

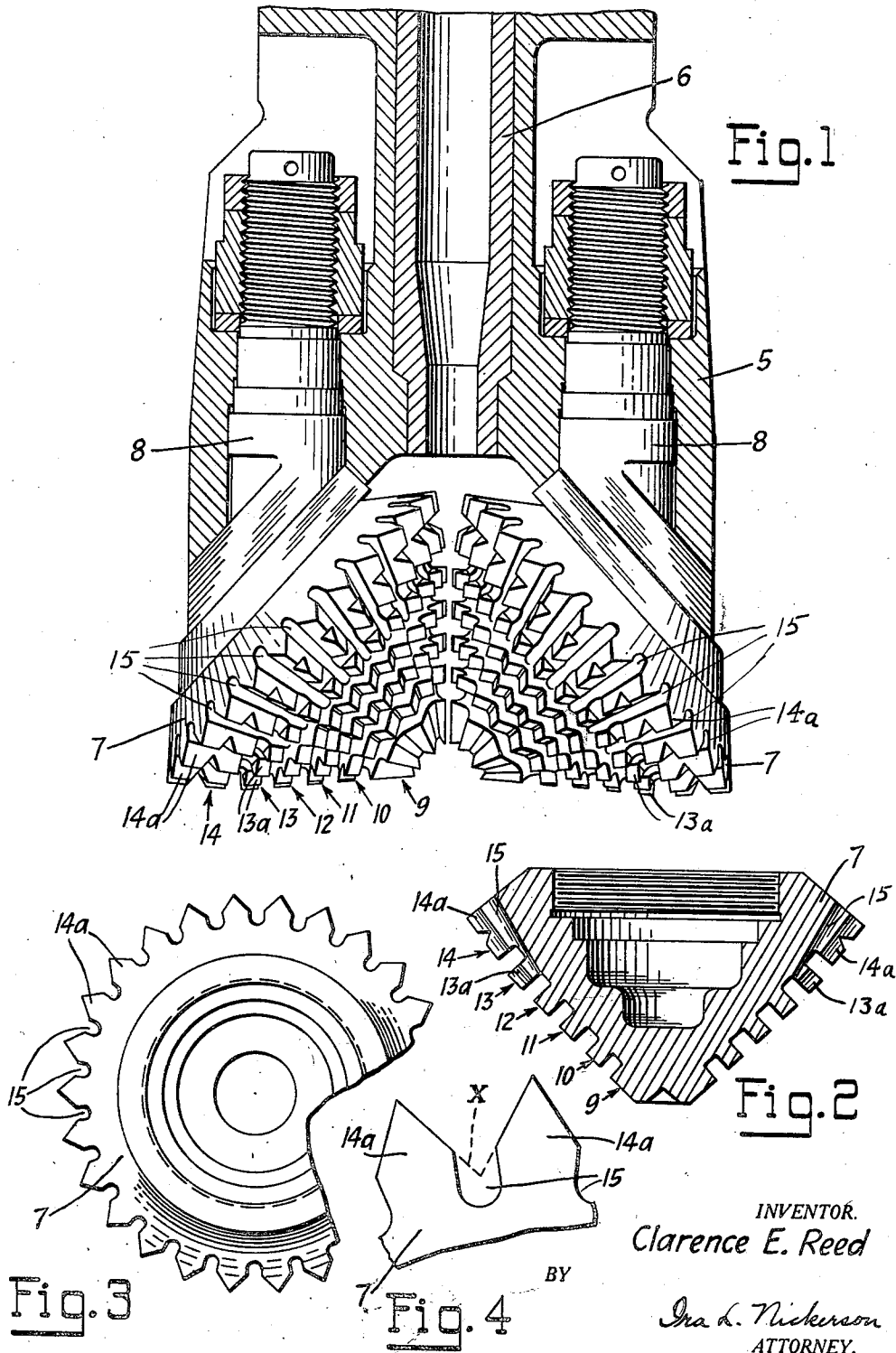
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TOOTH FORMATION AND ARRANGEMENT FOR ROTARY DRILLING

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UNITED STATES PATENT OFFICE

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TOOTH FORMATION AND ARRANGEMENT FOR ROTARY DRILLING

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This invention relates to apparatus for rotary drilling. More specifically it relates to the formation and arrangement of cutting teeth including the method of forming the same. While the tooth formation has features of general application it has been developed with particular relation to roller cutters for deep well drilling, especially the so-called cone cutters and in the detailed description attention will be confined to this type of cutter.

In its more specific aspect, the invention relates to the large teeth formed on roller cutters of frustoconical shape to adapt the same to general purpose drilling of all formations encountered and not to hard rock only. As heretofore made cone cutters have had annular concentric rows of inverted V or wedge shaped teeth, the broad slopes and wide edge of which set up resistance to penetration into the earth formation and the material displaced by the rolling edge moves into the groove between the edges and becomes packed hard and solid by the weight of the drill. This displaced material interferes with and makes impossible deep penetration by the edge even to the nominal length of the tooth because the material wedged into the bottom of the groove forms a stop to further penetration. Since the grooves between the teeth are shallow, the displaced earth material becomes so tightly wedged and packed therein as a result of frictional contact with the bottom of the hole that when the tooth has rolled under the stream of flushing fluid, the latter does not always and uniformly remove the packed material. This is particularly true in shales and sticky formations where it is not uncommon to encounter a condition in which the adhering material obliterates all the grooves between the teeth and between the rows of teeth, which condition is commonly referred to as "balling up". In such a condition the cones will no longer roll and are soon worn flat on one side and destroyed.

Some of the teeth at the heel of a cone must contact with the side of the hole as it is drilled and the cutting edge of the tooth must be backed up with sufficient material to take care of wear if a uniform hole diameter is to be

maintained. In conical cutters having inverted V or wedge type teeth so much metal is left at the heel that excessive friction results which hinders rapid penetration into the earth formation unless the cutter is tipped to an angle which gives not much more than a mere point contact at the side or heel. However, if penetration is secured by such an expedient, the point contact at the heel is soon ground off and the diameter of the drill hole reduced. This is disastrous in well digging since it requires dangerous reaming.

An attempt has been made to obtain maximum flushing efficiency and to avoid the above described condition by slabbing off the cones at the base or heel into substantial parallelism with the axis of the cone. While this may increase the flushing efficiency, such cones are deficient in other respects; the flushing fluid in addition to washing the grooves in the cones impinges to a great extent on the base of the cone with the result that the fluid stream is diverted laterally under heavy pressure against the angle face of the bit head above the body of the cone, cutting the same away and in time destroying the bit head which action may be very rapid when there is considerable abrasive material in the flushing stream; the slabbing off of the base of the cone further removes most of the material which is necessary to maintain the gauge of the hole.

One object of the invention is to provide an improved tooth formation for roller cutters which will increase footage, prolong the life of the cutters, and permit the same to perform work more efficiently and cheaply than previously known cutters. Another object is to avoid the difficulties of previously known arrangements and to secure the improved results without sacrifice of ability on the part of the cutters to maintain the gauge or diameter of the drill hole. Other objects will be apparent from the detailed description which follows.

This invention provides increased clearance between the teeth by widening and deepening the space between the cutting edges of the tooth. The tooth form is changed to a shape giving deep penetration under load without the sacrifice of strength, this being

effected by shortening the slope contact of the wedge tooth and providing a projecting base by cutting a groove between adjoining wedge shaped teeth, thus removing a portion 5 of the base of each. This not only gives clearance for a penetrating cutting edge but also provides greatly increased and ample space for the displaced material to move into. The groove preferably has parallel sides which 10 in the case of a roller cutter has the effect of slightly undercutting the base of the tooth so that the sides of the base diverge slightly toward the wedge shaped cutting edge. Thus the shallow space between the adjoining 15 wedge shaped teeth of the old arrangement is much increased by deepening the same and changing its shape, thereby providing an area and a receptacle, so to speak, for the displaced earth formation. The space thus provided has more capacity than the volume of 20 earth displaced by the cutting edge in one contact. With this large space the roll of the edges will not cause the body of the cone under the weight of the bit to pack the displaced earth in the groove so tightly and the shape of the groove will not permit the lightly packed material to fall out but will serve as a bucket on a conveyor to carry it from the cutting face at the bottom of the hole into 30 the path of the axially directed flushing fluid in the bit body. The flushing fluid issuing under high pressure directly over the end of the groove will clear the same thoroughly, with the result that the groove pockets will 35 pass down again into operating position clean and free to enable the tooth to enter deeply into the virgin formation. These uniquely shaped grooves between the wedge teeth remove so much metal from the heel of the cone 40 that excessive friction at the side of the hole is largely eliminated without requiring a change in the angle of the cone but at the same time the contacting edge of the tooth is supported by metal of ample width and 45 length parallel to the side of the hole to maintain the gauge of the latter.

In order to illustrate the invention, one concrete embodiment thereof is shown in the accompanying drawing in which:

50 Fig. 1 is a vertical sectional view through the lower end of a two cone bit head, the cone cutters being shown in elevation;

Fig. 2 is a vertical central sectional view through the cone shell on the left of the bit 55 head;

Fig. 3 is a rear or base plan view, partly broken away, of the cone shell shown in Fig. 2; and

60 Fig. 4 is a greatly enlarged and elevational view of adjoining teeth on the cutter, indicating in broken lines the former wedge formation of the teeth and, in full lines, the improved form of the present invention.

65 While the tooth formation of the present invention may be used generally and applied

to roller cutters of any known or desired type used in bit heads of any form, I have illustrated in Fig. 1 a two cone bit head, cone cutters, and a supporting arrangement therefor disclosed in my issued Patent No. 1,636,666 and Reissue Patent No. 17,741. The 70 cutter head is indicated at 5 and is provided with an axially disposed wash pipe 6 for flushing fluid which discharges parallel with and between the cutting faces of cone cutters 7 which are suitably supported by spindle 75 and shank members 8 in the lower end of the bit head.

The conical surface of each of the cone cutters 7 is provided with annular concentric rows 9-14 inclusive of inverted V or wedge shaped cutting teeth. From the heel or base end of each cone radial cuts 15 of considerable depth and slanting slightly toward the surface of the cone are cut through a portion 85 of the same, such as the last two rows of teeth 14 and 13. Each of the cuts as shown is made with parallel sides between adjoining teeth with the result that a portion of the base of each tooth is removed as clearly indicated 90 in the enlarged view (Fig. 4) where the broken line *a* shows the original cutting for the uniformly wedge shaped teeth and the full lines therebeneath show the groove 15 made by the additional cut. Grooves 15 are 95 of sufficient depth and width to form teeth 14a in rows 14 and 13a in rows 13 into long penetrating teeth and to provide a pocket for the displaced material. Inasmuch as the teeth are annularly arranged and grooves 100 15 have parallel sides, the effect upon teeth 13a and 14a is to make the bases of the same slightly diverging outwardly toward their wedge shaped cutting edges, this divergence being more pronounced in cones of small diameter than in cones of large diameter. 105

From the above it will be apparent that as cone 7 rolls into the formation, the cutting teeth 13a and 14a near the heel of the cone penetrate deeply and by reason of the enlarged pockets formed by grooves 15 the dislodged material is loosely pressed into the same, these pockets serving to hold the material as the teeth roll upwardly until they come under the powerful stream of flushing fluid issuing from wash pipe 6. There is 110 minimum dispersion of the flushing fluid which fully removes the loosely packed material in grooves 15 so that when the teeth again enter the formation the pockets are free and clear. It will also be apparent that the considerable amount of material removed from the heel of the cone cutters by grooves 15 reduce friction on the side of the hole but that ample metal is still left to back the cutting edge of the teeth 14a so as to maintain the gauge of the hole. 115

While the invention has been herein disclosed as to its method and apparatus aspects in what is now considered to be its preferred 120 125 130

form, it is to be understood that the invention is not limited to the specific details thereof but covers all changes, modifications, and adaptations within the scope of the appended claims.

I claim as my invention:

1. In rotary drilling apparatus for earth boring, a roller cutter having long penetrating teeth formed with a wedge shaped or inverted V point and substantially parallel sides below said point, adjacent teeth being spaced from one another to provide a pocket for the material displaced by the points of the teeth.

2. In rotary drilling apparatus for earth boring, a roller cutter having spaced annular rows of cutting teeth, the teeth in each row being spaced from one another and having inverted V or wedge points and extended bases with substantially parallel or slightly diverging sides toward said points.

3. In rotary drilling apparatus for earth boring, a cone cutter having concentric rows of inverted V or wedge shaped teeth, portions of the bases of adjacent teeth in certain of said rows being removed by transverse cuts to extend the overall length of the teeth and to provide pockets therebetween for the material displaced by the points of said teeth.

4. In rotary drilling apparatus for earth boring, a cone cutter having concentric rows of inverted V or wedge shaped teeth, portions of the bases of adjoining teeth in the base or heel rows having been removed by radial cuts between said teeth from the base of the cone to make longer teeth, to provide pockets for displaced material between the teeth, and to reduce the mass of metal in contact with the side of the drill hole thereby to reduce friction without sacrificing metal necessary to maintain the gauge of the hole.

5. In rotary drilling apparatus for earth boring, a cone cutter having one or more rows of teeth separated by grooves extending along lines converging at the apex of the cone, said grooves having substantially parallel side walls adjoining V-shaped walls on the teeth.

Signed by me at Wichita, in the county of Sedgwick and State of Kansas, this 6th day of December, 1930.

CLARENCE E. REED.