March 20, 1928. 1,663,014

M. C. LOWMAN ET AL

WELL UNDERREAMING TOOL

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Fig. 1.

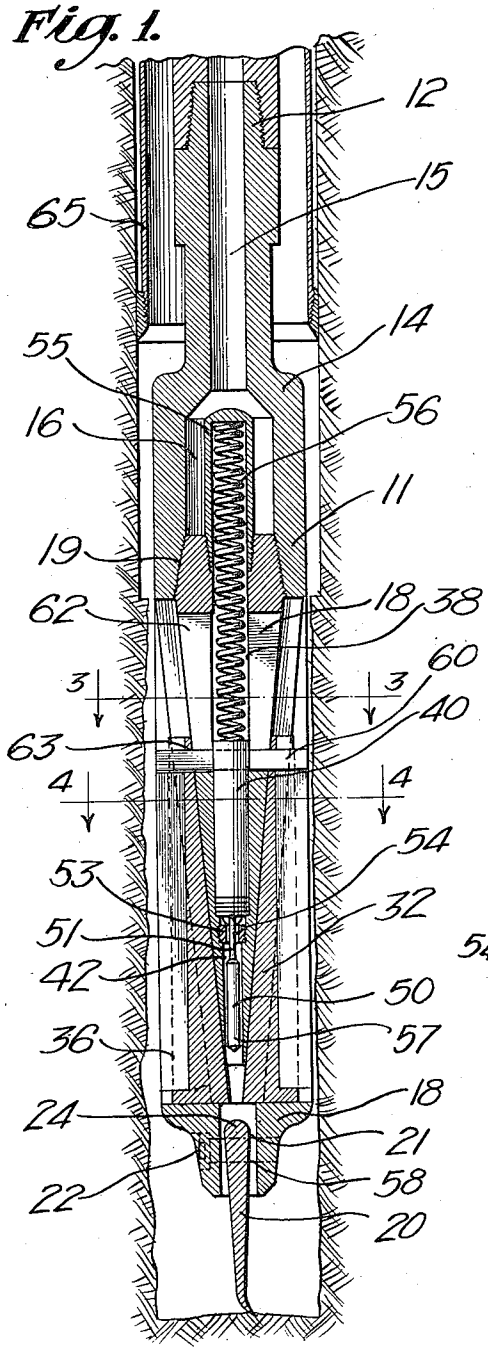


Fig. 2.

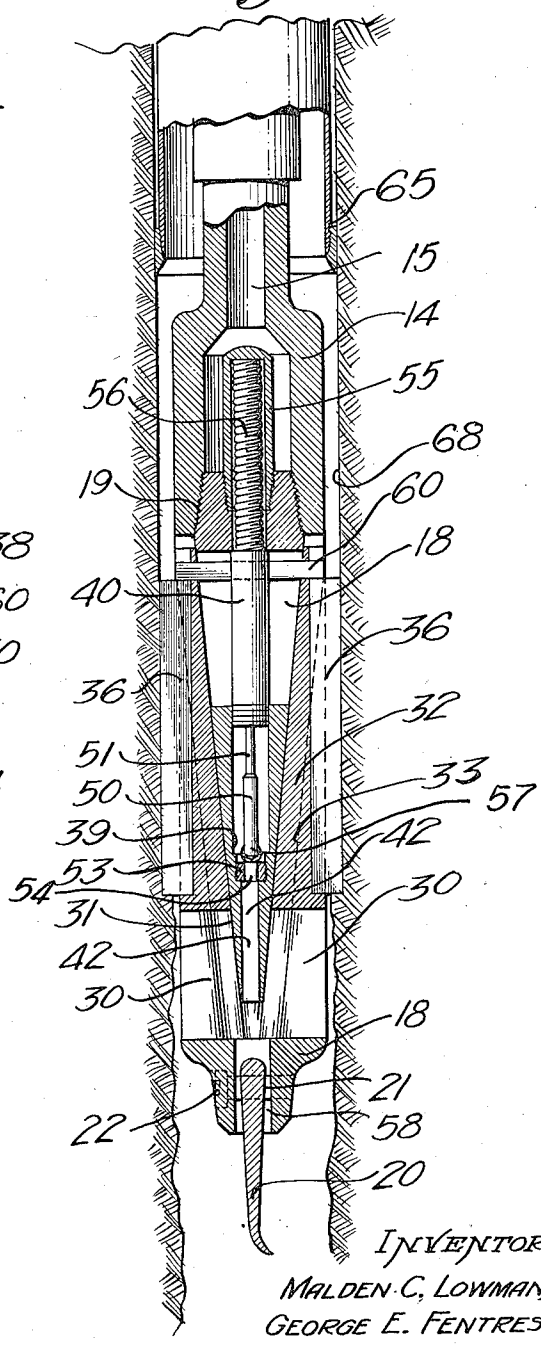


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Fig. 5.

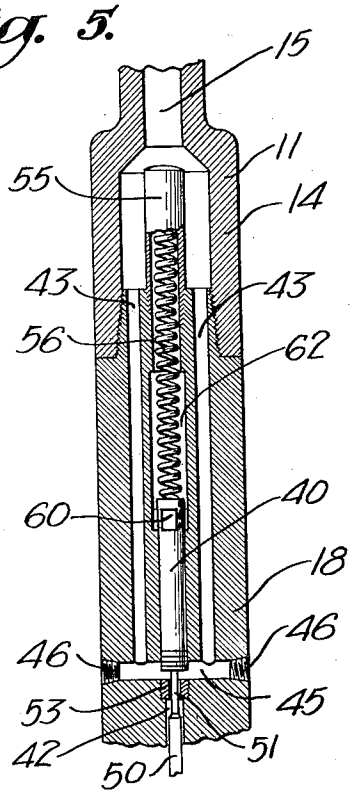



Fig. 6.

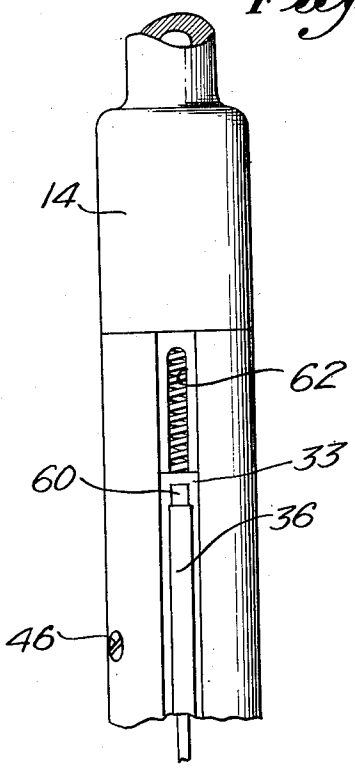



Fig. 3.

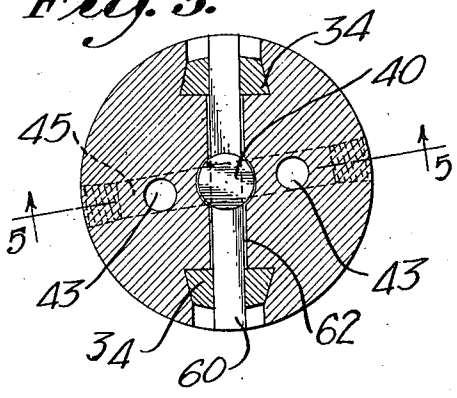
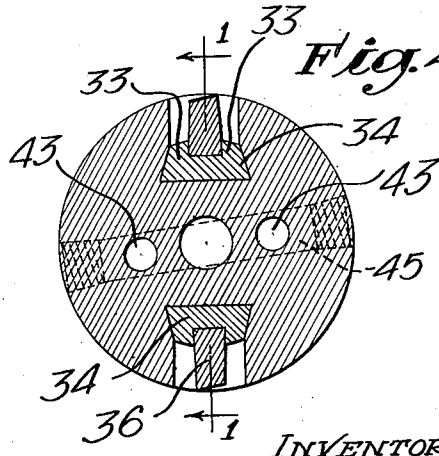



Fig. 4.

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# UNITED STATES PATENT OFFICE.

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## WELL-UNDERREAMING TOOL.

Application filed September 5, 1922. Serial No. 586,137.

This invention relates to well drilling equipment and relates particularly to hydraulic rotary equipment such as is used in oil well drilling.

In the drilling of oil wells, considerable difficulty is encountered in maintaining the full diameter of bore owing to the wearing off of the corners and sides of the well drilling bits so that the bit does not cut to its full original diameter. It is necessary that the full diameter of the bore be maintained in order that the casing may enter freely into the hole, as it is installed. It is quite often necessary to employ underreamers for the purpose of reaming the holes to large enough diameters to permit the casing to advance.

Underreamers generally employed are of the expanding type and are lowered through the casing to the point at which it is desired to operate and the blades of the underreamer expanded. In order to employ a separate underreamer, the drilling tool must first be lifted from the well and the underreamer screwed upon the lower end of the drill pipe. This removing of the drill pipe from the well consumes a very considerable portion of the time in which the drilling equipment is in operation and where hard formations are being operated in, such as cause the drilling tool to wear away quickly, the depth of the hole advances very slowly owing to the slow cutting speed of the tool and the necessity of withdrawing the line of drill pipe from the well in order to place an underreamer thereabout.

It is an object of the invention to provide a new underreamer suitable to be incorporated in one body with a drilling bit; but adapted to separate use, thus making it possible to employ either the drilling bit or the underreamer and eliminating the necessity of pulling the string of drill pipe as hereinbefore mentioned, when the use of an underreamer is required.

It is also an object of the invention to provide a tool of this character having reaming elements which are ordinarily maintained in retracted position, but which are adapted to be extended, for the purpose of operating upon the walls of the drill hole, by pumping an excess pressure upon the lubricating liquid.

It is a further object of the invention to provide a device of this character having removable underreaming blades.

It is a further object of the invention to provide a device of this character in which the entire pressure of the lubricating liquid may be exerted against the bottom of an operating piston thereof as it is raised, to expand the underreaming blades.

The special advantages of our invention and further objects thereof will be made evident hereinafter.

Referring to the drawings which are for illustrative purposes only,

Fig. 1 is a sectional view taken substantially upon a plane represented by the line 1—1 of Fig. 4, showing a drilling tool with which is associated an underreaming tool embodying the invention, the underreaming elements of the tool being shown in retracted position while a tool is employed for the purpose of increasing the depth of the hole.

Fig. 2 is a sectional view showing the underreamer elements of the tool expanded and employed for the purpose of increasing the diameter of the hole so that the casing may be advanced therein.

Fig. 3 is a section taken on a plane represented by the line 3—3 of Fig. 1.

Fig. 4 is a section taken on a plane represented by the line 4—4 of Fig. 1.

Fig. 5 is a vertical section taken upon a plane represented by the line 5—5 of Fig. 3.

Fig. 6 is an external view of the device, one of the blade channels being directed toward the beholder, in this view.

As shown in the drawing, the invention employs a body 11 having a tool joint 12 at the upper end thereof by which it may be connected into a line of drill pipe. This body 11 is comprised of an upper member 14 provided with a bore 15 which is enlarged at its lower end, as indicated at 16, and a lower member 18 which screws into the upper member 14 at 19. In the lower end of the member 18 a removable cutting blade 20 is held in a crosswise slot 21 in a terminal head and is secured therein against lateral displacement by screws 22. It will be perceived that the upper portion 24 of the blade 20 is the largest point in the blade and that the blade gradually tapers as it progresses

downwardly. The slot 21 adheres to this same formation, thus providing a perfect interlock between the blade and the slot, so that the blade cannot be removed vertically therefrom, but can only be removed by taking out the screws 22 and sliding the blade laterally from the slot.

Laterally upon each side of the lower member 18 but above the mentioned terminal head, shown as provided with slot 21, and diametrally disposed one from the other, a pair of channels 30 having inwardly downwardly sloping bottoms 31 are formed, into which underreamer elements 32 each comprised of a block 33 which dovetails into a channel 30, as indicated at 34 in Figs. 3 and 4, and has vertical channels 35 into which removable blades 36 are also dovetailed. The underreamer elements ordinarily rest at the bottoms of the channels 30 and in this position hold the blades 36 retracted as shown in Fig. 1. In order to bring the blades into operating position, the underreamer elements are moved upwardly in the outwardly sloping channels 30 to their positions of full projection, as indicated in Fig. 2. The manner in which the underreamer elements are moved upwardly will become evident throughout the following.

In the top of the lower member 18 of the body 11 a bore 38 is formed which extends down to a shoulder 39, as shown in Fig. 2, and in which bore is situated a plunger, or piston, 40. Downwardly from the bottom of the bore 38 a smaller bore 42 is continued. Upon each side of the large bore 38 vertical holes 43 are drilled down to a depth equal to that of the bore 38 and a diametral hole 45 is drilled across the member 18 at a point which will connect the bottoms of the drill holes 43 with the bottom of the bore 38, the ends of the holes 45 being afterward plugged, as shown at 46. A smaller plunger 50, having a reduced shank 51, is extended downwardly from the bottom of the piston 40 through a collar 53 which is threaded into the upper end of the small bore 42 and is provided with a bore 54 of substantially the same diameter as the plunger 50.

It will be perceived that a space is provided between the outer face of the plunger 50 and the walls of the bore 42. When the tool is in employment for drilling purposes the water, introduced through the bore 15 of the upper member 14, travels downwardly past a cap 55 which maintains a spring 56 in compression against the top of the piston 40, and entering the drill holes 43 is delivered through the cross channel 45, under the bottom end of the piston 40, through the normally open space of the bore 54 in the collar 53 surrounding the shank 51, past the plunger 50, and finally through a vertical hole 58 to the drill bit 20.

It will be perceived that the pressure of the lubricating water is at all times exerted upon the bottom of the piston 40. This feature is employed to cause the expansion or projection of the reamer elements by increasing the pressure on the lubricating liquid being delivered, so that the piston will be forced upwardly against the action of the spring 56. The movement of the piston is transferred through a horizontal bar 60 which extends through the upper end of the piston 40, through a vertical slot 62, and engages holes 63 povided in the upper ends of the blade holding blocks 33 of the reamer elements.

It will be noticed that the passage provided around the shank 51 and around the plunger 50 is considerably smaller in area than the passage provided by the vertical holes 43 so that when an additional pressure is exerted upon the column of lubricating liquid being delivered, a pressure will be built up above the collar 53 which will be exerted against the piston 40 and cause the lifting of the reamer elements 32, whereupon they travel outwardly in the channels 30 and may assume the positions at the tops of the channels in which they are shown in Fig. 2. The plunger 50 is carried upwardly with the piston and enters into the bore of the collar 53 as shown in Fig. 2, thus substantially shutting off the flow of liquid and making it possible to exert the entire pressure of the liquid upon the underside of the piston 40, so that its elevation into an upper position will be assured. The plunger 50 may be of such a length that when the piston 40 is entirely raised, as shown in Fig. 2, the lower end 57 of the plunger is above the opening 54 through the collar 53 and permits the passage of the liquid therethrough into the bore 42 from whence it circulates upwardly between the reamer blades and keeps them free from collecting mud.

It will be perceived that the plunger provides an automatic discharge valve which adjusts the closure of the outlet to suit the pressure upon the mud within the bore 39 so that the maintenance of the reamer blades in raised position is at all times assured. In other words, if the pressure in the line of drill pipe should drop so that the piston 40 and the blades 36 recede, the plunger 50 would immediately enter the collar 53 and shut off all discharge of liquid therethrough, thus retaining the entire pressure of the liquid within the bore 39, which would prevent the plunger from receding under the action of the spring 56.

A particular feature of our invention resides in the fact that the reamer blades expand with an upward travel of the blocks 32 in which they are held, thus preventing the possibility of the blades jamming by expanding as the tool is raised in the hole; and that the upward action of the walls of the

hole against the blades 36 when reaming assists in holding the blades in raised position.

Although this device is adapted to the use of the cutter and the reamer elements thereof separately, it is also possible and in many instances desirable to bring both the cutting and the reamer elements into action at the same time so that the reaming action will be accomplished as the drilling operation proceeds. This combination drilling and reaming, of course, would require considerably more power to drive the tool than if each are employed separately; therefore, our invention is adapted to suit the capacity of the drilling equipment.

The device shown herein makes it possible to place a tool upon the lower end of a string of drill pipe, and upon lowering it to the bottom of the well, to drill an additional depth of hole, this depth depending upon the abrasive nature of the formation being operated upon; to then raise the tool to a point directly beneath the bottom of the casing 65, whereupon the underreamer elements may be expanded so as to enlarge the hole, as indicated at 68 in Fig. 2, to permit the casing to enter further into the hole. A particular valuable feature of the invention is that after each drilling operation, the cutting blade 20 and the reaming blades 36 may be replaced without great delay, and also that a drilling and a reaming operation may be performed at each lowering of the string of drill pipe.

We claim as our invention:

1. In a well tool, the combination of: a body, having a fluid passage, adapted for securing to a drill pipe and comprising a member having longitudinal reamer channels and a head therebelow: projectile cutting means carried by said body; means actuable by fluid pressure for projecting said cutting means; and means whereby obstruction of said fluid passage is effected when said projecting means is actuated.

2. In a well tool, the combination of: a body adapted for securing to a drill pipe, said body having a fluid passage therein, and having channels therein which diverge as they progress upwardly; blocks slidable in said channels; reamer elements held by said blocks; a piston operable by fluid delivered under pressure through said drill pipe; said piston being arranged to move said blocks; and resilient means for resisting the advance of said piston; and means for obstructing said fluid passage when said piston is actuated.

3. In a well tool, the combination of: a body arranged for incorporation in a string of drill pipe and comprising a member having longitudinal reamer channels and a head therebelow, said body having a passage constricted near the end thereof, for circulation of liquid; projectile members carried by said body; and fluid operated means associated with said passage at a point above the constricted portion thereof arranged for projecting said projectile members when the pressure of said liquid is raised above a predesignated value; and valve means for reducing the flow of said liquid when said fluid operated means is actuated.

4. In a well tool, the combination of: a body arranged for incorporation in a string of drill pipe and comprising a member having longitudinal reamer channels and a head therebelow, said body having a passage for circulation of liquid; projectile members carried by said body; and piston means arranged for projecting said projectile members when the pressure of said liquid is raised above a predesignated value; and a valve member linked with said piston means for reducing the flow of said liquid when said piston is actuated.

In testimony whereof, we have hereunto set our hands at Los Angeles, California, this 24th day of August, 1922.

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