Aug. 21, 1962 A. W. KAMMERER ET AL 3,050,143

RETRIEVABLE WELL BORE DRILLING APPARATUS

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FIG. 1.

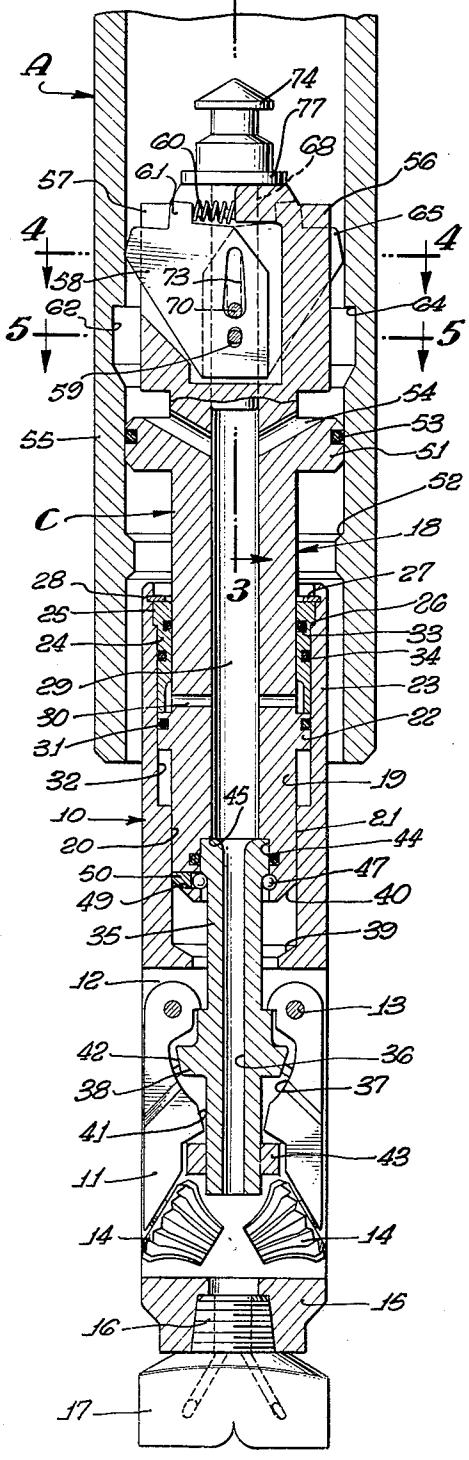
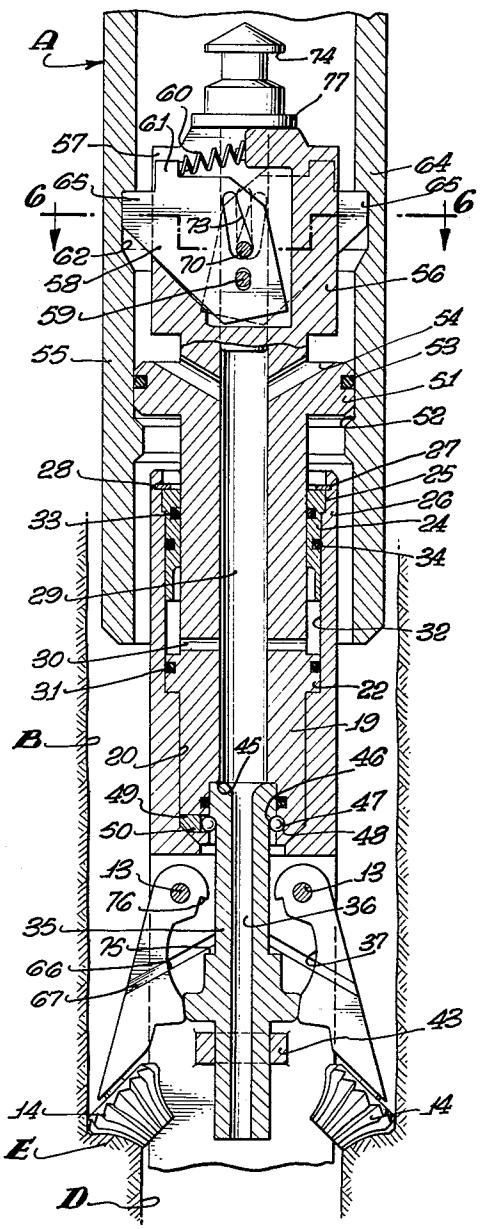



FIG. 2.




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FIG. 3.

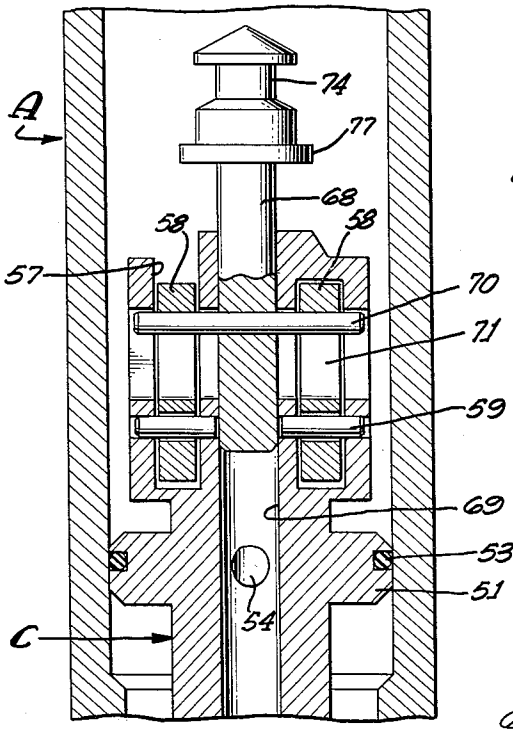



FIG. 4.

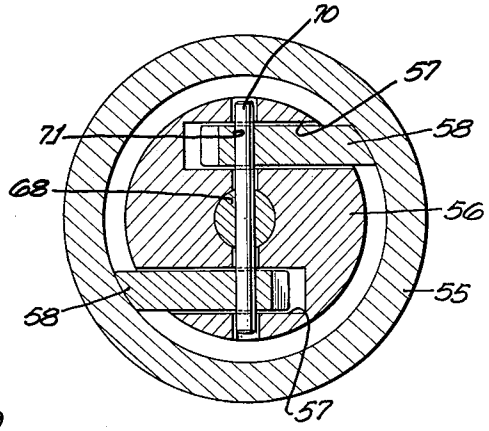



FIG. 5.

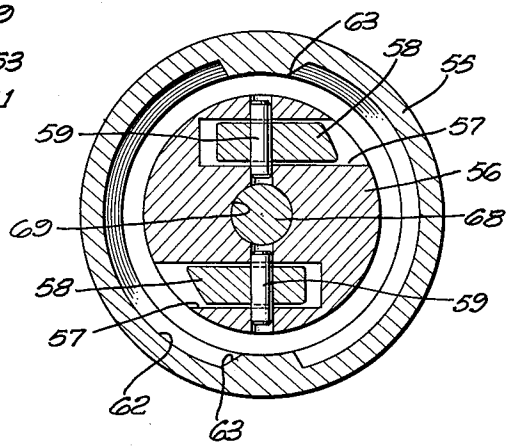
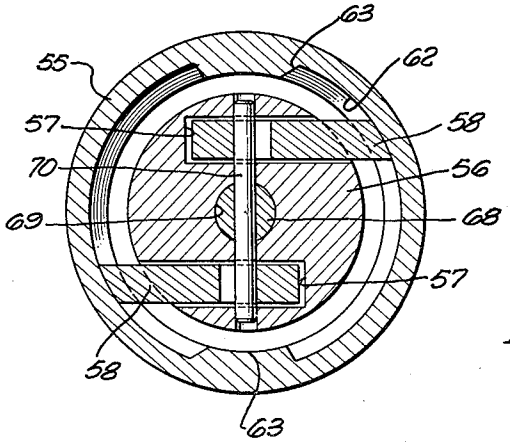



FIG. 6.




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RETRIEVABLE WELL BORE DRILLING APPARATUS

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FIG. 7.

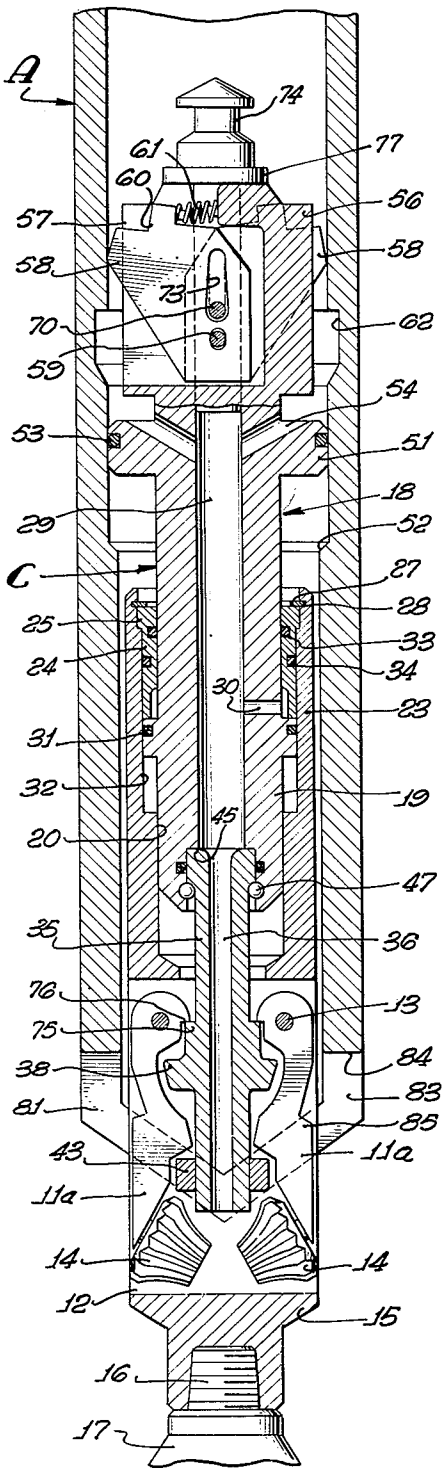
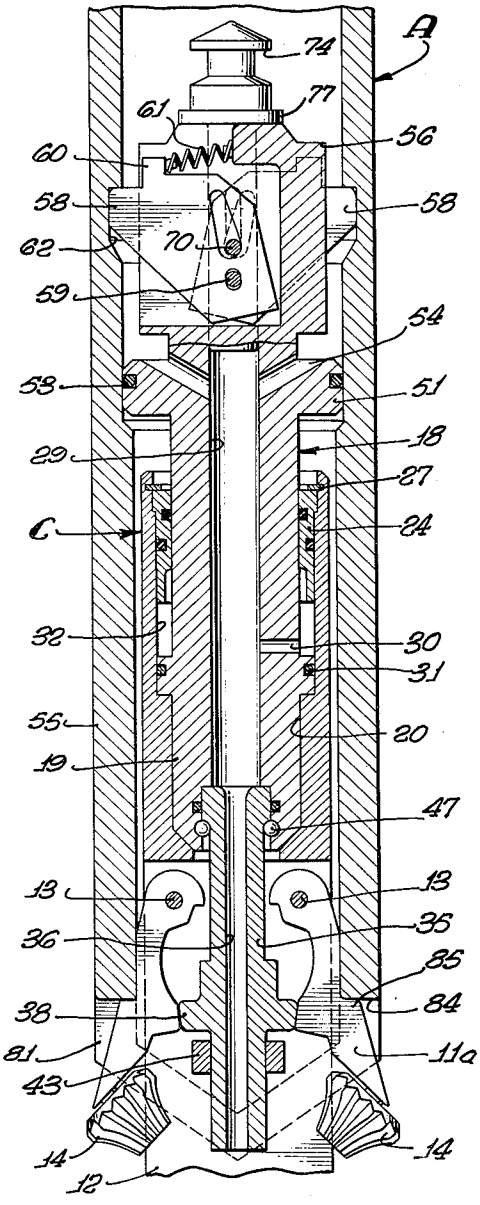



FIG. 8.




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RETRIEVABLE WELL BORE DRILLING APPARATUS

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FIG. 9.

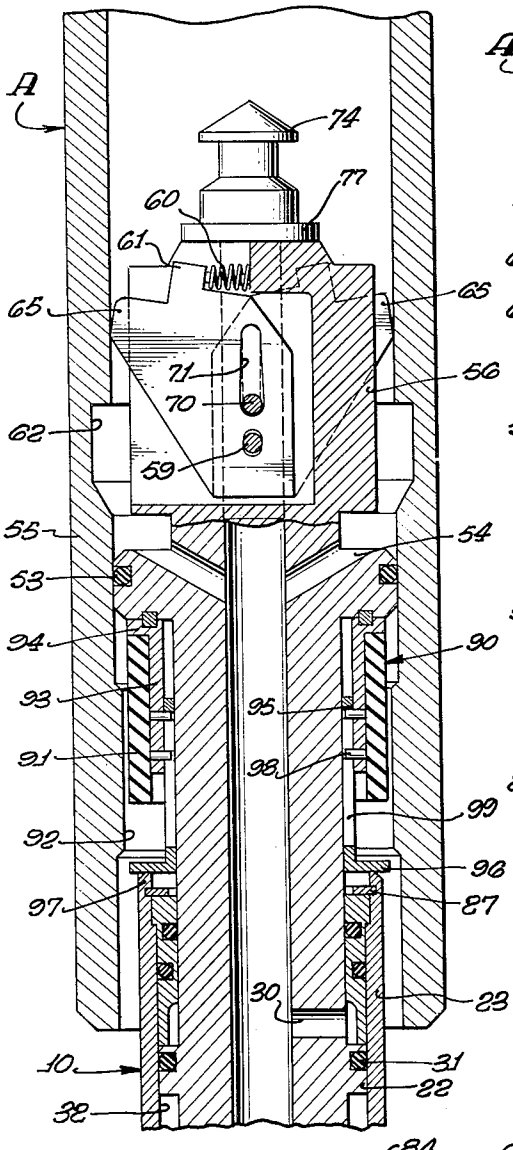



FIG. 10.

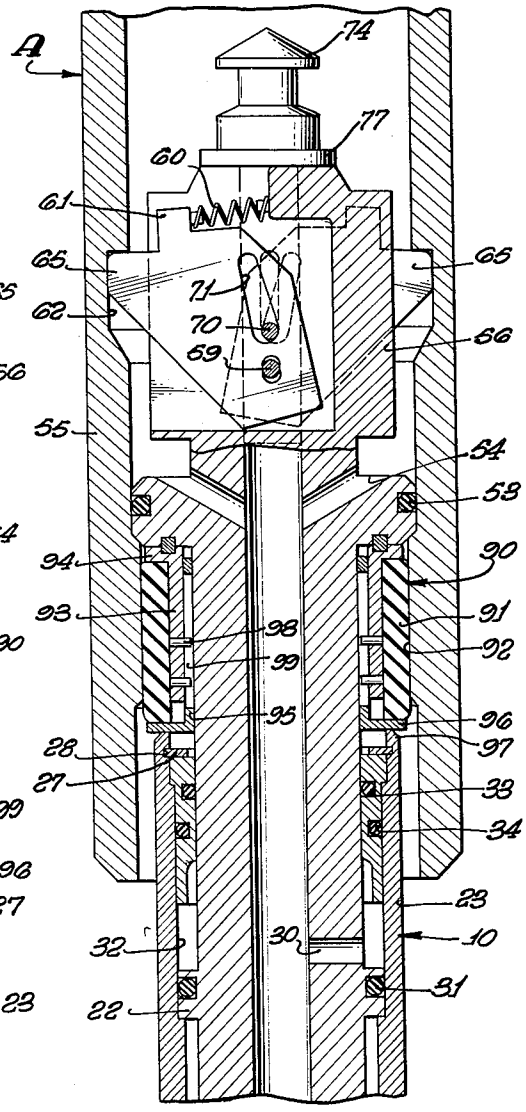
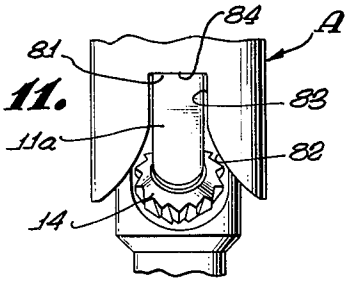



FIG. 11.




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United States Patent Office 3,050,143 Patented Aug. 21, 1962



3,050,143

# RETRIEVABLE WELL BORE DRILLING APPARATUS

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Filed July 6, 1959, Ser. No. 825,118
14 Claims. (Cl. 175—261)

The present invention relates to apparatus for drilling well bores by the rotary method.

Oil, gas, water, sulphur and similar well bores have been drilled through use of a drill bit attached to the lower end of a string of drill pipe. When a bit becomes dull, the drill pipe is removed from the well bore, another bit attached to its lower end, and the string of drill pipe relowered in the well bore. When the desired depth of hole has been produced, the drill pipe and drilling bit are removed, and casing or the like then lowered in the well bore to the desired depth and ordinarily cemented in place.

The frequent round trips required to change drill bits are time consuming and costly. In addition, potential damage to the well bore can occur due to pressures developed in the drilling mud as a result of raising and lowering the string of drill pipe. Moreover, there is the danger of encountering difficulty in lowering the casing in the drilled hole to the required depth, or in damaging the well formation during the lowering of the casing.

An object of the present invention is to provide hydraulically actuated drilling apparatus that avoids the necessity for repeated round trips of the drilling string to change drill bits, the apparatus being capable of lowering through the bore of a string of drill pipe that will form the ultimate casing for the well bore, of being readily coupled to the lower portion of the pipe, which is then rotated to accomplish the drilling of the hole, and of being released from the pipe and retrieved through its bore after the apparatus becomes dull, or is to be retrieved for any other reason.

Another object of the invention is to provide a retrievable drill bit capable of being lowered through a string of casing or similar pipe to its lower end, and of being rotationally coupled to such pipe, the drilling bit having cutters that are expandible outwardly hydraulically beyond the outside diameter of the pipe.

An additional object of the invention is to provide a retrievable drill bit having cutters expandible outwardly by fluid pressure, in which the drilling torque is transmitted directly from the string of pipe to the drill bit cutters, and in which the drilling weight is transmitted directly from the string of pipe to the cutters.

Still a further object of the invention is to provide a retrievable drill bit adapted to be run through and releasably attached to the lower end of a casing string or other pipe string, in which the bit cutters are expanded outwardly by fluid pressure and have a relatively large range of expansion to cut a hole diameter substantially greater than the outside diameter of the casing string, in order to provide adequate clearance around the exterior of the casing string for the circulation of drilling mud and the subsequent placement of cementitious material.

This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of several forms in which it may be embodied. Such forms are shown in the drawings accompanying and forming part of the present specification. These forms 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 a drill bit within and at the lower end of a string of casing or similar pipe, the apparatus being disposed in its retracted position for lowering the drilling bit through the well pipe;

FIG. 2 is a view similar to FIG. 1 illustrating the cutters of the drill bit expanded outwardly and the drill bit itself coupled to the string of casing or similar pipe;

FIG. 3 is an enlarged longitudinal section taken along the line 3—3 on FIG. 1;

FIG. 4 is an enlarged cross section taken along the line 4—4 on FIG. 1;

FIG. 5 is an enlarged cross section taken along the line 5—5 on FIG. 1;

FIG. 6 is an enlarged cross section taken along the line 6—6 on FIG. 2;

FIG. 7 is a view similar to FIG. 1 illustrating another embodiment of the invention;

FIG. 8 is a view similar to FIG. 7, with the drill bit cutters in the expanded position and coupled to the string of casing or similar pipe;

FIG. 9 is a longitudinal section through another embodiment of the invention, the drill bit being disposed in position for lowering through the well casing;

FIG. 10 is a view similar to FIG. 9, illustrating the drill bit coupled to the well casing and packed-off therewithin;

FIG. 11 is a side elevation of the cutter portion of the drill bit shown in FIGS. 7 and 8 coupled to the well casing.

The apparatus disclosed in the drawings includes the lower portion of a string of well casing A, or similar pipe, which extends to the top of the well bore B being drilled. The casing is rotated to transmit the drilling torque and the drilling weight to a retrievable drill bit portion C of the apparatus. The drill bit C is movable down through the string of casing A from the top of the hole B, and is releasably coupled to the lower portion of the casing, after which drilling of the well bore can proceed by rotating the string of casing and progressively moving it downwardly as the hole is produced. During the rotating operation, drilling mud or the like is pumped down through the interior of the casing A, discharging from its lower portion, or from the drill bit, to carry the cuttings upwardly around the string of casing to the top of the hole.

When the bit C becomes dull, it is released from the casing string and withdrawn through its interior to the top of the hole, whereupon the same drill bit with new cutters or another drill bit with sharp cutters is lowered through the casing and locked in place. When the new cutters become dull, the drill bit portion of the apparatus is again withdrawn through the interior of the casing string and the cutters replaced. This action is repeated as often as necessary in drilling the hole to the desired depth. It is to be noted that the casing A need never be withdrawn from the well bore B. In fact, after the hole has been drilled to the desired depth, the casing remains therein and may be cemented in place in substantially the same manner as casing strings have heretofore been cemented in a well bore.

As illustrated in FIGS. 1 to 6, inclusive, the drill bit C includes an elongate main body 10 having a plurality, such as a pair, of cutter supporting members 11 mounted in a body slot 12 on hinge pins 13 suitably secured to the body. A generally conical roller type of toothed cutter 14 is rotatably carried on the lower portion of each cutter arm

11 and initially occupies an inward or retracted position within the confines of the body 10. The lower portion of the body may be constituted as a threaded box 15 adapted to threadedly receive the upper pin end 16 of a lower pilot bit 17 which can drill the central portion D of the well bore. The cutters 14 are expandible outwardly, to enlarge the well bore drilled by the pilot bit 17 to a diameter substantially greater than the outside diameter of the string of drill casing A through which the drill bit is movable.

Outward expansion of the cutters 14 occurs as a result of relatively moving the body 10 upwardly along a mandrel 18 disposed within the body of the tool. The upper part or kelly 19 of the mandrel is slidably splined to the body 10, as by providing a non-circular bore 20 in the body receiving a companion portion 21 of the kelly. The exterior 21 of the kelly and the bore 20 of the body receiving such portion of the kelly may, for example, be hexagonal in shape.

The mandrel or kelly portion 19 has an outwardly directed piston 22 disposed within a cylinder 23 which constitutes the upper portion of the main body 10 of the drill bit. This cylinder has an upper cylinder head 24 secured thereto, the head having a flange 25 resting upon an upwardly facing shoulder 26 in the cylinder and being prevented from moving upwardly out of the cylinder by a suitable split snap retaining ring 27 overlying the upper end of the head and received within an internal groove 28 in the body or cylinder. Fluid under pressure within the mandrel passage 29 can pass through side ports 30 in the mandrel into the cylinder above the piston 22, acting in an upward direction on the cylinder head 24 to urge the body 10 upwardly along the mandrel 18. Leakage of fluid around the exterior of the piston 22 is prevented by a suitable side seal ring 31 mounted in the piston and slidably engaging the cylinder wall 32. Leakage of fluid around the interior and exterior of the cylinder head 24 is prevented by a suitable inner side seal 33 slidably and sealingly engaging the periphery of the kelly 19 and also by an outer side seal 34 engaging the cylinder wall 32.

The lower portion 35 of the mandrel 18 is constituted as a tubular member piloted upwardly within the lower end of the kelly portion 19 of the mandrel. The passage 36 through the tubular member has a lesser diameter than the passage 29 through the kelly portion of the tool, causing a back pressure to be built up in the latter which will pass through the ports 30 into the cylinder 23 and tend to elevate the body 10 of the tool relative to the mandrel. During such upward movement of the body 10 of the tool, tapered expander surfaces 37 on the cutter supporting arms 11 are moved upwardly along an expander 38 formed on the mandrel member 35, resulting in the supporting arms 11 and the cutters 14 mounted thereon being urged outwardly. When the body 10 has moved upwardly along the mandrel 18 to its fullest extent, as determined by engagement of an inwardly directed lower stop shoulder 39 on the body with the lower end 40 of the kelly, retainer surfaces 41 on the cutter supporting members or arms, which are located below the tapered expander surfaces 37, will engage the periphery 42 of the expander, which will then serve as a lock resisting and precluding inadvertent inward movement of the cutter supporting members 11 and the cutters 14 from their outwardly expanded position.

The lower portion of the mandrel member 35 below its expander and lock 38 is slidable through a guide 43 extending across the body slot 12; whereas the upper end of the tubular member 35 of the mandrel 18 is piloted within the lower socket or bore 44 of the kelly portion of the mandrel, to which it is swivelly secured so that the mandrel portions 19, 35, move longitudinally as a unit, but in which the lower tubular member 35 can turn arcuately (which need only be to a slight extent) with respect to the kelly portion 19 to facilitate proper operation of the apparatus. The tubular member 35 is retained in the upper mandrel portion 19 by a roller bearing device, the tubular member 35 engaging a downwardly facing shoulder 45 on the upper mandrel portion 19, there being an inner race 46 on the tubular member contacting a set of balls 47 that ride within an outer raceway 48 formed in the lower part of the kelly 19. The balls 47 may be inserted in the opposed raceways 46, 48 through a hole 49 that may then be closed by a suitable plug 50 welded to the kelly member.

When the drill bit portion C of the apparatus is lowered through the well casing A it can continue downwardly therethrough until a stop ring or flange 51 integral with the mandrel 18 engages a stop shoulder 52 on the casing or pipe A. This stop ring or flange has a side seal ring 53, such as a rubber or rubber-like O ring, mounted thereon and adapted to slidably seal against the wall of the casing to prevent fluid from passing around the stop flange 51. Instead, any fluid pumped down through the casing string A flows through inlet ports 54 in the kelly 19 and into the central passage 29 through the latter, continuing on downwardly through the tubular member passage 36 and discharging into the well bore B to carry the cuttings from the drilling region upwardly around the exterior of the well casing A to the top of the hole.

When the flange 51 engages the stop shoulder 52 in the casing, the upper mandrel member 19 becomes coupled to the lower portion or shoe 55 of the casing string. Above its stop flange 51, the upper mandrel member or kelly 19 is provided with a head 56 having slots 57 extending transversely thereof and receiving a pair of oppositely directed driving or coupling dogs 58 which are pivotally mounted on pins 59 secured to the head. Each dog or latch 58 is urged in an outward direction by a compression spring 60, one end of which engages the mandrel head 56 and the other end of which engages an upper lug 61 on the driving dog to urge its upper outer portion outwardly into a recess 62 in the casing shoe 55, with which the driving dogs become aligned when the stop ring 51 engages the stop shoulder 52. Companion dogs 63 are provided in this recess 62 integral with the casing shoe 55, which will engage the driving dogs 58 to transmit the rotational effort of the casing string A to the dogs, the latter engaging the sides of the mandrel slots 57 to rotate the mandrel 18, which has the slidable splined connection 21, 20 with the body 10 of the tool, thereby causing the tool body 10, the cutter supporting members 11 and the cutters 14 to rotate with the casing A.

Downward drilling weights are transferred from the casing A through its downwardly facing shoulders 64 defining the upper end of the casing recess 62, and which engages the upper ends 65 of the dogs 58. From the dogs the downward drilling weight is transmitted through the mandrel 18 and its lower end 40 to the body 10 of the tool, this downweight passing from the body, through the body stop shoulders 66 to the companion shoulders 67 on the cutter supporting members 11.

The mandrel 18 has a retrieving plunger 68 slidable in an upper mandrel bore 69, this retrieving plunger having a retrieving pin 70 secured thereto and extending through openings 71 in the driving dogs 58. When the dogs 58 swing outwardly into the casing recess 62, the retrieving pin 70 is disposed at the lower ends of the openings 71 and in a position to engage their inclined sides 73, such that upward movement of the retrieving plunger 68 within the mandrel 18 will cause the retrieving pin 70 to retract the dogs 58 from the casing recess 62. When the dogs 58 have been retracted, as by moving the plunger upwardly through use of a wire line and overshot (not shown) coupled to a retrieving head 74 on the upper end of the retrieving plunger, the mandrel is elevated by the wire line with respect to the body 10 of the tool, allowing the cutter supporting members 11 and cutters 14 to move inwardly. If such inward movement does not occur by gravity, then a retrieving shoulder 75 on the

tubular member 35 will engage the upper ends 76 of the cutter supporting arms and forcibly shift the cutter supporting members 11 and cutters 14 back within the confines of the body slot 12.

In the use of the apparatus illustrated in FIGS. 1 to 6, inclusive, the drill bit portion C has its parts initially occupying the relative positions illustrated in FIG. 1, in which the supporting members 11 and cutters 14 are in their inward position, the body 10 occupying its lowermost position along the mandrel 18 and the driving dogs 58 being held inwardly by the wall of the well casing A. The retrieving plunger 68 is disposed in its lowermost position within the mandrel 18, as determined by engagement of its flange 77 with the upper end of the mandrel head 56. The apparatus is lowered down through the string of well casing from the the top of the hole or may be pumped downwardly therethrough, the cutters 14 remaining in their retracted position. When the casing shoe 55 is reached, the lower pilot bit 17 and the cutter portions 11, 14 of the tool will extend below the lower shoe of the casing, the stop ring or flange 51 engaging the stop shoulder 52 on the shoe, which will then position the dogs 58 opposite the recess 62 and allow the springs 60 to shift the driving dogs outwardly thereinto. Drilling fluid, such as drilling mud, can now be pumped down the casing string A and the entire string of casing rotated, the rotational effort being transmitted from the casing shoe dogs 63 to the driving dogs 58 and from the latter through the mandrel 18 to the body 10 of the tool. The rotational effort is transmitted from the body 10 through the cutter supporting members 11 to the cutters 14. During such rotation the downward pumping of the drilling mud through the casing A, the mandrel ports 54 and the mandrel passage 29, 36 will cause a back pressure to build up in the latter which will act through the fluid in the ports 30 and in the cylinder 23 in an upward direction on the cylinder head 24, urging the latter upwardly and the expander surfaces 37 on the cutter supporting members 11 along the mandrel expander 38, which will face the cutters 14 outwardly. As they move outwardly, the body 10 is shifted further up along the mandrel to the extent limited by engagement of the body stop shoulder 39 with the lower end 40 of the mandrel kelly 19, at which time the cutters 14 are locked in their outwardly expanded position, such as shown in FIG. 2.

Drilling weight can now be imposed on the cutters 14, such drilling weight passing downwardly from the casing A through the driving dogs 58 to the mandrel 18, and from the lower end 40 of the mandrel to the body 10 of the tool. The extent of outward movement of the cutter supporting members 11 and cutters 14 is positively limited by engagement of side shoulders 67 on each cutter supporting member 11 with companion downwardly facing shoulders 66 on the body on opposite sides of the slot 12. The drilling weight is transferred through such shoulders to the cutter supporting members 11 and from the cutters 14 to the formation shoulder E on which the cutters 14 will roll during the rotation of the entire apparatus. The drilling fluid discharges from the lower end of the tubular member 35 and will carry the cuttings upwardly around the exterior of the casing to the top of the well bore. Of course, the central portion D of the well bore being drilled is produced by the pilot bit 17 secured to the expansible tool body 10.

When the drill bit apparatus is to be removed from the well casing, a suitable overshot (not shown) is lowered on a wire sand line (not shown), or the like, down through the casing A and will couple itself to the head 74 of the retrieving plunger 68, in a known manner. The taking of an upward pull on the wire line will move the plunger 68 upwardly, which will cause the retrieving pin 70 to engage the inclined sides 73 of the dogs 58, shifting the latter inwardly completely out of the recess 62 and within the confines of the normal cylindrical bore of the casing A. The retrieving pin 70 moves upwardly with the retrieving plunger 68 until the upper ends of the dog slots 71 are reached, whereupon the upward movement is transferred to the mandrel 18, which will be shifted upwardly within the main body 10 of the tool, until the mandrel piston 22 engages the cylinder head 24. Such upward movement of the mandrel within the body will dispose the mandrel expander 38 above the expander surfaces 37 of the cutter supporting members 11, allowing the latter to swing inwardly within the confines of the slot 12. The entire drill bit apparatus can now shift upwardly within the well casing A and be elevated to the top of the well bore for removal from the well casing A. The worn cutters are now replaced, or another drill bit with sharp cutters provided, and the different or reconditioned drill bit apparatus relowered through the well casing. When such drill bit again reaches the lower end 55 of the casing the stop ring or flange 51 will again engage the stop shoulder 52, positioning the driving dogs 58 opposite the coupling recess 62 in the casing. The casing can again be rotated and drilling mud pumped downwardly through the apparatus to produce the required pressure for expanding the cutters 14 outwardly to their fullest extent. Drilling weight can again be imposed on the casing, which will be transferred through the cutters 14 to the formation shoulder E on which the cutters operate.

Retrievable drill bits C are lowered within and elevated through the well casing A as often as required until the hole is drilled to the desired depth. When this occurs, the drill bit is retrieved from the well casing and the latter cemeted in place, if desired.

In the embodiment of invention illustrated in FIGS. 7, 8 and 11, the drilling torque and weight are transferred directly from the casing shoe 55 to the cutter supporting members 11*a*, rather than being transmitted through the mandrel 18 to the body of the tool 10 and thence to the cutter supporting members and cutters 14. When the drill bit is lowered through the well casing A, its stop flange 51 engages the stop shoulder 52 on the casing, at which time the cutter supporting members or arms 11*a* are disposed within and project below opposed downwardly opening slots 81 in the casing. The lower sides 82 of each slot diverge in a downward direction and the upper sides 83 of each slot are substantially parallel to one another, terminating at an upper shoulder 84 that lies in a plane substantially normal to the axis of the apparatus. As the pressure of the drilling fluid being pumped through the apparatus elevates the body 10 of the tool, the cutter supporting arms 11*a* also shift upwardly along the mandrel 18 and the well casing A. Such cutter supporting arms 11*a* will shift outwardly and engage the divergent sides 82 of the slots 81, the cutter supporting arms 11*a* being cammed by the slots toward the upper slot portions 83, the body 10 of the tool and mandrel 18, of course, also being turned within the casing. As the arms 11*a* are expanded, because of the hydraulic elevation of the body 10 along the mandrel 18 and of the expander surfaces 37 on the arms along the mandrel expander 38, the cutter arms shift outwardly to the fullest extent, at which time they will be disposed within the upper slot portions 83 and with upwardly facing shoulders 85 on the cutter supporting members 11*a* engaging the upper ends 84 of the casing slots. With the expanded cutters 14 engaging the transverse formation shoulder E, the drilling weight is transmitted directly from the casing A to the supporting member shoulders 85 and the supporting members 11*a*, causing the latter to urge the cutters 14 against the formation shoulder E. Similarly, the drilling torque is transmitted directly from the sides 83 of the slots to the cutter supporting arms 11*a*.

Rotation of the casing string A and of the cutter supporting arms 11*a* and cutters 14 will effect removal of the annulus of formation material which surrounds the pilot hole D drilled by the pilot bit 17. The cuttings

are removed by pumping drilling mud or the like downwardly through the casing string, which, as described above in connection with the other form of the invention, will pass through the mandrel ports 54 into its passage 29, 36, discharging through the lower end of the mandrel into the body slot 12 and then flowing outwardly around the cutters 14 and the formation shoulder E, comingling with the cuttings produced by all of the cutters and carrying them upwardly around the exterior of the casing to the top of the well bore.

In the event that the fluid pressure ceases and the casing string A is elevated, the drill bit body 10, the cutter supporting members 11*a* and cutters 14 may drop downwardly along the mandrel, the cutters shifting back into their retracted position. However, the mandrel 18 remains coupled to the casing through the locking dogs 58, and the reinstitution of pumping of drilling mud down through the casing and the apparatus will again elevate the body 10 of the tool along the mandrel 18 to re-expand the cutters 14 outwardly to their fullest extent, in which they will be coupled to the well casing as illustrated in FIG. 8.

When the apparatus is to be removed from the well casing, the overshot (not shown) is lowered on the sand line (not shown) in the same manner as in the other form of invention to retract the dogs 58 from the casing recess 62 and elevate the mandrel 18 with respect to the body 10 and the cutter supporting members 11*a*, whereupon the latter will swing inwardly out of coupling relation to the slots 31 in the casing shoe 55 and occupy an effective diameter less than the internal diameter through the casing shoe. The entire apparatus can now be elevated through the casing to the top of the well bore.

In order to insure a proper seal between the mandrel 18 and the wall of the well casing A, and the release of the mandrel from the wall of the well casing, the retracted packing structure 90 illustrated in FIGS. 9 and 10 may be used. The packing structure includes a rubber or rubber-like sleeve 91 that has an external diameter normally substantially less than the internal diameter of the casing shoe wall 92 against which it is to seal when the flange 51 engages the stop shoulder 52 on the shoe 55. This packing sleeve 91 is mounted on an outer sleeve 93, the upper end of which engages the stop flange 51 and which has an outwardly extending upper expander or abutment 94 engaging the upper end of the packing sleeve. The outer sleeve 93 is slidable along an inner sleeve 95 which encompasses the mandrel member 19, the lower end of the inner sleeve being constituted as a lower expander or abutment 96 resting upon the upper end 97 of the drill bit body 10. This lower expander or abutment 96 is adapted to engage the lower end of the packing sleeve 91. The inner and outer sleeves 95, 93 are prevented from rotating relative to each other by a slidable pin and slot connection. As illustrated, radial pins 98 are secured to the outer sleeve 93 which are received within longitudinally extending slots 99 in the inner sleeve 95.

When the apparatus embodying the packing structure illustrated in FIGS. 9 and 10 is lowered through the well casing, the packing structure will retain its retracted position as shown in FIG. 9. When the stop flange 51 on the mandrel engages the stop shoulder 52 in the casing, the rubber or rubber-like packing sleeve 91 will be disposed opposite the inner cylindrical wall 92 of the casing shoe 55. Pumping of fluid through the well casing A and the drill bit apparatus C will create a pressure in the cylinder 23 elevating the body 10 along the mandrel 18 to effect outward expansion of the cutters 14, as described in connection with the other forms of the invention. As the body 10 moves upwardly, the lower abutment 96 will engage the lower end of the packing sleeve 91. The lower abutment then moves closer to the upper abutment or expander 94, the length of the rubber sleeve being shortened and expanded outwardly into sealing engagement with the inner wall 92 of the casing shoe 55. Thus, assurance is had against leakage of fluid around the exterior of the mandrel 18, and reliance need not be had upon the rubber or rubber-like O-ring 53 mounted in the flange 51.

When the drill bit is to be released from the well casing A, the upward movement of the mandrel 18 within the body 10 of the tool will shift the upper abutment 94 away from the lower abutment 96, permitting the packing sleeve 91 to retract inherently and move fully away from the wall 92 of the casing shoe.

Because of the substantial clearance that exists between the packing sleeve 91 when in its retracted position and the inner wall 92 of the casing string, assurance is had that the packing will not be damaged during both raising and lowering of the drill bit apparatus in the well casing. As a result, the packing 91 will be in proper condition to effect a positive seal against the wall 92 of the casing shoe when the apparatus C is coupled to the string of well casing A, the cutters 14 being shifted to their fully expanded position.

The inventors claim:

1. In a retrievable drilling bit adapted to be lowered within and coupled to the lower portion of a string of pipe disposed in a well bore: a hollow body movable longitudinally through the pipe; initially retracted cutter means pivotally mounted on said body for expansion laterally outwardly of said body; said bit including means adapted to engage a lower portion of the pipe to locate the bit in the pipe with said cutter means projecting below the lower end of the pipe; hydraulically operable means movable within said body engaging said cutter means below its pivotal mounting on said body for expanding said cutter means laterally outwardly of the body to drill an effective hole diameter greater than the outside diameter of the pipe; means providing passage for fluid under pressure from the interior of the pipe above said body to said hydraulically operable means, whereby said fluid pressure actuates said hydraulically operable means; and means for coupling the bit to the pipe, whereby the pipe is adapted to rotate the bit.

2. In a retrievable drilling bit adapted to be lowered within and coupled to the lower portion of a string of pipe disposed in a well bore: a hollow body movable longitudinally through the pipe; initially retracted cutter means pivotally mounted on said body for expansion laterally outwardly of said body; said bit including means adapted to engage a lower portion of the pipe to locate the bit in the pipe with said cutter means projecting below the lower end of the pipe; hydraulically operable means movable within said body engaging said cutter means below its pivotal mounting on said body for expanding said cutter means laterally outwardly of the body to drill an effective hole diameter greater than the outside diameter of the pipe; means providing passage for fluid under pressure from the interior of the pipe above said body to said hydraulically operable means, whereby said fluid pressure actuates said hydraulically operable means; and means for coupling the cutter means directly to the pipe, whereby the pipe transmits its rotary motion and torque directly to the cutter means.

3. In a retrievable drilling bit adapted to be lowered within and coupled to the lower portion of a string of pipe disposed in a well bore: a body movable longitudinally through the pipe; initially retracted cutter means mounted on said body for expansion laterally outwardly of said body; said bit including means adapted to engage a lower portion of the pipe to locate the bit in the pipe with said cutter means projecting below the lower end of the pipe; means including a mandrel movable relatively downwardly in said body and engaging said cutter means to expand said cutter means laterally outwardly of the body to drill an effective hole diameter greater than the outside diameter of the pipe; hydraulically operable means for elevating said body along said mandrel

to effect lateral outward expansion of said cutter means; means for coupling the bit to the pipe, whereby the pipe is adapted to rotate the bit; and means for relatively elevating the mandrel in said body to permit retraction of said cutter means.

4. In a retrievable drilling bit adapted to be lowered within and coupled to the lower portion of a string of pipe disposed in a well bore: a body movable longitudinally through the pipe; initially retracted cutter means mounted on said body for expansion laterally outwardly of said body; said bit including means adapted to engage a lower portion of the pipe to locate the bit in the pipe with said cutter means projecting below the lower end of the pipe; a mandrel disposed within said body; coengageable expander means on said mandrel and cutter means; hydraulically movable means on said body subject to the pressure of fluid in the pipe for elevating said body and cutter means with respect to said mandrel to cause said expander means to expand said cutter means laterally outwardly; and means for coupling the bit to the pipe, whereby the pipe is adapted to rotate the bit.

5. In a retrievable drilling bit adapted to be lowered within and coupled to the lower portion of a string of pipe disposed in a well bore: a body movable longitudinally through the pipe; initially retracted cutter means mounted on said body for expansion laterally outwardly of said body; said bit including means adapted to engage a lower portion of the pipe to locate the bit in the pipe with said cutter means projecting below the lower end of the pipe; a mandrel disposed within said body; coengageable expander means on said mandrel and cutter means; hydraulically movable means on said body subject to the pressure of fluid in the pipe for elevating said body and cutter means with respect to said mandrel to cause said expander means to expand said cutter means laterally outwardly; means for coupling the bit to the pipe, whereby the pipe is adapted to rotate the bit; and means for relatively elevating the mandrel in said body to permit retraction of said cutter means.

6. In a retrievable drilling bit adapted to be lowered within and coupled to the lower portion of a string of pipe disposed in a well bore: a body movable longitudinally through the pipe; initially retracted cutter means mounted on said body for expansion laterally outwardly of said body; a mandrel disposed within said body; coengageable expander means on said mandrel and cutter means; means on said mandrel adapted to engage a lower portion of the pipe to locate the bit in the pipe with said cutter means projecting below the lower end of the pipe; hydraulically movable means on said body subject to the pressure of fluid in the pipe for elevating said body and cutter means with respect to said mandrel to cause said expander means to expand said cutter means laterally outwardly; and means for coupling the bit to the pipe, whereby the pipe is adapted to rotate the bit.

7. In a retrievable drilling bit adapted to be lowered within and coupled to the lower portion of a string of pipe disposed in a well bore: a body movable longitudinally through the pipe; initially retracted cutter means mounted on said body for expansion laterally outwardly of said body; said bit including means adapted to engage a lower portion of the pipe to locate the bit in the pipe with said cutter means projecting below the lower end of the pipe; a mandrel disposed within said body; coengageable expander means on said mandrel and cutter means; hydraulically movable means on said body subject to the pressure of fluid in the pipe for elevating said body and cutter means with respect to said mandrel to cause said expander means to expand said cutter means laterally outwardly; and means for coupling the cutter means directly to the pipe, whereby the pipe is adapted to rotate the bit.

8. In a retrievable drilling bit adapted to be lowered within and coupled to the lower portion of a string of pipe disposed in a well bore: a hollow body movable longitudinally through the pipe; initially retracted cutter means pivotally mounted on said body for expansion laterally outwardly of said body; said bit including means adapted to engage a lower portion of the pipe to locate the bit in the pipe with said cutter means projecting below the lower end of the pipe; hydraulically operable means movable within said body engaging said cutter means below its pivotal mounting on said body for expanding said cutter means laterally outwardly of the body to drill an effective hole diameter greater than the outside diameter of the pipe; means providing passage for fluid under pressure from the interior of the pipe above said body to said hydraulically operable means, whereby said fluid pressure actuates said hydraulically operable means; means for coupling the cutter means directly to the pipe, whereby the pipe transmits its rotary motion and torque directly to the cutter means; and means on said pipe engageable with said cutter means to transmit downweight directly from said pipe to said cutter means.

9. In a retrievable drilling bit adapted to be lowered within and coupled to the lower portion of a string of pipe disposed in a well bore: a body movable longitudinally through the pipe; initially retracted cutter means mounted on said body for expansion laterally outwardly of said body; said bit including means adapted to engage a lower portion of the pipe to locate the bit in the pipe with said cutter means projecting below the lower end of the pipe; a mandrel disposed within said body and having a passage communicable with the pipe; coengageable expander means on said mandrel and cutter means; hydraulically movable means subject to the pressure of the fluid in the pipe and mandrel passage for relatively moving said mandrel and said body and cutter means longitudinally of each other to cause said expander means to expand said cutter means laterally outwardly; and means for coupling the bit to the pipe, whereby the pipe is adapted to rotate the bit.

10. In a retrievable drilling bit adapted to be lowered within and coupled to the lower portion of a string of pipe disposed in a well bore: a body movable longitudinally through the pipe; initially retracted cutter means mounted on said body for expansion laterally outwardly of said body; said bit including means adapted to engage a lower portion of the pipe to locate the bit in the pipe with said cutter means projecting below the lower end of the pipe; a mandrel disposed within said body and having a passage communicable with the pipe; coengageable expander means on said mandrel and cutter means; hydraulically movable means subject to the pressure of the fluid in the pipe and mandrel passage for relatively moving said mandrel and said body and cutter means longitudinally of each other to cause said expander means to expand said cutter means laterally outwardly; and means for coupling the cutter means directly to the pipe, whereby the pipe is adapted to rotate the bit.

11. In a retrievable drilling bit adapted to be lowered within and coupled to the lower portion of a string of pipe disposed in a well bore: a body movable longitudinally through the pipe; initially retracted cutter means mounted on said body for expansion laterally outwardly of said body; said bit including means adapted to engage a lower portion of the pipe to locate the bit in the pipe with said cutter means projecting below the lower end of the pipe; a mandrel disposed within said body and having a passage communicable with the pipe; coengageable expander means on said mandrel and cutter means; hydraulically movable means subject to the pressure of the fluid in the pipe and mandrel passage for relatively moving said mandrel and said body and cutter means longitudinally of each other to cause said expander means to expand said cutter means laterally outwardly; means for coupling the cutter means directly to the pipe, whereby the pipe is adapted to rotate the bit; and means on said pipe engageable with said cutter means to transmit downweight directly from said pipe to said cutter means.

12. In a retrievable drilling bit adapted to be lowered within and coupled to the lower portion of a string of pipe disposed in a well bore: a body movable longitudinally through the pipe; initially retracted cutter means mounted on said body for expansion laterally outwardly of said body; said bit including means adapted to engage a lower portion of the pipe to locate the bit in the pipe with said cutter means projecting below the lower end of the pipe; a mandrel disposed within said body; coengageable expander means on said mandrel and cutter means; hydraulically movable means on said body subject to the pressure of fluid in the pipe for elevating said body and cutter means with respect to said mandrel to cause said expander means to expand said cutter means laterally outwardly; and coupling means on said mandrel expandible outwardly into coupling relation with the pipe.

13. In a retrievable drilling bit adapted to be lowered within and coupled to the lower portion of a string of pipe disposed in a well bore: a body movable longitudinally through the pipe; initially retracted cutter means mounted on said body for expansion laterally outwardly of said body; a mandrel disposed within said body and having a passage communicable with the pipe; coengageable expander means on said mandrel and cutter means; means on said mandrel adapted to engage a lower portion of the pipe to locate the bit in the pipe with said cutter means projecting below the lower end of the pipe; hydraulically movable means subject to the pressure of the fluid in the pipe and mandrel passage for relatively moving said mandrel and said body and cutter means longitudinally of each other to cause said expander means to expand said cutter means laterally outwardly; and means for coupling the bit to the pipe, whereby the pipe is adapted to rotate the bit.

14. In a retrievable drilling bit adapted to be lowered within and coupled to the lower portion of a string of pipe disposed in a well bore: a body movable longitudinally through the pipe; initially retracted cutter means mounted on said body for expansion laterally outwardly of said body; a mandrel disposed within said body and having a passage communicable with the pipe; coengageable expander means on said mandrel and cutter means; means on said mandrel adapted to engage a lower portion of the pipe to locate the bit in the pipe; hydraulically movable means subject to the pressure of the fluid in the pipe and mandrel passage for relatively moving said mandrel and said body and cutter means longitudinally of each other to cause said expander means to expand said cutter means laterally outwardly; and means on said mandrel expandible outwardly into coupling relation to the pipe, whereby the pipe is adapted to rotate the bit.

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