practice, such drilling mud or other fluid rises in the well 10 around the drilling structure 30, as indicated by arrows 58, carrying the cuttings to the surface of the ground where the fluid and its associated cuttings discharge through a pipe 59 into a sump 60.

The sub 34, forming the drive unit of this embodiment of the invention, provides an externally-threaded neck 61 threaded into a cavity 62 of the bit. The uppermost end of the sub 34 is suitably connected to the collar 31 or to some other element of the drill column 16. As shown, the upper end of the sub includes a threaded neck 63 threadedly received by the collar 31. In the present invention, the sub 34 is preferably formed as a massive tubular member relatively easy to fabricate and providing a longitudinal passage 64 through which mud or other fluid may flow to the chamber 56 under high pressure.

The invention provides a means for progressively disintegrating the central core portion 50 at a position within the drilling structure 30, and preferably within the drive unit 33. While various disintegrating means can be employed, the preferred embodiment of the present invention contemplates the use of a structure for subjecting the central core portion 50 to bending stresses, e. g., by providing an axially curved core passage means along which the central core portion 50 is moved to break core sections from the central core portion. An exemplary structure of this type is best shown in Fig. 2.

Referring particularly to Fig. 2, the central passage 47 is counterbored to receive the lower end of a tubular member 65 traversing the chamber 56 and of an internal size slightly larger than the central core portion 50. In this respect, the central passage 47 may be stepped in size at an intermediate position, as suggested in Fig. 2, and may be of slightly smaller diameter than the interior of the tubular member 65. Telescoping with an upwardly-extending tubular portion of the tubular member 65 and coaxial with the axis A—A is a lower tubular portion 66 of a tubular member 67, these two tubular portions cooperating in forming a core-receiving passage 68. If desired, the lower end of the tubular member 67 may be slightly enlarged to receive the upwardly-extending tubular portion of the tubular member 65 or such enlargement can be eliminated, in which event that portion of the core-receiving passage 68 provided by the lower tubular portion 66 can be of slightly larger diameter than the interior of the tubular member 65. In either event, it is desirable that the lower tubular portion 66 telescope with the upwardly-extending tubular portion of the tubular member 65 when the bit 32 is connected to the drive unit 33. The junction is preferably relatively snug to prevent any of the drilling mud or other fluid moving from the chamber 56 between the telescoping portions and into the core-receiving passage 68. Such drilling mud or other fluid reaches the chamber 56 by flow through a fluid-conducting space 69 within the longitudinal passage 64 outside the tubular member 67. In this embodiment of the invention, no centering support is required between the lower tubular portion 66 and the sub 34 as the tubular member 65 of the bit may serve in this capacity.

The tubular member 67 provides an upper tubular portion 70 having an axis angling from the axis A—A. For example, the tubular member 67 may be bent intermediate its ends before being mounted in the sub 34, the upper tubular portion forming a continuation of the core-receiving passage 68. In the embodiment shown in Fig. 2, the sub 34 provides an opening 71 angling upwardly and fixedly receiving the upper end of the tubular member 67. The upper end of the tubular member 67 thus provides an orifice 72 opening on the exterior of the drive unit, e. g., the sub 34, for expulsion of disintegrated material.

As drilling progresses, the central core portion will rise into the bent portion of the tubular member 67. If still affixed to the earth, such central core portion will be stationary relative to the now-oscillating upper tubular portion 70. This is the usual mode of operation. However, if the central core portion has for some reason been severed from the earth, it will rotate with the bit 32 and drive unit 33. In either event, forcing of such a central core portion into the bent portion of the tubular member 67 will cause disintegration due, for example, to the application of bending forces as the central core portion is guided by the inner walls of the tubular member 67 along the core-conducting passage. Thus, when the upper end of the central core portion contacts an arcuate wall 73 formed by the upper tubular portion 70, it will be forced sideward into contact with an opposing wall 74 and a bending stress will be established in the core portion tending to disintegrate it. Depending partially upon the character of the formation, this disintegration will be into core particles of size varying from minute subdivisions of the core portion to sizable core sections. In drilling through hard formations, sizable chunks are broken from the central core portion, usually along natural cleavage planes, such core sections being indicated by the numeral 75. These core sections will stack up in the upper tubular portion 70 to be progressively forced from the orifice 72.

In the event that sizable core sections 75 are formed and progressively pushed from the orifice 72, each core section may be poised in the orifice 72 with its outer end projecting into the body of fluid in the well around the drive unit 33. Such body of fluid will be flowing upwardly at a rate depending upon the cross-sectional area available for flow and upon the rate of pumping. Such body of fluid will not, however, be rotating at the same speed as the drive unit 33 and, in fact, will be relatively stationary. When the drive unit 33 is turning rapidly with respect to such fluid body, the outer end of that core section 75 poised for discharge will tend to be washed or eroded by the body of fluid. The fluid will also apply a sideward pressure thereto tending to force it against a side wall of the upper tubular portion 70. If undue erosion or impediment of explusion is encountered, a deflector means 76 may be employed, as suggested in Figs. 2, 3, and 4.

Such a deflector means may include a deflector 77 extending outward from the drive unit, preferably adjacent the leading side of the orifice 72. For example, if the drive unit is rotating in the direction of arrow 78 of Fig. 4, the action will be as if the body of fluid were rotating past the orifice 72 in a direction indicated by arrow 79, and the leading side of the orifice 72 will be that side indicated by the numeral 80. The deflector 77 will deflect the fluid outwardly from the immediate vicinity of the orifice 72 and relieve the poised-for-discharge core section from undue erosive action or fluid-induced pressure which would otherwise be present. Preferably, the deflector 77 provides a lower portion 82 extending to a position below the orifice 72. This portion 82 may serve further to protect the poised core section against undue erosion because of upward velocity of the body of fluid. No corresponding portion is usually needed at the upper end of the orifice where, in fact, the upper end of the deflector 77 provides a protecting channel or space through which the discharged core section may rise. Various forms of deflector means can be employed to serve the desirable function of protecting the poised core section against erosion until it is sufficiently expelled from the passage of the upper tubular portion 70 to enter the rising fluid for transportation to the surface of the ground where such core sections can be caught on a screen 83 for inspection. If desired, the core sections can be washed preparatory to such inspection by a water-spray device 84.

Irrespective of whether or not core sections are collected during continuous drilling, it is often desirable to remove with the bit when withdrawn for inspection, repair, or replacement a filamentary core section, e. g., at least a part of the central core portion 50 within the drilling structure 30. The invention contemplates any suitable means for severing the central core portion from the earth, preferably at a position adjacent the bottom of the bore, preparatory to removal of the bit from the well. Such severance can be effected by stopping the circulation of drilling mud while continuing to rotate the bit rapidly often with substantially increased cutting pressure applied to the bit. This "burns in" the core portion, causing it to wedge tightly in the lower section of the central passage 47 and causing severance from the earth's strata. A core-catcher means, such as shown in Fig. 12, can be added to assist in holding the core portion in position. Thereafter, the core portion or residual filamentary core in the drilling structure can be raised to the surface of the ground, whereupon it can be forced from the confining passage of the drilling structure by any suitable means to represent the strata during the last few feet of drilling.

The embodiment of Figs. 6 and 7 differs from that previously described primarily in providing a sectional structure in which a portion of the tubular member 67 is removable from the drive unit 33. In this embodiment, the drive unit 33 includes upper and lower sections 85 and 86 threadedly joined at 87. The tubular member 67 is made sectional and comprises an upper tubular portion 70 extending in the opening 71, as previously described, but being of somewhat sharper radius of curvature. Corresponding to the lower tubular portion 66 is a removable tubular member 88 providing an upper end telescoping within the upper tubular portion 70 adjacent the junction of the sections 85 and 86, the ends of the telescoping elements being beveled, as indicated, to facilitate the telescoping action when the sections 85 and 86 are joined. The telescoping joint is preferably snug to prevent mud or other fluid entering the upper tubular portion 70 from the fluid-conducting space 69 now formed within the longitudinal passage 64 around the removable tubular member 88. The lower end of the removable tubular member telescopes with the upwardly-extending tubular portion of the tubular member 65 of the bit, as previously described, but one or more arms 89 center the tubular member 65 with respect to the bit body 35 and serve as stops to carry the weight of the removable tubular member 88. Such arms 89 can be eliminated in the event that the removable tubular member 88 provides a lower enlarged or bell-shaped portion similar to that illustrated in Fig. 2 for receiving the upper end of the tubular member 65. To aid in centering the removable tubular member 88 in the longitudinal passage 64, spider-like arms 90 may extend radially therefrom to slidably engage the inner wall of the longitudinal passage.

The embodiment of Figs. 6 and 7 can be employed with any suitable bit having a central passage through which the core portion rises into the core-receiving passage 68 as drilling progresses. Disintegration of the core portion takes place in the curved upper tubular portion 70 and the resulting disintegrated material or core particles, whether large or small, are expelled from the orifice 72, which can open on the exterior fluid or which can be provided with the deflector means 76 previously described. However, this embodiment of the invention facilitates removal of any residual or filamentary core raised to the surface of the ground in the core-receiving passage 68 when the drilling structure is lifted from the well. Such residual or filamentary core can easily be removed by unscrewing the sections 85 and 86 and drawing the removable tubular member 88 from the drive unit 33. A relatively long length of the residual or filamentary core may be withdrawn with the removable tubular member or the tubular member may be lifted without detaching the bit 32 to leave a columnar core in the longitudinal passage 64, the column being broken to remove a desired section thereof for inspection.

The embodiment of the drive unit shown in Fig. 8 is quite similar to that shown in Fig. 2 except that the sub 34 is made more massive and provides an upper corner 91. The opening 71 in this embodiment extends to the corner 91 so that the orifice 72 faces more nearly upwardly than in the previous embodiments. This gives additional clearance space between the drive unit 33 or the collar 31 and the outer wall of the well.

Figs. 9 and 10 show an alternative bit construction in which the core cutting element 45 is constructed substantially as previously described except that four arms 100 extend radially outward from a tubular member 101 comprising an extension of the neck 54, previously described. The arms 100 may extend from openings 102 of the tubular member 101, being suitably welded in place.

In this embodiment the outer ends of the arms 100 are detachably connected to the sub 34, constructed as previously described. In the preferred construction, the lower end of the sub 34 provides four radial slots 104 receiving the outer ends of the arms 100. These arms may be held in the slots 104 permanently, as by being welded therein, or temporarily, as by being held in place by screws 105. The bit body provides a shoulder 106 which engages the lower faces of the arms 100 when the bit 32 is attached to the sub 34. This arrangement supports the core cutting element independent of the cutters 40 and 41. This construction has the additional advantage that the mounting means for the core cutting element is disposed a substantial distance from the zone of cutting, thus eliminating any possibility of dropping the core cutting element if it should be severely abraded.

As before, the upper end of the tubular member 101 preferably telescopes with the lower portion of the tubular member 67 of the sub. The drilling mud moves between the arms 100 into the chamber 56 and discharges toward the cutters through the passages 57. A small portion of this mud may also be discharged through the peripheral passages 55, as previously described.

Fig. 11 shows a similar structure applied to a pin-type bit having a neck 110 received by a threaded socket 111 at the bottom of the sub 34. In this embodiment, the outer ends of the arms 100 extend into slots 113 formed in the neck 110 but otherwise corresponding to the slots 104 of the previously-described embodiment. The sub 34 provides a shoulder 114, corresponding in function to the shoulder 106 previously described.

The embodiment disclosed in Figs. 12 and 13 employs rotary mill cutters 120 as core cutting elements whereby the central core portion 50 is shaped and sized by the lowermost sections of toothed frusto-conical portions 120*a* of roller-type cutters which provide main teeth 120*b* facing and cutting into the earth in an inner annular zone, the teeth 120*b* being formed on a main frusto-conical portion or face of each cutter. The mill cutters 120 are shown as rotatably mounted on inclined pins 120*c* extending inwardly from arms 121 at such angle that a line drawn in the plane of the portion 120*a* of either cutter from the axis of the corresponding pin 120*c* to the lowermost tip of the cutter will lie substantially parallel to the axis of rotation of the bit body whereby the teeth on the portion 120a will shape and size the core portion 50. This embodiment also provides rotary gage cutters 123, best shown in Fig. 13 which are journalled on pins 123a extending outward from a depending head 124 of the bit body, these cutters determining the size of the bore. The cutting zones of the cutters 120 and 123 overlap.

In this embodiment, the tubular member 101 is carried by arms 100, as described with reference to Fig. 11. However, the lower end of the tubular member 101 extends through a central opening 126 of the depending head 124. Preferably, the lowermost end of the tubular member 101 extends downwardly into the tapered space between the mill cutters 120, being shown as terminating in a tapered portion 128 terminating a short distance above the bottom of the bore. This tubular member provides a central passage 130 which is slightly larger than the central core portion 50. With the construction shown the central passage 130 extends downwardly to a position quite close to the base of the central core portion 50 so as to minimize any unconfined section of the central core portion.

With the embodiment of Fig. 12, it is usually unnecessary to provide the peripheral passages 55 although these may be employed if desired. It is usually preferable to direct the mud through passages 132 of the depending head, these passages being directed respectively toward the four rotary cutters.

It is often desirable to provide a core-catching means in the lower portion of the tubular member 101, for example, the core catcher 135 of the conventional fingered type shown. Such a core-catcher means aids in severing and lifting the central core portion with the bit when raised.

It will be clear that various types of bits can be used with any of the embodiments of the drive unit 33 herein disclosed; also, that various other changes and modifications may be made without departing from the spirit of the invention as defined in the appended claims.

I claim as my invention:

1. Apparatus for drilling into the earth, including: a rotary bit having a central opening and cutter means disposed therearound for cutting into the earth in an outer annular zone; a core-cutting means comprising a body positioned in said central opening, said body providing teeth at its lower end, said teeth cutting in an inner annular zone within said outer annular zone to leave a central core portion, said body of said core-cutting means including a central passage for receiving said central core portion as drilling progresses; a first tubular member carried by said body of said core-cutting means and providing an upwardly-extending tubular portion; a drive unit operatively connected to said bit to rotate same; a second tubular member extending in said drive unit and providing a lower tubular portion telescoping with said upwardly-extending tubular portion of said first tubular member; and walls defining a passage communicating between said second tubular member and the exterior of said drive unit and having an axis angling from the axis of said second tubular member.

2. Apparatus for drilling into the earth, including: a bit body having a chamber; a tubular member carried by said bit body and extending along said chamber, said tubular member providing an upper tubular portion; cutting means carried by said bit body for cutting into the earth in an annular zone to leave a central core portion, said tubular member being of a size to receive said core portion as drilling progresses; walls defining a passage means communicating between said chamber and said cutting means for conducting a fluid from the former to the latter; a drive unit detachably connected to said bit body and providing a longitudinal passage; and means for disintegrating said central core portion within said drive unit, said means including a drive unit tubular member having a lower tubular portion telescoping with said upper tubular portion of said tubular member carried by said bit body near the zone of detachable connection between said bit body and said drive unit to receive said core portion, said means including a passage means angling from and across the axis of said drive-unit tubular member and opening on the exterior of said drive unit on one side thereof, said drive-unit tubular member extending in and being of smaller size than said longitudinal passage to provide a fluid-conducting space communicating with said chamber of said bit body.

3. A drive means for operatively interconnecting a rotary element and a rotary earth-boring bit providing cutting elements adapted to cut into the earth in an annular zone to leave a central core portion, said drive means including: a drive unit including means for connecting same to said bit and said rotary element, said drive unit including a longitudinal passage; a tubular member and means for positioning same in said longitudinal passage, said tubular member providing a lower portion within said longitudinal passage to define a fluid-conducting space for conducting fluid from said rotary element to said bit, said lower portion providing a core-receiving passage of a size to receive said central core portion, said tubular member providing an upper end in said longitudinal passage; and a core-disintegrating means for progressively disintegrating said core portion, said core-disintegrating means including a passage opening on the exterior of said drive unit and including a wall bounding said passage and angling across the axis of said upper end of said tubular member to be contacted by said core portion to disintegrate same into core particles, said passage conducting said core particles to the exterior of said drive unit, said core-disintegrating means providing a depending tubular portion telescoping with said upper end of said tubular member.

4. Apparatus for drilling into the earth, including: a rotary bit providing means for cutting into the earth in an annular zone to leave a central core portion, said bit including an upwardly-extending threaded portion and an upwardly-opening chamber within said threaded portion; a tubular member attached to said bit and extending upwardly in said chamber, said tubular member having an internal diameter sufficient to receive said core portion; a tubular drive unit having a depending threaded portion detachably connected to said upwardly-extending threaded portion of said bit at a position adjacent the upper end of said tubular member; a drive-unit tubular member within said tubular drive unit and having a lower end telescoping with the upper end of said tubular member attached to said bit when said bit and said drive unit are connected, said tubular members cooperating to define a core-receiving passage receiving said central core portion and being separable at their telescoping junction when said bit is detached from said drive unit; and means near the upper end of

said drive-unit tubular member for subjecting said core portion to bending stresses to subdivide same into core particles, said last-named means including means for conducting such core particles to the exterior of said drive unit as drilling progresses.

5. Apparatus as defined in claim 4, in which said upper end of said tubular member of said bit extends upwardly in said chamber no farther than the upper end of said upwardly-extending threaded portion of said bit, and in which the lower end of said drive-unit tubular member extends downwardly in said tubular drive unit a distance no farther than the lowermost end of said depending threaded portion of said drive unit.

6. An apparatus for drilling wells with the aid of a circulation of fluid moving upwardly in the drilled portion of the well and by use of a bit providing cutting elements disposed around but spaced from the axis of the well to cut into the earth in an annular zone when the bit is rotated, thereby leaving a central core portion extending upwardly into said bit, said apparatus including: a tubular drive unit; walls defining a core-passage means in said drive unit to receive said core portion; means for progressively disintegrating an upper section of said core portion in said core-passage means and including an orifice positioned to open on the upwardly-moving fluid in the well to discharge the disintegrated material thereinto; and a deflector means extending outwardly from the periphery of said drive unit adjacent said orifice and into the upwardly-moving fluid for deflecting said fluid away from said orifice.

7. Apparatus as defined in claim 6, in which said deflector means includes a deflector element extending outwardly from the periphery of said drive unit adjacent the leading side of said orifice to deflect said fluid from the immediate vicinity of said orifice during turning of said drive unit.

8. Apparatus for drilling into the earth and adapted for use with a tubular drive unit containing a tubular member having a lower end and an upper portion, said drive unit including means for disintegrating a core portion, said apparatus including: a rotary bit comprising a bit body, a pair of depending arms and a head positioned between said arms and spaced therefrom to define cutter spaces; a pair of rotary cutters; means for journalling said cutters in said cutter spaces, said cutters providing teeth, the innermost portions of said teeth being spaced from the axis of rotation of said bit body to leave an upstanding core portion; and walls defining a core-receiving space of a size to receive said core portion and extending from a lower position below the axes of rotation of said cutters upwardly through said bit body, said walls including a tubular member attached to said bit and bounding at least the upper portion of said core-receiving space, said tubular member extending upward a sufficient distance to telescope with said lower end of said tubular member of said drive unit.

9. Apparatus for drilling into the earth and adapted for use with a tubular drive unit containing a tubular member having a lower tubular portion and an upper portion and containing a core-disintegrating means, said tubular drive unit having a threaded portion adjacent the lower end of said lower tubular portion, said apparatus including: a rotary bit body providing an upwardly-extending threaded portion and an upwardly-opening chamber within such threaded portion, said upwardly-extending threaded portion being adapted to be threadedly connected to said threaded portion of said drive unit; a plurality of cutters carried by said bit body to cut into the earth in an annular zone to leave a central core portion, said bit body having an opening for receiving said core portion; and a tubular member carried by said bit body coaxially with said opening and of a diameter to receive said core portion and to telescope with said lower tubular portion of said tubular member of said drive unit, said tubular member carried by said bit extending upwardly in said chamber and conducting said core portion to said lower tubular portion.

10. Apparatus as defined in claim 9, in which said tubular member carried by said bit extends upwardly in said chamber no farther than the upper end of said upwardly-extending threaded portion.

11. Apparatus as defined in claim 9, in which said chamber includes a bottom wall having an opening of a size to receive and retain the lower end of said tubular member carried by said bit, this tubular member providing an upper portion extending along said chamber to telescope with said lower tubular portion and being supported solely by its said lower end being retained in said opening of said bottom wall.

12. Apparatus for drilling into the earth, including: a rotary bit having a central opening and cutter means disposed therearound for cutting into the earth in an outer annular zone; a core-cutting means comprising a body positioned in said central opening, said body providing teeth at its lower end, said teeth cutting into the earth in an inner annular zone within said outer annular zone to leave a central core portion, said body of said core-cutting means including a central passage for receiving said central core portion as drilling progresses; a drive unit operatively connected to said bit to rotate same, said drive unit providing a longitudinal passage axially aligned with said central passage of said core-cutting means; and a tubular member providing a lower tubular portion having an axis aligned with the axis of said central passage, said lower tubular portion extending downwardly in said longitudinal passage and being of smaller size than said longitudinal passage to provide a fluid-conducting space, said tubular member providing an upper tubular portion in open communication with said lower tubular portion and with the exterior of said drive unit but having an axis angling from the axis of said lower tubular portion; and passage means disposed adjacent the periphery of said body of said core-cutting means for conducting fluid from said fluid-conducting space to said core-cutting means and toward the bottom of the bore at a position adjacent the junction of said zones.

13. Apparatus for drilling into the earth, said apparatus including: a rotary bit having a central opening and cutting elements disposed therearound to cut in an outer annular zone; core-cutting means comprising a body extending into said central opening, said body providing teeth cutting in an inner annular zone within said outer annular zone to leave a central core portion, said core-cutting means including a central passage to receive said central core portion as drilling progresses; means for detachably connecting said body of said core-cutting means within said central opening of said bit, said con-

necting means including an arm on said core-cutting means, walls defining a cavity in said bit to receive said arm, and means for securing said arm in said cavity; and means for disintegrating said central core portion at a position above said teeth of said core-cutting means.

14. Apparatus for drilling into the earth with the aid of a cutting fluid, said apparatus including: a rotary bit providing a body having a central opening providing an internal wall, said bit including cutting elements carried by said body for cutting into the earth in an outer annular zone, said body providing a chamber for receiving said cutting fluid; a core-cutting element having a central passage and providing teeth disposed around the lower end thereof; means for mounting said core-cutting element within said central opening, said teeth being adapted to cut in an inner annular zone within said outer annular zone to leave a central core portion received by said central passage as drilling progresses; and passage means within the confines of said central opening of said bit body and communicating with said chamber for conducting cutting fluid to said teeth, said core-cutting element providing longitudinally-extending peripheral grooves cooperating with said internal wall of said central opening to define said passage means.

15. Apparatus for drilling into the earth, including: a rotary bit providing means for cutting into the earth in an annular zone to leave a central core portion, said bit including a tubular member having an upwardly-extending tubular portion of an internal diameter to receive said core portion; a tubular drive unit detachably connected to said bit at a position adjacent said tubular member, said drive unit providing a tubular member cooperating with said drive unit in providing an annular mud-conducting space, said tubular member of said drive unit having a lower tubular portion telescoping in substantially fluid-tight relationship with said tubular member of said bit when said bit and said drive unit are connected, said substantially fluid-tight relationship preventing flow of mud from said annular mud-conducting space through the telescoping junction of said tubular members, said tubular members cooperating to define a core-receiving passage receiving said central core portion; and means for disintegrating said core portion within said drive unit as drilling progresses and as said core portion rises to a position above the telescoping junction of said tubular members.

16. Apparatus for drilling into the earth, including: a rotary bit providing means for cutting into the earth in an annular zone to leave a central core portion; a tubular member secured to said bit and having an upwardly-extending tubular portion of an internal diameter to receive said core portion; a drive unit providing a tubular member having a depending lower tubular portion telescoping with said upwardly-extending

tubular portion of said tubular member of said bit when said bit and said drive unit are connected, said tubular portions cooperating to define a core-receiving passage receiving said central core portion; means adjacent the telescoping junction of said tubular portions for detachably connecting said bit to said drive unit, said telescoping tubular portions separating upon removal of said bit from said drive unit and moving into telescoping relationship when said bit is attached to said drive unit; and means for disintegrating said core portion within said drive unit as drilling progresses and as said core portion rises to a position above the telescoping junction of said tubular members.

17. Apparatus for drilling into the earth, including: a rotary bit providing means for cutting into the earth in an annular zone to leave a central core portion; a tubular member secured to said bit and having an upwardly-extending tubular portion of an internal diameter to receive said core portion; a drive unit detachably connected to said bit at a position adjacent said tubular member; a removable tubular member positioned in said drive unit and having a lower tubular portion telescoping with said upwardly-extending portion of said tubular member of said bit when said bit and said drive unit are connected, said tubular portions cooperating to define a core-receiving passage receiving said central core portion, said removable tubular member providing an upper end; means for disintegrating said core portion at a position above said upper end of said removable tubular member, said disintegrating means including a wall angling across the axis of said removable tubular member above said upper end thereof to be contacted by said core portion to subdivide same, said disintegrating means including a passage for conducting the subdivided material to the exterior of said drive unit; and means for removably connecting said disintegrating means and said upper end of said removable tubular member.

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