Oct. 26, 1926. 1,604,388

A. W. CALVIN

ROTARY DRILL

Filed Dec. 27, 1924 4 Sheets-Sheet 1

Fig. 1.

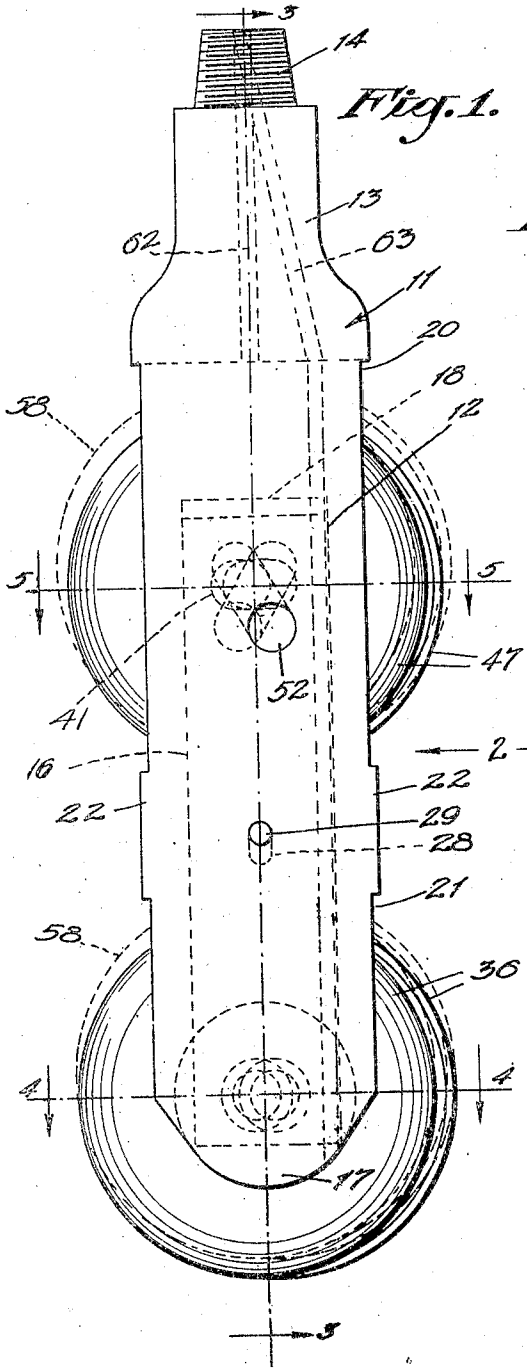
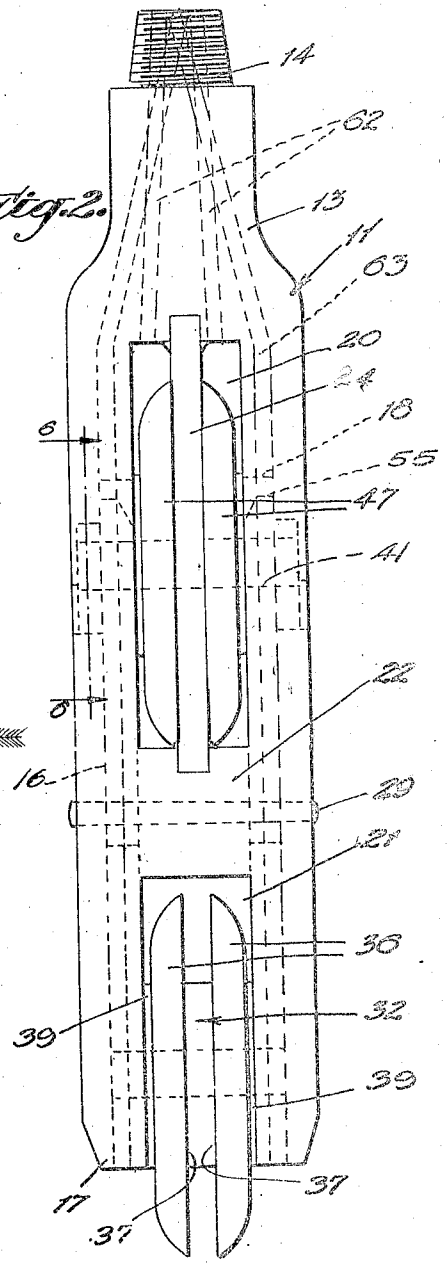


Fig. 2.



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Oct. 26, 1926. 1,604,388

A. W. CALVIN

ROTARY DRILL

Filed Dec. 27, 1924 4 Sheets-Sheet 2

Fig. 6.

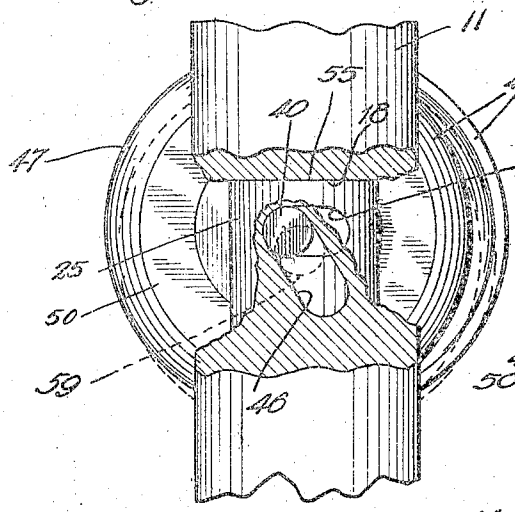


Fig. 5.

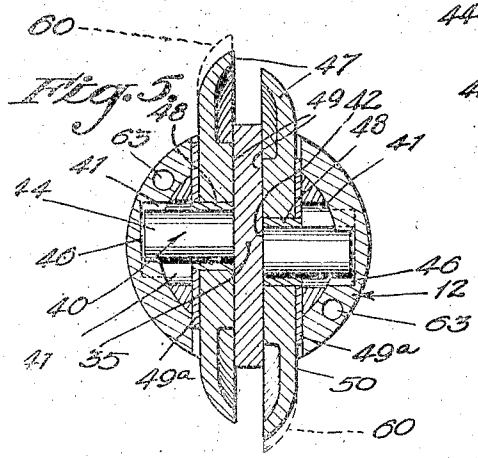


Fig. 4.

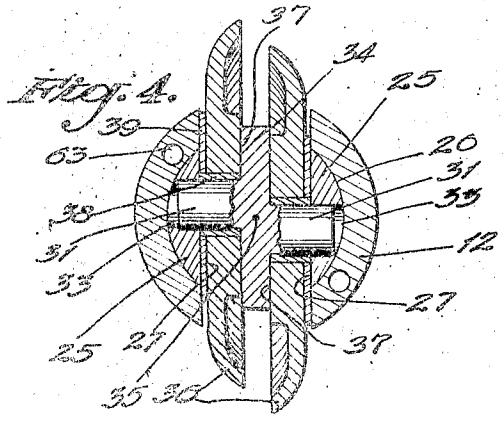
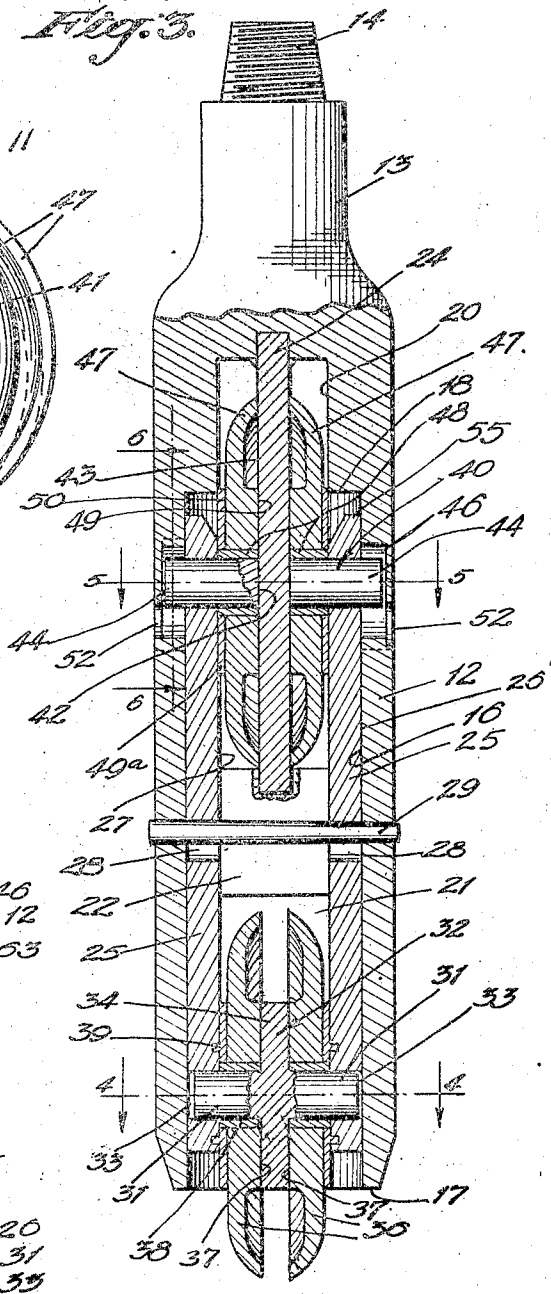


Fig. 3.



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Oct. 26, 1926. 1,604,388

A. W. CALVIN

ROTARY DRILL

Filed Dec. 27, 1924 4 Sheets-Sheet 3

Fig. 7.

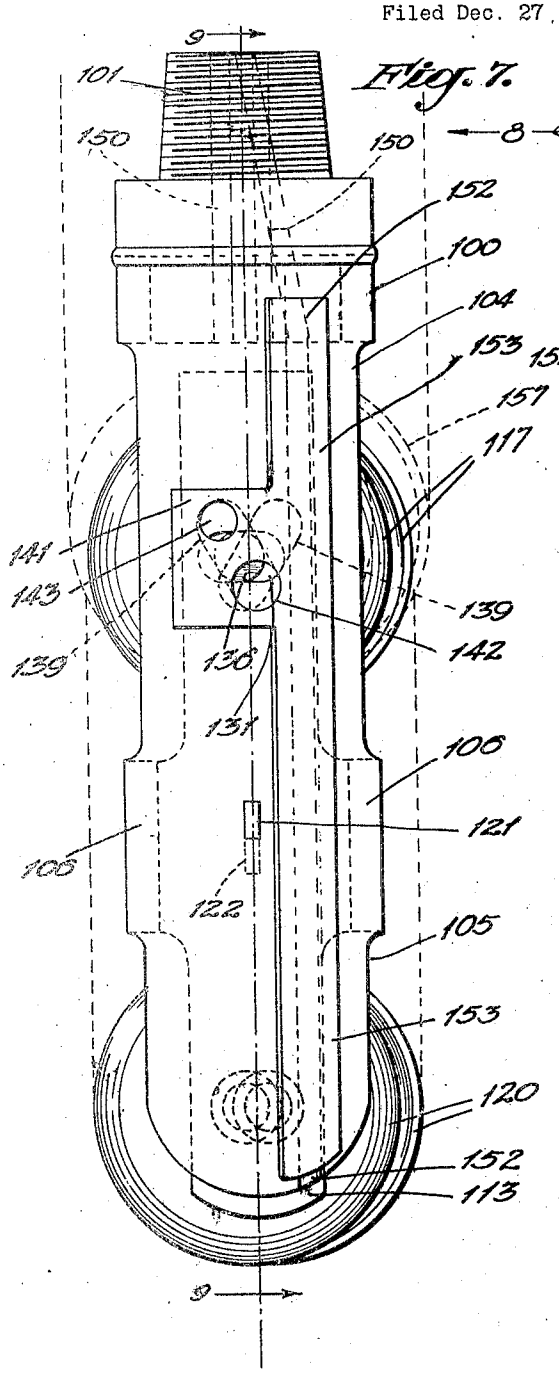
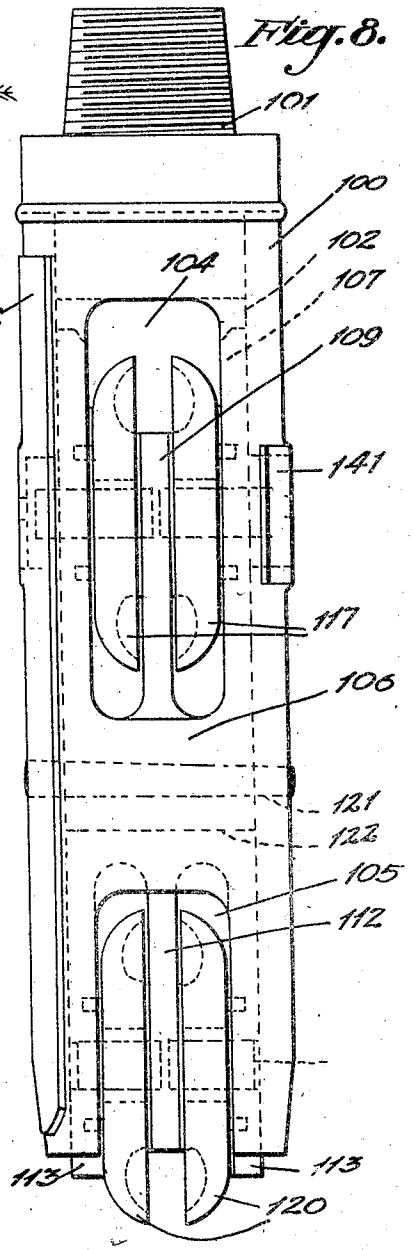


Fig. 8.



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Oct. 26, 1926. 1,604,388

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ROTARY DRILL

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Fig. 9.

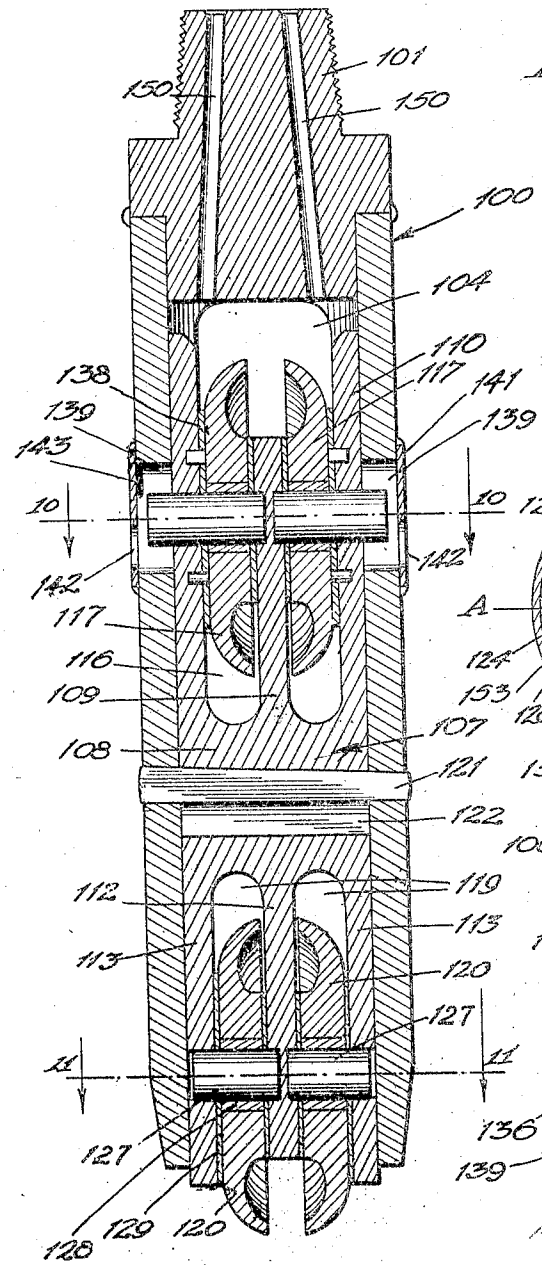


Fig. 10.

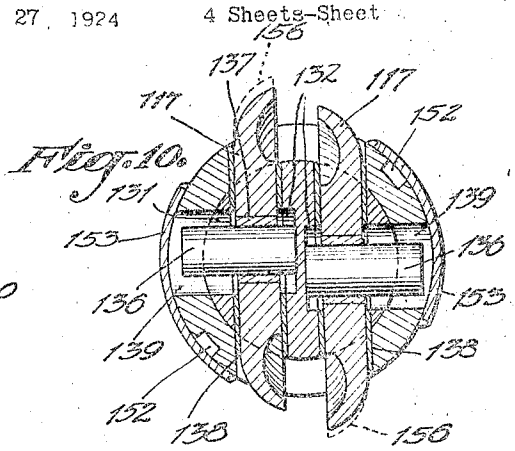


Fig. 11.

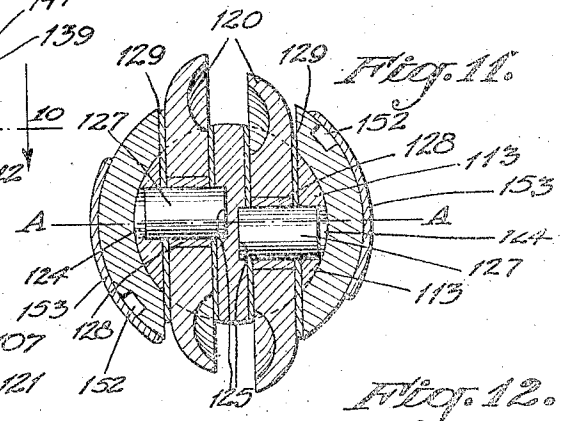
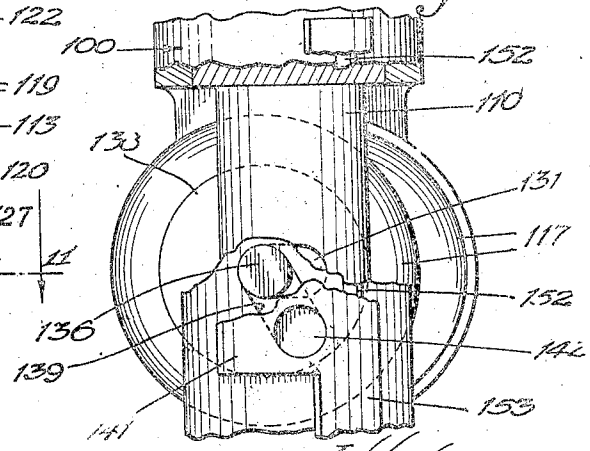


Fig. 12.



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Patented Oct. 26, 1926. 1,604,388

UNITED STATES PATENT OFFICE.

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ROTARY DRILL.

Application filed December 27, 1924. Serial No. 758,377.

This invention relates to the art of drilling oil wells by the rotary system, and it relates particularly to bits used in rotary drilling.

In this system, the rotary bit or cutter is secured to the bottom of a string of drill pipe, this string of drill pipe being rotated by means of a rotary table which is situated at the surface of the ground. Rotary mud is forced downward through the drill pipe and through openings in the bit at a point near the bottom of the hole. This mud is circulated by high pressure pumps situated on a derrick floor, the mud flowing from the bit into the hole being drilled and upward to the surface. Mud so circulated serves to carry upwardly with it cuttings from the bit; it serves to wash the surface being cut, thereby increasing the efficiency of the bit, and it also serves to mud up the walls of the hole and prevent caveins. There are various types of bits used in this system, my invention relating particularly to a reaming disc bit. It is customary practice, as a hole is drilled, to extend a reamer thereinto for the purpose of reaming the hole to a proper size for the reception of a well casing. It is sometimes the practice to carry the casing while the well is being drilled. In other words, the casing is advanced downward into the hole as the drilling proceeds. In this case it is necessary to employ a drill which will pass through a drill pipe. Therefore, the hole drilled will not be of sufficient size to permit an advancing of the well casing. For this reason it is necessary to ream the hole either by a separate underreaming tool, or by use of reaming elements which form a part of the bit.

It is an object of my invention to provide a bit having expanding reaming elements which are adapted to ream a hole to proper size as it is being drilled. I provide my invention in the form of a body carrying boring cutters and reaming cutters, the boring cutters cutting the hole, and the reaming cutters reaming the hole to proper size.

It is another object of my invention to provide a bit of this class in which the reaming cutters are automatically expanded when the boring members engage the bottom of the hole. When the reaming cutters are in retracted position, the bit may pass through the well casing. However, when the boring members of the bit engage with the bottom of the hole, these reaming cutters are automatically moved into expanded position, in which position they ream the hole to a size which will permit the advancing of the well casing.

It is a further object of my invention to provide in a bit of this character, a novel arrangement for expanding the reaming cutters. I accomplish this by supporting the boring cutters and the reaming cutters on insert members which are carried by the body of the bit, these insert members being movable relative to said body. When the boring cutters engage the bottom of the hole, a relative movement between the insert members and the body is incurred. Means is provided for automatically moving the reaming cutters laterally into expanded position when said relative movement occurs.

It is also an object of my invention to provide a bit of the character mentioned which may be readily assembled and disassembled. The bit is of such a character that it may be disassembled by removing certain pins, which is easily accomplished. The removing of these pins allows the facile removal of the reaming cutters, the insert members and the boring cutters.

It is also an object of my invention to provide a bit of this character which is very rugged in construction. My bit employs but few parts which may be made quite large, and are therefore very strong.

It is a still further object of my invention to provide a bit of this character in which the component parts are protected by the body of the bit.

It is another object of my invention to provide a disc bit having the above elucidated features.

Other objects and advantages of my invention will be made evident hereinafter.

Referring to the two sheets of drawings which are for illustrative purposes only:—

Fig. 1 is an elevational view through a disc bit embodying the features of my invention.

Fig. 2 is a view taken at right angles to Fig. 1 as indicated by the arrow 2 of Fig. 1.

Fig. 3 is a vertical section taken substantially on the line 3—3 of Fig. 1.

Fig. 4 is a cross section taken through boring members of the bit, this view being taken substantially on the line 4—4 of Fig. 3.

Fig. 5 is a cross sectional view taken through reaming cutters of my invention, this view being taken substantially on the line 5—5 of Fig. 3.

Fig. 6 is an enlarged fragmentary view taken substantially on the line 6—6 of Fig. 3, this view clearly showing means for removing reaming cutters into expanded position, the reaming cutters being shown in expanded position in this view.

Fig. 7 is an elevational view of an alternative form of my invention.

Fig. 8 is an elevational view of the bit shown in Fig. 7 taken as indicated by the arrow 8 of Fig. 7.

Fig. 9 is a vertical sectional view taken on the line 9—9 of Fig. 7.

Fig. 10 is a horizontal cross section taken as indicated by the line 10—10 of Fig. 9.

Fig. 11 is a cross section taken as indicated by the line 11—11 of Fig. 9.

Fig. 12 is an enlarged fragmentary view showing the means for removing the reaming cutters of this modification of my invention into reaming position.

The form of my invention shown in the drawings provides a body 11 having a cylindrical portion 12, a neck 13 and a tool joint pin 14 which is formed at the upper end thereof for attaching the bit to a string of drill pipe. A cylindrical bore 16 is formed concentrically in the body 11, this bore being extended from the lower end 17 thereof to a point 18 as clearly shown in Fig. 3. Upper rectangular openings 20 and lower rectangular openings 21 are provided in the portion 12, these openings 20 and 21 being separated by bridge portions 22 which are integral with and serve to strengthen the body 11. A central wall 24 extends through the upper rectangular openings 20 in an axial direction, this central wall 24 rigidifying the body 11. A pair of inserts 25 are carried in the cylindrical opening 16, these inserts 25 having curved faces 26 which are of the same radius as the inner face of the bore 16, and having flat faces 27. The flat faces 27 extend parallel to each other and are in alignment with the sides of the upper openings 20 and the lower openings 21. The inserts 25 are each provided with an elongated slot 28 through which a securing pin 29 extends, this securing pin 29 extending through the portion 12 of the body 11 and serving to retain the inserts 25 in the cylindrical hole 16, but permitting a relative axial movement therebetween.

Pins 31 of a boring disc supporting member 32 which is placed between the inserts 25, extend into openings 33 provided in the lower ends of the inserts 25. These pins 31 are integral with and extend from a central web 34, this central web 34 being arranged between the inserts 25 as clearly shown in the drawings. The pins 31 are eccentric with respect to the axis of rotation 35 of the bit as shown in Fig. 4. Boring discs 36 are rotatably carried on the pins 31 of the supporting member 32, these discs 36 being placed on each side of the central web 34, faces 37 of these discs 36 engaging walls of the central web 34. Bushings 38 are situated between the boring discs 36 and the pins 31 to take wear, these bushings 38 being replaceable. Between the outer faces of the boring discs 36 and the flat faces 27 of the inserts 25 are placed wear plates 39, these wear plates 39 likewise being for the purpose of taking wear, and are also replaceable. The boring discs 36 are relatively offset as shown in Fig. 4, due to the eccentricity of the pins 31. When the bit is rotated, the boring discs 36 engage the wall of the hole on the opposite side, as is obvious. The walls 27 and the wall of the central web 34 will take all the tangential thrust placed upon the cutters 36, supplying rigidity thereto. The supporting member 32 and the discs 36 are installed previous to the inserting of the inserts 25 into the openings 16. After these parts have been assembled, the inserts are extended into the opening 16 as shown in the drawings, the boring discs 26 extending outwardly through the lower rectangular openings 21 as clearly shown in Fig. 4.

Shafts 40 extend through slide slots 41 provided in the upper ends of the inserts 25. These slide slots 41 are elongated at right angles to the axis of the body 11, and permit a movement of these shafts 40 in a lateral direction. The inner ends 42 of the shafts 40 engage with faces 43 of the central wall 24. The outer ends 44 of the shafts 40 extend into cam slots 46 formed in the portion 12 of the body 11. As shown in Fig. 1, the cam slots 46 are arranged so that they extend diagonally upward in opposing directions, this being clearly indicated by the dotted lines in Fig. 1. Reaming discs 47 are carried by the shafts 40, there being wear bushings 48 provided between the reaming discs 47 and the shafts 40. These reaming discs 47 are arranged to extend through the upper openings 20 and are disposed on each side of the central wall 24 between the vertical walls of the slots 20. Inner faces 49 of the reaming discs 47 contact with the faces 43 of the central wall 24. Wear plates 49ª are placed between the vertical walls of the slots 20, the faces 27 of the inserts 25, and the outer faces 50 of these reaming cutters. Entrance openings 52 join with the lower ends of the cam slots 46 through which entrance openings 52 the shafts 40 are inserted. To install the reaming discs 47, the inserts 25 are extended into the cylindrical opening 16 to such a position that the slide slots 41 align with the entrance openings 52 in the body 11. The reaming discs 47 are then placed in the upper slots 20 in substantially

the position shown in the drawings so that the openings in the bushing 48 align with the entrance openings 52 and the slide slots 41. The shafts 40 are then inserted through the entrance openings 52, through the slide slots 41, the bushings 48, until the inner faces 42 thereof engage with the faces 43 of the central wall 24. The inserts 25 are then forced upwardly into the position shown in Fig. 3 of the drawings so that the securing pin 29 may be installed to retain the inserts inside the cylindrical hole 16. When the securing pin 29 is in place, the shafts 40 are always retained in a position above alignment with the entrance openings 52; therefore, it is impossible for the shafts 40 to move from proper position.

When the bit is not working, and when the boring discs 36 are not in engagement with a surface, the parts of the bit are in the position shown in full lines in Figs. 1, 2, 3, 4, and 5. The reaming discs 47 are at this time in retracted or in non-working position, these reaming discs being in such a position as to allow the lowering of the bit through a well casing. When the bit is working or when the boring discs 36 are in engagement with the bottom of the hole, the pressure of the contact between the boring discs 36 and the bottom of the hole forces the inserts 25 axially upwardly relative to the body 11, these inserts moving into such a position that the upper end 55 thereof, engages with the upper face 18 of the openings 16, the moving parts thereof moving into positions indicated by the dotted lines 58 of Fig. 4. When this relative movement occurs between the inserts 25 and the body 11, the reaming discs 47 are moved from retracted into expanded positions, the expanded positions being shown by the dotted lines in Fig. 1 and by full lines in Fig. 6. The discs 47 are expanded by reason of a lateral movement in the shafts 40 which is accomplished in the following manner. With especial reference to Fig. 6, it is evident that the slide slots 41 permit relative movement between the shafts 40 and the inserts 25 in a lateral direction only, that is, in a direction at right angles to the movement of the inserts. Therefore, when the inserts 25 are moved upwardly, the shafts 40 are moved upwardly therewith. The shafts 40 in moving upwardly must also move in the direction of the elongation of the cam slots 46. Therefore, as the inserts 25 are moved upwardly, the shafts 40 move upwardly and move laterally from the dotted line position 59 in Fig. 6 into the full line position of this figure. The opposing cam slots 46 being extended diagonally upward in crossing directions move the shafts 40 laterally in opposite directions. This serves to move one reaming disc 47 in one direction and the other reaming disc in the opposite direction, thereby accomplishing the moving of these discs from retracted into expanded position. When the reaming discs 47 are in expanded position, the cutting edges as indicated by the dotted lines 60 of Fig. 1 are situated on a larger diameter relative to the axis of rotation 35 of the bit. Therefore, when they are in this position, they will cut a larger sized hole than the boring discs 36. The pressure of cutting against the reaming discs 47 is taken directly by the body, the inserts 25, and the central wall 24, similar to the manner in which the thrust is taken in case of the boring discs 36.

When the boring discs 36 are removed from engagement with the bottom of the hole, the weight of these discs 36, the discs 47 and the inserts 25 move the reaming discs to their retracted positions, and consequently the bit may be readily removed from the well through the well casing. However, were there some interference to resist the movement of these parts into retracted position, an engagement between the peripheries of the reaming disc 47 and the lower end of the well casing would move these parts to retracted position.

Rotary mud is supplied to the reaming discs 47 through passages 62 provided in the body 11, and rotary mud is supplied to the boring discs through passages 63 provided in the body 11 as clearly shown in Figs. 1 and 2 of the drawings.

Referring to Figs. 7 to 12, inclusive, an alternative modification of my invention is provided in the form of a body 100 having a tool joint pin 101 formed at the upper end thereof. A concentric opening 102 is provided in the body 100, this opening extending from the lower end of the body 100 as shown clearly in Fig. 9. Upper rectangular openings 104 and lower rectangular openings 105 are formed in the body 100, which openings are separated by a bridge portion 106, the body being similar in construction with the first described modification of my invention.

Disposed in the opening 102 is an insert 107. The insert 107 comprises a central portion 108 from which there extends upwardly therefrom an upper central leg 109 and upper outer legs 110. Extending downwardly from the central portion 108 is a central lower leg 112 and outer lower legs 113. The upper legs 109 and 110 are spaced apart as shown, so as to provide spaces 116 in which reaming discs 117 are placed, and the lower legs 112 and 113 have spaces 119 therebetween in which boring discs 120 are arranged. The insert 107 is retained in the opening 102 by a key 121, this key being secured in the body 100 and extending through an elongated slot 122 formed in the central portion 108 of the insert 107. As is clearly evident from Fig. 9, the elon-

gated slot 122 is wider than the key 121. This arrangement serves to retain the insert 107 in the opening 102 in such a manner that there may be a relative movement therebetween.

With particular reference to Fig. 11, the legs 113 have openings 124 and the central leg 112 has cavities 125. The opening 124 in the right hand lower leg 113 is eccentric with respect to the center line A—A of Fig. 11, and the right hand cavity 125 is aligned therewith; and the left hand opening 124 and the left hand cavity 125 are eccentric with respect to the center line A—A, but are offset to the opposite side of the line A—A from which the right hand opening and cavity 124 are offset. Pins 127 are arranged to extend into the openings 124 and the cavities 125, these pins carrying boring discs 120, there being bushings 128 and wear plates 129 provided to receive wear. It is obvious that by offsetting the pins in this manner, the discs are likewise offset so that the oppostie edges thereof engage the wall of the hole. The boring discs and pins 127 are installed before the insert 107 has been entirely inserted into the concentric opening 102. The pins 127 are extended through the openings 124, the bushings 128 and into the cavities 125 from the outside.

As clearly shown in Fig. 10, elongated openings 131 are provided in the outer upper legs 110 and elongated cavities 132 are provided in the central leg 109, these openings and cavities being offset in the same manner as the openings and cavities in the lower legs of the insert 107. The openings 131 and cavities 132 are elongated in a direction at right angles to the axis of the bit. The shafts 136 extend through the openings 131 through the spaces 116 and into the elongated cavities 132. The reaming discs 117 are rotatably carried on these shafts 136 in the spaces 116, there being bushings 137 and wear plates 138 to receive the wear. The outer ends of the shafts 136 extend into cam slots 139 formed in the body 110. These cam slots 139 as clearly shown in Figs. 7 and 12 are arranged so that their elongations are directed diagonally with respect to the axis of the bit. The opposite cam slots 139 are extended upwardly in different directions. From an inspection of Figs. 9 and 10, it is seen that the cam slots 139 are cut entirely through the body 100 and that plates 141 are welded to the body 100 in such a manner as to close the outer edge of these slots. Entrance openings 142 are provided in the plates 141 near the lower ends of the cam slots 139. Small openings 143 are provided near the upper ends of the cam slots 139 to allow for the cleaning of mud from the slots 139. The shafts 136 and the reaming discs 117 are installed as follows:

The insert 107 is extended into the opening 102 to the extent that the elongated slots 131 align with the entrance openings 142. The discs 117 are then placed between the upper legs 109 and 110 so that the openings in the bushings 137 align with the slots and cavities 131 and 132. The shafts 136 are then inserted through the entrance openings 142 so as to extend through the openings 131, the bushings 137 and into the cavities 132. The insert 107 is then moved upwardly into its lower position in the cylindrical opening 102 and the securing key 121 is then installed, this securing key extending through the slot 122. After the key 121 is positioned, it is impossible for the insert 107 to drop low enough for the shafts 136 to align with the entrance openings 142; therefore, these openings will be retained in place by the plates 141. When the boring discs 120 and the reaming discs 117 are installed as shown, they project through the lower opening 119 and the upper rectangular openings 116, respectively.

The principle of construction in this drill bit is very similar to the construction of the first described modification of my invention. The important changes in this construction are, first, that the insert member is made integral instead of being made in two members. This practice tends to provide a more sturdy drill. Another difference in construction is that the central walls are formed integral with the insert 107 instead of being a separate part or a part of the body. This also tends toward strength. By cutting the cam slots 139 entirely through the body of the wall 100 and then covering the outer edges of these slots by a plate, it is possible to cheapen the manufacturing cost of the drill.

Lubrication for the reaming discs and the boring discs is supplied through passages 150. The passages 150 are drilled from a central point at the extreme upper end of the pin 101 diagonally downwardly so that they communicate with the outer face of the drill as indicated at 152. Channels 153 are then cut axially along the outer face of the body 100. The plates 141 have strips 153 which close the outer portions of the slots 152, thereby providing a closed passage. These plates 141 are secured in place preferably by welding. In this manner the cost of forming lubrication passages is greatly reduced. It is evident that it is an intricate task to drill a hole through a narrow wall such as is provided by the lower portion of the body 100, it being much simpler, cheaper and quicker to mill a slot from the outer face of the body and to then close the slot by a plate 141.

As shown in full lines in Figs. 7 to 11, inclusive, the drill is in a non-operative position. When this drill is lowered into

the well and the boring discs 120 come in contact with the bottom of the hole, the pressure thereagainst moves the insert 107 upwardly in the opening 102 relative to the body 100, this movement being permitted due to the fact that the slot 122 is wider than the securing pin 121. This relative movement between the insert and the body moves the reaming discs 117 from a retracted position into an expanded position in the following manner:

With especial reference to Figs. 10 and 12, it will be seen that the slots 131 and the cavities 132 are elongated and permit a movement of the shafts 136 in a lateral direction relative to the insert 107. When the insert is moved upwardly, the ends of the shafts must follow the direction of the elongation of the cam slots 139. This moves the shafts 136 from the position shown in full lines in Figs. 7 to 11 into a position shown by the full lines in Fig. 12. It will be seen that the pins move upwardly and outwardly. This movement of the shafts 136 moves the reaming discs 117 from retracted position into expanded position, this expanded position being shown in Fig. 12, and also being shown by dotted lines 156 of Fig. 10 and dotted lines 157 of Fig. 7. The complete operation of both types of bits are analogous.

From the foregoing description, it will be seen that my invention provides a disc bit which is very rugged in construction. I employ a minimum of parts which are made of sufficient size to withstand a maximum of strain. The smaller parts of the bit are well protected by the body, the peripheral parts of the discs 36 and 47 being the only parts which are directly exposed by the body. The wearing parts of the bit are readily replaced due to the ease with which the parts may be disassembled and assembled.

A bit of my invention is adapted for use in drilling either when a casing is being carried, or when a casing is not being carried. The bit will bore the hole and ream it to a proper size to receive a casing. By making the reaming disc 47 expansible, it is possible to use my bit when a well casing is carried because of the fact that when the reaming discs are in retracted position, they will readily pass through the well casing. However, when they are in expanded position, they will ream the hole to a sufficient size to permit the advancing of the casing.

The novel feature of expanding the reaming discs by contact of the boring disc 36 with the bottom of the hole is distinctive. It will be seen that I eliminate any spring releasing and other mechanism which might get out of order. The inherent tendency is for the bit to remain in retracted position, that is, the weight of the parts tend to hold the reaming disc 47 in retracted position; therefore, there is absolutely no danger of these discs expanding during the passage of the bit through the casing.

I claim as my invention:—

1. In a drill bit of the class described, the combination of: a body; inserts carried by said body, said inserts being secured to said body so as to be relatively movable with respect to said body; boring discs carried by said inserts, said boring discs moving said inserts relative to said body when said discs engage a surface; reaming discs; and shafts supporting said reaming discs, said shafts extending through slide slots in said inserts and into cam slots in said body, said shafts being movable by said cam slots in such a manner as to move said reaming discs from retracted into expanded position when said inserts are moved.

2. In a drill bit of the class described, the combination of: a body, said body having a cylindrical hole and upper and lower openings; inserts positioned in said cylindrical hole; means for securing said inserts in said cylindrical hole relatively movable to said body; boring discs carried between said inserts, said boring discs extending through said lower openings and moving said inserts when said boring discs engage a surface; reaming discs extending through said upper openings; and shafts supporting said reaming discs, said shafts extending through slots in said inserts and extending into cam slots formed in said body, said shafts being moved by said cam slots in a manner to move said reaming discs from retracted into expanded position.

3. In a drill bit of the class described, the combination of: a body, said body including a cylindrical hole, upper openings, lower openings and a central wall positioned in said upper openings; inserts placed in said cylindrical hole, said inserts being relatively spaced; a pin for securing said inserts to said body so as to permit an axial relative movement between said inserts and said body; boring discs, said boring discs extending through said lower openings between said inserts; a supporting member, said supporting member comprising a central web arranged between said boring discs, and pins extending from said central web, said pins extending into journal openings in said inserts, thus supporting said supporting member and said pins carrying said boring discs; reaming discs extending through said upper slots between said inserts and on either side of said central wall; and shafts carried by said inserts for carrying said reaming discs.

4. In a drill bit of the class described, the combination of: a body, said body including a cylindrical hole, upper openings,

lower openings and a central wall positioned in said upper openings; inserts placed in said cylindrical hole, said inserts being relatively spaced; a pin for securing said inserts to said body so as to permit an axial relative movement between said inserts and said body; a supporting member arranged at the lower end of said inserts, said supporting member comprising a central web placed between said inserts, and pins extending from said central web into openings in said inserts; boring discs, said boring discs being carried on said pins between said inserts and extending through said lower openings, said boring discs moving said inserts relative to said body; reaming discs, said reaming discs extending through said upper openings and being arranged between said inserts and to each side of said central wall; and shafts for supporting said reaming discs, said shafts extending through slide slots formed in said inserts into cam slots formed in said body and engaging said central wall, said shafts being moved laterally in said slide slots by said cam slots when said inserts are moved relative to said body.

5. A drill bit as defined in claim 4 in which said body has insertion openings joining with said cam slots for permitting the installation of said shafts.

6. In a drill bit of the class described, the combination of: a body, said body having a longitudinal cavity therein, there being upper openings and lower openings from said cavity to the outside of said body; a central wall provided upon said body in the cavity thereof and dividing the space between said upper openings; inserts placed in said cavity in spaced relationship; means for securing said inserts to said body so as to permit longitudinal displacement between said inserts and said body; boring discs disposed between said inserts and extending outwardly through said lower openings; a spacing member between said boring discs; pins extending from said spacing member, through said boring discs and into apertures in said inserts, thus supporting said boring discs; reaming discs extending through said upper openings between said inserts and on opposite sides of said central wall; and shafts carried by said inserts for carrying said reaming discs, said inserts being longitudinally displaceable relative to said body by said boring discs upon the latter contacting the bottom of a hole, and in which displacement the last mentioned shafts engage co-operating cam surfaces upon said inserts and said body, this engagement causing said reaming discs to be extended for a greater cutting radius.

7. A drill bit as defined in claim 6 in which said body is provided with insertion openings from the exterior thereof for permitting the installation of said reaming disc shafts.

In testimony whereof, I have hereunto set my hand at Los Angeles, California, this 13th day of December, 1924.

ALBERT W. CALVIN.