

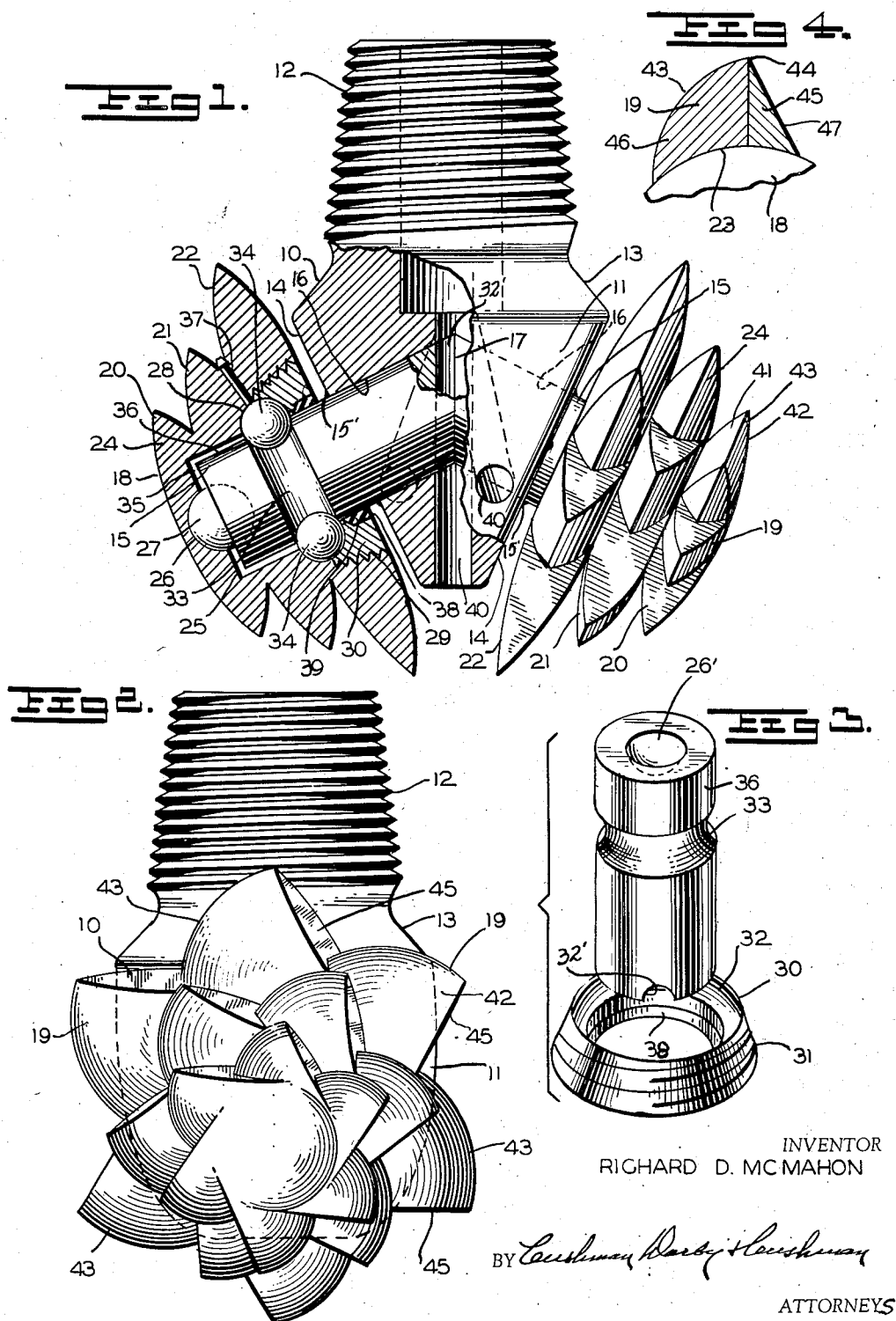
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ROTARY CUTTER FOR DRILLS

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ROTARY CUTTER FOR DRILLS

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The present invention relates to rotary boring tools and, more particularly, to shale and rock bits for use in drilling through hard, medium or soft formations.

An important object consists in providing an improved cone-shaped roller cutter for drill bits having means for detachably connecting or locking each of the cones to the bit spindle on the outside of the bit so as to prevent thrust or strain being applied against the body of the bit.

A further object consists in providing a substantially cone-shaped cutter with teeth arranged in axially spaced rows that progressively increase in diameter from the front to the rear ends thereof so that the row of largest diameter is positioned adjacent the body of the bit. Additionally, the teeth of the cutter are so shaped and arranged as to be self-sharpening and self-cleaning during the operation of the bit and may be set or adjusted at different angles relative to the vertical axis of the bit.

A further object consists in providing a shale and rock bit with means for insuring the drilling of a straight hole and in which the water jets are located in the lower portion of the bit body.

A still further object comprehends the provision of a substantially cone-shaped cutter for drill bits in which the cutter head is preferably formed with a shell and an interfitting locking collar to which the shell is detachably connected. Additionally, the sectional cutter is revolubly mounted on a downwardly inclined spindle carried by the bit through a ball bearing connection that functions to revolubly maintain the cutter on the spindle but which permits the ready and quick removal of the shell section from the collar section so that the cutter head may be changed or a new one substituted without throwing away or destroying the whole bit assembly.

Other objects and advantages of the invention will become apparent from the following description when taken in conjunction with the accompanying claims and drawings.

Referring to the drawings wherein is shown a preferred embodiment of the invention:

Figure 1 is a side elevational view of a roller cutter bit constructed in accordance with the present invention and with parts in section for clearness of illustration.

Figure 2 is a front end view of Figure 1.

Figure 3 is a disassembled view of a retaining spindle and its associated locking collar, and

Figure 4 is a detail sectional view of a cutter tooth constructed in accordance with the present invention.

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Referring to the drawings in which like numerals indicate like parts in the several views, 10 generally indicates a rotary shale and rock bit having a lower round or curved hollow head 11 and an upwardly externally threaded tubular shank 12 which may be connected to the head through an intermediate smooth curved or reduced portion 13. The threaded shank 12 may be tapered and is arranged to be detachably connected to a rotary drill collar or drill stem so as to rotate therewith during the operation of the bit. The head 11 is provided with two or more downwardly inclined flat smooth surfaces 14 (Fig. 1) which vary in number in accordance with the number of cutters to be associated with the bit. As shown, the head 11 is formed with two diametrically opposed downwardly inclined flat surfaces 14, each of which has extending outwardly and downwardly therefrom, an inclined supporting spindle or axle 15 which may be connected to the bit in any suitable manner. Preferably, the head 11 is formed with inclined openings 16 which extend inwardly and centrally from the flat surfaces 14 and converge at substantially the axial or vertical center of the head 11. The spindles 15 extend into the openings 16 so that their inner ends are brought into abutting engagement as at 17 (Fig. 1) in order to absorb the thrust of each other during the operation of the cutter. Each of the spindles 15 is maintained in a fixed position within an opening 16 in any suitable manner such as by the spaced spot welds 15'. The inner abutting ends of the spindle 15 is each provided with a complementary semi-circular recess 32 that coact to form a vertical passage for allowing the fluid to be discharged outwardly through an opening 40 from the head of the bit. Preferably, a substantially cone-shaped cutter 18 is revolubly mounted on each of the spindles or pins 15 and comprises teeth 19 arranged in axially spaced rows 20, 21 and 22 (Fig. 1) which may be varied in number as the particular operating conditions require. Each row of teeth comprises a base 23 (Fig. 4). It will be noted that the rows of teeth progressively increase in diameter from the outer row 20 to the inner row 22 so as to impart a cone shape to the cutter, and the teeth in each row are circumferentially spaced apart and of substantially uniform size and shape. Each cutter 18 preferably is formed of an outer shell 24 (Fig. 1) having a central longitudinally disposed recess 25, the bottom or inner wall of which is curved as at 26 to receive a ball bearing 27 that also fits into a complementary recess 26' (Fig. 3) in the

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adjacent end of the spindle 15. The inner wall of the recess 25 is formed with an annular segmental portion or curved surface 28 which terminates in an outwardly disposed enlarged tapered threaded portion 29 that extends to the inner end of the cone. An annular member or lock ring 30 is provided with an externally tapered threaded surface 31 (Fig. 3) arranged to engage the threads 29 of the cone and is formed on its outer or reduced end with an annular segmental surface 32. The retaining spindle 15 intermediate its length has an externally disposed annular groove 33 which constitutes a race for the ball bearings 34, which when the parts are assembled (Fig. 1) also engages the segmental surfaces 28 and 32 that coact with the groove 33 in order to rotatably mount the cutter 18 on the spindle 15 and lock the cutter to the spindle so as to prevent its accidental axial removal therefrom. The ball bearing 27 is preferably of such diameter as to provide a space or passage 35 between the wall of the recess 25 and the cylindrical portion 36 of the spindle 15. A radial passage 37 extends outwardly from the curved surface 28 and between the rows 21 and 22 and may be provided with a "Zerk" connection so as to introduce a suitable lubricant such as waterproof grease into the bearing surfaces of the rotary cutter. The lock ring 30 is spaced from the spindle 15 and has its inner wall provided at one end with an annular recess 38 in which is mounted a grease retaining packing 39, preferably of wedge shape, so that as the pressure is increased thereon by the plug 30, it will form a tighter seal with the adjacent smooth surface of the spindle 15 in order to prevent entrance of drilling mud or escape of grease from the cutter. Thus, means are provided for rotatably mounting the cutter on the spindle and permitting removal of the shell section 24 from the lock ring 30, so that the shell may be replaced when worn out, without disturbing the ring, ball bearings 34 or other parts of the bit assembly. Additionally, the packing 39 coacts with the seal produced by engagement of the lock collar with the ball bearings and the inner wall of the cutter so as to preclude the possibility of mud and other foreign matter working its way into the bearing surfaces of the cutter. The diameter of each of the ball bearings 28 is such that the annular groove 33 is substantially semi-circular relative to the ball bearings, while the curvature of the surfaces 28 and 32 are each a quarter of the same circle so as to coact with the groove 33 to completely enclose the ball bearings when the parts are assembled, and thus prevent the axial removal of the cutter from the spindle. The head 11 of the bit between the flat sides 14 and in its bottom may have any number of outwardly extending passages or openings 40 which communicate through the tubular member or shank 12 with the drill in order to supply fluid or water to disintegrate the earth or material during the drilling operation.

The teeth 19 of each row on the cutter 18 are so designed and shaped as to be self-sharpening and self-cleaning during the operation of the drill, and each tooth extends outwardly and radially from its base 23 so as to form converging solid opposed sides 41 and 42 (Fig. 1) which merge into the curved cutting edge 43 that starts at the base 23 and extend or taper upwardly in the manner as shown in Figure 4 to the apex 44 of the triangular-shaped end portion 45 that likewise extends upwardly from the base 23 in the form of a pyramid. The spaced straight lines

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46 and 47 in Figure 4 graphically indicate the direction and amount of uniform wear of each tooth during the operation of the drill. Thus, the particular configuration and arrangement of the teeth relative to the formation during the drilling operation provides means for causing the teeth to become sharper as they are ground down or used. The size, number and dimensions of the rows of teeth are preferably controlled by the particular type of work. Thus, when the drill is boring or operating in soft formations, fewer but larger teeth are used, when operating through medium formations, smaller teeth but more of them are provided. When drilling through hard formations, still smaller teeth and of a larger number or employed. The rows of teeth of different size and number are cut in different diameters so that the cuts in the formation or earth are staggered. When the parts are assembled, it will be seen that the spindles extend downwardly and outwardly from the body 11 of the bit and the cutters are revolvably locked on the spindles completely on the outside of the bit body. Additionally, the spaced passages 40 discharge a jet of fluid at an angle across the face of the body 11 and down over each corner so as to clean the same and wash out the cuttings.

In assembling the bit structure, each of the spindles 15 is threaded into its adjacent socket 17. The ball bearing 27 is positioned in its curved socket 26 and the ball bearings 34 and the shell 24 are positioned so as to fit on the spindle. The lock collar 30 is then threaded into the shell until the curved surface 32 thereof is brought into engagement with the ball bearings 34. The shell 24 and the collar 29 are now rotatably mounted on the spindle 15, but are prevented from being axially removed therefrom due to the locking connection effected by engagement of the ball bearings with the semi-circular groove 33 and the segmental curved surfaces 28 and 32. However, the shell 24 may be unthreaded from the collar 29 without disturbing any of the other parts of the cutter assembly. Consequently, when the teeth of a cutter are worn out, the cutter is not completely discarded or thrown away since it may readily be replaced by a new shell while retaining the same lock collar and may be installed at a minimum expenditure of time, labor and cost. The shape of the cutters and the arrangement of the rows of teeth in progressively increasing diameters toward the adjacent flat sides 14 allows the cone-shaped cutter to be placed on the body of the bit so that the cutters 18 will revolve on the spindles and be brought into cutting engagement with the earth formation, such as shale, so as to cut or reduce it to small particles that are forced out of the hole by the streams of water passing down through the spaced passages 40. The teeth of the cutter 18 are formed on the shell 24 so that when it is desired to replace the teeth, the shell is unscrewed from the collar 29 and a new shell is applied or connected to the lock ring so as to be revolvably mounted on the spindle by the ball bearings 27 and 34 in the manner as previously described. Proper lubrication of the bearing surfaces is provided through the passage 37, through which any suitable waterproof grease or lubricant may be introduced. It will be seen that the present invention provides a simple, efficient and economical bit structure in which, when the teeth become worn, they may be readily and economically replaced as con-

trusted to being discarded as was heretofore the custom.

The size and number of rows of teeth on each shell or cutter may be varied. The position of the teeth during the drilling operation is such that the bottom of each tooth engages the formation first and the cutting edge 43 then knifes its way through the formation. As the two cutters on opposite sides of the body 11 of the drill are inclined inwardly toward each other (Fig. 1) and converge toward the longitudinal center of the bit, it will be seen that during the drilling operation, the earth or material as it is cut or sheared, is crowded or forced toward the center of the hole in the paths of the streams of water discharging through the passages 40, so as to insure an efficient operation of the drill. By reason of the taper of the cutting surfaces of the teeth and the connection of the cutters with the bits, means are provided for preventing the bit from rocking and insures the drilling of a straight hole. Additionally, the teeth as they are worn, are self-sharpened and self-cleaned so that their life and durability are materially prolonged. When the teeth do become worn, they may be readily replaced by withdrawing the shell from its locking ring and substituting a new shell thereof. Thus, a substantial saving is effected since only a portion of the cutter has to be replaced as contrasted to throwing away the complete cutter as was heretofore customary. It will be manifest that three or four spaced cutters 18 may be connected to the head 11 by similarly formed spindles 15, and that the size and number of cutters employed will be determined by the particular type of formation with which the bit is to be used. The teeth 19 in each row are so disposed and formed that the curved cutting edge 43 extends upwardly from in front of the pyramidal end of the adjacent tooth. The upper end of the cutting edge terminates at the apex of its triangular front end, so that the teeth provide cutting surfaces of maximum solidity and strength which extend completely over the area of the cone to insure efficient operation and removal of the shale or formation from the hole.

The form of the invention shown is merely illustrative and it will be understood that such changes may be made as come within the scope of the following claims.

I claim:

1. A rotary drill bit having a head at the lower end thereof, said head being provided with spaced, flat, downwardly converging sides, each of said flat sides having a downwardly inclined spindle extending outwardly therefrom, each spindle intermediate its ends having an annular groove positioned outside of said head, a substantially cone-shaped cutter revolubly mounted on said spindle, said cutter including a shell section and an interfitting collar section spaced outwardly from said head, said shell section having

an internally threaded inner end portion, said collar section having an externally threaded surface engaging said threaded end portion, said sections adjacent said annular groove having segmental opposed surfaces, ball bearings mounted in said annular groove and engaged by said segmental opposed surfaces in order that each cutter is locked to the spindle on the outside of said head, said cutter having a passage therein communicating with said ball bearings for supplying lubricant thereto, and a packing between the collar section of the cutter and the spindle to prevent entering of drilling mud into the ball bearings and the escape of the lubricant therefrom.

2. A rotary drill bit having a head at the lower end thereof, said head being provided with spaced, flat, downwardly converging sides, each of said flat sides having a downwardly inclined spindle extending outwardly therefrom, each spindle intermediate its ends having an annular groove positioned outside of said head, a substantially cone-shaped cutter revolubly mounted on said spindle and spaced outwardly from said head, said cutter including a shell section and an interfitting collar section, said shell section having an internally threaded end portion, said collar section having an externally threaded surface engaging said threaded end portion, said sections adjacent said annular groove having segmental opposed surfaces, ball bearings mounted in said annular groove and engaged by said segmental surfaces so as to prevent axial removal of the cutter from the spindle, said cutter having a passage for conducting lubricant to said ball bearings, a packing between said collar and said spindle, said packing preventing introduction of drilling mud into the ball bearings and the escape of the lubricant therefrom, the parts being arranged so that the cutter is completely locked to the spindle on the outside of said head, and means for supplying liquid into and through the bit to clean the teeth during the operation of the drill.

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