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ROTARY DRILL BIT AND CUTTER THEREFOR

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2 Sheets-Sheet 1

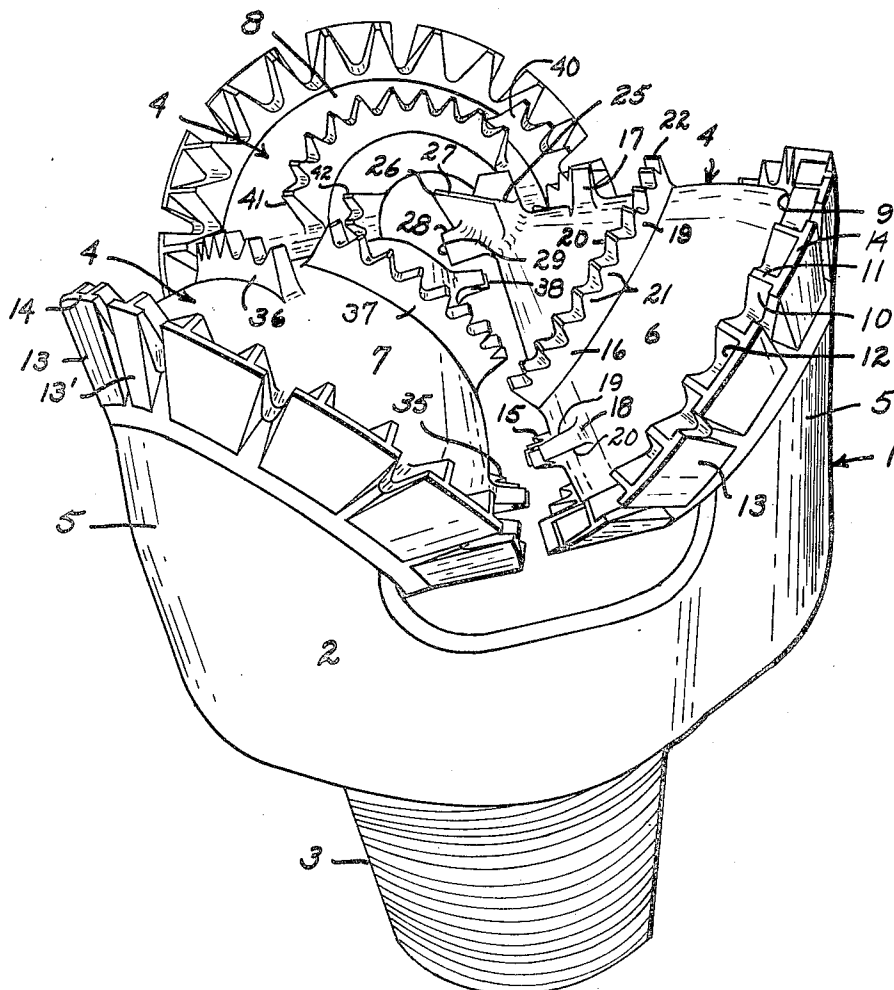


FIG 1

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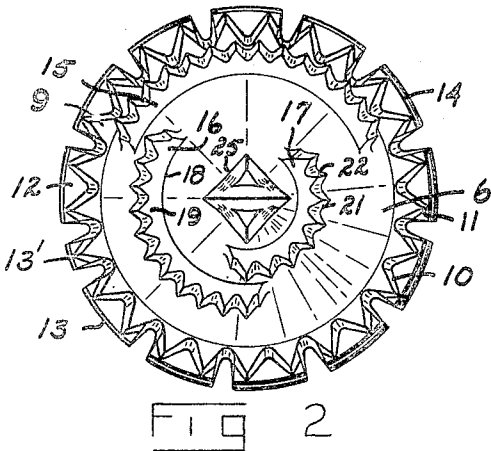
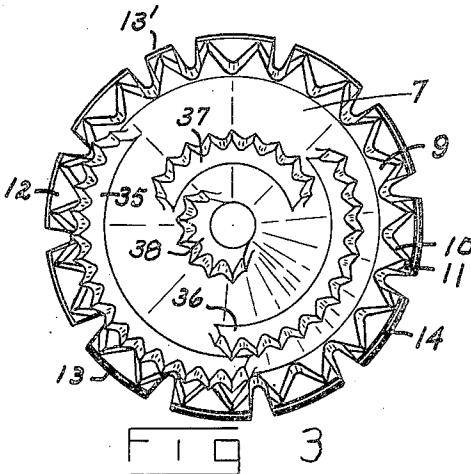
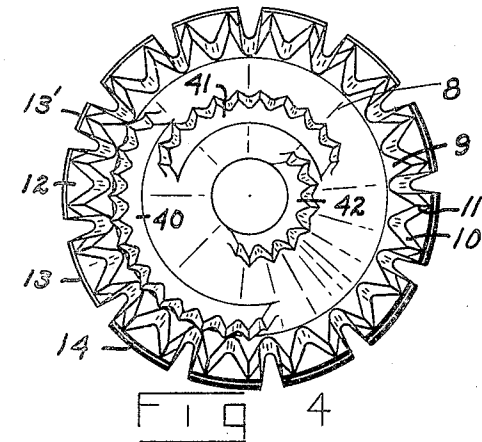
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ROTARY DRILL BIT AND CUTTER THEREFOR

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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

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ROTARY DRILL BIT AND CUTTER
THEREFOR

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9 Claims. (Cl. 255—71)

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This invention relates to rotating cutters for deep wells and pertains more particularly to the construction and arrangement of cutter elements on such cutters.

A difficulty experienced with rotating cutters in roller boring drills is that the normal wearing away of the cutting edges presents cutting surfaces which constantly enlarge throughout the useful life of the drills. For this reason pressure, which is applied to effect drilling, is distributed over a constantly enlarging area whereby disintegration of the earth material is effected through crushing action rather than cutting action. The progressing condition during drilling decreases the drilling rate, requires increasing weights or drilling pressures and eventually leads to a cessation of effective drilling or the use of excessive and destructive stresses in the drill itself or associated equipment.

It is also important that the configuration and arrangement of cutting elements upon the rotating cutters be such as will provide efficient drilling in various formations and that such action will obtain throughout the useful life of the drill or bit.

It is an object of the invention to provide a drill cutter having cutting elements thereon of such configuration that the cutting surfaces can not exceed a predetermined area as they wear away during the normal life of the cutter.

Another object of the invention is to provide cutters having substantially uniform cross section throughout their depth, such elements terminating at their outer ends in elemental teeth so that the initial cutting rate is high during the wearing away of such teeth, the inner portions of such elements being adapted to produce efficient cutting action as the elemental teeth have been worn away and until the cutting elements are entirely destroyed.

Still another object is to provide a set of cutters having segmental cutting elements spaced longitudinally of the cutters, such elements being provided with elemental teeth forming the crests thereof.

Another object is to provide a set of cutters having segmental cutting elements spaced circumferentially of the cutter bodies and staggered along such bodies in a manner that the cutting elements of adjacent cutters interfit, at least some of such elements being provided with elemental teeth on their crests.

The invention also comprehends the provision of cutters having cutting elements of the type

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above indicated, such elements supplementing and cooperating with an outer row of heel teeth which assure rotation of the cutters.

The foregoing objects together with other objects and advantages of the invention will be more fully apparent from the following description considered in connection with the accompanying drawings in which:

Fig. 1 is a bottom perspective view of a three-cone type of drill bit embodying the invention.

Figs. 2, 3 and 4 are end views of the individual cones of the bit shown in Fig. 1.

A cone type of drill bit embodying the invention is shown as 1 in Fig. 1 and such bit comprises the body 2 having the usual threaded shank 3 for attaching the bit directly to a drill stem or to an interposed drill collar used in the conventional rotary method of drilling wells. The cones or cutters 4 are rotatably mounted upon the legs 5 which extend downwardly from the body 2.

The drill bit 1 is illustrated as having three cones 6, 7 and 8, which are usually designated as cones Nos. 1, 2 and 3, respectively, and are numbered in this sequence because the first has the farthest inwardly disposed cutting element, the second has the next adjacent radially disposed cutting element while the inner cutting element of the third is outwardly disposed from that of either of the first two.

Cone No. 1 to which the reference character 6 is applied (Figs. 1 and 2) is of a generally conical configuration and is provided with an outer row 9 of longitudinal heel teeth 10 having crests or cutting edges 11 which extend generally longitudinally of the cone. The outer ends of these heel teeth are joined in groups by interrupted webs 12 whereby there are formed a plurality of gage blocks 13 presenting cutting edges 14 which engage the earth formation at the juncture of the bottom with the side wall of the well bore and thereby tend to prevent the formation of upwardly extending rock teeth in the bottom of the bore. The tendency for the formation of such teeth is further discouraged by providing a prime number of teeth 10 in the row 9 in which case the gage blocks 13 are not all symmetrical with the tooth or teeth with which they are united, or there is provided, in the series of gage blocks one or more blocks of a shorter or longer span such as that shown at 13'. Such an arrangement prevents tracking during succeeding revolutions of the bit of which the cone is an element.

Disposed inwardly of the row of heel teeth 10 on the cone 6 are longitudinally spaced cutter elements shown at 15, 16 and 17. Each of these

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cutter elements is shown as subtending an arc less than 180° about the cone but the elements are of such combined extent that they at least span the entire circumference of the cone body. Preferably their individual spans are equal to or greater than 120° and in any event they are so arranged that the cutting effort per unit area over the well bottom is substantially uniform.

The cutter elements 15, 16 and 17 are of such configuration that their bases 18 merge with the surface of the cone and their sides 19 and 20 extend outwardly from the cone body in substantially parallel relation as best seen in Fig. 1. The side faces may taper slightly but it is intended that they are so related that the cross section is substantially constant outwardly from the surface of the body of the cone whereby, as shown, these elements comprise fractional discs upon the cone body.

The crests of the cutter elements 15, 16 and 17 comprise elemental teeth 21 which terminate in cutting edges or crests 22 extending longitudinally of the cone. These teeth are herein termed "elemental" inasmuch as they comprise only the outermost portion of the respective cutter elements 15, 16 and 17 on cone 6. Similar elemental teeth are provided on the cooperating cutter elements or cones 7 and 8 to be more fully described. A suitable range of depth of these teeth is approximately one-third to two-thirds of the total height of the cutter elements although it is to be understood that these relative dimensions are offered as illustrative and not by way of limitation.

The cone 6 to which attention has been specifically directed has a cutting structure 25 (Figs. 1 and 2) at its inner end and such structure comprises a spear point 26 which presents tapered cutting edges 27. This spear point is flanked by teeth 28 having segmental cutting edges 29.

The No. 2 cone shown at 7 (Figs. 1 and 3) has cutter elements 35, 36, 37 and 38 of a structure similar to that just described in connection with the elements 15, 16 and 17 of the No. 1 cone. Inasmuch as this cone is not intended to remove the core that tends to form at the axis of rotation of the bit the cutting structure shown at 25 in cone No. 1 is omitted. The cutter elements are, however, four in number and are so spaced longitudinally of the cone body that they interfit with the cutter elements of the cones 7 and 8.

The No. 3 cone shown at 8 (Figs. 1 and 4) has but three cutter elements 40, 41 and 42 inwardly of the row of heel teeth 9. It is to be understood that the cutting element 42 is spaced further from the axis of rotation of the bit than is either of the cutter elements 41 or 40 of the cones 6 and 7. The cutter elements on the cone 8 likewise subtend substantially the complete circumference of the cone and are so spaced longitudinally thereof as to interfit with the cutter element of the adjacent cones.

Cooperating with the segmental cutting elements on the cones 6, 7 and 8 are, of course, the rows 9 of heel teeth 10 which not only effect cutting of the earth material proximate the periphery of the well bore but also sever the earth material at the junction of the bottom and side wall whereby the formation of rock teeth on the bottom is prevented while a uniform and smooth bore is maintained. At the same time the heel teeth resist slippage of the respective cones upon the bottom of the well bore, whereby a maximum in efficiency of cutting action is brought about.

A bit constructed in accordance with the fore-

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going description is capable of and is of a special utility in the drilling of relatively hard formations. At the same time, however, if it be used in softer or tough formations it will function comparably with bits specially designed for such formations.

An important feature of the invention resides in the fact that the elemental teeth 21 are comparable in dimensions with the tips of conventional cutter teeth having the same height as the cutter elements of the present invention. As distinguished from such conventional cutter teeth, however, this invention provides a base for the teeth, such base comprising a part of the cutter element of substantially uniform cross section.

During the initial use of the bit the wearing away of the elemental teeth 21 is quite comparable to that where conventional teeth are used. As such wear progresses the area presented to effect cutting action from applied pressure increases, such applied pressure being so regulated to compensate for the additional surface presented for cutting. However, the structure of the cutter elements is such that the area of the cutting surfaces becomes constant when the teeth 21 are entirely worn away. At such time there is considerable usable material remaining in the lower base portion of the cutter elements and hence the cutter possesses considerable usefulness in continued drilling. The area presented for the application of cutting pressure remains substantially constant throughout the period of further wear upon the cutter elements and in this manner efficient continued drilling operations may be had.

The invention is not confined to the forming of cutter elements, as described, upon conical shaped cutters but it is to be understood as applicable to roller cutters of all types. When cutter elements are formed upon cutters in accordance with the invention fast and uniform cutting action is obtained and such action is had throughout the entire useful life of the cutters and without the necessity of applying excessive drilling pressures thereto.

Broadly the invention contemplates a bit of the rotary type having at least some cutter elements of substantially uniform cross section and terminating outwardly in elemental teeth, such cutter elements acting in cooperation with series of heel teeth which maintain the gage of the bore and resist slippage of the cutters on bottom during rotation of the bit.

What is claimed is:

1. A rotary cone type drill comprising a body, a plurality of cones rotatably mounted thereon to roll upon the well bottom, cutter teeth longitudinally of said cones including at least one row of heel teeth, a plurality of segmental cutter elements on at least one of said cones inwardly of the heel teeth thereon, each of said cutter elements comprising a projection disposed circumferentially of the cone, and a plurality of elemental cutter teeth on each of said projections and extending outwardly therefrom.

2. A rotary cone type drill comprising a body, a plurality of cones rotatably mounted thereon to roll upon the well bottom, cutter teeth longitudinally of said cones including at least one row of heel teeth, a plurality of segmental cutter elements on at least one of said cones inwardly of the heel teeth thereon, each of said cutter elements comprising a projection disposed circumferentially of the cone, a plurality of elemental cutter teeth on said projections and ex-

tending outwardly therefrom, each of said cutter elements in successive rows being staggered circumferentially of the cone.

3. A rotary cone type drill comprising a body, a plurality of cones rotatably mounted thereon to roll upon the well bottom, cutter teeth longitudinally of said cones including at least one row of heel teeth, a plurality of segmental cutter elements on at least one of said cones inwardly of the heel teeth thereon, each of said cutter elements comprising a projection disposed circumferentially of the cone, a plurality of elemental cutter teeth on said projections, each of said cutter elements merging into the cone surface and all side surfaces thereof being substantially parallel.

4. A rotary cone type drill comprising a body, a plurality of cones rotatably mounted thereon to roll upon the well bottom, cutter teeth longitudinally of said cones including at least one row of heel teeth, a plurality of segmental cutter elements on at least one of said cones inwardly of the heel teeth thereon, each of said cutter elements comprising a projection disposed circumferentially of the cone, a plurality of elemental teeth on said projections, each of said cutter elements merging into the cone surface and all side surfaces thereof, together with said elemental teeth, being substantially parallel.

5. A rotary type of drill comprising a body, a plurality of cutters, rotatably mounted thereon to roll upon the well bottom, cutter elements thereon, said cutter elements comprising annularly arranged projections integral with and extending outwardly from the surfaces of the cones, and elemental teeth on and extending outwardly from the periphery of each of said projections.

6. A rotary type of drill comprising a body, a plurality of cutters rotatably mounted thereon to roll upon the well bottom, cutter elements thereon, said cutter elements comprising annularly arranged projections integral with and extending outwardly from the surfaces of the cones, and elemental teeth on and extending outwardly from the periphery of each of said projections, the cutter elements on each cone being spaced relative to the cutter elements of the adjacent cone so as to interfit.

7. A rotary type of drill comprising a body, a plurality of cutters rotatably mounted thereon

to roll upon the well bottom, cutter elements thereon, said cutter elements comprising annularly arranged projections integral with and extending outwardly from the surfaces of the cutters, elemental teeth on and extending outwardly from the periphery of each of said projections, the cutter elements on each cutter being spaced relative to the cutter elements of the adjacent cutter so as to interfit, and a row of peripheral longitudinal cutting teeth on each of said cutters.

8. A combination fractional disc and cluster tooth drill cutter comprising a body, a plurality of circumferentially extending segmental fractional disc cutter elements thereon at least some of said elements including a plurality of elemental cutter teeth along the crests thereof and having their cutting edges extending transversely of the crests.

9. A combination fractional disc and cluster tooth drill cutter comprising a body, a plurality of circumferentially extending segmental fractional disc cutter elements thereon at least some of said elements including a plurality of elemental cutter teeth along the crests thereof and having their cutting edges extending transversely of the crests, the depth of said elemental teeth being approximately one-half the depth of the cutter elements so that the teeth will effect a high initial rate of cutting and the fractional disc portion extending inwardly therefrom will continue to cut until worn substantially to the cutter body.

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