Dec. 5, 1933. L. C. BLACK 1,937,867

EARTH BORING DRILL

Filed Nov. 13, 1931 2 Sheets-Sheet 1

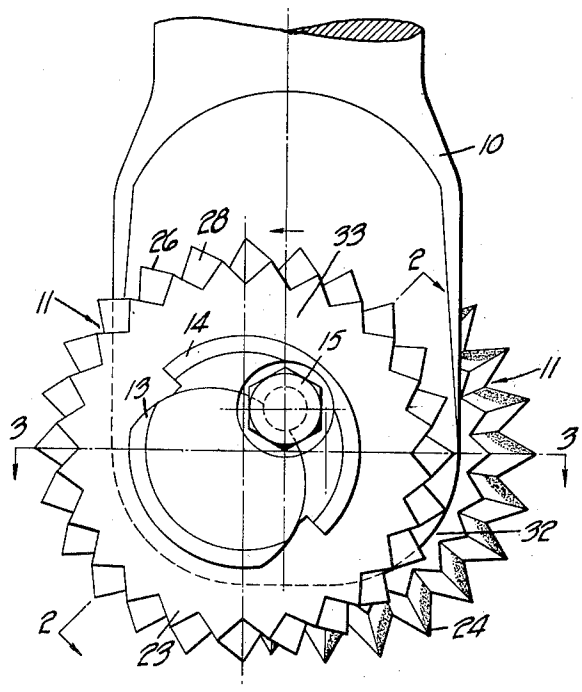


FIG. 1

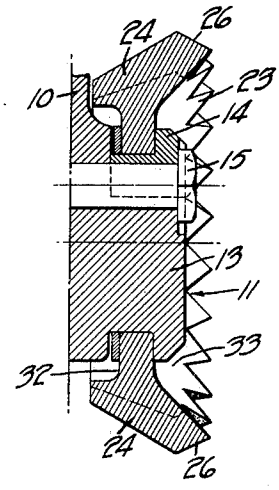


FIG. 2

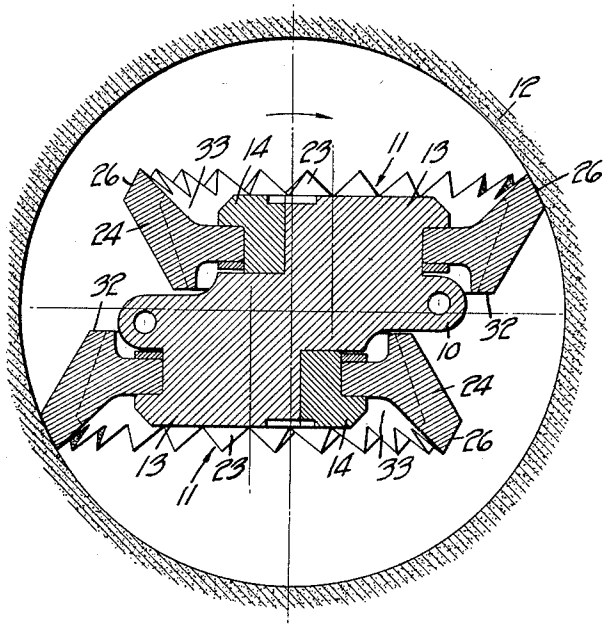


FIG. 3

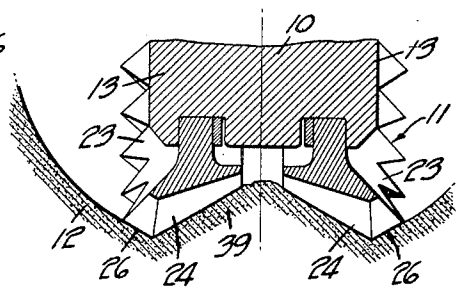


FIG. 4

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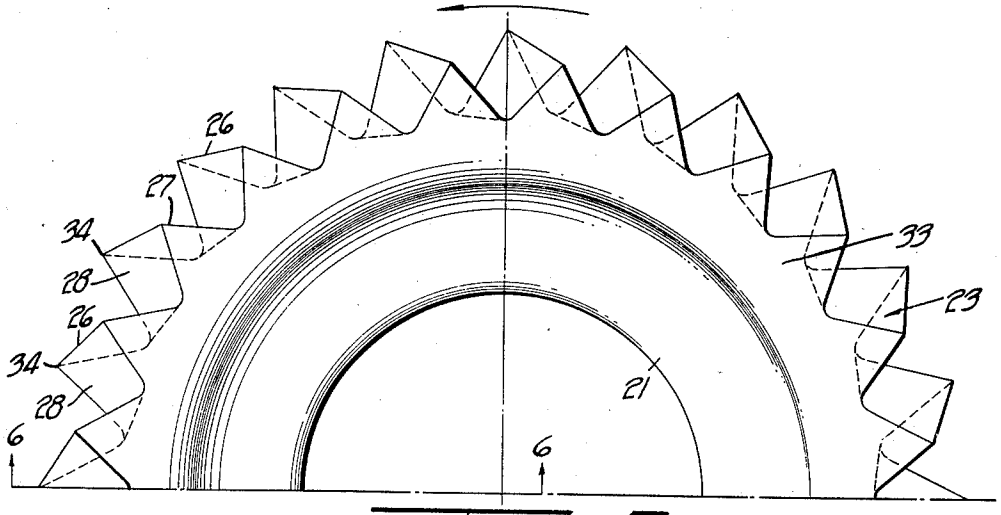


FIG. 5.

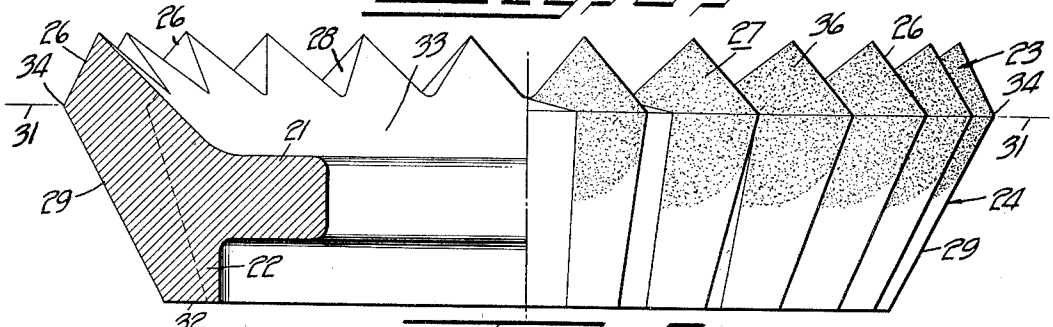
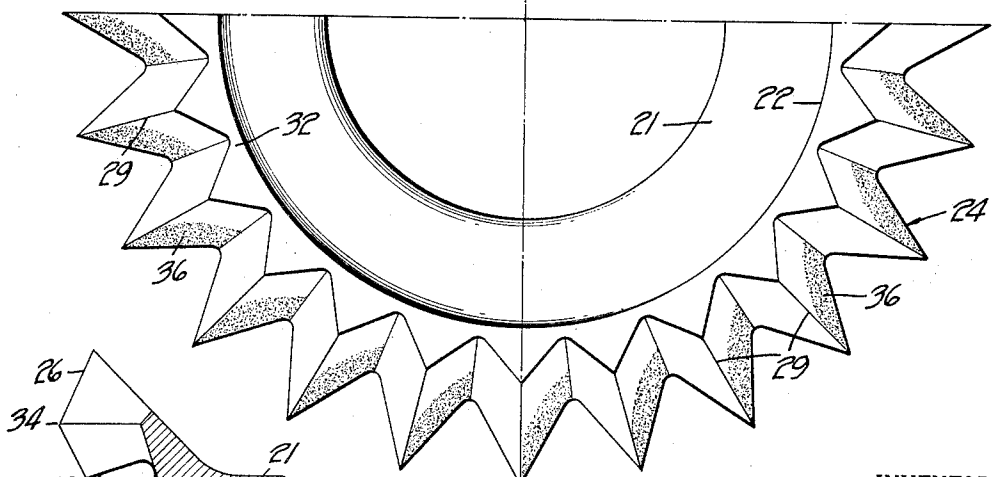


FIG. 6.



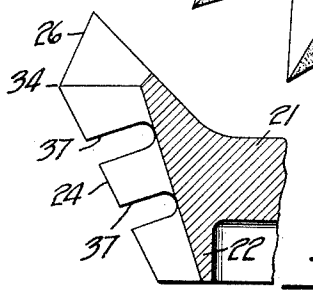


FIG. 7.

FIG. 8.

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EARTH BORING DRILL

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Application November 13, 1931
Serial No. 574,749

3 Claims. (Cl. 255—71)

This invention relates generally to earth boring drills of the type utilizing rotary disc cutters, and to cutters for use with such drills.

It is an object of the invention to generally improve upon the cutting efficiency of drills of the above type, both with respect to cutting speed and useful life. In this connection the invention is characterized by a construction which will afford both a slicing or scraping action and a grinding action against the formation being drilled, and which will also effect positive rotation of the cutters about their individual axes.

It is a further object of the invention to devise a rotary cutter of the disc type, particularly adapted for application of hard facing materials, such as tungsten carbide, or stellite.

It is another object of the invention to devise a rotary disc cutter for earth boring drills which can be readily manufactured as a steel or steel alloy forging.

Further objects of the invention will appear from the following description, in which the preferred embodiments of the invention have been set forth in detail in conjunction with the accompanying drawings. It is understood that the appended claims are to be accorded a range of equivalents consistent with the state of the prior art.

Referring to the drawings:

Figure 1 is a side elevational view illustrating an earth boring drill incorporating the present invention.

Figure 2 is a cross-sectional view taken along the line 2—2 of Figure 1.

Figure 3 is a cross-sectional view taken on the line 3—3 of Figure 1.

Figure 4 is a fragmentary cross-sectional detail view illustrating the central conical formation contacting the cutter.

Figure 5 is a side elevational view illustrating one-half of a rotary disc cutter constructed in accordance with my invention, this view being taken looking toward the outer face of the cutter.

Figure 6 is a quarter section taken along the line 6—6 of Figure 5.

Figure 7 is a side elevational view similar to Figure 5, but looking toward the inner face of the cutter.

Figure 8 is a cross-sectional detail illustrating a modified form of cutter tooth.

The drill illustrated in Figures 1 to 4 inclusive consists generally of a shank 10, to the lower end of which the rotary disc cutters 11 are secured. The shank 10, as in usual practice, is connected to the lower end of a drill stem which is rotated from the surface of the well. The cutters 11 are shown operating upon a rock formation 12. While the cutters can be variously secured to the shank, it is convenient to utilize a construction such as shown and claimed in my Patent No. 1,655,176. Thus, as illustrated in the drawings, the shank is provided with laterally extending studs 13 adapted to cooperate with removable filler blocks 14. Filler blocks 14 are adapted to be held in place by a single bolt 15. Studs 13, together with filler blocks 14, complete circular journals for the cutters, and by removing bolt 14 and filler blocks 13, the cutters can be removed for replacement. By reference to Figure 3 it will be noted that the axes of the two cutters 11 are offset laterally upon either side of the central axis of rotation of the shank 10. Likewise it is desirable to have the axes of the cutters parallel, so that in normal operation the cutters are in substantially upright planes as shown.

Cutters 11 can be identical in construction, and can be best understood by reference to Figures 5 to 7 inclusive. The body of each cutter includes a web portion 21 formed integrally with an outer portion 22 of enlarged width. Upon the outer periphery of portion 22 are formed two sets of teeth identified as 23 and 24. As will be presently explained, teeth 23 perform a reaming operation, while teeth 24 perform a grinding operation and also serve to effect positive rotation of the cutter upon rotation of the shank. Teeth 23 are formed with cutting edges 26 which are substantially linear, and with faces 27 and 28 which are illustrated as substantially planar. For reasons which will presently be apparent, faces 27 can be termed "advancing faces", while faces 28 can be termed "trailing faces" with respect to the formation being cut. Teeth 24 are likewise provided with edges 29, and while these edges do not form such cutting operations as are effected by edges 26, they do dig into the formation to effect positive turning of the cutter. For certain reasons, as for example to lend strength, to facilitate manufacture and to lend simplicity, teeth 23 and 24 are merged integrally together. This merging of the two sets of teeth is along a plane passed through the largest diameter of the cutter, and which has been indicated in Figure 4 at 31. In explanation of the appended claims it should be noted that plane 31 divides the periphery of the cutter into two portions, teeth 24 being formed upon that peripheral portion of greatest width, and teeth 23 upon the peripheral portion of lesser width. Referring

back to Figures 1 and 3, that side or face 32 of the cutter which is positioned adjacent the shank 10, can be termed the inner face, this being the lower face as viewed in Figure 4, while the other side of the cutter can be termed the outer face, corresponding to the upper face 33 as viewed in Figure 4. Teeth 24 extend between plane 31 and the inner face, while teeth 23 extend between plane 31 and the outer face. Teeth 24 are preferably tapered from plane 31 towards the inner cutter face, as is apparent from Figures 6 and 7, and their edges 29 extend generally toward the axis of rotation of the cutter. In other words, edges 29 can be considered as substantially coincident with the surface of an imaginary truncated cone having an axis coincident with the axis of rotation of the cutter.

Cutting edges 26 of teeth 23 have an inclination which is opposite to the inclination of edges 29 of teeth 24. In other words, these cutting edges 26 lie generally in lines which when projected converge toward the axis of rotation of the cutter, and can also be considered as lying approximately in the surface of an imaginated truncated cone having an axis coincident with the cutter axis. Cutting edges 26 also form such an angle with respect to a plane normal to the cutter axis, that the ends 34 of these cutting edges, adjacent the outer cutter face 33, are advanced in the direction of normal rotation of the cutter, indicated by arrows in Figure 5. In other words, cutting edges 26 can be said to lie generally in lines which converge toward but which do not intersect with the axis of rotation of the cutter.

The cutter described above is preferably made of an integral piece of suitable base metal possessing sufficient strength to withstand the severe stresses to which it is subjected. It can be conveniently manufactured as a forging since the character of the teeth makes it possible to form them in forging dies. Suitable steel alloys are preferable, such as manganese steel. To render the cutter more resistant to abrasion, the advancing faces 27 are shown provided with a layer 36 of hard abrasion resisting metallic material, which can be extended over at least a portion of the adjacent faces of teeth 24. This layer or facing is preferably directly bonded to the base metal of the teeth as by welding, and can be formed of materials like tungsten carbide or stellite. The facing is also preferably extended over all or a portion of the corresponding faces of teeth 24, shown in Figure 4.

Before explaining the mode of operation of my cutter, it can be pointed out that teeth 24 need not be continued as illustrated in Figures 3 to 5 inclusive, but can be provided with slots 37 as illustrated in Figure 6. Such a construction serves in effect to assist digging of teeth 24 into the formation being cut, thus assuring more positive rotation of the cutter.

Referring now to Figures 1 to 4 for an explanation of the mode of operation, it will be assumed that shank 10 is rotated in a clockwise direction as viewed in Figure 3. Because of the offset character of the cutter with respect to the vertical axis of the shank, only a portion of each cutter bears upon the formation being cut. The cutting edges 26 of teeth 23 are at such an angle that they are substantially coincident with the surface of the formation being drilled, when in contact with the same, as appears in Figure 3. The positioning of the cutters upon the shank affords a central formation cone 39, with which the teeth 24 engage. Engagement of teeth 24 with the sides of cone 39 causes relatively slow rotation of the cutters about their individual axes upon rotation of the drill shank. As the drill proceeds downwardly, the sides of cone 39 are gradually ground and broken away. Referring to Figure 2, and assuming a clockwise rotation of the shank 10, individual rotation of the left hand cutter is in a counter-clockwise direction as viewed toward its outer face, and individual rotation of the other cutter is in a similar direction when likewise viewed. The action of teeth 23 upon the formation can be described as being both a slicing or a scraping action and a grinding action. This is by virtue of the fact that the ends 34 of cutting edges 36 are advanced a certain amount with respect to the direction of rotation of each cutter. At the same time this angularity of the cutting edges 26 tends to apply the advancing faces 27 more directly against the formation. This makes it possible to apply hard facing materials like tungsten carbide to advancing faces 27, and with my construction a facing of this character will not readily break or chip away. In addition to aiding in the cutting action, and in making more practical the application of hard material such as tungsten carbide, the setting of cutting edges 26, instead of retarding individual rotation of the cutters, actually tends to assist such rotation, so that in conjunction with teeth 24 the cutters are positively rotated about their individual axes at all times. The formation of cone 39 during normal drilling operations not only assists in securing proper rotation of the cutters about their individual axes, but also materially assists in drilling a straight hole, as it functions as a guide for the cutters.

I claim:—

1. In an earth boring drill, a shank adapted to rotate about an axis, a disc type cutter rotatably secured to said shank, the axis of rotation of the cutter being transverse with respect to the axis of rotation of the shank and offset laterally therefrom, said cutter having teeth formed about its periphery, said teeth being so arranged that their outer cutting edges lie substantially in the frusto conical surface of either of oppositely faced truncated cones having axes coinciding with the axis of rotation of the cutter, thereby enabling teeth nearer the outer face of the cutter to perform a reaming operation, and teeth nearer the inner face to effect rotation of the cutter about its axis upon rotation of the shank, said teeth nearer the inner face of the cutter having cutting edges extending generally along lines which converge toward the axis of rotation of the cutter, the cutting edges of the teeth nearer the outer face of the cutter lying in non-radial planes with their inner ends advanced in the direction of rotation of the cutter about its axis.

2. In an earth boring drill, a shank adapted to rotate about an axis, a disc type cutter rotatably secured to said shank, the axis of rotation of the cutter being transverse with respect to the axis of rotation of the shank and offset laterally therefrom, said cutter having teeth formed about its periphery, said teeth being so arranged that their outer cutting edges lie substantially in the frusto conical surface of either of oppositely faced truncated cones having axes coinciding with the axis of rotation of the cutter, thereby enabling teeth nearer the outer face of the cutter to perform a reaming operation, and teeth nearer the inner face to effect rotation of the cutter about its axis upon rotation of the shank, the said cutting edges

of the teeth nearer the outer face of the cutter lying in non-radial planes with their inner ends advanced in the direction of rotation of the cutter about its axis.

3. In an earth boring drill, a shank adapted to rotate about an axis, a pair of disc-type cutters rotatably secured to said shank, said cutters being spaced upon opposite sides of the axis of rotation of the shank, and the axis of rotation of each cutter being transverse with respect to the axis of rotation of the shank and offset laterally therefrom, each of said cutters having teeth formed about its periphery, said teeth being so arranged that their outer cutting edges lie substantially in the frusto conical surface of either of oppositely faced truncated cones having axes coinciding with the axis of rotation of the cutter, thereby enabling teeth nearer the outer face of each cutter to perform a reaming operation, and teeth near the inner face of each cutter to effect rotation of the cutter about its axis upon rotation of the shank, the cutting edges of the teeth of each of said cutters nearer the outer face of the same lying in non-radial planes with their inner ends advanced in the direction of rotation of the cutter about its axis.

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