Oct. 10, 1944. C. L. WALKER 2,360,088

DRILLING TOOL

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Fig. 1.

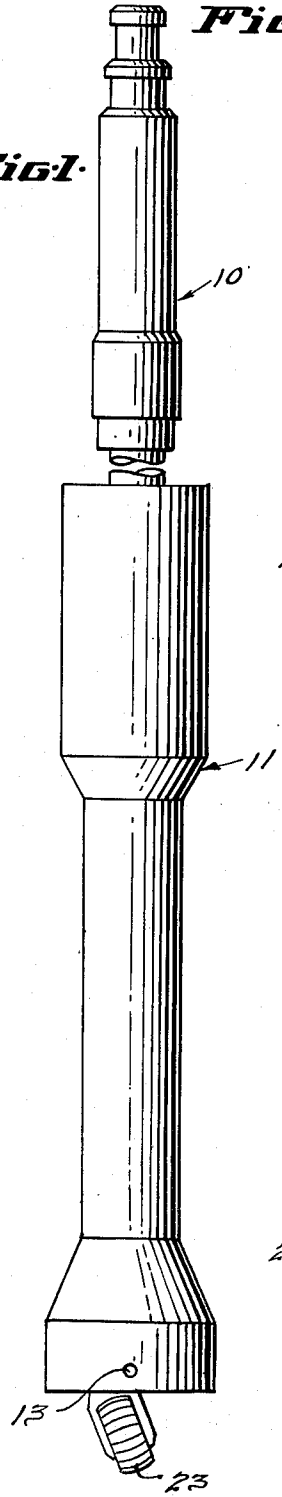


Fig. 2.

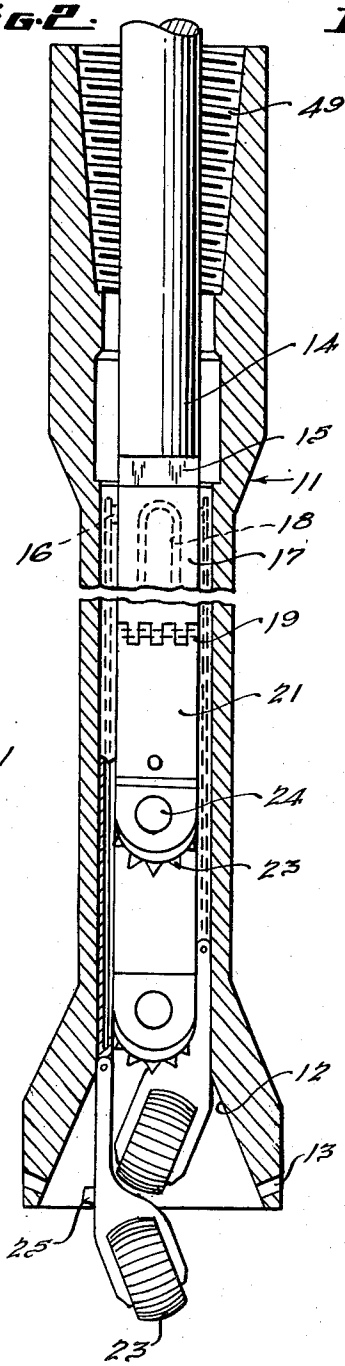
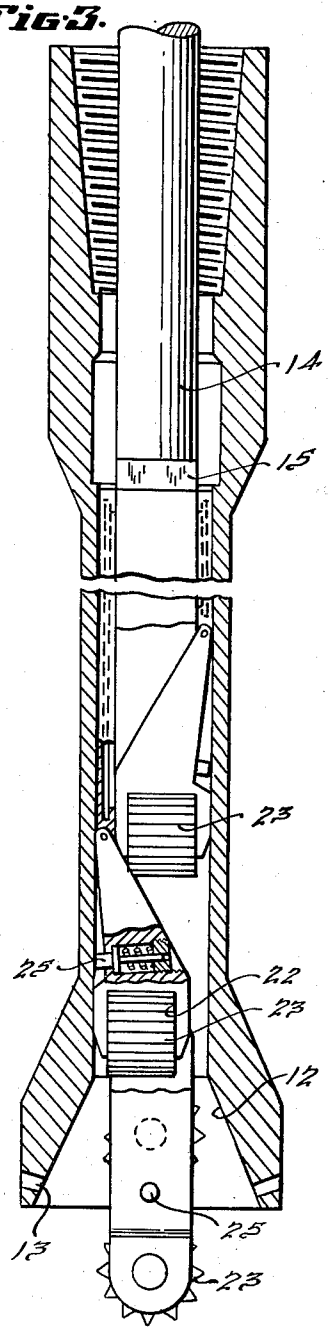


Fig. 3.



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Fig. 4.

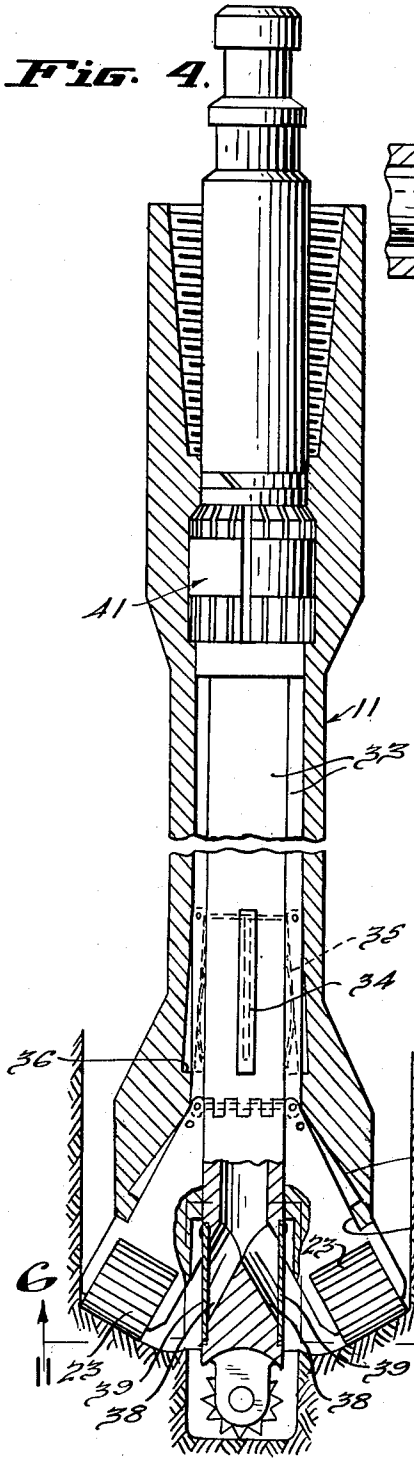


Fig. 5.

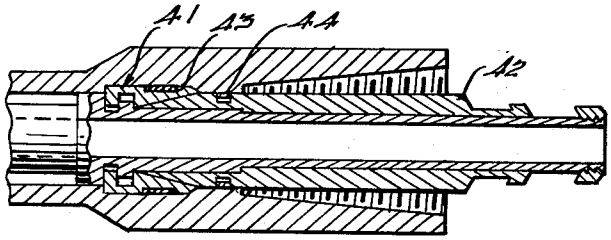
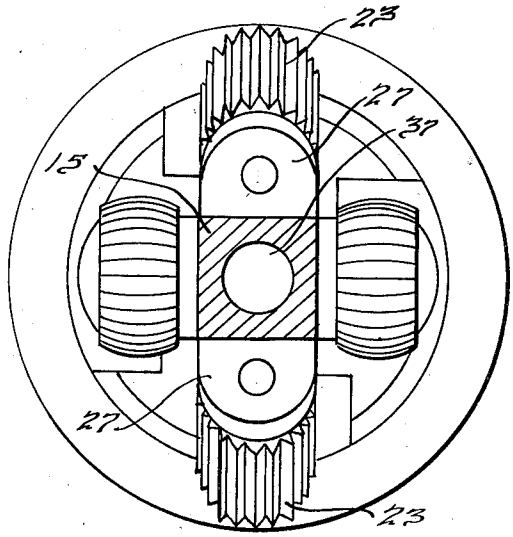


Fig. 6.



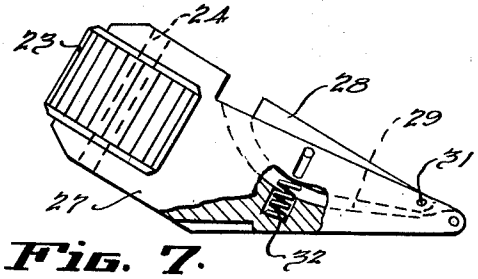


Fig. 7.

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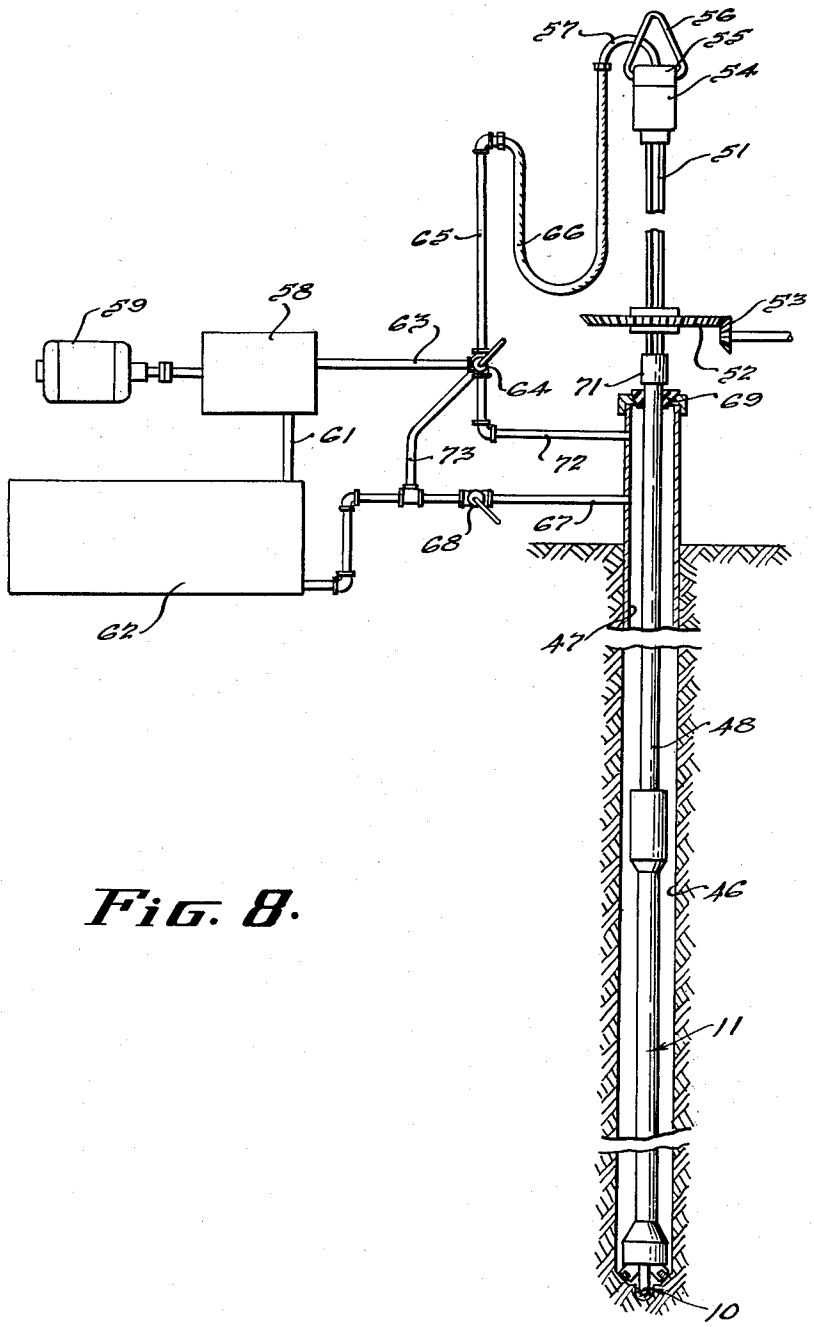


FIG. 8.

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UNITED STATES PATENT OFFICE

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DRILLING TOOL

Clinton L. Walker, Piedmont, Calif.

Application November 23, 1942, Serial No. 466,626

7 Claims. (Cl. 255—75)

This 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, and is a continuation in part of the co-pending application of Clinton L. Walker, Serial No. 411,106, filed September 17, 1941.

The present invention relates to new and novel means for locking the arms on which the cutting rollers are pivoted to the end of the supporting sleeve of the drill stem. The arms are provided with spring-pressed elements which project within recesses in the wall of the sleeve. A spring-pressed stop is employed for limiting the downward movement of the slides upon which the arms are pivotally supported to have the arms arrested in their downward movement, to be swung outwardly into drilling position by the further descent of the mandrel. In this position, the projecting elements are aligned with the receiving slots into which they extend to lock the arms against relative rotation with the rotatable drill stem. A spring-pressed locking collar is provided upon the upper end of the mandrel which is moved within a recess in the inner wall of the sleeve by a sleeve having a wedge end which moves downwardly after the mandrel has come to rest. The sealing ring is provided on the sleeve for the purpose of sealing the mandrel to the inner surface of the outer sleeve against the passage of the liquid delivered through the mandrel from the drill stem upon which the outer sleeve is supported. For the purpose of raising or assisting in the raising of the tool, flappet valves are employed.

The mandrel is provided with a large central opening with two angularly disposed outlet openings at the bottom through which the mud or other heavy fluid is pumped. Flappet valves are disposed over the outlet openings and employed for the purpose of raising or assisting in the raising of the drilling tool through the stem when a reverse flow of the fluid occurs which closes the flappet valves and floats the tool upwardly through the stem. The locking elements are mounted in the arms of the cutting tool, to eliminate any moving part from the sleeve on the end of the stem so that the locking element may be repaired when the tool is withdrawn from the drilling stem, if they become defective, without the necessity of dismantling the stem.

Accordingly, the main objects of the invention are: to provide an inner conical surface on the end of the tool supporting sleeve of the drill stem with which the arms on the drilling tool engage when swung outwardly at an angle into drilling position; to provide recesses in the conical surface at the end of the drill stem in which spring-pressed locking elements project when the drilling arms are swung outwardly against the surface; to provide a locking and sealing ring on the drilling tool which engages the sleeve on the end of the drill stem and locks the drilling tool in position while sealing the tool to the sleeve; to provide a large opening through the mandrel of the drilling tool which has outlets on the drilling end covered by flappet valves to prevent the flow of fluid upwardly through the drilling stem; to provide a reversing circuit for the fluid so that the normal flow of fluid down the stem and up the bore and casing may be reversed to have the fluid flow down the casing and bore to raise or float the tool upwardly through the stem; and, in general, to provide a collapsible drilling tool which is insertable and removable from the drill stem without requiring the removal of the stem from the casing and bore.

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

Figure 1 is a view in elevation of a sleeve and removable tool embodying features of this invention;

Fig. 2 is an enlarged sectional view of the structure illustrated in Fig. 1;

Fig. 3 is a sectional view of structure, similar to that illustrated in Fig. 2, taken at right angles thereto;

Fig. 4 is a view of structure, similar to that illustrated in Figs. 2 and 3, when the elements are moved into drilling position, and illustrating a modified form of the invention;

Fig. 5 is a sectional view of the sealing and locking element between the drill tool and the supporting sleeve;

Fig. 6 is an enlarged sectional view of the structure illustrated in Fig. 4, taken on the line 6—6 thereof;

Fig. 7 is an enlarged view of one of the cutter supporting arms illustrated in Fig. 4; and

Fig. 8 is a diagrammatic view of the drilling tool of the present invention and a reversible fluid system which may be employed for raising or assisting in the raising of the tool through the drill stem.

In Figures 1, 2, and 3 a drilling tool 10 is illustrated which is lowered through a drill stem into

a sleeve 11 on the end of the stem and secured in drilling position thereto. The sleeve is provided with an inner conical surface 12 on the end and a plurality of spaced apertures 13 which project through the sleeve. The drilling tool embodies a mandrel 14 having a square end portion 15, in each face of which a headed pin 16 is secured. Slides 17 of cylindrical section are provided with slots 18 which project over the headed pins 16 so as to permit relative movement between the slides and the square end portion 15. A hinge joint 19 connects the ends of the slides with cutter supporting arms 21, which freely pivot thereon. The ends of the arms are slotted at 22 for receiving the cutting rollers 23 which are secured thereon by the shafts 24.

As the mandrel 14 is lowered through the sleeve 11, the cutting arms which are in nested, aligned relation, one above the other, are stopped in their downward descent when in position at the end of the sleeve and the downward movement of the mandrel continues as the headed pins 16 move in the slots in the slides when the pivoted arm thereof is in lowermost position. The stop for limiting the downward movement of each arm may be that illustrated in the copending application above mentioned, or may be similar to that illustrated on the drilling tool in Fig. 4, which will be described more fully hereinabove.

After all of the four arms and cutting rollers illustrated have reached the end of the sleeve, they are swung outwardly against the truncated conical surface 12 by the continued downward descent of the square portion 15 of the mandrel, which forces the arms outwardly. The outer faces of the arms 21 are of a shape to have area contact with the truncated conical surface 12 to provide frictional engagement which prevents relative movement between the faces and surface during the drilling operation. In some instances, it may be desired to provide positive locks between the arms and the sleeve, in which case spring-pressed plungers 25 are mounted on the arms. Should the sleeve rotate relative to the drilling tool, the spring-pressed plungers 25 will be forced outwardly into the apertures 13 to thereby lock the drilling tool to the sleeve. When the tool is to be removed without raising the drilling stem, an overshot is employed for engaging the upper end of the tool and for releasing the securing and sealing element and for thereafter raising the mandrel. This movement raises the square portion 15 of the mandrel and releases the arms 21 which swing inwardly and move upwardly seriatim as the headed pins 16 engage the ends of the slots 18 of the slides 17.

In Figures 4 to 7, a further form of drilling tool is illustrated, that wherein the truncated conical surface 12 is provided with a plurality of spaced slots 26, one for each of the arms 27 which support the cutting rollers 23 on the shafts 24. An outwardly swinging link 28 is supported in a slot 29 in the inner face of each arm when secured therein by a pin 31. A spring 32 urges the link 28 outwardly a limited amount into a slot 26 when the arms are swung outwardly into angular drilling position, as illustrated in Figs. 4 and 6. The links 28 on the arms provide driving relation between the sleeve and tool when the sleeve and drill stem are rotated and slippage occurs between the engaged surfaces. In normal operation sufficient pressure is provided by the weight of the stem to prevent this slippage, so that the links 28 need not be employed in all instances.

The slides 33, which are similar to the slides 17 of the tool illustrated in Fig. 1, are provided with pivoted arms 34 which are urged outwardly of the slides by springs 35. The arms engage a shoulder 36 on the inner surface of the sleeve 11 to interrupt the downward movement of the slides and therefore the arms 27 to have them supported in position relative to the surface 12 to be movable into engagement therewith when the square portion 15 of the mandrel moves into drilling position between the arms, as illustrated in the figure. Upon the relative rotation of the tool and sleeve, the pivotal links 28 are urged into the slots 26 in the surface 12 for locking the arms to the sleeve.

The mandrel 14 is provided with a large central aperture 37 which communicates with a pair of outlet ports 38 near the lower end of the square portion 15 across the openings of which flappet valves 39 are secured. The valves 39 permit the downward flow of a fluid through the drill stem and the mandrel, out through the valves. This fluid provides pressure within the drill bore to prevent the wall from caving in and for raising the cuttings to the top of the bore and casing. The reverse flow of fluid down the casing and bore closes the valves 39 to prevent the fluid from moving upwardly through the tool and drill stem, so that a pressure is provided at the bottom of the tool for moving it upwardly through the drill stem.

When the clamping and sealing ring 41 is employed on the tool, the sleeve 42 having the locking wedge 43 and the sealing ring 44 must first be raised to permit the locking and sealing ring 41 to collapse and move upwardly in the sleeve 11. Upon the release of the locking ring, the pressure within the sleeve forces the stem upwardly and assists in releasing the drilling tool from the sleeve, raising the tool upwardly through the drill stem. The locking and sealing ring 41 is illustrated and described more fully in the above-mentioned copending application.

In Figure 8 a fluid system is illustrated in combination with a drilling rig which produces the change in direction of flow of the fluid in the casing and bore and the drill stem. The bore 46 drilled by the tool 10 within the sleeve 11 is provided with a string of casing at the upper end. A drill stem 48 extends within the casing and bore and is threaded to the upper end of the sleeve 11 on the threads 49. The upper end of the drill stem 48 is secured to a Kelly joint 51 which is longitudinally movable through a turntable 52 as the turntable is rotated by a bevel gear 53. The Kelly joint is supported on a universal head 54, from the non-rotatable portion 55 of which a clevis 56 is attached to the drilling cable. A conduit 57 extends from the end 55, which functions as a running gland, for supplying a fluid through the hollow interior of the universal joint 54, the Kelly joint 51, and the drill stem 48 to the tool 10.

Fluid is supplied from a pump 58 driven by a motor 59 which is connected by a conduit 61 to a sump 62. Fluid is delivered from a conduit 63 through a two-way valve 64 to a conduit 65 and flexible tube 66. After the fluid is forced down through the tool 10 it is carried upwardly in the bore 46 and casing 47 through the conduit 67 and valve 68 into the sump 62. When it is desired to reverse the flow of fluid and apply pressure to the end of the tool 10, a split sealing washer 69 is applied to the upper end of the casing 47 which seals the drill stem 48 when the collar 71 thereof is lowered on to the washer.

The valve 68 is closed and the valve 64 is reversed to direct the fluid from the pump through the valve 64, conduit 72, into the casing 47. The conduit 65 is then connected through a conduit 73 to the sump 62.

Pressure will build up in the fluid within the casing 47 and bore 46 which will be applied to the end of the tool 10 to close the valves 39 so that assistance is provided for moving the tool upward through the casing 11 and the drill stem 48. Any pressure which may otherwise be created within the stem 48, joint 51, and conduits 67, 66, and 65 will be relieved by having the fluid flow through the conduit 73 to the sump. By this arrangement the tool 10 may be assisted by fluid pressure to effect a release from the sleeve 11, and may be floated by pressure to the top of the drill stem or may assist in such raising when an overshot is employed for releasing the sealing ring of the tool and for raising the tool.

What is claimed is:

1. A drilling tool including, in combination, a sleeve having on the lower end a truncated conical surface provided with spaced apertures, an axially movable stem within said sleeve, arms supported on said stem movable to positions adjacent to said surface, said stem wedging said arms against said surface to provide frictional engagement therebetween, and a projecting element on said arms movable into the apertures in said sleeve when said sleeve and arms are relatively rotated in the presence of said frictional engagement.

2. A drilling tool including, in combination, a sleeve having on the lower end a truncated conical surface provided with spaced apertures, an axially movable stem within said sleeve, arms supported on said stem movable to positions adjacent to said surface, said stem wedging said arms against said surface to provide frictional engagement therebetween, and a projecting element on said arms movable into the apertures in said sleeve when said sleeve and arms are relatively rotated in the presence of said frictional engagement, said stem having an outlet opening for a fluid near the end, and a valve for closing said outlet opening when said arms are wedged against said surface.

3. A drilling tool including, in combination, a sleeve having on the lower end a truncated conical surface provided with spaced apertures, an axially movable stem within said sleeve, arms supported on said stem movable to positions adjacent to said surface, said stem wedging said arms against said surface to provide frictional engagement therebetween, a projecting element on said arms movable into the apertures in said sleeve when said sleeve and arms are relatively rotated in the presence of said frictional engagement, said stem having an outlet opening for a fluid near the end, a valve for closing said outlet opening, and a locking and sealing ring disposed on the upper end of said stem for engaging the inner wall of said sleeve.

4. A drilling tool including, in combination, a sleeve attachable to the end of a drill stem and provided with spaced apertures, a mandrel supporting a plurality of pivoted arms on which cutter rollers are secured one above the other within said sleeve, means for interrupting the downward descent of said arms seriatim, means for swinging said arms against the inner surface of the sleeve, projections movable on said arms, and springs for moving said projections into said apertures for locking said arms against relative rotation on said sleeve after being moved thereagainst.

5. A drilling tool including, in combination, a sleeve attachable to the end of a drill stem, a mandrel supporting a plurality of pivoted arms on which cutter rollers are secured, one above the other, within said sleeve, means for interrupting the downward descent of said arms seriatim, means for swinging said arms against the inner surface of the sleeve in which apertures are provided, projections on said arms movable into said apertures for locking said arms against relative rotation on said sleeve, an expansible sealing ring provided on the upper end of said mandrel, and a sleeve having a wedge-shaped end disposed on said mandrel for moving said sealing ring against the inner wall of said sleeve.

6. The combination, with a drilling tool, of a sleeve having a truncated conical surface in the inner face of its lower end, a mandrel movable downwardly through said sleeve, slides supported on said mandrel, a plurality of arms pivoted on the ends of said slides, cutting rollers on said arms, means for interrupting the downward descent of said arms seriatim when the mandrel is lowered into the sleeve, spring-pressed elements on said arms projecting outwardly of the outer surface thereof, the end of said sleeve being provided with apertures in which the spring-pressed elements of said arms engage when the arms are swung outwardly into engagement with the surface as the end portion of the mandrel is moved downwardly therebetween.

7. A drilling tool including a sleeve secured to the end of a drill stem, a mandrel supporting a plurality of cutting elements and movable through said stem, said mandrel having a passageway for a fluid terminating in an outlet opening at the bottom, and a unidirectional valve which may close said opening at the time the cutting elements are in cutting position.

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