Nov. 26, 1935. J. C. WRIGHT 2,022,101

WELL DRILL

Filed Oct. 23, 1933 3 Sheets-Sheet 1

Fig. 1

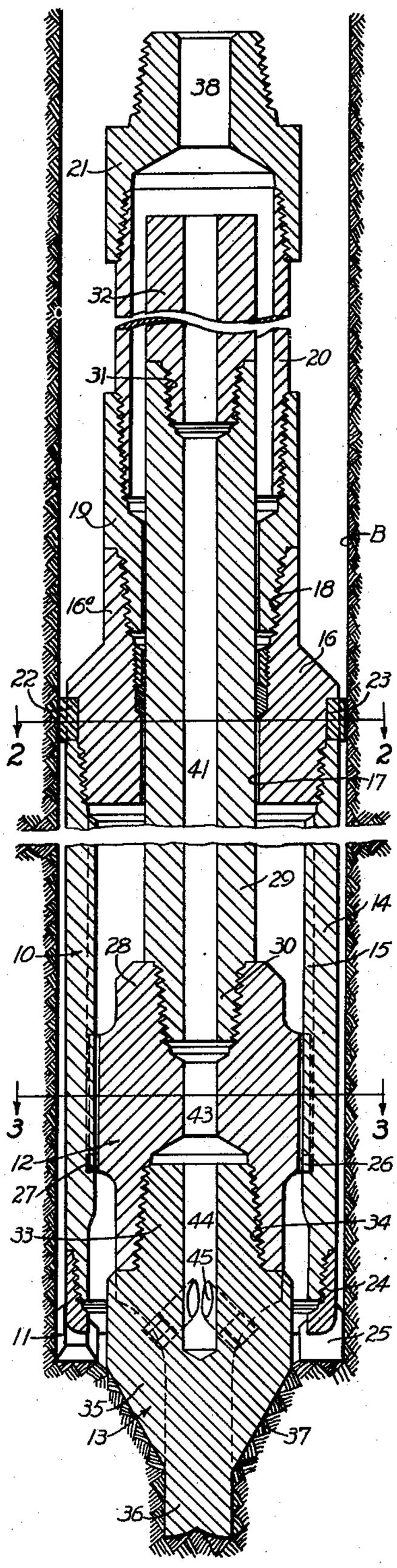


Fig. 2

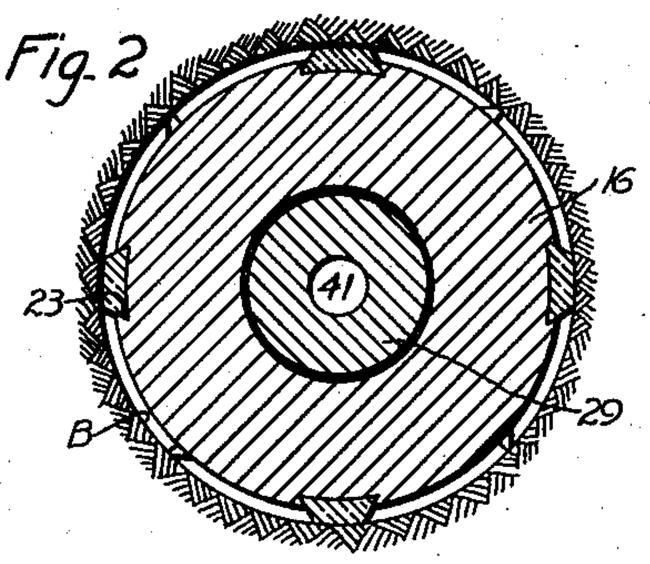


Fig. 3

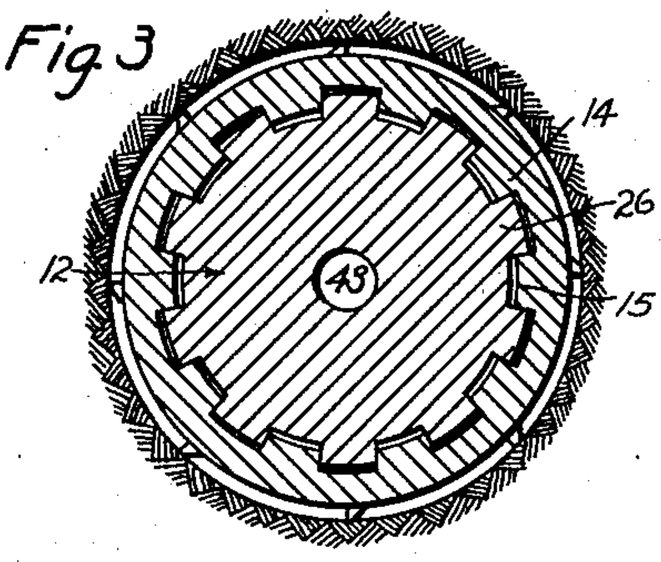
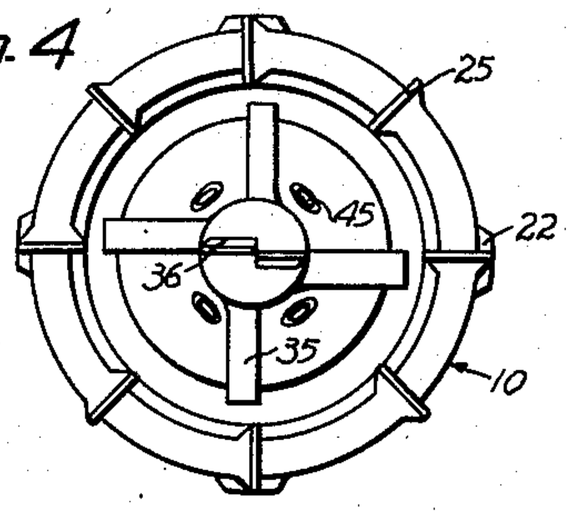


Fig. 4



Inventor
Jesse C. Wright

per Wm Hall Capwell
Attorney

Nov. 26, 1935. J. C. WRIGHT 2,022,101

WELL DRILL

Filed Oct. 23, 1933 3 Sheets-Sheet 2

Fig. 5

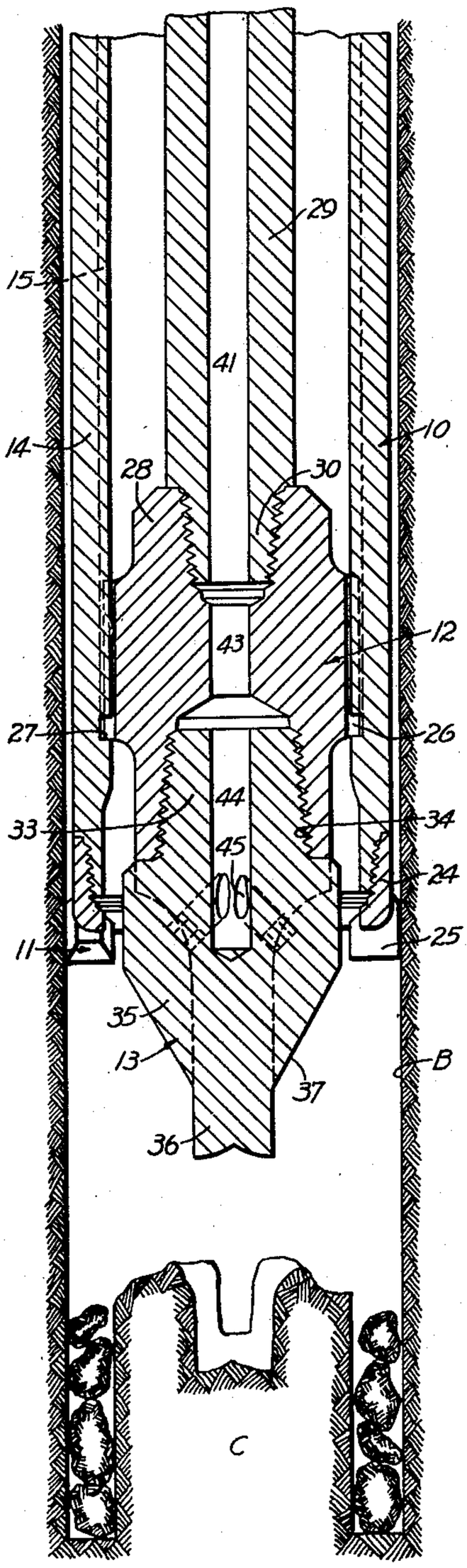
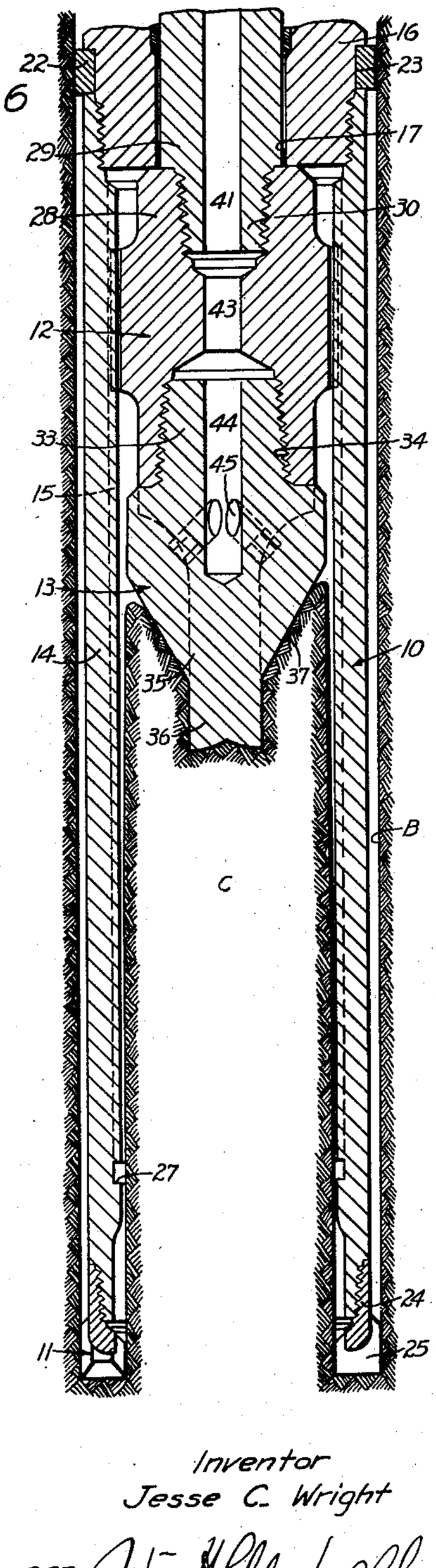


Fig. 6



Inventor
Jesse C. Wright
per W. Hollaswell
Attorney

Nov. 26, 1935. J. C. WRIGHT 2,022,101

WELL DRILL

Filed Oct. 23, 1933 3 Sheets-Sheet 3

Fig. 7

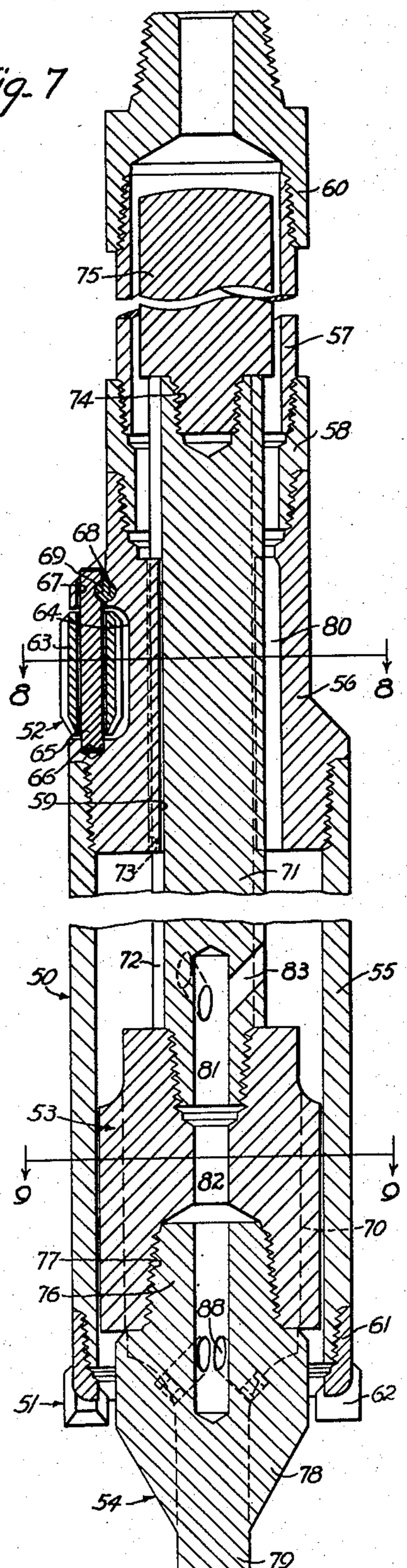


Fig. 8

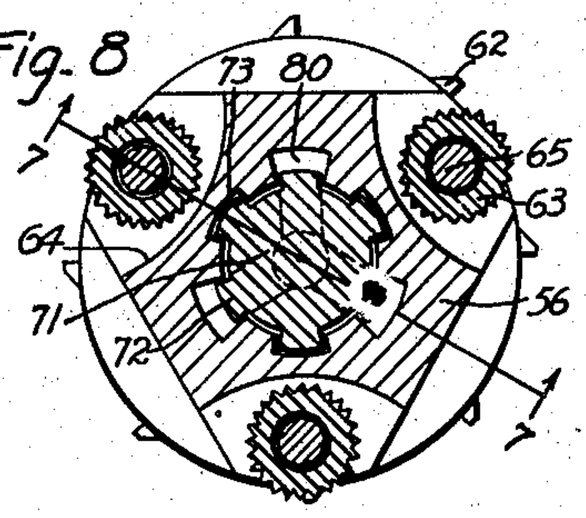


Fig. 9

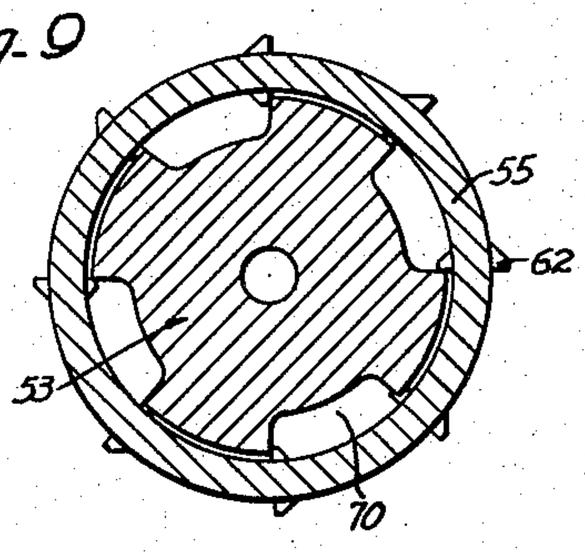
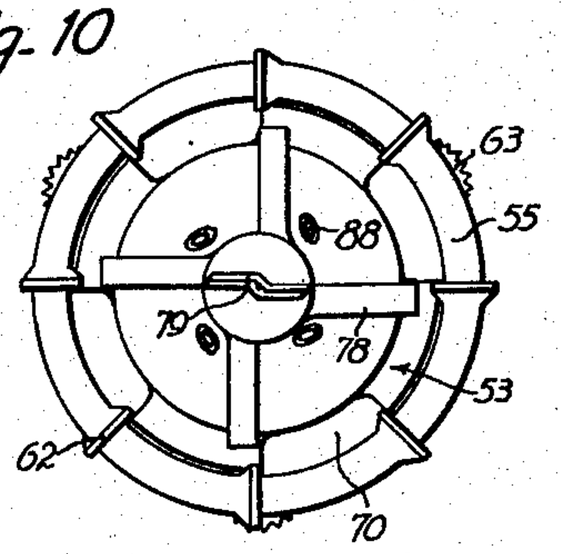


Fig. 10



Inventor
Jesse C. Wright
per W. H. Maxwell
Attorney

Patented Nov. 26, 1935 2,022,101

UNITED STATES PATENT OFFICE

2,022,101

WELL DRILL

Jesse C. Wright, Los Angeles, Calif., assignor to Globe Oil Tools Company, Los Nietos, Calif., a corporation of California

Application October 23, 1933, Serial No. 694,806

11 Claims. (Cl. 255—61)

This invention relates to a well tool, and relates more particularly to a well drill or well drilling bit. It is a general object of the present invention to provide a simple, practical and particularly efficient well drill.

In the art of well drilling bits it is recognized that a drill which cuts a compartively narrow annular channel in the earth formation and leaves a core is more efficient and rapid in its penetration of the formation than a drill which cuts a cylindrical bore of the same diameter. Well drills have been introduced which make an annular cut in the earth formation to leave a core which may be washed away through the eroding action of the circulation fluid if the formation is very soft, but which must be drilled away or freed from the formation and withdrawn from the well bore if the earth formation is hard or relatively hard. When a well drill of the character just referred to is provided with cutting means for cutting away the core during the operation of the drill, the efficiency and speed of the drill is materially reduced and its action is substantially the same as that of the typical drills for making cylindrical bores. There are various factors limiting the practicability of the type of well drill designed to make an annular cut in the earth formation and then carry the remaining core to the surface when it is withdrawn from the well. For example, it is often very difficult to break a large or hard core free from the formation, and the length or amount of bore hole that may be drilled is limited by the amount of core that may be safely and efficiently handled when the drill is pulled from the well.

It is an object of this invention to provide a well drill that cuts a comparatively narrow annular channel in the earth formation so that it is rapid and efficient in its cutting action and that includes a novel and effective means for breaking up any hard or relatively hard core that may resist the eroding action of the circulation fluid without reducing or impeding the drilling speed and efficiency of the tool.

It is another object of the invention to provide a well drill that includes cutting parts operatable by rotation of the tool to make a compartively narrow annular cut in the earth formation and leave a core and a core breaking bit that is adapted to break up the core by a percussive action independent of the rotary motion of the drill.

It is another object of the invention to provide a well drill that operates with the speed and efficiency of a core drill or core receiving drilling bit, and that is operatable to break up or destroy the hard or relatively hard core which resists the erosive action of the circulation fluid so as to drill a cylindrical bore.

It is another object of the invention to provide a well drill that includes cutting parts for making an annular cut in the earth formation when the drill is rotated in the usual manner and a core breaking cutter or bit that takes very little of the drilling weight or feed pressure during the rotation and operation of the tool and therefore does not appreciably retard the drilling speed of the cutting parts and which may be operated to quickly break up the core by successively raising the drill and allowing it to fall or drop.

It is another object of the invention to provide a well drill of the character mentioned in which the core breaking bit may be operated to quickly and effectively break up the core by an impacting or percussive action when the drill is successively raised and dropped, without subjecting the cutting parts for making the annular cut to any severe percussions or dulling action.

It is a further object of the invention to provide a well drill of the character mentioned that is easy and efficient to operate, and that is simple and inexpensive of manufacture.

Other objects and features of the invention will be fully understood from the following detailed description of typical forms and applications of the invention, throughout which description reference is had to the accompanying drawings, in which:

Fig. 1 is a longitudinal detailed sectional view of one embodiment of the invention illustrating it in operative position, and in relatively soft earth formation. Figs. 2 and 3 are transverse detailed sectional views taken as indicated by lines 2—2 and 3—3 respectively, on Fig. 1. Fig. 4 is a bottom elevation of the drill illustrated in Fig. 1. Fig. 5 is a longitudinal detailed sectional view of the lower portion of the drill raised to the position where it may be dropped to provide for the breaking up of the core by the core breaking bit. Fig. 6 is a view similar to Fig. 5 illustrating a core extending into the body and showing the core breaker in its up position. Fig. 7 is a longitudinal detailed sectional view of another embodiment of the invention, taken as indicated by line 7—7 on Fig. 8. Fig. 8 is a transverse detailed sectional view taken as indicated by line 8—8 on Fig. 7. Fig. 9 is a transverse detailed sectional view taken as indicated by line

9—9 on Fig. 7, and Fig. 10 is a bottom elevation of the drill shown in Fig. 7.

The form or embodiment of the invention illustrated in Figs. 1 to 6, inclusive, of the drawings, includes, generally, a body 10, cutting means 11 on the lower end of the body for making an annular cut in the earth formation, a longitudinally movable mandrel 12 in the body 10, and a bit 13 on the mandrel 12 operatable to cut away the central portion of the earth formation when the formation is soft, and operatable to break up the core when the earth formation is hard or relatively hard.

The body 10 is an elongate tubular structure that is capable of considerable variation without departing from the spirit of the invention. The particular body illustrated in the drawings includes a main tubular part 14 of substantial length and of comparatively large diameter. A plurality of longitudinal splines 15 is provided on the interior of the body part 14 for the purpose to be subsequently described. A member 16 is threaded into the upper end of the body part 14 and has a central longitudinal opening 17. The member 16 has a reduced socket portion 16a at its upper end provided with a socket 18. A sub 19 has its pin threaded into the socket 18 and carries an elongate tubular body section 20. The section 20 may be of considerable length and may be provided at its upper end with a sub 21 or other suitable means for facilitating connection with the drill collar of a drilling string.

The invention may include guide means on the body to stabilize the drill and to aid in guiding the drill during operation. In the form of the invention being described, a plurality of circumferentially spaced guide blocks 22 is arranged in dove-tailed recesses 23 in the member 16. The guide blocks 22 are clamped or retained in the recesses 23 by the upper end of the body part 14 and project outwardly to engage the wall of the well bore B. It will be apparent how the circumferentially spaced guide blocks 22 are operatable to effectively stabilize and guide the drill. The blocks 23 may be formed of a material having a relatively low resistance to abrasion so that they will not cause binding or sticking of the drill in the well bore.

The cutting means 11 is provided on the lower end of the body 10 and is operatable to make an annular cut or channel in the earth formation when the drill is rotated and fed downwardly in accordance with the usual practice in the rotary method of well drilling. The particular cutting means 11 illustrated in the drawings includes a body or shoe 24 screwthreaded onto the lower end portion of the body part 14. Cutting parts project from the shoe 24 to act on the earth formation. In accordance with the broader aspects of the invention, any suitable or desirable type of cutting parts may be embodied in the cutting means 11. In the specific embodiment of the invention illustrated in the drawings, the shoe 24 is provided with a plurality of circumferentially spaced cutting teeth or blades 25. The blades 25 project downwardly from the lower end of the shoe 24 and are suitably shaped to properly act on the formation. The cutting blades 25 project from the interior and exterior of the shoe 24 to make an annular cut of sufficient width to pass the main body part 14 with suitable clearance.

The mandrel 12 carries the core cutting and core breaking bit 13, and in accordance with the invention, has limited longitudinal movement in the body 10. In accordance with the invention, the mandrel 12 is arranged and constructed to have free longitudinal movement relative to the body 10, and to rotate with the body 10. In the particular form of the invention being described, a plurality of keys or splines 26 is provided on the mandrel 12 to slidably cooperate with the splines 15 on the interior of the body part 14. The body splines 15 terminate at their lower ends at an annular recess 27 in the inner wall of the body part 14. The lower ends of the splines 26 on the mandrel 12 are adapted to engage the lower wall of the recess 27 to limit the downward movement of the mandrel relative to the body. A socketed portion 28 of reduced diameter is provided on the upper end of the mandrel 12 and is adapted to engage the lower end of the member 16 when the mandrel is in the position illustrated in Fig. 6 of the drawings to limit the upward movement of the mandrel in the body. In the preferred construction, the mandrel 12 is provided with a guide means. The guide means may be in the nature of a stem 29 projecting upwardly from the portion 28. In the construction illustrated in the drawings, the stem 29 has a pin 30 on its lower end threaded into the socket in the socketed portion 28 of the mandrel. The stem 29 passes upwardly through the opening 17 in the member 16 and through the sub 19 to project into the body section 20. The stem 29 may be slidable in the opening 17 so as to effectively guide the mandrel 12 and the core breaking bit 13 for central longitudinal movement relative to the body 10. The guide stem 29 of the mandrel 12 is preferably comparatively heavy so that it acts as a weight to give added momentum and percussive force to the core breaking bit 13. A socket 31 or equivalent means may be provided at the upper end of the stem 29 to facilitate the connection of a weight 32 to the stem if it is found desirable or necessary to increase the weight of the mandrel assembly.

The bit 13 which is carried on the lower end of the mandrel 12 is operatable to cut away the core or central portion of the earth formation during the operation of the cutting means 11 if the earth formation is soft, and is operatable to break up the core if the earth formation is hard or relatively hard. The core cutting and breaking bit 13 may be attached to the mandrel 12 in any suitable manner, for example, it may have a pin 33 threaded into a socket 34 in the lower end of the mandrel. The bit 13 is preferably proportioned to move or operate through the main body part 14 with substantial clearance and to project from the lower end of the body when in its lower or down position. Suitable cutting parts are provided on the bit 13 for drilling into or cutting away the center of the bore where the earth formation is soft, and for breaking up the core when the tool is operating in hard earth formation. The particular bit 13 illustrated in the drawings is provided with four circumferentially spaced outer teeth or blades 35, and two central teeth 36 projecting downwardly beyond the blades 35, it being understood that the bit may be provided with cutting parts of any suitable type or character. The blades 35 are radially disposed relative to the vertical axis of the bit, and their edges 37 are inclined downwardly and inwardly to the teeth 36. The teeth 36 may be substantially radial, and may be proportioned and positioned to penetrate the central portion of the core or the earth formation some distance in advance of the blades 35.

The invention provides effective means for

handling the rotary mud or circulation fluid. The circulation fluid may be pumped downwardly through the operating string in the usual manner to discharge through the passage 38 of the sub 21. A central longitudinal fluid passage 41 is provided in the weight 32 and the guide stem 29. A passage 43 is provided in the mandrel 12 to communicate with the passage 41 and a central passage 44 in the bit 13. Ports 45 are provided in the bit head 13 to discharge the fluid from the passage 44 downwardly and outwardly between the blades 35.

It will be apparent how the circulation fluid is continuously discharged from the lower end of the drill during all phases of its operation. When the embodiment of the invention illustrated in Figs. 1 to 6, inclusive, of the drawings, is operating in soft or relatively soft earth formations, the cutting blades 25 make an annular cut in the formation, while the bit 13 may cut away the formation in the center of the bore surrounded by the annular cut. The drill is rotated and is fed downwardly into the formation under a suitable pressure in the usual manner, and where the earth formation is soft, the bit 13 may penetrate the formation in advance of the cutting means 11 somewhat in the manner illustrated in Fig. 1 of the drawings. The circulation fluid is discharged from ports 45 to maintain a suitable turbulence and circulation in the bottom of the bore. When the drill is operating in hard or relatively hard earth formations, the cutting blades 25 of the means 11 make an annular channel or cut B to leave a central upstanding core C. As the bit 13 is carried by the mandrel 12 which is shiftable longitudinally in the body 10, the bit 13 may not advance downwardly as rapidly as the body. Under such conditions, the bit 13 may cut away the core C to some extent due to its rotary motion with the body 10, however, as it is not positively fed or forced downwardly into the formation by the weight or a portion of the weight of the drilling string imposed on the body 10, it does not materially retard the advancing of the cutting means 11 into the formation. The cutting blades 25 of the means 11 cut the core C so that it is received in the body part 14 with suitable clearance. When the drilling has progressed to the point where the lower end of the body member 16 comes into contact with the upper end of the mandrel part 28, the bit 13 takes or assumes part of the downward feeding or drilling pressures, and thereby slows up the cutting action. The operator or driller is thus informed or made aware that a core C of substantial length has been cut and that it is desirable to break up the core to permit the cutting means 11 to continue its penetration of the formation without having the bit 13 acting on the core C to impede or slow up the operation of the drill. To break up the core C, the drill is raised a distance somewhat greater than stroke or longitudinal movement of the bit 13 relative to the body 10 and is then dropped to allow the bit 13 to strike or impact against the upper end of the core. This operation is continued until the bit 13 has effectively and substantially completely broken up the upstanding core C. It will be apparent how the bit 13 is operatable to effectively destroy or break up the core C by a percussive action when the drill is dropped or allowed to suddenly move downwardly. The mandrel 12 and stem 29, together with any other parts, such as the weight 32, that may be provided on the stem 29 materially add to the weight of the bit 13 and thus increase the effectiveness of its percussive or impacting action on the core. In practice, the bit 13 may break up the core so that the fragments or pieces of the core fall into the annular cut B made by the means 11.

After the core has been broken up in the manner just described, the drill may be lowered and put under the usual or desired drilling pressures, and rotated in the usual manner so that the cutting means 11 is again brought into operation to make the annular cut in the earth formation. It is to be noted that the cutting means 11 and the core breaking bit 13 act independently of one another, and are separately or independently operated. The cutting means 11 is permitted to operate to form the annular cut B in the formation practically unimpeded by the core breaking bit 13 so that the drill is very efficient and rapid in its penetration of the formation. The core formed or cut by the cutting means 11 may be easily and quickly broken up by the bit 13 when the core C becomes long enough to force the upper end of the mandrel against the body part 16. The engagement of the mandrel 12 against the body member 16 puts a positive downward pressure or feed on the bit 13 so that it acts on the core to retard the cutting action of the drill, informing the driller that the core should be broken up. The core may be broken up by means of the bit 13 without subjecting the cutting blades 25 to any severe dulling action.

The form of the invention illustrated in Figs. 7 to 10, inclusive, of the drawings, includes generally, a body 50, cutting means 51 on the body operatable during rotation of the drill to make an annular cut in the earth formation, reaming means 52 on the body 50, a mandrel 53 movable longitudinally in the body 50, and a bit 54 on the mandrel 53 for cutting away the central portion of the bore when the drill is operating in soft formation, and operatable to break up the core when the drill is operating in hard or relatively hard formations.

The body 50 may be similar to the body 10 above described, that is, it may include a main or lower body part 55, a member 56 on the upper end of the part 55, and a tubular upper section 57 connected with the member 56 by a suitable sub 58. The part 55 is of substantial length and is comparatively large in diameter to carry the cutting means 51 and to house or contain the longitudinally movable mandrel 53. The member 56 of the body is provided with a central longitudinal opening 59, extending from the interior of the body part 55, to the sub 58. A connecting member or sub 60 may be provided on the upper end of the body section 57 to facilitate connection of the drill with the drill collar of a drilling string.

The cutting means 51 is provided on the lower end of the body 50 to make a comparatively narrow annular cut in the earth formation. The cutting means 51 includes a shoe 61 threaded on the lower end of the body 55 and cutting parts or blades 62 projecting downwardly from the shoe. There is a plurality of circumferentially spaced blades 62 on the shoe 61 which project from the interior and exterior of the shoe to make a cut sufficiently wide to receive the body part 55 with suitable clearance. The cutting blades 62 are operable upon rotation of the drill to make the annular cut and form a central core when operating in hard or relatively hard formations.

The reaming means 52 is provided on the body 50 to ream the well bore and to stabilize the drill. The reaming means 52 may include three circumferentially spaced reaming cutters 63 positioned in recesses 64 in the body member 56. Pins or

spindles 65 extend vertically through the recesses 64 to carry the reaming cutters 63 for rotation about vertical axes. The spindles 65 have their lower ends seated in sockets 66, while their upper end portions pass through openings 67 joining the upper ends of the recesses 64. Lock or removable retaining members 68 in the form of pins, screws or keys are arranged in openings intersecting the openings 67 and cooperate with notches 69 in the spindles 65 to retain the spindles in position. The reaming cutters 63 project from the outer sides of the recesses 64 so that their cutting parts may engage or act on the wall of the well bore.

The mandrel 53 is arranged within the body part 55 and in accordance with the invention is movable longitudinally relative to the body. The mandrel 53 is proportioned to be freely movable in the body part 55 and its exterior is provided with a plurality of longitudinal grooves or fluid passages 70. A guide stem 71 projects upwardly through the opening 59 in the member 56. The stem 71 is of substantial length to project upwardly into the section 57 and a socket 74 may be provided in the upper end of the stem to permit the attachment of a weight 75 to the stem. A pin on the lower end of the weight 75 may be threaded into the socket 74. The stem 71 carrying the weight member 75 is comparatively heavy to materially add to the weight of the mandrel assembly. The stem 71 is provided with splines 72 to slidably operate in keyways 73 in the wall of the opening 59. Certain of the keyways 73 are enlarged or deepened to form fluid passages 80 connecting the interior of the body part 55 with the interiors of the sub 58 and upper body section 57.

The bit 54 is carried on the lower end of the mandrel 53 to penetrate or cut through the central portion of the bore when the drill is operating in a soft earth formation and is operatable by a percussive action to break up the core formed by the cutting means 51 when the drill is operating in hard or relatively hard earth formations. The bit 54 illustrated in the drawings is substantially identical with the bit 13 described above, it being understood that the core breaking bit may be modified as desired or found practical. The bit 54 has a pin 76 on its upper end threaded into a socket 77 in the mandrel. The bit 54 is proportioned to project downwardly beyond the cutting blades 62, and its lower end is provided with four circumferentially spaced outer blades 78 and two central lower blades 79 to operate in advance of the blades 78.

Means is provided for circulating the rotary mud or circulation fluid downwardly through the drill to discharge from its lower end and to discharge from the bit 54 around the cutting blades 62. A central longitudinal fluid passage 81 is provided in the lower portion of the stem 71 and communicates with a passage 82 extending downwardly through the mandrel and into the bit head 54. Ports 83 extend from the fluid passage 81 to the outer sides of the splines 72 to communicate with the passages 80 and carry the fluid to the passage 81. Ports 88 are provided in the bit 54 to discharge the fluid downwardly between the blades 78. The ports 88 may be provided with suitable jets or beans.

The operation of the form of the invention illustrated in Figs. 7 to 10, inclusive, of the drawings, is substantially identical with the operation of the previously described form of the invention. When the drill is operated in soft or relatively soft earth formations, the bit 54 which is rotated with the body 50 through the spline and keyway connection 72 and 73 may penetrate the formation at the center of the bore. In some instances the bit 54 may operate slightly in advance of the cutting blades 62 during rotation of the tool, while in other instances, it may remain in approximately the same plane as the cutting blades 62 as the rotary drilling progresses, it being apparent that the action and position of the bit 54 depends upon the character of the earth formation encountered. If the drill is operating in hard or relatively hard formations, the cutting parts 62 make an annular cut in the formation and penetrate the formation more rapidly than the bit 54, as the bit 54 is not positively fed into the formation by the feed or drilling pressure put on the drill. Upon the core cut by the means 51 reaching a substantial length, the upper end of the mandrel 53 is engaged by the lower end of the body part 56 so that part of the downward feeding or drilling pressure is imposed on the bit 54. This distribution of the drilling or feeding pressure to the bit 54 as well as the cutting parts 62 materially reduces the speed of operation or speed of penetration of the drill so that the driller is made aware that the core should be broken up. To break up the core the drill is successively raised and allowed to fall or drop so that the bit 54 strikes the upper end of the core. As the bit 54 is weighted by the mandrel 53, stem 51 and weight 75, it is particularly effective and rapid in breaking up the core when the drill is raised and allowed to drop. After the core has been broken up in this manner, the drill may be again rotated and put under a drilling pressure in the usual manner to cause the cutting parts or blades 62 to penetrate the formation and make an annular cut. The reaming cutters 63 operate to ream or enlarge the bore and act to steady or stabilize the drill.

Having described only typical forms and applications of my invention, I do not wish to be limited or restricted to the specific forms or applications herein set forth, but wish to reserve to myself any modifications or variations that may appear to those skilled in the art or fall within the scope of the following claims:

Having described my invention, I claim:

1. A well drill for use on a drilling string including, a body rigidly attached to the drilling string to rotate therewith, an annular series of cutting parts on the body operatable during rotaton of the body to make an annular cut in the formation and leave a core, a longitudinally movable bit for acting on the formation only within the bounds of said annular cut and retractable into the body during the formation of the core, and a connection between the bit and body whereby the bit is made to rotate with the body and is longitudinally movable therein.

2. A rotary well drill for use on a drilling string including, a tubular body rigidly connected to the drilling string to rotate therewith, cutting parts on the lower end of the body for making an annular cut in the formation during rotation of the body to form a core, a bit formed and proportioned to be entirely retractable into the body during the formation of the core, a sliding key connection between the bit and body whereby the bit is rotatable with the body to cut away soft cores and is operable to break up a hard core by a percussive action when the body is raised and dropped, and a guide stem on the bit slidably guided in the body above the key connection.

3. A rotary well drill for use on a rotary drilling

string including, a tubular body connected to the drilling string to rotate therewith, cutting parts on the body for making an annular cut in the formation during rotation of the body, a cutter keyed to the body to be rotatable with and longitudinally movable in the body, a weight element connected with the cutter and slidably guided in the body, the cutter being operatable to break up the core by a percussive action upon dropping of the body, and means for conducting fluid through the weight element and cutter.

4. A rotary well drill including, a tubular body adapted to be connected to a drilling string to rotate therewith, cutting parts on the body for making an annular cut in the formation during rotation of the body, a mandrel keyed to the body to be rotatable with and longitudinally movable in the body, packing means for sealing about the mandrel, and a bit on the mandrel retractable to a position entirely within the body and operatable by rotation of the body to cut soft earth formations and operatable by gravity to break a hard core.

5. A rotary well drill including, a tubular body adapated to be connected to a drilling string to rotate therewith, cutting parts on the body for making an annular cut in the formation during rotation of the body, a mandrel rotatable with and longitudinally movable in the body, a guide stem on the mandrel having a sliding key connection with the body, and a bit on the mandrel retractable into the body and operatable by rotation of the body to cut soft earth formations and operatable by gravity to break a hard core.

6. The combination with rotary well drilling string, of a tubular body rigidly connected to the drilling string to rotate therewith, cutting parts on the body for making an annular cut in the formation during rotation of the body, a mandrel splined in the body to be rotatable with and longitudinally movable in the body, a weight on the mandrel within the body, and a bit on the mandrel to move therewith to be operatable by rotation of the body to cut soft earth formations and operatable by gravity to break a hard core.

7. A rotary well drill for use on a drilling string including, a tubular body rigidly connected to the drilling string to rotate therewith, cutting parts on the body for making an annular cut in the formation during rotation of the body to form a core for reception in the body, a bit movable longitudinally with respect to the body to move entirely into the body during the formation of the core, a connection between the body and bit for transmitting rotary motion from the body to the bit whereby the bit is operatable by rotation to cut soft formations, the bit being operatable by a percussive action to break up a core upon dropping of the body, and means conducting circulation fluid to the bit to discharge from the lower end thereof.

8. A rotary well drill including, a tubular body adapted to be connected to a drilling string to rotate therewith, cutting parts on the body for making an annular cut in the formation during rotation of the body, reaming means on the body, and a cutting element connected with the body for rotation therewith and for longitudinal movement relative thereto and operatable to penetrate the formation in the center of the bore by a rotary cutting action when the formation is soft and adapted to break up the formation within said cut by a percussive action when the formation is hard.

9. A rotary well drill including, a tubular body adapted to be connected to a drilling string to rotate therewith, cutting parts on the body for making an annular cut in the formation during rotation of the body, guides on the body spaced above the cutting parts for engaging the wall of the bore, and a cutting element connected with the body for rotation therewith and for longitudinal movement relative thereto and operatable to penetrate the formation in the center of the bore by a rotary cutting action when the formation is soft and adapted to break up the formation within said cut by a percussive action when the formation is hard.

10. A well drill for use on a rotary well drilling string including a tubular body comprising an upper section, a lower section of enlarged diameter, and a member connecting the sections, cutting means on the lower end of the lower section for making an annular cut in the formation, a mandrel shiftable longitudinally in the lower section, a bit on the mandrel, a connection between the mandrel and body for transmitting rotary motion from the body to the mandrel whereby the bit may cut away the formation within said cut by a rotary action when the formation is soft and may retract into the lower section when a core is produced, a guide stem on the mandrel extending through the said member to be guided thereby and to project into the upper section, the guide stem and mandrel constituting a weight on the bit whereby the bit may destroy the core by a percussive action, and means for conducting fluid through the tool to discharge from the bit.

11. A well drill for use on a rotary well drilling string including a tubular body comprising an upper section, a lower section of enlarged diameter, and a member connecting the sections, cutting means on the lower end of the lower section for making an annular cut in the formation, a mandrel shiftable longitudinally in the lower section, a bit on the mandrel, a connection between the mandrel and body for transmitting rotary motion from the body to the mandrel whereby the bit may cut away the formation within said cut by a rotary action when the formation is soft and may retract into the lower section when a core is produced, a guide stem on the mandrel extending through the said member to be guided thereby and to project into the upper section, the guide stem and mandrel constituting a weight on the bit whereby the bit may destroy the core by a percussive action, there being a passage in the guide stem and mandrel for carrying fluid from the upper section to the bit to discharge therefrom, and means on the member for sealing about the guide stem.

JESSE C. WRIGHT.