J. C. SWAN.

UNDERREAMER.

APPLICATION FILED OCT. 26, 1909.

979,106. **Patented Dec. 20, 1910.**

3 SHEETS—SHEET 1.

FIG. 1.

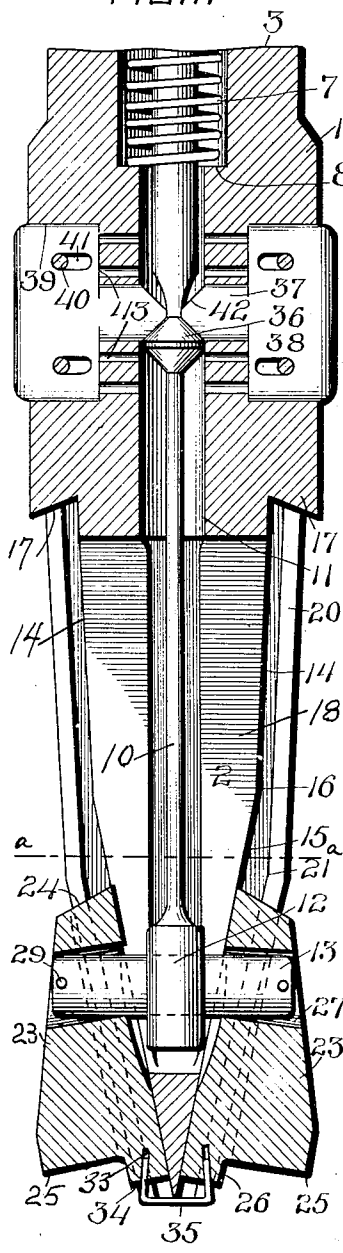


FIG. 3.

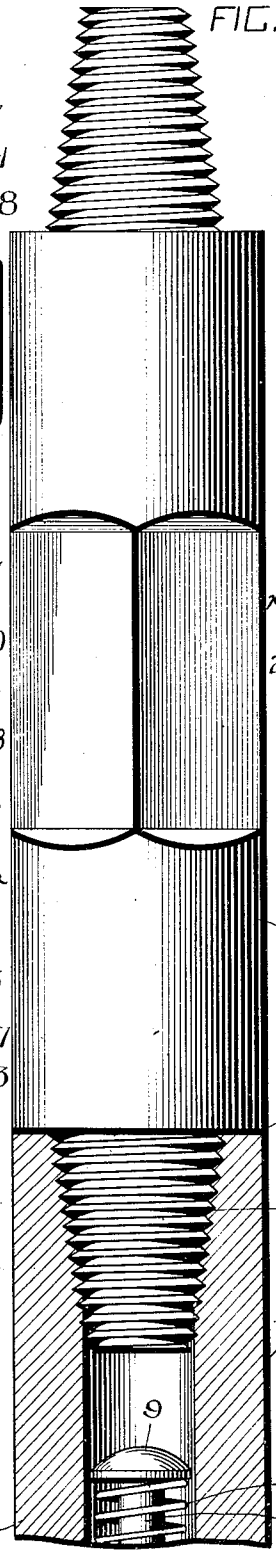
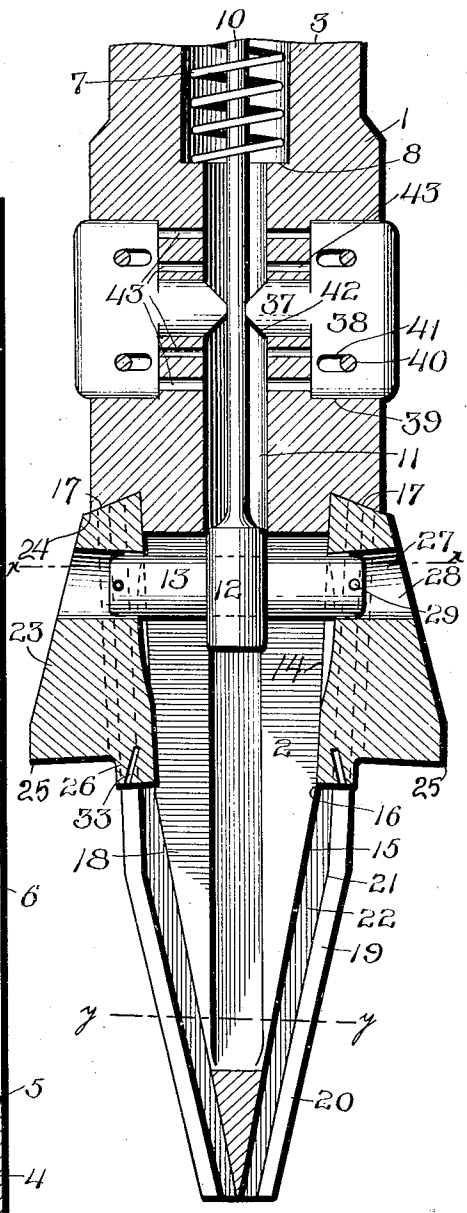


FIG. 2.



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3 SHEETS—SHEET 2.

FIG. 4.

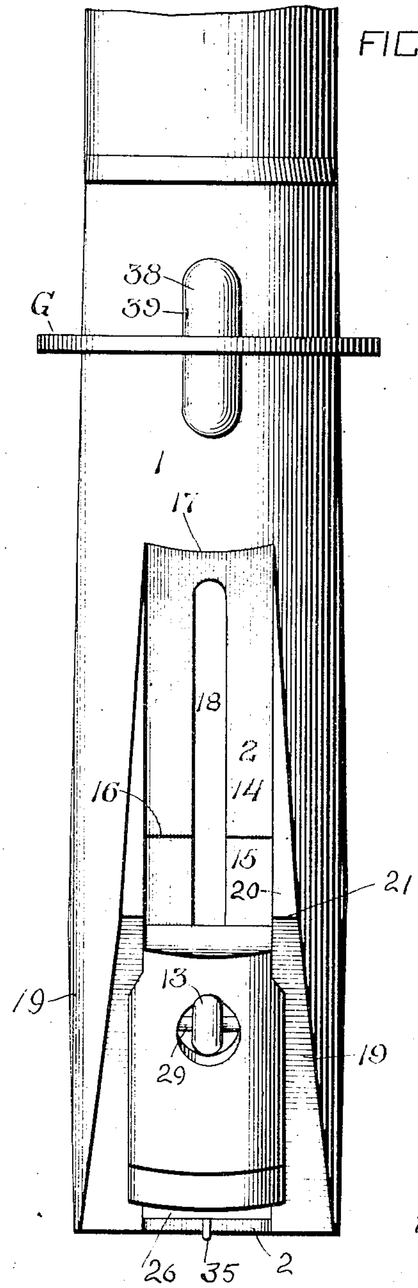


FIG. 5.

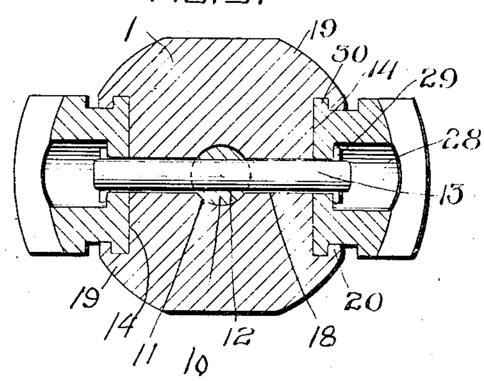


FIG. 6.

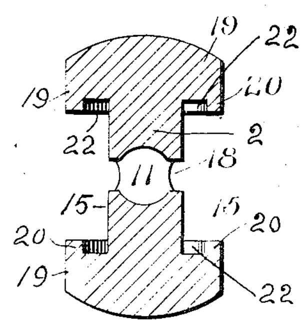


FIG. 7.

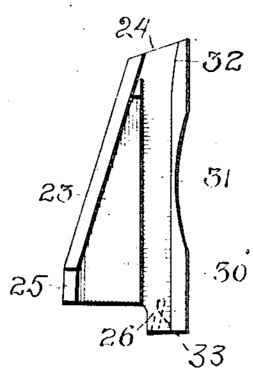
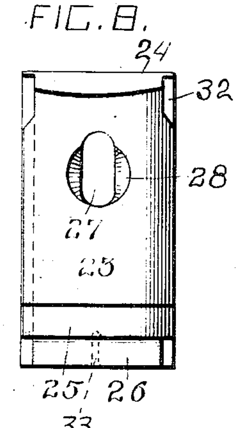


FIG. 8.



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APPLICATION FILED OCT. 26, 1909.

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3 SHEETS—SHEET 3.

FIG. 10.

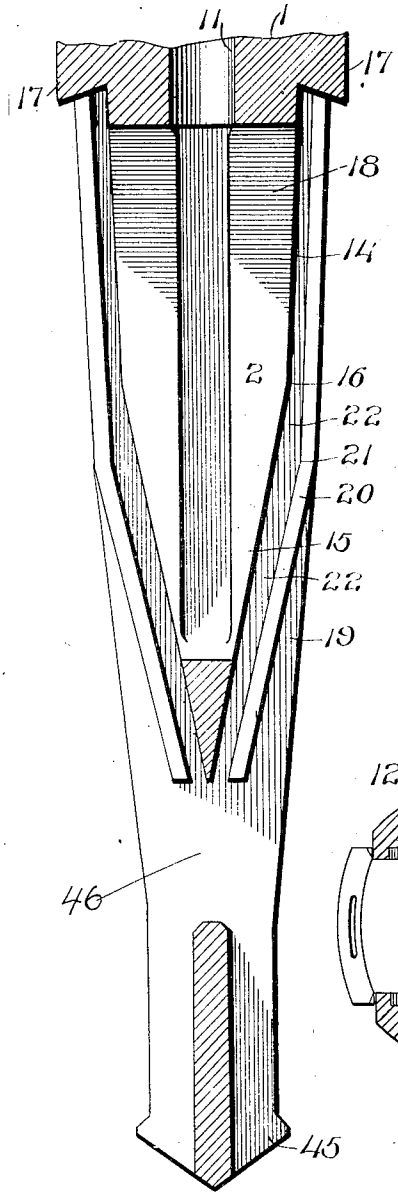


FIG. 9.

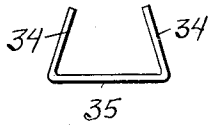


FIG. 12.

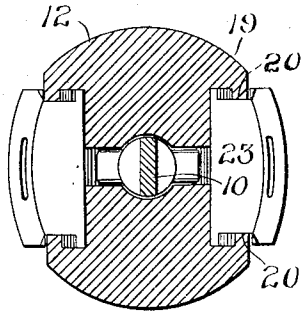
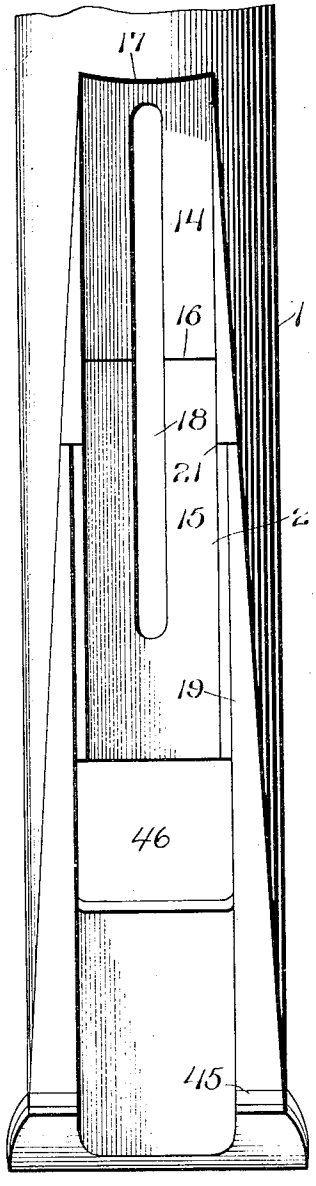


FIG. 11.



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UNDERREAMER.

979,106. Specification of Letters Patent. **Patented Dec. 20, 1910.**

Application filed October 26, 1909. Serial No. 524,731.

To all whom it may concern:

Be it known that I, JOHN C. SWAN, a citizen of the United States, residing at Marietta, in the county of Washington, State of Ohio, have invented certain new and useful Improvements in Underreamers, of which the following is a description, reference being had to the accompanying drawings, forming a part hereof.

My invention relates to devices for reaming out or enlarging well holes and particularly to devices for such purpose adapted for under reaming that is reaming out or enlarging the well hole drilled below casing in order to permit the casing to be lowered.

My invention is an improvement on the underreamer for which Letters Patent No. 683,352 were issued to me September 24, 1901, and it consists in the construction and combination of devices hereinafter described and particularly pointed out in the claims.

In the underreamer of my patent referred to the wedge on which the reaming bits or slips move from retracted position to expanded position is a straight wedge of uniform taper throughout and the degree of expansion given to the reaming bits or slips is necessarily limited by the length of the wedge and this in turn is necessarily limited by the distance through which the spring for moving the reaming bits or slips from contracted to expanded position can be depended on for effective work, as well as by the length of tool which is found to be suitable for practical use.

It is sometimes found desirable to enlarge the hole drilled below casing, for a portion or all of its length, to a diameter greater than that to which the reaming bits or slips of an underreamer such as is disclosed in my patent referred to will expand, the underreamer being of such dimensions as to pass through the casing when the reaming bits or slips are at the lower end of the wedge.

It is the purpose of my present invention to provide an underreamer which will be adapted to be used to enlarge the hole drilled below casing either to standard size or to a considerably larger size if desired.

It is a further purpose of the invention to provide an improved means for holding the reaming bits or slips in contracted position while the tool is being lowered through the casing.

Referring to the drawings: Figure 1 is a vertical sectional view through the lower portion of the reamer body on a plane at right angles to the faces of the wedge, showing the reaming bits or slips in contracted position. Fig. 2 is a similar view showing the reaming bits or slips in expanded or working position. Fig. 3 is a view in longitudinal section of the upper end of the reamer body also showing in elevation the double pin substitute by which the underreamer is connected with the string of tools. Fig. 4 is an elevation of the lower portion of the reamer body showing the reaming bits or slips in retracted position. Figs. 5 and 6 are cross-sections on lines *x*—*x* and *y*—*y* of Fig. 2 respectively. Figs. 7 and 8 are side and front views respectively of the reaming bit or slip. Fig. 9 is a detail view of a device for retaining the reaming bits or slips in contracted position. Fig. 10 is a vertical section similar to Fig. 2 showing an underreamer having a bit at its lower end. Fig. 11 is a side elevation of the combined underreamer and bit shown in vertical section in Fig. 10. Fig. 12 is a cross-section on line *a*—*a* of Fig. 1.

In the drawings, 1 is the reamer body having its lower portion shaped to form a wedge 2 and having its upper portion bored out to form a spring case 3. The upper end of the bore of the spring case is tapered and screw-threaded as shown at 4 to receive the tapered pin 5 of the double pin substitute 6. The bore of the spring case 3 is of sufficient diameter to receive the spring 7 which bears at its lower end against a shoulder 8 and bears at its upper end against a head 9 on the spring rod 10.

The spring rod 10 extends downward from the spring case through a bore 11 in line with the bore of the spring case concentric with the axis of the reamer body and extending nearly to the lower end of the wedge. The spring rod is provided near its lower end with a slot 12 through which extends a cross bar 13 by which the reaming bits or slips are connected with the spring rod.

The wedge 2 instead of being tapered uniformly from its base to its apex as in the construction disclosed in my patent above referred to, has the upper portion 14 of each of its faces at a different angle, relative to the axis of the reamer body, from that of the lower portion 15 of these surfaces. The upper portions 14 of the wedge surfaces are

at a comparatively slight angle to the axial line of the reamer body while the lower portions 15 are at a much greater angle. The upper and lower surfaces 14 and 15 come together at 16 at a slight angle as shown.

At the upper ends of the upper surfaces 14 I provide abutments 17 each having its face arranged preferably at an oblique angle to the axial line of the reamer body instead of at a right angle thereto.

Through the wedge at right angles to the wedge surfaces is formed a longitudinal slot 18 extending from a point near the abutment 17 nearly to the lower end of the wedge, the slot being of such width as to permit the cross bar 13 to extend through it and to travel freely in it.

The material of the reamer body extends outward at the sides of the wedge surfaces to form housings 19 and in these housings are formed guide ribs 20 for guiding the reaming bits or slips. These guide ribs 20 extend from the abutments 17 downward to a point below the line of the point 16 and preferably extend nearly or quite to the lower end of the wedge. These guide ribs extend in a line parallel with the upper surfaces 14 of the wedge to a point 21 somewhat below the point 16 at which the upper and lower surfaces 14 and 15 come together, and from the point 21 to the lower end the rib, while following the general direction of the lower surface 15 of the wedge, is preferably nearer the plane of the surface 15 at its lower than at its upper end. It will be seen that by reason of this construction the space 22 between the surface of the wedge and the rib 20 is of uniform width from the abutment 17 to the point 16 and from this point to the point 21 downward is of increasing width and from the point 21 to the lower end of the rib is of gradually decreasing width.

23 are the reaming bits or slips having their upper ends terminating in oblique faces 24 adapted to fit the oblique faces of the abutments 17 when the reaming bits or slips are in expanded or operating position as shown in Fig. 2. The reaming bits or slips 23 have cutting edges 25 and tail pieces or extensions 26 extending downward below the plane of the cutting edges; they are also each provided above the cutting edges with an opening 27 adapted to receive the end of the cross bar 13 and on their outer faces they are each provided with a recess 28 to receive the end of a pin 29 in the end of the cross bar. On their sides the reaming bits or slips are each provided with ribs 30 adapted to travel in the space 22 and to engage and be guided by the guide rib 20. In order that the reaming bits or slips may readily pass the angle 16 at which the upper and lower surfaces 14, 15 of the wedge come together their inner faces are concaved as shown at 31 and to further facilitate the free passage of the reaming bits from end to end of the wedge the ribs 30 are slightly eased off or cut away as shown at 32.

In the lower ends of the reaming hits or slips are formed holes or openings 33, these holes being bored at such an angle that when the reaming hits or slips are at the lower end of the wedge as shown in Fig. 1 the holes in the two reaming bits or slips will converge slightly from below upward. These holes are adapted to receive the slightly converging legs 34 of a staple 35 as shown in Fig. 1 by which the reaming bits or slips may be held together in retracted position.

The spring rod 10 is preferably formed at a suitable point between its ends with a shoulder 36 which is adapted to be engaged by the inward projecting ends 37 of trips 38 which are carried in recesses 39 formed in the reamer body above the abutments 17. The trips 38 are retained in position by pins 40 extending through slots 41 in the trips, the slots 41 being of sufficient length to permit the trips to move sufficiently to engage and disengage their ends 37 with the shoulder 36. The ends 37 of the trips terminate in inclined faces 42 to permit the shoulder 36, which also has inclined upper and lower faces, to pass the trips when the trips are not pressed inward.

The recesses 39 are preferably provided in their bottoms with openings or perforations 43 extending into communication with the bore 11 to permit water and any fine sand to pass through.

When the tool is to be introduced into a well hole the reaming bits or slips are drawn down to the lower end of the wedge to the position in which they are shown in Fig. 1, against the upward pull of the spring 7 and are held there temporarily by any convenient means as for instance by inserting the legs 34 of the staple 35 in the holes 33. The trips 38 are then pressed inward to cause their ends 37 to engage the upper face of the shoulder 36 and are held in such engagement by removable ring G as in the tool of my patent before referred to. The staple 35 may then be removed if desired. The reaming bits or slips are thus held opposite the lower surfaces 15 of the wedge being so far contracted or brought inward that the tool will pass freely through the casing. As the tool enters the casing the upper end of the casing will stop the ring G and the trips will engage the inner walls of the casing and hold the ends 37 in engagement with the shoulder 36. If the staple 35 was removed before introducing the tool into the casing the reaming bits or slips will be drawn up on the wedge into expanded position as soon as the trips 38 pass

below the lower end of the casing so that they are free to move outward to release the spring rod. If the staple 35 has been allowed to remain in position, as soon as one or the other of the reaming bits or slips strikes the shoulder at the upper end of the small hole below the casing, or any obstruction sufficient to stop it, it will be freed from engagement with the staple and at the same time the other reaming bit or slip will free itself from the staple which will drop off. The reaming bits or slips will thus be free to be moved to expanded position by the spring 7 and the tool is then ready for use in the usual manner of using an under-reamer.

By the use of the wedge as above described having upper and lower surfaces of different angle a degree of expansion and contraction of the reaming bits or slips is secured much greater than that obtainable where a straight wedge is used, without increasing the length of the wedge. For instance in a well in which 8¼ inch casing is used the straight wedge underreamer of usual length will enlarge the hole below casing to 10 inches which is sufficient to permit the casing to be lowered under ordinary conditions, but is not adapted to enlarge the hole to a greater diameter. A tool of the present invention capable of passing freely through the 8¼ casing when the reaming bits or slips are in contracted position, that is when at the lower end of the wedge resting against the lower surfaces 15, is capable, when the reaming bits or slips are in expanded position, that is against the abutments 17, of enlarging the hole to a diameter of 11 inches. This increased diameter is in some cases of great importance in order to enable the casing to pass obstructions which would otherwise stop it as where the hole is crooked or where a ledge of rock is encountered immediately below soft material in which bad caving has occurred.

The lower portions of the guide ribs 20 that is the portions opposite the lower portions 15 of the surface of the wedge hold the reaming bits inward against the possibility of outward swing which might be caused by striking an obstruction or by lowering the tool rapidly through water.

The spring rod 10 is preferably flattened between the shoulder 36 and the lower end of the rod as shown in Fig. 12 so as to give increased depth of shoulder 36 for the engagement of the trips without materially lessening the strength of the rod as would be done by turning down the rod.

For some purposes it is desirable to drill a small hole and simultaneously enlarge the drilled hole. For this purpose I may provide the underreamer with a bit 45 extending downward below the lower end of the wedge 2 as shown in Fig. 10. The bit in such case is provided below the apex of the wedge with an opening 46 of sufficient length and width to permit the reaming bits or slips to pass through it after they are moved down past the apex of the wedge. The housings 19 are extended downward to support the bit 45 the housing being of sufficient mass to give the necessary strength.

In the operation of under-reaming as the tool descends and causes the cutting edges of the reaming bits to strike on the shoulder of material to be cut away, the reaming bits will usually tend to stick in the material of the well wall by reason of the resistance of the material and the pinching in due to this resistance, but as the tool is drawn upward after striking a blow, the wedge is drawn slightly upward from between the reaming bits, relative movement of the wedge and reaming bits being permitted by the yielding of the spring 7, and as the wedge moves upward the reaming bits are drawn inward freeing them from the wall of the well hole. As the tool continues to rise the reaming bits are brought up above the shoulder into the portion already reamed to full diameter and are then at once returned to contact with the abutments by the contraction of the spring.

It will of course be understood that I do not desire to be limited to the precise construction or arrangement shown or described, as it is obvious that changes in the details of construction and proportion and arrangement of parts may be made without departing from the spirit of the invention.

Having thus described my invention and explained the operation thereof, I claim as new and desire to secure by Letters Patent:—

1. In an under-reamer the combination of a reamer body having a wedge shaped portion adapted to receive and support reaming bits, the upper and lower portions of the surfaces of the wedge being at different angles to the longitudinal axis of the wedge, guide ribs formed in the reamer body adjacent the upper portions of the surfaces of the wedge, and extending below said upper portions, reaming bits provided with means for engaging said guide ribs, and means for moving the reaming bits from one portion of the wedge to the other portion.

2. In an under-reamer the combination of a reamer body having a wedge shaped portion adapted to receive and support reaming bits, the upper and lower portions of the surfaces of the wedge being at different angles to the longitudinal axis of the wedge, guide ribs formed in the reamer body adjacent and parallel to the upper portions of the surfaces of the wedge, and extending below said upper portions, reaming bits provided with means for engaging said guide ribs, and means for moving the reaming bits

from one portion of the wedge to the other portion.

3. In an under-reamer the combination of a reamer body having a wedge shaped portion adapted to receive and support reaming bits, the lower portion of the surfaces of the wedge being at a greater angle to the longitudinal axis of the wedge than the upper portions, guide ribs formed in the reamer body adjacent the upper portions of the surfaces of the wedge, and extending below said upper portions, reaming bits provided with means for engaging said guide ribs, and means for moving the reaming bits from one portion of the wedge to the other portion.

4. In an under-reamer the combination of a reamer body having a wedge shaped portion adapted to receive and support reaming bits, the lower portions of the surfaces of the wedge being at a greater angle to the longitudinal axis of the wedge than the upper portions, guide ribs formed in the reamer body adjacent and parallel to the upper portions of the surfaces of the wedge, and extending below said upper portions, reaming bits provided with means for engaging said guide ribs, and means for moving the reaming bits from one portion of the wedge to the other portion.

5. In an under-reamer the combination of a reamer body having a wedge shaped portion adapted to receive and support reaming bits, the lower portions of the surfaces of the wedge being at a greater angle to the longitudinal axis of the wedge than the upper portions, guide ribs formed in the reamer body adjacent and parallel to the upper portions of the surfaces of the wedge, and extending below said upper portions adjacent to the lower portions of the surfaces, the spaces between said guide ribs and the lower portions of the surfaces being wider at the upper ends of said spaces than at their lower ends, reaming bits provided with means for engaging said guide ribs, and means for moving the reaming bits from one portion of the wedge to the other portion.

6. In an under-reamer the combination of a reamer body having a wedge shaped portion adapted to receive and support reaming bits, the upper and lower portions of the surfaces of the wedge being at different angles to the longitudinal axis of the wedge, guide ribs formed in the reamer body adjacent the upper portions of the surfaces of the wedge, and extending below said upper portions, reaming bits provided with means for engaging said guide ribs, and having their inner faces concaved, and means for moving the reaming bits from one portion of the wedge to the other portion.

7. In an under-reamer the combination of a reamer body having a wedge shaped portion adapted to receive and support reaming bits, the upper and lower portions of the surfaces of the wedge being at different angles to the longitudinal axis of the wedge, guide ribs formed in the reamer body adjacent and parallel to the upper portions of the surfaces of the wedge, and extending below said upper portions, reaming bits provided with means for engaging said guide ribs, and having their inner faces concaved, and means for moving the reaming bits from one portion of the wedge to the other portion.

8. In an under-reamer the combination of a reamer body having a wedge shaped portion adapted to receive and support reaming bits, the upper and lower portions of the surfaces of the wedge being at different angles to the longitudinal axis of the wedge, guide ribs formed in the reamer body adjacent and parallel to the upper portions of the surfaces of the wedge and extending below said upper portions, adjacent to the lower portions of said surfaces, the spaces between said guide ribs and said lower portions being wider at the upper ends of said spaces than at the lower ends, reaming bits provided with means for engaging said guide ribs, and having their inner faces concaved, and means for moving the reaming bits from one portion of the wedge to the other portion.

This specification signed and witnessed this 19th day of October A. D. 1909.

JOHN C. SWAN.

In the presence of—
CHAS. E. RIORDON,
A. P. GREELEY.