

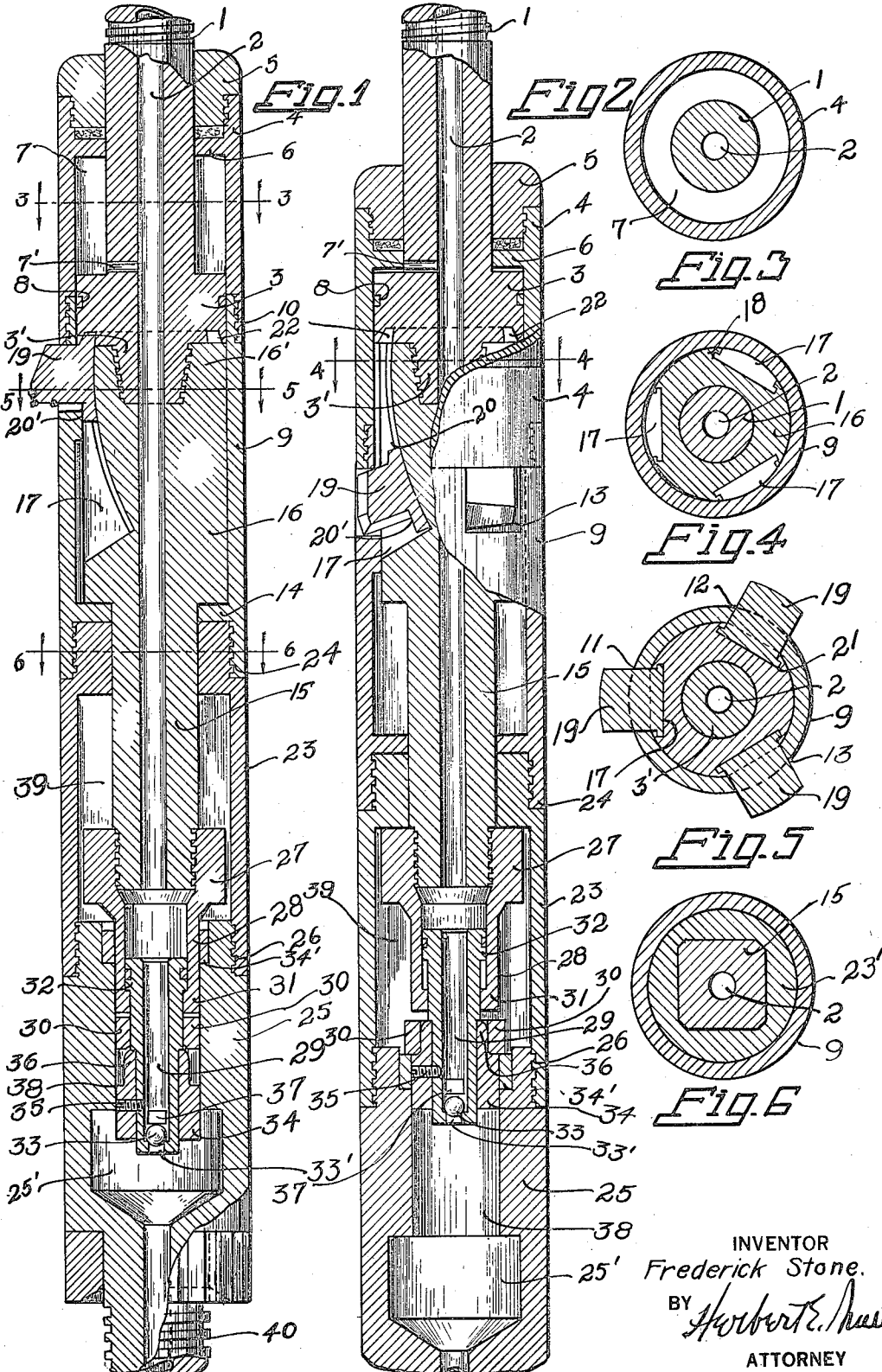
March 4, 1924.

1,485,642

F. STONE

EXPANDING ROTARY REAMER

Filed April 11, 1922 3 Sheets-Sheet 1



INVENTOR
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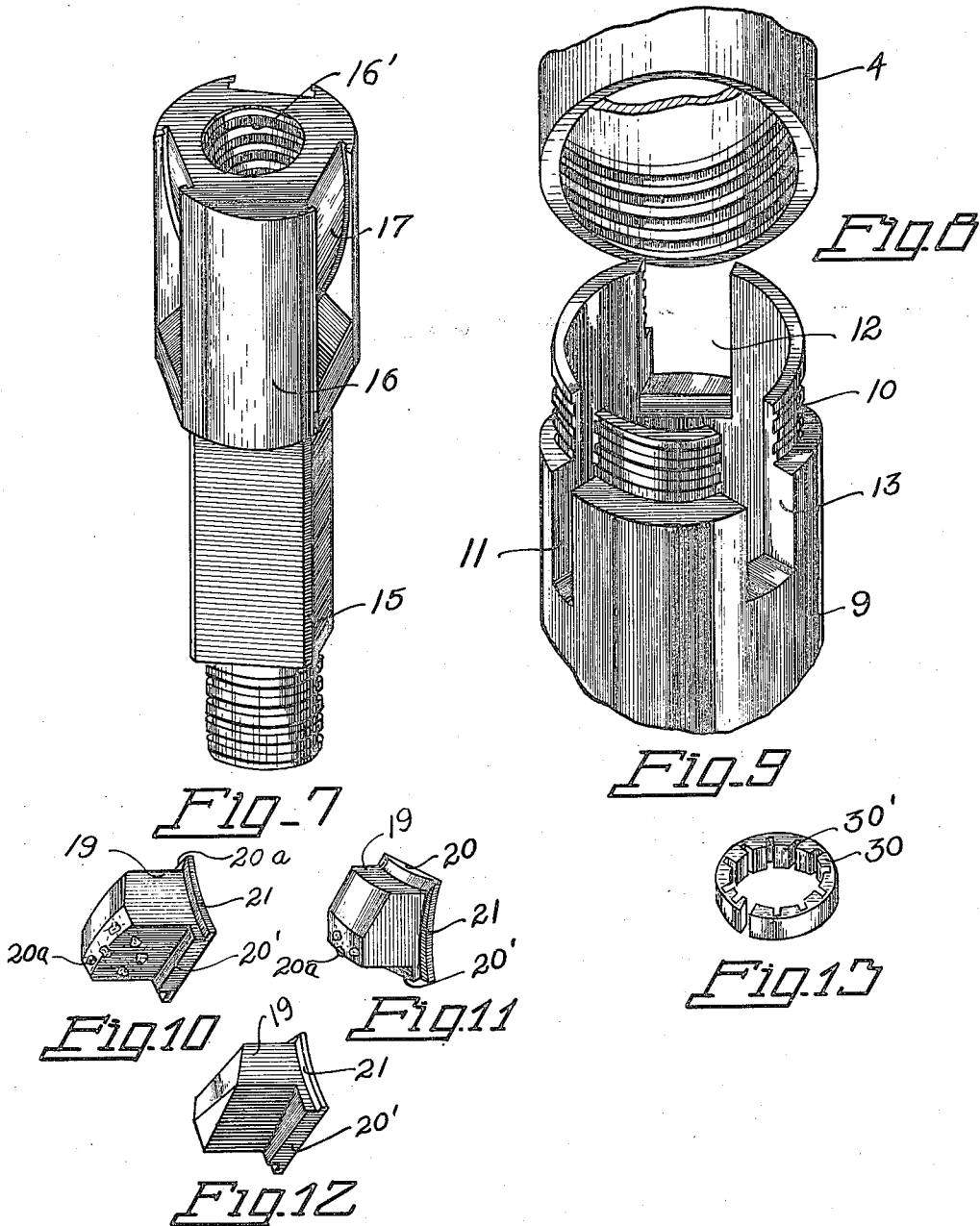
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EXPANDING ROTARY REAMER

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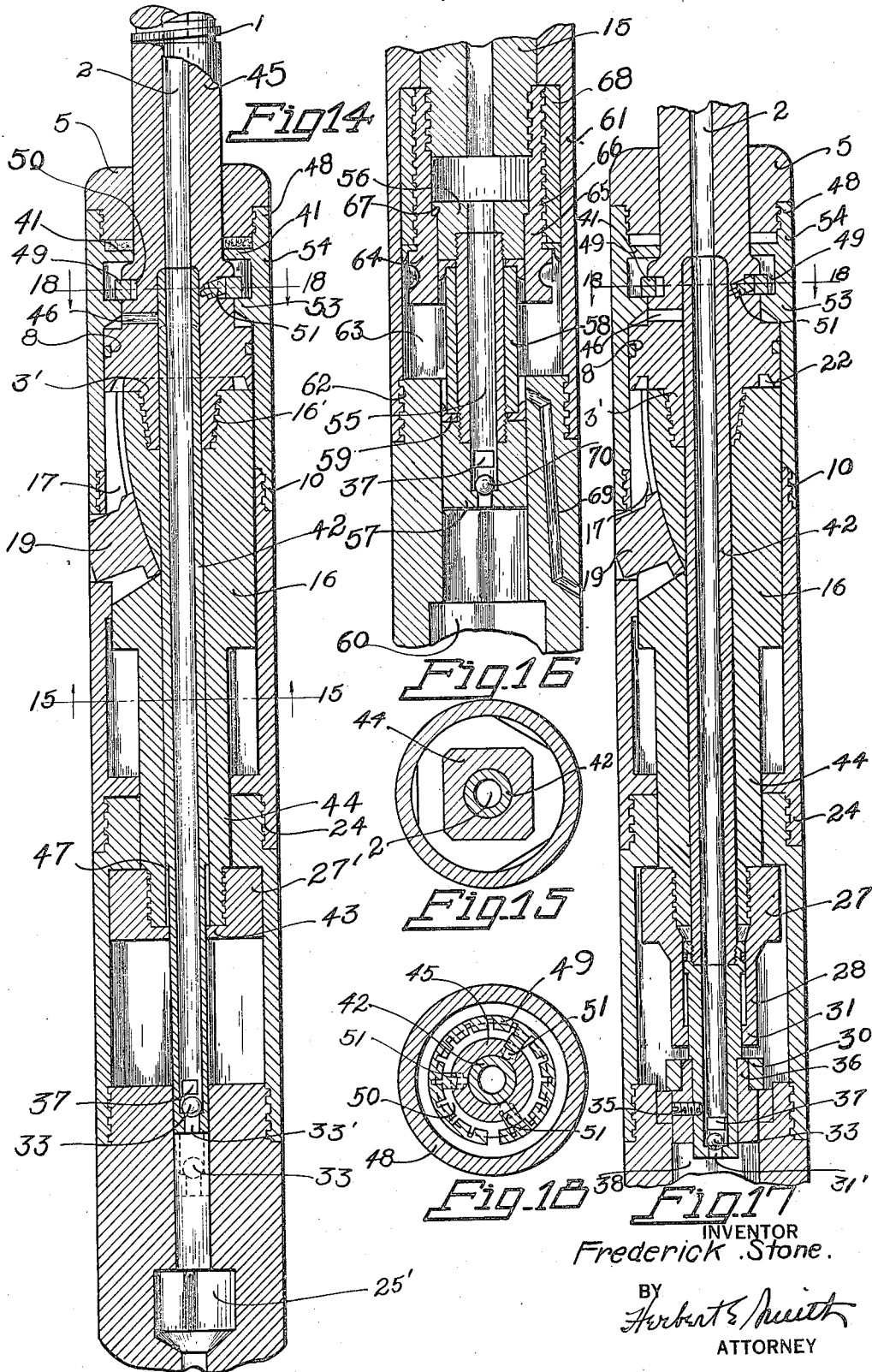
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EXPANDING ROTARY REAMER

Filed April 11, 1922 3 Sheets-Sheet 3



UNITED STATES PATENT OFFICE.

FREDERICK STONE, OF SPOKANE, WASHINGTON, ASSIGNOR TO DIAMOND DRILL CONTRACTING COMPANY, OF SPOKANE, WASHINGTON.

EXPANDING ROTARY REAMER.

Application filed April 11, 1922. Serial No. 551,549.

To all whom it may concern:

Be it known that I, FREDERICK STONE, a citizen of the United States, residing at Spokane, Spokane County, and State of Washington, have invented certain new and useful Improvements in Expanding Rotary Reamers, of which the following is a specification.

My present invention relates to improvements in expanding rotary reamers especially adapted for use in connection with a lead drill or bit, in the operation of drilling for water, oil, or gas and the like, either to remove a solid core or pulverized debris from material as minerals or rock. Simultaneously with the drilling operation of the center drill or bit at the lower end of the drilling tool, the previously drilled center hole is enlarged by the utilization of the laterally projecting underreaming cutters. This enlarged hole is required for the accommodation of the couplings and of the well casing sections that are added as the drilling operations proceed, and the center or pilot hole cut by the bit is thus enlarged by the reamer which follows after the bit at the lower end of the tool. The reaming tool is also applicable for use without the end cutting bit, and, if required, the cutters of the rotary reamer may be utilized for cutting the metal pipe or well casing within which the reaming tool is located. The primary object of my invention is the provision of an expanding rotary reamer by means of which many difficulties encountered in drilling operations are avoided. Provision is made for forcing the reaming cutters into expanded operative position by hydraulic pressure from the ground surface, and the maintenance of the cutters in operative position is indicated by the free and continuous flow of water from the casing above the cutting tool, which flow or circulation continues only as long as the rotary reamers are in operative position. Means are provided for guiding and positively forcing the reaming cutters to operative position and for retaining them in working condition as will be described. The reaming cutters are contracted and withdrawn within the tool by mechanical action of parts of the tool at the initial movement of elevating or pulling the tool from the casing or hole. And lubrication of the parts of the tool is provided for as will be hereinafter more fully set forth,

The invention consists essentially in certain novel combinations and arrangements of parts involving slidable members for radially and laterally moving the reamers or cutters to expanded or contracted position, and in other features of construction as will be more elaborately described and claimed.

In the accompanying drawings I have illustrated one complete example, and several modification, of my invention wherein the parts are combined and arranged according to the best modes I have thus far devised for the practical application of the principles of my invention.

Figure 1 is a vertical longitudinal section of the tool with the reamers in expanded position for operation.

Figure 2 is a similar view with the reamers or cutters in contracted position.

Figure 3 is a transverse sectional view at line 3—3 of Figure 1.

Figure 4 is a transverse sectional view through Figure 2 at line 4—4, showing the guide and retaining grooves for the reamers or cutters.

Figure 5 is a sectional view at line 5—5 of Figure 1 illustrating three reamers or cutters in expanded position for operation.

Figure 6 is a sectional view at line 6—6 of Figure 1 at a threaded joint and showing the squared driving shaft for rotating the reaming and cutting or drilling tool.

Figure 7 is an enlarged view, in perspective, of the cutter-holder with its integral driving shaft.

Figure 8 is a view in perspective at the lower end of the upper sleeve of the tool.

Figure 9 is a perspective view complementary to Figure 8 illustrating the upper end of the cutter-holder shell or sleeve, slotted to accommodate the cutters.

Figures 10, 11, and 12 are perspective views of standardized cutters or reamers applicable for use with the holder of Figure 7.

Figure 13 is a perspective view of a split, resilient locking ring for holding the reamers in position.

Figure 14 is a sectional view of a tool according to my invention with a slightly modified construction of tool holder and connections.

Figure 15 is a transverse section at line 15—15 of Figure 14.

Figure 16 is a sectional view of a further

modified form of the device for actuating the expanding reamers.

Figure 17 is another modified form of the expanding and locking mechanism for the reamers, and Figure 18 is a transverse sectional view of the locking device, at line 18—18 of both Figures 14 and 17.

For convenience of illustration the well casing and the center drilling bit are omitted from the drawings, but it will be understood that the tool is suspended within the well casing by means of the threads at the upper end of the tubular coupling member 1 which are attached as usual to the lower end of a tubular drill rod, and the drill rod is rotated or revolved from a suitable source of power. The drill-rod is usually encased within the well casing or pipes and the pipe-sections or casing-sections follow the drilling tool as the latter descends with progressive drilling. The bore or central longitudinal opening 2 of the coupling member extends throughout the length of the drilling tool, as will be described, and water under pressure is forced through the drill rod and tubular tool for expanding the reamers. At its lower end the coupling 1 is enlarged to form a cylindrical head 3, and this head is packed to form a piston having relative movement within a cylindrical sleeve 4. A packing nut or gland 5 encircles the coupling member and is threaded, as by left hand threads into the upper open end of the sleeve 4. A cylinder head 6 is formed of an annular, interior flange on the cylinder 4, and between the piston 3 and head 6 an annular water chamber 7 is fashioned which communicates with the bore of the coupling 1 and drill rod through port 7' in the coupling. By means of water pressure flowing through the bore 2 and port 7' into the water cylinder 7, as hereinafter described, the movable parts of the tool, by pressure applied to the head 6, are elevated from position of Figure 2 to operative position of Figure 1, thus expanding the reamer.

The piston portion 3 is provided with a packing ring 8 to prevent leak of water from the cylinder 7, and it will be understood that the piston remains stationary as the tool is elevated.

Below the sleeve 4 is located the barrel 9 which is secured to the sleeve by left hand threads 10, and this barrel, as best seen in Figure 9, is provided with a plurality of diametrically arranged, open end slots 11, 12, and 13 at its upper end, and near its lower open end an interior flange 14 is fashioned. This flange has a squared opening therethrough in line with the central axis of the tool to receive the squared drive shaft 15 formed integral with the cutter holder 16. The cutter holder is cylindrical and occupies the space within the barrel 9, and is secured to the lower end of the coupling 1 by

means of the threaded boss 3' thereon which threads into the socket 16' of the holder. Thus it will be seen that the barrel 9 which encases the holder is slidable relative to the holder, but rotates with the holder through the drive shaft 15 and the complementary squared flange 14. The cutter holder is fashioned with a series of undercut grooves 17 complementary to the slots 11, 12 and 13 of the core barrel. These grooves extend longitudinally of the holder and are vertically disposed in the tool having curved inner walls and undercut edges forming guide flanges 18 at the sides of the grooves. The grooves increase in depth from the top edge of the holder to the bottom of the groove, as best seen in Figure 1, and are adapted to receive a set of reamers or cutters indicated as 19 in Figures 10, 11, and 12. Each of the cutters has a top, rounded flange 20 and bottom flange 20', and side flanges 21 the latter fitting under the flanges 18 of the grooves 17 which guide the cutters as they move with relation to the holder and also retain them in position. In inoperative position these cutters rest in the lower enlarged parts of the grooves 17 of the holder with their working faces projecting into the slots as 11, 12 and 13 of the barrel, as seen in Figure 2. When the tool is actuated by water pressure to expand the cutters, the rising core barrel lifts the cutters, and they ride upward in the grooves which guide them to the tops of the grooves. As the cutters are elevated they are also projected laterally and radially and by the time they have reached the tops of the grooves the cutters are projected through the slots 11, 12 and 13, to operative position as in Figures 1 and 5. In this position the top flanges 20 are retained in complementary recesses 22 in the head 3 of the coupling 1, and the bottom flanges 20' of the cutters are forced against the inner wall of the barrel 9 and clamped between the barrel and the holder, as in Figure 1. The lower end of the squared driving shaft projects into a sleeve 23 with a squared flange 23' similar to the barrel 9 and attached thereto by left-hand threads 24 at the upper end of the sleeve and the lower end of the barrel, and below this sleeve is attached the coupling head 25 by right-hand threads 26. The coupling head is hollow and provided with an enlarged chamber 25' for water. The squared driving shaft in combination with the squared flange insures a positive drive or turning movement affording extensive wearing surfaces and great strength, though a key or spline might be used.

For limiting the movement of the sliding parts of the tool I utilize a stop nut 27, threaded on the lower end of the squared driving shaft, and in addition to performing its function as a stop, this nut also af-

fords support for the suspension of other parts. To this end the nut is fashioned with a cylindrical sleeve 28 in which a valve-casing 29 may reciprocate, in co-action with a locking member 30. This member as shown in Figure 13 is a split ring fashioned with interior grooves 30' to render it resilient and is located just below the sleeve 28. The lower end of the sleeve 28 is fashioned with an interior flange 31 forming a shoulder against which the head 32 of the valve casing contacts to limit downward movement of the valve casing within the sleeve.

Within the lower end of the tubular valve member or valve casing is retained a ball 33 adapted to close the seat 33' in the valve casing when forced to its seat by water pressure from above, which may flow down through the drill rod and tubular drilling tool. On the exterior of the valve case or casing, near its lower end is secured a bushing 34, as by set screw 35, and the upper end of this bushing is fashioned with a reduced extension 36 having a rounded top edge and adapted to enter and expand the resilient clamp ring 30. When the tool is inoperative, this resilient clamp ring 30 is clasped about the expander or extension 36, as in Figure 2. When water pressure is applied to the tool to expand the cutters 19 to operative position, the valve casing is first moved downwardly from position of Figure 2 to that of Figure 1. This movement slips the expander 36 out of the clamp ring 30, which ring is resting on the inset ring 34' of the coupling head 25, and the expanded clamp ring immediately contracts and clasps the valve casing, as in Figure 1.

In the lower end of the valve casing are lateral diametrically extending ports 37 which also pass through the fixed bushing 34. When the tool is in inoperative position these ports are closed by the wall of the chamber 38 above the enlarged chamber 25' of the head 25, but after the tool has expanded to operative position, the ports pass from the small chamber to the larger one, and water is then free to flow from the valve casing through the ports 37 into the chamber 25' and thence into the hole beneath the tool. The bore of the shell 23 is designated as a chamber 39 in which the nut 27 on the end of the drive shaft is adapted to reciprocate, in the expanding and contracting movements of the tool. On the lower end of the barrel 25 are threads 40 to which the pilot bit or lower drill is attached, said drill not being shown in the drawings.

The cutters or reamers 19 may have a variety of cutting members as diamond cutters indicated at 20^a in Figures 10 and 11, or the cutting faces of the cutters may vary as in Figure 12 to adapt the cutters or reamers for various kinds of work.

In preparing for drilling operations, be-

fore the tool is entered in the well hole, the cutters 19 are secured in retracted position within the core barrel 9, by pushing up the valve casing so that the expander 36 will enter the split clamp ring 30, and by means of the frictional engagement of the expanded clamp ring on the expander, and the fact that the clamp ring is seated on the inset-ring 34' the tool holder is retained in the upper end of the barrel. The coupling head 25 is then threaded into the lower end of the shell 23 and the tubular coupling 1 is connected to the lower end of the tubular drill rod not shown. The tool attached at the lower end of the drill rod is now lowered into the hole, or casing, and successive drill rod sections are added until the tool has reached the desired depth at which point the reaming is to take place. If necessary, water under pressure may be forced through the drill-rod and tool (the ball, valve 33 being absent) to wash away the debris and providing for progress of the center drilling bit until the reamers or cutters have reached a point below the lower end of the lowest well casing or section. The water connection is then removed from the top or surface end of the drill rod and the ball 33 is dropped through the tubular drill rod and tool to rest upon its seat 33' in the valve casing or slide valve 29, thus closing the lower end of the tool against passage of water. Water under pressure is then discharged down through the tubular drill rod and into the tool, forcing the ball valve tight against its seat. A pressure of between 150 and 500 pounds will be sufficient to force the slide valve from its position in Figure 2 to that of Figure 1, releasing the split clamp ring from its grasp on the expander 36 and forcing the head 32 of the slide valve to its seat 31 in the cylindrical sleeve 28, thus stopping the movement of the slide valve. The split ring at this time has contracted and embraces the slide valve, and its diameter is sufficiently reduced to permit it to pass into the bore 38 of the coupling head 25. Before the port 37 in the slide valve is uncovered, the pressure of water through the port 7' in the sleeve 4 enters the cylinder 7 or chamber in this sleeve, and upward pressure against the head 6 will elevate the parts 9, 23 and 25 and parts carried thereby, expanding the reamers or cutters as heretofore described. As the tool is lifted the coupling head 1, tool holder or cutter holder 16 and the squared shaft 15 remain stationary, and the port 37 is finally uncovered. Water is now released from the interior of the tool and flows through port 37 into the enlarged chamber 25' and thence to the bottom of the hole. The reaming cutters are now in operative position and the tubular drill rod is revolved to impart rotary motion to the cutter holder 16, the cutters or reamers 19 and the entire

tool. Circulation of water is provided for through the drill rod, the tool, and upward from beneath the tool, exteriorly thereof, past the rotating reamers 19, where the cuttings or debris are carried upwardly through the well hole or casing to the surface of the ground. The release of water through the port or ports 37, and the continued circulation of water as above described indicates that the reamers are in expanded working position; and it will also be apparent that all downward pressure exerted on the drill at the lower end of the tool will have a tendency to maintain the reamers in operative position. The reamers are thus backed against a solid support and the holder 16 takes the lateral thrust imposed on the reamers and part of the drag, while the grooves and slots which accommodate the reamers receive a part of the drag strains of the reamers.

After a section of the hole has been drilled and reamed by the progressive, downward movement of the tool, the circulation of water is stopped by cutting off the supply to the drill rod. After cutting off the water pressure, the drill rod and its tool are pulled from the well hole in usual manner. At the initial elevating movement of the drill rod and tool, the suspended parts 4, 9, 23, 25 and connections together with the attached pilot or center drill, are by their weight, held stationary, while the drill rod, drill holder 16, its shaft 15 and connections are relatively moved. Should the weight of these parts be insufficient for the purpose, contact of the expanded reamers 19 with the lower end of the well casing will hold these parts in stationary position, while the drill rod coupling, reamer holder and squared shaft are elevated. The movement of the grooved holder causes the reamers to be retracted or withdrawn from their projected position in the slots 11, 12, 13, and as the holder rises the reamers or cutters are finally seated in the bottoms of the grooves with their working faces withdrawn within the slots 11, 12, 13. The nut 27 is lifted to the top of the shell 23, carrying with it the slide valve 29, the slide valve, clamp ring 30 and sleeve 28 of the nut retaining their same relative positions as in Figure 1. The arcuate grooves in the reamer holder and slots 11, 12, 13 hold the reamers in inoperative position, and the drill rod and its tool may now be elevated from the well or casing. If required, new reamers may be applied to the holder, an additional casing or well section is added to the well tube, the parts again prepared as before indicated, and the drilling operations may be resumed.

In Figure 14 a modification of the invention is illustrated, in which the hydraulic pressure is delayed before being applied to the cylinder head 41 for expanding the

reamers. The slide valve in this instance, indicated as 42 is a comparatively long tube having a slide movement in the tool as indicated by dotted lines at the lower end of the slide valve. Here a flanged head 27' is threaded on the lower end of the squared shaft in place of the nut 27 of Figure 1, and the head has an open flange 43 at the lower end of the squared shaft 44. The slide valve extends through this flange and also projects into the drill rod coupling 45.

When hydraulic pressure is first applied preparatory to expanding the reaming cutters, the lateral port 46 in the coupling head 45 remains closed until hydraulic pressure forces the slide valve down releasing the clamping ring and causing the annular, exterior shoulder 47 to engage the flange 43. By this time the upper end of the slide valve has uncovered lateral port 46 to admit water pressure beneath the head 41 of the sleeve 48. But the slidable parts of the tool are not elevated until the split clamp ring 49 has released them. This ring is similar in construction to the ring 30 but is located in a different relative position. It is retained within an annular groove 50 in the coupling head 45 and has a number of distending pins 51 located in radially extending complementary sockets in the head. The elasticity of this split ring holds the pins with their inner pointed ends in contact with the exterior surface of the slide valve 42, near its upper end, and in this position, the split ring is held distended or expanded. While in retracted or inoperative position the reamers are locked and relative movement of the sliding parts of the tool and the tool holder is prevented because the split ring is seated on an annular flange 53 of the shell 54. When the slide valve is pushed down from position of Figure 14 its upper end is withdrawn from contact with pins 51 and the split ring is contracted due to its elasticity. In its contracted position the split ring is enclosed within the annular groove 50 and freed from its seat on the flange 53, thus permitting hydraulic pressure to expand the reaming cutters to operative position. The expansion movement of the reamers and the contraction movement of the reamers are attained by the same action as that of Figures 1 and 2.

In Figure 16 a further modification of the locking means for holding the remaining cutters in inoperative position is illustrated in connection with the lower end of the squared shaft 15. Here the slide valve includes a central tube 55 with upper and lower heads 56 and 57 respectively threaded thereon, and a packing sleeve 58 with rings 59 is interposed between the heads. The drill coupling head 60 and the shell 61 are threaded together as shown at 62, and the shell provides a space 63 which is packed

with grease to hold, temporarily, the coupling head 60 its required distance below the head 64 of the threaded bushing 65. This bushing is shouldered at 66 to receive the flange 67 of the valve head 56, and the bushing has external threads for the sleeve 68 within the shell 61. In Figure 16 the slide valve, which previously had been held in elevated position, by grease packed as through the grease port 69 in the wall of the drill holder or head 60, has been depressed by water pressure in the slide valve. And the head 56 of the valve has been moved from contact with the lower end of the squared shaft 15. This movement has pushed the packing ring 59 past the mouth or outlet opening of the grease port 69 and in the position shown, continued hydraulic pressure on the ball 70, causes a back or upward pressure in the tool for lifting the head 6 of Figure 1. Pressure on the head 6 elevates the sliding parts of the tool to expand the reaming cutters, and the grease in chamber 63 is forced out as the member 60 is elevated in Fig. 16.

This form of the invention is especially adapted for drilling comparatively shallow wells, and the grease packed in its chamber, with the valve elevated sufficiently to close the outlet port 69, retains the cutters or reamers in locked inoperative position until the hydraulic pressure is applied as heretofore described.

In Figures 17 and 18 a further modification of the tool is illustrated combining the comparatively long slide valve and resilient ring of Figure 14, with the expander and resilient ring of Figures 1 and 2. The action of the tool under hydraulic pressure, in this instance is the same as that previously described, but the duplex resilient or elastic clamping rings which lock the parts in inoperative position hold the parts more securely and support a heavier load.

From the above description taken in connection with my drawings it will be apparent that the tool as suspended from the drill-rod coupling and shaft, is temporarily locked with the reamers or cutters in inoperative position in order that the tool may be lowered into the well casing or hole. The reamers are positively expanded or projected to operative position by hydraulic pressure and maintained in rigid, stable position for cutting as the drill rod and tool are revolved. And the tool is retracted to inoperative position with facility and convenience by mechanical means in order that it may be withdrawn when required. By the utilization of my invention many objectionable features and difficulties in the process of boring are obviated, a strong and durable tool is provided, and a comparatively perfect tool of this type is effected for performing its required functions.

In earlier construction it was impossible to keep grit or rock particles from entering the barrel 9 and wearing the grooves and faces, and even choking the barrel so that the cutters could not function. It was also impossible to protect the carbons or diamonds from being broken, displaced and lost. In the present construction the cutters fit exactly in the slots in the barrel keeping out all foreign matter and through the functioning of the arcuate guide the cutters are retracted and tipped so that the precious stones are guarded and protected.

Having thus fully described my invention, what I claim as new and desire to secure by Letters Patent is—

1. The combination with a relatively stationary hollow cutter holder and hollow drill rod, of a movable tool including radially expansible reaming cutters, and means for admitting hydraulic pressure to the tool for expanding said reaming cutters.

2. The combination with a relatively stationary hollow cutter holder and drill rod, of a suspended tool and means for temporarily holding said tool in suspension, and means for admitting hydraulic pressure to the tool whereby the latter is moved to operative position.

3. The combination in a drilling tool including a rotary coupling head, a hollow cutter holder and expansible cutters carried thereby, of a rotary tool suspended from said coupling head, means for admitting hydraulic pressure to the tool, and means whereby the tool is moved relatively to the holder for expanding said cutters.

4. The combination with a relatively stationary hollow drill-rod coupling and a cutter holder forming a driving member connected thereto and a head on the coupling, of a tubular slidable tool, expansible cutters carried by said holder, a head on the tubular tool, means for temporarily retaining the tool in suspended position, and means for admitting hydraulic pressure between said heads for moving the tool to expand the cutters to operative position.

5. The combination in a rotary reamer with a tubular coupling head, a cutter holder and cutters, and a polygonal drive shaft on the holder, of a tubular, sectional tool-member suspended on said coupling-head and co-acting means between said head and tool-member whereby hydraulic pressure is applied to the tool member to elevate the same and move said cutters to operative position.

6. The combination in a rotary reamer with a tubular coupling head, a cutter holder and cutters, and a polygonal drive shaft on said holder, of a tubular sectional tool member suspended on said coupling head and forming a water cylinder therewith communicating with the tubular coupling head, and

co-acting means on the holder and tool member for laterally projecting said cutters by hydraulic pressure.

7. The combination in a reaming tool with a tubular rotary coupling head, a hollow grooved holder and cutters therein, of a slotted movable member forming part of said tool and engaging said cutters, and means for admitting hydraulic pressure to said tool for moving the latter and expanding said cutters to operative position.

8. The combination in a reaming tool including a rotary tubular coupling head, a hollow cutter holder and cutters carried thereby and an integral drive shaft, of a hollow sectional tool member suspended from said head and operatively connected with said shaft, means for temporarily suspending said tool and locking the cutters in inoperative position, and means actuated by hydraulic pressure for releasing said locking means and moving said tool member to expand said cutters.

9. The combination in a rotary reaming tool with a tubular coupling head, a cutter holder having a polygonal drive shaft, and expandible cutters carried by said holder, of an upper sleeve on the coupling head forming a head and cylinder adapted to receive water pressure from the coupling head, a slotted barrel connected with said sleeve and encasing the holder, a shell connected with said barrel and encasing said shaft, a lower coupling head connected with said shell, means for supporting said sleeve, barrel, shell and lower coupling from said first mentioned coupling head and means whereby, when said members are suspended by water pressure in said cylinder, the cutters are expanded.

10. The combination in a rotary reaming tool with a longitudinally grooved cutter holder and a cutter in said groove, of a relatively movable slotted tool member encasing said holder and adapted to engage said cutter and move it to radially extended position.

11. The combination in a rotary reaming tool with a cutter holder having a longitudinally extending exterior groove increasing in depth toward one end, of a cutter and means for guiding said cutter through the groove, a relatively movable slotted tool member adapted to engage said cutter, and means for moving said member to project the cutter to operative position.

12. The combination in a rotary reamer with a cutter holder having an exterior undercut groove forming guide flanges, the base of the groove extending in an arcuate line and said groove increasing in depth toward one end, of a cutter having lateral flanges engaged under said guide flanges, a relatively movable slotted tool member adapted to engage said cutter, and means

for moving said member to project the cutter to operative position.

13. The combination in a rotary expandible reamer with relatively stationary tool supporting members of tubular construction and relatively movable tubular members, and means for expanding the tool to operative position by hydraulic pressure, of means for supporting the movable members with the tool in inoperative position, said means being releasable under hydraulic pressure.

14. The combination in a rotary expandible reamer having relatively stationary tubular supporting and driving members and movable tubular members co-acting therewith to expand the tool to operative position under hydraulic pressure, of a slide valve operatively connected with the stationary and movable members, and means co-acting with said slide valve for temporarily locking the expandible reamer in contracted position.

15. The combination in a rotary reaming tool with tubular supporting and driving members, of relatively movable tubular members adapted to co-act therewith for expanding the tool to operative position under hydraulic pressure, a tubular slide valve connecting the stationary and movable members and adapted to resist hydraulic pressure, means for temporarily holding said valve to maintain the tool in inoperative position, and said holding means being releasable under hydraulic pressure.

16. The combination in a reaming tool with a stationary supporting member and movable driving member as described, of a tubular slide valve operatively connected with said members, and a resilient clamp ring adapted to temporarily hold said valve in locked position for the purpose described.

17. The combination in a reaming tool with stationary supporting and movable driving members as described, of a tubular slide valve connecting said members, and a detachable locking member carried by said valve adapted to hold the movable members in inoperative position.

18. The combination in a reaming tool with stationary supporting and movable driving members as described, of a tubular slide valve supported from the stationary member and engaging the movable member, a resilient clamp ring, and means actuated by movement of the valve for expanding said ring to position for holding the movable member in locked position.

19. The combination in a rotary reaming tool with a cutter holder and a relatively movable tool member and actuating means therefor, of flanged cutters having arcuate side flanges and end flanges one of which is square cut and the other beveled, and co-acting means between said holder and mov-

able tool member for radially projecting
said cutters to operative position.

20. The combination in a rotary reaming
tool with a longitudinally arcuate grooved
5 cutter holder and a flanged cutter operative
in said groove, said cutter having top and
bottom flanges for engaging the cutter

holder and a movable slotted tool member
respectively, of a relatively movable slotted
tool member encasing said holder and 10
adapted to engage said cutter and move it
to radially extended position.

In testimony whereof I affix my signature.

FREDERICK STONE.