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ROCK BIT WITH MEANS FOR RESISTING RADIAL THRUST

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Fig. 1

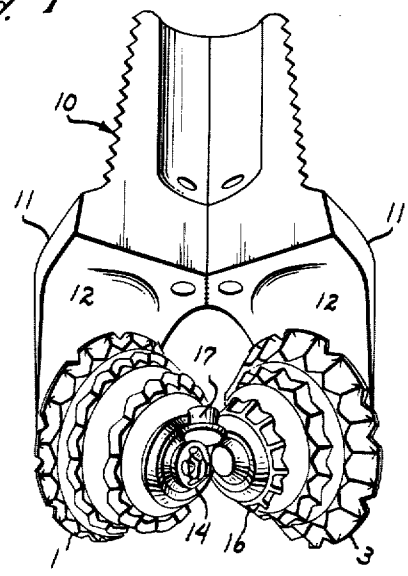


Fig. 2

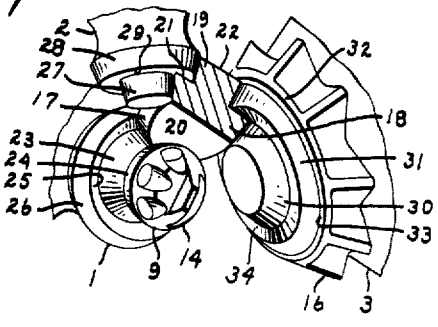


Fig. 4

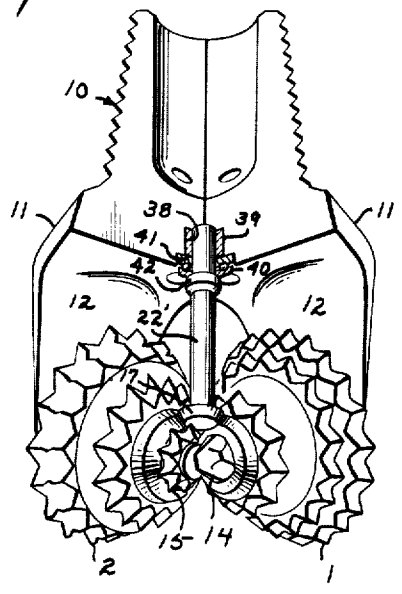
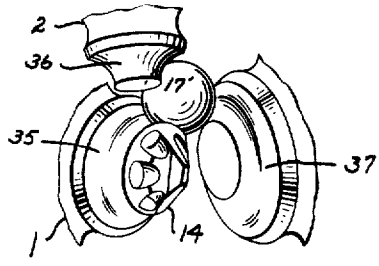


Fig. 3



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ROCK BIT WITH MEANS FOR RESISTING RADIAL THRUST

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This invention relates to an earth boring drill, or bit, and more particularly to a drill of the rolling cutter type.

Earth boring drills of the cone type have cutters provided with peripheral cutting elements which disintegrate the bottom of a hole being drilled and also each cutter has a gage cutting structure which disintegrates the wall of the hole and is intended to maintain a cylindrical bore of uniform diameter. During normal use severe forces are placed upon the cutters, both axially and radially of the bore, whereby bearing wear takes place and the radial forces tend to cause the cutters to move toward the axis of rotation of the drill. If the bit structure is inadequate to assume this inward thrust, the cutters will move inwardly toward the axis of the bit and as a result a progressively increasing taper in the diameter of the bore occurs. If then the bit is replaced by a new one capable of drilling full-gage hole, such new bit must first perform a reaming operation before it can reach bottom. Frequently such a reaming operation will consume the entire useful life of the new bit whereby a second replacement is necessary in order to advance drilling.

Although cutter bearings include a thrust bearing, such bearing structures are frequently inadequate to satisfactorily serve their intended purpose throughout the normal useful life of all parts of the bit structure and to maintain full gage hole throughout such life. Also, it frequently occurs that wedging of a bit in a tapered hole or striking of a cutter upon a ledge as the drill string and bit are being lowered into a hole will cause inwardly bending of a leg, or legs, of a bit whereby an undergauge hole is thereafter drilled.

It is the primary object of the invention to provide, in a cone type earth boring drill, means for successfully overcoming the inward forces exerted upon the cutters thereon so that a uniformly full-gage hole will be drilled throughout the normal useful life of the drill.

Another object is to provide a rolling cutter type of earth boring drill having adequate roller thrust bearing means to resist thrust forces upon the cutters radially of the drill.

A still further object is to provide, in a cone type drill, a thrust member rolling and retained within a raceway formed by complemental surfaces on the exteriors of the cutters.

Another object is to provide a rolling cutter type of earth boring drill in which inward thrust upon the cutters is assumed by the rolling thrust member and thence by mutual interaction of the cutters.

Another and more specific object is to provide, in a cone type well drill, surface contours on the cones which form a raceway therebetween, a rolling thrust member being positioned and retained in such raceway so that mutual interaction among the cutters overcomes the thrust forces exerted radially of the drill during normal drilling operations.

These and other objects of the invention will be more fully apparent from the following description and the accompanying drawings in which:

FIG. 1 is a side elevational view of a three-cone bit embodying the invention, a one-third segment of the bit head and cutter carried thereby being removed to more clearly show details of construction;

FIG. 2 is an enlarged view in modified perspective of

the innermost ends of the three conical cutters of a cone type bit, the thrust member being shown in section to show the relationship of all cooperative parts of the structure;

FIG. 3 is a view similar to FIG. 2 but showing a modification in which a spherical thrust member cooperates with the inner ends of the cutters to assume the inward thrust upon the cutters; and

FIG. 4 is a view similar to FIG. 1 showing still another modification in which the thrust member is integral with a downwardly extending spindle having its upper end rotatably supported in the bit head.

The drill **10** as shown in FIG. 1 of the drawings comprises a bit head made up of three segments, two of which are shown at **11**, the third segment being removed for purposes of better disclosing the thrust structure to be further described. The bit head segments have downwardly extending legs **12** having downwardly and inwardly extending shafts (not shown) upon which cutters **1**, **2** and **3** are rotatably mounted, in a manner well known in the art.

The cutters on a three-cone bit are customarily referred to as the No. **1** cone, the No. **2** cone, and the No. **3** cone, which are identified in the drawings by like reference characters, respectively. They are so designated in the order of their successive innermost cutting structures or teeth outwardly from the axis of the bit. These innermost cutting structures are shown as a spearpoint **14** on cone **1**, teeth **15** on cone **2** (FIG. 4) and teeth **16** on cone **3**.

In the present invention the on-bottom cutting structures of the cones **1**, **2**, and **3** may be of any of the conventional and well known designs except for the changes we have made to provide a structure to assume inward thrust upon the cutters. Likewise the gage cutting structure on the cutters may be of any suitable design such, for example, as that shown in United States Letters Patent No. 2,527,838. Inasmuch as these features of construction are well known and do not, per se, involve the present invention, specific description thereof is not here included.

In FIGS. 1 and 2 a thrust member or roller **17** is shown located within a composite raceway formed by the cutters and is positioned approximately on the axis of the bit. To provide this raceway the cutters are so contoured peripherally that they receive and hold the roller **17** in place, and such roller is thus mutually supported by the cutters so that forces on any cutter radially of the bit are transmitted through the roller to the two opposed cutters and hence the cutters are mutually self-supporting as regards such forces and the overall diameter of the bit is unchanged from the imposition of these forces.

Roller **17** in the embodiment shown in FIGS. 1 and 2 is generally T-shaped in longitudinal cross section, as shown, and comprises an enlarged portion **18** and a reduced portion **19** thus presenting a lower end face **20**, an intermediate annular shoulder **21** and a second end face **22** on the outer end of the reduced portion **19**. The peripheries of portions **18** and **19** are preferably cylindrical and approximately co-axial with the bit axis, i.e., they extend parallel to the bit axis for maximum effectiveness in transmitting radial forces, whereas end faces **20** and **22** and annular shoulder **21** extend generally radially or transverse the bit axis.

Cone No. **1** is provided with a raceway at the base of the spearpoint **14**, this raceway comprising surface **23** and adjacent surfaces **24** and **25** extending outwardly therefrom so that the raceway rollingly receives the enlarged portion **18** of the roller **17** and restrains it from axial movement. The raceway also includes an annular surface **26** which rollingly engages the periphery of the reduced portion **19** on the roller **17**.

As best seen in FIG. 2 the inner end of cone No. **2** has

a raceway comprising annular surfaces **27** and **28** and intermediate radially extending surface **29**. Surfaces **27** and **28** rollingly engage the peripheral surfaces on the roller **17** and surface **29** engages the radially extending face or shoulder **21** on the roller **17** whereby interengagement of these surfaces serve to restrain the roller **17** from axial upward movement.

The raceway on the inner end of cone No. **3** comprises raceway surfaces **30**, **31**, which likewise rollingly engage the peripheries of the portions **18** and **19** of roller **17** respectively. The teeth **16** on this cutter are joined at their inner ends by a web **32**, which presents an inwardly facing bearing surface **33** which engages the end face **22** of the roller **17**. Similarly the radially extending bearing surface **34** intermediate surfaces **30** and **31** rollingly engages the radially extending surface **21** on the roller **17** whereby the roller is restrained from upward movemnt from within the raceway on cone **3**.

By way of reiteration it is pointed out that each raceway about the periphery of one of the cutters is in opposed relation to the raceway on each of the other two cutters so that all of the raceways cooperate in the assembled drill **10** to form a composite raceway within which the thrust member **17** is free floating, is restrained from exit from such space and is so positioned that in its rolling action it effectively resists thrust upon the cutters radially of the drill during normal use thereof. It has been found that this construction is extremely effective in restraining the cutters from inward movement radially of the bit **10** and that a maximum of full gage hole can be drilled. Also bending of the legs **12** from impact or from wedging of the bit in a tapered hole are avoided.

In assembly and use of the bit of the invention the bit head segments, with cutters mounted thereon, are brought into proximity and in the order in which they are to be assembled. The roller **17** is then inserted into the raceway provided by the peripherally contoured raceways on the cutters **1**, **2**, and **3**. Then, as the head segments are moved to terminal assembled position, the roller fits within the space provided therefor and is held in place as above described. The head segments are then secured together in a suitable manner, as by welding, or otherwise, as is well established in the art. Thereafter the bit is operated in the customary manner, with the thrust bearing arrangement functioning in the manner above explained.

It is here noted that in the conventional three-cone bit, such as that shown in U.S. Patent 2,527,838 above referenced, the rows of teeth except the heel teeth on each cone interfit with rows of teeth on two adjacent cones. In the present invention the innermost row of teeth on the No. **2** cone has been omitted, and in the space thus provided we have formed the raceway on that cone within which the roller **17** is positioned and retained. Preferably the raceway surface **33** on the No. **3** cone comprises the inner surface of the web **32** joining the inner ends of the innermost row of teeth **16** on cone No. **3**.

Also a web **9** joins the outer ends of the cutting elements or teeth on the spearpoint **14** on cone No. **1** and provides the surface **24** to resist downward thrust on the roller **17**. As shown, webs **9** and **32** extend to the tooth crests but in some types of formation this is not necessary. That is to say, the webs may be of a lesser height than the teeth joined thereby. We have found, however, that a superior formation-breaking action takes place when the circumference of each web is at or near the tooth crests. The webs break away the earth formation in a direction radially of the bore farther than would the tooth crests alone. This superior breakage of the formation assists in preventing build-up of uncut bottom at the area where the said row of teeth was removed.

It would seem that even in spite of this feature in the operation of the device of the invention, build-up would occur in that area that would normally be traversed by the row of teeth omitted from the No. **2** cone and that destructive action would take place upon the surfaces of the raceway for the roller **17**. Actually it has been found that little such destructive action takes place, but that on the contrary the raceway and the roller **17** function satisfactorily throughout a long and useful life of a bit embodying the invention.

FIG. 3 shows a modification of the invention from the form shown in FIGS. 1 and 2. In this modified form the contouring of the surfaces on the cutters is such as to provide a composite raceway for the ball thrust member **17'**. This raceway comprises grooves **35**, **36**, and **37** in the cutters **1**, **2**, and **3**, respectively. Each of these grooves is arcuate in cross section whereby the composite raceway consists of arcuate surfaces to receive and hold the ball **17'** in place and the ball rolls freely within the raceway and resists inward thrust of the cutters.

FIG. 4 also shows a modified form of the invention. The showing is similar to that of FIG. 1 except that the bit head segment which carries the No. **3** cone has been omitted and thus cones Nos. **1** and **2** are shown in side elevation.

The form here shown comprehends the use of a spindle extension **22'**, on the roller **17**, which extends upwardly and enters an axial bore **38** in the lower end of the bit head **10**. A sleeve bearing **39** in the bore **38** rotatably supports the composite spindle **22'** and roller **17**. Thrust bearing **40** is positioned in a shallow counterbore **41** in the lower end of the bore **38** and engages a shoulder **42** on spindle **22'** whereby any tendency for the spindle to move upwardly during operation is resisted. It should be noted that this form of the invention may be utilized whether the drill or bit utilizes two rolling cutters or a larger number of cutters, the important aspect of the invention comprising the use of a rolling thrust member retained in place and engaging peripheral surfaces on the rolling cutters whereby interaction of the rolling cutters through the thrust roller **17** resist thrust upon the cutters radially of the drill. All embodiments of thrust member **17** and **17'** may be described as having exterior surfaces of revolution.

The embodiment of FIG. 4 also illustrates the fact that in accordance with the invention the races upon the peripheries of the cutters may be located at any desired position along the conical surfaces of the cutters. The thrust roller **17** will of course be of such size that it will engage surfaces in the races so that desired interaction will be had among the cutters and forces tending to move the cutters radially inwardly of the bit will be resisted.

The invention claimed is:

1. In a conventional rolling cone well drill including a head and a multiplicity of conical cutters disposed below the head with their axes of rotation inclined downwardly and inwardly with respect to the axis of the drill, such cutters being disposed with their small ends confronting one another proximate the axis of the bit, the improvement to eliminate inward movement of the cutters under radial forces comprising

(*a*) a peripheral raceway on each cutter proximate its inner end, each said raceway being annular with respect to the axis of the associated cutter and concentric therewith, and

(*b*) a thrust member having an exterior surface of revolution disposed with its axis of revolution substantially coincident with the axis of the bit and also being disposed above and adjacent the inner ends of the cutters and in contact with each of said raceways at approximately the uppermost and innermost portion thereof,

(*c*) each of said raceways having a cross section matching that of at least a portion of said surface of the thrust member,

(*d*) the contacting surfaces of said thrust member and each raceway including at least one portion which transmits forces radially of the bit, and

(*e*) said contacting surfaces also including portions disposed to retain said thrust member against axial movement.

2. The improvement of claim 1 which includes

(*f*) a recess in the head of the bit above said thrust member,

(*g*) a spindle portion of reduced diameter extending upwardly from said thrust member into said recess and

(*h*) means in said recess rotatably contacting said spindle and supporting it against axial thrust.

3. The improvement of claim in which there are at least three such cutters and said contacting surfaces include pairs of surfaces on said thrust member and on at least one of said raceways, said pairs of surfaces extending generally radially with respect to the axis of the bit, at least one pair of said contacting surfaces being disposed to resist upward axial movement and at least one other pair being disposed to resist downward movement of said thrust member.

4. In a conventional rolling cone well drill comprising a head and at least three conical cutters disposed below the head with their axes inclined downwardly and inwardly with respect to the axis of the drill, such cutters bing disposed with their small ends confronting one another proximate the axis of the bit, the improvement to eliminate inward movement of the cutters under the radial forces of drilling comprising

(*a*) a peripheral raceway on each cutter proximate its inner end, each said raceway being annular with respect to the axis of the associated cutter and concentric therewith, and

(*b*) a thrust member having an exterior surface of revolution disposed with its axis of revolution substantially coincident with the axis of the bit and also being disposed above and adjacent the inner ends of the cutters and in contact with each of said raceways at approximately the uppermost and innermost portion thereof,

(*c*) each of said raceways having a cross section matching that of at least a portion of said surface of the thrust member,

(*d*) the contacting surfaces of said thrust member and raceways including portions extending generally parallel to the bit axis and thus being adapted for the transmission of radial forces and portions extending generally transverse said axis and thus being adapted to prevent axial movements of said thrust member.

5. The improvement of claim 4 in which said thrust member is a sphere and said raceways have arcuate cross sections.

6. The improvement of claim 4 in which said thrust member has a lower flange portion of generally cylindrical cross section and having a bottom end surface and an upper, reduced diameter portion also of generally cylindrical cross section and having an upwardly facing end surface, there also being an upwardly facing end surface on said lower flange portion surrounding the upper portion at its juncture with said flange portion, each of said raceways including surfaces rollingly and slidably contacting both of the cylindrical surfaces of said portions, at least one of said raceways including a surface similarly contacting the bottom end surface of said flange portion and at least one of said raceways similarly contacting at least one of said upwardly facing end surfaces.

7. The improvement of claim 4 in which said thrust member is generally T-shaped in longitudinal cross section, the T being inverted so that the leg extends upwardly with a generally cylindrical surface and an end surface, the base or crossbar of the T also having a generally cylindrical surface, a bottom surface and an annular surface surrounding its union with the leg of the T, one of said raceways having surfaces rotatably and slidably contacting both said cylindrical surfaces, said bottom surface and said annular surface of the thrust member, a second raceway having surfaces similarly contacting both said cylindrical surfaces and said annular surface of the thrust member, and the third raceway having surfaces rotatably and slidably engaging both said cylindrical surfaces and said end surface thereof.

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