

June 24, 1930.

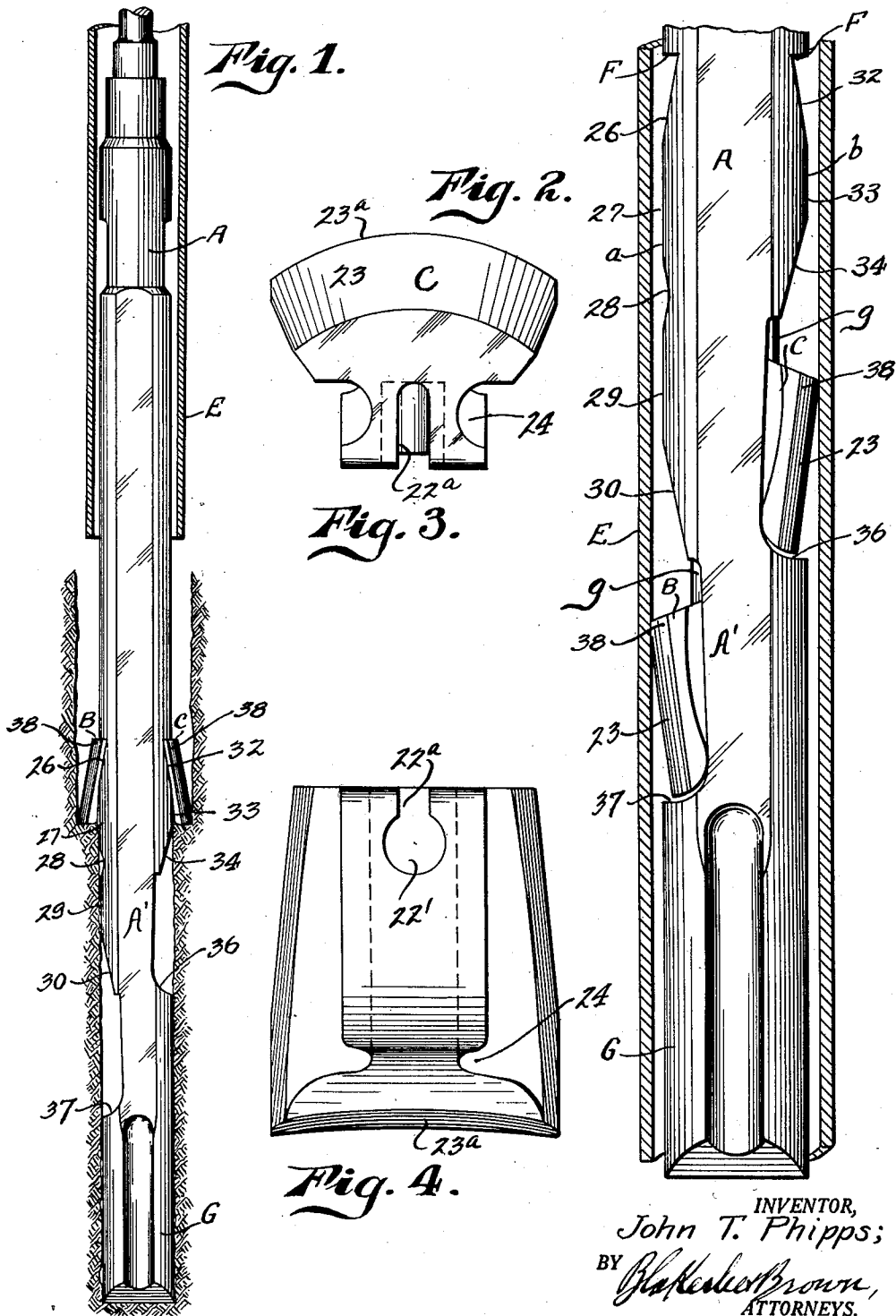
J. T. PHIPPS

1,767,474

UNDERREAMER

Filed May 15, 1925

3 Sheets-Sheet 1



INVENTOR,
John T. Phipps;
BY *Blakeslee Brown*,
ATTORNEYS.

June 24, 1930.

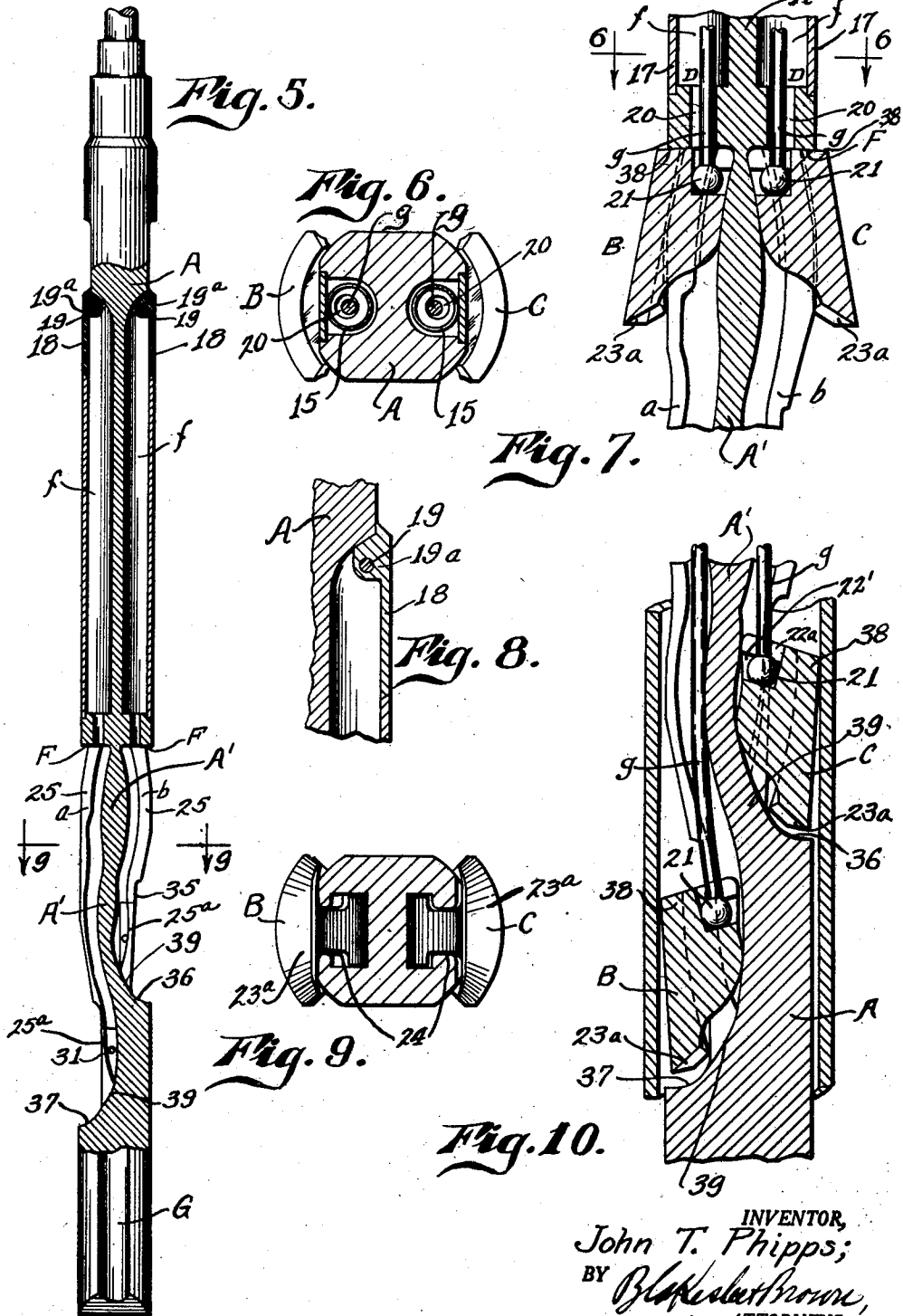
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UNDERREAMER

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3 Sheets-Sheet 2



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UNDERREAMER

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3 Sheets-Sheet 3

Fig. 11.

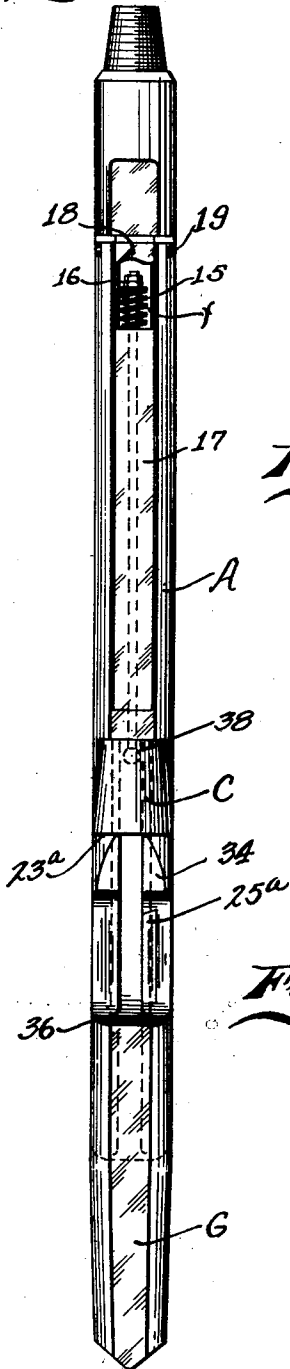


Fig. 12.

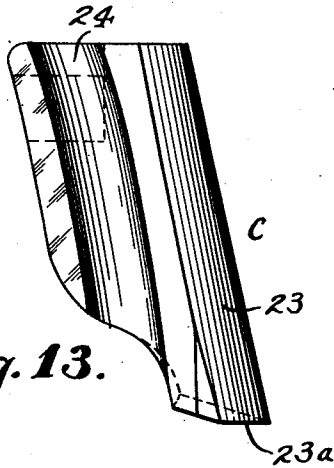


Fig. 13.

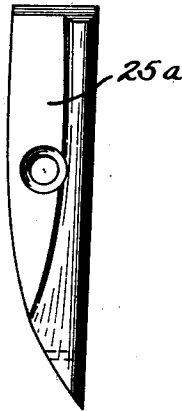
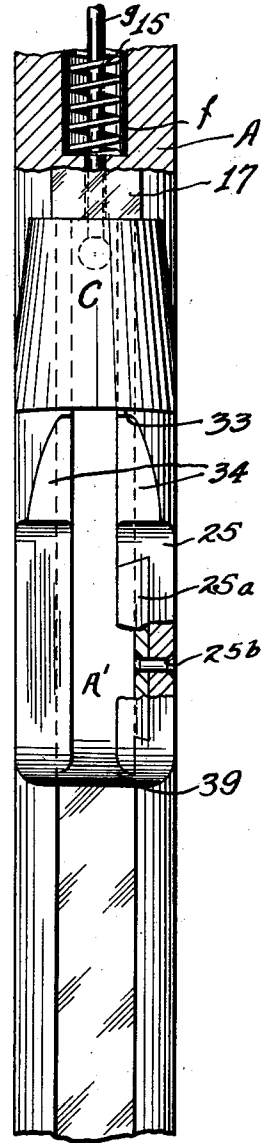


Fig. 14.



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UNITED STATES PATENT OFFICE

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UNDERREAMER

Application filed May 15, 1925. Serial No. 30,590.

This invention relates to underreamers for use in producing well hole, as in deep oil well practice, such underreamers being employed to enlarge the hole beneath the casing to permit the lowering thereof. Such an underreamer ordinarily includes a body and one or more cutters which is or are introduced within the casing in contracted or collapsed position, means being employed for suspending the cutter or cutters and causing same to move into projected or expanded condition or position after being lowered beneath the casing or the shoe thereon.

The invention has for general objects the provision of an improved underreamer which will be generally superior with respect to inexpensiveness and simplicity of construction, taken in conjunction with positiveness and efficiency and reliability in action and service, and generally superior in efficiency and serviceability.

Particular objects of the invention consist in the provision of an underreamer the cutters of which may be relatively large so as to produce a relatively large or wide cut on each reaming stroke, and which at the same time can be closely collapsed or contracted for lowering or raising within the casing.

A further particular object consists in the provision of an underreamer which is so assembled that the cutters are substantially free from liability of being lost in a hole. The cutter ways are so constructed that a part of each is removable for removing the cutter. Other particular objects consist in the strengthening of the underreamer and particularly the cutter-ways, such ways being strongest at the zone thereof at which the cutters are in expanded or projected condition or position.

In carrying out this invention, and to obtain certain of the advantages and objects above pointed out, I provide cutters and cutter-ways so arranged and inter-related that the cutters are out of registration or opposition when in contracted condition or position, thus permitting of collapsion or contraction within narrow limits, which is not possible where, as usual, the cutters when

collapsed are in opposition to each other. From such contracted positions the cutters move when expanded into opposition with each other.

With the above and other objects in view, the invention consists in the novel and useful provision, formation, construction, combination, association and inter-relation of parts, members and features, all as hereinafter described, shown in the drawings, and finally pointed out in claims.

In the drawings:

Figure 1 is a fragmentary vertical sectional view of a portion of a well hole at the bottom thereof, and of well casing to be lowered therein, an underreamer constructed to embody the invention being shown positioned within the casing and well hole with the cutters expanded and so disposed as to enlarge the hole upon operation of the reamer;

Figure 2 is an enlarged detail view showing the underreamer or a portion thereof within the casing with the cutters in collapsed condition;

Figure 3 is a top plan view of one of the cutters of the underreamer in detached position;

Figure 4 is an enlarged detail inner face view of one of the reamer cutters in detached position;

Figure 5 is a detail sectional elevation of the underreamer body with the cutters and suspension and actuation means thereof removed;

Figure 6 is a detail transverse sectional view taken upon the line 6—6, Figure 7, and looking in the direction of the accompanying arrows;

Figure 7 is an enlarged detail vertical sectional and fragmentary view of a portion of the underreamer body and of the cutters and cutter suspending and actuating rods and attendant features, showing the cutters in expanded or reaming positions;

Figure 8 is an enlarged detail fragmentary vertical sectional view of part of the construction shown in Figure 5;

Figure 9 is a detail transverse enlarged sectional view taken upon the line 9—9, Figure 5, showing in addition the reamer cutters

in the positions they assume when passing each other in proceeding either to expanded or collapsed condition;

Figure 10 is a view similar to Figure 7 showing, however, the cutters when in collapsed positions within the casing, a section of a fragment of which is likewise shown;

Figure 11 is a side elevation of the underreamer in detached position, with the cutters in expanded condition, part of the housing being broken away to show internal arrangement;

Figure 12 is an enlarged detail elevation, partly in section and partly broken away, showing a removable portion of one of the cutter-ways;

Figure 13 is a side elevation of one of the cutters in detached position; and,

Figure 14 is a side elevation of the detached portion of one of the cutter-ways shown in Figure 12.

Corresponding parts in all the figures are designated by the same reference characters.

Referring with particularity to the drawings, I have shown at A an underreamer body assembled and cooperating with which are underreamer cutters B and C. The underreamer cutters are mounted to operate in connection with separate ways *a* and *b*, in collapsing and expanding actions, and each of same is provided with separate preferably flexible suspension and actuation means D, serving to move the cutters into expanded positions and conditions when the cutters are liberated beneath the casing, after the lowering of the underreamer therein, whereupon the cutters assume the opposed operative relation shown in Figure 1. E designates a joint or section of casing such as is lowered in oil wells, particularly in the standard method of well drilling to case off the well and prevent cave-in. G designates a bit at the lower end of the body A, the same being employed for developing and drilling the well hole ahead of the reaming operation, if that be desirable, or being used to center the underreamer in the hole and cause it to move accurately in vertical reciprocation in the underreaming operation. It will be understood that the nature and type of such bit, or, in fact, its provision as part of or an adjunct of the underreamer is not essential to the main features and advantages of the underreamer.

The underreamer body A, here shown as a one-piece member, though this is not limitative on the invention, is reduced in transverse dimension, between its end portions, as at F, producing at that zone down-thrust shoulders against which the cutters bear when in expanded condition, and beneath such down-thrust shoulders F the body is provided with the ways *a* and *b*, which are provided above the bit G. Above the shoulders F the body is chambered out, as at *f*, to pro-

vide two chambers extending lengthwise of the body for reception and accommodation of preferably flexible spring-actuated rods *g*, which are associated with the cutters B and C, and cause the same to move into expanded condition, that is, into contact with the down-thrust shoulders F. These spring-actuated rods *g* are surrounded by the usual coiled helical compression springs 15 which bear at their lower ends upon the underreamer body at the bottoms of the chambers *f*, such springs at their upper ends bearing against an adjusting nut or nuts 16 whereby the compression of each spring may be varied to cause proper expanding action of the respective cutter. The chambers *f* may be sealed off by closure plates 17 which may be detachably secured in position or welded over the chambers, after the rods *g* and cutters and springs have been assembled; such closure plates, however, being somewhat shorter than the chambers to which they are applied, leaving portions of said chambers at the tops thereof, to be sealed off by removable closure plates 18 which are detachably held in place by pins 19 passed through heads 19^a at the tops of said plates and through the body of the underreamer at opposite walls of the respective chambers. These plates 18 provide access to the upper portions of the chambers so that the tensions of the springs 15 may be varied by manipulating the nuts 16, as desirable or necessary.

The rods *g* are movably accommodated within bores 20 produced in the body A beneath the chambers *f*, and communicating therewith, so that said rods may play vertically in said chambers and bores, in the collapse and expansion of the cutters; and the lower ends of said rods *g* are preferably provided with terminal balls 21 which are loosely connected with the upper portions of the cutters, respectively, said cutters having chambers 22' opening inwardly from the rear faces thereof, to receive such balls in ball socket relation, the cutters being slotted as at 22^a above said chambers to accommodate the rods; this connection of the rods with the cutters and their flexibility allows free play of the cutters in tilting actions incident to expansion and collapse.

The cutters B and C have elongated bodies 23 provided at their lower extremities with the usual cutting end and edge portions 23^a having a transverse curvature of suitable radius to ream out the well hole to proper form. Each cutter diminishes in thickness toward its lower cutting edge portion, and the major portion of the cutter is provided at each side with a groove or channel 24 ranging vertically of the cutter and having curved walls conforming to the formation of the ways *a* or *b*, each such groove or channel being likewise curved longitudinally to conform to the vertical curvature of such ways. These ways or

each set of ways *a* and *b* comprises oppositely disposed flanges 25, said flanges being curved in the main, or made up of angularly-related portions, to cooperate with the longitudinal curvature of the channels 24 of the cutters, which channels embrace said flanges. These flanges are thicker toward the tops or upper portions thereof, as clearly shown in Figure 5, so as to resist out-thrust of the cutters when in reaming position. The body portion A, at A' between the sets of ways, resists in-thrust of the cutters and the up-thrust of the cutters is imparted to the down-thrust shoulders F upon the body. The ways *a*, referring now particularly to Figure 2, are provided adjacent their top portions with downwardly and outwardly ranging zones, as at 26, against which the upper portions of the cutters bear when the cutters are in positions of expansion, so as to project the cutting edge portions 23^a outwardly into proper expansion. Beneath these portions 26 are substantially vertical zones 27, and beneath said zones 27 are zones of contraction, defined by curved walls, at 28, so that the cutters upon collapsing are permitted to tilt inwardly at their lower ends relieving the cutter in the collapsing operation. Beneath these zones are further substantially vertical zones 29, and these merge into sharply, inwardly and downwardly ranging zones 30, over which the cutter rides in its final collapsing action, in which position it is engaged in its side channels 24 with contracted and substantially vertical flange portions 31, shown particularly in Figure 5. The cutter B which cooperates with the ways *a* is lower down upon the body of the underreamer than the cutter C when the latter is in collapsed position, as clearly shown in Figure 2, and in Figure 10.

The ways *b* comprise outwardly and downwardly inclined upper terminal portions 32, directly beneath the respective shoulder F, beneath which are substantially vertical portions 33, these zones 32 and 33 serving to provide the proper outward tilt of the cutter C when in expanded condition. Beneath the zones 33 are abruptly inwardly and downwardly inclined zones 34 from which the cutter C rides into collapsed position, in which it is retained by terminal lower flange portions 35, particularly shown in Figure 5, such flange portions 35 being materially above the flange portions 31 of the ways *a*, so that the cutters are collapsed one above the other, C above B, and the intermediate wall portion A' is of sinuous formation vertically of the body A, as clearly shown in Figure 5, to accommodate marked collapse of the cutter C and marked collapse of the cutter B, so that portions of the same are substantially one over the other, as best shown in Figure 10, such extreme or marked collapse being impossible to obtain where, as usual, the cutters are in opposition to each other when col-

lapsed. When the cutters are collapsed their cutting edge portions 23^a lie within the figure of the body of the underreamer, being inwardly and downwardly directed and pocketed within pockets or cavities or chambers 36 and 37 within the body, so that the cutting edge portions are directed away from the casing through which the underreamer is being lowered or raised, preventing any interference with such operations. The cutters are provided with upper and outer riding shoulders 38 which are engaged with the casing or shoe thereon to initiate the collapsing action, and which are engaged at their extremities with the inner wall of the casing during the raising or lowering of the underreamer. Obviously portions of the chambers 36 and 37 within which the cutters are housed intrude beyond the vertical axis of the underreamer body, accommodating the close collapse of the cutters mentioned.

In each of the sets of ways *a* and *b* I provide at one side, or in one of the flanges 25, a detachable portion or section 25^a which is dovetailed as clearly shown in Figure 12 to be firmly fitted into a similar dove-tailed formation in the body of the flange, and such detachable portion and the flange are riveted together, as at 25^b, after the respective cutter has been positioned in the respective ways, and connected up with the respective spring-actuated rod, the upper end portion of which plays within the respective chamber *f*. The rivets 25^b are preferably soft and can be readily punched out when it is desired to remove the respective cutter from its rod. The use of these detachable flange portions 25^b permits of employing ways *a* and *b* which are closed at the bottom, as at 39, by downwardly curving portions of the intermediate body portion or web A'. This prevents loss of cutters in the hole, which frequently occurs in the use of the usual open-mouthed cutterways.

The operation and method of use of an underreamer constructed to embody the invention will be readily understood from the foregoing description, taken in connection with the accompanying drawings and following statement:

With the parts assembled, as shown and described, the cutters are drawn downwardly into collapsed positions as shown in Figure 2, and introduced within the casing at the mouth of the hole. The underreamer is then lowered and when the cutters are successively liberated at the bottom of the casing, which is slightly raised above the bottom of the hole, they are drawn upwardly into expanded condition by the spring-actuated rods *g*, the two cutters rising into expanded positions, as shown in Figure 7. The underreamer is now vertically reciprocated with or without a string of tools in the usual manner in standard drilling practice, chipping and cutting

away the formation beneath the casing, commonly known as the "shoulder", to enlarge the hole to permit the casing to be further lowered and drilling to proceed. When the underreaming operation has been sufficiently extended, the underreamer is elevated until the riding shoulders 38 are brought against the lower end of the casing or its shoe, whereupon the cutters are held relatively stationary and the body A continues to rise, until the cutter C is collapsed, whereupon it rises with the body and the cutter B remains relatively stationary until collapsed, and when the cutters are in the collapsed conditions shown in Figure 10, body and cutters all are elevated through and within the casing.

The invention provides for extreme collapsion of large cutters within small casing. Such cutters could not be employed within six-inch casing if fitted within underreamers of ordinary construction and would hardly collapse within eight-inch casing. But the provision for collapsing the cutters out of opposition to each other permits of extreme or marked collapsing action of large cutters within small casing, and at the same time the body of the reamer is unimpaired in strength of the intervening body wall or web A' between the cutters, it not requiring to be thinned down as is ordinarily necessary to produce sufficient collapsion when the cutters are opposite each other when contracted. As stated, the cutters cannot be lost in the hole but at the same time may be readily put in position of service or removed. The flanges of the ways of the cutters are strongest and thickest adjacent the top portions thereof, where they have to resist out-thrust and side-thrust stresses when expanded.

Another advantage of this type of underreamer is that the usual "sub" closing the lower end of the body, and usually provided in underreamers, to permit assemblage of same and attachment and detachment of cutters, is not necessitated or required, the lower end of the body being solid and provided with the bit G ahead if the same be desired.

Many other changes will be encountered in practicing the invention, and it is likewise obvious that many variations and changes and modifications and substitutions may be made in practicing the invention, in departure from the foregoing description and disclosure of the drawings, without departing from the true spirit of the invention.

Having thus disclosed my invention, I claim and desire to secure by Letters Patent:

1. In an underreamer, a body, cutters movable lengthwise on said body, and means for causing longitudinal movement of said cutters to cause collapsion and expansion of the cutters in cooperation with the body; said cutters being positioned out of opposition to each other when collapsed, and being posi-

tioned in opposition to each other when expanded.

2. In an underreamer, a body, cutters, and means for causing expansion and collapsion of the cutters in cooperation with the body; the body being provided with cutter-accommodating pockets to receive the cutters when collapsed, there being a pocket for each cutter, said pockets being in different zones of the body lengthwise thereof and said cutters being located in the same zone when expanded.

3. In an underreamer, a body, cutters, and means for causing expansion and collapsion of the cutters, in cooperation with the body; the body being provided with cutter-accommodating pockets to receive the cutters when collapsed there being a pocket for each cutter, said pockets being in different zones of the body lengthwise thereof and in part one over the other, said body supporting said cutters in opposition when expanded.

4. In an underreamer, a body, cutters, and means for causing expansion and collapsion of the cutters in cooperation with the body; the body being provided with cutter-accommodating pockets to receive the cutters when collapsed there being a pocket for each cutter, said pockets being in different zones of the body lengthwise thereof and in part one over the other whereby one of the cutters in part is disposed above the other cutter when the cutters are collapsed, said body supporting said cutters in opposition when expanded.

5. In an underreamer, a body, cutters, and means for causing expansion and collapsion of the cutters, in cooperation with the body; the body being provided with opposite ways extending lengthwise for the respective cutters, said ways having portions formed to produce tilting of the cutters into and out of collapsed and expanded condition, there being longitudinally spaced pockets on said body to receive said cutters in collapsed position and portions to support said cutters in opposition when expanded.

6. In an underreamer, a body, cutters, and means for causing expansion and collapsion of the cutters in cooperation with the body, the body being provided with opposite ways for the respective cutters, said ways having portions formed to produce tilting of the cutters into and out of collapsed and expanded condition; the body between said ways of the respective cutters constituting a sinuous web of material thickness.

7. In an underreamer, a body, cutter ways thereon ranging lengthwise thereof and ranging inwardly and outwardly thereof and out of lateral alignment at separate portions thereof, and cutters cooperating with said ways for expansion in opposition and collapsion out of opposition.

8. In an underreamer, a body, cutter ways

thereon ranging lengthwise thereof and ranging inwardly and outwardly thereof and out of lateral alignment at separate portions thereof, and cutters cooperating with said ways for expansion in opposition and collapse out of opposition, and yieldable means applied to the cutters in a manner tending to move them in one direction lengthwise of the body along the ways.

9. In an underreamer, a body, cutters, and means for causing expansion and collapse of the cutters, in cooperation with the body; the body being provided with cutter-accommodating recesses to receive the cutters when collapsed, there being a recess for each cutter, said recesses being in different zones of the body lengthwise thereof, and said cutters being movable lengthwise of the body to and from said recesses.

10. In an underreamer, a vertically extending body, cutters movable vertically and horizontally of the body between collapsed and expanded positions, said cutters when in expanded position each bearing inwardly against the body, the body being provided with vertically offset cutter receiving recesses into which the cutters are moved by their movement into collapsed positions.

11. In an underreamer, a vertically extending body, said body being provided with horizontally opposite, vertical cutter ways, there being vertically offset cutter receiving recesses in said ways, and cutters movable longitudinally through the ways between vertically offset positions while in said way recesses and horizontally opposite positions in said ways when out of said recesses.

12. In an underreamer, a vertically extending body, said body being provided with horizontally opposite, vertical cutter ways, there being vertically offset cutter receiving recesses in said ways, and cutters movable longitudinally through the ways to and from positions in said offset recesses.

13. In an underreamer, a body, cutters, and means for causing expansion and collapse of the cutters in cooperation with the body; the body being provided with cutter accommodating recesses to receive the cutters when collapsed, there being a recess for each cutter, said recesses being in different zones of the body lengthwise thereof and said cutters being movable longitudinally of the body to and from positions in the recesses.

In testimony whereof, I have signed my name to this specification.

JOHN T. PHIPPS.

CERTIFICATE OF CORRECTION.**Patent No. 1,767,474.****Granted June 24, 1930, to****JOHN T. PHIPPS.**

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 5, after line 55, add the following as claim 14:

14. In an underreamer, a body, a pair of cutters, each cutter being independently movable lengthwise on said body, and means for causing longitudinal movement of said cutters to cause collapsion and expansion of the cutters in cooperation with the body, said cutters being positioned in opposition to each other when expanded, and means establishing the extent of longitudinal movement of each cutter from its expanded to collapsed position, such extent of longitudinal movement of one cutter being less than such extent of longitudinal movement of the other cutter.;

and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 5th day of August, A. D. 1930.

(Seal)

Wm. A. Kinnan,
Acting Commissioner of Patents.