Feb. 18, 1930. W. V. SEIFERT 1,747,908

ROTARY DRILL BIT

Filed Aug. 11, 1923 3 Sheets-Sheet 1

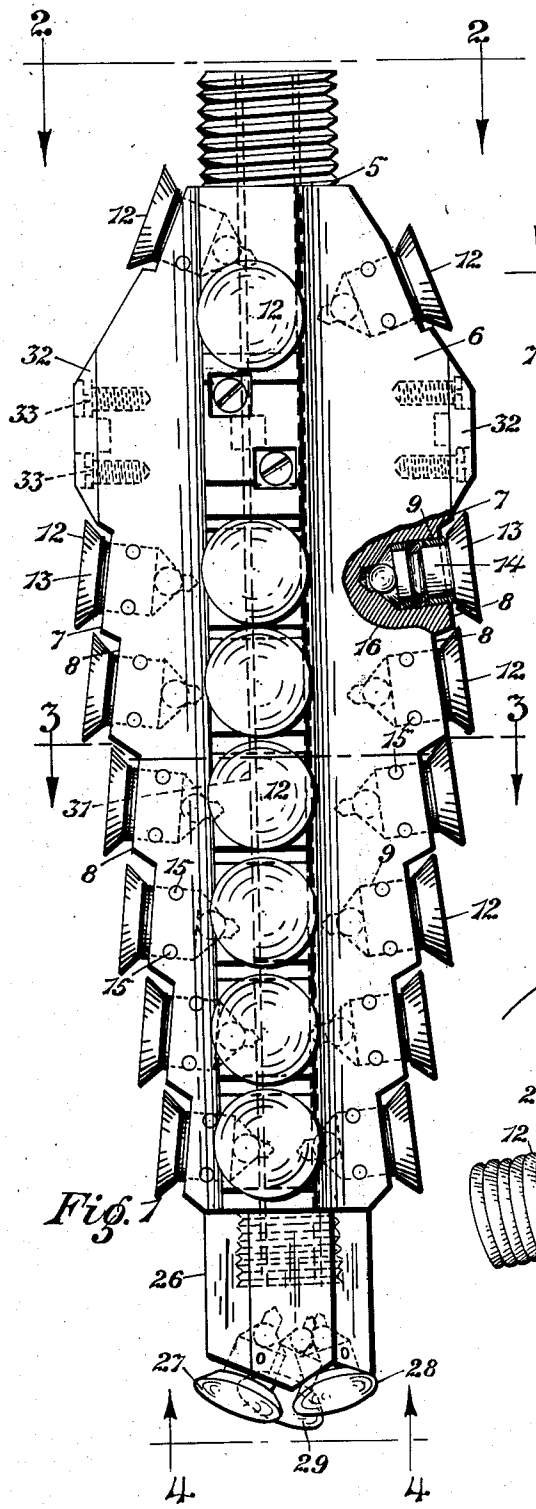


Fig. 1

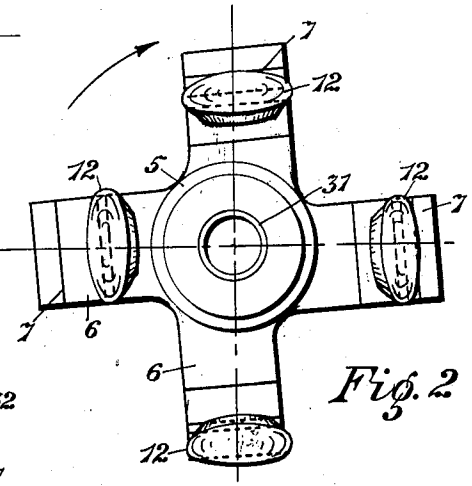


Fig. 2

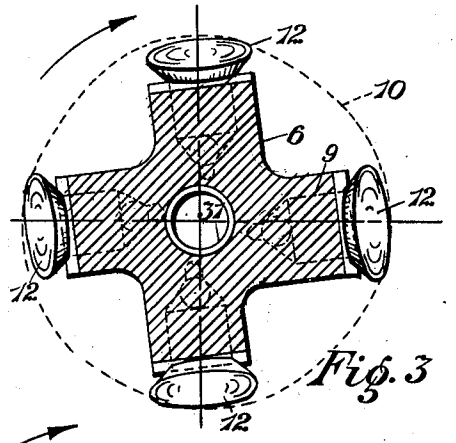


Fig. 3

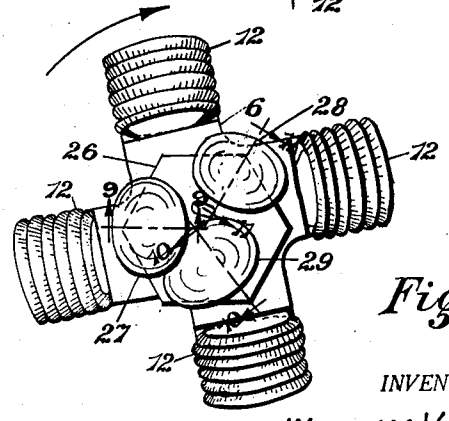


Fig. 4

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ROTARY DRILL BIT

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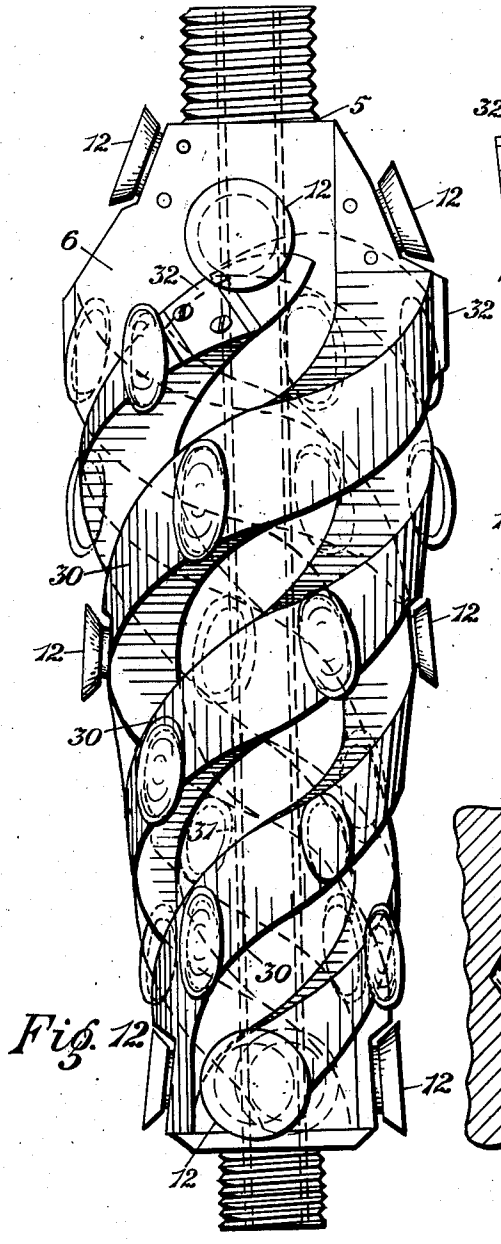


Fig. 12

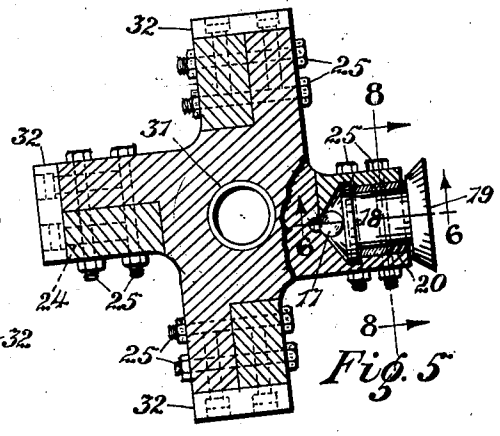


Fig. 5

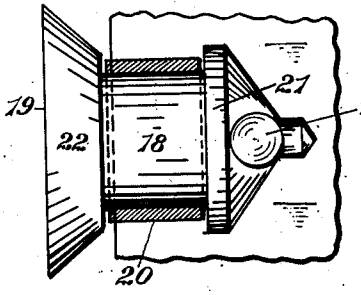


Fig. 6

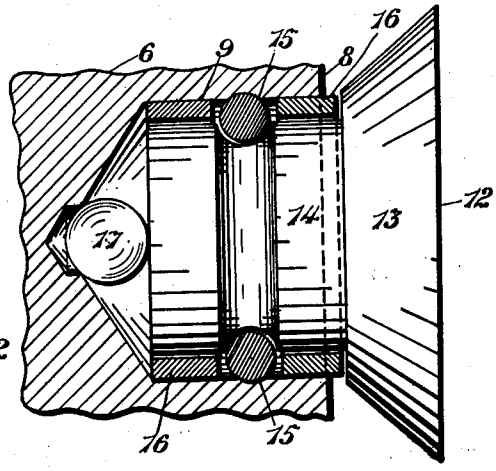


Fig. 7

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ROTARY DRILL BIT

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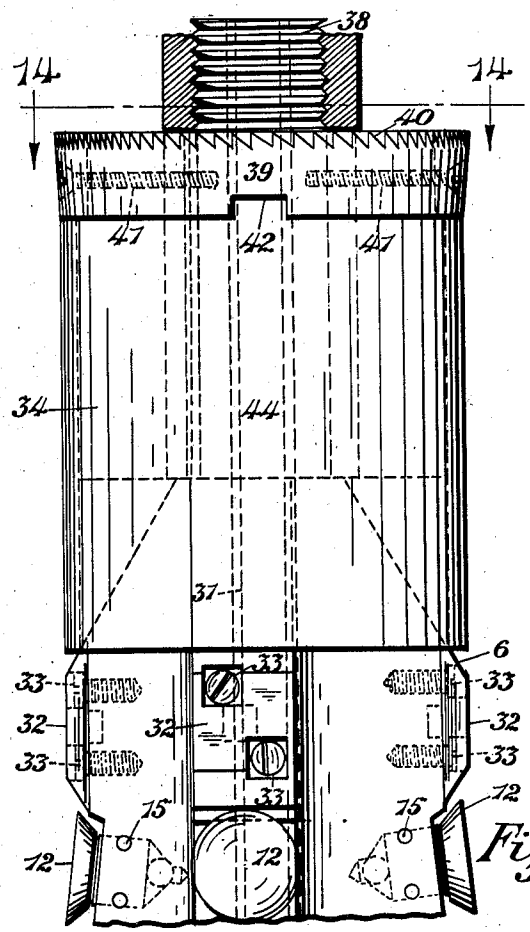


Fig. 13

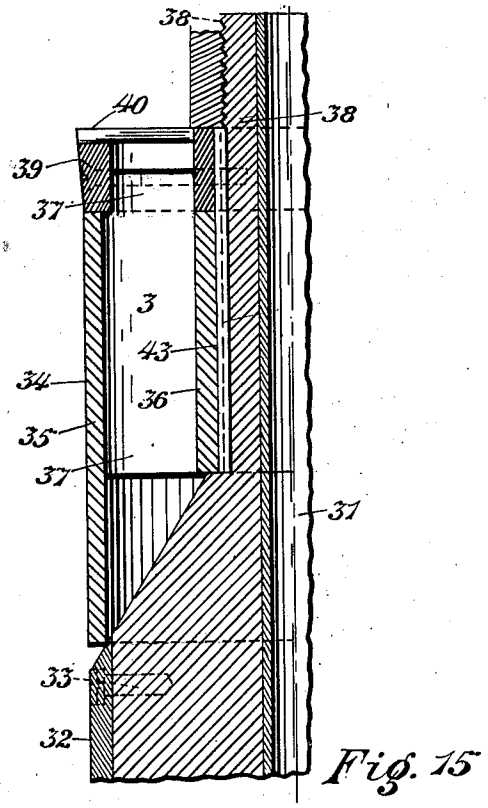


Fig. 15

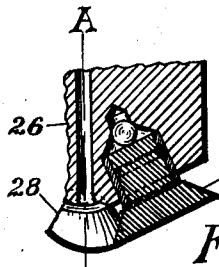


Fig. 9

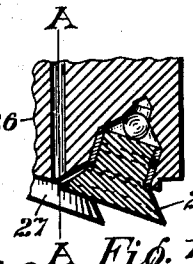


Fig. 10

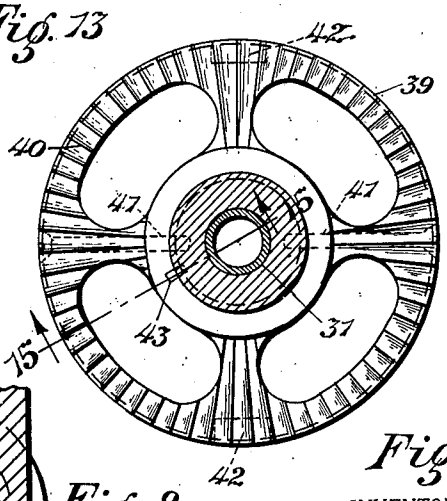


Fig. 14

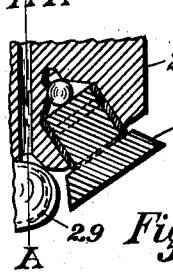


Fig. 11

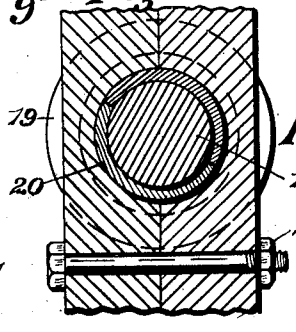


Fig. 8

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Patented Feb. 18, 1930 1,747,908

UNITED STATES PATENT OFFICE

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ROTARY DRILL BIT

Application filed August 11, 1923. Serial No. 656,886.

This invention relates to rotary bits for drilling wells and the like and aims to provide an improved bit designed for drilling through both soft and hard materials.

The invention is shown embodied in a bit provided at its end with a plurality of rotary cutting discs skewed with reference to their direction of bodily travel (so as to insure rotation thereof) and inclined to engage the material with a cutting action. The discs are in this instance arranged at different distances from the axis of the bit and travel in a plurality of concentric paths which collectively cover substantially the bottom of the hole. In the present bit this hole is enlarged by cutting discs disposed along the body of the bit and at different distances from the axis thereof so as to effect a progressive enlargement of the hole. These discs likewise are skewed with reference to their direction of bodily travel and inclined to engage the material with a cutting action. The lower end of the bit in addition to forming the hole serves as a pilot to center the cutters on the upper portion of the bit body.

The aforesaid bit embodying the invention is illustrated in the accompanying drawings.

In said drawings:—

Figure 1 represents a partially sectional elevation of the drill bit in its simplest form;

Figure 2, a plan view of the same;

Figure 3, a transverse section taken on the line 3—3, Figure 1;

Figure 4, an underneath view of the drill bit looking in the direction of the arrows drawn across the line 4—4, Figure 1;

Figure 5, a cross sectional view of a bit modified in construction for the application of cutting members of the improved form hereinbefore referred to;

Figure 6, an enlarged elevation of the improved cutting member in a plane indicated by the line 6—6, Figure 5;

Figure 7, an enlarged sectional elevation of one of the cutting members shown in Figure 1;

Figure 8, a cross section on the line 8—8, Figure 5;

Figures 9, 10 and 11, respectively, sections taken along the line 9—9, the line 10—10, and the line 11—11, indicated in Figure 4, to show the different positions of the cutting members on the pilot section of the bit relative to the longitudinal axis of the same;

Figure 12, an elevation of a drill bit in which the wings extend spirally around its axis for the purposes hereinbefore described;

Figure 13, an elevation of the upper portion of the drill bit showing the application of a boring element to clear a path through obstructive matter when the tool is withdrawn from the excavation;

Figure 14, a transverse section taken on the line 14—14, Figure 13; and

Figure 15, a fragmentary longitudinal section along the line 15—15, Figure 14.

Referring first to the form of my invention illustrated in Figures 1 to 4, the bit body designated in its entirety by the reference numeral 5, has four outwardly projecting longitudinally extending wings 6 at quadrant points of its circumference.

The outer edges 7 of the wings are stepped to provide bearing faces 8 at gradually decreasing distances from the axis of the body and each of said faces has a bore 9 at right angles thereto to receive the shank of a cutting member hereinafter to be described.

As best shown in Figures 2, 3 and 4, the wings are offset in the direction of rotation of the tool (indicated by the arrows) so that their edge-faces 7 slant relative to the planes of the radii passing through the centers thereof.

The bores 9 for the cutting members are formed at right angles to said faces so that the members when mounted in said bores as shown in the drawings, extend obliquely relatively to a concentric circle passing through the forward portions of their edges. This circle represents the circumference of the excavation produced in the operation of the tool and it will be apparent that by the position of the cutting members hereinabove described, ample clearance is provided for their outer faces.

The cutting members 12 each consist of a bevel-faced disk 13 formed integrally at an end of a cylindrical shank 14 which is circum-

ferentially grooved for the application of locking pins 15.

A bushing 16 of anti-friction metal is placed in the bore of the bit body around the shank of the cutting member and the locking pins extend transversely through openings of the bushings and therewith alined apertures in the respective wing of the body. It will be seen that the pins thus arranged lock the cutting members against longitudinal displacement while they permit of a free rotary movement thereof by engagement with the wall of the excavation during rotation of the tool.

The ends of the bores in which the bushings are fitted are tapered by the drilling tool and the recesses thus produced are utilized for the application of a thrust bearing in the form of a ball 17, which opposes the longitudinal stress on the cutting members in the operation of the drilling tool and thereby reduces the strain on the locking pins.

In the construction illustrated in Figures 5 and 6, the shanks 18 of the cutting members 19 are flanged at their ends and a bushing 20 composed of two complementary halves is fitted between the flanges 21 and the beveled disks 22 at the opposite ends of the shanks.

The bores in the wings of the bit body are recessed as at 23 to admit the flanges of the shanks of the cutting members and in order to mount the members in place, the wings are longitudinally divided in the plane of the axes of their bores, to provide a removable section 24 which normally is secured in place by means of bolts 25. Spherical thrust bearings 17 are placed in the recesses at the inner ends of the bores as before.

It will be apparent that the last mentioned construction of the cutting member combines strength with simplicity in that it eliminates the locking pins which are liable to breakage and require the provision of weakening holes in the wings of the bit body.

The pilot section 26 of the drill bit, which is detachably fastened at the lower end thereof, has three oblique bearing faces for cutting members which are similar in construction to those hereinbefore described.

The lower faces of two of the cutting members 27 and 28 slant from the axis A of the drill bit upwardly and outwardly and the third member 29 slants in the opposite direction as best shown in Figures 9, 10 and 11.

The three cutting members are relatively arranged so that their cutting or working portions collectively cover an area defined by the circle described by the outer portion of the cutting edge of the member whose axis of rotation is farthest from the axis of the bit body and the members are slanted at acute angles (in the present case about 30°) to the axis of the body whereby to insure their greatest efficiency with a minimum of wear and stress. As will also appear from the drawings, the axes of the cutters do not lie in tangential planes (i. e., vertical planes passing through tangents to the arcs of cutting travel) but are offset therefrom to skew the cutters to insure rotation about their own axes as the bit rotates.

As will appear from the drawings, the inner cutter 27, i. e., the cutter cutting the inner path, is arranged so that the inner part of its cutting edge engages the bottom of the hole as closely as practicable to the center of the hole. The next outer cutter 29 is arranged at a lower level than the cutter 27 and, therefore, cuts its path at a lower level than that cut by cutter 27; and in fact cuts away some material which would have been cut by cutter 27 were cutter 29 located at a higher level, namely, that material lying at the inner portion of the path cut by cutter 29. This has the effect of confining the material cut by cutter 27 to that traversed by the inner portion of its cutting edge, whereby the forces acting on the cutter edge cause it to rotate and present a continuously changing cutting edge. Owing to the location of cutter 27 close to the axis of the bit it is difficult for structural reasons, to skew its axis sufficiently to insure a reliably continuous rotation thereof about its own axis; but with the cooperation of cutter 29 sufficient unbalanced forces are applied to the edge of cutter 27 to insure its continuous rotation and thus to avoid the formation of any flat spots by temporary failure to rotate.

In the present case the axis of cutter 29 is inclined (inwardly instead of outwardly as those of cutters 27 and 28), thereby making it possible for the shaft of cutter 27 to intersect the axis of the bit body. If the shaft of cutter 29 were also inclined inwardly it would probably result in a weakened and unsatisfactory construction by reason of the close proximity or intersection of the holes for the cutter shafts.

The drill bit illustrated in Figure 12 differs from that hereinbefore described, principally, in that its wings are formed into ribs 30 which wind spirally around the longitudinal axis of the body.

The ribs have been shown as being gradually reduced in width for the purpose of forming a contour of downwardly tapering form.

It will be understood, however, that the ribs may be stepped like those shown in Figure 1 to place the cutting members mounted upon their outer edges at gradually decreasing distances from the axis of rotation of the bit.

The cutting members 12 are spaced equidistantly on the spiral ribs so that collectively they cover the greater part of the circumference of the excavation produced in the operation of the tool.

The advantages of providing spaced ribs in spiral form upon which the cutting members

are supported, have been explained hereinbefore, it being evident that by eliminating the straight channels found in the construction shown in Figure 1, the downward passage of rocks and other matter falling into the excavation is obstructed and that the rotary movement of the spirally ribbed body will produce an auger-like crushing action upon rocks dislodged in its operation and thereby reduce them to a size sufficiently small to readily move upwardly through the channels.

It is desirable that the surface of the excavation be constantly plastered with mud to prevent cave-ins of loose sand and rocks.

The mud is constantly formed in the operation of the tool, by water supplied through an axial bore of the drill body, shown in broken lines 31 in Figures 1 and 12, and the pressure of the water forces the mud containing the cuttings of the drilling action, upwardly through the longitudinal channels between the wings of the rotating body to and through the mouth of the excavation.

When the body is formed according to the construction illustrated in Figure 12, the spirality of the channels will aid in throwing the mud against the wall of the excavation.

Each of the drill bits shown in Figures 1 and 12 have at their point of greatest diameter, guard plates 32 which are detachably fastened by means of screw-bolts 33 countersunk into their outer surfaces.

The plates are preferably fastened upon the upper portions of the wings 7 in the one form, or the ribs 30 of the other form and they function in the operation of the tool to prevent lateral displacement of the drill bit and thereby maintain its vertical position, and to lift obstructive matter from the excavation while the bit is being withdrawn, whereby to provide a clear, upward passage for the cutting members at the peripheral edges of the bit.

Referring to Figure 13, 14 and 15 of the drawings, the numeral 44 designates a boring and milling element which is mounted at the top of the drill bit for the purpose of clearing a way for the tool through matter fallen into the excavation by caving of its wall, when the tool is withdrawn from the hole.

The element consists of an annular supporting member 34, composed of two concentric cylinders 35 and 36 connected by radial webs 37 which are extended beyond the upper ends thereof.

The inner cylinder fits snugly around the axial shank 38 which connects the drill bit to a superposed part of the drilling tool and which has been elongated for the application of the milling element, and both cylinders rest upon shoulders at the top of the drill bit as best shown in Figure 15.

Superimposed upon the supporting member is a cutting member 39 of substantially similar cross sectional form, the upper edge of which is serrated to provide a continuous series of radial teeth 40 of ratchet form.

The cutting member fits upon the extensions of the webs of the lower member as shown in Figure 15, and it is securely fastened by bolts 41 passing through said extensions and by tenons 42 on the upper edge of the outer cylinder of the supporting member, which fit into correspondingly shaped notches in the outer part of the cutting member.

The two members are furthermore connected to rotate in conjunction with the drill bit by a key 43 fitted in a longitudinal groove of the shank thereof.

The upper member of the milling element flares outwardly to a diameter equal to or slightly exceeding the distance between opposite guard plates of the drill bit, hereinbefore described and it will be apparent that when the tool is withdrawn from the excavation, its rotary motion will cause the milling element to bore a clearance through matter obstructive to the upward movement of the drill bit, through which it may freely pass to the mouth of the hole.

Having thus described my invention, I desire it understood that the two forms of bits are equally effective under different conditions and that one or the other may be used according to the nature of the soil to be excavated, the size of the well to be produced, the construction of the drilling tool of which the bit is a part and other circumstances.

What I claim and desire to secure by Letters Patent is:

1. In a drill bit, a rotary body, and a pilot element at the lower end thereof comprising a plurality of cutting disks, mounted exteriorly thereof to rotate about axes slanting relative to the axis of rotation of the body, the working portions of the cutting edges of the disks being at progressively increasing distances from said axis and commencing with the inner disk, at progressively decreasing distances from the lower end of the body.

2. A bit for deep well drilling through earth and rock comprising in combination a bit body rotatable about a vertical axis, a plurality of exteriorly located rotatable cutters of frusto-conical shape mounted substantially at the bottom of the bit body and in fixed relation to each other, said cutters being inclined to the material to be cut at angles substantially less than 90° and being arranged to work at different elevations and at different distances from the axis of the bit, whereby they cut in a plurality of concentric paths and loosen the material by a cutting wedging action.

3. A bit for deep well drilling through earth and rock comprising in combination a bit body rotatable about a vertical axis, a plurality of exteriorly located rotatable cutters of frusto-conical shape mounted sub-

stantially at the bottom of the bit body and in fixed relation to each other, said cutters being inclined to the material to be cut at angles substantially less than 90°, said cutters being arranged at different distances from the axis of said bit so as to cut in a plurality of paths of different diameter, the inner cutter being arranged to cut a path as closely as practicable about the center of the hole, and the next outer cutter being arranged to cut at a lower level than said inner cutter so as to confine the material cut by the inner cutter to that lying in the path traversed by the inner portion of the cutter edge, whereby the cutter is caused to rotate to present a continuously changing cutting edge.

4. A bit for deep well drilling through earth and rock comprising in combination a bit body rotatable about a vertical axis, a plurality of exteriorly located rotatable cutters of frusto-conical shape mounted substantially at the bottom of the bit body and in fixed relation to each other, said cutters being inclined to the material to be cut at angles substantially less than 90°, said cutters being arranged at different distances from the axis of said bit so as to cut in a plurality of paths of different diameter, the inner cutter being arranged so that the inner portion of its circular cutting edge engages the material and cuts in a path as close as practicable to the center of the hole, and the next outer cutter being arranged to cut at a lower level than said inner cutter so as to remove material which otherwise would lie in the path of the inner cutter, thereby limiting the width of the path cut by the inner cutter to that traversed by the inner portion of its cutting edge and causing said cutter to rotate to present a continuously changing cutting edge.

5. A bit for deep well drilling through earth and rock comprising in combination a bit body rotatable about a vertical axis, a plurality of exteriorly located rotatable cutters of frusto-conical shape mounted substantially at the bottom of the bit body and in fixed relation to each other, said cutters being inclined to the material to be cut at angles substantially less than 90°, said cutters being arranged at different distances from the axis of said bit so as to cut in a plurality of paths of different diameter, the cutter cutting the second path from the center being arranged to cut at a lower level than that of the cutter cutting the inner path so as to confine the material cut by the inner cutter to that traversed by the inner portion of its cutting edge, whereby the action of the material against the inner portion of its cutting edge causes said cutter to rotate to present a continuously changing cutting edge.

6. A bit for deep well drilling through earth and rock comprising in combination a bit body rotatable about a vertical axis, a plurality of projecting rotary cutters at the lower end of the body in fixed relation to each other and having cutting edges arranged to engage the bottom of the well hole and to travel in a plurality of paths of progressively increasing diameter, shafts projecting from said bit body for rotatively carrying said cutters and inclined relatively to the axis of said bit to cause said cutters to rotate about their respective axes so that the cutting edges of said cutters engage the material to be cut at angles substantially less than 90° so as to cut the material with a sliding and upward wedging cut which throws the cut material out of the path of cut, removable bearing bushings in said body and surrounding said shafts, said shafts each having a circumferential retaining groove therein intermediate the ends thereof, and removable locking pins carried by said bit body and extending through openings in said bushings into said grooves respectively, whereby to retain said shafts and cutters in place.

7. A bit for deep well drilling through earth and rock comprising in combination a rotary bit body, a plurality of rotary cutters mounted in the end of the bit body in fixed relation to each other and having their cutting edges arranged to engage the bottom of the well hole, said cutters being carried on shafts projecting from the bit body and inclined relative to the axis thereof to incline the cutting edges of said cutters to the material to be cut at angles substantially less than 90°, said cutters also being substantially skewed relatively to the direction of bodily movement of said cutters to cause the cutters to rotate to present continuously changing cutting edges and to throw the cut material out of the path of cut, said cutters being arranged on said body so that the working portions thereof travel in paths located at different levels relative to the bit body and of progressively increasing radii from the inner cutter outward.

8. A bit for deep well drilling through earth and rock comprising in combination a bit body rotatable about a vertical axis, a plurality of projecting rotary cutters at the lower end of the body in fixed relation to each other and having cutting edges arranged to engage the bottom of the well hole and to travel in a plurality of paths of progressively increasing diameter, shafts projecting from said bit body for rotatively carrying said cutters and inclined relatively to the axis of said bit to cause said cutters to rotate about their respective axes so that the cutting edges of said cutters engage the material to be cut at angles substantially less than ninety degrees so as to cut the material with a sliding and upward wedging cut which throws the cut material out of the path of cut, the cutter cutting the inner path being

inclined so that the inner portion of its cutting edge engages the material, whereby said cutter will rotate in the same direction as the body of the bit rotates.

9. A bit for deep well drilling through earth and rock comprising in combination a rotary bit body, a plurality of rotary cutters mounted in the end of the bit body in fixed relation to each other and having their cutting edges arranged to engage the bottom of the well hole, said cutters being carried on shafts projecting from the bit body and inclined relative to the axis thereof to incline the cutting edges of said cutters to the material to be cut at approximately thirty degree angles, said cutters also being substantially skewed relatively to the direction of bodily movement of said cutters to cause the cutters to rotate to present continuously changing cutting edges and to throw the cut material out of the path of cut, said cutters being arranged on said body so that the working portions thereof travel in paths located at different levels relative to the bit body and of progressively increasing radii from the inner cutter outward.

10. A bit for deep well drilling through earth and rock comprising in combination a bit body rotatable about a vertical axis, a plurality of exteriorly located rotatable cutters of frusto-conical shape mounted at the lower end of the bit body in fixed relation to each other and inclined relative to the axis of the bit so as to engage the material to be drilled at angles substantially less than 90° whereby to loosen the material with a cutting wedging action, said cutters being arranged on the lower end of the bit body to travel at different distances from the axis of the bit so as to travel in a plurality of concentric paths collectively covering the bottom of the hole, each path being of a width substantially less than the diameter of the cutter, whereby the work required of a given cutter will not exceed what it is capable of practically withstanding.

11. A bit for deep well drilling through earth and rock comprising in combination a bit body rotatable about a vertical axis, a plurality of exteriorly located cutters of frusto-conical shape rotatably mounted at the lower end of the bit body, said cutters being inclined relative to the horizontal to engage the material to be drilled at angles substantially less than 90° thereby to loosen the material with a cutting wedging action, said cutters also being substantially skewed relative to their direction of travel to insure rotation about their own axes during rotation of the bit, said cutters being relatively arranged to cut a plurality of concentric paths collectively covering the bottom of the hole, each path being narrow compared with the diameter of its cutter, whereby a limited amount of work is required of each cutter and the life of a set of cutters in cutting through rock is increased to a maximum.

12. A bit for deep well drilling through earth and rock comprising in combination a bit body rotatable about a vertical axis, a plurality of exteriorly located cutters of frusto-conical shape rotatably mounted at the lower end of the bit body, said cutters being inclined relative to the horizontal to engage the material to be drilled at angles substantially less than 90° thereby to loosen the material with a cutting wedging action, said cutters also being substantially skewed relative to their direction of travel to insure rotation about their own axes during rotation of the bit, said cutters being relatively arranged to cut a plurality of concentric paths collectively covering the bottom of the hole, the second cutter from the center cutting at a lower level than the inner cutter and traveling in a path overlapped by the inner cutter, whereby to limit the width of the path cut by the inner cutter, the second cutter from the outside cutting at a lower level than the outside cutter and in a path overlapped by said outside cutter thereby limiting the width of the path cut by the outer cutter.

13. A bit for deep well drilling through earth and rock comprising in combination a bit body rotatable about a vertical axis, a plurality of exteriorly located rotatable cutters of frusto-conical shape mounted substantially at the bottom of the bit body and in fixed relation to each other, said cutters having their axes inclined in the direction of rotation of the body of the bit so as to cause said cutters to engage the material to be cut at angles substantially less than 90° and being arranged to work at different elevations and at different distances from the axis of the bit, whereby they cut in a plurality of concentric paths and loosen the material by a cutting wedging action.

14. A bit for deep well drilling through earth and rock comprising in combination a bit body rotatable about a vertical axis, a plurality of exteriorly located rotatable cutters of frusto-conical shape mounted at the lower end of the bit body in fixed relation to each other and having their axes, respectively, inclined in the direction of rotation of the bit so as to cause their cutting edges to engage the material to be drilled at angles substantially less than 90° whereby to loosen the material with a cutting wedging action, said cutters being arranged on the lower end of the bit body to travel at different distances from the axis of the bit so as to travel in a plurality of concentric paths collectively covering the bottom of the hole, each path being of a width substantially less than the diameter of the cutter, whereby the work required of a given cutter will not exceed what it is capable of practically withstanding.

15. A bit for deep well drilling through earth and rock comprising in combination a

rotary bit body, a plurality of rotary cutters mounted in the end of the bit body in fixed relation to each other and having their cutting edges arranged to engage the bottom of the well hole, said cutters being carried on shafts projecting from the bit body and inclined in the direction of rotation of the bit body so as to cause the cutting edges of said cutters to engage the material to be cut at angles substantially less than 90°, said cutters also being substantially skewed relatively to the direction of bodily movement of said cutters to cause the cutters to rotate to present continuously changing cutting edges and to throw the cut material out of the path of cut, said cutters being arranged on said body so that the working portions thereof travel in paths of different diameters.

In testimony whereof I have affixed my signature.

WILLIAM V. SEIFERT.