Aug. 9, 1932. M. SCHUERMAN 1,870,592

CORE DRILL

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FIG. 1.

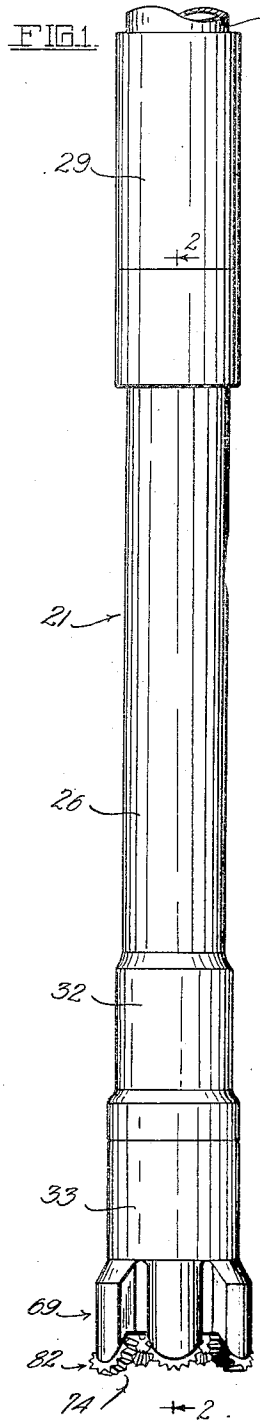


FIG. 2.

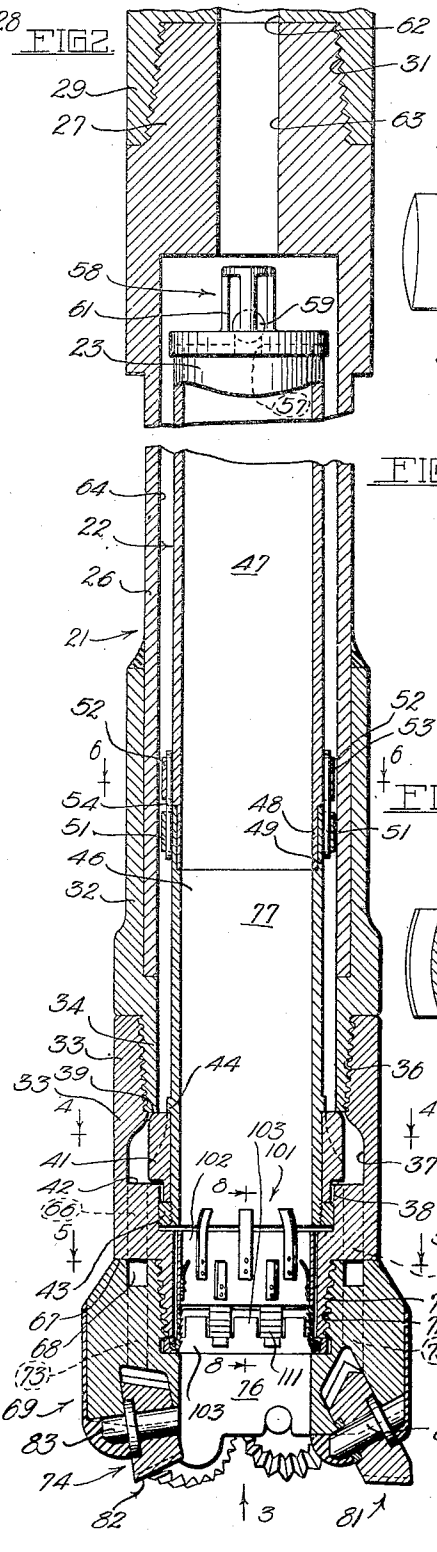


FIG. 3.

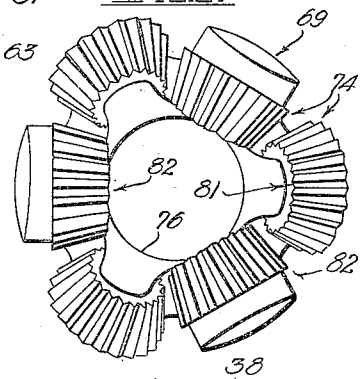


FIG. 4.

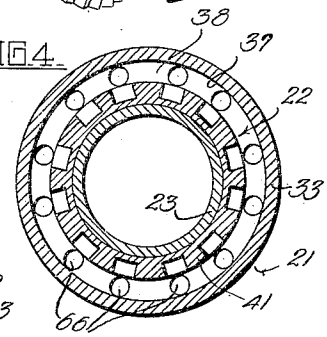
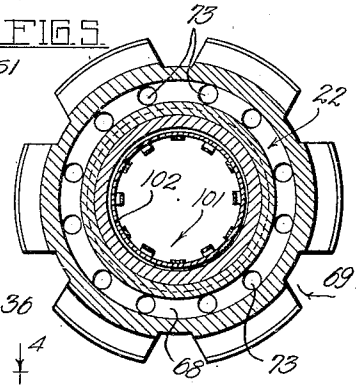


FIG. 5.



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FIG 6.

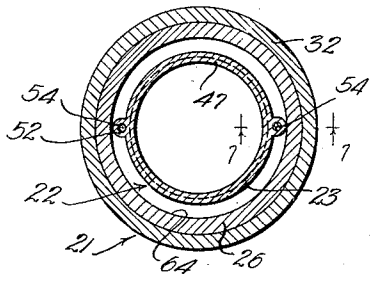


FIG 7.

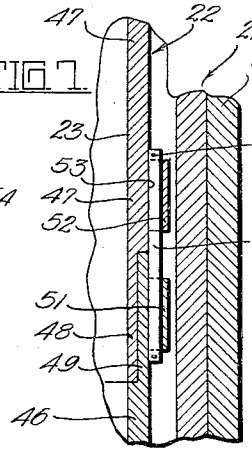


FIG 8.

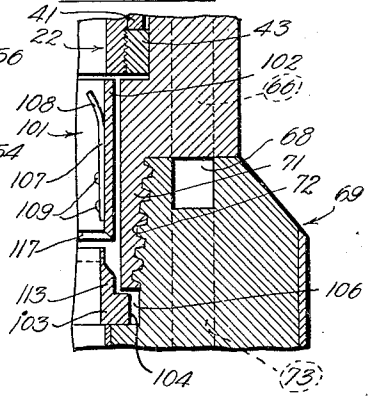


FIG 9.

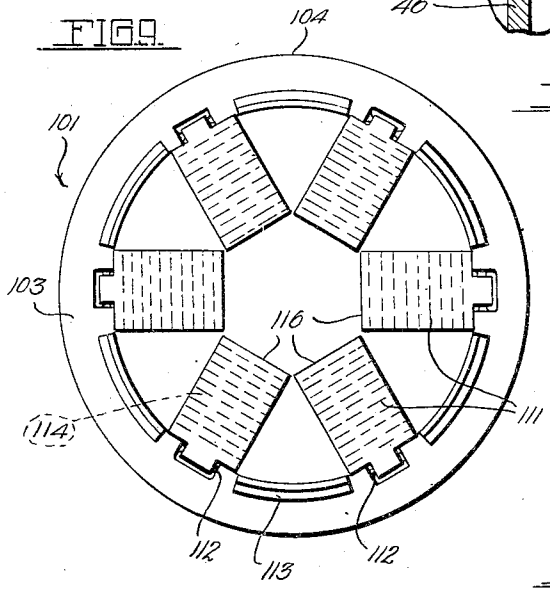


FIG 10.

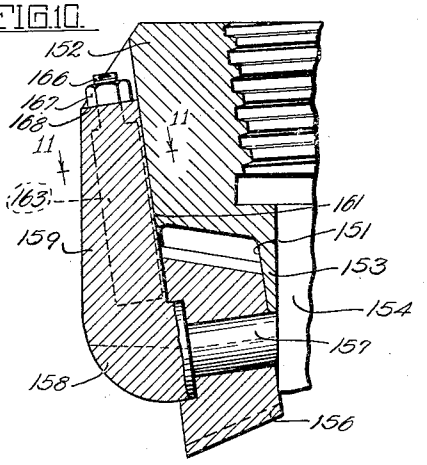


FIG 11.

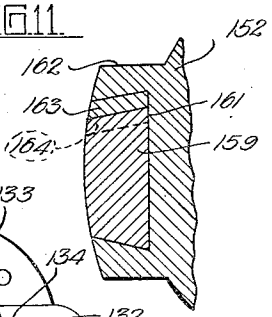


FIG 12.

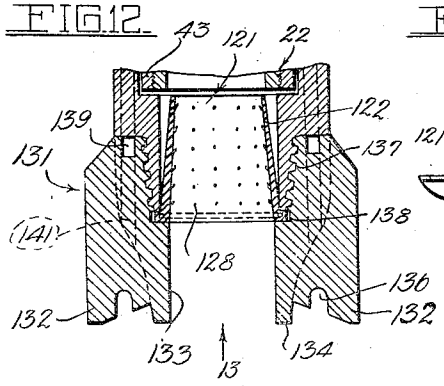
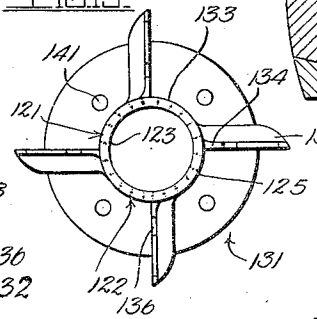


FIG 13.



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FIG. 14.

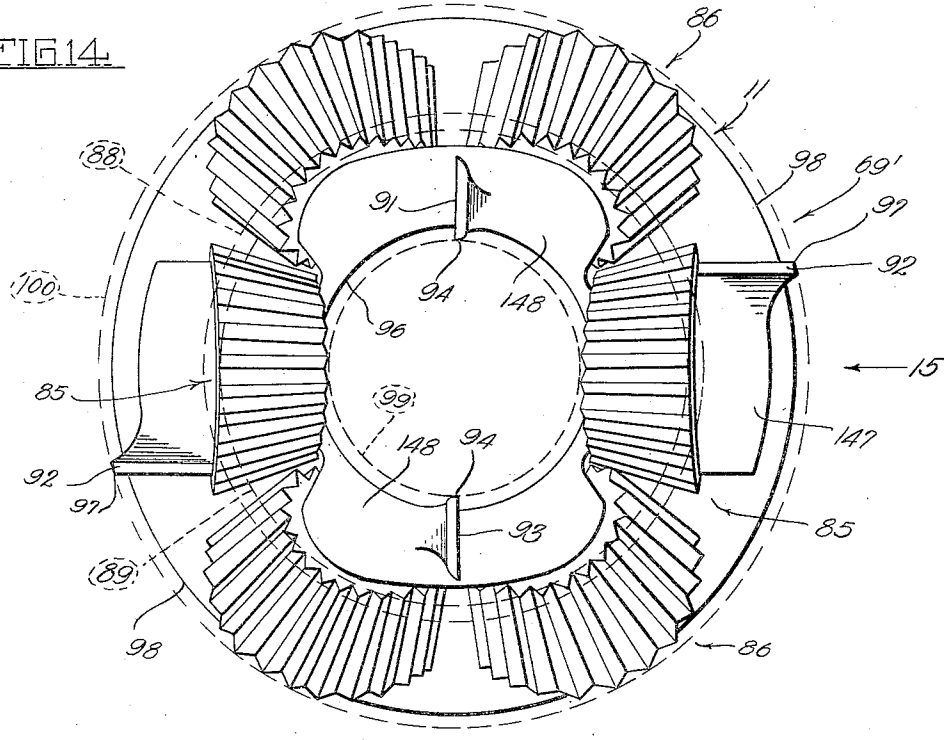


FIG. 15.

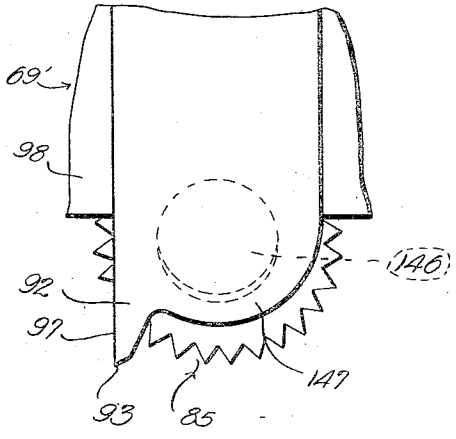
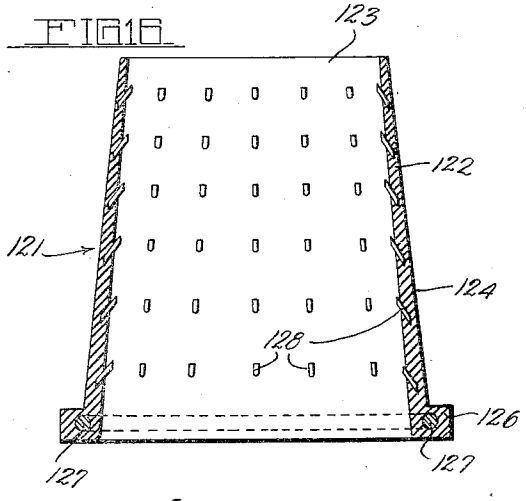


FIG. 16.



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UNITED STATES PATENT OFFICE

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CORE DRILL

Application filed May 21, 1931. Serial No. 539,006.

This invention relates to core drills, and has for an object the provision of a core drill in which various improved details of construction have been incorporated as refinements, each of which cooperates with the remainder of the drill, causing the entire drill to operate with a greater degree of surety and efficiency, and thereby making it possible to take cores in formations which are so stratified and/or frangible that it has been impossible to take cores successfully with previously available equipment.

In greater detail, one of the objects of the invention is to provide novel means for mounting the inner barrel within the outer barrel for free rotation with respect thereto, but held with the lower end of the inner barrel in accurate coaxial relationship with respect to the bore of the outer barrel.

Another object is to provide several different types of improved core catchers which may be selectively mounted in operative position below the inner barrel, the particular type of core catcher to be employed depending upon the nature of the formation being drilled.

Another object is to provide a core drill having a plurality of different types of cutter heads which may be selectively mounted upon the lower end of the core drill body so that the particular type of cutter head best suited to the formation being drilled may quickly and easily be mounted in operative position.

Another object is to provide an improved type of roller cutter head, wherein inner and outer sets of roller cutters are provided, and wherein the number of rollers in the outer set exceeds the number in the inner set, thereby compensating for the increased amount of wear to which the outer rollers are subjected as a result of their being required to travel through longer circumferential paths.

A further object in this connection is to so proportion and arrange the cutters that they are carried by the rotation of the drill, in circular paths of different diameter than those in which they tend to travel because of their tapering configuration. This causes them to develop a cutting, scraping or chipping action against the formation, in addition to their normal rolling action.

Another object is to provide a novel welded construction for mounting the journal pins of the roller cutters upon the head of the core drill, and for interconnecting certain of the pins to impart greater strength to the drill.

A still further object is to provide a core drill cutter head which uses both roller cutters and drag teeth cutters, the two different kinds of teeth cooperating with each other to cut the formation away in an annular path, and leave a smooth core standing in the center of the annular cut. Preferably, the drag teeth are faced with diamond substitute or its equivalent, so that they will retain their sharp edges and thereby trim the core accurately to size and keep the bore of the hole true to gauge.

The invention possesses other objects and advantageous features, some of which, with those enumerated, will be set forth in the following description of the invention's particular embodiments which are illustrated in the drawings accompanying and forming a part of the specification.

Referring to the drawings:

Fig. 1 is a view in side elevation of a core drill constructed in accordance with the principles of the present invention.

Fig. 2 is an enlarged vertical medial sectional view, the plane of section being taken upon the line 2—2 of Fig. 1, with the direction of view as indicated. A portion of the figure is broken away to reduce its length.

Fig. 3 is a bottom plan view, the direction of view being indicated by the arrow 3 of Fig. 2.

Fig. 4 is a horizontal sectional view taken upon the line 4—4 of Fig. 2, with the direction of view as indicated.

Fig. 5 is a horizontal sectional view taken upon the line 5—5 of Fig. 2, with the direction of view as indicated.

Fig. 6 is a horizontal sectional view taken upon the line 6—6 of Fig. 2, with the direction of view as indicated.

Fig. 7 is an enlarged detail view in vertical section taken upon the line 7—7 of Fig. 6, with the direction of view as indicated.

Fig. 8 is another enlarged view in vertical section taken upon the line 8—8 of Fig. 2, with the direction of view as indicated.

Fig. 9 is an enlarged top plan view of the lower portion of the core catcher illustrated upon Fig. 2.

Fig. 10 is an enlarged detail view in vertical section showing a slightly modified form of device for attaching the roller cutters to the face of the cutter head.

Fig. 11 is a detail transverse sectional view taken upon the line 11—11 of Fig. 10, with the direction of view as indicated by the arrows.

Fig. 12 is a vertical medial sectional view taken through the lower end of the body of the core drill, and showing slightly modified forms of cutter and core catcher.

Fig. 13 is a bottom plan view, the direction of view being indicated by the arrow 13 of Fig. 12.

Fig. 14 is an enlarged view similar to Fig. 3, but showing a slightly modified form of roller cutter.

Fig. 15 is a detail view in side elevation, the direction of view being indicated by the arrow 15 of Fig. 14.

Fig. 16 is an enlarged view in vertical section of the modified form of core catcher which is illustrated upon Figs. 12 and 13.

The core drill of the present invention comprises an outer barrel 21 and an inner barrel 22 mounted for free rotation thereinside, but held against axial movement with respect thereto. One of the details of construction of the device of the present invention which represents an improvement over core drills previously produced, lies in the fact that the inner barrel 22 is connected to the outer barrel 21 adjacent only the lower end of the inner barrel 22, leaving the upper end 23 of the inner barrel 22 free, as far as any immediate connection to the outer barrel 21 is concerned.

The outer barrel 21 comprises an elongated tubular portion 26 having a threaded pin 27 at its upper end, whereby it may removably be attached to the lower end of a drill stem 28, a suitable tool joint 29 having a socket 31 therein complementary to the pin 27 being provided upon the lower end of the drill stem 28 for this purpose. Also included as a portion of the outer barrel 21 is a sub 32 rigid with the lower end of the tubular portion 26, and a tubular body 33 removably connected to the lower end of the sub 32 by means of a threaded pin 34 rigid with the sub 32 and receivable within a complementary, threaded socket 36 provided in the upper end of the body 33. An annular recess 37 is formed in the bore 38 of the body 33 at the bottom of the socket 36, the parts being so proportioned and arranged that when the body 33 is threadedly engaged upon the pin 34 of the sub 32, the upper end of the recess 37 is defined by the lower end 39 of the pin 34.

The means for revolubly mounting the inner barrel 22 within the outer barrel 21 is in the form of an annulus 41 rigidly secured to the inner barrel 22 adjacent the lower end thereof and seated within the recess 37. The outside diameter of the annulus 41 is slightly less than the smallest inside diameter of the recess 37, permitting the annulus 41 to be slid into the recess 37 from that end thereof which is proximal to the socket 36. However, when the body 33 is threaded onto the pin 34, upward and downward axial movement of the annulus 41 is prevented by the end 39 of the pin 34 and the lower wall 42 of the recess 37, respectively. However, the annulus 41 fits within the recess 37 sufficiently loosely to permit free rotation of the annulus with respect to the outer barrel 21. Preferably, the annulus 41 is rigidly mounted upon the inner barrel 22 as by welding.

A nut 43 adjacent the annulus 41 is threaded to the lower end of the inner barrel 22, and is adapted to engage the bore 38 of the body 33 so as to permit the inner barrel 22 to rotate, but to hold it in coaxial relationship with respect to the outer barrel 21.

In view of the fact that it is often desirable to take a relatively long core, say fifteen or twenty feet in length, I have provided means for rigidly assembling a plurality of sections 46, 47 to define the elongated inner barrel 22. In the modification illustrated but two of these sections are shown. It should be understood, however, that any number of sections may be employed, depending upon the length of inner barrel desired. The joint between the sections includes a reduced cylindrical portion 48 extending from the lower end of the upper section 47 and seated within a complementary enlarged portion 49 of the bore of the lower section 46 (see Figs. 6 and 7). The fit between these two portions is sufficiently tight to hold the two sections 46, 47 accurately in coaxial alinement. Alined bosses 51 and 52 are formed on the sections 46 and 47, respectively, having vertical holes 53 therethrough. Through the holes 53 of each pair of alined bosses 51, 52, a rod 54 extends, and a pin 56 through each end of each rod 54 holds the sections 46 and 47 rigidly together.

Inasmuch as the core enters the inner barrel 22 from the lower end, an opening 57 is formed in the upper end of the barrel 22 to permit the escape of air and/or circulation fluid which might be entrapped within the inner barrel. A check valve 58 including a ball 59 enclosed within a cage 61 is associated with the opening 57 so as to prevent circulation fluid from entering the inner barrel 22 from its upper end. It should be understood that circulation fluid is supplied to the lower end of the core drill from the bore 62 of the drill stem 28 by way of the bore 63 through the pin 31 which communicates with the bore

64 of the outer barrel 21. Hence circulation fluid is forced downwards around the outside of the inner barrel 22 to the recess 37, but inasmuch as the nut 43 fits relatively tightly within the bore 64 below the recess 37, the circulation fluid is substantially prevented from flowing to the lower end of the inner barrel 22 by way of the bore 64 of the outer barrel 21. Instead, it is caused to flow through a plurality of passages 66 leading downwards from the lower wall 42 of the recess 37 through the wall of the body 33 to a shoulder 67 at the lower end thereof. Hence all of the passages 66 lead into an annular groove 68 in the upper end of the cutter head 69, which is removably attached to the lower end of the body 33 through the expedient of the threaded pin 71 extending downwards from the shoulder 67 of the body 33 and received within a complementary, threaded socket 72 in the upper end of the cutter head 69. From the annular groove 68 a plurality of passages 73 extend downwards through the wall of the cutter head 69 so as to deliver the circulation fluid directly to the cutters 74 which are revolubly mounted upon the lower face of the cutter head 69.

The cutter head 69 also is annular, having a bore 76 which registers with the bore 77 of the inner barrel 22, so as to permit the core which is cut out from the formation being drilled by the cutters 74 to pass upwards into the inner barrel 22, as will readily be understood.

Two sets 81 and 82 of roller cutters 74 are provided. In the modification illustrated upon Figs. 1, 2 and 3, there are three cutters in each set arranged in alternation with each other. All of the cutters 74 taper inwards, i. e., towards the axis of revolution of the core drill. The cutters 74 of the innermost set 82 are journaled upon pins or spindles 83 which incline upwards and inwards, as clearly shown upon Fig. 2, whereas the cutters 74 of the outer set 81 are journaled upon pins or spindles 84 which incline downwards and inwards. Accordingly, that portion of the cutting face of each cutter 74 of the inner set 82 which engages the formation is inclined upwards and inwards, whereas the corresponding portion of the face of each cutter 74 of the outer set 81 is disposed substantially at right angles with the axis of revolution of the core drill. In other words, the rollers of the two sets cut the formation in different planes, thereby making it possible for the cutters 74 to operate efficiently in cutting away the formation in an annular path with the least disturbance to the remainder of the formation, and enhancing the probability of leaving the core intact.

Figs. 14 and 15 disclose a slightly modified form of cutter head 69′ which also is provided with inner and outer sets 85 and 86, respectively, of roller cutters, all of which cutters taper inwardly. Whereas the respective spindles upon which the cutters of the two sets are journaled are inclined as described in connection with the modification illustrated upon Figs. 1, 2 and 3, the number of cutters in the outer set 86 exceeds the number of cutters in the inner set 85, there preferably being four cutters in the outer set and two in the inner set. The purpose for this arrangement is to compensate for the fact that the outermost cutters travel through a circular path of greater diameter than that traversed by the inner cutters, with the result that they are subject to a greater amount of wear. By increasing the number of the cutters which do the major portion of the work, all of the cutters are caused to wear more evenly, thereby prolonging the period during which a single set of cutters may be employed.

The cutters 85 and 86 are so arranged that the outer cutters 86 engage the formation in an annular path, the inner circumference 88 of which is spaced slightly outside the outer circumference 89 of the path traversed by the inner rollers 85. Hence, a relatively thin annular wall of material will be left standing between the inner and outer rollers 85 and 86 respectively. This wall is so thin that it will be broken down before it attains any appreciable height. Nevertheless, it will present sufficient ridge to develop the tendency for the inner rollers to be pressed radially inwards, and for the outer rollers to be pressed radially outwards on their respective spindles or pins. One effect of this arrangement is to insure that the hole will be drilled true to gauge, and that the core will be formed accurately to the desired size.

In this modification of cutter head, inner and outer drag teeth 91 and 92, respectively, are provided, which cooperate with the cutters 85 and 86. Whereas all the teeth have lower horizontal cutting edges 93 which lie substantially in the horizontal plane within which the lowermost portions of all the rotary cutters 86 lie, the inner teeth 91 are also provided with vertical cutting edges 94 which extend inwards slightly from the bore 96 of the head 69′, and the outer teeth 92 have vertical cutting edges 97 which are set outwards slightly from the outer circumferential wall 98 of the head 69′. The vertical cutting edges 94 of the inner teeth are at slightly less radial distance from the axis of rotation of the drill than the extreme innermost portions of the inner rollers 85, with the result that they traverse the circular path which is indicated at 99 which accurately defines the outside diameter of the core being formed. Similarly, the vertical cutting edges 97 of the outer drag teeth 92 are disposed at slightly greater radial distance from the axis of rotation of the core drill than the extreme outermost portions of the outer roll-

er cutters 86, with the result that they move in a circular path 100 to define accurately the bore of the hole being drilled, which is thus maintained true to gauge.

I also prefer that the rollers of both sets 85 and 86 be so proportioned and arranged upon the face of the head 69' that they are dragged in circular paths on account of the rotary motion of the entire core drill, which paths are of different diameter from those which would be traversed by the rollers if they were merely permitted to roll freely while resting upon their sides. That is to say, each of the rollers is of conical configuration, and accordingly if it were permitted to roll freely it would traverse a circular path. However, the spindles whereupon the rollers are journaled are positioned in such a manner that the rollers are not carried in the circular paths which they would traverse if they were permitted to roll freely. Instead, they are carried in circular paths which preferably are of slightly greater diameter, the result being that each roller develops a cutting, chipping, or scraping action against the formation, in addition to the rolling action which is developed as the cutter moves with respect thereto.

A core catcher 101 is mounted within the lower end of the bore 38 of the head 33. This core catcher, the design of which also represents a portion of the present invention, comprises a tubular shell 102 and an annulus 103 of substantially the same inside diameter and arranged coaxially with respect to the bore 77 of the inner barrel 22. The shell 102 floats freely within the bore 38 of the head 33, and is held against moving upwards therefrom by engagement with the lower end of the inner barrel 22. Downward motion of the shell 102 is limited by the annulus 103, which is adapted to rotate freely within the head 33, but which is held against axial movement with respect thereto by means of an annular shoulder 104 (see Fig. 8) which is received within a recess 106 between the lower end of the pin 71 and the bottom of the socket 72. The shell 102 is provided with a plurality of leaf springs 107, each of which is inclined upwards and inwards at its upper end 108, and each of which is rigidly attached to the bore of the shell 102 by rivets 109 or their equivalent. The annulus 103 is provided with a plurality of teeth 111 which are pivotally mounted at their lower ends upon pivot pins 112 extending between tongues 113 projecting rigidly upwards from the shoulder 104 of the annulus 103. Each of these teeth 111 is provided with relatively sharp corrugations 114 upon its inner face, and is materially longer than the tongues 113, with the result that when the teeth 111 extend vertically upwards from their respective pivot pins 112 their upper ends 116 are in position to be engaged by the lower end 117 of the shell 102. The lower end 117 of the shell is inclined downwards and outwards, as are also the upper ends of the teeth 111, with the result that when the shell 102 moves downwards upon the upper ends of the teeth 111 the teeth will be wedged inwards. Accordingly, after the core drill has been operated long enough to cause a core to be received within the inner barrel 22, and the entire device then lifted from the bottom of the hole, the core will tend to move downwards by its own weight within the core drill. However, the curved ends 108 of the leaf springs 107 will engage the core and cause the shell 102 also to be carried downward therewith, thereby disposing a relatively great weight upon the teeth 111, which as described hereinabove will thereby be wedged radially inwards, causing them also to bite into the core. Any further downward motion of the core will therefore cause the teeth 111 to be swung into horizontal position, as illustrated upon Fig. 9, wherein they are disposed substantially in a plane to which the axis of the core is perpendicular, and in which all the teeth 111 cooperate to define a bottom wall which holds the core within the inner barrel 22, permitting elevation of the core drill to the surface without danger of losing the core.

On Figs. 12 and 16 a modified form of core catcher 121 is illustrated. This core catcher 121 comprises a tubular shell 122 of resilient material, such as vulcanized rubber. The shell 122 tapers in an upward direction, i. e., the bore 123 is of less diameter adjacent its upper end than adjacent its lower end. Moreover, the wall 124 of the shell 122 also tapers in an upward direction, i. e., the wall is of less thickness adjacent its upper end than its lower end, the purpose being to increase the ease with which the upper end of the shell 122 can be stretched. A shoulder 126 is formed at the lower end of the shell 122, and any suitable means for holding the lower end to a predetermined diameter are provided, such as an endless wire cable 127 embedded within the shoulder 126. I also prefer to provide a plurality of metal pins 128 embedded within the wall 124 and projecting into the bore 123, each of the pins inclining upwards and inwards so as to enable them to penetrate a core that tends to move downwards within the bore of the shell. The diameter of the bore 123 at the lower end of the core catcher 121 preferably corresponds to or is slightly larger than the diameter of the bore of the cutter head 69, so as to permit a core to enter the core catcher easily. As the core passes upward within the core catcher, the upper end of the shell 122 will be expanded, thereby permitting the core to pass freely therethrough. However, owing to the resilience of the material of which the core catcher 121 is constructed, it will continually be pressed inwards against the core so that instantly

any downward motion of the core with respect to the core catcher occurs, the pins 128 will penetrate the core. Hence, any such downward motion of the core within the core catcher will cause the flexible wall 124 thereof to be collapsed and crumpled to such an extent that it fills a sufficient portion of the bore, through which the core would otherwise tend to move, to prevent the core from dropping out of the core barrel.

Still another type of cutter head 131 is illustrated upon Fig. 12. This cutter head is a drag cutter, and is provided with a plurality of rigid cutting teeth 132 arranged at spaced angular intervals about the central bore 133 of the head 131. Preferably, the teeth 132 lie in planes extending radially from the axis of the bore 133, and instead of having perfectly straight cutting edges 134, the cutting edges are serrated with relatively deep irregularities 136, so as to avoid causing the teeth 134 to cut the formation in a single plane. The head 131 is provided with a threaded socket 137 similar to the socket 72 of the head 69, the purpose being to make the heads interchangeable upon the body 33, whereby either a roller cutter or a drag cutter may be employed with the remainder of the core drill, the particular head selected depending upon the nature of the formation to be drilled. A suitable recess 138 is provided at the bottom of the socket 137 to receive the shoulder 126 of the core catcher 121 or the shoulder 104 of the core catcher 101, as the case might be. An annular groove 139 is provided in the upper end of the head 131, and a plurality of passages 141 extend downward through the wall of the head 131 from the groove 139 to the spaces between the teeth 132, so as to conduct circulation fluid to that portion of the head which engages the formation.

The present invention also contemplates providing novel methods for anchoring the spindles or pins whereby the roller cutters 85 and 86 are journaled upon the head 69′. In the modification illustrated upon Figs. 14 and 15, each of the spindles or pins 146 is permanently and rigidly attached to the head 69′ by metal 147 which is welded both to the head and to the pin. Preferably, this metal 147 is built up by welding to a material thickness, encircling both ends of the pins 146 whereon the inner rollers are journaled. It is by this same welded metal 147 that the drag teeth 91 and 92 are rigidly fastened to the face of the head 69′. Inasmuch as there are four outer rollers 86 and but two inner rollers 85, the pins 146 associated with the outer rollers 86 will be arranged in pairs, and consequently I prefer that sufficient metal 148 be built up between the inner ends of these pins of each pair, thereby imparting still greater rigidity and strength not only to the pins 146, but to the entire assembly of the head 69′. Preferably, the inner drag teeth 91 are carried by this metal 148 which is built up between the pairs of pins 146. The teeth 91 and 92 of both sets may either be separate metal welded to the metal 148, or they may be built up by the welder to the desired configuration. In either event, I prefer that they be provided with the hard facing, such as diamond substitute or its equivalent, so as to increase the length of time during which they can be used without impairing their sharp edges.

Figs. 10 and 11 illustrate a modified construction for interchangeably mounting the roller cutters in operable position. An annular recess 151 is formed in the lower face of the cutter head 152, leaving an annular flange 153 extending downwards to define the bore 154 of the head. The roller cutters, which in this modification are indicated at 156, are journaled upon spindles 157 which extend across the lower edge of the recess 151 so as to position the upper edges of the rollers 156 within the recess, with the result that the flange 153 serves to hold the cutters 156 from sliding off the spindles 157 into the bore 154. Each of the spindles 157 is carried by a block 158 which extends upwards from the spindle 157, and which is of dovetail cross sectional configuration, as indicated at 159 upon Fig. 11. The dovetail portion 159 of each block 158 is adapted to be received within a groove 161 formed in the outer surface of a boss 162 which extends outwards from the outer circumferential face of the head 152. The groove 161 also is of dovetail cross sectional configuration, but is wider than the block 159, thereby permitting the reception of a wedge 163 within the groove 161 beside the block. The wedge 163 is wider at its lower end 164 than at its upper end, whereas the block 159 is narrower at its lower end than at its upper end, with the result that when the wedge 163 is pulled upwards with respect to the block 159, these two members will be forced laterally apart and into tight engagement with the sides of the groove 161, thereby rigidly clamping the block 159 in position. A threaded pin 166 on the upper end of the wedge 163 carries a nut 167 which engages the shoulder 168, which represents the upper end of the boss 162 and also the upper end of the block 159, so that when the nut 167 is tightened the wedge 163 will be drawn upwards with respect to both the head 152 and the block 159. In this manner the spindles 157 for the roller cutters 156 may be attached to the head 152 substantially as securely as though they were welded thereto or integral therewith, even though the spindles 157 may easily be removed whenever it is desired to replace the roller cutters 156.

It is to be understood that the details of the invention as herein disclosed, are subject

to alteration within the spirit or scope of the appended claims.

I claim:

1. In a core drill, a tubular head, a set of two oppositely arranged spindles rigid therewith and inclining upwards and inwards toward the axis of rotation of the head, an inwardly tapered roller cutter journaled for free rotation on each of said spindles, and drag teeth rigid with said head and having vertical cutting edges at slightly less radial distance from said axis than the innermost portion of said cutter to trim the core being formed by said cutters.

2. In a core drill, a tubular head, a set of four spindles rigid with said head and inclining upwards and outwards from the axis of rotation of said head, an inwardly tapered roller cutter journaled for free rotation on each of said spindles, means for fastening said spindles to said head comprising welded metal built up around both ends of each of said spindles and filling the space between the inner ends of adjacent spindles to develop a unitary construction, and drag teeth rigid with said head and having vertical cutting edges at slightly greater radial distance from said axis than the outermost portions of said cutters to smooth the bore being cut by said cutters.

3. In a core drill, a tubular head, an inner set of two oppositely arranged spindles rigid therewith and inclining upwards and inwards toward the axis of rotation of said head, an outer set of four spindles rigid with said head and inclining upwards and outwards from said axis, and an inwardly tapered roller cutter journaled for free rotation on each of said spindles, the outer rollers being carried in a circular path of slightly greater inside diameter than the outside diameter of the annular path traversed by the inner rollers to leave an annular ridge of formation therebetween.

4. In a core drill, the combination of a tubular head, inner and outer sets of rotary cutters journaled on the lower face of said head, and inner and outer sets of drag teeth extending rigidly downwards from said head, the teeth of the inner set being positioned radially inwards from rollers of said outer set and the teeth of the outer set being positioned radially outwards from the rollers of said inner set, said teeth having horizontal cutting edges substantially in the plane of the lowermost portions of said roller cutters, the teeth of said inner set having vertical cutting edges set inwards from the bore of said head and the teeth of said outer set having vertical cutting edges set outwards from the outer circumferential wall of said head.

In testimony whereof I have signed my name to this specification.

MARTIN SCHUERMAN.