

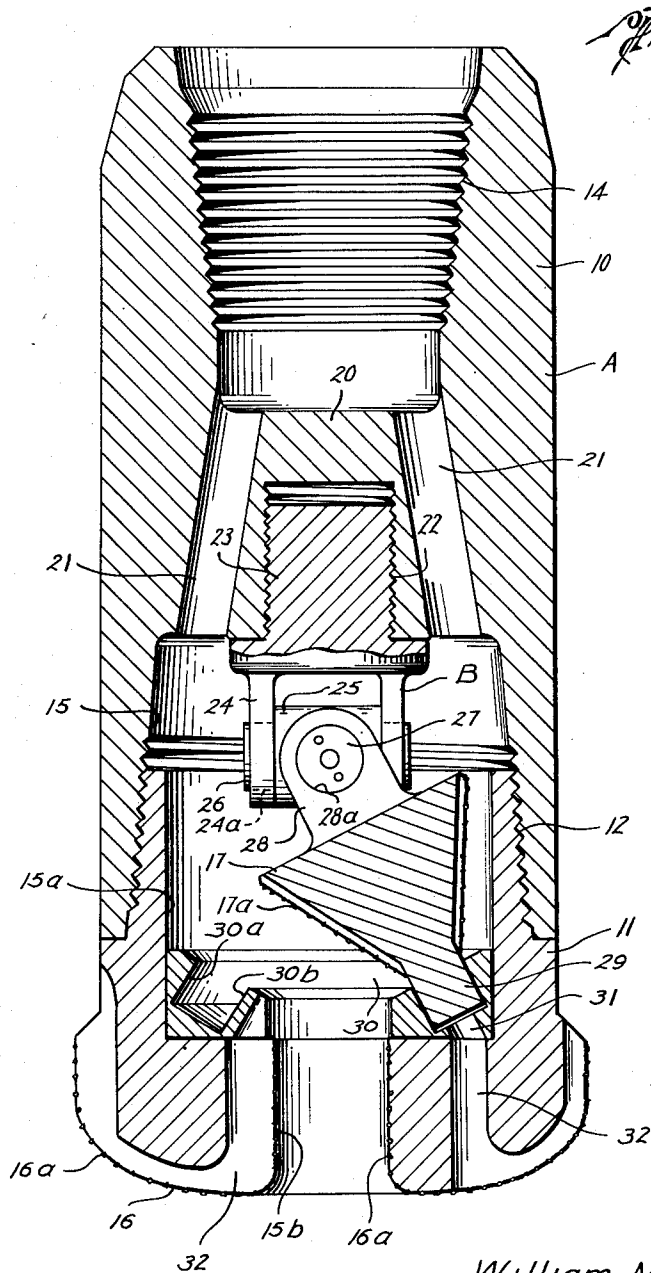
March 13, 1956

W. M. KOCH
DIAMOND DRILLING BITS

2,738,166

Filed Oct. 15, 1952

4 Sheets-Sheet 1



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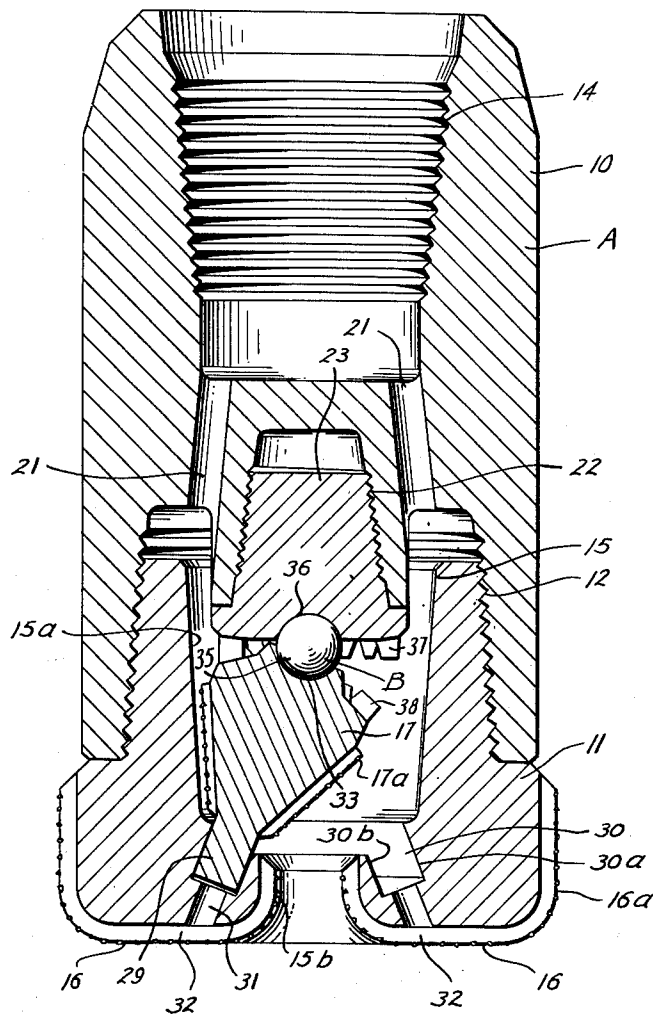
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Fig. 2



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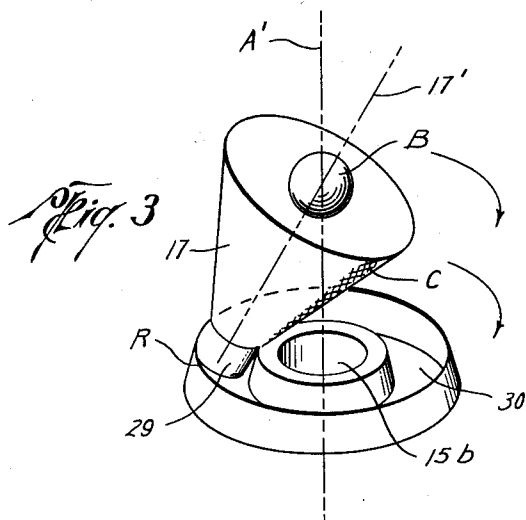
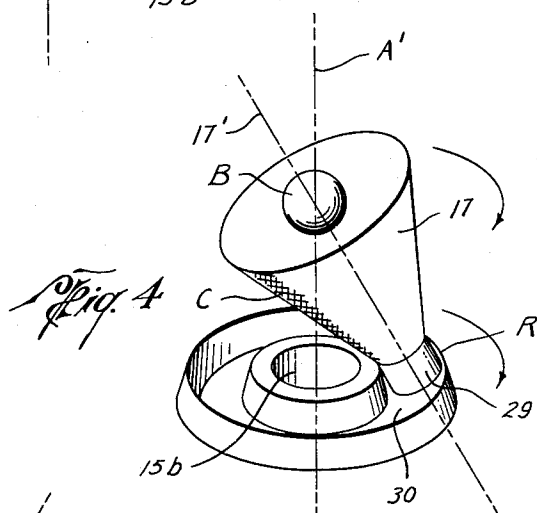
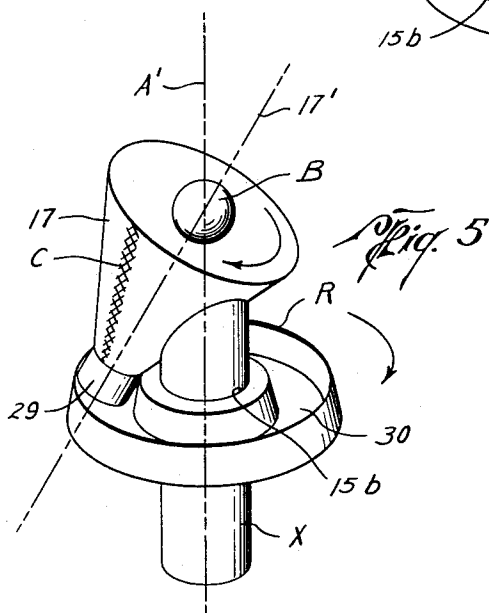
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4 Sheets-Sheet 4

Fig. 6

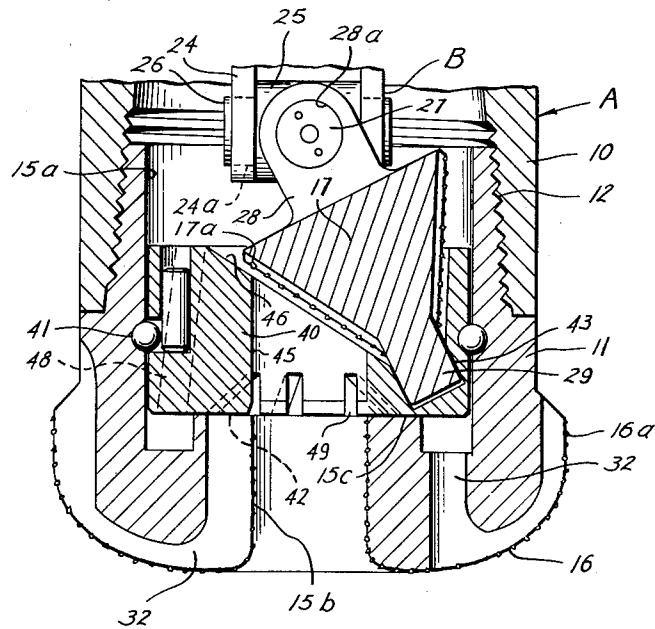
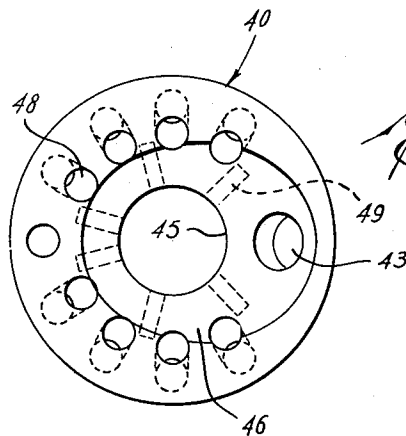


Fig. 7

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1

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DIAMOND DRILLING BITS

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Application October 15, 1952, Serial No. 314,893

7 Claims. (Cl. 255—72)

This invention relates to new and useful improvements in diamond drilling bits.

As is well known, the usual diamond drill bits for oil wells and the like do not satisfactorily cut the full diameter of the well bore since the lineal surface speed near the center of the bit is too low.

An object of this invention, therefore, is to provide a diamond drill bit capable of cutting the full diameter of a well bore, wherein said bit has an annular cutting surface which leaves a central uncut core, and an auxiliary cutter disposed within said bit to cut the central uncut core at a sufficient lineal surface speed.

An important object of this invention is to provide a diamond drill bit having an auxiliary central cutter which is capable of remaining stationary with respect to the bit for rotation therewith, or upon contact with an uncut central core or the like, of being rotated about its own axis while said bit rotates relative thereto.

Another object of this invention is to provide a diamond bit having an annular cutting surface which leaves a central uncut core, and an auxiliary central cutter connected to said bit through a universal joint, whereby said auxiliary cutter rotates about its own axis upon contact with the uncut core.

The construction designed to carry out the invention will be hereinafter described together with other features thereof.

The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawings forming a part thereof, wherein an example of the invention is shown, and wherein:

Figure 1 is a vertical view, partly in section and partly in elevation, illustrating one form of the diamond bit of this invention;

Figure 2 is a view similar to Figure 1, but illustrating a different embodiment of the invention;

Figure 3 is a diagrammatic view illustrating the relationship of the axes of the bit body and the auxiliary cutter;

Figure 4 is a view similar to Figure 3, but showing the relative positions of the cutter and the bit body during rotation of the bit body when no core is extending into contact with the cutter;

Figure 5 is a view similar to Figure 3, but illustrating the relative movement of the bit body with respect to the cutter as well as the rotational movement of the cutter about its own axis when such cutter is contacted by an uncut core;

Figure 6 is a partial view in section of a modified form of the bit of this invention; and

Figure 7 is a plan view of the shield used in the form of the invention shown in Figure 6.

In the drawings, the numeral A designates the bit body which is composed of an adapter sub 10 and a bit head 11 connected thereto by any suitable means such as threads 12. The upper end of the adapter sub 10 has a threaded box 14 for connection with the pin end of

2

the drill stem which extends to the surface of the well. The bit body A has an axial bore or opening 15 which includes an upper portion 15a and a lower portion 15b which is of reduced diameter as compared to the upper portion 15a. At the lower end of the bit head 11, there is formed an annular cutting surface 16 which extends along the bottom of the bit head and the outer sides thereof, as well as on the inner wall of the axial opening 15b. Within the enlarged bore portion 15a of the axial bore 15, there is mounted an auxiliary cutter 17 and has connection with the bit body A through a connecting means B which provides for universal joint action. The annular surface 16 and the auxiliary cutter 17 together cut the full diameter of the bore hole and to this end, hard wearing inserts such as diamonds 16a and 17a are disposed on the cutting surfaces of the annular cutting surface 16 and the auxiliary cutter 17, respectively.

Referring now to Figure 1, therein it can be seen that the adapter sub 10 of the bit body A has a central hub or spider 20 disposed within the axial bore of the bit body above the bit head 11. This spider 20 has mud or slush passages 21 disposed circumferentially thereabout. The lower end of the spider 20 has a threaded socket 22 which receives a threaded pin 23 formed on the upper end of the universal connection B.

The universal connection B shown in Figure 1 is of conventional construction and includes a clevis 24 extending from the pin 23 and in which is mounted a sleeve 25 on a pin or shaft 26 which extends through openings 24a in the two arms of the clevis 24. The sleeve 25 has on diametrically opposite sides thereof pins or arms 27 which fit into the two arms of the clevis 28 mounted on the cutter 17, such arms 27 extending through opening 28a in the arms of the clevis 28. As will be observed in Figure 1, the cutter 17 is conical in shape with the portion of largest diameter at the top thereof and converging into a cylindrical projection 29 at the lower end thereof. The projection 29 fits into a circular track 30 which has inclined walls 30a and 30b which are parallel to each other, and are of the same inclination as the angle of inclination of the longitudinal axis of the cutter 17 with respect to the longitudinal axis of the bit body A. The track 30 and the projection 29 are slidable relative to each other, whereby when the cutter 17 is held in one position with respect to the ground, the track 30 moves relative to such projection 29 during rotation of the bit body A.

The track 30 has a plurality of openings 31 which are below the track 30 and which provide communication with the slush passages 32 in the annular cutting surface 16.

In the operation of the diamond bit of Figure 1, the bit body A is rotated through the rotation of the drill stem (not shown) which extends to the well surface in the usual manner. This rotation, of course, imparts rotation to the annular surface 16 whereby an annular path is cut in the well bore, leaving an uncut central core which extends into the reduced diameter portion 15b of the axial opening 15 in the bit body A.

The uncut central core formed in the axial opening 15b will continue to be formed and will extend upwardly until it contacts the inclined cutting face of the cutter 17 which extends across the full diameter of such opening 15b. Prior to the time that the uncut central core actually contacts the cutter 17, the cutter 17 will be rotating with the bit head 11. The relationship of the cutter 17 to the bit head 11 can best be appreciated by considering Figures 3-5. Thus, in Figure 3, the cutter 17 is shown before rotation is imparted to the bit body A. In this position a selected band C on the cutter 17 is disposed over the axial opening 15b, and the projec-

tion 29 is located adjacent a selected point R on the track 30. When no core is contacting the cutter 17, the cutter 17 simply rotates with the bit body A, but there is no rotation of the cutter 17 about its own axis 17'. Thus, the entire movement of the cutter 17 would be about the axis A' of the bit body A with the projection 29 remaining in the same position in the track 30 relative to the point R and with the band C on the cutter surface remaining over the axial bore 15b. This can best be appreciated by considering the movement of the bit from the position shown in Figure 3 to that shown in Figure 4. It will also be appreciated that there would be no movement of the universal connection B when moving from the position shown in Figure 3 to that shown in Figure 4. Therefore, the cutter 17 may be said to be stationary with respect to the bit body A.

However, when a core X extends through the axial bore 15b and contacts the circumferential cutting surface of the cutter 17, the core X then provides a reaction point or a resistance which prevents the projection 29 on the cutter 17 from moving relative to the ground. Thus, if the core X contacted the cutter 17 in the position shown in Figure 3 during rotation of the bit body A, the projection 29 would remain stationary relative to the bottom of the well, that is, assuming the projection 29 to be pointing north, it will remain pointing north even though the track 30 is rotated relative thereto. However, the rotation of the bit body A and the track 30 effects a rotation of the cutter 17 about its own axis 17' since the cutter 17 is directly connected to the bit body A through the universal joint B. As can be seen in Figure 5, a position is shown assuming that the cutter has revolved about its own axis 17' one-quarter revolution from that shown in Figure 3, whereby the band C has moved one-quarter of a revolution and the point R on the track 30 has moved one-quarter of a revolution with respect to the projection 29. By reason of this rotation of the cutter 17 about its own axis 17', a new cutting face is constantly being presented to the uncut central core X which is in contact with the cutting surface of the cutter 17, thereby assuring equal and distributed wear on the cutting surface of the cutter 17. Since the cutter 17 is cutting the uncut central portion X and the annular cutting surface 16 is cutting the remainder of the well bore hole, it will be appreciated that the full diameter of the bore hole is thereby being cut and that satisfactory lineal speed is obtained with the auxiliary cutter 17, as well as with the annular cutting surface 16. The term "lineal speed" as herein employed, refers to the relative surface speed between the auxiliary cutter 17, and the central uncut core X which extends into the central opening of the drill bit.

In Figure 2, a modification of the diamond bit of this invention is illustrated, wherein all parts are substantially the same with the exception of the universal mounting or connection means B. In Figure 2 the universal connection B includes a ball 35 which is mounted between curved sockets 36 and 33 in the plug 23 and cutter 17, respectively. Also, beveled gear teeth 37 are circumferentially disposed on the lower end of the plug 23 and mating gear teeth 38 are provided on the upper end of the cutter 17, such gears 37 and 38 serving as the sole drive connection between the cutter 17 and the bit body A.

The operation of the form of the diamond bit shown in Figure 2 will be substantially the same as that shown in Figure 1 except that the cutter 17 will be rotated about its own axis 17' when the cutting surface thereof is in contact with an uncut central core X by reason of the meshing of the gear teeth 37 and 38, with the ball 35 serving as a pivot point for the cutter 17. Thus, in the form shown in Figure 2, the cutter 17 would revolve about the longitudinal axis A' of the bit body A but would not rotate about its own axis when the uncut central core is not in contact with the cutter 17. However, when the core does contact the cutter 17 it then remains sta-

tionary with respect to the ground while the bit body A rotates relative thereto, and at the same time the cutter 17 will rotate about its own axis 17' to provide a constantly changing cutting surface which abrades or otherwise cuts the uncut central core extending through the bore 15b.

In Figure 6, another modification of the drill bit illustrated in Figure 1 is shown. The bit of Figure 6 is identical with that shown in Figure 1 except that a shield 40 is utilized in place of the trackway 30 of Figure 1. The shield 40 is rotatable with respect to the bit head 11 and preferably an anti-friction means such as the ball bearings 41 are disposed circumferentially between the shield 40 and the bore portion 15a of the bore 15 of the bit body. These bearings 41 may also serve to support the bottom surface 42 of the shield 40 slightly above and out of contact with the transverse surface 15c of the bore 15, whereby frictional engagement therebetween is prevented.

The shield 40 has an inclined cylindrical recess 43 therein for the reception of the cylindrical projection 29. The wall of the recess 43 is of the same angle of inclination as that of the cutter 17 and the walls 30a and 30b of the trackway 30 shown in Fig. 1. It will be apparent that with the projection 29 in the recess 43, the shield 40 and the cutter 17 must rotate together.

The shield 40 has a central bore 45 of substantially the same diameter as the lower bore 15b in the bit head 11 and such bore 45 forms a continuation of the bore 15b up to the cutting surface 17a of the cutter 17. The upper surface of the shield 40 is inclined and concavely curved at 46 to correspond with the inclination and curvature of the cutting surface 17a of the cutter 17. This inclined curved surface 46 merges with walls of the recess 43 as best seen in Figure 7. The inclined curved surface 46 also is just slightly below the surface 17a of the cutter so that a core cut by the bit during rotation thereof, will extend upwardly through the bore 15b and the bore 45 until it contacts the cutting surface 17a. Thus, the core is supported throughout substantially its entire length and is thereby prevented from fracturing transversely or otherwise into large pieces, thereby allowing the cutter 17 to abrade the core at its upper end into the small pieces rather than break it into large pieces which would be too large to be circulated downwardly through the slush passages.

Circulation or washing away of the abraded pieces of the core is effected through downwardly and outwardly inclined circular openings 48 extending from the upper to the lower end of the shield 40, with the lower ends of the openings 48 communicating with the outer passage 32 in the bit head 11. Triangular slots 49 may also be provided in the lower surface 42 of the shield 40 in communication with the bore 45 thereof and the inner slush passages 32 of the bit head 11. It will be appreciated that the particular shape and inclination of the openings 48 and slots 49 may be changed if desired.

The operation of the bit of Figure 6 is substantially identical with that of Figure 1 except that the shield 40 remains fixed with respect to the cutter 17 during the rotation of the bit head 11. Thus, as the core X is initially formed in the bore 15b, and before it contacts the surface 17a of the cutter 17, the cutter 17 and shield 40 will rotate with the bit head 11. When the core X contacts the surface 17a the resistance thereof prevents the cutter 17 and shield 40 from rotating with the bit head 11, but since the universal connection B is connected to the bit body, rotation of the cutter 17 about its own axis is effected while the bit body is rotated about its axis relative to the cutter 17. Thus, it can be seen that the same relative movement of the cutter 17 and the bit body is effected in the form shown in Figure 6 as in Figure 1.

It will be appreciated, of course, that other universal connections for connecting the cutter 17 to the bit body

5

6

A could be employed in place of the two forms illustrated herein.

The foregoing disclosure and description of the invention is illustrative and explanatory thereof, and various changes in the size, shape and materials, as well as in the details of the illustrated construction may be made, within the scope of the appended claims without departing from the spirit of the invention.

What is claimed is:

1. A diamond bit having a bit body with an annular cutting surface for cutting an annular path in a well bore leaving an uncut central core, said body having an axial central opening into which the uncut central core is adapted to extend, an auxiliary central cutter within said axial opening adapted to contact said uncut central core, an annular track within said axial opening of said bit body, one end of said auxiliary cutter fitting into said track, and the other end of said auxiliary cutter being connected to said bit body through a universal connection, whereby upon contact of said cutter with the central uncut core rotational movement of said bit body effects a rotation of said auxiliary cutter about its own axis.

2. The structure set forth in claim 1, wherein said annular track is formed in the bit body within said axial opening.

3. The structure set forth in claim 1, wherein annular track is a separate member supported on said bit body within said axial opening.

4. In a bit having an axial bore, an auxiliary cutter disposed within said bore at an angle to the longitudinal axis of said axial bore, said auxiliary cutter being provided with an upper and a lower end, means connecting said auxiliary cutter with said bit including means connecting the lower end of said cutter to said bit for permitting the bit to rotate relative to said cutter when said cutter is in contact with a material that is stationary with respect to said bit during the rotation thereof, and including means connecting the upper end of said cutter to said bit for transmitting the rotation of said bit to said cutter for rotating said cutter about its own axis passing through said ends when said bit is rotated relative to said cutter.

5. In a bit having an axial bore, an auxiliary cutter disposed within said bore at an angle to the longitudinal axis of said axial bore, said auxiliary cutter being provided with an upper and a lower end, means connecting said auxiliary cutter with said bit including means connecting the lower end of said cutter to said bit for per-

mitting the bit to rotate relative to said cutter when said cutter is in contact with a material that is stationary with respect to said bit during the rotation thereof, and and a universal connection connecting the upper end of said cutter to said bit for transmitting the rotation of said bit to said cutter for rotating said cutter about its own axis passing through said ends when said bit is rotated relative to said cutter.

6. In a bit having an axial bore, an auxiliary cutter disposed within said bore at an angle to the longitudinal axis of said axial bore, said auxiliary cutter being provided with an upper and a lower end, means connecting said auxiliary cutter with said bit including a projection on the lower end of said cutter and an annular track within the bore of said bit in which said projection is mounted for permitting the bit to rotate relative to said cutter when said cutter is in contact with a material that is stationary with respect to said bit during the rotation thereof, and a universal connection connecting the upper end of said cutter to said bit for transmitting the rotation of said bit to said cutter for rotating said cutter about its own axis passing through said ends when said bit is rotated relative to said cutter.

7. A diamond bit having a bit body with an annular cutting surface for cutting an annular path in a well bore leaving an uncut central core, said body having an axial central opening into which the uncut central core is adapted to extend, an auxiliary central cutter within said axial opening, and means connecting said cutter to said bit body including means connecting one end of said cutter to said bit body for permitting the bit body to rotate about its axis and relative to the cutter when said cutter is in contact with said central uncut core, and a universal joint connection including mating gears on said body and said cutter connecting the other end of said cutter to said bit body for transmitting the rotation of said bit body to said cutter for rotating said cutter about its own axis when said bit body is rotated about its axis and relative to said cutter.

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