Oct. 6, 1953 A. W. KAMMERER 2,654,574

EXPANSIBLE ROTARY DRILL BIT

Filed Jan. 9, 1950 2 Sheets-Sheet 1

Fig. 2.

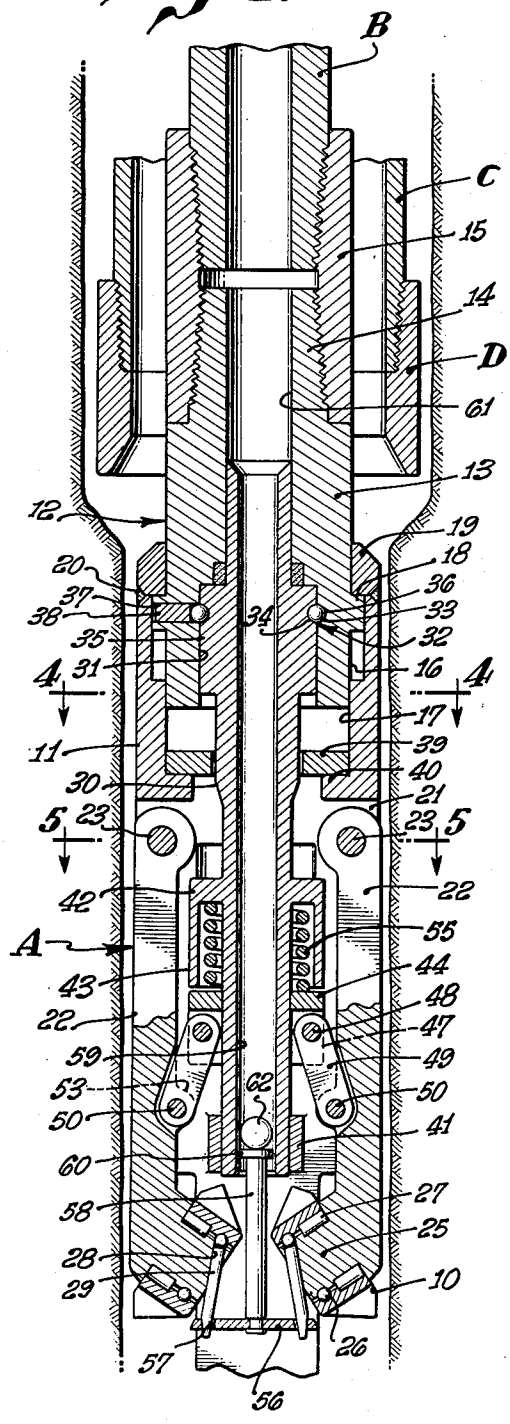
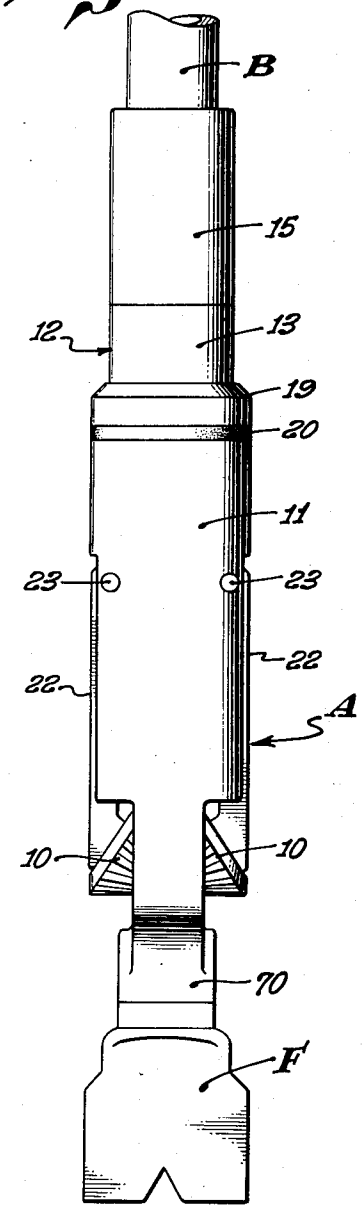


Fig. 1.



INVENTOR.
ARCHER W. KAMMERER,
BY
Bernard Kriegel
ATTORNEY.

Oct. 6, 1953 A. W. KAMMERER 2,654,574

EXPANSIBLE ROTARY DRILL BIT

Filed Jan. 9, 1950 2 Sheets-Sheet 2

Fig. 3.

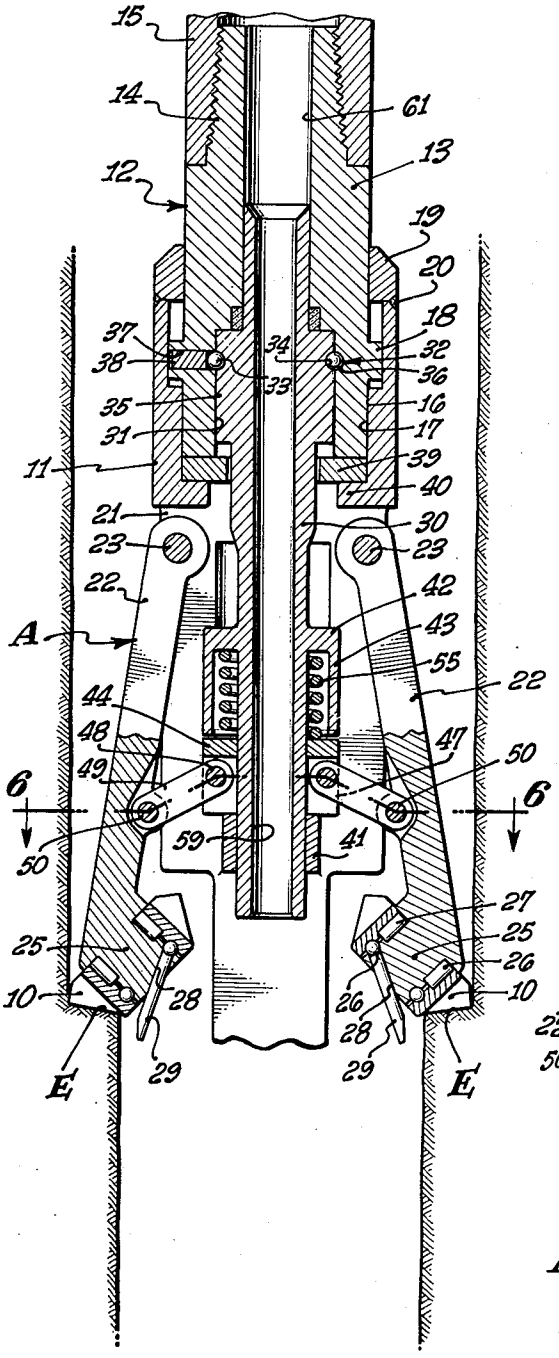


Fig. 4.

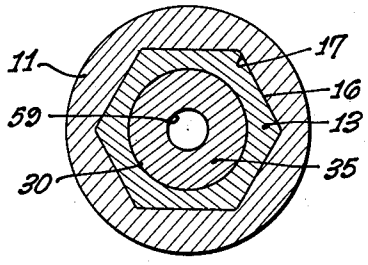


Fig. 5.

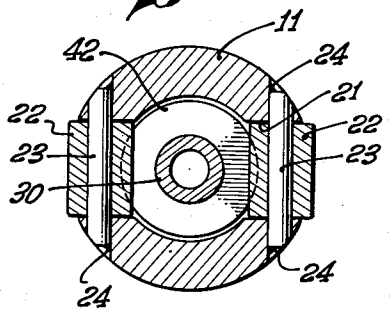
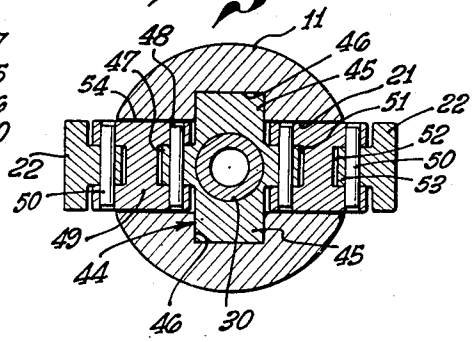


Fig. 6.



INVENTOR.
ARCHER W. KAMMERER,
BY
Bernard Kriegel
ATTORNEY.

Patented Oct. 6, 1953

2,654,574

UNITED STATES PATENT OFFICE

2,654,574

EXPANSIBLE ROTARY DRILL BIT

Archer W. Kammerer, Fullerton, Calif.

Application January 9, 1950, Serial No. 137,535

14 Claims. (Cl. 255—76)

1

The present invention relates to drill bits, and more particularly to bits capable of enlarging well bores to greater diameters than the inside diameters of well casings through which the bits are capable of passing.

Heretofore, drill bits have been made with expansible cutters to enlarge the diameter of a well bore below well casing. However, the necessary strength in the tool is obtainable only by limiting the extent of expansion of its cutters. This is particularly true of expansible bits embodying roller cutters for enlarging well bore diameters in comparatively hard formations.

Accordingly, an object of the present invention is to provide a drill bit of strong and sturdy construction and arrangement, despite the fact that its cutters can be expanded outwardly to a comparatively large extent for correspondingly enlarging the diameter of the well bore.

Another object of the invention is to provide a drill bit having a cutter supporting member that can be expanded outwardly of the main body of the bit to a great extent, and in which such supporting member is braced appropriately despite its large outward expansion, to enable it to withstand safely the drilling weights and torques imposed upon it.

Still another object of the invention is to provide an improved rotary expansible drill bit, which can commence its hole enlarging operation without the necessity for resting on the bottom of the well bore, and in which the bit cutters are expandible laterally outward to a predetermined and large extent, so as to assure the reaming of the hole to a known enlarged diameter.

A further object of the invention is to preclude any substantial inward movement of the cutters of an expansible rotary drill bit after they have been expanded to their maximum diameter, which diameter is substantially greater than their initial retracted diameter.

Yet a further object of the invention is to expand the cutters of an expansible rotary drill bit outwardly and impose the desired drilling weight on the cutters without transmitting it through the device which effects cutter expansion.

This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of a form in which it may be embodied. This form is shown in the drawings accompanying and forming part of the present specification. It will now be described in detail, for the purpose of

2

illustrating the general principles of the invention; but it is to be understood that such detailed description is not to be taken in a limiting sense, since the scope of the invention is best defined by the appended claims.

Referring to the drawings:

Figure 1 is a front elevation of an expansible drill bit embodying the invention, attached to a drill string;

Fig. 2 is an enlarged longitudinal section through the drill bit disposed in a well bore, with the parts of the bit in retracted position;

Fig. 3 is a view similar to Fig. 2, disclosing the cutter parts of the bit in expanded position;

Fig. 4 is a cross-section taken along the line 4—4 on Fig. 2;

Fig. 5 is a cross-section taken along the line 5—5 on Fig. 2;

Fig. 6 is a cross-section taken along the line 6—6 on Fig. 3.

A drill bit A is disclosed in the drawings as being attached to the lower end of a string of drill pipe B, by means of which it can be lowered through well casing C, for the purpose of enlarging the well bore below the casing shoe D. The drill bit cutters 10 are expanded outwardly, for the purpose of producing an annular formation shoulder E in the well bore, upon which the cutters can continue to operate in enlarging the diameter of the well bore to the desired predetermined extent.

The drill bit A includes an elongate main body 11, in which a tubular member 12 is piloted. The upper portion of this member is constituted by a kelly 13 having an upper threaded pin 14 screwed into a sub 15, which may form the lowermost portion of the drill pipe B. The drill stem member 13 itself is slidably splined in the upper portion of the body, as by forming the exterior 16 of the kelly of hexagonal shape, fitting within a corresponding hexagonal socket 17 in the body. The drill stem member is provided with an external flange 18 fitting within the body, and serving the purpose of holding the drill stem member within the body. After the drill stem member has been placed into the upper end of the body 11, a retainer ring 19 may be disposed over the member above its flange 18 and secured to the upper end of the body, as by use of welding material 20, in order to prevent upward withdrawal of the kelly 13 from the body 11.

The body is provided with a longitudinal transverse slot 21 extending through it, in which a pair of opposed cutter supporting members 22

are disposed. These cutter supporting members are opposed to one another and have their upper ends mounted on pivot or hinge pins 23 extending across the body slot and suitably secured to the body, as by the use of welding material 24. The cutter supporting legs 22 depend from their hinge pins 23 to a substantial extent. They each have a bearing supporting pin 25 at the lower end, on which a roller side cutter 10 is rotatably mounted. Anti-friction roller and ball bearing elements 26, 27 are disposed between each bearing supporting pin 25 and cutter 10, to reduce the friction therebetween. The ball bearing elements 27 also serve to retain the cutter on the bearing supporting pin.

The balls 27 may be inserted between each cutter 10 and its associated pin 25 through a passage 28 in the latter, which is closed by a suitable plug 29 welded, or otherwise suitably secured, to the pin.

The bearing supporting members 22 and their cutters 10 are opposed to one another, and may occupy retracted positions substantially entirely within the confines of the main bit body 11, or they may be expanded outwardly of the body to a larger effective diameter than the inside diameter of the casing string C through which the bit is moved, for the purpose of enlarging the well bore below the casing shoe. In expanding the cutters 10, their supporting legs 22 are swung outwardly about the hinge pins 23 to a predetermined extent.

The device for expanding the cutters includes a lower tubular member 30, which actually forms part of the mandrel 12, and which is piloted within a lower socket 31 in the kelly 13. The kelly 13 and lower tubular member 30 are assembled together for joint longitudinal movement by a swivel connection 32, which enables the lower tubular member to move angularly with respect to the upper kelly. Such swivel connection may include ball bearing elements 33 mounted in a raceway 34 formed on the boss portion 35 of the lower member 30, the ball bearing elements also being rollable in an internal raceway 36 formed in the kelly itself. The balls may be inserted in place through a passage 37 extending through the Kelly flange 18. After the required number of balls have been mounted in the raceways 34, 36, they are held in assembled position by a plug 38 in the passageway 37, which is prevented from inadvertent outward movement from the passageway by engaging the main bit body 11.

The lower tubular member 30 depends from its boss portion 35 through a guide and thrust member 39, which rests upon a shoulder 40 formed on the body. This thrust member initially is disposed below the lower end of the kelly 13, so as to allow the kelly 13 and tubular member 30 to be moved downwardly, for the purpose of holding the cutters 10 and their supporting members 22 in an outward position, resisting inward movement of the cutters 10 from their outward position and, under some conditions, actually shifting the cutters to their outwardly expanded position. The lower end of the mandrel member 30 is slidable in a lower guide 41 integral with the body 11, and forming a support for the mandrel to resist its lateral movement.

The mandrel also has a cup-shaped thrust head 42 intermediate the upper and lower guides 39, 41 which has a depending skirt 43 terminating above a thrust block 44 slidable along the exterior of the mandrel member 30 below the skirt 43. The block is in the form of a cross in transverse

section, its diametrically opposed ribs 45 being slidable in longitudinal grooves or guideways 46 in the body 11. Another pair of diametrically opposed ribs 47, at right angles to the other ribs 45, are in longitudinal alignment with the cutter supporting legs 22. Each rib 47 carries a pin 48 on which the upper end of an inclined thrust link 49 is pivoted, the lower end of each link carrying a pivot pin 50 passing through a supporting leg between the hinge pin 23 and cutter 10, and preferably nearer the latter.

It is to be noted that the block ribs 47 are each received within a groove 51 in an associated link 49, and that the lower end of each link is also provided with a groove 52 slidably receiving a rib 53 formed on the inner portion of the leg 22. The sides 54 of the links themselves are slidable along and are guided by the walls of the body slot 21 (see Fig. 6).

The cutters 10 may be expanded outwardly upon downward movement of the kelly 13 and lower tubular member 30 with respect to the body 11, causing the lower end of the thrust skirt 43 to engage the block 44, shifting the latter downwardly and swinging the legs 22 outwardly about their hinge pins 23 through the agency of the thrust links 49. If desired, outward expansion of the cutters 10 and their supporting legs 22 may be accomplished by means of a helical compression spring 55 disposed within the skirt 43 and bearing at its upper end upon the thrust block 44. It is evident that this spring 55 tends to urge the thrust block 44 downwardly and the legs 22 in an outward direction.

The cutters 10 may be locked in retracted position by a holding device to insure the downward passage of the bit through the casing C, and to enable the bit to be moved to any desired point in the well bore below the casing shoe D before the hole enlarging operation is commenced. This holding device may include a holding plate 56 having holes 57 receiving the lower ends of the ball retaining plugs 29. The plate 56 will prevent outward expansion of the cutters 10 until the plate is removed. As disclosed in the drawings, removal may be effected hydraulically. A central rod 58 is secured to the plate 56 and projects upwardly into the central passage 59 formed through the lower tubular member 30. A head 60 at the upper end of the rod 58 fits loosely within the passage 59, to enable fluid to pass upwardly through the tubular member passage 59 and the body passage 61 and into the drill pipe B. A ball 62 may also be disposed in the passage 59, or may be dropped down the drill pipe B when the cutters are to be expanded, this ball having a diameter substantially equal to the diameter of the passage 59, so as to function as a piston and enable the fluid under pressure within the drill pipe B and drill bit A to force the central rod 58 downwardly and remove the holding plate 56 from the plug elements 29, whereupon the cutters 10 and their supporting members 22 can be shifted laterally outward.

The tool A is assembled at the well bore, with the parts occupying the position illustrated most clearly in Fig. 2, the holding plate 56 securing the cutters 10 in retracted position, with the spring 55 (when a spring is used) under maximum compression. The tubular mandrel 12 is disposed upwardly with respect to the body 11, as limited by engagement of the Kelly flange 18 with the retainer ring 19. The bit is attached to the drill pipe B and is lowered in the well bore.

When the location in the bore hole below the casing shoe D has been reached at which the

underreaming or hole enlarging operation is to commence, the pumps at the top of the well bore are started and the fluid in the drill pipe B subjected to pressure. This pressure acts upon the ball 62 and forces both the ball and the central rod 58 out of the passage 59, which removes the holding plate 56 from the plug elements 29, and allows the entire holding device to be ejected from the bit, leaving the passage 59 free and allowing the circulating fluid to exit from the lower end of the passage 59 onto the cutters 10, for the purpose of maintaining them in a clean condition and to wash the cuttings upwardly to the top of the well bore.

After the holding device has been removed, the spring 55 can expand. This expanding action urges the thrust block 44 downwardly and, through the thrust links 49, swings the cutter supporting legs 22 about their hinge pins 23 in an outward direction, forcing the cutters 10 against the wall of the formation. The drill pipe B and the rotary drill bit A are then rotated at the proper speed, the cutters digging into the wall of the formation and forming a shoulder E therein, the spring 55 expanding and forcing the cutter supporting members 22 and cutters 10 outwardly to an extent limited by engagement of the thrust block 44 with the upper end of the lower body guide 41 (see Fig. 3). When the thrust block has reached this lowermost position relative to the body, the cutters 10 have been expanded outwardly to the maximum extent.

With the formation shoulder E having been formed, the drill pipe B may be lowered, which will shift the mandrel 12 downwardly relative to the body 11, to the extent limited by engagement of the kelly 13 with the upper guide and thrust member 39. The drilling weight is then transmitted through this latter member to the body 11, and from the body and hinge pins 23 to the cutter supporting legs 22 and roller cutters 10. With the imposition of the proper drilling weight, the drill pipe and tool can be rotated to roll the cutters around the formation shoulder E and cause it to dig into the latter.

Following release of the holding device from the cutter supporting members 22, the spring 55 expands and moves the slide block 44 away from the lower end of the thrust skirt 43. Accordingly, after the formation shoulder E has been formed and the driving kelly 13 has been shifted downwardly of the body 11 into engagement with the guide 39, the cup-shaped thrust member 42 and its skirt 43 are shifted toward the slide block 44, which has the effect of recompressing the spring 55 and causing it to increase its outward thrust on the cutter supporting legs 22, thereby tending to maintain the cutter supporting legs 22 in their maximum expanded positions. The parts are so proportioned and arranged that, after lowering of the kelly 13 into engagement with the guide washer 39, the lower end of the skirt 43 is slightly above the upper end of the thrust block 44 (Fig. 3). In this manner, none of the drilling weight is transmitted through the lower tubular member 30 to the thrust block 44; all of it passing from the kelly 13 through the thrust member 39 directly to the body 11. However, the slight space that then exists between the thrust block 44 and the lower end of the skirt 43 limits the inward movement of the cutters 10 from their fully outward position. In the event that the formation tends to squeeze the cutters inwardly, they can only move from their fully expanded position to a comparatively minor extent, limited by engagement of the thrust block 44 with the lower end of the skirt 43, as the thrust block is shifted upwardly.

After the well bore has been enlarged to the proper extent, or the cutters have become worn, the tool may be withdrawn from the well bore simply by raising the string of drill pipe B. At the commencement of this elevating movement, the kelly 13 and tubular member 30 are lifted within the bit body 11, to the extent determined by engagement of the Kelly shoulder 18 with the retainer ring 19. This action decreases the compression of the spring 55 and allows the cutters 10 to be returned to retracted position more readily upon movement of the cutter legs 22 within the casing shoe D. The shoe engages the cutter legs 22 and shifts them inwardly of the bit body, the legs riding the wall of the well casing C during elevation of the device within the latter.

The cutter expanding spring 55 need not be used in the event that the body 11 can be supported against downward movement. As disclosed in Fig. 1, a pilot bit F may be threaded into a box 70 formed at the lower end of the tool body. The device can be lowered through the well casing, with the latch mechanism 56, 58 in place, and with the spring 55 omitted. When the pilot bit F engages the bottom of the well bore, the pumps may be started and the holding device ejected hydraulically from the plug elements 29 and from the bit itself. Since the pilot bit F is resting on the bottom of the hole, the body 11 attached thereto cannot be moved downwardly. This enables the drill pipe B to be lowered while the drill pipe and the bit are being rotated, which forces the lower end of the thrust skirt 43 against the thrust block 44, shifting the latter in a downward direction and forcing the legs 22 and cutters 10 outwardly through the agency of the links 49. In this manner, the shoulder E is produced in the formation, the outward extent of the shoulder being determined by engagement of the thrust block 44 with the lower body guide 41, or by engagement of the lower end of the kelly 13 with the upper guide member 39.

The hole enlarging operation may then proceed in the same manner as described above, the pilot bit F drilling the small diameter central portion of the hole and the reaming cutters 10 enlarging the hole to the desired diameter.

Inasmuch as the lower end of the skirt 43 is engaging the upper end of the thrust block 44, the cutters 10 are prevented from moving inwardly from their desired maximum position to even a slight extent.

By providing the swivel connection 32 between the kelly 13 and lower tubular member 30, the drilling torque is not transmitted to the latter, and, therefore, cannot have any tendency for turning the thrust block 44 and the links 49 attached to it. This action might tend to bend the pins 23 and other parts of the device. All of the drilling torque is transmitted from the kelly 13 to the body 11 of the tool. In addition, the drilling weight is preferably transmitted directly from the kelly 13 to the body 11 of the tool by causing the lower end of the kelly to engage the upper washer 39, and without the thrust skirt 43 engaging the thrust block 44, which would tend to urge the cutters 10 further outward beyond their desired reaming diameter.

It is to be noted that the link connection 49 between the thrust block 44 and each cutter leg

22 is close to the cutter itself. As a result, comparatively long cutter supporting legs 22 can be used, to obtain comparatively large outward expansion of the cutters 10, and still maintain adequate strength in the cutter supporting parts 22. The link connections 49 form intermediate braces between the cutters 10 and their hinge pins 23, which not only tends to withstand the bending moment imposed on the cutter supporting legs 22 by the drilling weight, but also resists inward movement of the cutters 10 as a result of the reactive thrust of the formation thereon. The actual lever or moment arm of the cutter force against the formation is held to a relatively low value, inasmuch as the links 49 are connected to the cutter supporting members 22 close to the cutters themselves. These links 49 not only act as braces in preventing deflection of the long cutter supporting legs 22, but they also interconnect the legs through the thrust block 44, offering assurance that the torque transmitted through the cutter supporting legs is substantially evenly divided between such legs and preventing inordinately high loads from being imposed on any one arm.

The thrust block 44 also resists inward movement of the cutter supporting legs 22 from their outward expanded position, inasmuch as any inward thrust is transmitted through the links 49 to the block, and from the block ribs 45 to the main body 11 of the bit. As noted above, the ribs 45 have a sliding fit in the grooves 46 of the body and contact the body walls of the grooves. In addition to resisting such inward thrust, the block 44 and the links 49 serve to transmit the rotary motion and torque from the body 11 to the cutter supporting legs 22. It is to be noted that the ribs 49 of the blocks make a sliding fit in the inner link grooves 53 and that the links themselves make a sliding fit with the walls of the body slot 21. Moreover, the leg ribs 53 make a sliding fit in the outer link grooves 52. By virtue of this arrangement, the turning effort imparted to the body 11 by the kelly 13 is transmitted directly from the body to the links 49 and from the links to the supporting legs 22. Part of this turning effort is transmitted from the side walls of the body grooves 46 to the thrust block 44 and from the thrust block ribs 47 to the thrust links 49, from where it passes to the supporting legs 22.

From the arrangement of parts, it is apparent that the major portion of the torque is transmitted directly from the body to the thrust links 49, and from the thrust links to the supporting legs 22 at points that are relatively close to the cutters 10. Very little of the torque is transmitted to the supporting legs 22 at or near their upper hinge pin ends. The link connecting pins 48, 50 also transmit very little, if any, of the drilling torque, in view of the manner in which the thrust links 49 straddle and closely embrace the thrust block ribs 47 and the ribs 53 projecting inwardly from the cutter supporting legs 22. Since the links are connected to the legs near the cutters 10, relatively long legs can be used to obtain a large expansion of the cutters without much bending effort being imposed on the legs.

It is, accordingly, apparent that an expansible rotary drill bit has been provided, which has a very large range of expansion, enabling it to enlarge well bores to diameters that are exceedingly greater than the inside diameter of the casing string through which the tool must pass. Despite such extreme range of expansion, the tool possesses adequate strength and sturdiness.

The inventor claims:

1. In a rotary drill bit: a main body; a plurality of supporting members pivotally mounted on said body; a mandrel connectible directly to a drill string and slidably splined to said body; cutters mounted on said supporting members; means movable longitudinally relative to said mandrel and connected to said supporting members for expanding said supporting members and cutters outwardly; means for moving said movable means longitudinally relative to said mandrel; an abutment on said mandrel adjacent said longitudinally movable means; said mandrel being movable longitudinally with respect to said body to locate said abutment in a position to engage said longitudinally movable means to limit retraction of said longitudinally movable means, whereby the cutters are held in their outwardly expanded position.

2. In a rotary drill bit: a main body; a plurality of supporting members pivotally mounted on said body; a mandrel connectible directly to a drill string and slidably splined to said body; cutters mounted on said supporting members; a member slidable along said mandrel and longitudinally movable with respect to said body; links interconnecting said slidable member and supporting members to expand said cutters outwardly upon longitudinal movement of said slidable member with respect to said body; means for moving said slidable member longitudinally with respect to said body to expand said cutters outwardly; an abutment on said mandrel adjacent said slidable member; said mandrel being movable longitudinally with respect to said body to locate said abutment in a position to engage said slidable member to limit retraction of said slidable member, whereby said cutters are held in their outwardly expanded position.

3. In a rotary drill bit: a main body; a plurality of supporting members pivotally mounted on said body; a mandrel having an abutment thereon and connectible directly to a drill string and slidably splined to said body; cutters mounted on said supporting members; a thrust member slidable along said mandrel; links interconnecting said thrust member and supporting members; and spring means engaging said thrust member and said abutment for shifting said thrust member along said mandrel, in order to expand said supporting members and cutters laterally outward.

4. In a rotary drill bit: a main body; a plurality of supporting members pivotally mounted on said body; a mandrel connectible directly to a drill string and slidably splined to said body; cutters mounted on said supporting members; a thrust member slidable along said mandrel and movable longitudinally of said body; links interconnecting said thrust member and supporting members; means on said mandrel engageable with said thrust member to move said thrust member longitudinally of said body; and means on said body engageable with said thrust member to stop movement of said thrust member with respect to said body.

5. In a rotary drill bit: a main body; a plurality of supporting members pivotally mounted on said body; a mandrel connectible directly to a drill string and slidably splined to said body; cutters mounted on said supporting members; a thrust member slidable along said mandrel; links interconnecting said thrust member and sup-

porting members to swing said supporting members and cutters laterally outward upon longitudinal movement of said thrust member in one direction along said body; means for moving said thrust member longitudinally along said body in said one direction; and means on said mandrel engageable with said thrust member to limit return movement of said thrust member in the opposite longitudinal direction.

6. In a rotary drill bit: a main body; a plurality of supporting members pivotally mounted on said body and depending from their pivotal axes; a mandrel connectible directly to a drill string and slidably splined to said body; cutters mounted on the lower ends of said supporting members; a thrust member slidable along said mandrel; links interconnecting said thrust member and supporing members, said links being connected to said supporting members between their pivotal axes and the cutters; and means on said mandrel for moving said thrust member downwardly relative to said body to swing said supporting members and cutters outwardly.

7. In a rotary drill bit: a main body; a plurality of supporting members pivotally mounted on said body and depending from their pivotal axes; a mandrel connectible directly to a drill string and slidably splined to said body; cutters mounted on the lower ends of said supporting members; a thrust member slidable along said mandrel; links interconnecting said thrust member and supporting members, said links being connected to said supporting members between their pivotal axes and the cutters; means on said mandrel for moving said thrust member downwardly relative to said body to swing said supporting members and cutters outwardly; and means on said body engageable with said mandrel to limit downward movement of said mandrel with respect to said body.

8. In a rotary drill bit: a main body; a plurality of supporting members pivotally mounted on said body and depending from their pivotal axes; a mandrel having an abutment and connectible directly to a drill string and slidably splined to said body; cutters mounted on the lower ends of said supporting members; a thrust member slidable along said mandrel; links interconnecting said thrust member and supporting members, said links being connected to said supporting members between their pivotal axes and the cutters; and a spring engaging said abutment and said thrust member for moving said thrust member downward relative to said body to swing said supporting members and cutters outwardly.

9. In a rotary drill bit: a main body; a plurality of supporting members pivotally mounted on said body and depending from their pivotal axes; a mandrel connectible directly to a drill string and slidably splined to said body; cutters mounted on the lower ends of said supporting members; a thrust member slidable along said mandrel; links interconnecting said thrust member and supporting members, said links being connected to said supporting members between their pivotal axes and the cutters; means for moving said thrust member downwardly along said body to swing said supporting members and cutters laterally outward; and an inverted cup-shaped member secured to said mandrel and engageable with said thrust member to prevent upward movement of said thrust member relative to said body.

10. In a rotary drill bit: a main body; a plurality of supporting members pivotally mounted on said body and depending from their pivotal axes; a mandrel connectible to a drill string and slidably splined to said body; cutters mounted on the lower ends of said supporting members; a thrust member slidable along said mandrel; links interconnecting said thrust member and supporting members, said links being connected to said supporting members between their pivotal axes and the cutters; an inverted cup-shaped member secured to said mandrel and engageable with said thrust member to prevent upward movement of said thrust member relative to said body; and a spring within said cup-shaped member engaging said thrust member for shifting said thrust member downwardly relative to said body to swing said supporting members and cutters outwardly.

11. In a rotary drill bit: a main body; a supporting member pivotally mounted on said body; a mandrel connectible directly to a drill string and slidably splined to said body; a cutter mounted on said supporting member; means movable longitudinally relative to said mandrel and connected to said supporting member for expanding said supporting member and cutter outwardly; means for moving said movable means longitudinally relative to said mandrel; an abutment on said mandrel adjacent said longitudinally movable means; said mandrel being movable longitudinally with respect to said body to locate said abutment in a position to engage said longitudinally movable means to limit retraction of said longitudinally movable means, whereby said cutter is held in its outwardly expanded position.

12. In a rotary drill bit: a main body; a supporting member pivotally mounted on said body; a mandrel having an abutment thereon and connectible directly to a drill string and slidably splined to said body; a cutter mounted on said supporting member; a thrust member slidable along said mandrel; a link interconnecting said thrust member and supporting member; and means for shifting said thrust member along said mandrel, in order to expand said supporting member and cutter laterally outward, said means including spring instrumentalities engaging said thrust member.

13. In a rotary drill bit: a main body; a plurality of supporting members pivotally mounted on said body; a mandrel connectible directly to a drill string and slidably splined to said body; cutters mounted on said supporting members; a thrust member slidable along said mandrel; links interconnecting said thrust member and supporting members to swing said supporting members and cutters laterally outward upon longitudinal movement of said thrust member in one direction along said body; means on said mandrel engageable with said thrust member to shift said thrust member in said one direction along said body; and means on said mandrel engageable with said thrust member to limit return movement of said thrust member in the opposite longitudinal direction.

14. In a rotary drill bit: a main body; a supporting member pivotally mounted on said body; a mandrel connectible directly to a drill string and slidably splined to said body; a cutter mounted on said supporting member; means movable downwardly along said body and operatively connected to said supporting member for expanding said supporting member and cutter outwardly; an abutment on said mandrel above said downwardly movable means; means engage-

able with said movable means for moving said movable means downwardly of said body; said mandrel being movable downwardly along said body to locate said abutment in a position to engage said downwardly movable means to limit retraction of said downwardly movable means, whereby the cutter is held in its outwardly expanded position.

ARCHER W. KAMMERER.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
274,740	Douglass	Mar. 27, 1883
987,266	Smith	Mar. 21, 1911
1,710,998	Rudkin	Apr. 30, 1924
1,731,732	Terrell	Oct. 15, 1929
1,737,960	Cramer	Dec. 3, 1929
2,169,502	Santiago	Aug. 15, 1939
2,481,781	Rawlinson, Sr.	Sept. 13, 1949