May 8, 1945. C. L. WALKER 2,375,335

COLLAPSIBLE DRILLING TOOL

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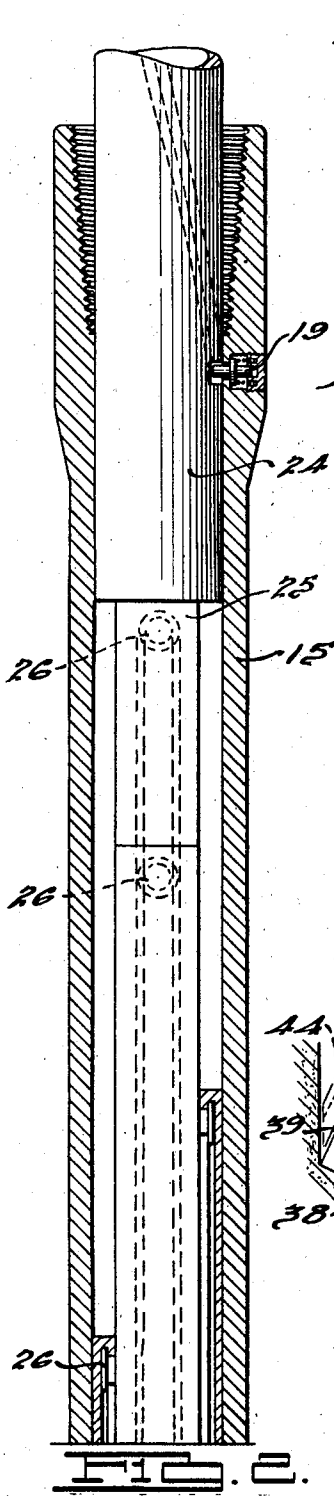


FIG. 2.

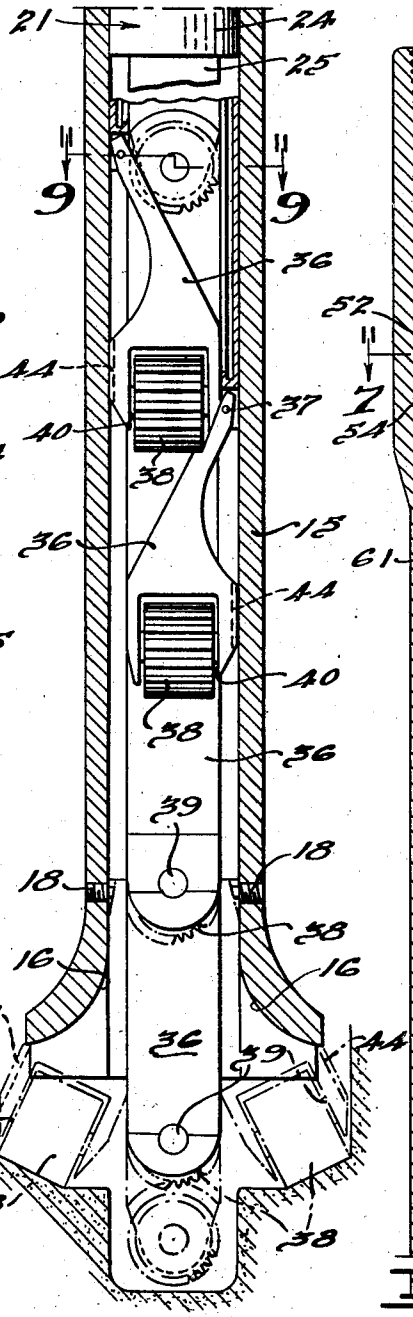


FIG. 1.

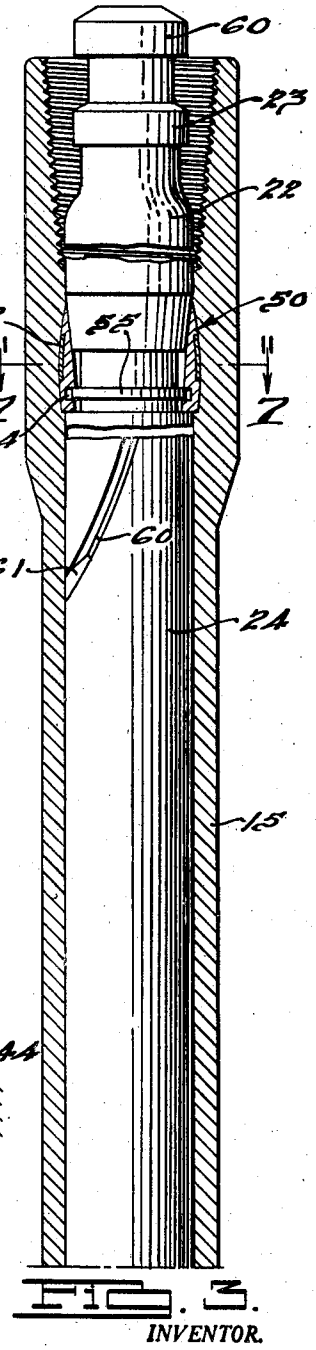


FIG. 3.

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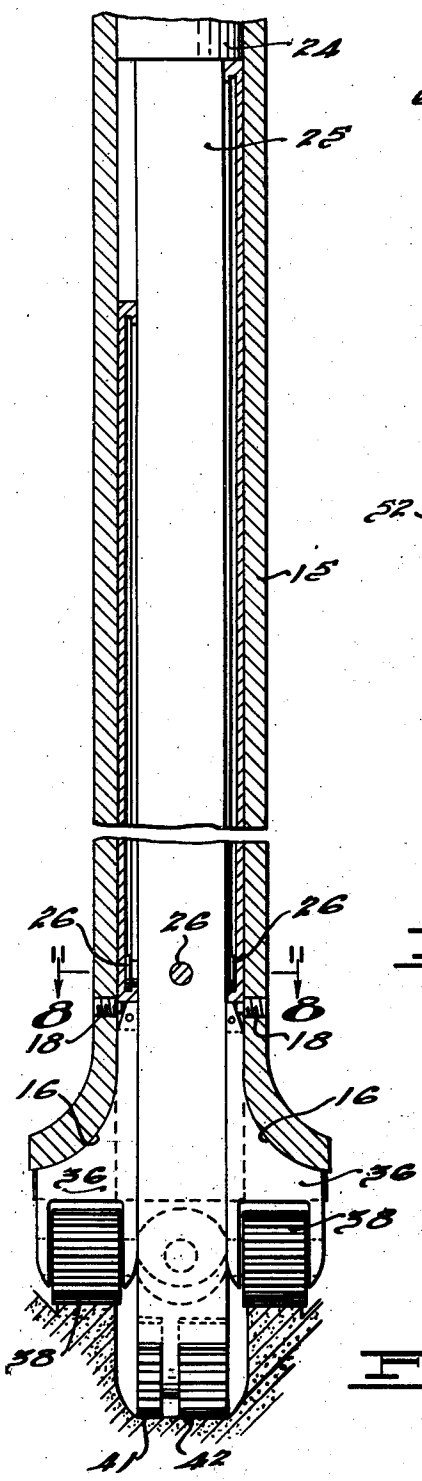
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COLLAPSIBLE DRILLING TOOL

Filed Sept. 17, 1941 3 Sheets-Sheet 2



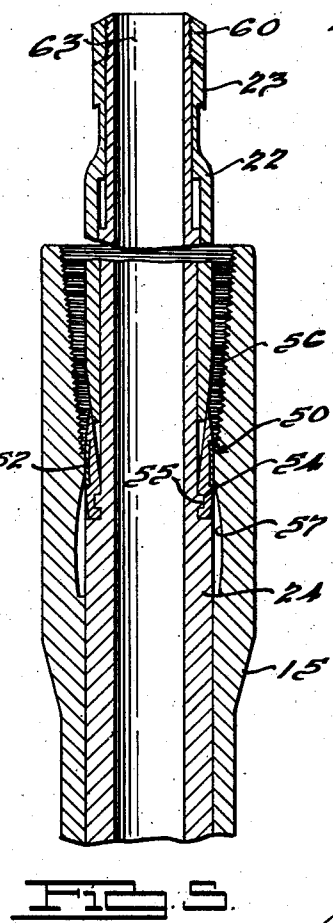


FIG. 5.

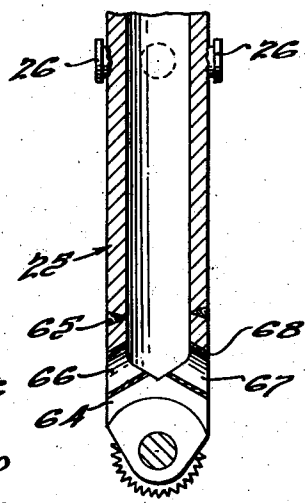


FIG. 6.

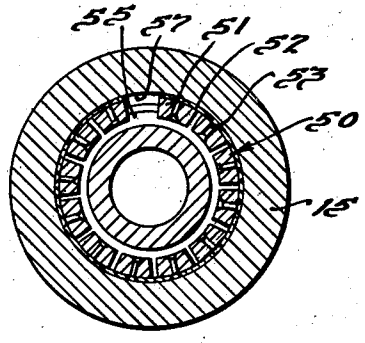


FIG. 7.

FIG. 4.

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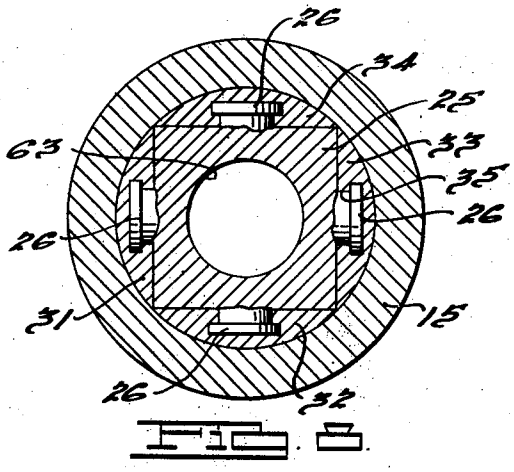


Fig. 8.

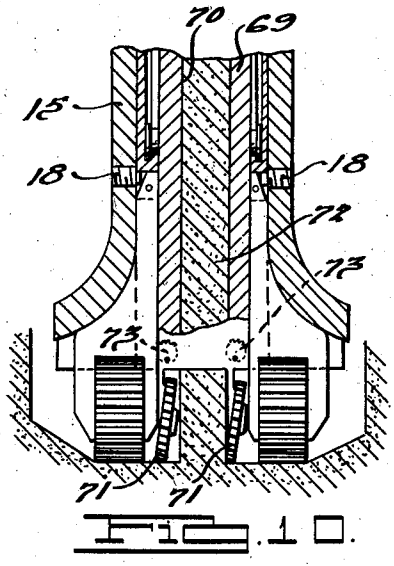


Fig. 10.

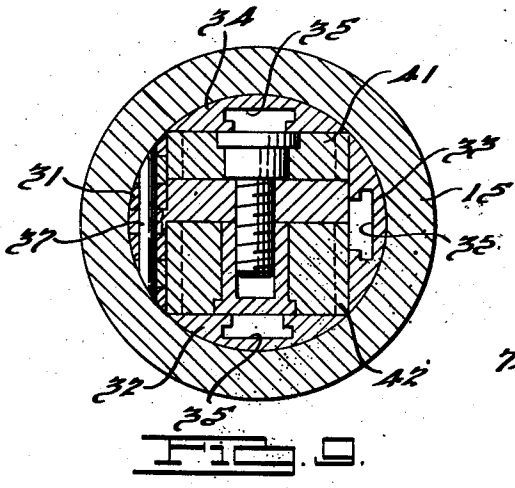


Fig. 9.

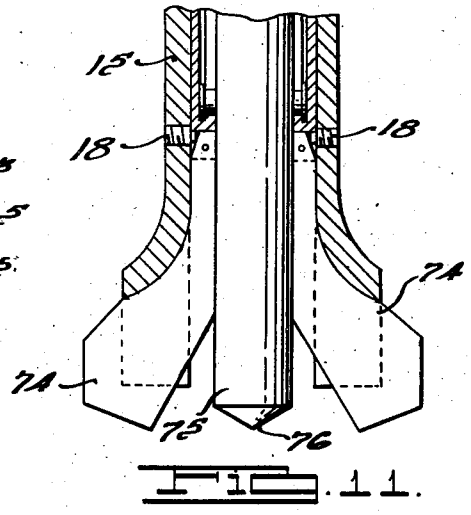


Fig. 11.

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UNITED STATES PATENT OFFICE

2,375,335

COLLAPSIBLE DRILLING TOOL

Clinton L. Walker, Piedmont, Calif.

Application September 17, 1941, Serial No. 411,106

10 Claims. (255—74)

My invention relates to drilling apparatus, and particularly to a drilling tool which is attachable and detachable, to and from, the end of a hollow drill stem.

The invention relates more specifically to the rotary type of drill stem which progressively advances into the bore as it is drilled by the tool on the end of the stem. Sections of the drill stem are added as the bore lengthens so that a problem is presented when it is necessary to sharpen or renew the tool at the stem end. When the tool is to be withdrawn, the stem is raised and section after section is removed until the stem is entirely disassembled. When the tool is to be inserted in the bore, the sections are again assembled seriatim until the tool reaches the bore bottom.

The present invention relates to a tool which is attachable and detachable to the end of the hollow drill stem without the necessity of removing the stem from the bore. The invention pertains to a sleeve attached to the end of the drill stem which co-operates with the drilling tool to secure the tool in drilling position on the stem end from which it may be released and withdrawn through the drill stem. The tool embodies a square central mandrel having headed pins on its four sides which mate with a slot in segmental bars carried thereby and which have roller supporting arms pivoted on the lower ends. The segmental bars are of different lengths so as to be picked up by the mandrel serially to have the arms suspended one below the other when being raised or lowered in the drill stem. By this arrangement, larger cutting rollers may be mounted at the end of the stem and a more rigid construction may thereby be provided.

In the present invention four arms and rollers, one for each of the sides of the mandrel, are provided and additional rollers are mounted on the end of the mandrel to operate on the area in the center of the bore. Slots are provided in the bottom of the sleeve on the stem end for receiving the four arms, and a spiral slot is cut on the cylindrical body of the tool in which a spring-pressed dog projects and rotates the tool at least ninety degrees to locate the roller supporting arms relative to the slots. A stop element limits the downward movement of the individual arms and causes them to pivot outwardly into a slot in the end of the sleeve where they are locked in position by the mandrel when all of the arms are moved into one of the slots.

When the weight is entirely removed from the tool an overshot, carried by the end of the lowering cable, is released from the tool and the cable may thereafter be pulled from the drill stem. A large water passageway is provided through the mandrel from which water is delivered to the bottom of the bore to form a sludge with the cuttings which is forced upwardly between the drill stem and the bore wall to the top of the bore.

A similar tool may be provided having the central mandrel of hollow construction to form a core-receiving recess with core cutting rollers provided on the mandrel end for cutting a core as the bore is increased in length. Means are provided for supporting the core in the tool so that it may be removed along with the tool from the drill stem.

Accordingly, the main objects of my invention are: to provide a sleeve for the end of a drill stem and a cooperating tool having pivoted arms which extend beyond the sleeve after being inserted through the hollow drill stem; to provide a hollow sleeve for a hollow drill stem which receives drilling tools which are insertable through the hollow stem along with pivotally supported cutting elements which are swung outwardly and locked on the sleeve end; to provide a tool having a plurality of drilling elements pivoted on arms suspended one above the other from the end of a mandrel which may be swung seriatim into place at the end of the drill stem after passing therethrough and locked in position by the mandrel which moves therebetween; to provide a plurality of drilling elements on the end of a supporting member which is hollow to form a core passageway having means to cut and support a core as well as means to lock the drilling elements in expanded position at the end of the drill stem; and, in general, to provide a tool which is insertable through a hollow drill stem and which is locked to the stem end without removing the stem from the bore, all of which is rugged in construction, positive in operation, and economical of use.

Other objects and features of novelty of my invention will be either specifically pointed out or will become apparent when referring, for a better understanding of my invention, to the following description taken in conjunction with the accompanying drawings, wherein:

Figure 1 is a sectional view of the lower end of a drill stem and a removable tool embodying features of my invention, with the tool in position to be withdrawn from the stem from an expanded position illustrated in broken line;

Fig. 2 is a sectional view of the central por-

tion of the tool illustrated in Fig. 1 with the mandrel in raised position;

Fig. 3 is a view of the top portion of the tool illustrated in Fig. 2, with the mandrel in lowered locked position;

Fig. 4 is a sectional view of the structure illustrated in Fig. 1, taken 90° therefrom;

Fig. 5 is a view of the upper end of the tool and stem end of Fig. 4 when in unlocked position:

Fig. 6 is a sectional view of the mandrel of the tool illustrating the fluid passageway provided therethrough;

Fig. 7 is an enlarged sectional view of the structure illustrated in Fig. 3, taken on the line 7—7 thereof;

Fig. 8 is an enlarged sectional view of the structure illustrated in Fig. 4, taken on the line 8—8 thereof;

Fig. 9 is an enlarged sectional view of the structure illustrated in Fig. 2, taken on the line 9—9 thereof;

Fig. 10 is a view of structure similar to that illustrated in Fig. 4, showing a modified form of my invention; and

Fig. 11 is a view of structure similar to that illustrated in Fig. 4, showing a further form which my invention may assume.

Referring to Figures 1, 2, and 3, a hollow sleeve 15 is supported on the end of a drill stem which is made up of a plurality of sections of tubing which projects to the bottom of the bore and which is rotated to perform a drilling operation. The sleeve is provided on its ends with a plurality of slots 16, herein illustrated as four in number, disposed 90 degrees apart. Individual stop pins 18 are mounted on the inside wall of the sleeve 15 a predetermined distance above its lower end. A dog 19 is mounted near the top end of the sleeve having a spring which urges the dog inwardly of the inner sleeve wall.

A drilling tool 21 is illustrated as being suspended within the sleeve 15 on a cam sleeve 22 having a supporting knob 23 on the top end. The cam sleeve is mounted on a cylindrical element 24 having an outer diameter slightly less than the inner diameter of the sleeve 15. A mandrel 25, provided in extension of the tubular portion 24, is square in shape and provided with headed pins 26 near the lower end.

Slidable segmental bars 31, 32, 33, and 34, having an outer arcuate surface to mate with that of the sleeve 15 are of different lengths and are provided with T-shaped slots 35 which receive the projecting headed pins 26. The segmental bars have arms 36 pivoted on the lower ends by pins 37. The ends of the segmental bars and roller supporting arms have a plurality of mating lands and grooves to reduce the shear strain on the pins 37. A roller 38 is pivoted in a slot 40 in the end of each arm 36 on a pin 39. Rollers 41 and 42 are mounted on the end of the mandrel portion 25 of the element 24, with one roller of greater thickness than the other so that one side of the roller 42 may be disposed substantially on the axis of the sleeve 15.

The slots 16 are of the same curvature, while the pair of arms illustrated in Fig. 1 are so shaped as to project outwardly a greater distance than the arms illustrated in Fig. 4 to have the rollers 38 on the respective pair of arms operate in different annular areas. This disposition of the rollers 38 and rollers 41 and 42 assures cutting on all portions of the areas of the bottom of the bore.

In Fig. 1, I have illustrated the mandrel portion 25 as being in raised position with the lowermost arm 36 in position to be swung outwardly of the axis of the sleeve 15. In this position the tool can be raised from the sleeve 15 and the sections of the drill stem. If the tool is to be assembled on the end of the sleeve, further downward movement thereof swings the arm 36 on the segmental bar 32 outwardly into one of the slots 16 through the engagement of the stop pin 18 with the end of the segmental bar 32. A further downward movement of the mandrel portion 25 moves the arm 36 on the segmental bar 34 into the opposite slot 16. Thereafter the arm 36 on the segmental bar 33 will be swung into the right hand slot 16, as viewed in Fig. 1, while further downward movement will move the arm 36 on the segmental bar 31 into the opposite slot 16. The downward movement of all of the arms is terminated by a pin 18, and the arms are swung outwardly into the positions illustrated in Figs. 1 and 4 when the mandrel portion 25 passes downwardly therebetween.

The rollers 41 and 42 on the end of the mandrel portion 25 in their lowered position project below the rollers 38 on the arms 36, as illustrated in Figs. 1 and 4. All of the rollers are locked on the end of the sleeve 15 in expanded position with the rollers on one set of arms extending outwardly a greater amount than the pair of rollers on the other arms, as seen in Figures 1 and 4. With the face of the roller 42 on the center line of the sleeve 15, the rollers are in a position to cut all of the material in the bottom of the bore as the tool is rotated. The arms 36 on the segmental bars 31 and 33 have a slot 44 in the outer wall through which the projecting pins 18 extend when the arms move through the sleeve.

The upper end of the cylinder portion 24 is shouldered to receive the cam sleeve 22 and a locking ring 50 which, as illustrated in Fig. 7, is made up of a plurality of elements 51 secured to an annular spring ring 52 by rivets 53. The elements 51 have a slot 54 in their inner faces which receives an annular projection 55 on the element 24 and prevents relative longitudinal movement therebetween. The ring 52 retains the elements 51 expanded while maintaining the projection 55 within the slots 54. The outer wall of the elements 51 are convex in shape to eliminate the possibility of the lower edges of the elements engaging a joint in the drill stem and arrest the movement of the tool at that point. This eliminates the possibility of the locking ring climbing onto the tapered surface 56 of the sleeve 22 during the downward movement of the tool which would wedge the tool within the drill stem. A threaded collar 60 is screwed upon the upper end of the element 24 to limit the upward movement of the sleeve 22, the head 23 of which is engaged by a releasable overshot support on a cable by which the tool is raised or lowered.

When the tool has reached its lowermost position, the downward movement of the mandrel portion 25 is arrested by the locking ring 50 which contacts the lower ledge of an annular groove 57 provided in the top portion of the inner wall of the sleeve 15. When the overshot is released from the knob 23 of the sleeve 22, the sleeve moves downwardly to cam the ring 50 into the slot 57 as illustrated in Fig. 7. This securely locks the element 24 against upward movement as the drill stem is rotated and moved downwardly in the bore.

When the tool is to be removed, the overshot

is lowered through the drill stem into a position to engage the head 23 and upon being drawn upwardly, moves the sleeve 22 upwardly therewith to release the locking ring 50 which permits the tool to be moved upwardly out of the cylinder 15. The initial movement of the element 24 moves the mandrel portion 25 from between the arms 36 which swing inwardly and move upwardly with the mandrel as the headed pins 26 thereof engage the segmental bars 31, 33, 34, and 32 seriatim, to thereby be suspended below the mandrel portion 35 and each other as they are moved upwardly out of the drill stem.

When the tool is lowered into the sleeve 15, the spring pressed dog 19 engages a slot 60 provided in the wall of the cylindrical element 24 for the purpose of turning the element a portion of an angle of 90° to thereby align the arms 36 with the slots 16. A cam surface 61 is provided at the lower end of the slot 60 for moving the pin out of the slot as the cylinder element 24 moves upwardly. The rotation of the cylinder element and mandrel portion occurs before the arms are in a position to be swung into the slot 16 and after they have been drawn upwardly into the sleeve 15.

One advantage of this type of drill tool is that permitting the use of rollers of large diameter so positioned as to drill over all points of the area of the bore. A further advantage resides in the possibility of employing a large central aperture 63 through the cylindrical element 24 and a portion of the length of the mandrel portion 25. This large opening permits the passage of a large volume of water or mud through the tool which is pumped down through the drill stem and passes upwardly between the drill stem and the bore wall or casing out of the top of the casing. The locking ring 50 is also useful in sealing the upper end of the cylindrical portion 24 relative to the inner wall of the sleeve 15.

In Figure 6, I have illustrated the mandrel portion 25 as having an end portion 64 which is preferably cast from manganese steel or other hard alloy. The end is welded at 65 to the end of the mandrel portion 25 and is provided with delivery openings 66 and 67 which are disposed, respectively, at 27° and 15° from the horizontal for delivering the fluid to the bottom of the bore at different inclinations to the tool axis. The walls of the openings 66 and 67 may be surfaced with hardened steel 68 which may be a sleeve welded thereto or which may be a material welded directly to the metal of the casting 64. By having the walls of the delivery apertures 66 and 67 hardened in this manner, the wear produced by the passage of mud therethrough is materially reduced.

In Fig. 10, I have shown a modified form of drilling tool wherein a mandrel portion 69 of the element 24 is provided with a central opening 70 for receiving a core. The end of the element 69 carries a pair of core cutting rollers 71 which, as will be seen from the figure, cut a core 72 from the bottom of the bore. A pair of toothed cam elements 73 are carried by the mandrel portion 69 near its lower end for the purpose of engaging and supporting the core 72 within the opening 70 when the tool is raised from the drill stem. When it is desired to obtain a core from the bottom of the bore, the tool as illustrated in Figures 1 to 9, inclusive, is raised from the end of the drill stem and the tool illustrated in Fig. 10 is substituted therefor. After the core has been cut, the tool of Figure 10 is removed and the original tool is replaced on the stem end.

In Figure 11, I have illustrated a further form of my invention, that wherein blades 74 are employed in place of the arms 36. The pairs of the blades will project different amounts from the sleeve axis, the same as the arms 36, and the mandrel portion 75 on the end of the element 24 has a cutting portion 76 disposed between the blades. This type of tool may be substituted for the tool shown in Figures 1 to 9, inclusive, when a soft strata is encountered during the drilling operation. When rock or hard strata is again encountered, the tool having the blades 74 may be removed and the original tool replaced.

It will be seen that I have constructed a removable drilling tool for a drill stem which provides a large area of contact for the bottom of the bore. By having the arms and cutting elements supported individually, one below the other, a stronger and more rugged structure is provided. The tool is readily removable and attachable to the end of the drill stem and a coring or blade type of tool may be employed when a core is to be cut or when soft strata is reached. After the blades or arms have been swung outward on the stem end, they are wedged outwardly by the central tool portion, the tool and sleeve are locked together by a locking collar which seals the tool to the sleeve wall. This construction of the tool permits the employment of a large passageway for the water or mud pumped therethrough into the bottom of the bore.

What I claim is:

1. A drilling tool for the end of a drill stem, including in combination, a sleeve, means for securing said sleeve to the end of said stem, a square drilling device insertable through said stem into said sleeve, segmental cylindrical drilling elements pivoted on said device, means for rotating said drilling device to have it disposed in predetermined relation to said sleeve, means for angularly moving said drilling elements outwardly of the axis of the sleeve different amounts for covering substantially the entire area of the bottom of the bore being drilled, means for locking said elements in drilling position, and means for locking said drilling device to said sleeve.

2. A drilling tool for the end of a drill stem including, in combination, a sleeve having slots in its lower end, means for securing the sleeve to the end of the stem, a drilling device embodying an upper cylindrical portion and a lower mandrel portion of square section, segmental cylindrical bars of different lengths supported on said mandrel portion to form a cylinder therewith, arms pivoted on said bars, drilling elements on the end of said arms, means for swinging said arms and elements at an angle outwardly in a radial direction into the slots in the sleeve as the drilling device is lowered thereinto, and an additional drilling element on the end of the mandrel portion positioned between the other of said drilling elements when the mandrel portion wedges the arms in drilling position.

3. A drilling tool for the end of a drill stem including, in combination, a sleeve having slots in its lower end, means for securing the sleeve to the end of the stem, a drilling device embodying an upper cylindrical portion and a lower mandrel portion of square section, segmental cylindrical bars of different lengths supported on said square mandrel portion to form a cylinder therewith, arms pivoted on said bars, drilling ele-

ments on the end of said arms, means for radially swinging said arms and elements at an angle outwardly into the slots in the sleeve as the drilling element is lowered thereinto, an additional drilling element on the end of the mandrel portion positioned between the other of said drilling elements when the mandrel portion wedges the arms in drilling position, and additional means for locking the drilling device to the sleeve near the upper end thereof.

4. A drilling tool for the end of a drill stem, a sleeve having slots on the end thereof, means by which the sleeve is attached to the stem end, a drilling device having a cylindrical and a square portion a plurality of arms having drilling elements on the end thereof, pivotal means for supporting the arms one above the other on the square end of said device, means for swinging said arms at an angle into the slots in the sleeve, and additional drilling elements on the square end of the device which are centrally disposed relative to the other of said elements when the device is positioned between the arms to lock them in extended position.

5. A drilling tool for the end of a drill stem, a sleeve having slots on the end thereof, means by which the sleeve is attached to the stem end, a drilling device having a cylindrical and a square portion, segmental cylindrical members longitudinally movable on the faces of said square portion, a plurality of arms having drilling elements on the end thereof, pivotal means for supporting the arms on said members one above the other on the axis of said device, means for swinging said arms into the slots in the sleeve, additional drilling elements on the end of the device which are centrally disposed relative to the other of said elements when the device is positioned between the arms to lock them in extended position, and means for locking the device to the sleeve.

6. A drilling tool for the end of a drill stem including, in combination, a sleeve secured to said stem, a drilling device insertable into said sleeve, an expansible sealing member carried by said drilling device by which said drilling device is locked to said sleeve, a sleeve slidable on said drilling device having a means on one end for expanding said member, and means on the opposite end by which said last sleeve is movable relative to said sealing member.

7. A drilling tool for the end of a drill stem including, in combination, a sleeve secured to said stem, a drilling device insertable into said sleeve having an upper cylindrical portion and a lower square portion, segmental cylindrical slidable elements on the faces of said square portion, and cutting elements pivoted to said sliding elements.

8. A drilling tool for the end of a drill stem including, in combination, a sleeve secured to said stem, a drilling device insertable in said sleeve, said drilling device having an upper cylindrical portion and a lower square portion, segmental cylindrical slidable elements on said square portion having pivoted arms thereon, cutters on said arms and a sealing element carried by said cylindrical portion for sealing said drilling device to the inner surface of the sleeve while the square portion locks said arms in angular relation to the axis thereof.

9. A drilling tool for the end of a drill stem including, in combination, a sleeve attachable to the end of the stem, a square mandrel in said sleeve having supporting projection on each face, a segmental cylindrical bar on each face supported on projections and forming a cylinder therewith, pivotal arms on said bars swingable radially outward, cutting elements on said arms, and means for retaining said arms in position at the end of the sleeve when the mandrel is moved downwardly therein to swing and lock said arms in cutting position.

10. A drilling tool for the end of a drill stem including, in combination, a sleeve attachable to the end of the stem, a square mandrel in said sleeve having supporting projection on each face, a segmental cylindrical bar on each face supported on projections and forming a cylinder therewith, pivotal arms on said bars swingable radially outward, cutting elements on said arms, and means for retaining said arms in position at the end of the sleeve when the mandrel is moved downwardly therein to swing and lock said arms in cutting position, said bars being of different length to support the arms centrally of the tool when the mandrel is moved from the sleeve.

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