

July 12, 1932.

C. E. REED

1,867,531

DEEP WELL DRILLING APPARATUS

Filed March 1, 1927

2 Sheets-Sheet 1

Fig. 1.

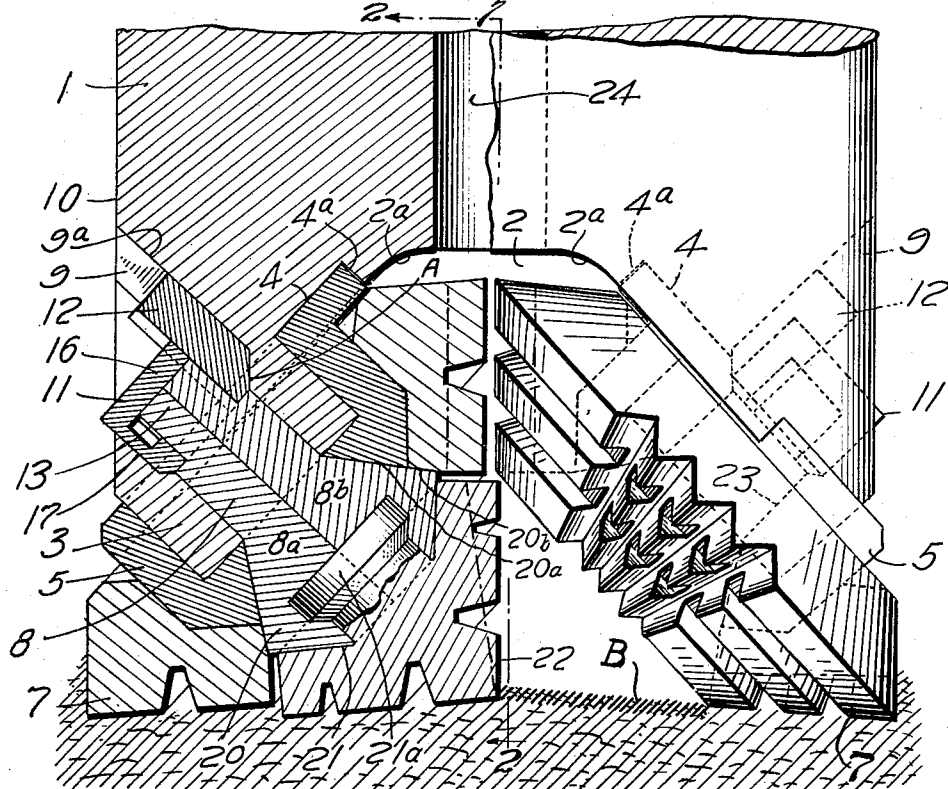
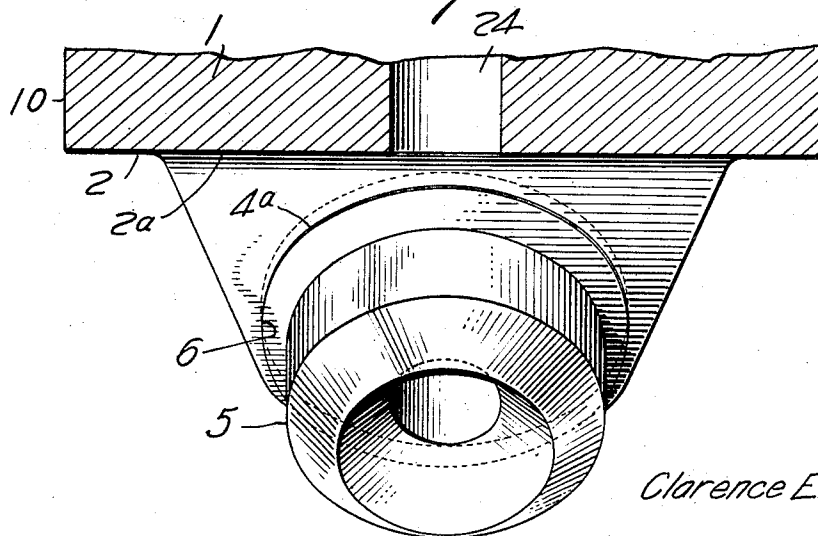


Fig. 2.



Inventor
Clarence E. Reed

By Spear, Middleton, Donaldson & Hall

Attorney

July 12, 1932.

C. E. REED

1,867,531

DEEP WELL DRILLING APPARATUS

Filed March 1, 1927

2 Sheets-Sheet 2

Fig. 5.

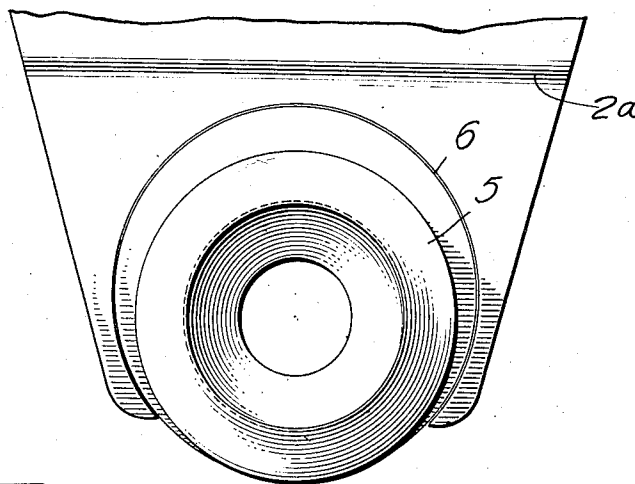


Fig. 3.

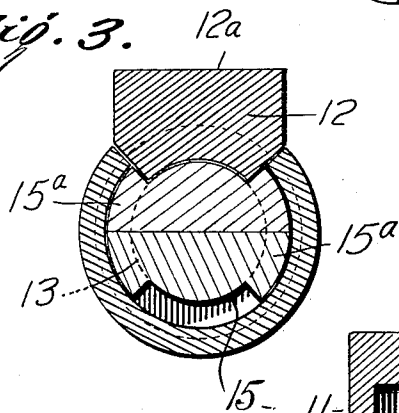


Fig. 6.

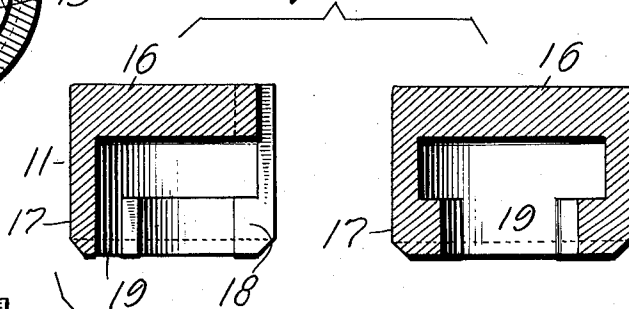
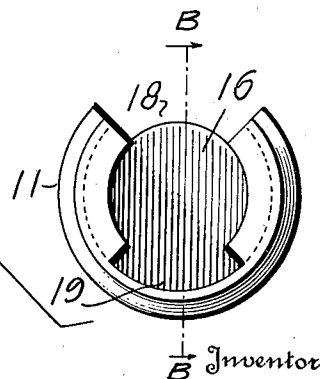
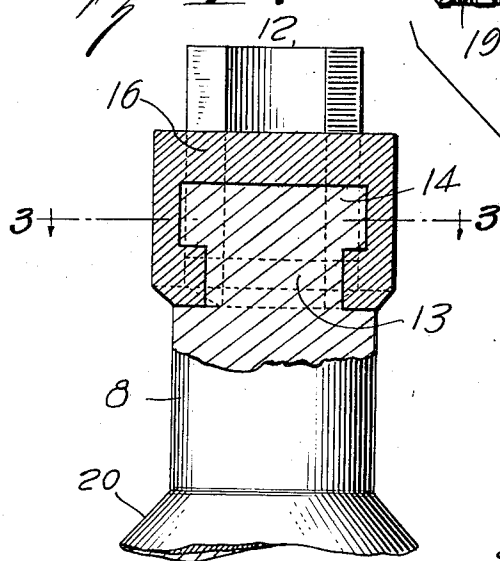


Fig. 4.



B Inventor

Clarence E. Reed

By Spear, Middleton, Donaldson, & Hall

Attorney

UNITED STATES PATENT OFFICE

CLARENCE E. REED, OF WICHITA, KANSAS, ASSIGNOR TO CHICAGO PNEUMATIC TOOL COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY

DEEP WELL DRILLING APPARATUS

Application filed March 1, 1927. Serial No. 171,831.

This invention relates to a roller cutter assembly for deep well drilling apparatus.

under side and having a hollow spindle 3 extending at right angles from each of the opposite inclined walls 2a of the recess.

An object of the invention is to provide an arrangement of cutters adapted to cut soft formations, lime in particular, which ordinarily locks and balls up the usual forms of rock bit rolling cutters causing them to stop cutting.

The drill head 1 is also provided on each inclined wall 2a with a depression or seat 4 forming a thrust shoulder 4a for sustaining the upward thrust upon bushing 5 which engages the spindle 3 and which has an eccentric portion 6 which contacts the thrust shoulder 4a of the seat 4.

Another object is to provide a cutter assembly in which the amount of metal opposed to the bottom of the hole is a minimum so that the gouging action will be increased by reason of the sinking of the metal bits in the soft lime formation and the gouging thereof upon turning of the bit head.

A main frusto-conical cutter cone or roller 7 is mounted upon each bushing 5 and these trail each other. Through one of the sets comprising disc roller cutter 7, bushing 5 and spindle 3 extends a shank or shaft 8 of a spindle 20 at right angles to wall 2a, which shank enters one of a pair of recesses 9 formed one in each of the opposite outer walls 10 of the drill head, which shank terminates short of the outer end of the recess 9 to be engaged by a locking collar 11 and locking member 12. This cutter section has its cutting surface projecting beyond the plane of the cutting surface of the side roller cutter section 7, with which it is associated, and this cutter 22 is arranged to singly cut the area at the bottom of the hole within the annular zone cut by the tracking side roller cutters.

Another object is to obtain a gouging action upon a tough so-called soft lime formation or the like to gouge out the material by the weight of the drill stem forcing the teeth of the cutter into the material, as distinguished from the usual crumbling action of hard rock under a rolling cutter.

A further object is to provide the cutters with teeth of sufficient depth to penetrate the soft formation under the weight of the drill stem so as to cause the gouging out of the material upon turning of the drill.

The invention consists in the features, combination and arrangement of parts herein-after described and particularly pointed out in the claims.

In the drawings:

Figure 1 is a sectional view on the center line of the drill head and assembly.

Fig. 2 is a sectional view on the line 2—2 looking in the direction of the arrow, with the cutters removed.

Fig. 3 is a view of the locking collar and locking pin for the end of the shank, the shank being shown in the outer recess in the drill head.

Fig. 4 is another view of the end of the shank with the locking collar and pin in place.

Fig. 5 is a view of the bushing showing its eccentricity.

Fig. 6 is a view of the locking collar.

Referring to the drawings, 1 represents a drill head formed in one piece and having an inverted V-shaped recess 2 formed in its

The end of the shank 8 in the recess 9 has a reduced portion 13 with an enlarged portion or head 14 on the end of the reduced portion. The head 14 has segments cut out of its peripheral edge leaving oppositely disposed spaces or gates 15.

Locking collar 11 comprises a disc 16 having a depending flange 17 with portions or gates cut away at 18 and 19 to cooperate with the flanges 15a of the head 14 of the shank 8 to form a bayonet joint locking device. Where the flange 17 is cut away at 18, a locking member or pin 12 is adapted to be inserted to prevent relative movement between the collar 11 and the shank 8, as well as between the shank and the head 1. The flat wall 12a of the locking pin 12 engages a corresponding flat surface 9a of the recess 9, thus preventing any turning movement of the pin 12, which in turn holds the shank 8 against turning. The locking collar and pin are also

adapted to engage the drill head at A to hold the shank or shaft in the drill head. A shaft member 23 is provided for supporting the other cutter 7. The shaft member 23 is secured in the head in exactly the same manner as is the shank 8 and is identical with shank 8 except that it does not have a spindle at its inner end and is not split into two parts.

The shank 8 has a spindle 20 on its inner end. The shank 8 with its integral spindle 20 is divided into two parts 8a and 8b, longitudinally thereof, so that the spindle 20 may be inserted in the inclined groove 21 to grasp the overhanging head 21a of the supplemental roller cutter 22 in a manner similar to that shown in my application filed January 12, 1927, Serial Number 160,668 patented July 19, 1927, No. 1,636,667.

The cutter 22 is disposed between the two main cutters 7, adjacent that cutter 7 through which the shank 8 of spindle 20 extends, and lying mainly to one side of the vertical axis of the head 1.

The spindle is provided with a conical enlargement 20a which engages corresponding conical surfaces in the bore of bushing 5 to hold the bushing to the head, and which extends beyond the bushing over a portion of cutter 7 as at 20b to hold the cutter on the bushing.

The purpose and function of the supplemental cutter 22 is to remove the earth or rock formation from the central uncut portion of the hole indicated at B on the drawings. The uncut or raised portion shown at B is slightly exaggerated to clearly show the portion which must be gouged out by the cutter in each revolution thereof about the vertical axis of the drill head. While the teeth of this cutter have the usual shape employed on rock bits, grooves are cut therein to aid in the gripping and gouging action.

While the roller cutter 22 is capable of rolling and crumbling action, by reason of its being mounted to roll, as are the cutters 7, the principal function of the cutter 22 is to secure a gouging action upon the central part of the formation in the hole, by reason of its deep grooves and its rotation about the vertical axis of the head 1. Each of the main cutters 7 and the supplementary cutter 22 are provided, in addition to the V-shaped teeth or V-shaped ridges, with relatively deep concentric grooves as shown in Fig. 1, which grooves cross the V-shaped teeth and form the teeth into individual projections of spike like nature, and such a tooth can readily be forced into a tough soft lime formation and the rotation of the drill head will cause the teeth to gouge out the bottom of the hole.

As shown in Fig. 1 the large cutter 7 which is coaxial with cutter 22 is provided with but one groove, while the other is provided with two concentric grooves. Cutter 22 as shown has two concentric grooves, and the apex of

this cutter is a wedge shaped point similar to the point of a center drill used in machine tool practice.

The formation of the cone cutters and the deep spiked teeth on the cutters, with plenty of space provided between the cutters (such as the space opposite cutter 22) for the reception of the soft, tough material upon sinking of the teeth into the material under the weight of the drill head, permits the material to be gouged out upon turning of the drill head. The single supplementary cutter 22 provides a conical pointed wedge like portion which will much more rapidly penetrate the formation than if the space opposite it were occupied, since the space receives loose material and gets it out of the way, and thus permits the cutter 22 to act freely and effectively in its gouging action. The weight of the drill head and stem forces the teeth of cutter 22 and main cutter 7 into the tough lime formation or the like and by reason of the rotation of the drill head and the consequent revolution of the cutter 22 about the vertical axis of the head, the material is gouged out, as distinguished from the usual crumbling action of hard rock under a rolling cutter.

The flushing fluid conduit is arranged axially of the bit head and the grooves of the roller cutters pass the fluid issuing from this axial conduit in sufficient quantity to produce an hydraulic effect upon the bottom of the hole.

In assembling the main cutters 7 in the head, the cutters are placed against each other so that their oppositely disposed teeth deeply intermesh during the act of their insertion into the head. The extent to which the teeth may be intermeshed during insertion is indicated by the position of the root lines of the teeth in the cutters.

The formation of the V-shaped teeth is shown in Fig. 1 in which the V-shaped ridges forming radial grooves are intersected by deep concentric grooves. A portion only of the toothed surface of the cutter is shown.

It will be seen that the grooves which extend along the cutters between the teeth from the larger to the smaller ends thereof register in succession with the vertical flushing fluid passage and that these grooves are free throughout their extent because the teeth on the opposed cutters do not intermesh and there is nothing to obstruct the flow of the flushing fluid through these grooves so that the said fluid will impinge directly upon the bottom of the hole and will dislodge the material at that point. The teeth on one cutter overlap the circumferential grooves between the teeth on the opposed cutter.

I claim:

1. In a deep well drilling apparatus, a drill head having a recess in its under side, the opposite inclined walls of which recess

diverge downwardly, a pair of main roller cutters of substantially equal diameter and altitude mounted one on each inclined face with their axes respectively at right angles thereto and converging downwardly, and a smaller diameter supplemental roller cutter coaxially mounted with respect to one of said main cutters and disposed mainly to one side of the vertical axis of the drill head and between the main roller cutters there being a vacant space between said supplemental roller and the other main roller and on the opposite side of said vertical axis.

2. In a deep well drilling apparatus, a drill head having an inverted V-shaped recess in its under side, the opposite inclined walls of which recess diverge downwardly at equal angles from the vertical axis of the drill head to provide substantially equal spaces on opposite sides of the vertical axis, a pair of roller cutters coaxially mounted on one of said inclined walls in one of said equal spaces, and a single roller cutter mounted on the opposite inclined wall in the other space said single roller being of substantially the same size as one of the rollers of said pair, thus leaving a substantial portion of said other space unoccupied.

3. In a drilling apparatus, a drill head having a recess in its under side, the opposite inclined walls of which recess diverge downwardly, a pair of relatively large main roller cutters of equal diameter and altitude mounted one on each inclined face with their axes respectively at right angles thereto and converging downwardly, and a single relatively smaller supplemental roller cutter coaxially mounted with respect to one of said main cutters only and disposed within the crown of the same and mainly to one side of the vertical axis of the drill head.

4. In a drilling apparatus, a drill head having an inverted V-shaped recess in its under side, the opposite inclined walls of which recess diverge downwardly, a pair of roller cutters of equal diameter mounted one on each inclined wall with their axes respectively at right angles to the walls whereby the inner faces of the roller cutters are parallel respectively to the inclined walls and define a second inverted V-shaped space within the recess, and a supplemental roller cutter mounted coaxially with one of said roller cutters and disposed mainly to one side of the vertical axis of the drill head to occupy substantially one-half of the said second inverted V-shaped space leaving the other half of said second space vacant.

5. In a drilling apparatus, a drill head having an inverted V-shaped recess in its under side, the opposite inclined walls of which recess diverge downwardly, the opposite inclined walls each having a hollow spindle projecting at right angles therefrom, each of said walls also having a recessed seat there-

in adjacent the hollow spindle, said seat forming a thrust shoulder, each of said walls having a bore extending from said hollow spindle through said head and terminating in a second recess at the outer wall of the head, an eccentric bushing surrounding each hollow spindle, the eccentric portion of which engages said seat and thrust shoulder to hold the bushing against turning, a main roller mounted for turning movement on each bushing, a single supplemental frusto conical cutter between the main cutters and located at one side of the vertical axis of the drill, a divided spindle interlocked with said supplemental roller cutter and having a divided shank passing through one of the said bushings and hollow spindles, and means at the outer side of the head for holding the shank in place, substantially as described.

6. In combination with a deep well drill, a head having a recess, a cutter in said recess, a spindle on which the cutter turns, said spindle having a shank extending through the head and terminating in a recess on the outer side of the head, a collar on the end of the shank having gateways for the passage of flanges on the shank, and having flanges to pass through gateways on the shank, and a locking member to pass through the aligned gateways of the collar and shank, said locking member being held in position by the wall of the outer recess, substantially as described.

7. In an apparatus of the class described, a drill head having an inverted V-shaped recess in its under side, a pair of main cutter rollers mounted one on each of the opposite inclined walls of the recess with their axes respectively at right angles to the walls, a spindle having a shank extending axially through one of said rollers and secured to said head, said spindle and shank being split longitudinally into two parts, and a supplemental roller cutter carried by said spindle.

8. In an apparatus of the class described, a drill head having an inverted V-shaped recess in its under side, the opposite inclined walls of which recess each have a hollow spindle projecting at right angles therefrom, and each having a recessed seat therein adjacent the hollow spindle, said seat forming a thrust shoulder, an eccentric bushing surrounding each hollow spindle, the eccentric portion of which engages said seat and thrust shoulder to lock the bushing against turning relative to the head, a pair of roller cutters mounted one on each bushing, and means for holding said roller cutters, said means extending through the hollow spindles and secured to said head.

9. In apparatus of the class described, a drill head having an inverted V-shaped recess in its under side, roller cutters mounted on the opposite inclined walls of said recess, said head having a bore through each inclined wall at right angles thereto, a wall of each bore having a locking pin receiving recess there-

in, a shaft in each bore for mounting said roller cutters, locking means for securing said shaft in the bore comprising a locking collar and a locking pin, said shaft having a reduced portion and a head on the end of the reduced portion having gates cut in its flange, said locking collar having gates cut therein complementary to the flange portions of the shaft to provide a bayonet joint, said locking pin being adapted to be received in the recess in the bore and to engage and lie in the coinciding gates of the shaft and collar to lock the shaft and collar against turning in the head, said locking collar also being adapted to engage the drill head to hold the shaft in position.

10. In a deep well drilling apparatus, a drill head having an inverted V-shaped recess in its under side, an inclined wall of the recess having a hollow spindle projecting at right angles therefrom, a bushing mounted on the spindle, a cutter mounted on the bushing and a shaft extending through said cutter, bushing and spindle, and secured to said head, said shaft having a conical enlargement on its free end which is adapted to engage the bushing and cutter to hold them in place.

11. In a deep well drilling apparatus, a drill head, a hollow roller cutter bearing mounted on said head, an outer cutter mounted for rotation on the outside of the bearing and an inner cutter organization mounted on the inside of the bearing, the outer cutter being held in place on the bearing by the inner cutter organization the latter including a split spindle with a split shank in the bearing and on which spindle the inner cutter turns.

12. In a deep well drilling apparatus a drill head having an inverted V-shaped recess in its under side, roller cutter means in said head mounted on opposite side walls of said recess, said means comprising substantially conical roller cutter means on one wall occupying substantially all of the recess to one side of the vertical axis of the head, and a frusto-conical roller cutter on the opposite wall of less altitude than the said conical cutter means, thus leaving an uncut area between the path of the frusto-conical roller and the vertical axis of the head to be gouged out by the apex portion of the said conical cutter means.

13. In a deep well drilling apparatus, a drill head having a wall inclined to the vertical axis and defining a recess in the underside of the head, a spindle projecting from said wall, a recess seat in the wall, a bushing on the spindle, said bushing having an eccentric flange base engaging said seat, and a roller on the bushing.

14. In combination a bit head having an inverted V shaped recess in its lower end, a hollow spindle projecting from the inclined wall of said recess, a bushing on said spindle, a roller cutter on said bushing, a

split spindle having a split shank extending through the hollow spindle, means for holding said split spindle and shank to the head, a supplemental roller having a stem held between the members of the split spindle, said split spindle holding the roller cutter first mentioned and the bushing in place, substantially as described.

15. In combination, in a deep well drilling apparatus, a bit head having a wall at its lower end inclined to the vertical axis, and with a hollow spindle projecting relative to said wall, a bushing on said hollow spindle covering the sides and end portion of the hollow spindle, with means for holding said bushing against rotation on said hollow spindle, a supplemental spindle having a shank held within the hollow spindle and having an enlarged head projecting beyond said hollow spindle, and a roller cutter means held by said enlarged head and turning about the same and having a portion turning on the bushing, the latter having an opening to permit the supplemental spindle to be assembled with the hollow spindle projection, substantially as described.

16. In a deep well drilling apparatus, a drill head having a wall inclined to the vertical axis and defining a recess in the underside of the bit head, a hollow spindle projecting at right angles from said wall, a bushing mounted on said hollow spindle, a roller cutter mounted on the bushing and a supplemental spindle extending through said cutter, bushing and spindle, and secured to said bit head, said supplemental spindle having an enlargement at its free end which engages the bushing and cutter to hold them in place, and a supplemental roller cutter turnable on said supplemental spindle substantially as described.

17. In combination in an earth boring tool, a bit head having an inverted V-shaped recess, there being a socket in the head opening into said recess and with its axis at right angles to the downwardly and outwardly inclined wall of said recess, a longitudinally split spindle in said socket, means for holding said spindle in said socket a roller cutter having a stem projecting axially beyond the plane of its base, and leaving a groove between said stem and the body of the cutter, said stem having its terminal portion overhanging said groove, said split spindle embracing said projecting stem.

18. In combination in a deep well drilling apparatus a bit head having an inverted V-shaped recess at its lower end, an annular spindle projecting from the inclined wall of said V-shaped recess downwardly and inwardly towards the vertical axis of the drill, roller cutter means and bearing means for the roller cutter means, said bearing means being fixed in the head and having a portion surrounding the said annular spindle and a

shank portion extending within the annular spindle.

19. A deep well drilling apparatus comprising a bit head having an inverted V-shaped recess at its lower end, an annular spindle projecting from the inclined wall of said V-shaped recess downwardly and inwardly towards the vertical axis of the drill, roller cutter means, and bearing means for said roller cutter means, said bearing means having a downwardly and inwardly extending portion, a portion embracing the spindle and a stem portion extending through the spindle and fixed in the body of the head.

20. In a deep well drilling apparatus, a drill head having a wall inclined to the vertical axis of the apparatus and defining a recess in the under side of the bit head, a hollow spindle projecting at right angles from said wall, a roller cutter surrounding the said hollow spindle, a bushing interposed between said roller cutter and the hollow spindle, a supplemental spindle extending through said hollow spindle and secured to the bit head, said supplemental spindle having an enlargement, and a roller cutter covering the outer end of the enlargement and rotatably connected to said enlargement, said first mentioned roller and the bushing being on the inner side of said enlargement, and means for holding the bushing against rotation, substantially as described.

21. In combination a bit head having a recess in its lower end with the side walls inclining downwardly and outwardly, annular flanges on said side walls, projecting downwardly and inwardly, side roller cutters on said flanges, means for holding the side roller cutters in place, and a roller cutter adjacent one of the side roller cutters arranged coaxially therewith and arranged to singly cut a zone within the annular zone, jointly cut by the side cutters which trail each other, substantially as described.

22. In combination a bit head having a recess in its lower end with its side walls inclining downwardly and outwardly, side roller cutters mounted on said inclined walls with their axes converging downwardly and inwardly to the vertical axis of the head and an additional roller cutter arranged coaxially with and directly adjacent one of the side cutters and spaced apart from the other side cutter, said additional cutter singly cutting the bottom of the hole within the annular zone cut by the side cutters which trail each other.

23. A roller cutter organization for earth boring drills comprising frusto-conical side cutters to incline upwardly and inwardly towards the vertical axis of the drill and to track with each other, and a substantially conical cutter to be arranged coaxially with and at the smaller end of one of the side cutters and having its teeth projecting beyond the plane of the cutting surface of said co-

axial side cutter, to singly cut a zone within the annular zone jointly cut by the side cutters.

24. In a deep well drilling apparatus, a drill head having an inverted V shaped recess in its underside, tapered roller cutter means in said recess, mounted on the opposite side walls thereof and on axes at right angles to the said side walls of the recess and converging downwardly, the tapered roller cutter mean on one wall occupying substantially all of the recess to one side of the vertical axis of the head, the said tapered roller cutter means on the opposite wall being of less altitude than the roller cutter means first mentioned, thus leaving an uncut area between itself and the vertical axis of the head to be cut by the roller cutter means first mentioned, substantially as described.

25. In a rotary boring drill, a spindle having an enlarged portion and a roller cutter having a base section and a point section, said base section resting against the inner face of said enlarged portion, and said point section resting against the outer face of said enlarged portion and being rotatably secured to said spindle.

26. In a rotary boring drill, a spindle having an enlarged portion and a roller cutter having a base section and a point section, said base section having a recess against the bottom of which said enlarged portion rests, and said point section resting on the enlarged portion and having a recess in which the end of the spindle is rotatably secured.

27. In rotary well drilling apparatus a head, a pair of frusto-conical opposed cutters at the lower end of the head having deep radial grooves intersected by deep circumferential grooves, forming cutting teeth, said cutters being spaced apart with their teeth-non-interfitting and having the space between them unobstructed and in line with the vertical axis of the head, said head having a passage in line with the vertical axis of the apparatus and in the same vertical plane in which the axes of the cutters lie to direct flushing fluid to said unobstructed space for its direct impingement upon the bottom of the hole, one of said cutters having an independently rotatable apex portion extending to near the vertical axis of the apparatus, the opposing cutter being minus an apex portion and thus providing a space on the other side of the axis substantially equivalent in size to the apex portion of the cutter first mentioned, said space exposing an area of the bottom of the hole acted on by the flushing fluid coming down through said axial unobstructed space.

28. A roller bit cutter organization comprising a roller cutter element positioned to cut the area centrally of the bore hole in non-tracking relationship and intermediate inclined roller cutters enlarging the hole de-

fined by the first mentioned element, all cutting elements having their axes disposed in the same transverse vertical plane, said cutting elements being located at the lower face of the bit head and cutting the entire area at the bottom of the hole, each of said cutting elements being independently rotatable.

29. An earth boring roller bit comprising an independently rotatable roller cutter arranged at the lower face of the bit head intermediate roller cutters that enlarge the hole dug by said first-mentioned cutter, the enlarging cutters being set at an angle to the bit axis on opposite sides of the bit, the first-mentioned cutter being in non-tracking relationship to any other cutter, said cutters cutting the entire area at the bottom of the hole.

30. In combination with a rotary drill stem and bit head for penetrating earth formations, side roller cutters whose peripheries are divided by deep grooves forming teeth and an intermediate roller cutter whose periphery is divided by deep grooves, the intermediate cutter being arranged to cut in a central zone between the side cutters and adjacent the longitudinal axis at the end of the head, said intermediate cutter lying to one side of the axis of the head and opposite a space on the other side of said axis extending across said central zone on said other side of the axis, and a flushing fluid conduit in the head, the axes of all the cutters lying in the same transverse vertical plane and each of the cutters being independently rotatable, all of said cutters being at the lower face of the bit head and cutting the entire area at the bottom of the hole.

31. In combination in a deep well drilling apparatus, a bit head having a recess in its lower end, roller cutting means disposed in said recess on opposite sides of the vertical axis of the head to cut the entire area at the bottom of the hole, and comprising side cutters at opposite sides of said axis, the roller cutter means on one side of said vertical axis of the drill comprising a plurality of independently rotatable cutters, cutting annular paths from the axis to the side and slightly beyond the head and a flushing fluid conduit in the head, the cutter means being so arranged that only the peripheral cutters track each other.

32. In combination with a rotary drill stem and bit head for penetrating earth formations, side roller cutters the peripheries of which are divided by deep grooves forming teeth, an intermediate roller cutter to cut the bottom of the hole at the center on a different plane from the cutting plane of the side cutters and in non-tracking relationship, the intermediate cutter and the deep grooves reducing to a minimum the active cutting edges necessary to cut the entire area at the bottom

of hole, the said combination under the weight and rotation of the drill stem being adapted to wedge and gouge out rapidly the earth formation, and a flushing fluid conduit in the head, each side cutter and the intermediate cutter being rotatable independently and all being located at the lower face of the bit head.

33. A rotary well drill having roller cutters disposed at the lower face of the bit head, cutting areas inclined to the axis of the bore hole, and mounted to cut the entire area at the bottom of the hole with a rolling motion, one of the cutters being arranged for cutting in a central zone adjacent the longitudinal axis of the drill head and opposite an open space portion above said central zone extending to the inner side of one of said roller cutters placed at opposite sides of bit axis and beyond the central zone, one of the said cutters being a rolling side cutter placed next adjacent the first mentioned cutter, said cutters each being independently rotatable and each having relatively deep grooves forming teeth therein, deep and rapid penetration of earth formation being thereby attained under the weight and rotation of the drill stem, and a flushing fluid conduit disposed to deliver fluid across the cutters downwardly and to impinge on the bottom of the hole.

34. In combination a bit head having a recess in its lower end with its side walls inclining downwardly and outwardly, side roller cutters mounted on said inclined walls with their axes converging downwardly and inwardly to the vertical axis of the head and an intermediate independently rotatable roller cutter arranged adjacent one of the side cutters, cutting a central zone, and spaced apart from the other side cutter, a distance not less than the width of the central zone, said intermediate cutter cutting the bottom of the hole within the annular paths of the side cutters, said cutters cutting the entire area at the bottom of the hole.

35. In a deep well drilling apparatus, a drill head having a recess in its under side, roller cutter means in said recess, mounted on the opposite side walls thereof and on axes at right angles to the said side walls of the recess and converging downwardly, the roller cutter means on one wall occupying substantially all of the recess to one side of the vertical axis of the head and comprising at least two cutters capable of independent rotation and the said cutter means on the opposite wall being a side cutter spaced apart from the first mentioned cutter means and arranged to cut an annular path outwardly from the central area cut by the first mentioned means.

36. A roller bit comprising a roller cutter set to one side only of the bit axis and having an open space on the opposite side of said axis of substantially the same width as the

cutter, the cutter and space being intermediate roller cutters on the opposite sides of the bit head set to enlarge the hole by cutting an annular area adjacent to and outside the area cut by the first mentioned cutter, the
5 axes of all cutters being disposed in the same vertical plane, and the axes of the second mentioned cutters inclining downwardly and inwardly, all the cutters being at the lower face of the bit head, independently rotatable
10 and cutting the entire area at the bottom of the hole.

37. An earth boring drill bit comprising a bit head having a recess at its under end, roller cutter means in said recess mounted
15 upon the opposite side walls thereof and on axes at right angles to said side walls and converging downwardly, said cutter means being adapted to track each other over a limited area extending inwardly from the outer
20 edge of the bore hole, and additional independently rotatable roller cutter means mounted on the bit head in such radial position that it provides non-tracking cutting means for the central area of the hole.

38. An earth boring drill comprising a bit head, cutters arranged at opposite points at the lower face of the head to cut an annular path, a third cutter arranged to one side of
30 and adjacent the vertical axis of the drill and cutting an annular zone at the center of the bore hole within the zone cut by the cutters first mentioned, the portion of said central zone on the opposite side of the vertical
35 axis of the drill from the said third cutter being unoccupied by any cutter and thus providing a space within the cutter organization of a width substantially equal to that occupied by the said third cutter, and a flushing
40 fluid passage in the head directed to the space between the cutters and to said unoccupied space, the axes of all the cutters being in the same vertical plane, all of said cutters being
45 independently rotatable and cutting the entire area at the bottom of the hole.

In testimony whereof I affix my signature.

CLARENCE E. REED.