Aug. 14, 1956 A. W. KAMMERER, JR 2,758,820

EXPANSIBLE ROTARY DRILL BITS

Filed Nov. 23, 1953 2 Sheets-Sheet 1

Fig. 1.

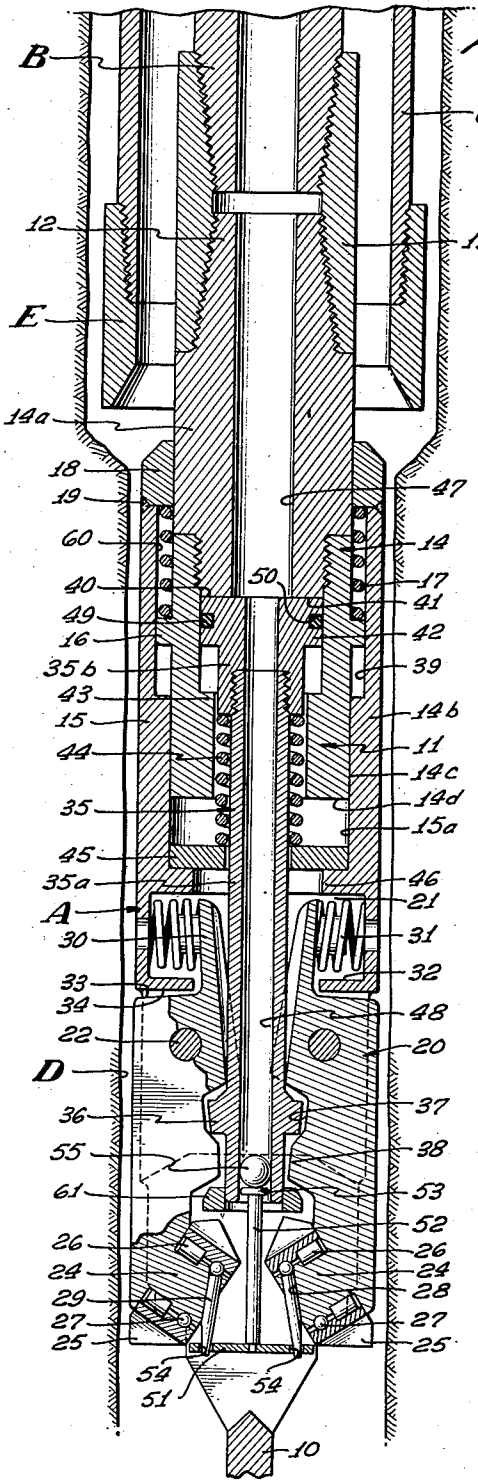
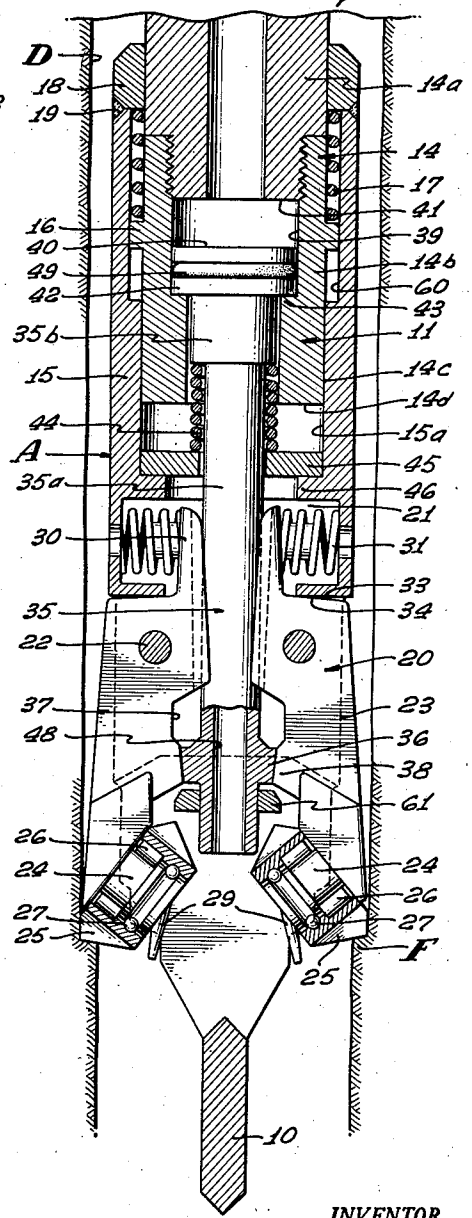


Fig. 2.



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

Aug. 14, 1956 A. W. KAMMERER, JR 2,758,820

EXPANSIBLE ROTARY DRILL BITS

Filed Nov. 23, 1953 2 Sheets-Sheet 2

Fig. 3.

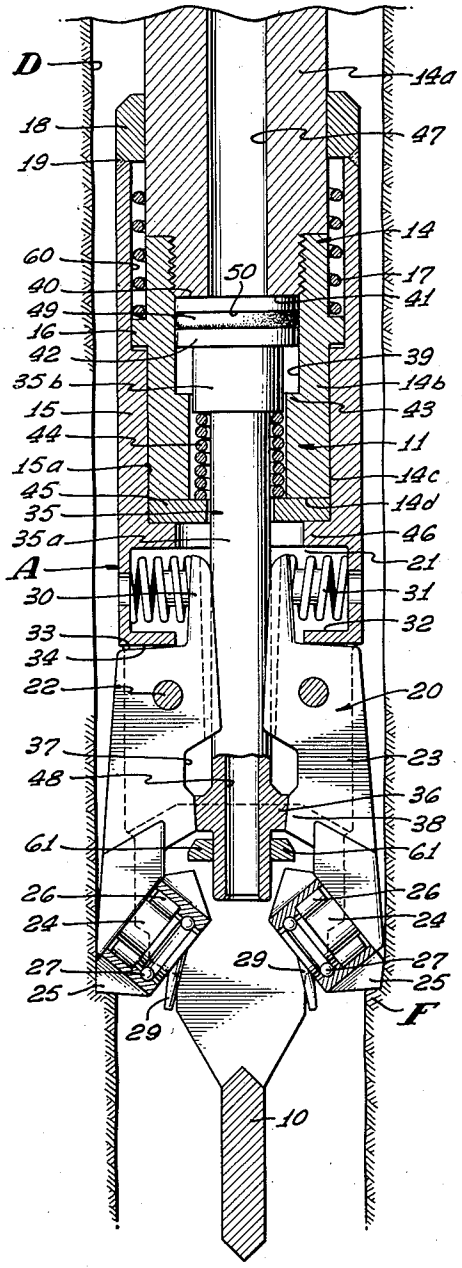
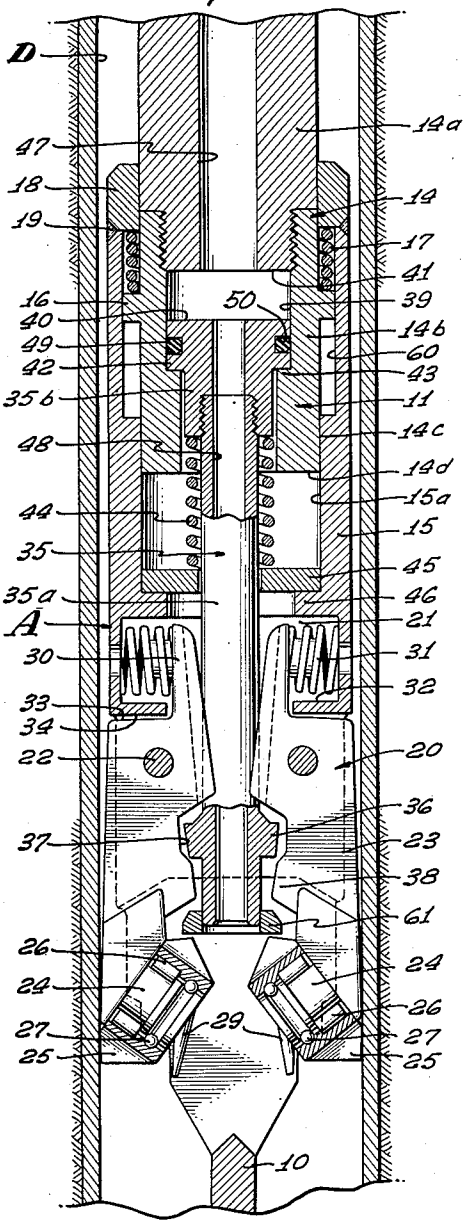


Fig. 4.



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

United States Patent Office 2,758,820
Patented Aug. 14, 1956

2,758,820

EXPANSIBLE ROTARY DRILL BITS

Archer W. Kammerer, Jr., Fullerton, Calif., assignor, by direct and mesne assignments, to Rotary Oil Tool Company, Huntington Park, Calif., a corporation of California

Application November 23, 1953, Serial No. 393,573

16 Claims. (Cl. 255—76)

The present invention relates to rotary drill bits, and more particularly to drill bits of the expansible type capable of enlarging the diameter of a well bore below a string of well casing disposed in the well bore.

Expansible drill bits are known in which the cutters are expanded laterally outward and locked in such expanded position through the medium of a mandrel telescopically arranged in the body of the drill bit. Usually, the mandrel moves down relative to the body to lock the cutters in an outward position. When the mandrel moves up relative to the body, the cutters are released and can be moved inwardly toward retracted position.

There are disadvantages to bits of the above type heretofore produced. A downward force must be maintained on the mandrel to hold it in its locked position for the purpose of securing the cutters in their expanded position. Elimination of this downward force, which may occur as a result of the cutters no longer engaging a formation shoulder, allows the body and cutters to move or drop down with respect to the mandrel, thereby, in effect, producing relative elevation of the mandrel in the body and shifting the mandrel to an unlocked position that could allow the cutters to retract, at least partially. It then becomes necessary to reshift the mandrel down in the body to again lock the cutters in their fully expanded position, but before this occurs, a length of undergauged hole might be drilled.

Accordingly, it is an object of the present invention to provide an improved expansible type of drill bit, in which the cutters are locked in their fully expanded position, despite the relieving of the cutters of drilling weight, such as occurs when the cutters are elevated above the formation shoulder on which they have been operating, or the cutters enter a cavity, or the like, in the bore hole. The cutters are locked hydraulically in their fully expanded position despite the removal of the drilling weight from the cutters or the absence of drilling weight on the cutters.

Another object of the invention is to provide an expansible type of drill bit in which the cutters are locked hydraulically in their expanded position, the cutters remaining locked in such expanded position so long as the drilling weight is being imposed upon them, and despite the relieving of the hydraulic locking force imposed thereon.

A further object of the invention is to provide an expansible type of drill bit in which the cutters can be locked in their outwardly expanded position either hydraulically or mechanically, or by both hydraulic and mechanical devices operating simultaneously.

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 embodiment of the invention disposed in a well bore, with the cutters and other parts in their initial retracted position;

Fig. 2 is a longitudinal section, similar to Fig. 1, disclosing the cutters locked hydraulically in their fully expanded position preparatory to the imposition of drilling weight on the cutters;

Fig. 3 is a longitudinal section, similar to Fig. 1, disclosing the cutters both mechanically and hydraulically locked in their fully expanded position;

Fig. 4 is a longitudinal section, similar to Fig. 1, disclosing the relationship and condition of the parts when the tool is being withdrawn through the well casing disposed in the well bore.

The expansible drill bit disclosed in the drawings is of the type shown in the patent to Archer W. Kammerer, Patent No. 2,545,036. The rotary drill bit A is attached to a string of drill pipe B, by means of which it is lowered through a well casing C in a well bore D to a point below the casing shoe E at which the diameter of the bore hole is to be enlarged. The drill bit may have a pilot bit **10** at its lower end for centering the tool in a hole that may have already been drilled, or for drilling the central portion of new hole in the absence of preexisting hole. The main portion of the bit is capable of enlarging the bore hole by producing and operating upon a formation shoulder F, as hereinafter described.

The bit A consists of a composite driving mandrel **11** having an upper pin **12** threadedly connected to a sub **13** forming the lower end of the drill pipe string B. This mandrel **11** includes an upper kelly or drill stem member **14** slidably splined to the main body **15** of the bit. As an example, a portion of the kelly **14** may have a non-circular or hexagonal exterior **14***c*, being telescopically received within a companion hexagonal internal socket **15***a* formed in the body **15**. The mandrel **11** has a limited range of longitudinal movement within the body **15**, its upward movement being limited by engagement of an external shoulder **16** on its kelly portion **14** with the lower end of a helical spring **17** encompassing the kelly portion, the upper end of which engages a retainer ring **18** on the body, which may be secured to the latter by the use of welding material **19**.

The body **15** has a plurality of expansible parts mounted on it, comprising cutter supporting members **20** pivotally mounted in body slots **21** on hinge pins **22** suitably welded to the body. Each cutter supporting member **20** consists of a depending leg **23** having a bearing supporting pin **24** inclined inwardly and downwardly, and on which a roller side cutter **25** is rotatably mounted. Anti-friction roller and ball bearing elements **26**, **27** are preferably placed between each cutter and bearing pin **24**, the roller bearings **26** transmitting radial thrust and the ball bearings **27** both radial and axial thrusts. The ball bearings **27** also retain each cutter **25** on a pin **24**, being inserted and placed in a passage **28** of the bearing support, which is then closed by a plug **29** welded to the pin **24**. The plug or pin **29** depends from the passage **28** and is used to hold the cutters **25** in retracted position, as explained below.

Each cutter supporting member **20** also includes an upwardly extending arm **30** against which an elastic expander **31** bears. This expander, in the form of a compressed coil spring, is received within a retainer pocket **32** in the body **15** and exerts its force against the arm **30**, tending to swing it inwardly and thus urge the cutter **25**, on the other side of the fulcrum pin **22**, in an outward direction. The extent of this outward movement is limited by engagement of a suitable stop shoulder **33** on the cutter supporting member **20** with a cooperable stop portion **34** on the body.

After the cutters 25 have been expanded outwardly by the expander springs 31 to their maximum extent, they can be locked in this position by a lower tubular member 35 of the composite mandrel 11, the upper end of which is telescopically arranged within the kelly 14. The tubular member is provided with a lock portion 36 movable from an upper position in transverse alignment with inner supporting member recesses 37, that allow retraction of the cutters 25, to a lower position opposite lugs 38 formed on and projecting inwardly from the cutter supporting legs 23, which prevents retraction of the cutters.

The tubular member 35 extends centrally of the tool, its lower portion 35*a* being threaded into an upper portion 35*b* which is constituted by a piston slidable within a cylinder 39 formed in the kelly 14. As disclosed, the kelly is made of two portions, one of which is an upper portion 14*a* threaded into a lower portion 14*b*, in which the cylinder 39 is provided. The upper end 40 of the piston 35*b* is movable with respect to the kelly 14 into engagement with the lower end 41 of the upper kelly portion 14*a*, whereas a lower shoulder 42 on the piston is movable downwardly with respect to the kelly cylinder 39 into engagement with an inwardly directed release shoulder 43 formed on the lower kelly portion 14*b*, and which is spaced longitudinally from the lower end 41 of the upper kelly portion 14*a* by an amount substantially greater than the length of the piston 35*b* which engages the cylinder wall 39, to allow relative longitudinal movement to take place between the tubular member portion 35 of the mandrel 11 and the kelly portion 14.

The yieldable spring 17 surrounding the kelly 14 and bearing upon its flange 16 causes the body 15 of the drill bit, as well as the cutters 25, supporting members 20, and other parts mounted thereon, to be yieldably supported by the kelly 14 in an upward position. A helical return spring 44 encompasses the tubular member 35, its upper end bearing upon the lower end of the piston 35*b* and its lower end bearing upon a thrust washer and spring seat 45 supported on an internal body shoulder 46. This return spring 44 normally urges the tubular member 35 in an upward direction, to locate its lock portion 36 in alignment with the supporting member recesses 37, which will enable the cutters 25 and their supporting members 20 to remain or be shifted to a retracted position. When the return spring 44 is supporting the tubular member 35 and its piston 35*b* in an upward position, the lower shoulder portion 42 of the piston is disposed a substantial distance above the release shoulder 43 on the kelly (as in Fig. 1).

The upper portion 14*a* of the kelly has a central passage 47 therethrough communicating with the cylinder 39 and which is in alignment with a central passage 48 extending completely through the tubular member 35 and its piston 35*b*. The piston passage 48 is of a comparatively restricted diameter with respect to the diameter of the kelly passage 47, so that a back pressure can be built up in the kelly passage above the piston when fluid is being pumped through the apparatus, which pressure is sufficient to move the piston 35*b* in a downward direction with respect to the body 15 and against the action of the compression spring 44, to shift the tubular member 35 downwardly and thereby place its lock portion 36 opposite the lugs 38 of the supporting members 20, to hold the cutters 25 in their outwardly expanded position. Fluid leakage between the piston 35*b* and the cylinder 39 is prevented by providing a suitable piston ring 49, such as a rubber O ring, in a peripheral groove 50 in the piston which sealingly and slidably engages the wall of the kelly cylinder 39.

When the mandrel 11 and its tubular member 35 are disposed in an upward position relative to the body 15, to place the lock portion 36 opposite the cutter supporting recesses 37, the cutters 25 and their supporting members 20 may be retained in their inward retracted position against the force exerted by the springs 31. The holding device accomplishing this purpose includes a holding member 51 secured to the lower end of a central rod 52 whose upper end projects into the tubular member passage 48. A head 53 is secured to the upper end of the rod 52, having substantial clearance in the passage 48 to allow fluid to pass upwardly into the central passages 48, 47 and the drill string B. The holding member 51 has spaced holes 54 in its outer portions for receiving the lower ends of the ball bearing plugs 29.

When the holding device 51 is disposed over the plugs 29, as disclosed in Fig. 1, the cutter supporting members 20 are prevented from expanding under the influence of the springs 31, thereby holding the cutters 25 in retracted position. Release of the holding member 51 from the plugs 29 occurs as a result of dropping a ball 55 in the tubular string B which will gravitate through the latter and through the kelly passage 47 and tubular member passage 48 into engagement with the head 53, the ball having substantially the same diameter as the tubular member passage diameter, to allow fluid pressure to be built up thereabove. When fluid pressure is supplied to the fluid in the drill pipe B and the mandrel passages 47, 48, the ball 55, rod 52 and holding member 51 are shifted downwardly, to free the latter from the plugs 29 and allow the springs 31 to move the arms 30 inwardly and the cutters 25 outwardly. The drill pipe B and the drill bit A are rotated, the springs 31 urging the cutters 25 outwardly until they are in their fully expanded position and have produced a formation shoulder F in the wall of the well bore D. Thereafter, the mandrel 11 may be moved downwardly within the body 15, which will place the lock portion 36 of the tubular member 35 behind the supporting member lugs 38, to positively hold the cutters 25 in their outward position. Such locked position is secured since the downward movement of the kelly 14 within the body causes the lower end 41 of the upper kelly section 14*a* to engage the upper end 40 of the piston 35*b* and move the piston and tubular member 35 in a downward direction. The engagement of the cutters 25 upon the formation shoulder F resists downward movement of the body 15.

So long as downweight is being imposed upon the apparatus, the lock portion 36 will be held in its appropriate position behind the supporting member lugs 38. It is desired to retain the lock portion behind the lugs, despite the fact that the cutters 25 may be relieved of drilling weight.

After the release of the latching device 51 from the plugs 29, the drill pipe B and the apparatus A are rotated to drill away the formation shoulder F. During such rotation, fluid is pumped down through the drill pipe string B and through the passages 47, 48 in the apparatus, in order to carry the cuttings away from the drilling region and upwardly around the string of drill pipe to the top of the well bore. In view of the restricted passage 48 through the piston 35*b*, a back pressure is built up on the latter, urging it in a downward direction against the restoring force of the return spring 44 bearing upon the piston, this pressure tending to shift the tubular member 35 in a downward direction. Prior to outward expansion of the cutters 25 and their supporting members 20, the tubular member 35 cannot move downwardly since the lock portion 36 is engaging the upper ends of the lugs 38 (Fig. 1). However, once the springs 31 have expanded the cutters 25 outwardly to substantially their maximum hole enlarging position, the lock portion 36 can move downwardly behind the lugs 38. Accordingly, even before downweight has been imposed on the cutters, to telescope the kelly 14 within the body 15 of the tool, the fluid pressure acting upon the piston 35*b* will have shifted the tubular member 35 downwardly, to hold the lock portion 36 in its locking position behind the cutter supporting member lugs 38, such as disclosed in Fig. 2.

Downweight may now be imposed upon the drill string B, and the kelly portion 14 of the mandrel 11 attached thereto, to shift the kelly 14 downwardly within the body

15 to the extent allowed by engagement of the lower end 14*d* of the kelly portion 14*b* with the thrust washer and spring seat 45. At this time, the lower end 41 of the upper kelly portion 14*a* will again have been moved into engagement with the upper end 40 of the piston, or almost into engagement therewith (Fig. 3). As drilling proceeds and downweight is imposed on the apparatus, the drilling effort is being transmitted directly from the kelly portion 14 of the mandrel 11 to the body 15 of the tool, and from the latter through the engaging shoulders 34, 33 to the cutter supporting members 20 and cutters 25. The downward movement of the kelly 14 within the body 15 is permitted in view of the initial longitudinal distance which is allowed between the lower end of the kelly flange 16 and the lower end of the recess or counterbore 60 in the body in which the flange is positioned.

With the parts in the position just described (Fig. 3), the tubular member 35 of the mandrel 11 is being held with its locked portion 36 behind the supporting member lugs 38 by the hydraulic force of the drilling fluid acting upon the upper end of the piston 35*b*, and also by the mechanical action of the kelly 14 in engaging the piston 35*b* during the imposition of drilling weight on the cutters 25. If the fluid force were to be discontinued during the imposition of drilling weight on the cutters, the tubular member 35 would still be prevented from elevating itself with respect to the body 15, to move its lock portion 36 above the supporting member lugs 38, since the tubular member 35 is held positively in a downward direction by the kelly portion 14 of the mandrel bearing thereagainst, as disclosed in Fig. 3.

On the other hand, with the pumps continuing to force circulating fluid down through the drill pipe B and the apparatus A, the relieving of the drilling weight on the tool, as by elevating the tool to raise the cutters 25 above the shoulder F, would still result in the retention of the lock portion 36 in its locking position behind the supporting member lugs 38. The pump pressure would still be acting upon the piston 35*b*, to hold it in a downward and locking position, such as disclosed in Fig. 2. Accordingly, the cutters 25 cannot shift inwardly to a retracted position, despite the absence of drilling weight thereon. The cutters can only shift inwardly to their retracted position when the fluid pressure imposed on the piston 35*b* is no longer present and the kelly 14 has also been elevated within the body 15. This action will allow the return spring 44 to shift the piston and its tubular member or plungre 35 upwardly, to relocate the lock portion 36 in alignment with the supporting member recesses 37 and above the lugs 38.

In the operation of the equipment, the parts are originally arranged with respect to each other in the positions disclosed in Fig. 1, in which the latching device 51—54 holds the cutters 25 positively in retracted position. The apparatus is then lowered on the string of drill pipe B through the well casing C to the point in the well bore D therebelow at which the hole enlarging operation is to commence. The ball 55 may or may not be located in the apparatus during its lowering in the well bore. In any event, it is placed in the passage 48 and will come to rest upon the rod ahead 53. Fluid pressure is then imposed upon the fluid in the drill pipe and the drill pipe and the apparatus are rotated, the fluid pressure acting upon the ball 55 and ejecting the latching device 51—54 from the supporting member plugs 29, which then allows the expansion springs 31 to urge the supporting member arms 30 inwardly and the cutters 25 outwardly. During the rotation of the apparatus, the cutters 25 will commence operating upon the wall of the formation and will produce the formation shoulder F therewithin. During such rotation, drilling fluid may be pumped down the tubular string B through the tubular member passage 48, for the purpose of removing the cuttings from the well bore. This fluid acts upon the piston 35*b*, urging it in a downward direction against the action of the return spring 44. However, the piston cannot move substantially downward until the cutters 25 have been expanded outwardly to substantially their maximum extent, whereupon the fluid pressure acting on the piston will shift it downwardly of the body 15 and with respect to the kelly 14 until the lock portion 36 of the tubular member is disposed behind the lugs 38. As disclosed in Fig. 2, the extent of the downward movement of the piston 35*b* and its tubular member 35 may be limited by engagement of the lower shoulder 42 on the piston with the release shoulder 43 on the kelly, or it may be limited by engagement of the lower end of the lock portion 36 with a lower guide 61 secured to the body 15, and in which the lower end of the tubular member 35 is piloted.

After the formation shoulder F has been produced and the cutters 25 expanded outwardly to their full extent, rotation of the apparatus continues while fluid is being pumped therethrough, and the necessary downweight is imposed on the tool. The exertion of a downward force on the kelly 14 causes it to shift downwardly within the body 15 until its lower end 14*d* engages the thrust washer 45, which locates the lower end 41 of the upper kelly portion contiguous the upper end 40 of the piston 35*b*, effectively mechanically locking the tubular member 35 in its lower position, to retain its lock portion 36 behind the lugs 38. Accordingly, if the fluid pressure were discontinued at this time, the cutters 25 would still be held positively in their outward expanded position. Rotation of the apparatus continues while the required drilling weight is imposed on the cutters 25, to ream away the hole as downward movement of the apparatus in the well bore continues.

As stated above, if the drilling weight is discontinued from the cutters, as by elevating the drill string B and the kelly 14 within the body 15, the cutters will still be held in their outward locked position so long as fluid is being pumped down through the apparatus, this fluid pressure acting upon the piston 35*b* to hold it in its downward position with respect to the body. When it is desired to retrieve the apparatus A from the well bore, the tubular member 35 should be elevated within the body, to remove the lock portion 36 upwardly from its location behind the supporting member lugs 38. The upward movement of the kelly will raise it above the piston 35*b* and the discontinuance of the hydraulic pressure in the drill string and the apparatus will allow the return spring 44 to shift the piston and tubular member 35 back to the position disclosed in Fig. 1, in which the lock portion is disposed opposite the supporting member recesses 37. The apparatus can now be raised in the well bore until the cutter supporting members 20 engage the lower end of the shoe E. A further upward strain is then taken on the drill string B and kelly 14 attached thereto, which will cause the kelly to move upwardly to a further extent with respect to the body 15, compressing the stop spring and body support 17 and causing the casing shoe E to engage the outer surfaces of the cutter supporting legs 23 and shift the cutters 25 inwardly to a retracted position within the well casing C. The apparatus may now be elevated in the well casing to the top of the well bore and removed from the latter.

In the event the return spring 44 is incapable of shifting the piston 35*b* and its tubular member 35 in an upward direction to an unlocking position, after the fluid pressure within the apparatus has been relieved, the drill pipe B is elevated, to elevate the entire apparatus A, until the cutter supporting legs 23 reach a restricted diameter portion in the well bore D or engage the shoe E. When this occurs, a further upward pull can then be taken on the drill pipe and the kelly 14, the release shoulder 43 on the kelly engaging the lower shoulder 42 of the piston 35*b*, enabling the kelly to forcibly shift the tubular member 35 upwardly within the body 15 and elevate its lock portion 36 above the lugs 38, which will allow the cutters 25 to retract. Such upward movement of the kelly 14 in forcibly elevating the tubular member 35 and its piston

35*b* can occur, since the yieldable stop spring 17 can compress and will, therefore, allow the necessary relative upward movement of the kelly 14 and the tubular member 35 to take place with respect to the body 15.

It is, accordingly, apparent that an expansible rotary drill bit has been provided in which the cutters 25 are retained in their maximum expanded position, despite the relieving of drilling weight thereon. So long as the hydraulic force is being imposed upon the piston 35*b*, the lock portion 36 of the device will be held behind the lugs 38. Not only is the lock portion held behind the supporting member lugs hydraulically, but it is also held in that position mechanically and positively so long as drilling weight is being imposed upon the cutters 25. Thus, two separate devices are provided for locking the cutters in their maximum outwardly expanded position, one of which is the hydraulic device, and the other the mechanical device, either or both of which may be effective at any one time. When it is desired to retract the cutters, the lock device 36 is removed merely by relieving the cutters of drilling weight and by discontinuing the application of pump pressure on the piston 35*b*. If the discontinuance of the pump pressure does not effect a release of the lock device with the respect to the cutter supporting members, then such release can occur positively by the upward engagement of the kelly portion 43 of the mandrel 11 with the lower shoulder 42 of the piston.

The inventor claims:

1. A rotary well drilling bit, including a main body, cutter means mounted on said body for expansion laterally outward of said body, means for expanding and holding said cutter means laterally outward, said expanding and holding means comprising a mandrel having a connection for securing said mandrel directly to a drill string, said mandrel being slidably splined to said body, whereby torque is transmitted from said mandrel to said body, said mandrel being movable relatively downward of said body to hold said cutter means laterally outward, and hydraulically operable means responsive to the pressure of fluid in the drill string for urging said mandrel relatively downward in said body.

2. A rotary well drilling bit, including a main body, cutter means mounted on said body for expansion laterally outward of said body, means for expanding and holding said cutter means laterally outward, said expanding and holding means comprising a mandrel having a connection for securing said mandrel directly to a drill string, said mandrel being slidably splined to said body, whereby torque is transmitted from said mandrel to said body, said mandrel including a hydraulically operable portion movable downward of the body by the pressure of the fluid in the drill string into a position holding said cutter means laterally outward.

3. A rotary well drilling bit, including a main body, cutter means mounted on said body for expansion laterally outward of said body, means for expanding and holding said cutter means laterally outward, said expanding and holding means comprising a mandrel having a connection for securing said mandrel directly to a drill string, said mandrel being slidably splined to said body, whereby torque is transmitted from said mandrel to said body, said mandrel including a hydraulically operable portion movable downward of the body by the pressure of the fluid in the drill string into a position holding said cutter means laterally outward, said mandrel also including another portion movable downwardly of said body into a position adapted to engage said hydraulically operable portion to prevent retraction of said hydraulically operable portion from its holding position.

4. A rotary well drilling bit, including a main body, cutter means mounted on said body for expansion laterally outward of said body, means for expanding and holding said cutter means laterally outward, said expanding and holding means comprising a mandrel having a connection for securing said mandrel directly to a drill string, said mandrel being slidably splined to said body, whereby torque is transmitted from said mandrel to said body, said mandrel including a hydraulically operable portion movable downward of the body by the pressure of the fluid in the drill string into a position holding said cutter means laterally outward, said mandrel also including another portion movable downwardly of said body into a position adapted to engage said hydraulically operable portion to prevent retraction of said hydraulically operable portion from its holding position, and means on said another portion engageable with said hydraulically operable portion to retract said hydraulically operable portion from its holding position.

5. A rotary well drilling bit, including a main body, cutter means mounted on said body for expansion laterally outward of said body, means for expanding and holding said cutter means laterally outward, said expanding and holding means comprising a mandrel having a connection for securing said mandrel directly to a drill string, said mandrel being slidably splined to said body, whereby torque is transmitted from said mandrel to said body, said mandrel being movable relatively downward of said body to hold said cutter means laterally outward, hydraulically operable means responsive to the pressure of fluid in the drill string for urging said mandrel relatively downward in said body, and means for retracting said hydraulically operable means from its position holding said cutter means laterally outward.

6. A rotary well drilling bit, including a main body, cutter means mounted on said body, means engaging said cutter means for expanding said cutter means laterally outward of said body, a mandrel having a connection for securing said mandrel directly to a drill string, said mandrel being slidably splined to said body, whereby torque is transmitted from said mandrel to said body, said mandrel including a portion movable in one longitudinal direction relative to said body into engagement with said cutter means to prevent inward movement of said cutter means from its outwardly expanded position, and hydraulically operable means responsive to the pressure of fluid in the drill string for urging said portion in said one longitudinal direction.

7. A rotary well drilling bit, including a main body, cutter means mounted on said body, means engaging said cutter means for expanding said cutter means laterally outward of said body, a mandrel having a connection for securing said mandrel directly to a drill string, said mandrel being slidably splined to said body, whereby torque is transmitted from said mandrel to said body, said mandrel including a hydraulically operable portion movable downward of the body by the pressure of the fluid in the drill string into a position holding said cutter means laterally outward.

8. A rotary well drilling bit, including a main body, cutter means mounted on said body, means engaging said cutter means for expanding said cutter means laterally outward of said body, a mandrel having a connection for securing said mandrel directly to a drill string, said mandrel being slidably splined to said body, whereby torque is transmitted from said mandrel to said body, said mandrel including a hydraulically operable portion movable downward of the body by the pressure of the fluid in the drill string into a position holding said cutter means laterally outward, said mandrel also including another portion movable downwardly of said body into a position adapted to engage said hydraulically movable portion to prevent retraction of said hydraulically movable portion from its holding position.

9. A rotary well drilling bit, including a main body, cutter means mounted on said body, means engaging said cutter means for expanding said cutter means laterally outward of said body, a mandrel having a connection for securing said mandrel directly to a drill string, said mandrel being slidably splined to said body, whereby torque

is transmitted from said mandrel to said body, said mandrel including a hydraulically operable portion movable downward of the body by the pressure of the fluid in the drill string into a position holding said cutter means laterally outward, said mandrel also including another portion movable downwardly of said body into a position adapted to engage said hydraulically operable portion to prevent retraction of said hydraulically movable portion from its holding position, and means on said another portion engageable with said hydraulically movable portion to retract said hydraulically movable portion from its holding position.

10. A rotary well drilling bit, including a main body, cutter means mounted on said body, means engaging said cutter means for expanding said cutter means laterally outward of said body, a mandrel having a connection for securing said mandrel directly to a drill string, said mandrel being slidably splined to said body, whereby torque is transmitted from said mandrel to said body, said mandrel including a portion movable in one longitudinal direction relative to said body into engagement with said cutter means to prevent inward movement of said cutter means from its outwardly expanded position, hydraulically operable means responsive to the pressure of fluid in the drill string for urging said portion in said one longitudinal direction, and means for retracting said hydraulically operable means from its position holding said cutter means laterally outward.

11. A rotary well drilling bit, including a main body, cutter means mounted on said body, means engaging said cutter means for expanding said cutter means laterally outward of said body, a first member connectible to a drill string and slidably splined to said body, whereby torque is transmitted from said first member to said body, a second member telescoped within said first member and including fluid pressure actuated means movable by fluid pressure in the drill string longitudinally in one direction to shift said second member relative to said body into engagement with the cutter means to prevent inward movement of said cutter means from its outwardly expanded position, said first member being movable longitudinally in said one direction relative to said body into a position adapted to engage said second member to prevent retraction of said second member from its position preventing inward movement of said cutter means.

12. A rotary well drilling bit, including a main body, cutter means mounted on said body, means engaging said cutter means for expanding said cutter means laterally outward of said body, a first member connectible to a drill string and slidably splined to said body, whereby torque is transmitted from said first member to said body, a second member telescoped within said first member and including fluid pressure actuated means movable by fluid pressure in the drill string longitudinally in one direction to shift said second member relative to said body into engagement with the cutter means to prevent inward movement of said cutter means from its outwardly expanded position, said first member being movable longitudinally in said one direction relative to said body into a position adapted to engage said second member to prevent retraction of said second member from its position preventing inward movement of said cutter means, and means on said first member engaging said second member to retract said second member from said position upon longitudinal movement of said second member in the opposite direction relative to said body.

13. A rotary well drilling bit, including a main body, cutter means mounted on said body, means engaging said cutter means for expanding said cutter means laterally outward of said body, a first member connectible to a drill string and slidably splined to said body, whereby torque is transmitted from said first member to said body, a second member telescoped within said first member and including fluid pressure actuated means movable by fluid pressure in the drill string downwardly to shift said second member relative to said body into engagement with said cutter means to prevent inward movement of said cutter means from its outwardly expanded position, said first member being movable downwardly relative to said body into a position adapted to engage said second member to prevent elevation of said second member within said body from its position preventing inward movement of said cutter means.

14. A rotary well drilling bit, including a main body, cutter means mounted on said body, means engaging said cutter means for expanding said cutter means laterally outward of said body, a first member connectible to a drill string and slidably splined to said body, whereby torque is transmitted from said first member to said body, a second member telescoped within said first member and including fluid pressure actuated means movable by fluid pressure in the drill string downwardly to shift said second member relative to said body into engagement with said cutter means to prevent inward movement of said cutter means from its outwardly expanded position, said first member being movable downwardly relative to said body into a position adapted to engage said second member to prevent elevation of said second member within said body from its position preventing inward movement of said cutter means, and means on said first member engaging said second member to elevate and retract said second member from said position upon elevation of said first member relative to said body.

15. A rotary well drilling bit, including a main body, cutter means mounted on said body for expansion laterally outward of said body, means for expanding and holding said cutter means laterally outward, said expanding and holding means comprising a first member connectible to a drill string and slidably splined to said body, whereby torque is transmitted from said first member to said body, a second member telescoped within said first member and including fluid pressure actuated means movable by fluid pressure in the drill string downwardly to shift said second member relative to said body into engagement with said cutter means to prevent inward movement of said cutter means from its outwardly expanded position, said first member being movable downwardly relative to said body into a position adapted to engage said second member to prevent elevation of said second member within said body and its retraction from its position preventing inward movement of said cutter means.

16. A rotary well drilling bit, including a main body, cutter means mounted on said body for expansion laterally outward of said body, means for expanding and holding said cutter means laterally outward, said expanding and holding means comprising a first member connectible to a drill string and slidably splined to said body, whereby torque is transmitted from said first member to said body, a second member telescoped within said first member and including fluid pressure actuated means movable by fluid pressure in the drill string downwardly to shift said second member relative to said body into engagement with said cutter means to prevent inward movement of said cutter means from its outwardly expanded position, said first member being movable downwardly relative to said body into a position adapted to engage said second member to prevent elevation of said second member within said body and its retraction from its position preventing inward movement of said cutter means, and means on said first member engaging said second member to elevate and retract said second member from said position upon elevation of said first member relative to said body.

References Cited in the file of this patent

UNITED STATES PATENTS

1,786,484	Duda	Dec. 30, 1930
2,457,628	Baker	Dec. 28, 1948
2,602,642	Baker	July 8, 1952
2,654,576	Kammerer	Oct. 6, 1953