March 13, 1945. E. B. WILLIAMS, JR 2,371,489

DRILL BIT

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Fig. 1.

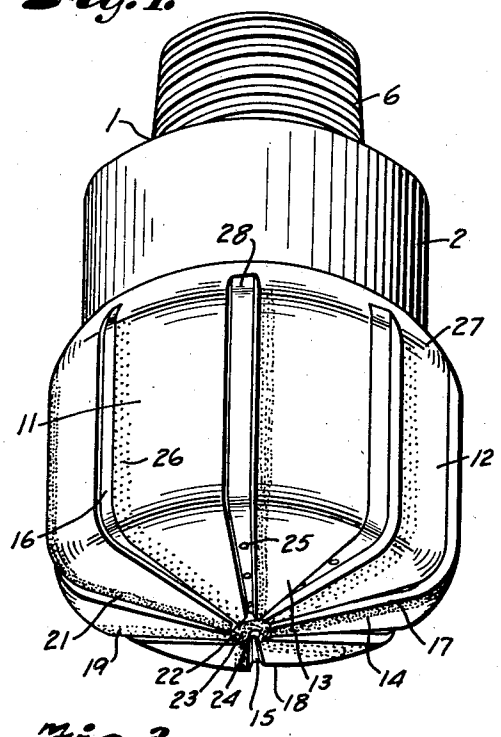

Fig. 2.

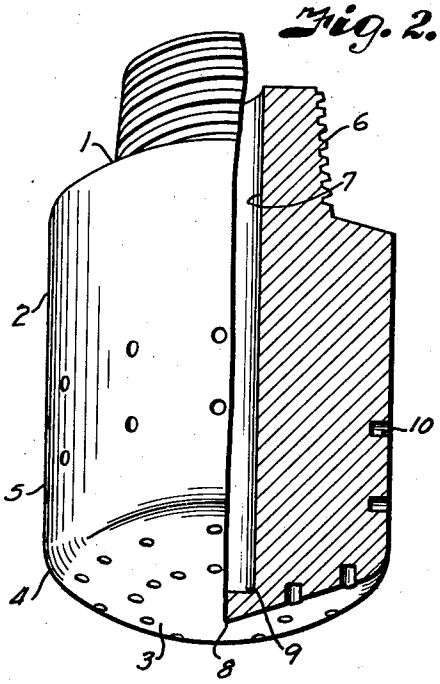

Fig. 3.

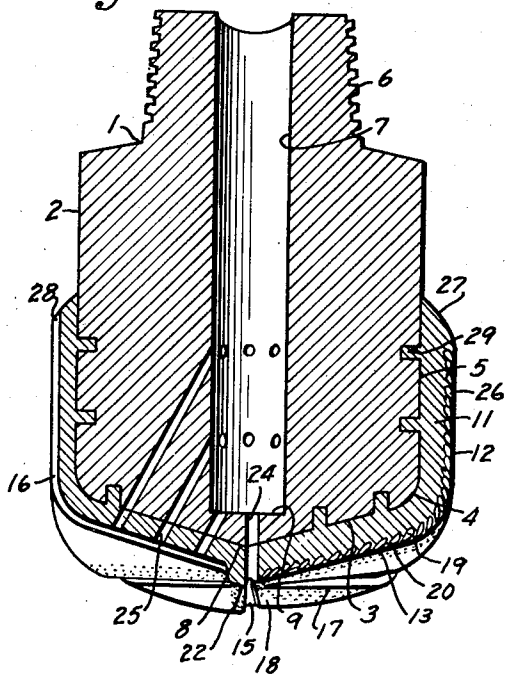

Fig. 4.

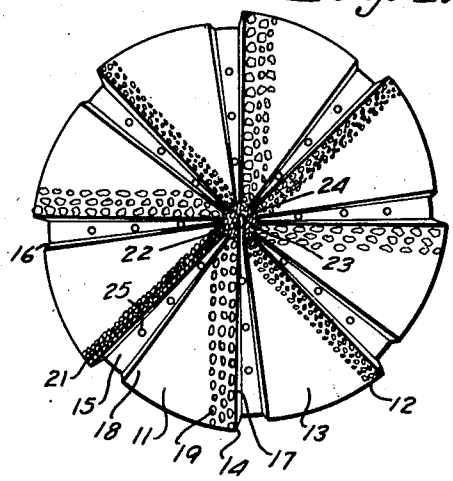

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Fig. 5.

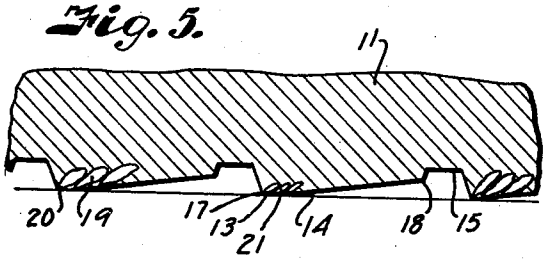


Fig. 6.

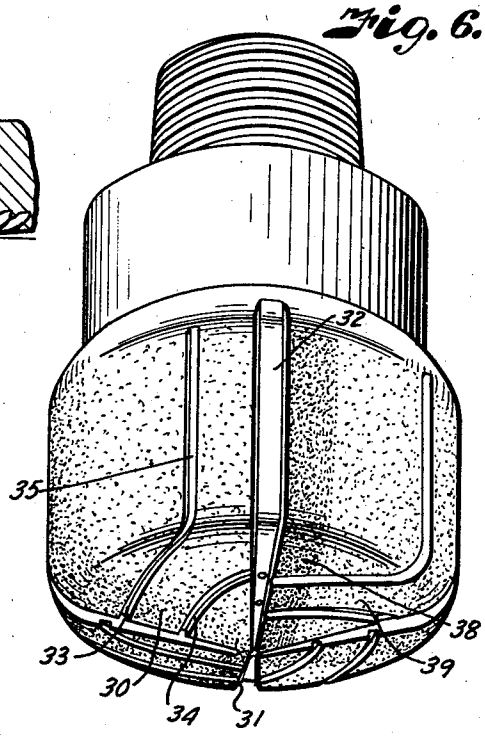


Fig. 7.

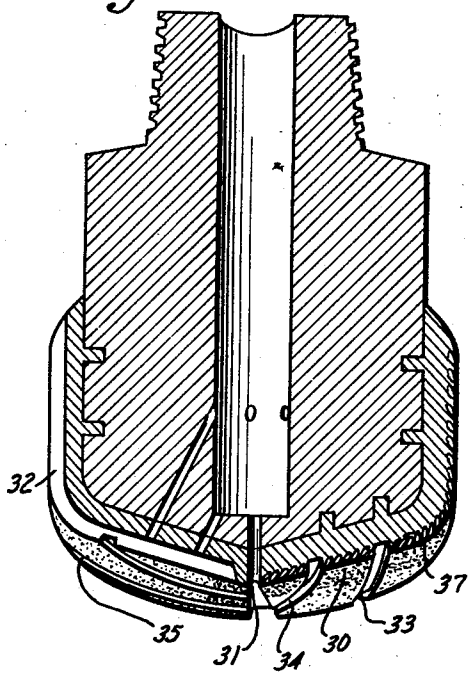


Fig. 8.

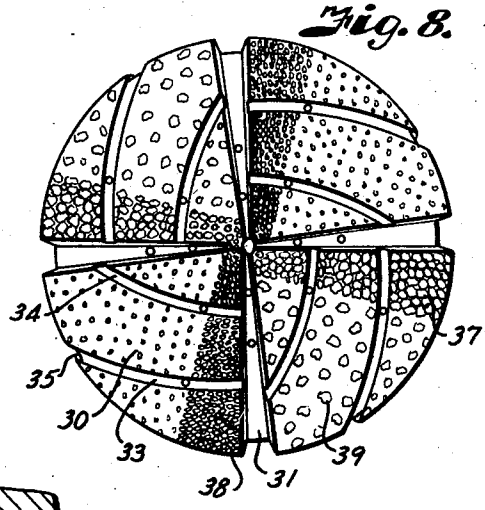
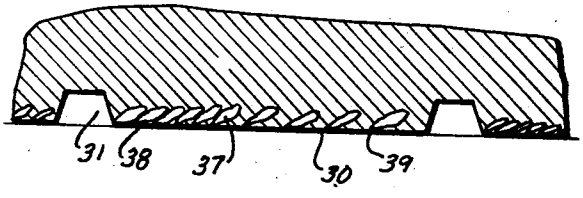


Fig. 9.



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Patented Mar. 13, 1945

2,371,489

UNITED STATES PATENT OFFICE

2,371,489

DRILL BIT

Edward B. Williams, Jr., Greenville, Tex., assignor of one-third to Sam P. Daniel and one-third to Howard C. Grubb, Tulsa, Okla.

Application August 9, 1943, Serial No. 497,898

11 Claims. (Cl. 255—61)

This invention relates to drill bits particularly those of the type used in drilling earth formations and has for its principal object to provide a bit of this character adapted for efficient and rapid drilling of limestone, shale and other difficult to drill earth formations.

Other objects of the invention are to provide a drill bit having a cutting face studded with cutting elements such as diamonds and traversed with water-courses through which a drilling fluid is circulated to clear the cutting faces and assure faster cutting action of the bit; to provide an arrangement of cutting elements which facilitates the cutting action; to provide a drill bit with a plurality of end cutting faces, each having relief from the advanced portions toward the rear thereof; to provide a drill bit with reaming faces formed as continuations of the end cutting faces; and to provide a secure attachment of the cutting elements to the body of the drill bit.

It is a further object of the invention to provide an arrangement of cutting elements, and for water circulation at the center of the bit so as to prevent "riding of the bit."

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

Fig. 1 is a perspective view of a drill bit constructed in accordance with the present invention.

Fig. 2 is a perspective view, partly in section, of the body portion of the bit.

Fig. 3 is a vertical central section through the bit.

Fig. 4 is an end face view of the bit.

Fig. 5 is an enlarged fragmentary section showing orientation of the cutting elements and relief of the cutting faces.

Fig. 6 is a perspective view of a modified form of bit which is particularly adapted for drilling limestone and chert formations.

Fig. 7 is a vertical central section through the bit illustrated in Fig. 6.

Fig. 8 is an end view of the bit illustrated in Fig. 6.

Fig. 9 is an enlarged fragmentary section, particularly illustrating orientation of the cutting elements and watercourses traversing the cutting faces of the bit illustrated in Fig. 6.

Referring more in detail to the drawings:

1 designates a drill bit constructed in accordance with the present invention and which is particularly adapted for drilling limestone and shale formations. The bit includes a substantially cylindrical body 2 formed of a suitable material to withstand drilling strains and is shaped to provide a slightly coned end face 3 rounding as at 4 into the cylindrical side face 5. Formed on the upper end of the body is an externally 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 which terminates short of the central tip portion 8 of the coned end face 3 as indicated at 9. The exterior of the cylindrical face portion 5 and the conical end face 3 is provided with a plurality of bores or recesses 10 for anchoring a matrix material 11 for embedding the cutting elements of the bit, later described. The matrix is formed of a relatively hard and tough material such as bronze or similar metal alloy or a plastic capable of being cast upon the body of the bit and having the property for securely retaining the cutting elements. The material is also selected so that it is capable of wearing to expose the cutting elements that are bedded thereby. The matrix material is of suitable thickness to provide ample strength and bed the cutting elements and is shaped to provide a cylindrical reaming face 12 and a slightly coned end face 13 covering the coned end face 3 of the body and which is divided into a plurality of sector-shaped cutting faces 14 by means of radial grooves or watercourses 15 radiating from near the center of the end face and widening toward the periphery of the bit where they extend upwardly into the reaming face of the bit as indicated at 16. Each of the sector-shaped cutting faces 14 has an advance cutting edge 17 forming one side of a watercourse 15 and each cutting face tapers at an angle of substantially 15° upwardly to the trailing edge 18 which is the opposite side of a watercourse 15 so as to provide sufficient relief to keep the cutting faces clear of cuttings which are washed into the radial watercourses and upwardly through the courses 16 to the top of the borehole when the bit is in operation. Embedded within the advance marginal edges adjacent the edge 17 of each cutting face is a plurality of cutting elements 19 comprising diamonds or other suitable crystals having points 20 capable of cutting the formation being drilled. The cutting elements are preferably oriented within the matrix material with their axes at substantially 15° relatively to the plane of the sector faces as shown in Fig. 9 and with the points extending in the rotational direction of the bit. The cutting elements of alternate sectors are preferably of differential size as shown in Fig. 4 to facilitate

cutting. The smaller cutting elements 21 are staggered with respect to each other and produce a great number of scratches in the formation being drilled, which scratches are cleared away by the larger cutting elements of the intermediate sectors which large cutting elements are also arranged in staggered relation with respect to each other. The sector-shaped watercourses terminate short of the axis of the bit and the area 22 between the terminating points thereof and the axis is provided with a plurality of small cutting elements 23 to provide ample cutting surfaces at the center of the bit and prevent riding thereof. In order to clear this portion of the bit of cuttings, it is provided with a water port 24 drilled through the matrix material and into the bore of the bit to intersect with the bore 7, the port being offset relatively to the axis of the bit and thereby accommodates the location of cutting elements 23 up to and including the axis of the bit so as to avoid any lack of cutting elements in any particular path and to assure circulation of drilling fluid under the center portion of the bit. The sector-shaped watercourses are provided with a plurality of ports or channels 25 which are drilled upwardly through the matrix material and the body of the bit to intersect with the bore 7 as best shown in Fig. 3. The cutting elements of the bit extend upwardly in continuous formation along the sides of the vertical watercourses as indicated at 26 to cut the side walls of the borehole and maintain ample clearance for the bit. The upper marginal edge of the matrix material terminates short of the threaded neck and is rounded toward the cylindrical face of the body portion as indicated at 27 and through which the vertical watercourses are extended to provide outlets 28.

In forming the bit, the matrix material is cast on to the body 2 within a suitable mold which may be formed of sand and suitable binder and baked to provide the desired stability, the mold being shaped to form the cutting faces and watercourses when the matrix material is poured into the mold. Before insertion of the body of the bit, the cutting elements are glued to the surfaces of the mold in the desired patterns, after which the bit body is inserted into the mold and the matrix material is poured. The matrix material flows in and around the cutting elements and into the recesses 10 for forming keys 29. When the matrix material has set and the bit is removed from the mold, the cutting elements are rigidly embedded therein and the matrix material is securely anchored to the body of the bit. Since the mold is shaped to form the sector-shaped cutting faces and watercourses, these portions of the bit are complete but it is necessary to drill the water ports or channels 24 and 25 to connect with the bore 7.

The form of bit shown in Figs. 6 to 9 inclusive is similar to the form of the invention just described with the exception that the sector-shaped cutting faces 30 at the end of the bit are not relieved but are located within the conical surface of the end of the bit. The sector-shaped cutting faces are divided by the sector-shaped watercourses 31 extend upwardly alongside of the bit to provide vertical watercourses 32 similar to the watercourses 16 previously described. The sector-shaped faces are traversed by smaller preferably arcuate shaped watercourses 33 arranged eccentrically of the axis of the bit. The watercourses 33 are preferably arranged so that selected courses connect adjacent radial watercourses as indicated at 34 while others of the courses 33 connect with upward continuations 35 extending substantially parallel with vertical watercourses 32 as shown in Fig. 6. In this form of the invention, the cutting elements 37 on the advancing sides 38 of the sector-shaped cutting faces are arranged in relatively close relation and those to the rear are more widely spaced as indicated at 39, Fig. 8.

Like in the first form, alternate segments are provided with larger cutting elements so as to enhance cutting action of the bit. The cutting elements are oriented at substantially an angle of 15° with the cutting points arranged in the direction of rotation as previously described. The cutting elements also extend upwardly covering the reaming faces of the bit as shown in Fig. 6. The bit is otherwise constructed in the same manner as the bit previously described.

When the bit illustrated in Figs. 1 to 5 inclusive is to be used, it is attached to a string of drill pipe as in conventional practice and the assembly lowered to the bottom of the borehole and rotated by a conventional rotary drilling rig, not shown. When the bit is rotated, contact of the faces of the matrix material with the formation wears the matrix material to expose the points of the cutting elements. As rotation progresses, the points of the smaller cutting elements begin to form scratches in the rock-like formation and the scratches are cleared away by the points of the larger cutting elements. Simultaneously with rotation, a drilling fluid is being circulated downwardly through the drill pipe to the bore 7 and through the ports or channels 24 and 25 to the sector-shaped watercourses for washing the sector-shaped cutting faces free of cuttings which due to the relief of the sector-shaped faces are carried thereunder into the sector-shaped watercourses where the drilling fluid flows upwardly through the vertical watercourses and around the drill pipe to the top of the well.

The bit illustrated in Figs. 6 to 9 inclusive, operates substantially in the same manner with the exception that the cuttings are washed from the cutting faces through the traversing courses 33 which connect through the sector-shaped watercourses with the main vertical courses 32 or in the instance of other of the grooves 32 with the secondary vertical courses 35.

From the foregoing it is obvious that I have provided a bit structure which is capable of cutting extremely hard formations at relatively rapid cutting rates.

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

1. A drill bit body having a matrix material thereon forming an end cutting face, said end cutting face being provided with radial water courses dividing said end face into a plurality of sector-shaped areas, and cutting elements bedded in said areas, the cutting elements in one sector-shaped area being of larger size than the cutting elements of the adjacent sector-shaped areas.

2. A drill bit body having a matrix material thereon forming an end cutting face, said end cutting face being provided with radial water courses dividing said end face into a plurality of areas having advance and trailing edges along sides of the water courses, and cutting elements bedded in said areas in closely grouped formation along said advance edges and in scattering formation toward the trailing edges.

3. A drill bit body having a matrix material thereon forming an end cutting face, said end cutting face being provided with radial watercourses dividing said end face into a plurality of sector-shaped areas, having advance and trailing edges on the respective sides of the watercourses, and cutting elements bedded in said areas in closely grouped formation along said advance edges and in scattering formation toward the trailing edges, the cutting elements of one area being a larger size than those of an adjacent area.

4. A drill bit body having a matrix material thereon forming an end cutting face, said end cutting face being provided with radial watercourses dividing said end face into a plurality of areas having advance and trailing edges on the respective sides of the watercourses, said areas being relieved from the advance edges toward the trailing edges, and cutting elements bedded in said areas.

5. A drill bit body having a matrix material thereon forming an end cutting face, said end cutting face being provided with radial watercourses dividing said end face into a plurality of areas having advance and trailing edges on the respective sides of the watercourses, said areas being relieved from the advance edges toward the trailing edges, and cutting elements bedded in said areas in closely grouped relation along said advance edges and scattering toward the trailing edges of the areas.

6. A drill bit body having a matrix material thereon forming an end cutting face, said end cutting face being provided with radial watercourses dividing said end face into a plurality of areas, and cutting elements bedded in said areas, said areas having spirally arranged watercourses connected with the radial watercourses at points spaced from the center of the cutting face for passing a drilling fluid to wash cuttings from said areas into the radial watercourses.

7. A drill bit body having a matrix material thereon forming an end cutting face, said end cutting face being provided with radial watercourses dividing said end face into a plurality of areas, having advance and trailing edges, said areas being relieved from the advance edges toward the trailing edges, and cutting elements bedded in said areas, said areas having traversing watercourses connected with the radial watercourses.

8. A drill bit body having a matrix material thereon forming a conical end cutting face, said cutting face being provided with radial watercourses dividing said end face into a plurality of substantially sector-shaped areas, and cutting elements bedded in said areas, said areas having spirally arranged watercourses connected with the radial watercourses at points spaced from the center of the axis of the conical cutting face for passing a drilling fluid to wash cuttings from said areas into the radial watercourses.

9. A drill bit body having a matrix material thereon forming an end cutting face, and a reaming face, said end cutting face being provided with radial watercourses extending upwardly of said reaming faces and dividing said faces into a plurality of areas, and cutting elements bedded in said areas, said areas having secondary watercourses connected with the radial watercourses at points spaced from the center of the cutting face for passing a drilling fluid to wash cuttings from said areas into the radial watercourses.

10. A drill bit body having a matrix material thereon forming an end cutting face provided with watercourses dividing said face into a plurality of areas having advance and trailing edges on the respective sides of the watercourses, said areas being relieved from the advance edges toward the trailing edges, and cutting elements embedded in said areas.

11. A drill bit body having a matrix material thereon forming an end cutting face and a cylindrical reaming face, said end cutting face being provided with radial watercourses dividing said end face into a plurality of substantially sector-shaped areas, said reaming face having watercourses connected with the radial watercourses, and bedded in said sector-shaped areas including the reaming face of the adjacent areas, the cutting elements in one sector-shaped area being of differential size than those in an adjacent sector-shaped area.

EDWARD B. WILLIAMS, JR.