

July 16, 1963

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3,097,707

APPARATUS FOR DRILLING WELL BORES WITH CASING

Filed April 25, 1960

2 Sheets-Sheet 1

FIG. 1.

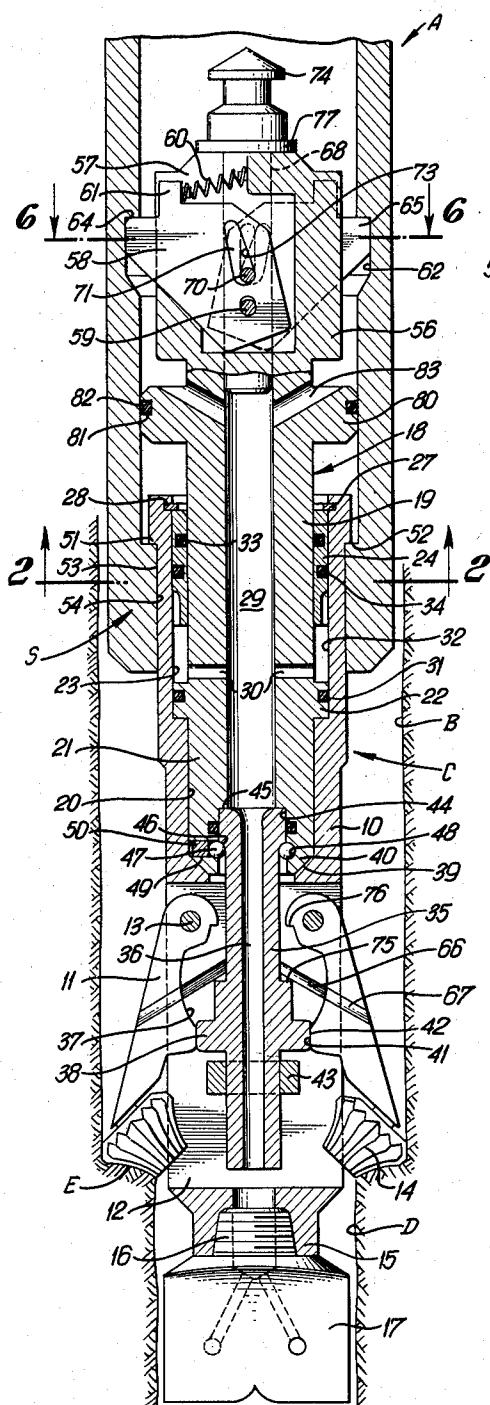


FIG. 2.

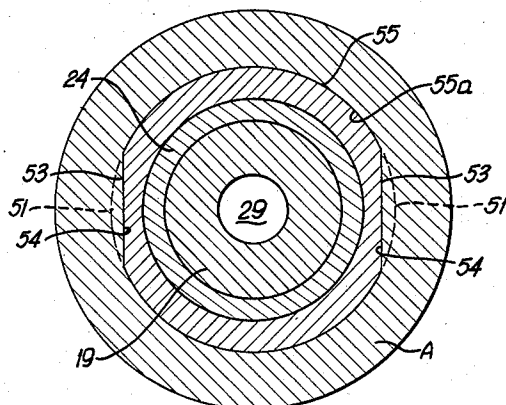
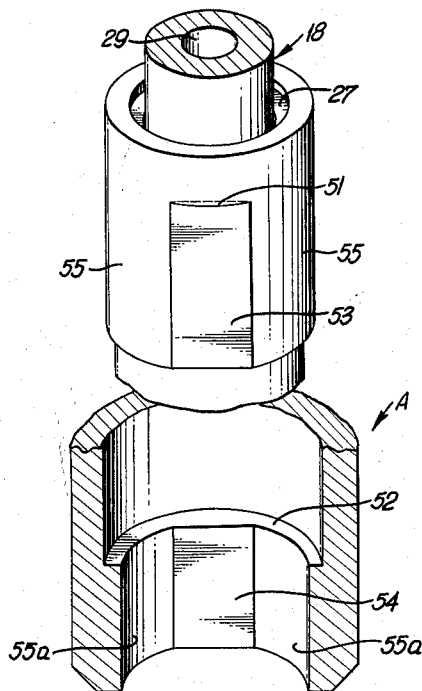


FIG. 3.



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2 Sheets-Sheet 2

FIG. 4

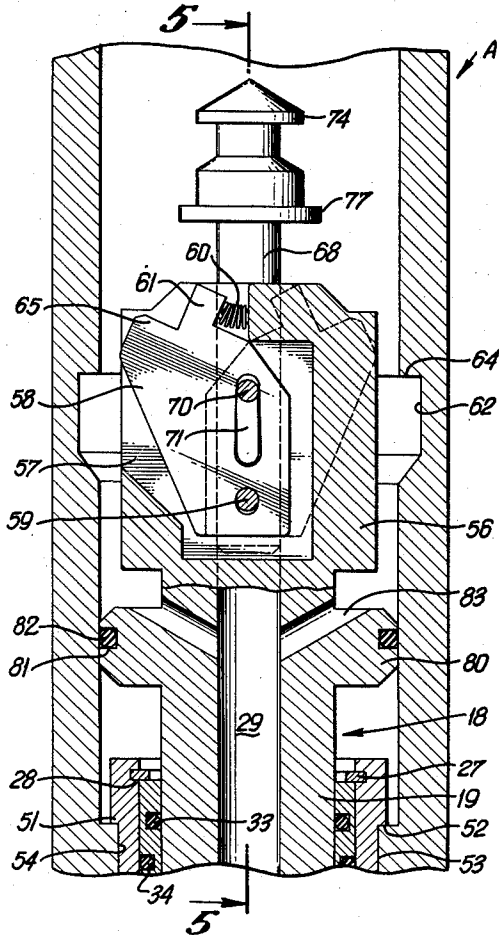


FIG. 5.

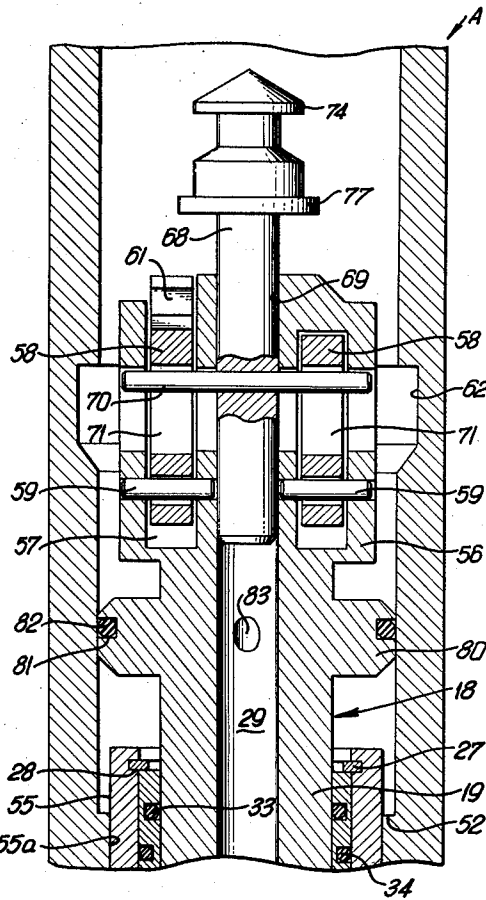
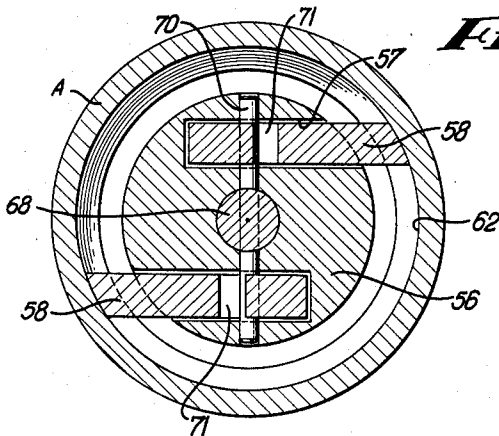


FIG. 6.



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3,097,707 APPARATUS FOR DRILLING WELL BORES WITH CASING

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12 Claims. (Cl. 175-258)

The present invention relates to apparatus for drilling well bores by the rotary method through use of a string of well casing.

Well bores have been drilled through use of a drill bit attached to the lower end of a string of drill pipe. The drill pipe is removed from the well bore after the bit becomes dull and another bit attached to its lower end, the string of drill pipe then being relowered in the well bore. When the well bore has been drilled to the required depth, the drill pipe and drilling bit are removed and casing, or the like, lowered in the well bore and ordinarily cemented in place.

The repeated 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 lowering of the casing.

An object of the present invention is to provide improved 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 positively 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, the main body of the bit being coupled directly to the pipe so that substantial torque can be transmitted directly to the body and the cutters carried thereby, the cutters being expandible outwardly of the body beyond the outside diameter of the casing and of being retracted to permit the drill bit to be elevated through the pipe to the top of the hole.

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 a drill bit within and extending from the lower end of a string of casing or similar pipe, the apparatus being disposed in its expanded position coupled and latched to the casing;

FIG. 2 is a cross-section, on an enlarged scale, taken along the line 2-2 on FIG. 1;

FIG. 3 is an exploded isometric projection, partly in section, through the lower portion of the casing and the portion of the drill bit adapted to coact therewith in coupling the drill bit to the casing for the transmission of torque therebetween;

FIG. 4 is an enlarged longitudinal section, with parts

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shown in elevation, through the latching portion of the drill bit shown in FIG. 1, the latch being retracted;

FIG. 5 is a longitudinal section taken along the line 5-5 on FIG. 4;

FIG. 6 is an enlarged cross-section taken along the line 6-6 on FIG. 1.

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 the drawings, 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 belly 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 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

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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 38, 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 body 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 accurately (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 stop ring flanges 51 integral with the body 10 engage stop shoulders 52 on the casing or pipe A. The flanges 51 can only engage the stop shoulders 52 as a result of the body 10 moving downwardly through the lower casing portion or shoe S, the upper portion of the body having diametrically opposite flat coupling faces 53 that are adapted to be located opposite companion flat faces 54 in the casing shoe S below its shoulders 52. The upper portions 55 of the body between its flat faces 53 may be cylindrical and are located in a companion cylindrical bore 55a at the lower portion of the casing shoe S. The flat coupling faces 53 on the exterior of the body 10 are milled or shaped inwardly from the normal cylindrical configuration 55 of the body and terminate short of the upper end of the body to form the stop flange portions 51 of the body. The body must be properly oriented relative to the shoe so that the body will slide downwardly within the shoe, with its opposed flat faces 53 sliding along the flat faces 54 of the shoe, until the flanges 51 engage the stop shoulders 52 on the

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shoe S. When this occurs, the body 10 is coupled to the shoe to rotate therewith, the turning effort or torque from the casing string A and shoe S being transmitted from the shoe faces 54 to the body faces 53 and to the cutters 14.

The mandrel 18 has a flange 80 integral therewith which is slidable along the wall of the casing shoe S, this flange having a peripheral groove 81 receiving a seal ring 82, such as a rubber or rubber-like O ring, adapted to seal against the wall of the well casing. Any fluid pumped down through the casing string A flows through inlet ports 83 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 flanges 51 engage the stop shoulders 52 of the shoe, and when the mandrel 18 moves downwardly relative to the body 10, as described hereinbelow, so that the arms 11 and the cutters 14 have been expanded outwardly to their fullest extent, the mandrel member 18 becomes coupled or latched to the shoe S above the region that the shoe is coupled to the body 10 of the tool C. Above its flange 80, 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 coupling dogs or latches 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 latch dog to urge its upper outer portion outwardly into a recess 62 in the casing shoe S, with which the dogs become aligned when the stop flanges 51 engage the stop shoulders 52 and the mandrel 18 is in its lower position in the body 10.

Downward drilling weight is transferred from the casing A through its downwardly facing shoulder 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 on opposite sides of the slot 12 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 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 68, the mandrel 18 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 arms or members 11 and cutters 14 back within the confines of the body slot 12.

In the use of the apparatus illustrated, the drill bit portion C has its parts initially occupying positions 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 latching dogs 58 being held inwardly by the wall of the well casing A. The retrieving plunger 68 is disposed in its lowermost

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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 top of the hole or may be pumped downwardly therethrough, the cutters 14 remaining in their retracted position.

When the apparatus reaches the casing shoe S, the lower pilot bit 17 and the cutter portions 11, 14 of the tool move therethrough and extend below the lower shoe. The upper portion of the body 10 will slide downwardly through the casing shoe S with its coupling faces 53 oriented with the companion flat faces 54 of the shoe until the stop flanges 51 on the body engage the companion shoulders 52 on the casing shoe, which precludes further downward movement of the body 10 of the drill bit and the cutters 14 relative to the well casing A. If the companion faces 53, 54 on the drill bit body and the shoe are not in alignment, the dogs 58 will not latch in the recess 62 so that drilling weight cannot be imposed on the tool. The casing A need only be turned slowly, turning of the tool C being resisted by engagement of its bit 17 with the wall of the hole until the casing shoe S moves arcuately of the body 10 to the proper extent at which the body 10 of the tool will then shift downwardly in the shoe to its fullest extent, with the stop shoulders 51 engaging the casing shoe shoulders 52.

Fluid under pressure is now pumped down through the casing string A, this fluid flowing through the ports 83 in the mandrel into the passage 29, and then downwardly through the tubular member passage 36, which is of the restricted diameter. A back pressure is built up in the passage 29 which exerts a downward force on the mandrel 18. The pressure also passes through the ports 30 into the cylinder 23 and also exerts a downward force on the piston 22 to urge the mandrel downwardly. Downward movement of the mandrel causes the expander 38 to engage the inclined expander faces 37 on the cutter supporting arms 11 to expand the arms and the cutters 14 outwardly. At this time the casing string is being rotated without any downward drilling weight imposed thereon, until the cutters 14 have been expanded outwardly to their fullest extent, as determined by the disposition of the expander 38 of the mandrel behind the lock surfaces 41 on the cutter supporting arms 11, and by engagement of the lower end 40 of the kelly with the body stop flange 39. When this position has been achieved, the dogs 58 are opposite the casing recess 62, the springs 60 snapping such dogs into the recess, allowing down-weight or drilling weight to be imposed from the casing A on the drill bit C, 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 the side shoulders 67 on each cutter supporting member 11 with the companion downwardly facing shoulders 66 on the body on opposite sides of the slot 12. The drilling weight is transferred through such shoulder to the cutter supporting members 11 and from the cutters 14 to the formation shoulder E on which the cutters 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. The central portion of the well bore being drilled is produced by the pilot bit 17 secured to the expandible tool body 10.

With the drilling weight imposed on the apparatus C in the manner described, the casing string A is rotated at an appropriate speed. The turning torque or effort is transmitted from the flat faces 54 of the casing shoe S directly to the body of the tool, and from such body of the tool to the cutter supporting members 11 and the

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cutters 14, to cause the latter to roll around the shoulder E of the formation and disintegrate the latter.

When the drill bit apparatus C 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 (FIG. 4). 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. When the piston 22 engages the cylinder head 24, upward movement of the mandrel will then carry the body 10 of the tool upwardly. The retrieving shoulder 75 on the mandrel engages the upper ends 76 of the cutter supporting arms and forcibly shifts the cutter members 11 and the cutters 14 inwardly, if they have not dropped by gravity to an inward position upon elevation of the expander 38 above the expander surfaces 37. The entire drill bit apparatus C can 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 S of the casing, the body 10 of the tool is properly oriented arcuately with respect to the shoe so that the upper portion of the body will pass through the shoe until its flanges 51 again engage the stop shoulders 52, the faces 53, 54 being against one another. Drilling mud can be pumped downwardly through the apparatus to produce the required pressure for relatively shifting the mandrel 18 downwardly of the body 10, for expanding the cutters 14 outwardly to their fullest extent. When this occurs, the latch dogs 58 will be disposed opposite the coupling recess 62 in the casing, expanding into such recess and allowing drilling weight to again be imposed upon the casing A, which will be transferred through the latch dogs 58, mandrel 18 and body 18 of the tool to the cutters 14, and from 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 required depth. After this occurs, the drill bit is retrieved through the well casing and the latter cemented in place, if desired.

I 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 body movable longitudinally through the pipe; initially retracted cutter means mounted on said body for expansion laterally outwardly of said body; said body having stop means engageable with 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 movable longitudinally in said body for expanding said cutter means laterally outwardly; means on said mandrel responsive to the pressure of fluid in the pipe for moving the mandrel longitudinally in said body to expand said cutter means; said body having means for coupling said body to the pipe whereby rotary motion and torque is transmittable directly from the pipe to said body; retractable means on said mandrel expandible

against the pipe for transmitting downweight from the pipe to the bit; and means movable relative to said mandrel for retracting said retractable means.

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 body movable longitudinally through the pipe; initially retracted cutter means mounted on said body for expansion laterally outwardly of said body; said body having stop means engageable with 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 movable longitudinally in said body for expanding said cutter means laterally outwardly; said body having means for coupling said body to the pipe whereby rotary motion and torque is transmittable directly from the pipe to said body; means for transmitting downweight from the pipe to said mandrel; and coengageable means on said mandrel and body for transmitting such downweight from said mandrel to said body.

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 body having stop means engageable with 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 movable downwardly in said body for expanding said cutter means laterally outwardly; said body having means for coupling said body to the pipe whereby rotary motion and torque is transmittable directly from the pipe to said body; means for transmitting downweight from the pipe to said mandrel; and coengageable means on said mandrel and body for transmitting such downweight from said mandrel to said body.

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, the lower pipe portion having a groove therein: a body movable longitudinally through the pipe; initially retracted cutter means mounted on said body for expansion laterally outwardly of said body; said body having stop means engageable with 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 movable downwardly on said body for expanding said cutter means laterally outwardly; said body having means for coupling said body to the pipe whereby rotary motion and torque is transmittable directly from the pipe to said body; latch means on said mandrel expandible into the pipe groove to transmit downweight from the pipe to said mandrel; and coengageable means on said mandrel and body for transmitting such downweight from said mandrel to said body.

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, the lower pipe portion having a groove therein: a body movable longitudinally through the pipe; initially retracted cutter means mounted on said body for expansion laterally outwardly of said body; said body having stop means engageable with 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 movable downwardly on said body for expanding said cutter means laterally outwardly; said body having means for coupling said body to the pipe whereby rotary motion and torque is transmittable directly from the pipe to said body; latch means on said mandrel expandible into the pipe groove to transmit downweight from the pipe to said mandrel; coengageable means on said mandrel and body for transmitting such downweight from said mandrel to said body; and means engageable with said latch means for retracting said latch means from the pipe groove.

6. In combination: a string of pipe adapted to be disposed in a well bore and having a groove in its lower

portion: a rotary drilling bit adapted to be lowered in and coupled to the lower portion of said pipe, said bit including a body movable longitudinally through the pipe; initially retracted cutter means mounted on said body for expansion laterally outwardly of said body; said pipe having stop means in its lower portion; said body having stop means engageable with said stop means of said pipe to locate the bit in the pipe with said cutter means projecting below the lower end of the pipe; a mandrel movable downwardly in said body for expanding said cutter means laterally outwardly; said body having means for coupling said body to said pipe whereby rotary motion and torque is transmittable directly from said pipe to said body; latch means on said mandrel expandible into said pipe groove to transmit downweight from the pipe to said mandrel; and coengageable means on said mandrel and body for transmitting such downweight from said mandrel to said body.

7. In combination: a string of pipe adapted to be disposed in a well bore and having a groove in its lower portion; a rotary drilling bit adapted to be lowered in and coupled to the lower portion of said pipe, said bit including a body movable longitudinally through the pipe; initially retracted cutter means mounted on said body for expansion laterally outwardly of said body; said pipe having stop means in its lower portion; said body having stop means engageable with said stop means of said pipe to locate the bit in the pipe with said cutter means projecting below the lower end of the pipe; a mandrel movable downwardly in said body for expanding said cutter means laterally outwardly; said body having means for coupling said body to said pipe whereby rotary motion and torque is transmittable directly from said pipe to said body; latch means on said mandrel expandible into said pipe groove to transmit downweight from the pipe to said mandrel; coengageable means on said mandrel and body for transmitting such downweight from said mandrel to said body; and means engageable with said latch means for retracting said latch means from said pipe groove.

8. In combination: a string of pipe adapted to be disposed in a well bore and having a groove in its lower portion, the lower portion of said pipe having a non-circular passage therein; a rotary drilling bit adapted to be lowered in and coupled to the lower portion of said pipe, said bit including a body movable longitudinally through the pipe and having a non-circular periphery adapted to fit within said non-circular passage, whereby rotary motion and torque is transmittable directly from said pipe to said body; stop means in the lower portion of said pipe; initially retracted cutter means mounted on said body for expansion laterally outwardly of said body; said body having stop means engageable with said stop means in said pipe to dispose the non-circular periphery of said body in said non-circular passage and to locate said cutter means projecting below the lower end of said pipe; a mandrel movable longitudinally in said body for expanding said cutter means laterally outwardly; means on said mandrel responsive to the pressure of fluid in the pipe for moving the mandrel longitudinally in said body to expand said cutter means; means expandible into said groove for transmitting downweight from said pipe to said bit; and means movable relative to said mandrel for retracting said expandible means from said groove.

9. In combination: a string of pipe adapted to be disposed in a well bore and having a groove in its lower portion, the lower portion of said pipe having a non-circular passage therein; a rotary drilling bit adapted to be lowered in and coupled to the lower portion of said pipe, said bit including a body movable longitudinally through the pipe and having a non-circular periphery adapted to fit within said non-circular passage, whereby rotary motion and torque is transmittable directly from said pipe to said body; stop means in the lower portion of said pipe; initially retracted cutter means mounted

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on said body for expansion laterally outwardly of said body; said body having stop means engageable with said stop means in said pipe to dispose the non-circular periphery of said body in said non-circular passage and to locate said cutter means projecting below the lower end of said pipe; a mandrel movable downwardly in said body for expanding said cutter means laterally outwardly; said pipe having a groove; latch means on said mandrel expandible into the pipe groove to transmit downweight from said pipe to said mandrel; and coengageable means on said mandrel and body for transmitting such downweight from said mandrel to said body.

10. In combination: a string of pipe adapted to be disposed in a well bore and having a groove in its lower portion, the lower portion of said pipe having a non-circular passage therein; a rotary drilling bit adapted to be lowered in and coupled to the lower portion of said pipe, said bit including a body movable longitudinally through the pipe and having a non-circular periphery adapted to fit within said non-circular passage, whereby rotary motion and torque is transmittable directly from said pipe to said body; stop means in the lower portion of said pipe; initially retracted cutter means mounted on said body for expansion laterally outwardly of said body; said body having stop means engageable with said stop means in said pipe to dispose the non-circular periphery of said body in said non-circular passage and to locate said cutter means projecting below the lower end of said pipe; a mandrel movable downwardly in said body for expanding said cutter means laterally outwardly; said pipe having a groove; latch means on said mandrel expandible into the pipe groove to transmit downweight from said pipe to said mandrel; coengageable means on said mandrel and body for transmitting such downweight from said mandrel to said body; and means engageable with said latch means for retracting said latch means from said pipe groove.

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, the lower pipe portion having a groove therein: a body movable longitudinally through the pipe; initially retracted cutter means mounted on said body for expansion laterally outwardly of said body; said body having stop means engageable with 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 movable downwardly on said

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body for expanding said cutter means laterally outwardly; piston means on said mandrel adapted to sealingly engage the pipe below said groove and subject to the pressure of fluid pumped down the pipe to move said mandrel downwardly in said body to expand said cutter means; said body having means for coupling said body to the pipe whereby rotary motion and torque is transmittable directly from the pipe to said body; latch means on said mandrel above said piston means expandible into the pipe groove to transmit downweight from the pipe to said mandrel; and coengageable means on said mandrel and body for transmitting such downweight from said mandrel to said body.

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, the lower pipe portion having a groove therein: a body movable longitudinally through the pipe; initially retracted cutter means mounted on said body for expansion laterally outwardly of said body; said body having stop means engageable with 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 movable downwardly on said body for expanding said cutter means laterally outwardly; said body having means for coupling said body to the pipe whereby rotary motion and torque is transmittable directly from the pipe to said body; latch means on said mandrel expandible into the pipe groove to transmit downweight from the pipe to said mandrel; coengageable means on said mandrel and body for transmitting such downweight from said mandrel to said body; and means slidable longitudinally in said mandrel and engageable with said latch means for retracting said latch means from the pipe groove.

References Cited in the file of this patent

UNITED STATES PATENTS

474,080	Bullock et al.	May 3, 1892
1,326,509	Humanson	Dec. 30, 1919
1,571,931	Church	Feb. 9, 1926
2,287,714	Walker	June 23, 1942
2,389,208	Orr	Nov. 20, 1945
2,771,275	Ortloff	Nov. 20, 1956
2,863,641	Kammerer	Dec. 9, 1958
2,997,119	Goodwin	Aug. 22, 1961