Oct. 6, 1953 A. W. KAMMERER 2,654,576

EXPANSIBLE ROTARY DRILL BIT

Filed Aug. 18, 1950 2 Sheets-Sheet 1

Fig. 1.

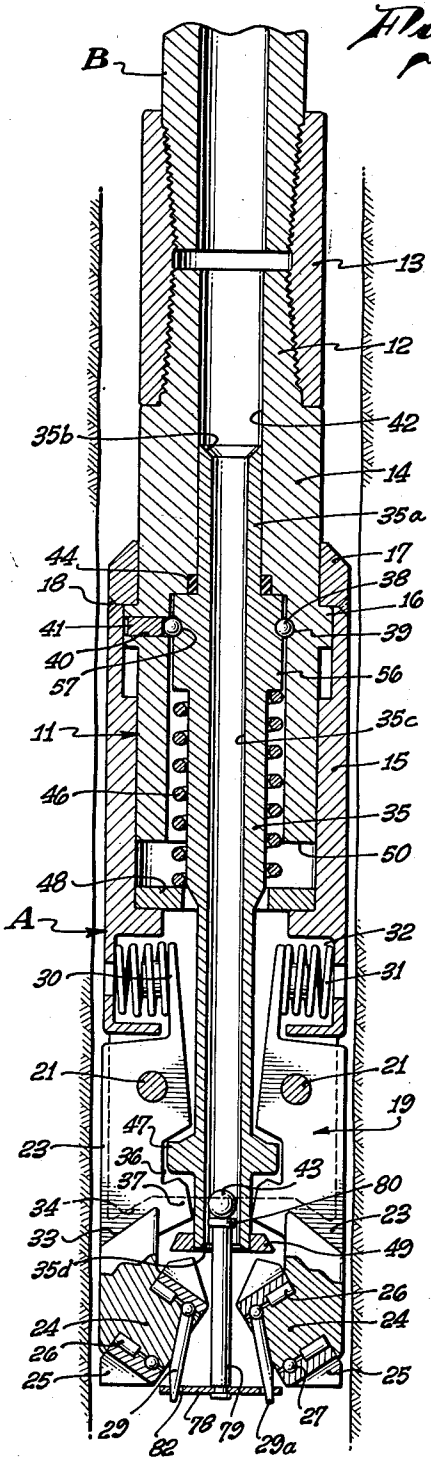
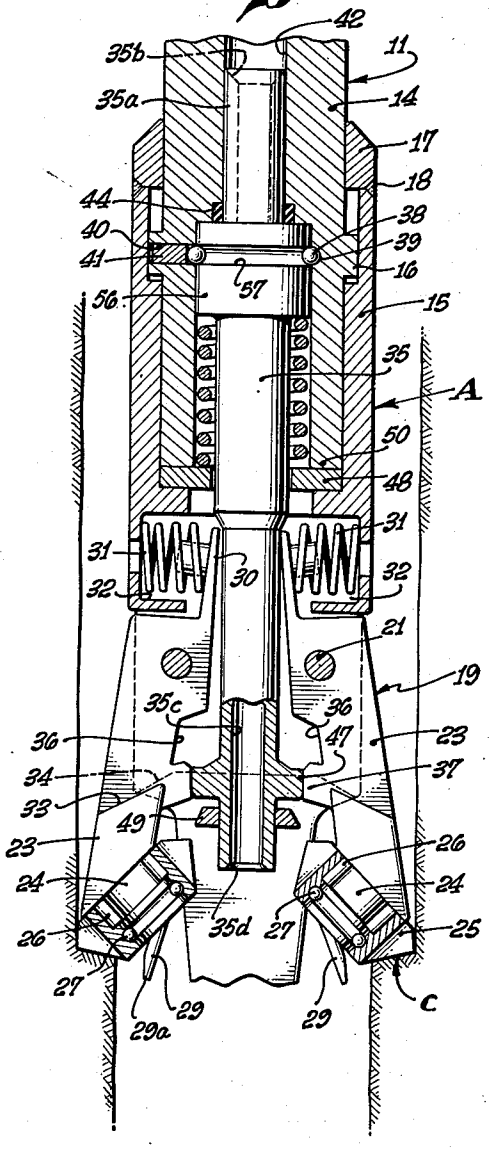


Fig. 2.



ARCHER W. KAMMERER,
INVENTOR.

BY

Bernard Kriegel
ATTORNEY.

Oct. 6, 1953 A. W. KAMMERER 2,654,576

EXPANSIBLE ROTARY DRILL BIT

Filed Aug. 18, 1950 2 Sheets-Sheet 2

Fig. 3.

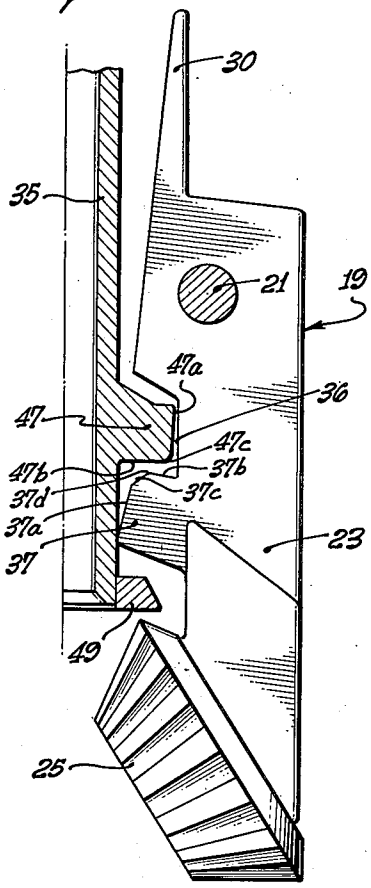
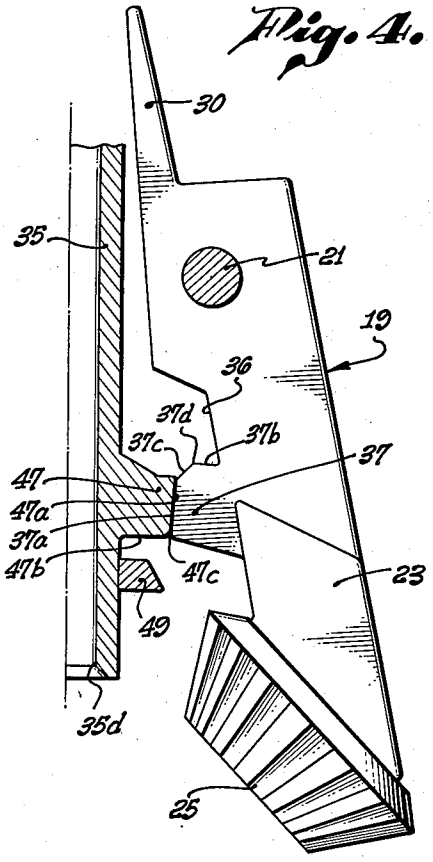


Fig. 4.



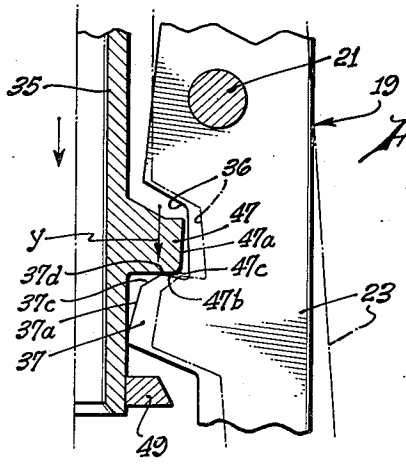


Fig. 5.

ARCHER W. KAMMERER,
INVENTOR.

BY
Bernard Kriegel
ATTORNEY.

Patented Oct. 6, 1953

2,654,576

UNITED STATES PATENT OFFICE

2,654,576

EXPANSIBLE ROTARY DRILL BIT

Archer W. Kammerer, Fullerton, Calif.

Application August 18, 1950, Serial No. 180,168

9 Claims. (Cl. 255—76)

1

The present invention relates to rotary drill bits, and more particularly to rotary drill bits of the type embodying cutters that are shiftable between retracted and expanded positions, to drill a hole below a casing string larger in diameter than the inside diameter of the casing string through which the bit is lowered.

In my prior Patent 2,466,991, a rotary drill bit is disclosed having cutters that are expanded outwardly to their full enlarged drilling diameter before any drilling weight is imposed on the cutters. After their expansion, a downward thrust on the drilling string locks the cutters in their outward expanded position and prevents their retraction.

The type of lock device disclosed in the above patent may urge the cutters outwardly from retracted, or partially retracted, positions in the event drilling weight is imposed on the bit before the cutters have been expanded to their maximum position. The operator may not be advised of the fact that the cutters have not been moved to their maximum expanded position, since the wedging or expanding force imposed on the cutters would enable them to support the drilling weight. Accordingly, the lock device would be the instrumentality for expanding the cutters, which would result in the imposition of loads on such lock device that they preferably should not carry. Moreover, an undergauged hole might be produced along a certain length of the well bore.

In certain types of hole enlarging operations, such as the increasing of the well bore size along only a portion of its length, the cutters may be pulled upwardly into a relatively small diameter well bore portion, as would occur in the event the kelly at the top of the hole were to be removed from the drill string. Thereafter, upon reconnecting the drill pipe and kelly, and lowering of the drill string and bit, the lock device might tend to urge the cutters outwardly in the smaller diameter hole, merely as an incident of the lowering movement of the drill string for the purpose of relocating the bit back into the enlarged portion of the well bore. Such premature outward expansion of the cutters is not desired.

Accordingly, it is an object of the present invention to provide a lock device which does not tend to expand the cutters outwardly, at least until such cutters have been expanded to a substantial extent by some other means.

Another object of the invention is to provide a locking arrangement in an expansible rotary drill bit which will exert substantially no outward expansive force on the cutters until after

2

they have moved outwardly beyond a predetermined hole drilling diameter, but which can thereafter forcibly urge the cutters outwardly to their maximum hole drilling diameter.

A further object of the invention is to preclude any downward forces imposed on an expansible rotary drill bit by the drill string from urging the cutters outwardly, unless such cutters have previously been expanded beyond a certain hole drilling diameter; so as to offer assurance that the cutters would be resting upon a substantial formation shoulder in the well bore before any appreciable drilling weight can be imposed upon them. Because of the arrangement noted, the downward drilling weight would merely slide the entire tool down the hole without enlarging the latter, in the event that the cutters are in their substantially fully retracted position.

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 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 longitudinal section through an expansible rotary drill bit disposed within a well bore, with the parts of the drill bit in retracted position for lowering in the well bore;

Fig. 2 is a view similar to Fig. 1 of the drill bit, with its parts in their fully expanded position;

Fig. 3 is an enlarged somewhat diagrammatic view through the lock portion of the bit, with a cutter in fully retracted position;

Fig. 4 is a view similar to Fig. 3, illustrating the locking device preventing retraction of a cutter from its maximum outward expanded position;

Fig. 5 is a view similar to Fig. 3, illustrating the coaction between the lock device and the cutter device when the latter occupies intermediate positions between its fully retracted and fully expanded positions.

As shown in the drawings, the expansible rotary drill bit A is attached to a string of drill pipe B by means of which it is lowered in the well bore to the point at which enlargement of the bore hole is to commence. The bit is capable

of enlarging the bore hole by producing and operating upon a formation shoulder C, as hereinafter described.

The upper end of the bit consists of a driving mandrel 11 whose upper pin 12 is threadedly connected to a sub 13, forming the lower end of the drill pipe string B. This mandrel includes an upper kelly or drill stem member 14 slidably splined to the main body 15 of the bit in any suitable manner, such as disclosed in my Patent 2,466,991. The mandrel 14 has a limited range of longitudinal movement within the body, its upward movement being determined by engagement of an external shoulder 16 on the kelly with a retainer ring 17 suitably secured to the upper end of the body 15, as by the use of welding material 18.

The body 15 has a plurality of expansible parts mounted on it, comprising opposed cutter supporting members 19, 19 pivotally carried on pivot or hinge pins 21, 21 suitably secured to the body. Each cutter supporting member consists of a depending leg 23 having a bearing supporting pin 24 inclined inwardly and downwardly and on which is rotatably mounted a roller side cutter 25. Anti-friction roller and ball-bearing elements 26, 27 are preferably placed between each cutter 25 and bearing pin 24, the roller bearings 26 transmitting radial thrusts, and the ball bearings 27 both radial and axial thrusts.

Each cutter supporting member 19 also includes an upwardly extending arm 30 against which an elastic expander 31 bears. This expander is in the form of a compressed coil spring received within a retainer pocket 32 in the body 15, exerting its force against the arm 30 and tending to swing it inwardly and thus urge the cutter 25 on the other side of the fulcrum pin 21 in an outward direction. The extent of this outward movement is limited by engagement of stop shoulders 33, 33 on opposite sides of the cutter supporting member 19 with cooperable body stop shoulders 34, 34.

After each cutter 25 has been expanded outwardly by its cooperable expander spring 31 to the maximum extent, it can be locked in this position by a tubular member 35 of the mandrel 11, which is piloted in the kelly 14 and is provided with a lock portion 47. The latter is movable from an upper position in transverse alignment with inner supporting member recesses 36, permitting retraction of the cutters, to a lower position opposite lugs 37 formed on and projecting inwardly from the supporting member legs 23, preventing retraction of the cutters 25.

The tubular member 35 is connected in swivel fashion to the kelly 14 to permit relative arcuate or rotary movement therebetween. However, the kelly and tubular member are movable together for longitudinal movement in both directions. All this is accomplished by providing a shoulder 56 on the tubular member containing an external toroidal raceway 57 receiving bearing balls 38 that are also ridable in an opposed internal raceway 39 formed in the kelly 14. The balls 38 are insertable through a hole 40 extending through the kelly shoulder 16, and, after having been mounted in place within the raceways 57, 39, this hole can be closed by a suitable plug 41 which is prevented from moving out of the hole by the main body 15 of the bit.

The upper portion 35a of the tubular member 35 is piloted within the fluid passage 42 through the kelly 14, and has its end 35b flaring upwardly and outwardly to guide a ball 43, or corresponding element, into the central passage 35c through the tubular member 35. Fluid pumped down the drill string B will flow through the kelly pin 12 and into the central passage 35c. It is prevented from flowing around the exterior of the tubular member 35 by a suitable packing 44 disposed between the upper portion 35a of the tubular member and the kelly 14 adjacent the upper end of the tubular member shoulder 56.

The arrangement between the tubular member 35 and kelly 14 is such that both downward and upward movement is transmitted between the kelly 14 and tubular member 35 from one raceway 57 or 39, through the ball bearing elements 38, to the other raceway 39 or 57. In this manner, the kelly 14 and tubular member 35 are caused to move jointly in both longitudinal directions, but they are able to partake freely of relative movement therebetween.

The mandrel 11 is normally held in its upper position with respect to the main body 15 of the bit and the supporting members 19 by a helical retractor spring 46 encircling the tubular member 35, with its upper end engaging the mandrel shoulder 36 and its lower end engaging a spring seat 48 resting on the body 15. This spring seat 48 also serves as an upper bearing guide for the tubular mandrel member 35, whose lower end is slidable within a lower bearing guide 49 below the lugs 37, which is integral with or secured to the main body of the bit. The two guides 48, 49 form a spaced two-point support for the mandrel member 35 and assist it in resisting inward movement of the cutter legs 23 to retracted position during the reaming or cutting operation.

Circulating fluid can pass downwardly through the string of drill pipe B and through the tubular mandrel 11 for ejection from its lower discharge nozzle 35d and onto the cutters 25, to cleanse them of cuttings and flush the latter from the drilling area to the top of the well bore. This circulating fluid is also availed of to unlatch the cutter supporting members 19, in the event it is desired to hold them positively in retracted position.

The cutters may be retained initially in retracted positions against the expansive forces of the springs 31 by means of a trip device. This device includes a holding plate or member 78 secured to the lower end of a central rod 79, whose upper end projects into the tubular member passage 35c. A head 80 is secured to the upper end of the rod, which has substantial clearance therearound, in order to allow fluids to pass upwardly into the central passage 35c and into the drill string B. The holding member 78 has spaced holes 82 in its outer portion for receiving the lower ends 29a of ball bearing plugs or pins 29 which hold the cutter bearing balls 27 in operative position.

When the holding device 78 is disposed over the pins 29, the cutter supporting members 19 are prevented from expanding under the influence of the springs 31, thereby holding the cutters 25 in retracted position. It is to be noted that the pins 29 are inclined initially in a downward and outward direction, so as to prevent the holding member 78 and the rod 79 connected thereto from moving downwardly until purposely released, which downward movement would allow outward expansion of the cutters 25. Such release can occur as a result of fluid pressure acting downwardly on the ball 43, which can rest on the head 80.

During lowering of the cutting tool to the point

at which the reaming operation is to begin, the holding device 78, 79 retains the cutters 25 in retracted position. During this lowering operation, fluid may flow upwardly around the holding device rod 79 and around the head 80 into the tubular member passage 35c.

When the point in the well bore has been reached at which the reaming operation is to begin, the pumps at the top of the well bore are started and drilling fluid pumped down the drill string B. The ball is then forced down through the passage 35c onto the head 80. Since the diameter of the ball is preferably equal to the diameter of passage 35c, it substantially closes the passage to downward flow of fluids, which allows the pumps at the top of the well bore to exert a pressure on the fluid in the drill string B and tubular member. This pressure acts downwardly on the ball 76, which correspondingly exerts a downward force on the holding device 79, 78, shifting the latter in a downward direction off the pins 29, and the ball 76 and rod 79 completely out of the passage 35c. The pins 29 are thereby released, allowing the springs 31 to expand the cutters 25 outwardly, while at the same time the passage 35c is free from restrictions, which allows fluid to be pumped through its lower nozzle 35d onto the cutters.

In the operation of the device, the tool A is mounted on the lower end of the drill string B, with its parts held in retracted position by the latch or trip device 78, 79, as shown in Fig. 1. In this position of operation, the compressed retractor spring 46 holds the mandrel 11 and its kelly 14 in an upward position with respect to the body 15, as determined by engagement of the kelly shoulder 16 with the body retainer ring 17. With the mandrel in this position, its lock portion 47 is elevated above the lugs 37 on the cutter supporting members 19, being received within the inner recesses 36 in the supporting members, which permits the latter to be held inwardly against the action of the expander springs 31.

The tool is lowered through the well casing, and upon reaching the position in the well bore at which the drilling operation is to begin, the pumps are started at the surface of the well bore, the fluid under pressure in the drill string and bit A forcing the trip device 78 off the pins 29, releasing the cutter supporting members 19 for outward expansion under the influence of the springs 31.

The drill string B is then rotated to rotate the main bit body 15 through the splined kelly and body connection, the expander springs 31 forcing the arms 30 inwardly and the cutters 25 outwardly against the formation. Rotation is continued without moving the drill string longitudinally until the side cutters 25 enlarge the diameter of the hole to the maximum extent, as determined by the eventual abutting of the supporting member stop shoulders 33 with the companion body stop shoulders 34. Thereafter, the drill string is lowered to cause the formation shoulder C, produced in the well bore by the cutters 25 under the action of the expander springs 31, to support the cutter members 19 and body 15, and prevent their downward movement.

Since the body 15 cannot move downwardly, drilling weight imposed on the drilling string B shifts its connected mandrel 11 downwardly within the body 15 against the action of the retractor spring 46 until the lower end 50 of the kelly 14 engages the upper spring seat and guide 48. This downward movement also shifts the tubular member 35 downwardly, because of the interlocking ball thrust bearing 37, 38, 39, to position the mandrel or tubular member lock portion 47 opposite and in alignment with the lugs 37 on the inner portions of the cutter supporting members 19, providing a positive lock by preventing inward movement of the cutters. So long as down weight is imposed on the drill string B, and the cutters 25 rest on the formation shoulder C, the cutters are prevented from moving inwardly by engagement of their lugs 37 with the mandrel lock portion 47. It is also to be noted that further outward movement of the cutters beyond the predetermined maximum reaming diameter is prevented by contact between the supporting member shoulders 33 and the body shoulders 34, through which the drilling weight is transmitted to the roller cutters 25, thus relieving the hinge pins 21 of this load.

Drilling is continued by rotating the drill bit and imposing the proper drilling weight on the cutters to cause their removal of the formation material and reaming of the hole in a downward direction for the desired extent or length. When the drill bit is to be retracted and removed to the top of the well bore, all that need be done is elevate the drill string B, which moves the side cutters 25 above the formation shoulder C, and permits the retractor spring 46 to press downwardly on the body 15 and move it, together with the cutter supporting members 19, downwardly with respect to the mandrel 11. This action re-positions the mandrel lock portion 47 opposite the supporting member recesses 36 and above their lugs 37, because of the ball bearing coupling 38, permitting inward swinging of the cutters 25 and their supporting members 19 when the tool passes back into a well casing (not shown), upon elevation of the drill string B. The cutters 25 and their supporting members 19 will ride the wall of the casing during elevation of the string until the tool is removed from the top of the well bore.

As noted above, after the springs 31 have expanded the cutters 25 outwardly to their full hole enlarging position, the mandrel 11 can be lowered to dispose the lock portion 47 behind and in alignment with the cutter supporting member lugs 37. The outer surfaces 47*a* on the lock portion of the mandrel will engage the inner surfaces 37*a* on the lugs, to preclude retraction of the cutter supporting members 19 and their roller side cutters 25. These surfaces 47*a*, 37*a* are preferably flat, and may be substantially parallel to the axis of the drill bit. However, it is preferred that the outer lock or retainer surfaces 47*a* on the lock portion of the mandrel and companion inner surfaces 37*a* on the lugs 37, when the cutters are in their maximum outwardly expanded position, be inclined slightly to the vertical, converging toward the axis of the drill bit in a downward direction. Such slight tapering will result in a slight wedging action of the mandrel lock portion 47 within the cutter supporting members 19, and will tend to hold the retainer surfaces 47*a*, 37*a* snugly in engagement with one another, thereby avoiding play or looseness between the parts.

Before the springs 31 have expanded the cutters outwardly from their initial retracted positions to a substantial extent, any down weight or drilling weight imposed on the drilling string B and the mandrel 11 cannot have any effect

in urging the cutters outwardly. After the cutter latching device 78, 79 has been removed from its holding relation with respect to the cutter supporting members 19, the mandrel 11 can move downwardly. If the drill bit body 15, or the cutters 25 themselves, encounter sufficient resistance to downward movement, a downward force imposed on the drill string B and the mandrel 11 will overcome the force of the spring 46 and urge the tubular member 35 downwardly. However, the lock portion 47 of the tubular member will not, at this time, exert an outward expansive force on the cutter supporting members. This is due to the fact that the undersurface 47b of the lock portion 47 will not engage the supporting member lugs 37 in such a manner as to urge the supporting members 19 outwardly. As specifically disclosed, such undersurfaces 47b are substantially at right angles to the axis of the tubular member 35. Each lug 37 has an upper thrust surface 37b partly defining the supporting member recess 36, which intersects an expander surface 37c on the lug, that is tapered in a downward and inward direction, intersecting the thrust surface 37b on the lug, which extends from the expander surface. The thrust surface 37b on the lug is inclined to the horizontal in an inward and upward direction, forming an edge 37d along its line of intersection with the expander surface that will be engaged by the undersurface 47b of the mandrel lock 47, in the event that such undersurface is moved downwardly with the mandrel 11 prior to appreciable expansion of the cutter supporting members 19 and cutters 25 by the springs 31.

As illustrated in Fig. 3, the cutter supporting member 19 and its cutter 25 is disposed in a fully retracted position. When in this position, any downward movement of the mandrel 11 and its tubular member 35 will engage the undersurface 47b of the lock portion 47 with the upper edge 37d of the lug 37. The force transmitted between such engaging elements will be in the direction of the arrow Y, illustrated in Fig. 5, which is parallel to the axis of the bit, there being no outward horizontal thrust components tending to urge the cutter 25 outwardly. This relation of parts is shown in Fig. 5, in which the undersurface 47b of the lock portion of the tubular mandrel is engaging the cutter supporting member lug 37, illustrated in full lines.

Such line engagement between the undersurface 47b of the lock portion 47 and the lug 37 offers very little resistance to the outward expansion of the cutter supporting members 19 and the cutters 25 under the influence of the springs 31. As the drill string B and the drill bit are rotated, the springs 31 can still urge the arms 30 inwardly about the hinge pins 21 and the cutter legs 19 outwardly, the lugs 37 sliding, with little resistance, along the undersides 47b of the mandrel lock portion. The springs 31 will continue to urge the cutter supporting members 19 outwardly until they have been shifted to their maximum hole enlarging operative position, shown in Figs. 2 and 4. However, after the cutter supporting members and cutters have been expanded outwardly to a substantial extent (but not their maximum extent), wherein the cutters have formed a formation shoulder of appreciable lateral extent, downward force imposed on the drill string B and the mandrel 11 can be utilized to urge the cutters 25 outwardly to their maximum hole enlarging diameter. This is due to the location of the inclined expander surface 37c on each lug under the lower outer corner 47c of the lock portion of the mandrel, when the cutter supporting member 19 has been expanded outwardly to a comparatively large extent. The downward movement of the mandrel 11 will cause its lower corners 47c, which are preferably curved, to engage the inclined expander surfaces 37c, the downward force being transmitted to such surfaces 37c having an outwardly directed lateral thrust component urging the cutter supporting members 19 and their cutters 25 in an outward direction. Such outward movement will occur until the rounded corners 47c ride off the inclined expander surfaces 37c and allow the lock portion 47 of the mandrel to move downwardly within the lugs 37, with the retainer surfaces 47a in full bearing engagement with the inner retainer surfaces 37a of the lugs (Fig. 4).

It is, accordingly, apparent that a locking arrangement has been provided which has substantially no effect in shifting the cutters 25 outwardly from their initial retracted positions, until expansion under the influence of the springs 31 has taken place to a substantial extent, which is sufficient to insure their resting upon a formation shoulder well able to support the drilling weight imposed on the drill bit. After such shoulder is established, the lock portion 47 may assist the springs 31 in forcing the cutters laterally outward to their full extent, providing a positive expander arrangement for insuring that the cutters will be moved outwardly to their maximum hole enlarging diameter.

Thus, it is apparent that the lack of any appreciable expansion of the cutters from their initial retracted positions will not preclude downward movement of the drilling tool in a well bore. If the drill bit has been moved upwardly into a small diameter hole, in which the cutters 25 are substantially fully retracted, the bit can just as readily be moved downwardly through and out of such smaller diameter hole, without the tool hanging up. The downward movement under the conditions noted will not cause the lock portion 47 to force the cutters 25 outwardly, or to dig them into the formation. The only expansive force available is that supplied by the springs 31, and such force is usually insufficient to force the cutters appreciably into the wall of the hole in the absence of continued rotation of the drilling tool, with the cutters remaining in the same longitudinal location in the well bore. After the tool has been moved downwardly out of the small diameter hole portion, the springs 31 can readily shift the cutters in an outward direction, allowing the lock portion 47 to engage the expander surfaces 37c and urge the cutters outwardly to their full extent, in the event that they have not already been moved to such extent by the springs 31.

The inventor claims:

1. In a rotary well drilling bit: a main body; cutter means mounted on said body; a mandrel slidably splined to said body and adapted for connection to a drill string; means engaging said cutter means for expanding said cutter means laterally outward independently of movement of said mandrel along said body; retainer means on said mandrel movable in one longitudinal direction along said body into holding engagement with said cutter means for preventing inward movement of said cutter means from its outward expanded position; said retainer means and cutter means having portions contactable with each other, prior to full lateral outward movement of said cutter means, to preclude location of said

retainer means in holding engagement with said cutter means, said contactable portions, when in contact with each other, being positioned relative to each other such that the resultant force exerted between the portions extends in a direction parallel to the axis of said mandrel, whereby said contacting portions do not urge said cutter means outwardly.

2. In a rotary well drilling bit: a main body; cutter means mounted on said body and having an abutment member; means engaging said cutter means for expanding said cutter means laterally outward; a mandrel slidably splined to said body and adapted for connection to a drill string; a retainer member on said mandrel movable with said mandrel in one longitudinal direction along said body into holding engagement with said abutment member to prevent inward movement of said cutter means from its outward expanded position; said retainer member and abutment member having portions contactable with each other, prior to full lateral outward movement of said cutter means, to preclude location of said retainer member into holding engagement with said abutment member, said contactable portions, when in contact with each other, being positioned relative to each other such that the resultant force exerted between the portions extends in a direction parallel to the axis of said mandrel, whereby said contacting portions do not urge said cutter means outwardly.

3. In a rotary well drilling bit: a main body; cutter means mounted on said body and having an abutment member; means engaging said cutter means for expanding said cutter means laterally outward; a mandrel slidably splined to said body and adapted for connection to a drill string; a retainer member on said mandrel movable with said mandrel in one longitudinal direction along said body into holding engagement with said abutment member to prevent inward movement of said cutter means from its outward expanded position; said retainer member having a lower transverse surface substantially normal to the axis of said mandrel and engageable with an upper portion of said abutment member which is inclined in an inward and upward direction.

4. In a rotary well drilling bit: a main body; cutter means mounted on said body; a mandrel slidably splined to said body and adapted for connection to a drill string; means engaging said cutter means for expanding said cutter means laterally outward independently of movement of said mandrel along said body; retainer means on said mandrel movable in one longitudinal direction along said body into holding engagement with said cutter means for preventing inward movement of said cutter means from its outward expanded position; said retainer means and cutter means having portions contactable with each other, prior to full lateral outward movement of said cutter means, to preclude location of said retainer means in holding engagement with said cutter means, said contactable portions, when in contact with each other, being positioned relative to each other such that the resultant force exerted between the portions extends in a direction parallel to the axis of said mandrel, whereby said contacting portions do not urge said cutter means outwardly; said retainer means and cutter means having expander portions which are contactable with each other after partial lateral outward movement of said cutter means and prior to full lateral outward movement of said cutter means to urge said cutter means outwardly upon longitudinal movement of said retainer means along said body toward holding engagement with said cutter means; said expander portions being removed from the location of contact between said other contactable portions of said retainer means and cutter means.

5. In a rotary well drilling bit: a main body; cutter means mounted on said body and having an abutment member; means engaging said cutter means for expanding said cutter means laterally outward; a mandrel slidably splined to said body and adapted for connection to a drill string; a retainer member on said mandrel movable with said mandrel in one longitudinal direction along said body into holding engagement with said abutment member to prevent inward movement of said cutter means from its outward expanded position; said retainer member and abutment member having portions contactable with each other, prior to full lateral outward movement of said cutter means, to preclude location of said retainer member into holding engagement with said abutment member, said contactable portions, when in contact with each other, being positioned relative to each other such that the resultant force exerted between the portions extends in a direction parallel to the axis of said mandrel, whereby said contacting portions do not urge said cutter means outwardly; said members having coengaging expander portions removed from the location of contact between said contactable portions for urging said cutter means outwardly, said expander portions being engageable with each other only after said cutter means has been partially expanded.

6. In a rotary well drilling bit: a main body; cutter means mounted on said body and having an abutment member; means engaging said cutter means for expanding said cutter means laterally outward; a mandrel slidably splined to said body and adapted for connection to a drill string; a retainer member on said mandrel movable with said mandrel in one longitudinal direction along said body to place a longitudinal surface of said retainer member behind said abutment member to prevent inward movement of said cutter means from its full outward expanded position; said retainer member having a lower transverse surface substantially normal to the axis of said mandrel and engageable with an upper portion of said abutment member which is inclined in an inward and upward direction; said abutment member having an expander surface inclined in a downward and inward direction and leading away from the upper portion of said abutment member to be engaged by said retainer member to urge said cutter means outwardly when said cutter means has been partially expanded by said expander means.

7. In a rotary well drilling bit: a main body; cutter means mounted on said body and having an abutment member, said abutment member having an upper outer surface inclined in an inward and upward direction, as well as an expander surface extending from said upper surface and inclined in a downward and inward direction; means engaging said cutter means for expanding said cutter means laterally outward; a mandrel slidably splined to said body and adapted for connection to a drill string; a retainer member on said mandrel movable downwardly with said mandrel along said body to place a longitudinal surface of said retainer behind said abutment member to prevent inward

movement of said cutter means from its full outward expanded position; said retainer member having a lower transverse surface substantially normal to the axis of said mandrel and engageable with the intersection of said abutment surfaces when said cutter means is in substantially its fully retracted position; said retainer member having a portion between its longitudinal surface and transverse surface engageable with said expander surface to urge said cutter means outwardly, upon downward movement of said mandrel along said body, when said cutter means has been partially expanded by said expander means.

8. In a rotary well drilling bit: a main body; cutter means mounted on said body and having an abutment member provided with an upper edge; means engaging said cutter means for expanding said cutter means laterally outward; a mandrel slidably splined to said body and adapted for connection to a drill string; a retainer member on said mandrel movable with said mandrel in one longitudinal direction along said body into holding engagement with said abutment member to prevent inward movement of said cutter means from its outward expanded position; said retainer member having a lower transverse surface substantially normal to the axis of said mandrel and engageable in line contact with said upper edge of said abutment member, prior to disposition of said retainer member into holding engagement with said abutment member, to

transmit a resultant force between said members having substantially no lateral component tending to urge said cutter means outwardly.

9. In a rotary well drilling bit: a main body; cutter means mounted on said body and having an abutment member; means engaging said cutter means for expanding said cutter means laterally outward; a mandrel slidably splined to said body and adapted for connection to a drill string; a retainer member on said mandrel movable with said mandrel in one longitudinal direction along said body into holding engagement with said abutment member to prevent inward movement of said cutter means from its outward expanded position; one of said members having an edge and the other of said members having a transverse surface substantially normal to the axis of said mandrel and engageable in line contact with said edge, prior to disposition of said retainer member into holding engagement with said abutment member, to transmit a resultant force between said members having substantially no lateral component tending to urge said cutter means outwardly.

ARCHER W. KAMMERER.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
2,466,991	Kammerer	Apr. 12, 1949