June 16, 1931. E. F. RAYMOND 1,810,030

UNDERREAMER

Filed May 5, 1926

Fig. 1

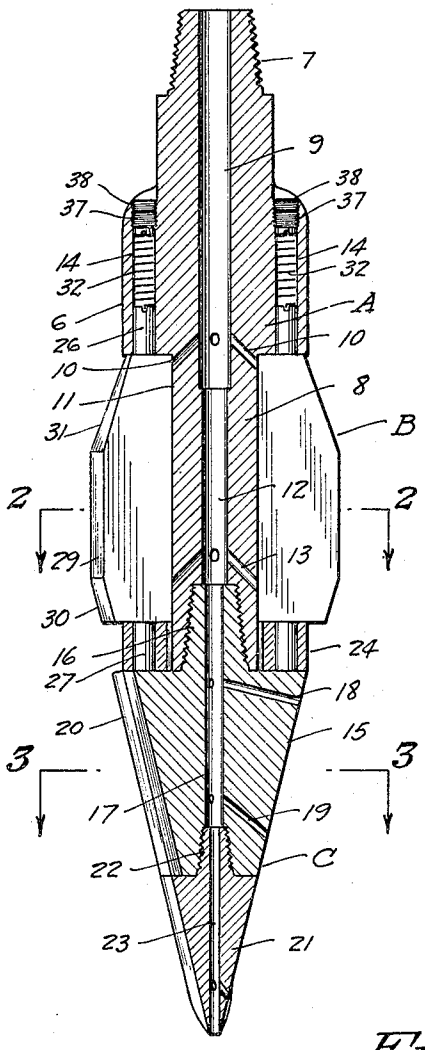


Fig. 3

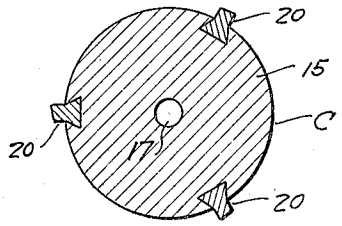


Fig. 4

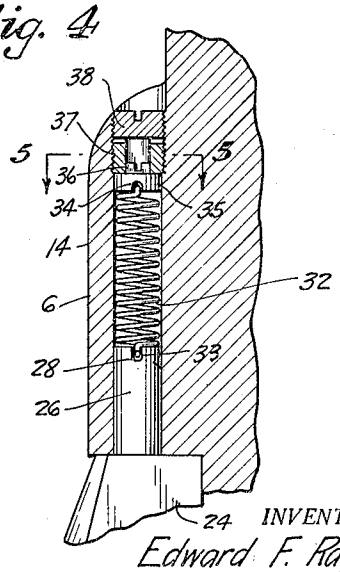


Fig. 2

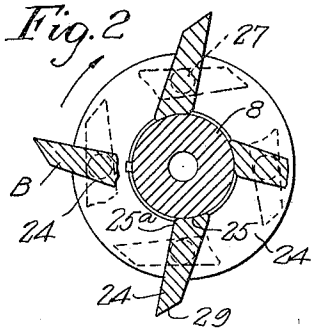
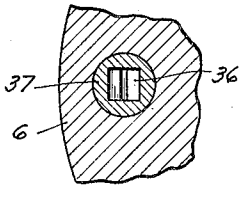


Fig. 5



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Patented June 16, 1931 1,810,030

UNITED STATES PATENT OFFICE

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UNDERREAMER

Application filed May 5, 1926. Serial No. 106,814.

This invention relates to an expansible underreamer and pertains more particularly to a tool having a body provided with laterally swingable cutters arranged so as to be disposed either in housed or inoperative position within said body or projected in cutting position.

The present invention has for an object the provision of a body having chambers, cutters mounted on axes longitudinally of said body so as to be swung laterally, whereby the cutters will be housed or sheltered within the body or extended beyond the body. Another object of this invention is to provide an underreamer of the character described which has cutters resiliently urged outwardly into projected position and which by pressure upon the upper sides of the cutters will cause the latter to be moved into sheltered or inoperative position.

Another object of the invention is to provide the body for the expansible and retractable cutters with a cooperating pilot end adapted to properly guide the tool as it is lowered through a well casing with the cutters retracted so that when the tool has been guided by the pilot end to position below the end of the casing the cutters may automatically expand to operative position. Another object of the invention is to provide the pilot end which cooperates with the cutters, with suitable blades adapted to properly prepare the well bore for subsequent underreaming by the expanded cutters.

A still further object of the invention is to so mount the cutters units which form the underreamer that they may swing and be held in expanded position simply by radial abutment against the body of the tool and without the body circumferentially obstructing such swinging movement, and to also provide for discharge of a circulating fluid in back of the swinging cutter units when the latter are retracted, so that the fluid discharge will cooperate with the described swinging mounting to expand the cutters and prevent any clogging action.

Another object of the invention is to provide for such discharge of a fluid circulating medium at spaced points along the length of the tool, and to arrange the circulating bore which supplies fluid to the different discharge points so as to equalize the pressure at said various discharges.

These objects together with other objects and corresponding accomplishments are obtained by means of the embodiment of my invention illustrated in the accompanying drawings, in which:

Fig. 1 is a vertical section showing the underreamer incorporated in a side-tracking tool; Fig. 2 is a section as seen on the line 2—2 of Fig. 1; Fig. 3 is a section as seen on the line 3—3 of Fig. 1; Fig. 4 is a vertical section on an enlarged scale showing a fragment of the structure and particularly the mounting of the blades within the body; and Fig. 5 is a section as seen on the line 5—5 of Fig. 4.

Referring more particularly to the drawings, the invention is shown embodied in a side tracking tool of the type shown in Patent 1,577,810, granted to me March 23, 1926. It comprises a body A at the upper end of which is an annular recess to receive underreamer cutters indicated generally by B. The lower end is provided with a tapered pilot end C.

The upper portion of the body indicated by 6 has an overall cylindrical outer wall. At its uppermost end it is provided with a tapered threaded pin 7 for connection to a string of drill pipe. The intermediate portion of the body is reduced in diameter to provide a cylindrical mandrel 8. Extending longitudinally through the body is a passage 9 for circulation water from which extends courses 10 to the outside above the annular chamber 11 formed in the body. Passage 9 is reduced in diameter as indicated by 12 and water courses 13 extending through the mandrel communicate therewith. A tapered internal threaded socket is formed at the lower end of the mandrel, and the pilot end C is connected thereto by means of a threaded pin. Extending longitudinally through the portion of the body 6 are pivot pin bearing holes 14. There are four shown herein, there being four cutters for the underreamer. The upper ends of the holes 14 are internally

threaded and the lower ends are smooth providing bearings for the cutter trunnions.

The pilot end C comprises a conical portion 15 having a tapered threaded pin 16 for engagement with the threaded socket in the body A. Extending therethrough is a water passage 17 of retracted diameter and communicating with the reduced portion 12 of water passage 9 and having courses 18 and 19 opening to the outside adjacent dovetail longitudinally extending grooves which are adapted to receive blade cutters 20. These cutters are removable and are held in position by a point 21. Point 21 has a threaded pin 22 engaged in the threaded socket in the conical body. It has extending through its central portion a water course 23 of reduced diameter communicating with the passage 17, and the water courses 10, 13, 18, 19 and 23 are thus adapted for discharge of fluid from the tool with the successive restrictions 12, 17 and 23 in the water passage equalizing the pressure of the discharge through the various water courses. The point 21 prevents downward displacement of the cutter blades. Resting upon the upper wall of the conical body is a ring 24', which may be keyed to the mandrel 8 to prevent it from rotating upon the body. The ring 24' is provided with a number of holes to receive the pins on the underreamer cutters and serve as bearings therefor.

The underreamer cutter units are shown herein as blades 24 having heels 25 which throughout the major portion of the width of the blades are of a curvature equal to the curvature on the cylindrical surface of the mandrel. At the ends of the blades are pins 26 and 27. The upper pin 26 has a kerf 28 extending across its end. The blade has an outer edge substantially parallel with the heel of the blade, the parallel edge being inclined and indicated by 29. It is tapered inwardly at the lower end as indicated by 30, and similarly tapered inwardly at the upper edge as indicated by 31. The pivot pins and heels of the cutters are so arranged that when the cutters are in their outer position as shown in Figs. 1 and 2, the upper edge of the cutter indicated by 31 underlies the cylindrical portion of the body indicated by 6.

Disposed in the openings 14 are torsion springs 32. These springs end in diametrical portions 33 and 34. A portion 33 is disposed in the kerf 28 of a trunnion. A cap 35 slidably fits within the bore of the hole 14 and has a kerf on its lower face adapted to receive the portion 34 of the spring. The cap is provided with a square head 36 having a kerf. Disposed within the bore 14 is a plug 37 having external threads engaged with the threads in the bore and an opening square in cross section to receive the head 36. A closure plug for the bore is indicated by 38.

To mount the blade 24, the conical end is detached from the body and the ring 24' removed from the mandrel. The blades are positioned with their trunnions 26 in corresponding holes 14. The torsion springs are mounted in position above the pins with the caps 35 and plugs 37 in position. The ring 24' is then positioned on the mandrel with trunnions 27 in the bearings. The pilot C is then attached.

The torsion springs urge the blades into their outer or working position and the curved surfaces 25 at the heels of the blades terminate at the ends thereof which are circumferentially rearwardly disposed with relation to the direction of said movement, in reversely curved surfaces 25[a] which permit turning of the blades without obstruction by the body of the tool until the heels 25 abut against the mandrel at appreciable angles to the lines of radial thrust through the cutters so as to fix the cutters in position projecting slightly non-radially from the tool as shown in full lines in Fig. 2. In cutting the formation, the tool is rotated in the direction indicated by the arrow in Fig. 2. The resistance of the formation is such as to tend to swing the blades in the same direction as the torsion springs urge. The mandrel firmly holds the blades in position. If it is found that the torsion springs do not exert enough pressure, the closure plugs 37 are removed and the blade of a screw driver or like instrument inserted through the bore of a plug 37 and engaged in the kerf of the cap. The cap is then forced downwardly until the head clears the bore of plug 37, whereupon the cap may be turned to twist the spring and cause greater torsion. When the spring has been twisted an amount sufficient, the cap is permitted to move upwardly until the head 36 engages in the bore of the plug, thereby locking the torsion spring.

The tool may be collapsed by pressing the blades inwardly until they are housed within the annular recess, the body 6 shielding the blades and mandrel 8 forming no pockets or recesses in back of the expanded or retracted blades which may clog with mud or the like. In this condition, the tool may be inserted in a well casing. As it is lowered and passes the end of the casing or the shoe, the torsion springs cause the blades to be moved into expanded or working position. The water courses 10 and 13 open through the tool in back of the outwardly swinging portions of the blades so that fluid discharge through these water courses also tends to swing the blades to operative position, and the fluid discharge flushes the space in back of the blades which as previously stated is formed without pockets or recesses which might retain mud or the like, and as a consequence the flushing action of the fluid will positively clear such space of any material tending to clog the swinging action of the

cutter units. The abutment of the heels of the blades against the mandril at substantial angles to the lines of radial thrust through the cutters positively supports the blades in their extended, slightly non-radial position with both the radial and circumferential thrust directed against the angular abutment surfaces formed between the mandrel and the heels of the blades so as to relieve the pivotal mounting for the blades of the cutting stress and transmit it directly to the mandril; and the relative curvature of surfaces 25—25[a] of the blades and the cylindrical surface of mandril 8, whereby these surfaces are non-concentric with the pivot stems 26—27, fixes the cutters in operative position with sufficient circumferential abutment between surfaces 25—8 to afford an adequate support but without extended frictional contact at these abutment surfaces, and particularly without extended frictional contact between surfaces 25[a]—8 when the blades are swung to retracted position. Upon the tool being withdrawn into the casing, the bottom thereof or the shoe engages the inclined portion or shoulder 31 of the blade and due to the slightly non-radial position of the blade when in expanded position acts to swing the latter inwardly as the tool is withdrawn into the casing.

What I claim is:

1. A tool of the character described comprising a body having an annular undercut external chamber and a downwardly extending mandrel terminating in a pilot end having an upper wall forming a ledge outstanding from said mandrel, cutter bearing means supported by said ledge, cutters having trunnions at the ends for disposal in bearings in said body and said means, said cutters having heels movable into and out of engagement with said mandrel, said cutters being so mounted that when in expanded position cutting pressure exerted thereon will tend to swing them so that said heels will abut said mandrel thereby holding the cutters rigidly in outer position, and resilient means urging said cutters into expanded position.

2. A tool of the character described comprising a body having an annular undercut external chamber and a downwardly extending mandrel, a pilot end depending from said mandrel and having an upper wall forming a ledge outstanding from said mandrel, a cutter bearing ring detachably mounted on said mandrel and secured thereto against rotation, said ring being supported on said ledge, cutters having trunnions at the ends, bearing openings for said trunnions in the overhanging portion of said body, torsion springs in said bearing openings and connected with said trunnions tending to urge said cutters into expanded position, there being bearing openings in said ring receiving trunnions at the lower ends of said cutters, said cutters having heels movable into and out of engagement with said mandrel and being so mounted that when expanded cutting pressure exerted thereon will tend to swing them so that their heels will abut said mandrels thereby holding the cutters rigidly in outer position.

3. A tool of the character described comprising a body having an annular undercut external chamber and a downwardly extending mandrel, a pilot end detachably secured to said mandrel and having an upper wall forming a ledge outstanding from said mandrel, cutter bearing means supported by said ledge, cutters having trunnions at the ends for disposal in bearings in said body and said means, said cutters having heels movable into and out of engagement with said mandrel and being so mounted that when in expanded position cutting pressure exerted thereon will tend to swing them so that their heels will abut said mandrel thereby holding the cutters rigidly in outer position, resilient means urging said cutters into expanded position, said cutters having rearwardly bevelled outer edges inclined outwardly and downwardly for engaging a casing at their upper portion.

4. A tool of the character described comprising a body having an annular undercut external chamber and a downwardly extending mandrel, a pilot end detachably secured to said mandrel and having an upper wall forming a ledge outstanding from said mandrel, a cutter bearing ring detachably disposed on said mandrel and being secured thereto against rotation, said ring being supported by said ledge and having bearing openings, cutters having trunnions at the ends for disposal in said bearing openings in said body and said ring, said cutters having heels movable into and out of engagement with said mandrel and being so mounted that when in expanded position cutting pressure exerted thereon will tend to swing them so that their heels will abut said mandrel thereby holding the cutters rigidly in outer position, resilient means urging said cutters into expanded position, said cutters having rearwardly bevelled edges inclined outwardly and downwardly for engaging a casing at their upper portion.

5. A tool of the character described comprising a body having an annular undercut external chamber and a downwardly extending mandrel, there being bearing openings extending through said body at the overhanging portion, a pilot end detachably secured to said mandrel and having an upper wall forming a ledge outstanding therefrom, a cutter bearing ring detachably mounted on said mandrel against rotation and supported by said ledge, said ring having bearing openings, cutters having trunnions at the ends for disposal in said bearing openings, said cut-

ters having heels movable into and out of engagement with said mandrel and being so mounted that when in expanded position cutting pressure exerted thereon will tend to swing them so that their heels will abut said mandrel thereby holding the cutters rigidly in outer position, torsion springs mounted in the bearing openings in said body and engaged with said trunnions urging said cutters into expanded position, said cutters having rearwardly bevelled edges inclined outwardly and downwardly for engaging the lower end of a casing.

6. A tool of the character described comprising a body having an undercut shoulder and an axially projecting mandrel, an outstanding bearing means axially spaced from the shoulder, a pilot end projecting axially beyond the bearing means, a cutter having trunnions at its ends journalled respectively in the shoulder and in the bearing means and adapting the cutter for swinging to expanded or contracted position, and a torsion spring on one of the journaled trunnions tending to swing the cutter to expanded position.

In witness that I claim the foregoing I have hereunto subscribed my name this 27th day of April, 1926.

EDWARD F. RAYMOND.