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E. B. WILLIAMS, JR

2,371,490

STEP CUT DRILL BIT

Filed April 10, 1944

Fig. 1.

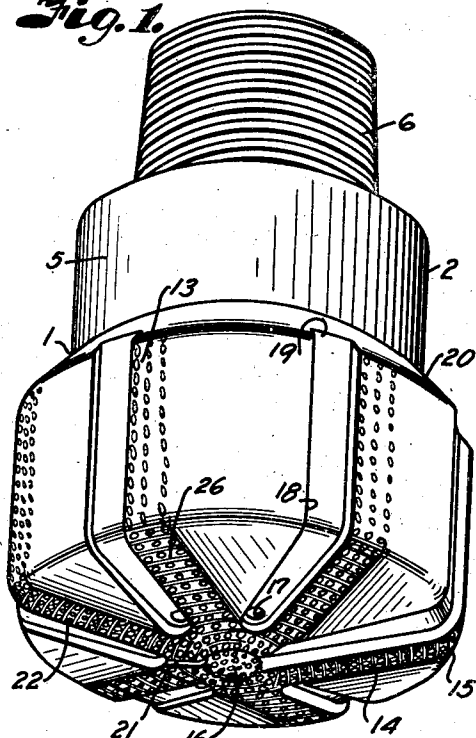


Fig. 2.

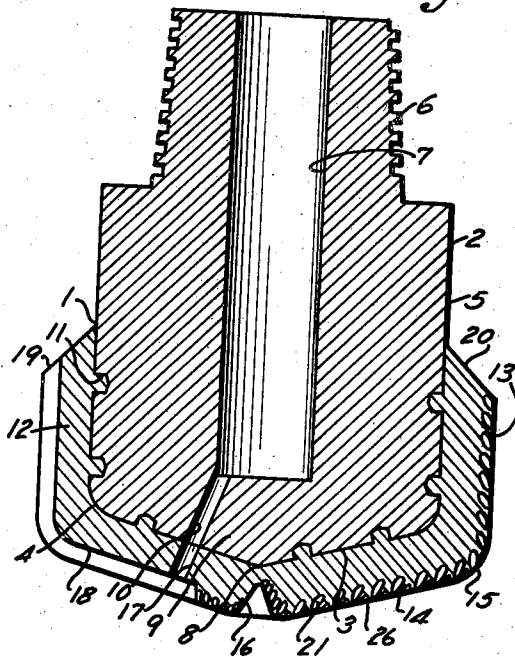


Fig. 3.

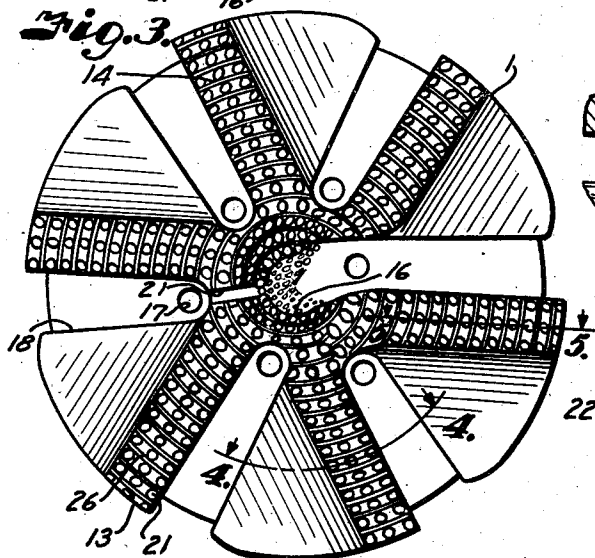


Fig. 4.

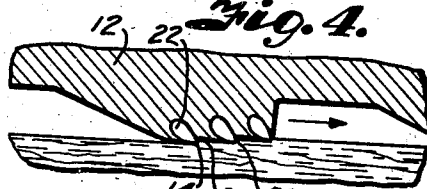


Fig. 5.

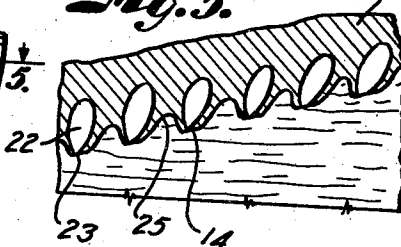
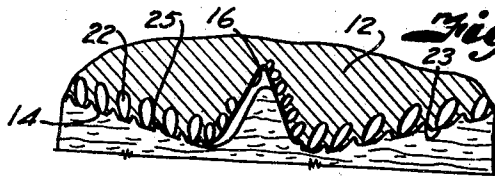


Fig. 6.



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STEP-CUT DRILL BIT

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8 Claims. (Cl. 255-61)

This invention relates to drill bits, particularly those equipped with cutting elements such as diamonds or the like and has for its principal object to provide a drill bit of this character with a cutting element arrangement which limits the depth to which an element can cut when the drill bit is in use.

Other objects of the invention are to provide cutting clearance for each row of cutting elements; to provide for orientation of the cutting elements in rows wherein each row is set forward one-half a position so that each row of cutting elements cuts only one-half the face cut of a preceding row; to provide a bit structure wherein the cutting elements are arranged to prevent heating and "stone polishing" when the bit is used in cutting chert; to provide for flushing of drilling fluid on the cutting elements at the center of the bit; to provide the tip of the bit with a slightly off-center cone to cut off the tip of the formation being drilled; to provide grooves between the rows of cutting elements for facilitating discharge of cuttings; and to provide a bit structure that does not require wearing in before cutting begins.

In accomplishing these and other objects, I have provided improved details of structure, the preferred form of which is illustrated in the accompanying drawing wherein:

Fig. 1 is a perspective view of a drill bit embodying the features of the present invention.

Fig. 2 is a vertical section taken through the axis of the bit.

Fig. 3 is a plane view of the cutting face of the bit.

Fig. 4 is a fragmentary section through one of the bit cutters on the line 4-4 of Fig. 3 particularly illustrating the stepped arrangement of the cutting elements and the cutting clearance thereof.

Fig. 5 is a radial section on the line 5-5 of Fig. 3 particularly illustrating the grooves between the rows of cutting elements.

Fig. 6 is an enlarged section through the tip of the bit particularly illustrating the offset cone.

Referring more in detail to the drawing:

1 designates a drill bit constructed in accordance with the present invention and particularly designed for drilling hard earth formations such as chert and the like. The bit includes a substantially cylindrical body 2 formed of suitable material to withstand drilling strains and is shaped to provide a slightly coned end face 3 rounding as at 4 into a cylindrical side face 5. Formed on the upper end of the body is an ex-

teriorly threaded neck 6 for attachment of the bit to a drill pipe (not shown).

The body of the bit is provided with an axial bore 7 extending inwardly from the neck 6 and terminating short of the central tip 8 of the end face 3 to provide a suitable wall thickness 9 for accommodating a plurality of distribution ports 10 having their upper ends connected with the bore 7 and their lower ends extending through the face 3 at substantially right angles thereto. The conical end face 3 and cylindrical face 5 of the body are provided with a plurality of recesses 11 for anchoring a matrix material 12 which embeds the cutting elements and forms the cutting faces of the bit as later described. The matrix is a relatively hard, tough material such as bronze or similar metal alloy or a plastic capable of being cast upon the bit body and having the property of retaining the cutting elements. The material is of suitable thickness to provide necessary strength and bed the cutting elements therein and to provide a cylindrical reaming face 13 of larger diameter than the diameter of the body.

When cast upon the bit body, the matrix material enters the recesses 11 and is rigidly anchored so that it forms a permanent and fixed part of the drill bit. The matrix is shaped to have a generally coned end face 14 substantially conforming to the cone face 3 and has a periphery 15 curving into an annular reaming face 16.

Formed in the tip of the face 14 and offset slightly from the axis of rotation of the bit is a cone-shaped recess 16. Also formed in the face 14 and extending substantially radially from continuations 17 of the ports 10 are water channels 18 which continue upwardly through the reaming face of the bit and have outlets 19 opening through the annular shoulder 20 formed by the matrix material so that a drilling fluid delivered through the drill pipe (not shown) to the bore 7 is distributed through the ports 10 and extensions 17 into the watercourses to wash the cuttings therethrough and upwardly to the top of the well as will be readily understood. One of the watercourses is also connected with the cone-shaped recess 16 by a groove 21 which provides an auxiliary course so as to flush the cuttings therefrom.

The radial cutters are formed along the trailing edges of the watercourses and are of a suitable width to contain a plurality of cutting elements such as diamonds 22 which have their cutting points 23 oriented at a desired angle in the

direction of bit rotation and arranged so that the cutting points of the cutting elements in the forward rows are offset slightly from the cutting edges of the succeeding rows to provide a series of cutting steps as best shown in Fig. 4.

The matrix material 12 between each row of cutting elements is sloped upwardly to provide a slight clearance 25 to avoid heating while the bit is cutting and to prevent "stone polishing" when the drill bit is used in cutting chert and similar formations. The stepped formation of the rows of cutting elements as shown in Fig. 4 limits the amount of cut that can be made by each row of cutting elements and also provides for better support of the elements. This clearance space connects with water grooves 26 which in turn connect with the watercourses on the respective sides of the cutting ridges of the bit so that the cuttings removed by each individual cutting element are readily cleared and washed to the top of the well.

The face portions of the bit on the retractive sides of the cutting ridges are inclined to provide clearance and facilitate removal of the cuttings produced by the bit. As shown in Fig. 3, the cutting ridges have their forward edges coextensive with diameter of the bit while their trailing edges are substantially parallel and extend substantially tangential with a circle of rotation formed at the center of the bit. The center of the bit surrounding the cone is also oriented with rows of diamonds or similar cutting elements spaced by grooves similar to the grooves previously described. The rows are arranged eccentrically with the rotational axis of the bit and the diamonds in one circular row are offset in the forward direction relative to the direction of rotation substantially one-half a position relative to the cutting elements in an adjoining row so that each element in one row cuts only one-half the face of the formation cut by the cutting elements in a preceding row. This arrangement is preferably maintained throughout the cutting surface of the bit. Off-center is achieved by using a succession of larger stones in the inner row sufficient to get a position between the cutting elements of the next row. The rows on the offset side are blended into the offset rows on the cutters as shown in Fig. 3.

With the arrangement disclosed, the diamonds are oriented so as to prevent as much as possible the trailing cut of one diamond in the path of another and so that each cutting element is effective in making its own cut in the formation. The offset cone 16 is provided on the offset side thereof with a plurality of cutting elements to cut the formation and effect reduction thereof at the center of the bit.

When the bit is in operation, a drilling fluid is circulated through the bore 7 of the bit simultaneously with rotation thereof and jets of drilling fluid are discharged through the ports 10 and extensions 17 thereof into the watercourses to wash the cuttings produced by the bit to the top of the bore hole. As the bit is rotated the cutters are caused to gyrate with respect to the axis of rotation so as to promote cutting action of the bit. The bit in operation forms a hole bottom having upwardly sloping portions as shown in Fig. 6 and a central cone-like tip is formed within the cone-like recess 18 of the bit, which tip is being constantly chipped away by reason of eccentric mounting of the recess and the cutting elements in the offset side thereof. The cuttings are flushed from the cone-like recess into the

grooves between the rows of diamonds by the jet discharged through the auxiliary watercourse and through the side of the cone which is connected with the inner end of the opposite watercourse as shown in Figs. 1 and 3. As the rows of cutting elements reduce a formation, the cuttings pass through the clearance spaces into the grooves between the cutting elements and they are discharged from the grooves into watercourses for delivery with the drilling fluid to the top of the bore hole.

From the foregoing it is obvious that I have provided a drill bit of the type described wherein the cutting elements are oriented to provide a rapid cutting action and the stepped arrangement of the cutting elements limits the amount of cut that can be made by any one row of cutting elements thereby providing a bit of substantially long life and in which the diamonds are not likely to become disarranged and destroyed when the bit is in operation.

What I claim and desire to secure by Letters Patent is:

1. A drill bit including a body member having a drilling face on the end thereof provided with substantially radial ridge portions, said drilling face having an axial portion provided with a recess offset with respect to the axis of said body member, and cutting elements embedded in said ridge portions including said axial portion and a side of said recess.

2. A drill bit including a drill bit body member having a drilling face provided with substantially radial ridge portions, and cutting elements embedded in said ridge portions and arranged in rows extending transversely of the ridge portions on the respective sides of grooves formed in said ridge portions, said drilling face having watercourses intermediate said ridge portions and connecting said grooves.

3. A drill bit including a drill bit body member having a drilling face provided with substantially radial cutting ridge portions, and cutting elements embedded in said ridge portions and arranged in stepped rows extending transversely of the ridge portions on the respective sides of grooves formed in said ridge portions, said drilling face having watercourses intermediate said ridge portions and connecting said grooves.

4. A drill bit including a drill bit body member having a cone-shaped drilling face provided with substantially radial ridge portions, cutting elements embedded in said ridge portions and arranged in stepped rows extending transversely of the ridge portions, said face having watercourses intermediate said ridge portions and grooves between said rows of cutting elements, said drilling face being provided with a recess offset from the axial center thereof, and cutting elements embedded in a side of said recess.

5. A drill bit including a drill bit body member having a slightly cone-shaped face provided with substantially radial ridge portions, and cutting elements embedded in said ridge portions and arranged in rows extending transversely of the ridge portions, said face having watercourses intermediate said ridge portions and grooves between said rows of cutting elements.

6. A drill bit including a drill bit body member having a drilling face provided with substantially radial cutting ridge portions, and cutting elements embedded in said ridge portions and arranged in rows extending transversely of the ridge portions, said face having watercourses intermediate said ridge portions and grooves be-

tween said rows of cutting elements, said drilling face being coned and provided with a recess offset from the axial center thereof and having a groove connecting a pair of said watercourses to flush said recess of cuttings when the bit is in use.

7. A drill bit including a drill bit body member having a drilling face provided with substantially radial ridge portions, cutting elements embedded in said ridge portions, said face having watercourses intermediate said ridge portions and provided with a recess offset from the axial center thereof and having a groove connecting a pair of said watercourses to flush said recess of cuttings when the bit is in use, and cutting elements embedded on a side of said recess.

8. A drill bit including a drill bit body member having a drilling face provided with substantially radial cutting ridge portions, cutting elements embedded in said ridge portions and arranged in rows extending transversely of the ridge portions, said face having watercourses intermediate said ridge portions and grooves between said rows of cutting elements, said drilling face being coned and provided with a recess offset from the axial center thereof and having a groove connecting a pair of said watercourses to flush said recess of cuttings when the bit is in use, and cutting elements embedded on a side of said recess.

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