June 29, 1965 L. W. SHORT 3,191,698

BLADE-TYPE DRILL BIT

Filed May 17, 1962

FIG. 1

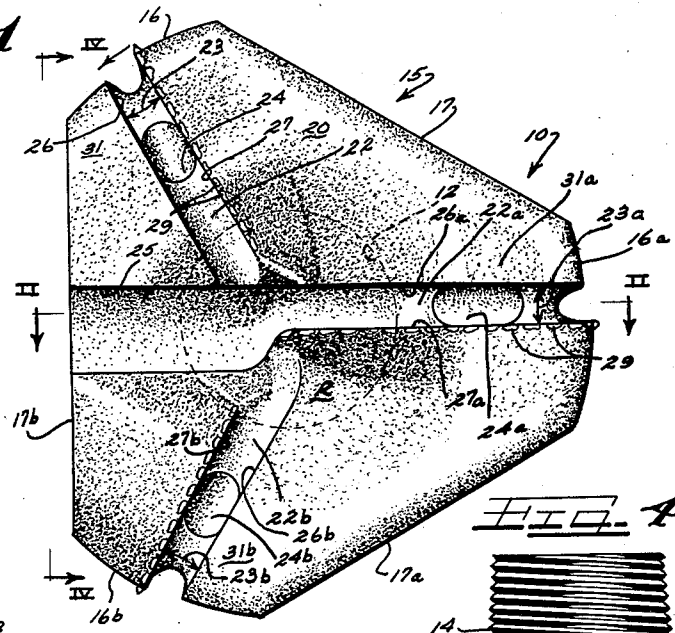


FIG. 2

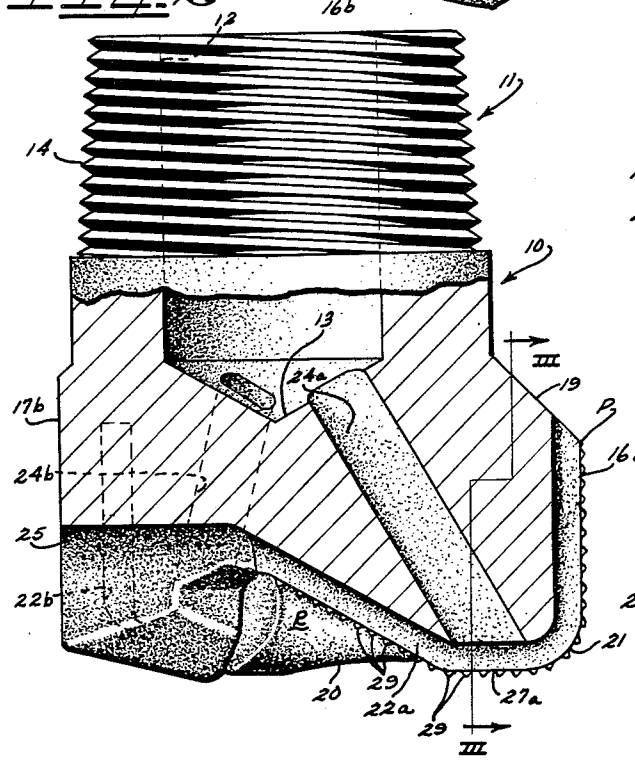


FIG. 4

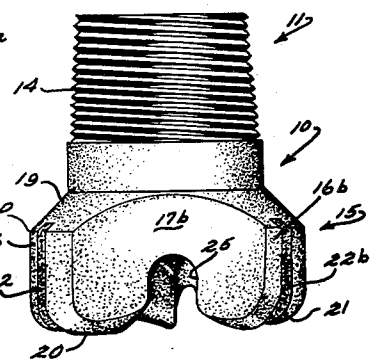
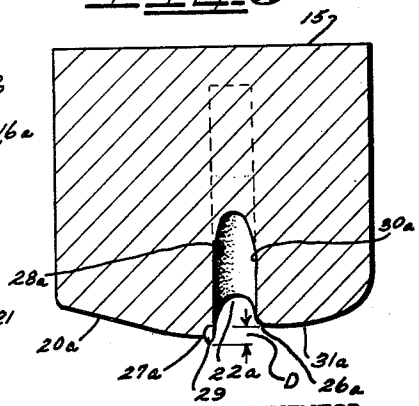


FIG. 3



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United States Patent Office 3,191,698 Patented June 29, 1965

3,191,698

BLADE-TYPE DRILL BIT

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Filed May 17, 1962, Ser. No. 195,595
10 Claims. (Cl. 175—329)

This invention relates to a blade-type drill bit and more particularly to a drill bit using hard, abrading elements, such as diamonds, arranged along generally radially extending blade-like projecting ribs forming the cutting edges of the bit.

The present invention constitutes a modification of the bit described and claimed in my United States Letters Patent No. 2,990,897, issued July 4, 1961, and possesses certain advantages over the drill bit of that patent in the drilling of bore holes in earth formations, particularly with respect to a more economical use of diamonds, or other hard abrasive abrading elements. In accordance with my present invention, I preferably employ the generally triangular configuration, when viewed in bottom plan view, that is shown in my aforesaid patent, but instead of providing abrading particles in closely spaced relationship embedded in the lower working face and lateral reaming faces substantially throughout their entire area, I embed, preferably, a single row of diamonds along the leading, or cutting, edge of each of a plurality of blade-like projecting ribs that extend radially outwardly from near the center of the lower face of the bit and upwardly along the lateral, segmental-cylindrical, reaming faces of the bit. The projecting blade-like ribs are formed between the lower surface of the bit and the generally radially extending water grooves that also extend upwardly along the lateral reaming faces of the bit. The lower working face of the bit on the other, or trailing, edge of each of the radially extending grooves is slightly offset axially upwardly and/or inwardly, and is generally flattened to provide an abutment or bumper that is free of abrading particles. The edge of the abutment at each groove will be referred to as the trailing edge of the abutment.

Additionally, provision is made for conducting a drilling fluid under high pressure into each of the radially extending grooves intermediate the length thereof, and the grooves are preferably restricted in cross-section outwardly toward the periphery of the lower working face to insure a high velocity flow of drilling fluid over and around the abrading elements to cool the same and upwardly along the extensions of said grooves in the lateral faces of the bit to carry away cuttings and loose material formed during the drilling operation. For the purpose of removing larger cuttings, a groove of greater cross-sectional area than the grooves previously mentioned extends from a closed recess near the center of the working face of the bit outwardly to and through a non-reaming facet that lies wholly within the lateral periphery of the bit generated by the segmental-cylindrical faces thereof.

It is therefore an important object of this invention to provide a drill bit of a blade-type construction that makes a more economical use of the diamonds, or other abrading elements, and that possesses novel operational advantages in the drilling of bore holes in certain types of earth formations.

It is a further object of this invention to provide a drill bit of improved construction in which there is a more efficient utilization in operation of high velocity streams of drilling fluid in the cooling of the abrading elements and in the removal of the cuttings and loose particles of earth formation formed or encountered in drilling.

It is a further object of this invention to provide, in a drill bit, an arrangement of generally radially extending water grooves, each forming with the lower working face of the bit a blade-like projecting rib that constitutes the leading edge and that is set with a row of abrading elements along its length, with the opposite or trailing edge of the respective grooves slightly offset axially upwardly and/or inwardly, and with the lower face of the bit adjacent such trailing edge providing a generally flattened abutment or bumper that cooperates by contact with the bottom of the bore hole to cause a high velocity flow of the drilling fluid over the leading edge of the corresponding blade to cool and free the abrading elements set therein for their cutting action.

It is a further important object of this invention to provide a blade-type of drill bit the lower working face of which is provided near its center with a recess from which extend water grooves that are of restricted cross-sectional area toward the periphery of the working face and that are supplied with a drilling fluid intermediate their lengths for high velocity flow over the abrading elements that are set in the leading blade-type edges of such grooves.

Other objects, features and advantages of this invention will become apparent to one skilled in the art from the following description of the embodiments of the invention illustrated in the accompanying drawings, in which:

FIGURE 1 is a bottom plan view of a drill bit embodying the features of my invention;

FIGURE 2 is a sectional view taken substantially along the line II—II of FIGURE 1;

FIGURE 3 is a sectional view taken substantially along the broken line III—III of FIGURE 2; and

FIGURE 4 is a reduced, fragmentary elevational view taken substantially along the line IV—IV of FIGURE 1.

As shown on the drawings:

The drill bit illustrated in the drawings is one adapted to be attached to the lower end of a rotary drill stem in the drilling of oil wells and the like, wherein the drill stem (not shown) is rotated by a rotary table (not shown) and wherein a drilling fluid, such as any of those commonly used for the purpose, is circulated down through the drill stem and discharged through the lower working end of the drill bit. The drilling fluid is for the purpose of cooling the abrading elements of the bit and of carrying away from the bottom of the bore hole the particles of earth formation generated by the abrading action of the drill bit or otherwise present in the bottom of the hole. As is well understood, the drilling fluid is usually a water suspension of a bentonite clay or the like, and is pumped down to the drill bit under considerable pressure. As will later be explained, the particular arrangement of fluid discharge bores and water grooves in the bit of my invention, in combination with the configuration of the lower working face of the bit and the constriction of the water grooves toward the periphery of such working face results in a higher velocity flow of drilling fluid over and around the abrading elements during their cutting action than has heretofore been usually the case.

With more specific reference to the drawings, the reference numeral **10** indicates generally a drill bit of my invention, provided at its upper end with a shank **11** having an axially extending recess **12** that is open at the top for receiving the drilling fluid from the drill stem and that is counterbored at the bottom, as at **13**. The shank **11** is thus hollow, and is provided with an externally tapered, threaded portion **14** for attachment to the drill stem. The body of the bit, indicated at **15**, is carried by the shank **11** at the lower end thereof and is usually integral therewith. Said body **15** is preferably of a generally triangularly shaped configuration when viewed in bottom plan, as in FIGURE 1.

As there shown, the body portion **15** comprises three segmental-cylindrical lateral faces **16**, **16***a* and **16***b*, between which extend non-reaming facets **17**, **17***a* and **17***b*, each of which is of greater peripheral extent than any of the segmental-cylindrical reaming faces **16**, **16***a* or **16***b*,

and each of which lies wholly within the cylinder generated by said segmental-cylindrical lateral faces. While the non-reaming facets **17**, **17***a* and **17***b* are illustrated as being substantially flat in FIG. 1, they may be arcuate, either convexly or concavely, so long as they lie wholly within the generated cylinder. As shown in FIG. 4, the non-reaming facets, such as **17***b*, extend laterally upwardly to near the top of the enlarged body portion **15** of the bit, while the reaming lateral faces, such as **16** and **16***b*, terminate in a transverse plane, indicated at P, above which the body of the bit is smoothly tapered, as at **19**, to merge with the lower cylindrical end of the shank **11**.

The lower working face **20** is provided near its center with a generally conical blind recess, indicated at R (FIG. 2) from which the surface extends outwardly through a convexly smooth peripheral surface portion **21** to the segmental-cylindrical surfaces **16**, **16***a* and **16***b*. Three water grooves **22**, **22***a* and **22***b* extend from near the upper closed apex of said recess R in a generally radially outwardly direction and then along the convex portions **21** and upwardly along the respective segmental-cylindrical lateral faces **16**, **16***a* and **16***b*, preferably through the tapered surface **19** (FIG. 2). Said water grooves **22**, **22***a* and **22***b* are constricted in their cross-sectional area toward the peripheral extent thereof, as at **23**, **23***a* and **23***b* for a purpose that will later appear. Bores **24**, **24***a* and **24***b* extend downwardly in an inclined direction from the counterbore **13** of the shank recess **12** into the respective grooves **22**, **22***a* and **22***b*, near the midpoints of the length thereof. Thus, the drilling fluid introduced into the recess **12** of the hollow shank **11** is discharged, during operation, through the respective bores **24**, **24***a* and **24***b* into the corresponding water grooves **22**, **22***a* and **22***b*. The cross-sectional area of each of said bores **24**, **24***a* and **24***b*, is considerably greater than the cross-sectional area of the corresponding water grooves so as to increase the pressure and therefore the velocity of the drilling fluid as the same enters and flows through the water grooves. The restriction of said water grooves toward their respective peripheral extents tends to build up a back pressure causing the drilling fluid to flow inwardly through the respective grooves toward the apical recess portion R for discharge laterally therefrom through an enlarged water course **25**, which constitutes an extension of the water groove **22***a* and that opens for discharge of the drilling fluid through the non-reaming facet **17***b*. Larger portions of earth formation, and particularly those broken off within the apical recess R, can thus be discharged through said enlarged water course **25** and pass freely upwardly between the non-reaming facet **17***b* and the wall of the bore hole.

As viewed in FIGURE 1, with the bit turning counterclockwise, as indicated by the arrow, that edge of each of the grooves **22**, **22***a* and **22***b* which constitutes the diamond set blade will be termed the leading edge, and the other will be termed the trailing edge. With this understanding, the respective grooves **22**, **22***a* and **22***b* have trailing edges **26**, **26***a* and **26***b*, and have leading edges **27**, **27***a* and **27***b*. The respective leading edges, as best illustrated in FIGURE 3 by the leading edge **27***a*, are constituted by blade-like projecting ribs formed at the junction of the adjacent portion of the lower working face **20** and the wall of the groove, in this case, the groove **22***a*. Since all of the projecting ribs are similar, only that best shown in FIGURE 3 need be described. The portion of the lower working face indicated by the reference numeral **20***a* slopes upwardly and away from the projecting rib **27***a*, while the adjacent wall **28***a* of the groove **22***a* lies in a substantially vertical plane, with the result that a blade-like rib is formed at the junction of the two surfaces **20***a* and **28***a*. A single row of closely set diamonds **29** is embedded in the edge **27***a* formed by such blade-like projecting rib, and as shown in FIGURES 1 and 2, this single row of diamonds extends from within the blind recess R continuously along the radial length of the edge **27***a* and

upwardly along substantially the full extent thereof on the lateral segmental cylindrical reaming face **16***a*. The diamonds, or other hard abrading elements, are set relatively closely together, preferably but not necessarily in a single row right in the very edge itself, and are suitably embedded in the matrix or alloy of which the working face of the bit is constituted so as to exert maximum cutting, or abrading, action throughout the useful life of the diamonds during the drilling operation.

The other, or trailing edges of the grooves **22**, **22***a* and 22b, are all generally similar and all generally follow the contour of the corresponding leading edge of the respective grooves but in a plane slightly offset upwardly and/or inwardly from a transverse plane passing through the diamond-set edges **27**, **27***a* and **27***b*. This can best be understood by reference to FIGURE 3, wherein the letter D represents the amount of offset between the plane of the trailing edge **26***a* and that of the leading edge **27***a*. The distance D may vary from as little as from 1/16", or so, up to 1/4" or greater, depending upon the nature of the earth formation to be drilled, the fluid energy available at the bit, the torque limits of the drill stem and the weight available to be applied to the bit during drilling. The trailing edge **26***a* is preferably smoothly rounded at the junction of the adjacent groove wall **30***a* and portion **31***a* of the working face of the bit. Said working face portion **31***a* is preferably nearly flat, or only slightly sloping, for a substantial distance away from the edge **26***a*, thereby forming, in effect, an abutment, or bumper, that minimizes the flow of drilling fluid between such abutment and the bottom of the bore hole. Said abutment **31***a* and the similar abutments **31** and **31***b*, are all free from abrading particles, or diamonds, and therefore, exert no cutting or abrading action. They do, however, limit the "bite" taken by the blade-type edges by the fact that the abutment, or bumper surface, rests against the bottom of the hole at all times during drilling.

In operation, as a result of the correlation between the flow capacity of the bores **24**, **24***a* and **24***b*, and the corresponding water grooves **22**, **22***a* and **22***b*, and also as a result of the restriction of said water grooves toward their peripheral extent, the drilling fluid flows along said water grooves at a relatively high velocity to carry loose particles of earth formation away from the bottom of the hole. In particular, by virtue of the blade-like projecting ribs **27**, **27***a* and **27***b*, and their corresponding, upwardly offset abutments **31**, **31***a* and **31***b* extending away from the leading edges **26**, **26***a* and **26***b*, there is a high velocity flow of the drilling fluid over and around the diamonds **29** in the leading edges of the water grooves and this serves to cool the diamonds and to free them from particles formed by the abrading or cutting action of the diamonds. Inasmuch as the water groove **22***a* is somewhat longer than the water grooves **22** and **22***b*, the bore **24***a* supplying said water groove **22***a* is of larger capacity than either of the bores **24** or **24***b*. Also, the blade-type projecting rib, or edge **27***a*, is longer than the other edges **27** and **27***b*, in that the blind recess R is offset from the true axis of the drill bit in the direction toward the non-reaming lateral facet **17***b* and the edge **27***a* continues for the length of said water groove **22***a* up into said recess R. Consequently, there is some abrading action caused by the diamonds **29** that lie within the apical recess R, and the particles of earth formation resulting from such abrading action of those diamonds are carried along with the stream of drilling fluid that discharges radially outwardly through the enlarged water groove **25** through the non-reaming facet **17***b*. Because of the axially offset position of the conical recess R, there is more of a crushing than of an abrading action, with a result that larger particles of earth formation are produced within the extent of the recess, and these larger particles are readily accommodated by the larger cross-sectional area of the

water groove 25 and by reason of the relatively large free space between the lateral facet 17*b* and the wall of the bore hole.

In general, the diamonds 29 are selected of a size and shape suited for the purpose, and are set along the leading edges 27, 27*a* and 27*b* in such a manner as to accentuate the blade-type projecting ribs afforded by the contour of the lower working face 20 and the water grooves 22, 22*a* and 22*b*. As stated, the rows of said diamonds 29 are preferably only one diamond in width. This results in a great saving in the cost of diamonds, as compared with prior art drill bits in which the diamonds are set in closely spaced relation over substantially the entire lower and lateral working faces of the drill bit.

It will, of course, be understood that various details of construction and arrangement may be varied somewhat without departing from the principles of this invention, and it is, therefore not the purpose to limit the patent granted hereon otherwise than necessitated by the scope of the appended claims.

I claim as my invention:

1. A drill bit comprising:
a bit body having at its upper end an axial recess and at its lower end a working face,
said working face being formed with a blind recess near the center thereof and with a plurality of water grooves extending from said recess to the periphery of said working face,
the working face along a corresponding one side of each of said grooves forming with the adjacent groove wall a narrow radially extending blade-like projecting rib,
each of said ribs being set with closely spaced abrasive particles along the length thereof and presenting abrasive cutting edges toward the groove side thereof,
the working face along the other side of each groove being generally flat and offset axially upwardly of a plane transverse to the axis and passing through said abrasive cutting edges to form a bumper area extending continuously from said groove side to the next succeeding rib,
there being a bore through said bit body from said axial recess opening into each of said grooves radially outwardly of said blind recess to discharge drilling fluid into each of said grooves for high velocity flow across said recess and over said abrasive cutting edges the full lengths thereof,
said bumper areas serving to limit the bite taken by said blade-like projecting ribs.

2. A drill bit comprising:
a bit body having at its upper end an axial recess, at its lower end a working face and at its periphery lateral segmental cylindrical reaming faces with intervening radially inward non-reaming facets,
said working face being formed with a blind conical recess near the center thereof and with a plurality of water grooves extending from and across said recess to the periphery of said working face and upwardly along said segmental cylindrical reaming faces,
the working face along a corresponding one side of each groove forming with the adjacent groove wall a narrow radially extending blade-like projecting rib,
each of said ribs being set with substantially a single row of diamonds extending therealong and presenting and abrasive cutting edge toward the grooved side thereof,
the working face along the other side of each groove being generally flat and offset axially upwardly of a plane transverse to the axis and passing through said abrasive cutting edges to form a bumper area limiting the bite of said ribs,
there being a bore through said bit body from said axial recess opening into each of said grooves radially outwardly of said recess to discharge drilling fluid into each of said grooves for high velocity flow through said grooves, across said recess and over said abrasive cutting edges.

3. A drill bit comprising:
a hollow cylindrical shank,
an enlarged bit body at the lower end of said shank having a lower face of generally triangular configuration in bottom plan merging at its periphery into three coaxial segmental cylindrical lateral reaming faces and three intermediate non-reaming facets each of greater peripheral extent than any of said segmental cylindrical faces and lying radially wholly within the latter,
said lower face having near the center thereof a closed recess and three water grooves extending outwardly therefrom along said lower face and upwardly along said segmental cylindrical lateral faces,
said lower face along a corresponding one side of each of said grooves forming with the adjacent groove wall a narrow radially extending blade-like projecting rib and along each corresponding other side of said grooves forming an abutment offset axially upwardly of the corresponding rib and conforming generally in contour to one of said ribs throughout the length thereof,
each of said ribs along the adjacent groove wall edge being set with abrasive particles extending from adjacent said recess outwardly along said groove wall edge,
there being a bore through said bit body from said hollow shank opening into each of said grooves radially outwardly of said recess to discharge drilling fluids into said grooves for high velocity flow therealong and across said recess and for cooling said abrasive particles in said ribs along said grooves and the upward extensions thereof.

4. A drill bit as defined in claim 3, wherein, said grooves are restricted in cross-section toward the periphery of said lower face.

5. A drill bit as defined in claim 3, wherein, an additional water groove extends from said recess in substantially diametrical alignment with one of said three grooves to the nearest of said non-reaming facets for discharge of drilling fluid upwardly along said facet.

6. A drill bit comprising:
a bit body having at its upper end an axial recess and at its lower end a working face smoothly merging at its periphery into upwardly extending lateral reaming faces and intermediate radially inwardly relieved non-reaming facets,
said working face being formed near the center thereof with a closed recess and with a plurality of water grooves extending from and across said recess to the periphery of said working face and upwardly along said lateral reaming faces of said bit,
a radially extending blade-like projecting rib formed along a corresponding edge of each of said grooves, substantially the full length thereof,
the working face along the other side of each of said grooves extending back from one groove edge to the next groove edge to form therebetween a generally flat abutment similar in contour to the contour of said projecing rib but offset axially upwardly from said rib substantially the full length thereof to limit the bite of said rib during drilling,
there being a bore through said bit body from said axial recess to each of said grooves radially outwardly of said recess to discharge drilling fluid into said grooves for high velocity flow therealong and across said recess,
and a narrow row of abrasive particles set along each of said blade-like projecting ribs for substantially the full length thereof,
the working face being otherwise free of abrasive particles.

7. A drill bit as defined in claim 6, wherein, there is an addtional groove, but without any bore leading directly thereinto, formed substantially as a diametrical continuation of one of said first-named grooves on the other side of said closed recess from said one groove and discharging along a radially inwardly relieved non-reaming facet.

8. A drill bit as defined in claim 6, wherein, the lower working face is of generally triangular configuration in plan and is defined by three segmental cylindrical lateral reaming faces including upward continuations of said ribs and three intermediate non-reaming facets each of the latter of which is of greater peripheral extent than each of said segmental cylindrical faces and lies wholly within the cylinder generated by said segmental cylindrical faces.

9. A drill bit comprising:

a bit body having at its upper end an axial recess and at its lower end a working face,

said working face being formed with a plurality of water grooves extending from near the center of said face to the periphery thereof,

each of said water grooves being restricted in cross-section toward the periphery of said working face, the working face along the corresponding one side of each groove forming with the adjacent groove wall a blade-like projecting rib,

each of said ribs being set with closely spaced abrasive particles along the length thereof and presenting abrasive cutting edges toward the groove side thereof,

the working face along the other side of each groove being generally flat and offset axially upwardly of the plane transverse to the axis and passing through said abrasive cutting edges,

there being a bore through said bit body from said axial recess to each of said grooves to discharge drilling fluid into each of said grooves for high velocity flow with said abrasive cutting edges,

each of said bores being of larger cross-sectional area than that of a groove into which said bore discharges,

10. A drill bit comprising:

a bit body having at its upper end an axial recess and at its lower end a working face,

said working face being formed with a plurality of water grooves extending from near the center of said face to the periphery thereof,

the working face along the corresponding one side of each groove forming with the adjacent groove wall a blade-like projecting rib,

each of said ribs being set with a single row of closely spaced diamonds extending therealong and presenting abrasive cutting edges to the groove side thereof,

the working face along the other side of each groove being generally flat and offset axially upwardly of a plane transverse to the axis and passing through said abrasive cutting edges,

there being a bore through said bit body from said axial recess to each of said grooves to discharge drilling fluid into each of said grooves for high velocity flow over said abrasive cutting edges.

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