

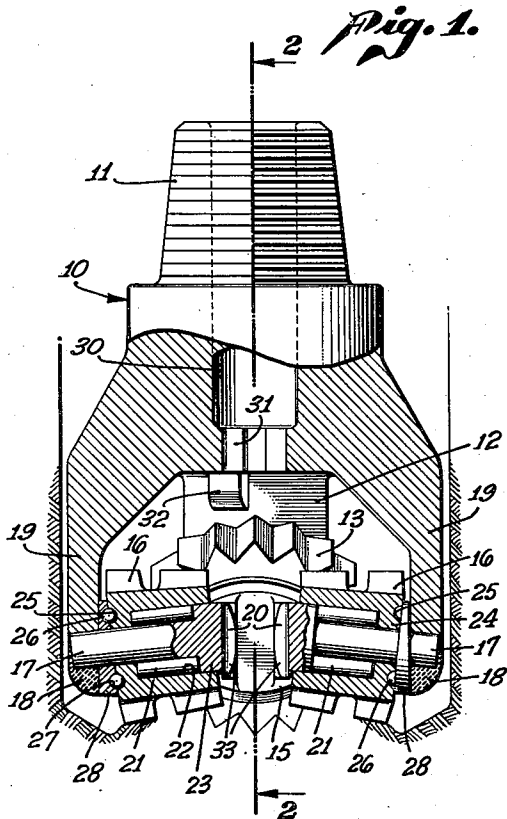
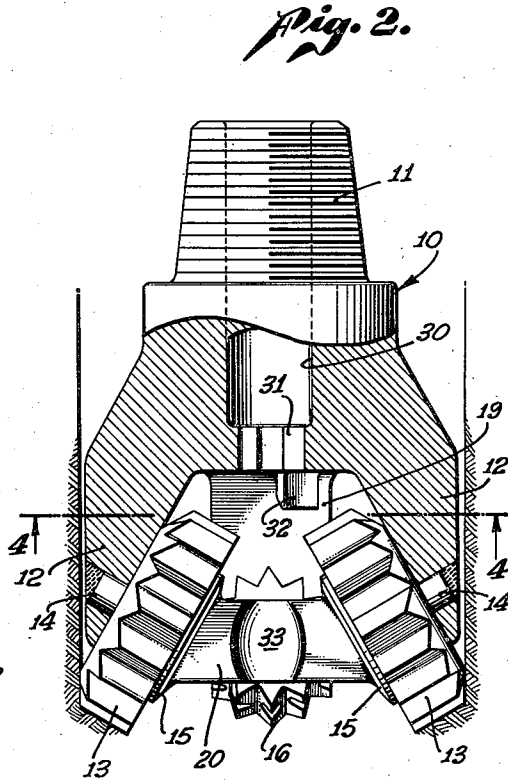
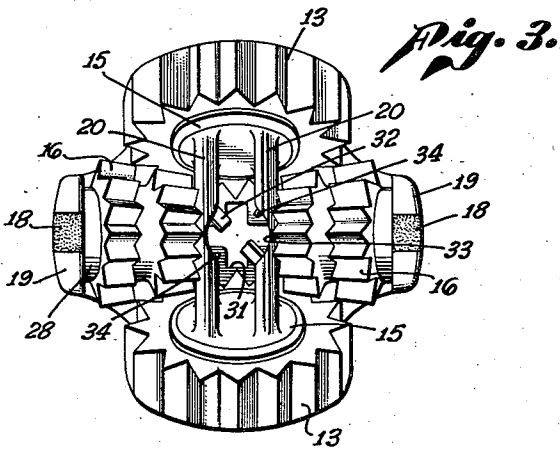
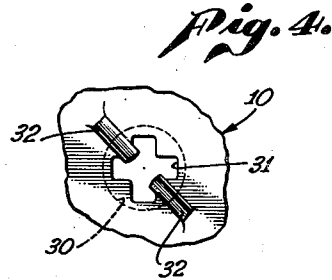
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2,358,642

ROTARY DRILL BIT

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ROTARY DRILL BIT

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1 Claim. (Cl. 255—71)

This invention relates to earth boring tools, and more particularly to drilling bits employed in the rotary drilling of oil, gas, and similar wells.

Drilling progress of the prior art rotary drill bits embodying roller types of cutters is impeded by accumulated masses of cuttings remaining at the bottom of the bore hole being produced, which provide a cushioning action on the cutter teeth and prevent their maximum penetration in the hole bottom. These masses of cuttings remain because the drilling fluids issuing from the bit nozzles act directly upon the cutters to dissipate the energy of the fluid jets before they can have effective washing action upon the bottom of the hole.

Accordingly, it is an object of the present invention to provide an improved rotary drill bit embodying roller cutters capable of effectively making drilling progress in the well bore, in which the hole bottom is maintained free from cutting by the direct action thereagainst of an impinging jet of fluid. As a result, the teeth on the bit cutters are capable of maximum penetration in the formation without being impeded by a mass of cuttings.

Still a further object of the invention is to provide an improved rotary drill bit embodying roller cutters, in which the drill bit is of sturdier and stronger construction than heretofore available.

This invention possesses many other advantages and has other objects that will become apparent from a consideration of the embodiment shown in the drawing accompanying and forming part of the present specification. This form will now be described in detail to illustrate the general principles of the invention, but it is to be understood that such detailed description is not to be taken in a limited sense, since the invention is best defined by the claim appended hereto.

Referring to the drawing:

Fig. 1 is a longitudinal section through a drill bit, with parts shown in elevation;

Fig. 2 is a generally longitudinal section taken along the line 2—2 of Fig. 1;

Fig. 3 is a bottom plan view of the drill bit; and

Fig. 4 is a bottom plan view of part of the drill bit illustrated in Fig. 3.

As disclosed in the drawing, the drill bit includes a main body or shank 10 having the usual threaded, tapered pin 11 at its upper end for attaching the bit to a tubular string of drill pipe (not shown), by means of which the drill bit is rotatable from the surface of a bore hole, in a

well known manner. Depending from the main body 10 is a pair of legs 12 rotatably carrying side or gauge tooth cutters 13 whose purpose is to remove an outer annulus of formation material and maintain the hole to its required diameter. These cutters are each rotatably mounted on a suitable stationary bearing support 14 fixed to a leg 12 and inclined inwardly and downwardly toward the axis of the bit. The inner end of each bearing support 14 preferably is provided with an enlarged head 15 for a purpose hereinafter explained.

The formation material within the annulus cut by the side roller cutters 13 is removed by cross roller cutters 16 rotatably mounted on bearing supports 17 whose axes lie in a plane substantially at right angles to the axes of rotation of the side roller cutters 13. The outer ends of these bearing supports are fixed, as by welding material 18, to legs 19 depending from the main body 10 and positioned between the other pair of legs 12 supporting the side cutters 13. The inner end of each cross cutter bearing support 17 is integral with oppositely directed webs or braces 20, whose outer ends are welded or otherwise suitably fixed to the inner head ends 15 of the bearing supports 14 for the side cutters. In effect, the braces or webs 20 form a generally T-shaped structure in conjunction with the cross-cutter bearing support 17, the oppositely directed webs of each T supporting the inner ends of the bearing supports 17 through their integration with the side roller cutter bearing supports 14.

Each bearing support 17 is cylindrical in shape to provide a raceway for a plurality of anti-friction roller bearings 21 which also ride upon a corresponding raceway 22 formed in the cross roller cutter 16. The rollers 21 are confined on their raceways by an inner boss 23 on the T-shape member engageable with the inner ends of the rollers 21, and by an inwardly directed flange 24 on each cutter engageable with the outer ends of the rollers 21. The outer end of each cross cutter 16 is also provided with a generally toroidal raceway 25 for receiving a set of anti-friction ball bearings 26 riding within an opposed toroidal raceway 27 formed in an axial thrust bearing 28 engaging the inner side of the leg 19 and secured thereto by the welding material 18.

From the bearing construction described, it is apparent that radial bearing loads are transmitted between the bearing support 17 and cross cutter 16 through the roller bearings 21; that outwardly directed axial thrusts are transmitted

between the cross cutter 16 and thrust bearing 28 through the ball bearings 26; and that inwardly directed thrusts are transmitted between the cutter 16 and bearing boss 23 through the roller bearings 21. Thus, the co-operation between the 5 cutter flange 24, roller bearings 21 and boss 23 prevents each cross cutter from moving inwardly, whereas its outward movement is forestalled by the thrust bearing 28 and depending leg 19.

The braces 20 of the T-shaped bearing supporting members 20, 17 cooperate with the side roller cutter bearing supports 14 to provide two spaced points of support for the inner end of the bearing 17, by transmitting the load in two oppositely directed paths to the side cutter bearing supports 14, and thence to the depending legs 12. This mode of support, in cooperation with the direct attachment of the outer ends of the bearing supports 17 to the other depending legs 19, provides three supporting points for each cross cutter 16, imparting great strength and 10 sturdiness to the drill bit. The braces or webs 20 are spaced apart on opposite sides of the bit axis, and are generally parallel to each other so as to provide two transverse supports for the side roller cutter bearing members 14. In effect, these spaced braces 20 integrate the side roller legs 12 with each other so that the load imparted to the side cutter bearing supports 14 is transmitted not only to its adjacent leg, but also to the opposed leg, as well as to the depending legs 19 carrying the cross cutters, this latter transmission of loading occurring through the braces 20 and bearing supports 17. As a result, all of the non-rotatable parts of the bit constitute a functionally unitary structure capable of safely carrying loads of large magnitude and of operation at high rotative speeds.

The cross roller cutters 16 do not extend inwardly to the axis of the bit, leaving a space through which fluid may be discharged from the drill bit directly onto the bottom of the bore hole being produced. Such fluid passes through the usual passage 30 in the body 10 of the drill bit, through a central nozzle 31 and between the spaced braces 20 for direct discharge against the hole bottom. This fluid in jet form strikes the central portion of the bottom of the hole and spreads outwardly in all directions so as to clean the bottom of all cuttings, as well as flush the teeth on the cross cutters 16 and side cutters 13 as they roll around on the bottom during rotation of the drill bit. Part of the jet probably diverges to act directly upon the upper teeth on the side roller cutters 13 to clean them of any adherent matter. However, substantially the entire power of the jet issuing from the coaxial nozzle 31 is available for direct cleansing action upon the bottom of the hole.

The inner ends of the cross cutters 16 terminate short of the bit axis so as not to interfere with the jet issuing from the nozzle 31. As a result, a small core remains or tends to remain at the bottom of the hole, which is probably incapable of sustaining itself and breaks off, either due to the vibration of the bit against the bottom of the hole, or due to the hydraulic action of the central jet. However, as a precautionary measure, additional cutter means are provided for disintegrating this core should it form and enter the confines of the drill bit.

A pair of opposed core cutters 32 of the drag type are attached to the underside of the main body 10 of the bit on opposite sides of the nozzle outlet. These cutters 32 extend inwardly almost 75

to the axis of the bit to effectively remove any upstanding core that might remain after passage of the side and cross cutters 13, 16 through the formation.

In order for the nozzle to eject a jet of large force, its discharge area cannot be too great. For this reason, the outlet of the jet is in the shape of a cross, which not only restricts the outlet area to the desired value, but also enables the core cutters 32 to be positioned closer to the bit axis by placing them in a diagonal position extending outwardly from the square common to the crossing portions of the nozzle.

In the event that a core were to be formed by the cross cutters 16 during rotation of the bit, it might engage the braces 20 and prevent or retard further drilling progress. To obviate this difficulty, the bearing supports 17 for the cross cutters are inclined upwardly and inwardly so that the inner ends of the cutter teeth, when in their bottommost positions, extend inwardly across the plane of the braces. Such upward and inward inclination of the cross cutters 16 causes them to reduce the diameter of the core, so that it passes inwardly between the braces 20. Although the cross cutters could be inclined to a great extent to effectively achieve this purpose, it is preferred to have only a slight angle of inclination. Despite the use of a slight angle, the resulting core would still be incapable of engaging the webs 20 due to the reliefs 33 provided at their juncture with the bearing supports 17. Such relief 33 is of generally arcuate shape so that the distance between the relieved surface of each web 20 or boss 23 and the axis of the bit is no greater than the distance of the inner ends of the bottommost cross cutter teeth from the axis of the bit. This relieving of the braces 20 does not weaken them to any material extent since there is ample metal integrating them with the bearing supports 17.

As a precautionary measure, a plurality of inward extensions 34 of hard-faced material may be placed on the braces 20 to decrease the diameter of any core that might be formed by the cross cutters 17. As the teeth of these cutters wear during the drilling operation, they will not extend inwardly to as great an extent as formerly resulting in the production of a larger diameter core. Whenever this occurs, the hard-faced inward extensions 34 operate upon the core to reduce its diameter and insure its unimpeded passage upwardly into the bit, where it will be removed by the drag cutters 32 positioned adjacent the central nozzle 31.

It is therefore apparent that a drill bit has been devised of strong and sturdy construction capable of effectively removing hard formations. The fluid issuing from the central nozzle can thoroughly flush away all detritus or cuttings at the bottom of the hole, as well as clean the cutter teeth, enabling the latter to penetrate the formation to their maximum extent without interference from an intervening cushion of formation cuttings.

I claim:

A rotary drill bit, including a body having a pair of opposed depending legs, bearing supporting means secured to said legs and extending inwardly therefrom, side roller cutters rotatably mounted on said bearing supporting means, a second pair of opposed legs depending from said body between said first mentioned pair, a bearing support secured to each of said second pair of legs and extending inwardly to terminate short 75

of the bit axis, cross roller cutters mounted on said bearing supports for rotation about axes inclined upwardly and inwardly, a set of oppositely directed braces secured to the inner end of each bearing support and having their outer ends secured to the inner ends of said side roller cutter bearing supporting means, said sets of braces being disposed in spaced relation on opposite sides of the bit axis, said body having a central

5 nozzle whose outlet is above said cross cutters for directing drilling fluid between said sets of braces upon the bottom of the bore hole being produced by the drill bit, and the inner ends of said bearing supports being relieved so as to extend no closer to the bit axis than the inner ends of said cross cutters.

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