April 16, 1929. H. E. BROWN 1,708,932

RENEWABLE CUTTER REAMER

Filed March 3, 1928

Fig. 1.

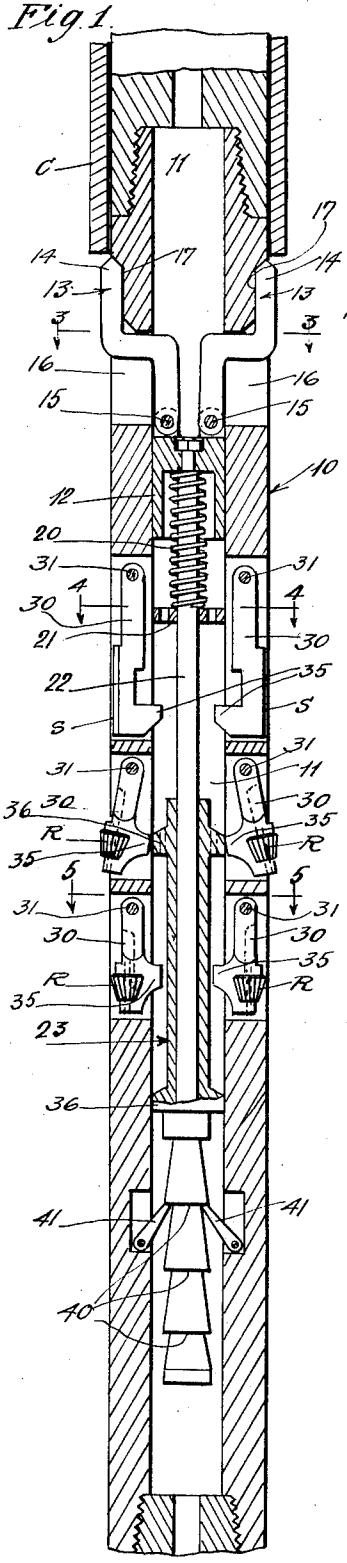



Fig. 2.

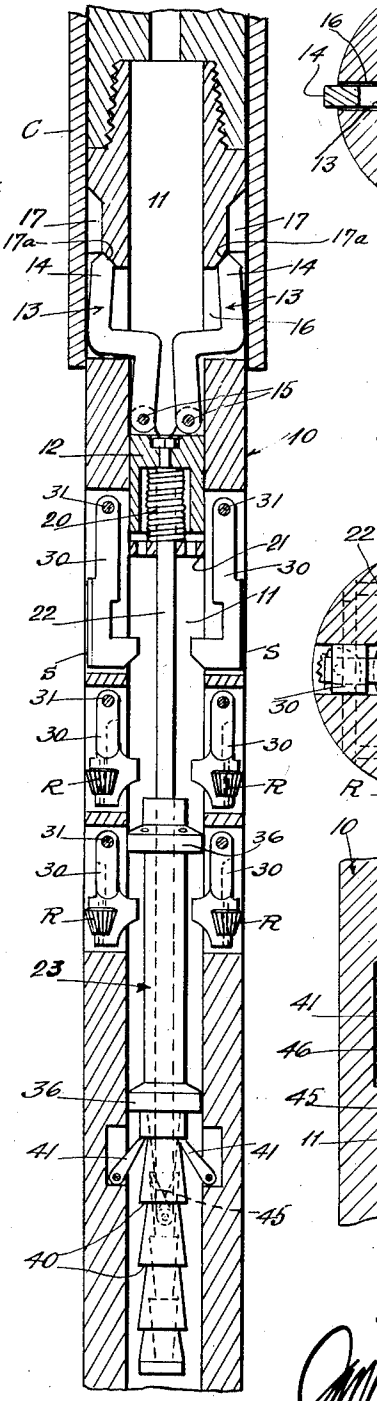



Fig. 3.

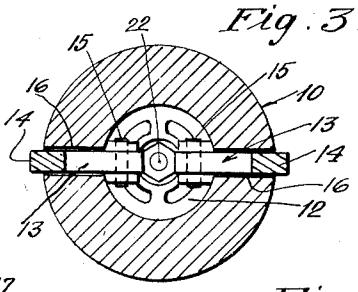



Fig. 4.

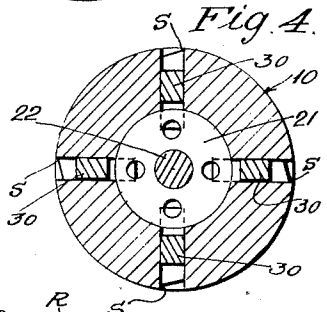



Fig. 5.

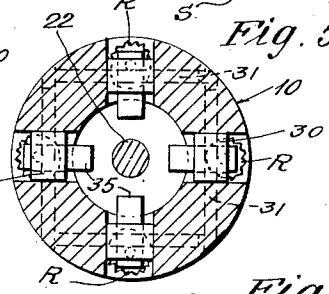
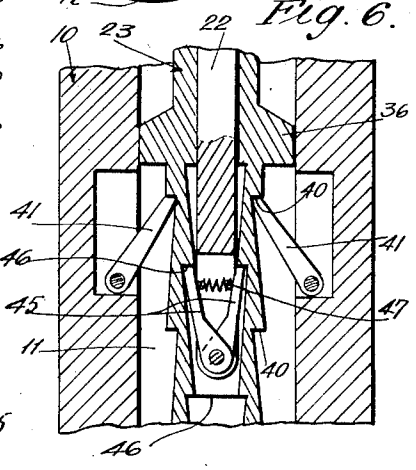



Fig. 6.




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# UNITED STATES PATENT OFFICE.

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## RENEWABLE-CUTTER REAMER.

Application filed March 3, 1928. Serial No. 253,305.

This invention relates to reamers or underreamers and the major object of the invention is to provide an improved construction of a type wherein the cutters or cutting elements may be changed or renewed without lifting the tool to the surface.

My invention is characterized by the use of a plurality of cutters or cutter carriers, or a plurality of sets of cutters or cutter carriers spaced vertically or longitudinally from each other, a longitudinal mandrel being adapted to cause expansion and contraction of the cutters or cutter carriers by reason of relative longitudinal movement of the mandrel. To move the mandrel longitudinally and under control, so as to expand or contract any selected cutter carrier or set of cutter carriers, I provide a mechanism which I may conveniently term a ratchet mechanism, actuated by contact with the lower end of the drill pipe, the action being such that each time the tool is drawn up into contact with the lower end of the pipe the mandrel is moved longitudinally through a predetermined distance—a step in its movement—so as either to contract or expand some one cutter carrier or set of cutter carriers.

It will be understood that I do not claim the broad and initial invention of a changeable cutter reamer in which change or renewal of cutters is effected by drawing the tool up against the end of the drill pipe, that broad invention being understood by me to have been previously made by others. I do, however, claim the general type of changeable cutter reamer which is herein described and wherein the mandrel, by virtue of step by step vertical movement, causes expansion and contraction, selectively, of several different cutters or sets of cutters.

My invention will now best be understood by reference to the following detailed description of a preferred form, and to the accompanying drawings, in which:

Figure 1 is a longitudinal central section showing my reamer with one set of cutters expanded;

Fig. 2 is a similar view showing all the cutters contracted;

Fig. 3 is a cross-section on line 3—3 of Fig. 1;

Fig. 4 is a cross-section on line 4—4 of Fig. 1;

Fig. 5 is a cross-section on line 5—5 of Fig. 1; and

Fig. 6 is an enlarged longitudinal sectional detail of the parts at the lower end of the mandrel.

In the drawings I show at 10 a suitable tubular body with a central bore 11 through it. The body is formed at its upper end in any suitable manner for attachment to a drill stem and the bore 11 forms the bearing guide for certain parts and also forms the water course which delivers circulating fluid from the hollow drill stem to the vicinity of the cutters.

Slidably mounted in bore 11 is a slider 12 carrying at its upper end two pivoted triggers 13 whose upper outer ends 14 are so related to the body that by swinging on the pivots 15 they may either extend beyond the cylindrical periphery of the body or may swing in so as to be substantially within that periphery. The two positions are shown respectively in Figs. 1 and 2. These triggers project out through slots 16 in the body wall and their upper ends play in grooves 17 in the body wall. The upper ends of the triggers may be bevelled as illustrated and there may be bevelled corners $17^a$ at the lower ends of groove 17, so that when the triggers are moved upwardly from the position of Fig. 2 towards the position of Fig. 1 they are also forced outwardly to positions projecting beyond the periphery of the body.

A spring 20 urges the slider 12 upwardly and thus is constantly urging the triggers upwardly toward the position of Fig. 1—their normal position. Spring 20 is seated on a spring seat 21 mounted in the body bore, and a mandrel actuating rod 22 is connected at its upper end to slider 12 and extends down through the bore 11 as illustrated. Mounted on and around this rod 22 is a cutter actuating mandrel 23 adapted to move longitudinally along the rod and longitudinally in the bore 11, preferably

fitting bore 11 rather snugly so that the bore forms a guide for the mandrel.

The body may be provided with any suitable number of longitudinally spaced cutters or cutter sets. For instance, I here show three spaced cutter sets, each set comprising four cutters. And in order to show that the cutters may be of any desired or selected character I show the uppermost cutters as having plain cutting blades S particularly adapted to cut shale; and I show the cutters of the two lower sets as being roller cutters R which are adapted for cutting various kinds of formation and particularly hard formation. Rollers R are carried in pivoted cutter carriers 30 and the blades S are likewise carried in similar pivoted cutter carriers 30. Those cutter carriers and their cutting elements play in slots in the body wall and are shown as pivoted to the body at 31 at their upper ends. It will be recognized from the description that these cutter carriers are thus mounted so as to be transversely movable with relation to the body and movable between relatively expanded and contracted positions. Any sort of cutter mounting that allows such relative transverse movements of the cutters will suit my invention, as long as there are several vertically spaced cutters or cutter sets to be acted upon individually and selectively by the vertically movable mandrel.

In the particular design here shown each cutter carrier 30 has an inward projection 35 adapted to be engaged by an enlarged portion or head 36 of the mandrel, or by one of several such enlarged portions 36. In the particular design here shown I illustrate a mandrel having two vertically spaced enlarged parts 36 so that, if desired, more than one set of cutters can be expanded at one time.

The lower end of the mandrel 23 is provided with a plurality of what may be termed ratchet shoulders 40 arranged in vertical spacing and adapted to be engaged by pawls 41 which are pivoted to body 10, the pawls projecting upwardly and engaging under the horizontal ratchet shoulders 40. From a consideration of the drawings it will be easily understood how these pawls hold the mandrel elevated in any one of a number of spaced positions of elevation. The lower end of the mandrel actuating rod 22 is also provided with a pair of pawls 45 which engage with a similar set of similarly spaced ratchet shoulders 46 on the inside of the mandrel. A spring 47 tends to press pawls 45 outwardly and properly engage shoulders 46.

Suppose now that the tool is in the condition shown in Fig. 2, being lowered through the casing C. Immediately the triggers 14 pass below the casing the triggers are forced upwardly to the position of Fig. 1 and rod 22 is raised and also mandrel 23 is raised from the position of Fig. 2 to the position of Fig 1, by the action of pawls 45 on a ratchet shoulder 46. The amount of upward movement of rod 22 and mandrel 23 is just enough to carry the mandrel from the position of Fig. 2 to the position of Fig. 1, carrying the upper mandrel head 36 to a position between the cutter carriers 30 of the intermediate set of cutters. The intermediate set of cutters is thus expanded and reaming operations may be performed.

If, because of wearing of the cutters, or for any other reason, it is desired to retract this intermediate set of cutters and expand another set, then the tool is again pulled up until the triggers 14 contact with the casing and are again relatively forced down to the position of Fig. 2. Forcing the triggers down causes rod 22 to move downwardly but mandrel 23 cannot move downwardly because it is held up in the position of Fig. 1 by the pawls 41. Consequently rod 22 and its pawls 45 move down and catch on the next ratchet shoulder below; so that when the tool is again lowered away from the casing the rod 22 moves upwardly and moves mandrel 23 up a step in its movement. This movement of the mandrel will carry the upper head 36 to a position above the intermediate set of cutters and allow those cutters to contract. The cutters are now all contracted, just as they were when the mandrel was in the position of Fig. 2. In any such contracted position the tool may be lowered through the casing or pulled out through the casing. If it is desired however to expand another set of cutters, then the tool is again raised so that the triggers come into contact with the casing and are again pushed down; and when the tool is then lowered from the casing the triggers and rod 22 again move upwardly, moving mandrel 23 up through another step of its movement. This movement of the mandrel will carry the upper head 36 to a position between the uppermost cutter carriers 30 and cause them to be expanded; and drilling operations may then be carried on with those cutters.

From what I have said it will be seen that the essence of the cutter expanding and contracting operation lies in the fact that the several sets of cutters are spaced apart vertically and that the mandrel is moved step by step through successive distances equal to about one-half the distance between adjacent sets of cutters; so that at successive actuations first one set of cutters is expanded, then next all the cutters are contracted and then next another set of cutters is expanded. And it will now readily be seen how any number of cutter sets can be arranged in my tool to be selectively expanded and contracted in such a manner that

any one set of cutters can be expanded and thus substituted in operation for any other set of cutters. And the arrangement may also be made to expand more than one set of cutters at one time. For instance, as shown in the drawings, the mandrel may also have a lower head 36 so placed that when the upper head 36 is in operative position between the uppermost cutter carriers the lower head 36 will be in operative position between the lower set of cutter carriers. Thus, in the particular design here shown, either the intermediate set or the uppermost set may be expanded as the operator may desire; and also the lowermost set may be expanded simultaneously with the uppermost set.

Other variations and modifications will occur to those skilled in the art. I do not here attempt to explain all modifications that may be made within my invention, but it will be understood that the invention is not limited to the specific structures which have been described in detail except in so far as expressly so stated in the following claims.

I claim:

1. An expansive reamer of the character described, comprising a body, a plurality of cutter carriers mounted in the body in vertically spaced relation and each cutter carrier movable transversely of the body for expansion and contraction, a vertically movable mandrel in the body and having a carrier engaging part adapted to engage one carrier when in one vertical position and another carrier when in another vertical position, and means actuatable by engagement with a well casing to move the mandrel vertically between its two carrier engaging positions.

2. An expansive reamer of the character described, comprising a body, a plurality of cutter carriers mounted in the body in vertically spaced relation and each cutter carrier movable transversely of the body for expansion and contraction, a vertically movable mandrel in the body and having a carrier engaging part adapted to engage one carrier when in one vertical position and another carrier when in another vertical position, and means actuatable by engagement with a well casing to move the mandrel vertically in step by step movement.

3. An expansive reamer of the character described, comprising a body, a plurality of cutter carriers mounted in the body in vertically spaced relation and each cutter carrier movable transversely of the body for expansion and contraction, a vertically movable mandrel in the body and having a carrier engaging part adapted to engage one carrier when in one vertical position and another carrier when in another vertical position, and means actuatable by engagement with a well casing to move the mandrel vertically, said means embodying a vertically reciprocable member, a spring urging said member upwardly, a trigger carried by said member and adapted to be engaged by the lower end of the casing to be moved down relative to the body, and a ratchet mechanism acting between the reciprocable member and the mandrel.

4. An expansive reamer of the character described, comprising a body, a plurality of cutter carriers mounted in the body in vertically spaced relation and each cutter carrier movable transversely of the body for expansion and contraction, a vertically movable mandrel in the body and having a carrier engaging part adapted to engage one carrier when in one vertical position and another carrier when in another vertical position, and means actuatable by engagement with a well casing to move the mandrel vertically, said means comprising a vertically reciprocable member in the body having a limited vertical movement equal substantially to half the distance between the vertically spaced cutters, a spring urging said member upwardly, a trigger connected with said member and adapted to be engaged by the casing to move it downwardly, a ratchet mechanism supporting the mandrel in the body, and a ratchet mechanism acting between said member and the mandrel to cause upward movement of the mandrel with said member.

5. An expansive reamer of the character described, comprising a body, a plurality of cutter carriers mounted in the body in vertically spaced relation and each cutter carrier movable transversely of the body for expansion and contraction, a vertically movable mandrel in the body and having a carrier engaging part adapted to engage one carrier when in one vertical position and another carrier when in another vertical position, and means actuatable by engagement with a well casing to move the mandrel vertically, said means comprising a vertically reciprocable member in the body having a limited vertical movement equal substantially to half the distance between the vertically spaced cutters, a spring urging said member upwardly, a trigger connected with said member and adapted to be engaged by the casing to move it downwardly, a ratchet mechanism supporting the mandrel in the body, and a ratchet mechanism acting between said member and the mandrel to cause upward movement of the mandrel with said member, each of said ratchet means embodying spaced ratchet shoulders whose spacing is substantially equal to half the distance between the vertically spaced carriers.

6. An expansive reamer of the character described, comprising a body, a plurality of cutter carriers mounted in the body in ver-

tically spaced relation and each cutter carrier movable transversely of the body for expansion and contraction, a vertically movable mandrel in the body and having a carrier engaging part adapted to engage one carrier when in one vertical position and another carrier when in another vertical position, and means actuatable by engagement with a well casing to move the mandrel upwardly, at each such actuation, through a distance substantially equal to half the distance between the vertically spaced carriers.

In witness that I claim the foregoing I have hereunto subscribed my name this 2nd day of February, 1928.

HARRY E. BROWN.