March 17, 1931. J. J. SANTIAGO 1,796,479

EXPANDING ROLLER UNDERREAMER

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Fig. 2.

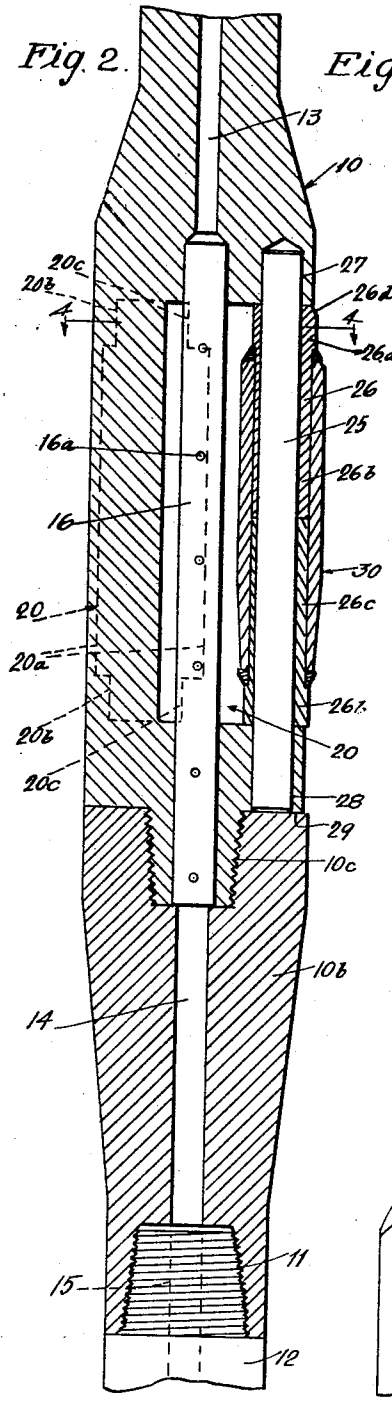


Fig. 1.

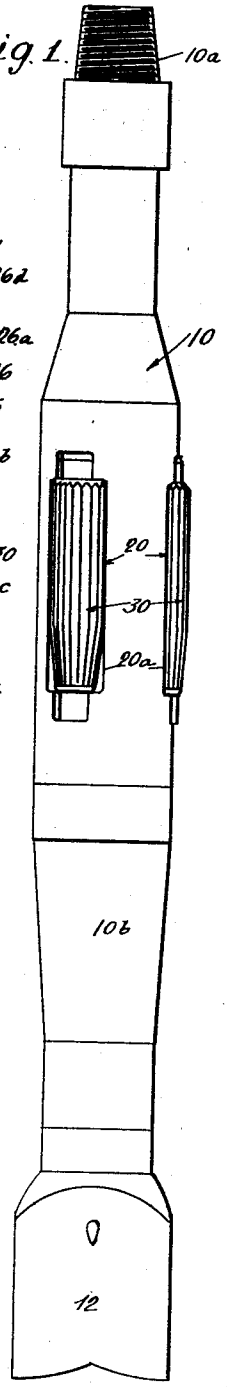
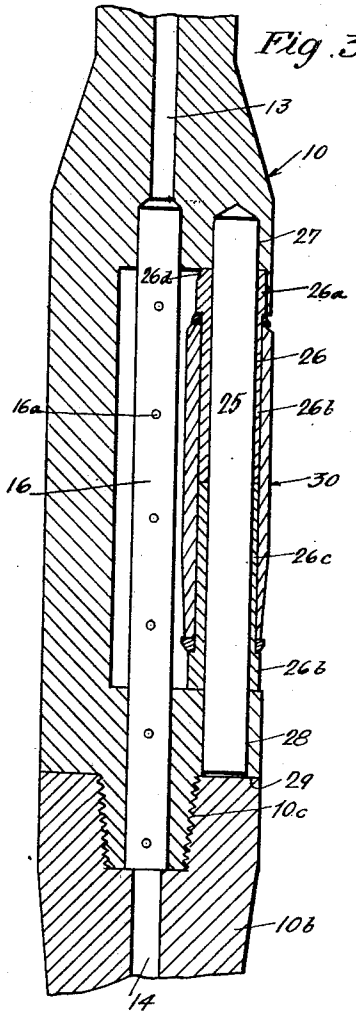


Fig. 3.



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Fig. 4.

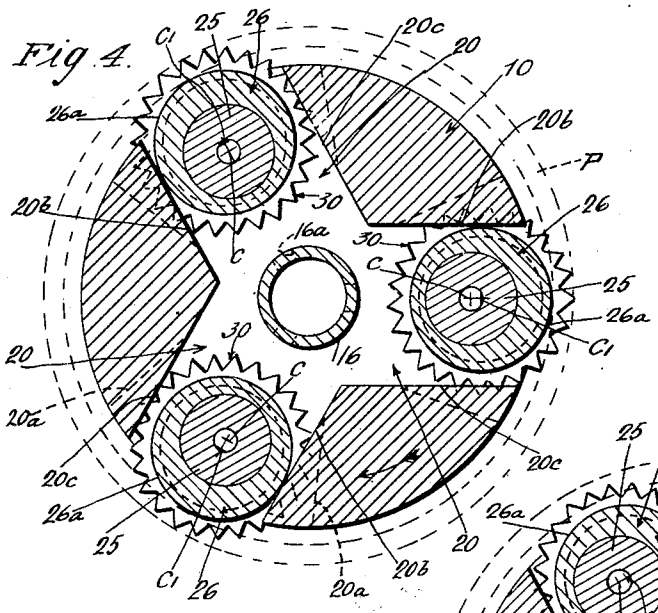


Fig. 5.

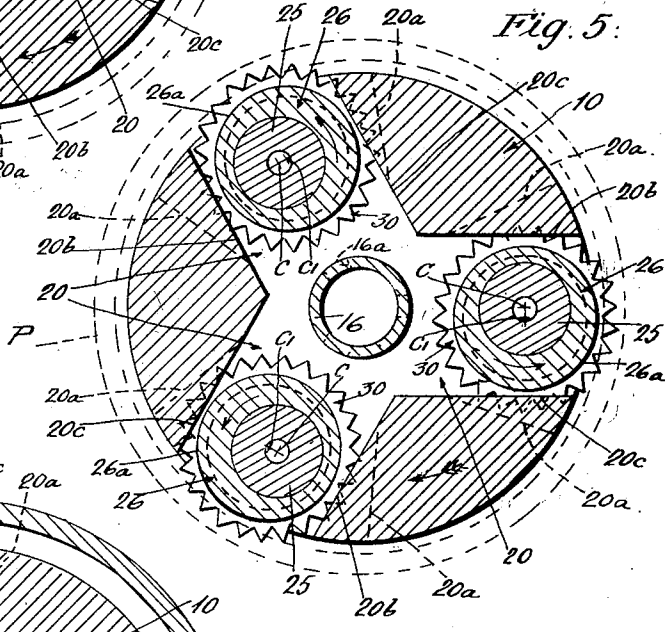
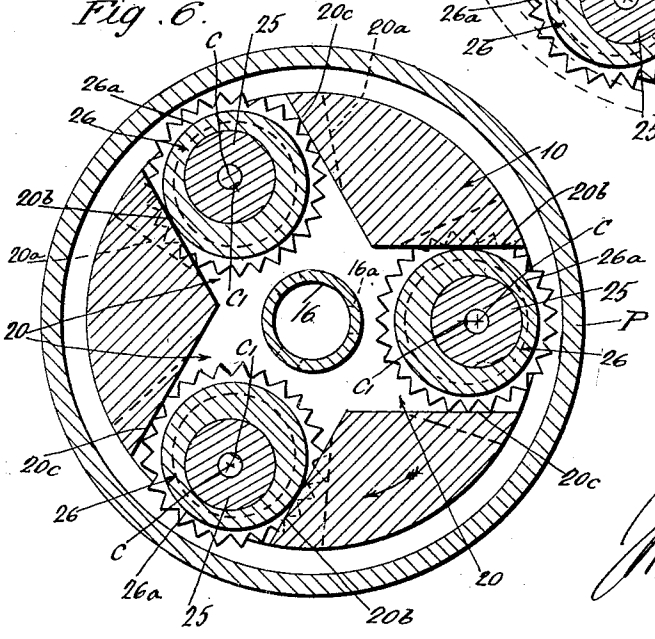


Fig. 6.



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UNITED STATES PATENT OFFICE

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EXPANDING ROLLER UNDERREAMER

Application filed October 19, 1927. Serial No. 227,107.

This invention relates to expanding reamers of the type used in rotary drilling or reaming, and usually for underreaming below the casing; the general object of the invention is the provision of a compact, simple and strong expansive reamer which presents a maximum of cutting edge to the strata. There are various other objects and corresponding accomplishments of the invention, but all these will be best understood from the following detailed description of an illustrative specific embodiment of the invention.

The present invention bears certain relationships to that set out in the application of John Grant, Serial Number 122,340, filed July 14, 1926, for expanding well reamer; the application of said John Grant filed Oct. 10, 1927, Serial No. 225,270 (Case "A"); and the application filed by me on Oct. 19, 1927, Serial No. 227,106 (Case "B"); this present application being known in the series as Case "C". The first Grant application sets forth an expansive reamer wherein a cutter element, typically an annular roller, surrounds the mandrel and is shiftable laterally with relation to that mandrel by virtue of longitudinal movement with relation to the mandrel. The second Grant application sets out a series of such cutter elements mounted on individual mandrels arranged around the main reamer body, and each shiftable laterally with relation to its individual mandrel pin by virtue of relative longitudinal movement. My co-pending application identified above sets out a construction wherein the cutter elements, typically annular rollers, surround the main body mandrel and are shiftable laterally on that mandrel without relative longitudinal motion to and from an offset bearing surface, the shifting being accomplished by eccentric action. This present application deals with an arrangement and combination wherein a plurality of cutter elements are arranged on a plurality of individual mandrel pins spaced around the main reamer body, and are shiftable laterally without relative longitudinal movement. A specific and illustrative design embodying the features of my present invention is illustrated in the accompanying drawings, in which:

Fig. 1 is an elevation of a complete reamer;

Fig. 2 is an enlarged fragmentary longitudinal section of the same showing a cutter element in expanded position;

Fig. 3 is a similar section showing a cutter element in contracted position;

Fig. 4 is a further enlarged cross-section showing the cutters in expanded position and taken on line 4—4 of Fig. 2;

Fig. 5 is a similar section showing the cutters in intermediate position; and

Fig. 6 is a similar section showing the cutters contracted.

In the drawings a typical reamer body is shown at 10 having the usual screw-threaded pin 10*a* at its upper end for connection to a rotary drill string. The reamer body may be made in two parts, comprising the body proper 10 and a body extension 10*b* joined by the usual pin and box connection 10*c*; the extension at its lower end being connected by the usual pin and box connection 11 to a drill bit 12 of any desired type. Water courses 13 and 14 extend longitudinally through body 10 and extension 10*b* to connect with water course 15 in the drill bit. Through the slotted part of the body the water courses 13 and 14 are connected by a tube 16 having spaced lines of perforations 16a to deliver water inside the several cutting elements and their mountings to supply them with circulation water and to keep them washed clean throughout their lengths. As shown in Fig. 4 these perforations are preferably located so as to deliver water directly onto the several cutting elements.

It will be understood that a reamer of the type here described may be designed to embody any suitable number of cutting elements; the principles of construction and operation concerned herein being applicable to any number of cutting elements. For purposes of illustration I have preferred to show a construction embodying three cutting elements or cutter assemblies; and therefore the body 10 is shown as provided

with three radial and longitudinally extending slots 20 which meet at the center of the body, as is best shown in the cross-sectional views, the circulation tube 16 passing longitudinally through the center of the space thus formed. For functional purposes to be described these slots 20 are each widened out as at 20*a* in their central portions, being there defined by side walls 20*b* and 20*c*.

Extending longitudinally through each body slot, and mounted at its upper and lower ends in the reamer body, is a cylindric mandrel pin 25 which may either be rotationally stationary or may rotate with the surrounding eccentric sleeve 26. However, I prefer to fit the mandrel pins 25 fairly tightly at their upper ends into sockets 27 and at their lower ends into sockets 28, so that the pins may remain stationary and so that the bearing face where relative rotation takes place will be comparatively long—the whole length of eccentric sleeve 26. Socket 28 which takes the lower ends of the mandrel pins extends downwardly to the body shoulder 29 where body 10 shoulders up against extension 10*b*; so that, by removal of extension 10*b*, the mandrel pins may be slipped out longitudinally and the whole reamer thus easily disassembled.

Each mandrel pin has an eccentric sleeve 26 surrounding it, the eccentric sleeve having an eccentric cylindric outer bearing surface which carriers the roller cutter 30. These roller cutters may be, in my construction, of some considerable longitudinal extent, so that each presents to the strata a long cutting edge. The roller cutters may be of any preferred construction or design and provided with any preferred or desired teeth or other cutting formation on their outer faces.

Eccentric sleeves 26 are preferably made in two parts 26*b* and 26*c*, each part being provided with a head 26*c* which is formed in such a manner as to provide in effect a stop lug which brings up against one of the walls of the body slot, thus to limit the relative rotations of the eccentric sleeve. For ease and simplicity of manufacture these stop heads 26*c* can be made, and are here shown, as eccentric heads of the same eccentricity as, although larger in diameter than, the eccentric sleeves 26. It will be understood that eccentric sleeves 26 are divided into two halves merely for ease of manufacture and assembly; so that the heads 26*a* may be made integral with the sleeve halves and the sleeve halves inserted lengthwise into the roller from opposite ends. In operation the sleeve halves rotate together just as though each sleeve were one piece from end to end. The rollers extend lengthwise on the sleeves from head to head; the heads are made as short as consistent with good design; and the rollers are, as nearly as practicable, of substantially the same length as the slots. This gives a long cutting edge, and also gives to the roller a very direct support, through the eccentric and mandrel, without putting the mandrel under any large bending stresses.

Fig. 6 shows the contracted positions of the cutters, moved inwardly far enough that the whole tool will pass through the well pipe P. In this position the eccentrics 26 are so located that their centers C—1 are located inward of the center C of mandrel pins 25. In the drawings centers C—1 are shown located directly radially inwardly of centers C—that is, directly toward the central axis of the whole tool. In this position it will be seen that the eccentric outer surface of heads 26*a* have brought up against the walls 20*b* of slots 20. The eccentrics can therefore make no further rotation in a right hand direction in Fig. 6. In this collapsed position of the cutters the tool may be lowered through the well pipe P and into the drill hole beneath the pipe. Then the whole tool is rotated right-handedly, looking down upon it, and the relative drag due to contact of the cutters and of the eccentrics 26 with the walls of the hole then causes the eccentrics to move around in a relative left-hand direction—in the relative directions indicated by the arrows placed on those eccentrics in Fig. 5. Walls 20*c* of slots 20 are spaced further from mandrel centers C than are walls 20*b*, so that when the eccentric heads 26*a* reach such positions as shown in Fig. 5 they will clear walls 20*c*. Accordingly the eccentrics rotate in a relatively left-hand direction until they reach the position shown in Fig. 4, where the eccentric centers C—1 are located substantially radially outwardly from mandrel centers C and where the eccentric heads 26*a* have again brought up against slot walls 20*b*, as shown in Fig. 4. In this position the eccentric sleeves can make no further movement, the contact of the eccentric heads with the slot walls acting as a movement stop. During continued right hand rotation of the tool for drilling and reaming operations the reaction and drag on the rollers and eccentrics is such as always to keep the eccentric heads 26*a* up against the limiting stops; and accordingly the cutters remain, during drilling and reaming operations, in their expanded positions.

To contract the cutters it is only necessary to rotate the tool a short distance in a left-handed direction, when the cutters will be turned back to the position of Fig. 6 by the drag of the strata; or the tool may be pulled up to a position where the upper heads 26*a* come in contact with the lower end or shoe of the casing, and then if the tool is rotated a little to the left, friction of the casing

with the heads will cause them to rotate back into the reamer body. At the same time, if a slight upward pressure of the eccentric head is maintained against the lower end of the casing, the usual conical inner face of the casing shoe will, just as soon as the eccentrics have rotated slightly back from their positions shown in Fig. 4, have the action of pressing the eccentrics inwardly—rotate them around right-handedly—as the tool is moved upwardly. For this kind of collapsing action the design, if desired, may be slightly modified to stop the expansive rotation of the eccentric sleeves in a position a little short of the absolutely radial position shown in Fig. 4, so that the eccentric sleeves will always be rotatably movable by contact with the conical opening in the lower end of the casing shoe. And, if the lower end of the casing shoe have a square edge, instead of an inner conical taper, a bevel 26*a*, as illustrated in Figs. 2 and 3, applied to the upper edge of upper eccentric head 26*a*, will have the same action.

I have specifically described this reamer as having rotating roller cutters 30 which surround and rotate directly upon the eccentric sleeves 26. It will be understood, however, that the rotating rollers may typify any kind of cutting element mounted upon the eccentrics and shifted bodily by rotation of the eccentrics. The construction, however, lends itself very readily to the very simple shiftable mounting for the rotatable roller cutter. And whatever specific kind of cutter may be used, the whole construction will be recognized as very simple and strong and as affording a comparatively long, effective cutting edge that is strongly supported on the body against all stresses and thrusts.

I claim:

1. In a tool of the character described, a body with a plurality of longitudinal slots extending into the body substantially radially and meeting at its center, the body having a longitudinal water course formed in part by a central tube that extends through the slotted part of the body, longitudinal mandrel pins mounted in the slots and extending through their lengths and in positions outside the central longitudinal tube and parallel with it, eccentric sleeves rotatably mounted on said mandrel pins and of lengths equal to the length of the slots, roller cutters revolubly mounted on said eccentric sleeves and of lengths substantially equal to the slot lengths, and the central tube having for each roller a set of longitudinally spaced perforations adapted to direct fluid upon each roller and eccentric substantially throughout their lengths.

2. In a tool of the character described, a body with a longitudinal slot, a longitudinal mandrel pin extending through the length of the slot, a cutter carrying member in the form of an eccentric sleeve revolubly mounted on the mandrel pin, a cutter carried on said sleeve, an eccentric head on the sleeve, and a wall of the slot positioned to be engaged by the eccentric head in two rotative positions of the sleeve.

3. In a tool of the character described, a body with a longitudinal slot, a longitudinal mandrel pin extending through the length of the slot, a cutter carrying member in the form of an eccentric sleeve revolubly mounted on the mandrel pin, a cutter carried on said sleeve, an eccentric head on the sleeve, and a wall of the slot positioned to be engaged by the eccentric head in two rotative positions of the sleeve spaced from each other by an angle of substantially 180°.

4. In a tool of the character described, a body with a longitudinal slot, a longitudinal mandrel pin extending through the length of the slot, a cutter carrier comprising an eccentric sleeve rotatably mounted on the mandrel pin, said eccentric sleeve being divided into two parts and each part having at its outside end an eccentric head, a cutter carried on said sleeve, and the slot having wall portions at its ends adapted to be engaged by the eccentric heads in two different rotative positions of the eccentric sleeve.

5. In a tool of the character described, a body with a longitudinal slot, a longitudinal mandrel pin extending through the length of the slot, a cutter carrier comprising an eccentric sleeve rotatably mounted on the mandrel pin, said eccentric sleeve being divided into two parts and each part having at its outside end an eccentric head, a cutter carried on said sleeve, the slot having wall portions at its ends adapted to be engaged by the eccentric heads in two different rotative positions of the eccentric sleeve, and a roller cutter rotatively mounted on said eccentric sleeve and embracing the sleeve parts throughout their lengths except their heads.

6. In a tool of the character described, a body with a longitudinal slot, a longitudinal mandrel pin extending through the length of the slot, a cutter carrier comprising an eccentric sleeve rotatably mounted on the mandrel pin, said eccentric sleeve being divided into two parts and each part having at its outside end an eccentric head, the slot having wall portions at its ends adapted to be engaged by the eccentric heads in two different rotative positions of the eccentric sleeve, and a roller cutter rotatively mounted on said eccentric sleeve and embracing the sleeve parts throughout their lengths except their heads, the roller being larger in diameter than the heads, and the slot having a relatively widened medial por-

tion to accommodate the roller and its eccentric movement with the sleeve.

7. In a tool of the character described, a body, a mandrel pin mounted therein, a cutter carrier comprising an eccentric sleeve rotatably mounted on the mandrel pin, said eccentric sleeve being divided transversely into two parts and each part having at its outside end an eccentric head, a cutter mounted on the eccentric sleeve between the heads, and the body having a surface adapted to be engaged by the eccentric heads to limit their rotation and the rotation of the sleeve about the mandrel pin.

8. In a tool of the character described, a body with a longitudinal slot, a cutter carrying member in the form of an eccentric lying within the slot and mounted on an axis longitudinal of the slot, a cutter carried on said eccentric, an eccentric head on the cutter carrier, and a wall of the slot positioned to be engaged by the eccentric head in two rotative positions.

9. In a tool of the character described, a body with a longitudinal slot, a cutter carrying member in the form of an eccentric lying within the slot and mounted on an axis longitudinal of the slot, a cutter carried on said eccentric, an eccentric head on the cutter carrier, and a wall of the slot positioned to be engaged by the eccentric head in two rotative positions spaced from each other by an angle of approximately 180°.

In witness that I claim the foregoing I have hereunto subscribed my name this 5th day of October, 1927.

JAMES J. SANTIAGO.