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EXPANSION DRILL BIT
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Fig.13.

Fig.17.

Fig.14.

Fig.16.

Fig.15.

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My invention relates to the deep well drilling art and more particularly to bits used with rotary drilling equipment.

Such rotary equipment includes a drill pipe having a drill bit provided on its lower end. The drill pipe extends vertically into the earth and is rotated by a rotary table of the derrick to cause the bit to form a hole. As the bit employed usually has a fixed diameter, which is larger than the inside diameter of the casing to be put in the hole, the hole is formed to a desired depth and the drill stem withdrawn, after which the casing is extended into the hole and cemented in place at the bottom of the hole. Then, after the cement has hardened, a smaller drill bit which will pass down inside the casing is used to drill through the cement and deepen the hole. The deepened portion of the hole is then provided with a second casing which extends through the first casing and is cemented in place at the bottom of the deepened portion of the hole. The drilling of the hole is then continued with a still smaller bit which will pass through the second casing. The hole thus formed receives a third and still smaller casing which is extended down through the second casing. Thus, the drilling of the well continues until oil is reached.

In using a bit of fixed diameter, as above outlined, each successively deepened portion of the hole is of smaller diameter than the casing through which a bit must be passed to form that deepened portion. Thus, when the drill bit and stem are withdrawn and a casing extended down into this deepened portion, there is very little space between the hole and the casing in which to force cement for the cementing job. It is of vital importance that ample space be provided for this cement as the success of the entire well depends upon the exclusion of water strata from the well by this cement.

It is another object of my invention to provide an expansion drill bit which may be expanded after passing through a casing or after it has been lowered to the level where it is to be operated so that the hole formed beneath that casing may be larger than the diameter of that casing.

The improved expansion drill bit is characterized by the provision of a bit stem which may be expanded against the casing as it drills the hole for it, the drill being adapted to be contracted and withdrawn through this casing.

Expansion bits have been previously provided, but these have had a tendency to collect mud on the cutters so as to form a hard ball on the bit so that the bit cannot be withdrawn upward through the casing through which it was extended into the well. Thus, it is necessary to waste a considerable length of time waiting for the ball of mud formed on the bit to dissolve so that the bit may be collapsed and withdrawn through the casing.

It is a further object of my invention to provide an expansion drill bit which is adapted to be operated to break up and remove a ball of dirt whenever such a ball starts to form on the bit.

Expansion bits heretofore produced required the collapsing of the cutters into positions in which they were closer together than when extended into cutting position, in order that the bit might be withdrawn through the casing. Many times such contraction is made impossible due to the presence of detritus between the cutters, which keeps the cutters separated and prevents their moving into retracted or collapsed position.

It is yet another object of my invention to provide an expansion drill bit in which a space between the cutters is greater when these are in retracted or collapsed position than when these cutters are in extended position.

It is of vital importance to the proper operation of an expansion drill bit that the parts thereof be free at all times to have the proper movement relative to each other.

It is a further object of my invention to provide an expansion drill bit in which this freedom of the parts of the bit is maintained by a flushing action of a lubricating fluid supplied thereto.

Further objects and advantages will be made manifest in the following description and in the accompanying drawings in which several forms of drill bits embodying my invention are illustrated.
In the drawings,—

Fig. 1 is a side elevational view of one embodiment of my invention with the cutters thereof in extended position.

Fig. 2 is a view similar to Fig. 1 in which the cutters are moved to retracted position.

Fig. 3 is a bottom plan view of Fig. 1.

Fig. 4 is a bottom plan view of Fig. 2.

Fig. 5 is a vertical sectional view taken on the line 5—5 of Fig. 3.

Fig. 6 is a horizontal sectional view taken on the line 6—6 of Fig. 5.

Fig. 7 is a vertical sectional view taken on the line 7—7 of Fig. 3.

Fig. 8 is a horizontal sectional view taken on the line 8—8 of Fig. 7.

Fig. 9 is a vertical sectional view similar to Fig. 5, illustrating cutter parts of the drill bit shown in Fig. 5, shifted downward into flushing position.

Fig. 10 is a horizontal sectional view taken on the line 10—10 of Fig. 9.

Fig. 11 is a plan view of the bit shown in the previous views.

Fig. 12 is a perspective view of a cutter and cutter support which forms a part of the drill bit shown in the foregoing figures.

Fig. 13 is a vertical sectional view taken on the line 13—13 of Fig. 16 and illustrates a second form of the bit of my invention.

Figs. 14 and 15 are horizontal sectional views taken on the correspondingly numbered lines of Fig. 13.

Fig. 16 is a bottom plan view of Fig. 13 partially in section for illustrating the mounting of the cutters upon their supports.

Fig. 17 is a side elevational view of the drill bit shown in Fig. 13, taken from the same view-point and showing the cutters thereof disposed in retracted position.

Referring specifically to the drawings and particularly to Figs. 1 to 8, and 11 and 12, the numeral 20 indicates one embodiment of the drill bit of my invention. This bit includes a body 21 which has a slight upward taper and which is provided with a threaded pin 22 at its upper end for securing it to the lower end of a drill stem. Extending upward into the body 21 are bores 23 which are identical in shape and symmetrically formed on opposite sides of the axis of the body 21. The upper end of each of the bores 23 is connected by a rotary mud passage 24 which leads to the top of the pin 22 so as to connect with the supply passage of the drill stem to which the pin is attached. Formed in the body 21 so that each connects with the upper portion of one of the bores 23 are two threaded detent pin holes 25. The upper portion of the bores 23 are substantially cylindrical, while the lower portion is enlarged toward one side thereof to form a semi-annular frusto-conical cavity 27. Each cavity 27 has radial abutment faces 28 and 29.

Extending upward into each of the bores 23 is one of a pair of identical cutter supports 30. Each of the supports 30, as clearly shown in Fig. 12, has a cylindrical shank 37 which extends into the upper portion of the bore 23, the shank 37 being turned down at its upper end to provide a pin 38 and a bearing seat 39. Formed in the shank 37 a slight distance below the bearing seat 39 is an annular detent channel 40. Formed integrally with the lower portion of the shank 37 is a semi-annular frusto-conical shoulder 45 from which a cutter supporting arm 46 extends downward. Formed in the lower end of the leg 46, with its axis disposed in crossing relation with, and to one side of, the axis of the shank 37, is a cutter pin bore 50. Adapted to be mounted upon the arm 46 is a cutter 51 which, in the present instance, is shown as a disc cutter. The cutter 51 has a central bearing hole 53 and bearing bushings 54 countersunk into opposite faces of the cutter 51 and surrounding the hole 52. Passing through the hole 52 and the bushing 53 and extending into the pin hole 54 is a cutter pin 55. The pin 55 has a head 56 which retains the cutter 51 upon the pin 55 and the latter is secured in the bore 50 by a key pin 56 which is driven into a suitable hole bored through the arm 46 and the cutter pin 55. The cutter pins are on horizontal axes A—A which are offset a distance B from the axes C—C of the supports 30.

Extending longitudinally through each cutter support 36 is a main lubricating fluid passage 60, the upper end of which is disposed opposite the lower end of one of the fluid passages 54 formed in the bit body 21 and the lower end of which opens from the bottom of the cylindrical shank 37 so that the axis thereof intersects the upper edge of the cutter 51 carried by that support 36. Lateral fluid passages 62 are formed in each shank 37 and lead from the central passage 60 therein to the peripheral surface of the shank. Other lateral openings 63 are formed in each shank 37 which lead from the central fluid passage 60 and open on opposite sides of the shoulder 45.

In assembling the bit 20, an anti-friction thrust bearing 65 is placed around the pin 38 on each cutter support 36 so that when the supports 36 carrying the cutters 51 are extended upward into the bores 23, the thrust bearings 65 abut against the upper ends of the bores 23 so as to permit free rotation of the supports 36 in the bores 23 within the limits described hereinafter. The supports 36 are retained against removal from the bores 23 by threaded detent pins 68 which are secured into the threaded holes 25 and project into the detent channels 40.

When the supports 36 are thus assembled on the body 21, the shoulders 45 are disposed in the cavities 27. As clearly shown in Fig. 6, the shoulders 45 are formed with their...
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outer frusto-conical surfaces co-axial with the
axis of the shank 37 so that each shoulder 45 is free to rotate in its respective cavity 27 as its shank 37 rotates in a bore 23. This rotation of the shank 37 is limited, however, to the angular movement between the position in which the shoulder 45 abuts against the abutting face 28 and the position in which that shoulder abuts against the face 29. As clearly shown in Figs. 3 and 4, the cutters 51 are disposed in extended or cutting position when the shoulders 45 abut against the faces 29, but are disposed in retracted or collapsed position when the shoulders 45 abut against the faces 28. The operation of the bit 20 is as follows: The bit is secured upon the lower end of the drill stem and advanced downward through a string of well casing which is slightly larger than the maximum diameter of the body 21 and while the cutters 51 are in retracted position, as shown in Fig. 4. As the bit passes out of the lower end of the casing and approaches the solid earth at the bottom of the hole, the drill stem is rotated in a right-hand direction which causes the cutters 51 to engage the earth and rotate the supports 36 ninety degrees, so as to bring the shoulders 45 in contact with the abutting faces 29. The cutters 51 are now disposed, as shown in Fig. 3, and obviously, when the drill is rotated, will form a hole considerably larger than the diameter of the body 21 and also larger than that of the casing through which it was extended. Referring particularly to Figs. 3 and 4, it will be seen that the axes C—C are eccentric of the body 21, and further that the axes A—A are eccentric of the body 21, and also of axes C—C. Thus the parts 36 are of the trailing or caster type and when they are rotated on their axes C—C, the axes A—A are rotated around the axes C—C; therefore when the supports rotate from the positions shown in Fig. 4 into the positions shown in Fig. 3, the cutters 51 will be swung bodily outward with respect to the body 21, and will occupy cutting position as shown. While the bit 20 is being lowered to operating position and also while it is being operated, the circulation of lubricating fluid, which in general practice is rotary mud, is maintained at all times. This passes down through the drill stem, the drill bit passages 24 and 60, and after lubricating the parts of the bit 20, passes upward through the casing carrying with it the detritus which has been formed by the boring action of the drill. Each shank 37 has a fairly loose fit in its respective bore 25 so that rotary mud will flow through the lateral passages 62 and downward between the supports 36 and the bores 25. This keeps this space free from dirt or other material which might otherwise be forced thereinto so as to prevent easy rotation of the cutter supports 36 when it is desired to swing these to extend or retract the cutters 51. As shown particularly in Figs. 3 and 6, a portion of each of the cavities 27 is open when the shoulders 45 are in either of their extreme positions in these cavities. Owing to the fact that the lateral fluid passages 63 connect the central passage 60 of each support 36 with the space opposite each side of the shoulder 45 thereof, a stream of lubricating fluid is at all times passing outward through the open portion of each cavity 27 so as to maintain this entirely clear and thus permit the shoulder 45 to be rotated at any time in this cavity for the purpose of manipulating the cutters of the bit.

As clearly shown in Figs. 5 and 9, the width of the annular detent channel 40 of each cutter support 36 is greater than the diameter of the inner portion of the detent pin 68 which projects into this channel, and the detent pin 68 is so disposed that when the weight of the bit is placed upon the cutters thereof, the cutter supports 36 are moved upward so that there is a slight space between the upper face of the channels 40 and the detent pin 68. Thus, when the weight of the bit 20 is raised from the cutters 51, the supports 36 drop downward a sufficient distance so that the upper face of the channels 40 engages the detent pin, as shown in Fig. 9. This leaves a slight space 75 between each of the shoulders 45 and the surface of the cavities 27 so that the lubricating fluid discharged from the lateral passages 62 washes downward between the outer faces of the shoulders 45 and adjacent portions of the surfaces of the cavities 27. This flushes out any foreign matter which may have become lodged in the space 75.

Referring specifically to Figs. 13 to 17 inclusive, a second form of the bit of my invention is indicated by the numeral 80. The bit 80 has a body 81 which is substantially cylindrical in shape and is provided with a threaded pin 82 which extends upward therefrom and which is adapted to connect with the lower end of a drill stem upon which the bit 80 is adapted to be supported and operated. Extending downward from the upper end of the pin 82 into the body 81 are main body fluid passages 84, the lower end of each of which connects to the upper end of one of a pair of bores 85 which are identical and which are disposed symmetrically on opposite sides of the axis of the body 81. The bores 85 are formed upward from the lower end of the body 81 and have openings 86 at their lower ends which communicate laterally with the exterior of the body 81. Formed at opposite ends of each of the openings 86 are abutment faces 87 and 88. Formed centrally in the body 81 is a detent pin bore 90. Connecting the inner end of the bore 90 with the opposite sides of the body 81 is a detent pin-locking 130.
screw hole 91 which is countersunk at its outer end, as clearly shown in Fig. 14.

Extending upward into each of the bores 85 is one of a pair of cutter supports 95 which are identical. Each cutter support 95 includes a substantially cylindrical shank 96 which has a pin 97 of reduced diameter formed at its upper end to provide a bearing shoulder 98 at the base thereof. Disposed about the pin 97 to rest against the shoulder 98 is an anti-friction thrust bearing 100. Formed in the outer surface of the shank 96 a slight distance below the shoulder 98 is an annular detent channel 101. Formed integrally with the lower portion of the shank 96 is a shoulder 103. Also formed integrally with the shank 96 and extending downward therefrom are cutter supporting arms 105 and 106, the lower ends of which are spaced apart and provided with aligned cutter pin holes 107 and 108 in which a cutter pin 109 is receivable and upon which a cutter 110, which in this instance shown as a disc cutter, is rotatably mounted between the legs 105 and 106.

The cutter pins 109 are arranged on axes E—E which are offset distances G from the axes F—F of the supports 95.

Extending longitudinally through each support 95 is a central lubricating fluid passage 115, the upper end of which is disposed opposite the lower end of the body fluid passage 84 and the lower end of which opens directly over the cutting edge of the cutter 110 which is mounted upon that support 95.

Connecting each passage 115 with the exterior of the shank 96 are lateral passages 120. The central passage 115 is also connected by laterals 122 to channels 123 which are formed in the peripheral surface of the shank 96 so as to be symmetrically disposed in opposite directions from the axis of the shoulder 103 which passes through the axis of the shank 96.

In assembling the bit 80, the shanks 96 are extended upward into the bores 85 so that the thrust bearing 100 bears against the upper end of the bore 85. The shanks are then retained in place by extending a detent pin 130 into the detent pin bore 90 and retaining this in place by a machine screw 131 which extends through the bore 91 formed for that purpose. As clearly shown in Fig. 14, opposite portions of the pin 130 project into the detent channels 101 of the cutter support shanks 96 so as to prevent the latter being withdrawn from their respective bores 85. The shanks 96 have a sufficiently loose fit within the bores 85 so that rotary mud supplied to the bit 80 will flow from the body passage 84 and the central cutter support passages 115 through the lateral passages 120 and downward through the space between the support shanks 96 and the inner surface of the bores 85.

The bit 80 operates in identically the same manner as the bit 20. A particularly novel feature of a bit 80 is the provision of the cavities 86 so that these open outward and so that there is almost no chance whatever for these to be filled with detritus so as to prevent the operation of the bit. The shanks 96 may be rotated between the positions in which the shoulders 103 contact the abutment faces 87 and the positions in which the shoulders contact the abutment faces 88. In order to wash out any detritus which might be disposed in the open portions of the cavities 86, a constant stream of fluid flows outward through the lateral passages 122 and the semi-annular channels 123 while the shoulders 103 are moving towards one of the abutment faces 87 or 88.

Another important feature of the bit 80 is the provision of the arms 105 and 106 upon each of the cutter supports 95 as a mounting for the cutters 110. The cutters are thus mounted in an extremely rigid manner so that there is no possibility that they could be broken from the bit by strain incident to the ordinary use thereof.

Owing to the fact that the axes of the cutters of my bit are disposed outward from the axes of their respective cutter supports in planes parallel to the cutting edges of the cutters, the cutter are practically self-closing when the bit is drawn upward into the lower end of the well casing through which the bit is operated. The movement of the cutters from extended position to retracted position is facilitated by the fact that the space between the cutters increases in this movement as may easily be seen by a comparison of Figs. 3 and 4. Thus it is impossible for any detritus to become lodged between the cutters so as to prevent their being retracted. The greatest single drawback of the expansion bits previously devised is thus entirely overcome, as the possibility of the bit becoming stuck in expanded position is eliminated.

I claim as my invention:

1. In an expansion drill bit, the combination of: a bit body; cutter supports pivotally mounted longitudinally therein; cutters rotatably mounted upon said supports, said supports being swingable about their longitudinal axes to move said cutters between retracted and extended positions, there being circulation passages in said supports through which lubricating fluid is supplied to said cutters.

2. In an expansion drill bit, the combination of: a bit body having vertical journal recesses formed upwardly therein; cutter supports vertically journalled in said recesses to swing transversely about their vertical axes; cutters rotatably mounted on said supports; means for retaining said supports in said recesses; and stop means provided upon...
auxiliary ducts are formed in said supports 25
such as to said cutters that the planes of the inner faces of said cutters will move apart as said cutters supports move into retracted positions.

3. In an expansion drill bit, the combination of: a body; a pair of cutter supports at all times swingable on said body on substantially vertical axes, said cutter supports being at all times swingable between retracted and expanded positions; cutters carried by said cutter supports, said cutters being offset from the axes of said cutter supports; and stops for limiting the swing of said cutter supports, said stops being so positioned that the inner portions of said cutters will move apart as said supports swing from expanded to retracted position.

4. A combination as in claim 3 in which auxiliary ducts are formed in said supports to convey lubricating fluid from said passages to said stop means to keep the latter from fouling.

5. In an expansion drill bit, the combination of: a bit body having recesses formed upwardly therein; cutter supports extending into said recesses and rotatable therein; cutters provided upon said supports; means for retaining said supports in said recesses; and stop means provided upon said body and said supports, limiting rotation of said supports on said body between positions in which said cutters are retracted and positions in which said cutters are extended, there being circulation passages formed in said body and said supports through which lubricating fluid is supplied to said cutters.

6. In an expansion drill bit, the combination of: a body having a degree of longitudinal movement in said recesses when said bit is lifted, said movement setting up a passage between said body and said supports, there being lubricating fluid supply means in said body from which said fluid flushes through said passage until said bit is set down.

7. In an expansion drill bit, the combination of: a body; cutter supports pivoted to said body on substantially vertical axes, said cutter supports being at all times swingable between retracted and expanded positions; cutters carried by said cutter supports, said cutters being positioned so that imaginary lines drawn through their centers at right angles to the planes of their cutting edges do not intersect the axis of said cutter supports; and stops for limiting the swing of said cutter supports, said stops being so positioned that the inner portions of said cutters will move apart as said supports swing from expanded to retracted position.

8. In an expansion drill bit, the combination of: a body; cutter supports pivoted to said body on substantially vertical axes, said cutter supports being at all times swingable between retracted and expanded positions; rotary cutters carried by said cutter supports, said cutters being offset from the axes of said cutter supports; and stops for limiting the swing of said cutter supports, said stops being so positioned that the inner portions of said cutters will move apart as said supports swing from expanded to retracted position.

9. In an expansion drill bit, the combination of: a body; cutter supports pivoted to said body on substantially vertical axes, said cutter supports being at all times swingable between retracted and expanded positions; cutters carried by said cutter supports, said cutters being offset from the axes of said cutter supports; and stops for limiting the swing of said cutter supports, said stops being so positioned that the inner portions of said cutters will move apart as said supports swing from expanded to retracted position.

10. In an expansion drill bit, the combination of: a body; cutter supports pivoted to said body on substantially vertical axes, said cutter supports being swingable between retracted and expanded positions; and cutters journalled on said cutter supports, said cutters being rotatable on horizontal axes not intersecting the axes of said cutter supports and being so positioned that the projecting peripheries of said cutters will provide vertically rotatable engagement means for producing movement of said cutter supports into retracted position when said cutters are moved vertically into engagement with an obstruction.

11. In an expansion drill bit, the combination of: a bit body having recesses formed upwardly therein; cutter supports vertically journalled in said recesses and at all times rotatable therein; cutters provided upon said supports; means for retaining said supports in said recesses; stop means provided upon said body and said supports, limiting rotation of said supports on said body between positions in which said cutters are retracted and positions in which said cutters are extended; and means for supplying a washing fluid to said stop means.

12. In an expansion drill bit, the combination of: a body; cutter supports pivoted to said body on substantially vertical axes, said cutter supports being at all times swingable between retracted and expanded positions; cutters carried by said cutter supports, said cutters being positioned so that imaginary lines drawn through their centers at right angles to the planes of their cutting edges do not intersect the axis of said cutter supports; and shoulders on said cutter supports, the retracted and ex.
panded positions of said cutter supports being thereby determined, there being passages extending directly to the spaces between said abutment faces and shoulders for directing flushing fluid thereto.

13. In an expansion drill bit, the combination of: a body; cutter supports pivoted to said body on substantially vertical axes, said cutter supports being swingable between retracted and expanded positions; and disc cutters rotatable on said cutter supports, said cutters being rotatable on horizontal axes not intersecting the axes of said cutter supports.

14. In an expansion drill bit, the combination of: a body having vertical journal bores formed upwardly therein; cutter supports having vertical pivot shanks extending into said bores and adapted for pivotal movement therein; disc cutters rotatable on said supports; means for retaining said supports in said bores; stop means provided upon said body and said supports, limiting rotation of said supports on said body between positions in which said cutters are retracted and positions in which said cutters are extended; and means for supplying a washing fluid directly to said stop means.

15. In an expansion drill bit, the combination of: a body; cutter supports pivoted to said body on substantially vertical axes, said cutter supports being swingable between retracted and expanded positions; disc cutters carried by said cutter supports; abutment faces on said body; and shoulders on said cutter supports, the retracted and expanded positions of said cutter supports being thereby determined, there being passages extending directly to the spaces between said abutment faces and shoulders for directing flushing fluid thereto.

16. In an expansion drill bit, the combination of: a body; cutter supports pivoted to said body on substantially vertical axes, said cutter supports being swingable between retracted and expanded positions; rotary disc cutters operably mounted on said cutter supports, said cutters being offset from the axes of said cutter supports; and stops limiting the swinging movement of said cutter supports, said cutters and said stops being so positioned relative to said cutter supports that the inner faces of said cutters will move apart as said cutter supports move from expanded to retracted position.

17. In an expansion drill bit, the combination of: a body; cutter supports of the castor type having cylindrical shanks pivoted to said body on substantially vertical axes and provided with depending transversely offset legs swingable between retracted and expanded positions; rotary disc cutters carried by the free ends of the legs of said cutter supports; and means for disposing said cutters wider apart in retracted position than in expanded position.

18. In an expansion drill bit, the combination of: a body; cutter supports of the castor type having cylindrical shanks pivoted to said body on substantially vertical axes and provided with depending transversely offset legs swingable between retracted and expanded positions; rotary disc cutters carried by the free ends of the legs of said cutter supports; and means for disposing said cutters wider apart in retracted position than in expanded position.

19. In an expansion drill bit, the combination of: a body; cutter supports of the castor type having cylindrical shanks pivoted to said body on substantially vertical axes and provided with depending transversely offset legs swingable between retracted and expanded positions; and cutters carried by the free ends of the legs of said supports, said cutters being disposed wider apart in the retracted position of said supports than in the expanded position of said supports.

20. In an expansion drill bit, the combination of: a body; cutter supports of the castor type having cylindrical shanks pivoted to said body on substantially vertical axes and provided with depending transversely offset legs swingable between retracted and expanded positions; cutters carried by the free ends of the legs of said supports, said cutters being disposed wider apart in the retracted position of said supports than in the expanded position of said supports.

21. In an expansion drill bit, the combination of: a body; cutter supports of the castor type having cylindrical shanks pivoted to said body on substantially vertical axes and provided with depending transversely offset legs swingable between retracted and expanded positions; cutters carried by the free ends of the legs of said supports, and means for disposing the confronting faces of said cutters wider apart in retracted position than in expanded position.

22. In an expansion drill bit, the combination of: a body; a plurality of cutters having inner portions outlining a space; and cutter supports for holding said cutters on said body, said cutter supports rotating relative to said body through arcs and carrying the inner faces of said cutters into greater spaced relationship and at the same time carrying said cutters into retracted positions relative to said body.

In testimony whereof, I have hereunto set my hand at Los Angeles, California, this 5th day of August, 1927.

ANTHONY E. CARLSON.