April 21, 1931. J. GRANT 1,801,552

LOCKING UNDERREAMER

Filed Feb. 24, 1930

Fig 1.

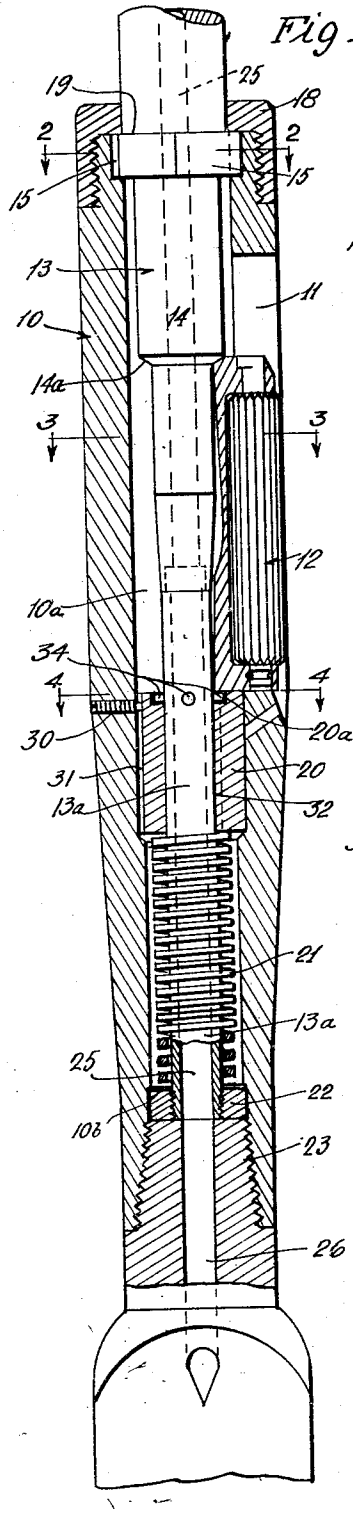


Fig. 2.

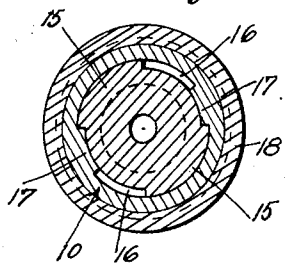


Fig 3.

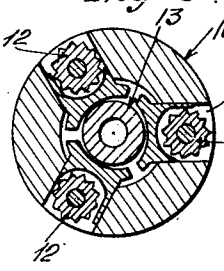


Fig. 4.

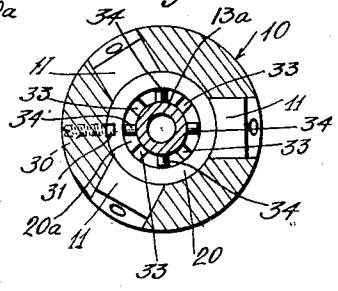
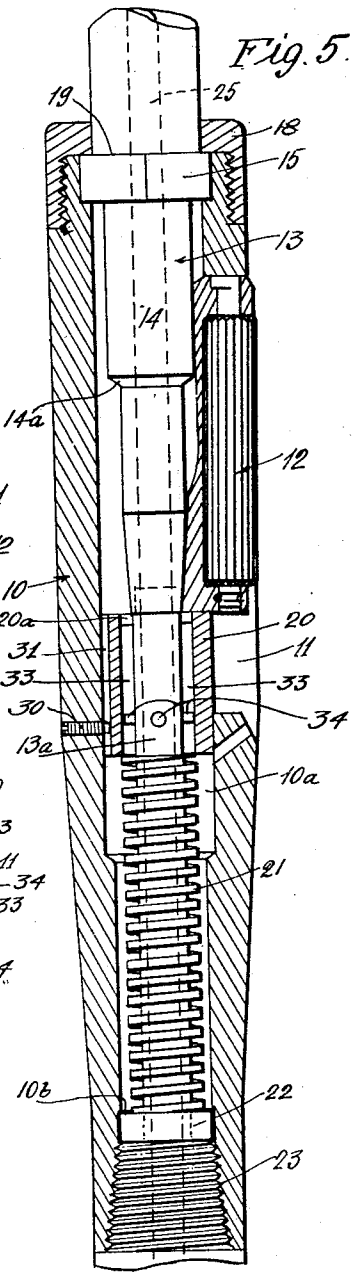


Fig. 5.



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UNITED STATES PATENT OFFICE

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LOCKING UNDERREAMER

Application filed February 24, 1930. Serial No. 430,748.

This invention has to do with expansive reamers or underreamers; and a primary object is the provision of means for locking the expansive cutters in collapsed position so that, on being lowered through the well casing, the cutters will not bear outwardly against the casing to cut and score it and to wear the cutters. There are other objects and corresponding accomplishments of the invention, but they will be best understood from a consideration of the following description.

In applying my invention to a typical form of expansive reamer or underreamer, I utilize relative rotation between two parts of the reamer structure to cause locking and unlocking. Such relative rotation may, for instance, be between the cutter carrying body and any part which is rotatively connected with the rotary drill stem or drill pipe, and that part need not be the internal mandrel which forms the cutter abutment. However, in a typical expansive reamer to which my invention is applied, I prefer to use the cutter expanding mandrel as the relatively rotative part to cause locking and unlocking. Such a mandrel is normally connected with the drill pipe; and arrangements are easily made to allow such mandrel a limited relative rotation within the body, so that such limited relative rotation will first act to unlock the cutter actuating spring; and then when the mandrel reaches its stopped limit of rotation, further rotation of the mandrel drives the body and cutters for rotary reaming.

Without the necessity of limiting my invention to the particular type of expansive reamer herein described, I now proceed to describe my invention as applied to the selected type, for the purpose of illustrating it by describing in particular one preferred embodiment. For this purpose, I refer to the accompanying drawings, in which:

Fig. 1 is a central vertical section showing my invention applied to the selected type of underreamer, the cutters being shown contracted and the locking device in action to prevent expansion;

Figs. 2, 3 and 4 are cross-sections, respectively, on lines 2—2, 3—3, and 4—4 of Fig. 1; and

Fig. 5 is a view similar to Fig. 1, showing the reamer unlocked and the cutters expanded.

In the drawings a typical reamer is illustrated as having a body 10, tubular in form and provided with cutter-receiving slots 11. The cutter-receiving slots are here shown as three in number, a three cutter reamer being here illustrated. The cutters are designated generally by the numeral 12. They are here shown as comprising cutter carrying blocks and roller cutters; but the particular make-up of the cutters is of no consequence in the present invention—each cutter can be considered merely as a single entity.

Within the tubular body is a central cutter expanding and cutter abutment mandrel 13 which has a relatively large upper part 14, below which is a rather abrupt diagonal cutter expanding surface 14*a*, under which the upper ends of the cutters lie when the cutters are in their lowermost contracted positions, as indicated in Fig. 1. The mandrel connects at its upper end to the drill pipe by any usual joint. The remaining details of cutter and mandrel formation need not be here considered; it only being essential to note that upward movement of the cutters on the mandrel causes them to move outwardly to the expanded positions indicated in Fig. 5. By preventing such upward movement—by locking down the cutter propeller mechanism (typically a spring-propelled plunger or propeller) the cutters are prevented from being forced upwardly and outwardly and are thereby prevented from forcibly bearing outwardly against pipe during lowering.

In the typical underreamer here shown, the body 10 is longitudinally stationary with reference to the mandrel; and the cutters move vertically, longitudinally, in the slots 11 and with reference to the body. It is, however, of no consequence to my present invention, considered in its broader aspects, whether or not the cutters move vertically in the body and the body be vertically stationary with reference to the mandrel. The characteristic feature of this type of reamer, in so far as it plays a part in my present invention, lies in the fact that the cutters move vertically with

reference to an expanding member (the mandrel) in order to expand.

Illustrating thus a body which is vertically stationary with reference to the mandrel, the mandrel may be joined to the body in any manner suitable to allow a limited relative rotation. For instance, the mandrel is shown as provided near its upper end with circumferentially extending ribs 15 which fit into corresponding circumferential recesses 16 in the upper part of the body; the body lugs 17, intermediate the body recesses 16, coacting with mandrel ribs 15 to form limiting stops. A suitable cap 18, screw-threaded to the upper end of the body, may overhang the upwardly facing shoulder 19 of the mandrel to hold the body and mandrel together as regards longitudinal movement. As shown in the section of Fig. 2, it will be seen that the mandrel is capable of a limited right handed rotation with reference to the body; and that limited angle of rotation is utilized to unlock the cutter propeller 20 after the tool has been lowered through the well pipe or casing.

Cutter propeller 20 is illustrated in the form of a cylindric plunger upon which the lower ends of cutters 12 rest. Although various means may be used for forcing the cutter propeller upwardly, a spring, as shown at 21, is the element most usual. In the particular underreamer here illustrated, this spring surrounds a lower mandrel extension 13*a* and is rested at its lower end upon some footing which is stationary with reference to the mandrel. In this particular case it is rested upon a collar 22 which is screw-threaded on the lower end of mandrel extension 13*a*. The lower end of the mandrel extension 13*a* extends close to the upper end of the joint pin 23 so that circulating fluid, which is carried down through the mandrel through circulation bore 25, is delivered to circulation passage 26 leading to the drill bit. Collar 22 lies under a downwardly facing shoulder 10*b* of the body, so that engagement of the collar with this shoulder will prevent the body dropping off the mandrel in case the connection at the upper end of the mandrel should break or work loose.

Cutter propeller 20 is vertically movable in bore 10*a* of the body, but is held from relative rotation by any suitable means, as by a pin 30 entering a vertical slot 31 in the propeller. The propeller has a central longitudinal bore 32 through which the mandrel extension 13*a* passes; and along the wall of this bore 32 the cutter propeller has preferably a plurality of longitudinal slots 33 adapted to receive a corresponding plurality of radial locking pins 34 which are mounted on the mandrel extension 13*a*. For instance, these slots and locking pins may be four in number.

When the parts are in the relative positions shown in Figs. 1, 2 and 4, the pins 34 rest on the upwardly facing bottom surface of a circular recess 20*a* in the upper end of propeller 20 and are located in the spaces between the slots 33; so that the propeller 20 cannot be pushed upwardly by spring 21. The tool may be put in this contracted and locked position before lowering through the pipe by forcing the cutters and propeller 20 downwardly to the position shown in Fig. 1 and by then giving the body a limited right handed rotation with reference to the mandrel. With the parts in this contracted and locked position, the cutters are not forced upwardly and are therefore not forced outwardly; and consequently they cannot have any tendency to wedge outwardly forcibly against the well pipe while the tool is being lowered.

Upon reaching the point where underreaming is to start, the drill pipe is rotated right-handedly. The cutters, in their contracted positions being loose, will be thrown outwardly and obtain sufficient contact with the wall of the hole to cause the cutters and the body to drag rotatively behind the mandrel, and thus cause the mandrel to advance, with relation to the body and cutter propeller 20, through the limited angle necessary to unlock the cutter propeller. The propeller then immediately moves up under the impulse of spring 21, which forces the cutters to their upper expanded positions.

Or, if in any case the loose contact of the cutters with the side of the hole be not sufficient to cause relative rotation, the tool may be lowered slightly below the point where the hole has been previously underreamed, into that part of the hole where the cutters fit more tightly. Then rotation will cause the cutters to drag and cause the relative rotation before described, allowing the spring to push upwardly on the cutters. Then the tool may be raised to a point where underreaming has to commence; the cutters on reaching the larger part of the whole will be immediately pushed upwardly and expanded. Or, if there is no such previously underreamed or enlarged part of the hole, the heavy pressure of the spring, pressing upwardly on the cutters, wedges them out against the wall; and then the spring pressure and the upward drag of the wall tends to pull the cutters upwardly with relation to the mandrel to cause them to expand fully.

I claim:

1. In combination with an expansive reamer having a body and cutters therein which move upwardly to expand, a cutter propeller engaging the cutters to move them upwardly, means pressing the cutter propeller upwardly, and a rotary lock acting upon the cutter propeller to hold it down.

2. In combination with an expansive reamer having a body and cutters therein which move upwardly to expand, a cutter

propeller engaging the cutters to move them upwardly, means pressing the cutter propeller upwardly, a member within the body adapted to be rotated and having a limited rotation relative to the body, and a locking means between said rotative member and the cutter propeller adapted to be unlocked by limited relative rotation.

3. In combination with an expansive reamer having a body and cutters therein which move upwardly to expand, a cutter propeller engaging the cutters to move them upwardly, means pressing the cutter propeller upwardly, a cutter expanding and abutment mandrel in the body, means interconnecting the mandrel and body for limited relative rotation of the mandrel within the body, and locking means acting between the rotative mandrel and the cutter propeller and adapted to be unlocked by relative rotation of the mandrel.

4. In combination with an expansive reamer having a body and cutters therein which move upwardly to expand, a cutter propeller engaging the cutters to move them upwardly, means pressing the cutter propeller upwardly, a cutter expanding and abutment mandrel in the body, means interconnecting the mandrel and body for limited relative rotation of the mandrel within the body, the mandrel extending vertically through the cutter propeller, radial locking pins carried by the mandrel, and the cutter propeller having circumferentially spaced grooves adapted to receive said locking pins when the mandrel is in one rotative position with relation to the cutter propeller.

In witness that I claim the foregoing I have hereunto subscribed my name this 31 day of January, 1930.

JOHN GRANT.