

DRILL BITS

This invention relates to drill bits for drilling through rock and other hard formations in drilling oil wells, and more particularly to rotary bits having depending legs with cutters rotatably mounted on journals extending inwardly and downwardly from the inner sides of the legs.

Drilling bits of this type are conventionally suspended from drill pipe extending downwardly from the drilling rig located at the surface. Generally, the string of drill pipe is rotated by the drilling rig and this rotation is transmitted to the bit at the bottom of the hole. In some cases, rotation of the bit is accomplished through the use of a fluid motor mounted on the bottom of the drill string just above the bit. In either case, the drill string, being of less diameter than the hole being drilled, is subjected to lateral whipping or other movement which creates a certain amount of angularity to the string which is imparted, to a certain degree, to the bit itself. This results in a tilting of the bit which causes excessive pressure of the lower leg portions of the bit against the formation as the bit is rotated. This phenomenon is even more critical in directional drilling where the bit is oriented at extreme angles from the vertical. Because of physical constraints within the bore hole, bits were originally constructed with relatively thin leg constructions. As a result, the rotating bit operated with an undue lateral swinging or rocking motion which greatly reduced the operating life of the bit since the lower portion of the legs rapidly wore away, leading to a seal and/or bearing failure.

Stabilizers for the drill string have been utilized heretobefore but they were located above the

drill bit some distance away from it, so that the bit still had an opportunity to move or tilt laterally.

US Patent No. 3,628,616 obviated some of these problems by providing stabilizing means
5 directly on the drill bit, thereby eliminating the need for additional subs and greatly reducing the rocking motion of the bit. This stabilization means consisted of hard metal pads welded directly onto the upper portion of the bit body. These pads were of
10 sufficient thickness to greatly lengthen the life of the bit while still keeping the upper bit body diameter within the limits provided by the diametrical cutting path or bore described by the rotary cutters.

15 In addition, this type of welded pad structure of necessity had sharp corners which created stress risers on the leg. This, of course, is undesirable, since it greatly shortens the fatigue life due to the mechanical notch created by welding
20 in the weakest part of the leg.

Moreover, it was found that high flow rates of drilling fluid during operation can erode the weld-on "plate" type pad right off.

Another shortcoming with the structure
25 found in the aforesaid patent was that the lower portion of the lug with its straight surface, formed a dam for hindering the upward flow of the drilling fluid through the borehole annulus. This in turn created undue pressures and increased erosion on the
30 lower leg portions of the bit.

The type of bit described in US Patent No. 3,628,616 also included a plurality of tungsten carbide inserts mounted on the wear pad. However, these inserts have a tendency to crack and unduly
35 wear during operation.

The drill bit to be described obviates the above mentioned shortcomings, by providing stabilizing means integrally forged on the drill bit body. This construction is achieved by having the stabilizing lugs pre-formed on the leg forgings. The lower section of each stabilizing pad is rounded toward its outer sides and functions to co-operate with a recessed portion of the drill bit body located beneath the lug to create a flow channel away from the lower extremities of the bit body.

A primary advantage of this construction is that a metallurgically solid bit body is formed that will resist breakage. In addition, being forged part, the forged lugs gain a substantial increase in toughness and reliability through improvement of grain structure in the metal. With this design, the fibrous metal grain is lined up parallel to the most severe stresses and shock loads that will be imposed on the leg. By taking advantage of metal flow during the forging process, maximum mechanical properties are obtained at the critically stressed sections.

Such a construction can also be conformed optimally to offer good stabilization while enhancing fluid flow and cutting removal created by the flow channel construction.

Another advantage of the drill bit to be described is that the forged construction provides a readily machinable boss that can be turned to any diameter and require less operations than weld-on legs.

The drill bit to be described also utilizes polycrystalline diamond compacts pressed into the stabilizer lugs to maximize wear resistance. The insert configuration can either be flat or rounded and be flush with the lug surface or extend beyond

it. The advantage of the rounded inserts extending beyond the lug is that the annular space available for cuttings to flow by is increased. This construction also provides secondary gage cutting to help maintain bore hole diameter. Moreover, less torque is generated due to the reduction of surface area in contact with the hole wall.

According to the present invention there is provided a drill bit comprising a drill bit body having a main body portion having a plurality of legs extending downwardly therefrom, the lower end of each leg having a relatively thin tapering extremity commonly known as the shirttail portion, a stabilizer lug integrally forged thereon directly above each leg, each lug having a lesser circumferential extent than each leg but extending radially outwardly from the main body portion to substantially the same diameter as the circular path of cut, a cutter rotatably mounted on each leg, the cutters, upon rotation of the bit body, defining a circular path of cut, the outer diameter of the cutters forming the outer diameter of the drill bit; and flow channel means recessed along the lower portion and sides of each lug for enhancing fluid flow from around each shirttail portion upwardly around the respective stabilizer lug.

According to the present invention there is further provided a method of manufacturing a rotary drill bit comprising the steps of, forging a plurality of elements each having an upper body portion with a stabilising lug extending outwardly and a lower leg portion, each lug having a lesser circumferential extent than the body portion of which it forms part; machining each element to form a shirttail portion located on the lower leg portion;

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machining each element to form a journal on the lower leg portion; providing a cutter to be rotatably mounted on each journal; orienting and securing the elements into a unitary structure such that the cutters have an outer extent defining the outer diameter of the tool, and the stabilizing lugs extend radially outwardly to substantially the same diameter as the cutter extensions directly above the respective shirttail portion.

A drill bit embodying the present invention will now be described, by way of example, with reference to the accompanying drawings in which:

Figure 1 is a prespective view of the drill bit;

Figure 2 is an enlarged sectional view on one of the legs of the drill bit taken along lines 2-2 of Figure 1;

Figure 3 is a sectional view of the forging utilized to form the leg;

Figure 4 is an enlarged side view of the leg;

Figure 5 is an enlarged fragmentary view of the stabilizer lug of the bit of Figure 1; and

Figure 6 is an enlarged fragmentary view of a modified stabilizer lug for the bit of Figure 1.

Figure 1 illustrates a drill bit 10 having a body 12 and a threaded pin portion 14 which is adapted to be threadably connected to the lower end of a drill string. Extending downwardly from the bit body 12 are legs 16. As shown in Figure 2, each leg 16 has an inwardly and downwardly directed journal 18 which is adapted to rotatably support a cutter illustrated at 20 in Figure 2 by broken lines. The cutters 20 are oriented to describe a circular path, the outer diameter of which forms the gage diameter of the bit.

The base of the journal 18 is defined by a

surface of revolution 22 lying in a plane normal to the longitudinal axis of the journal 18. The surface of revolution 22 and the lower end of the leg 16 defines a relatively thin tapering bottom leg portion commonly known as a shirrtail 24. The radial extremity of the shirrtail 24 does not extend out to the outer diameter of the bit 10 but has a clearance with the sidewalls of the bore hole.

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Stabilizer lugs 30 are formed on the upper portion of each leg 16 extending radially outwardly to substantially the gage diameter of the bit 10. Figure 3 illustrates a forging 40 of one of the legs 16. The forging 40 comprises a dome section 41, a journal section 42, a shirrtail section 43 and a stabilizer section 44.

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The journal section 42 is machined to form the journal 18 and the surface of revolution 22 as shown in Figure 2. The shirrtail section 43 is also machined to remove some parent metal, shown in broken lines, of the forging 40 to form the shirrtail 24. This is more clearly shown in Figure 4.

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The forging 40 is also turned to machine away a portion of the stabilizer section 44, shown in broken lines, to form the stabilizer pad 30. Three such leg forgings are welded together to form the rock bit.

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As shown in Figure 1, the lower portion of each stabilizer pad 30 forms a rounded portion 51 which curves upwardly to join with the sides 53 of the lug 30. This rounded portion 51 co-operates with a recessed portion 55 formed on the leg 16 to form a flow channel to enhance the flow of drilling fluid from around the shirrtail 24 upwardly around the stabilizer lug 30.

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Drilling fluid (not illustrated) enters the

bore hole via a plurality of nozzles 60 extending through the bit body 12.

Referring again to Figures 1 and 2, a lubricating system is also illustrated having a reservoir 61 having a pressure equalizer 62 located therein. The one side of the equalizer communicates with the outside of the bit through the ports 63 formed in a cap 65. The other side of the equalizer 62 communicates with the interior of the bearing chamber through passages 66 and 67. Lubricant (not illustrated) completely fills the reservoir 61, passages 66 and 67 and the bearing cavity.

Figure 4 more clearly illustrates a plurality of bores 45 for receiving a plurality of inserts 46. Each insert 46 is preferably made of polycrystalline diamond and can have its outer surface 47 substantially flat in order to be flush with the outer surface of the stabilizer lug 30. (See Figure 5).

Alternatively, each insert 46 can also have rounded outer projections 48 extending beyond the outer surface of the stabilizer lug 30 (See Figure 6).

In addition, each insert 46 may be comprised entirely of polycrystalline diamond, or else it may comprise of a wafer brazed to a root portion made of tungsten carbide.

In operation, it has been found that integrally formed stabilizer lugs 30 have obviated many of the shortcomings found in the prior art constructions. In addition, the diamond inserts 46 have greatly reduced wear on the stabilizer lugs, thereby greatly increasing the useful life of the drill bit.



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CLAIMS

1. A drill bit comprising a drill bit body having a main body portion having a plurality of legs extending downwardly therefrom, the lower end of each leg having a relatively thin tapering extremity commonly known as the shirttail portion, a stabilizer lug integrally forged thereon directly above each leg, each lug having a lesser circumferential extent than each leg but extending radially outwardly from the main body portion to substantially the same diameter as the circular path of cut, a cutter rotatably mounted on each leg, the cutters, upon rotation of the bit body, defining a circular path of cut, the outer diameter of the cutters forming the outer diameter of the drill bit; and flow channel means recessed along the lower portion and sides of each lug for enhancing fluid flow from around each shirttail portion upwardly around the respective stabilizer lug.
2. A drill bit according to Claim 1 wherein said flow channel comprises a curved surface formed on the lower portion of each stabilizer lug.
3. A drill bit according to Claim 1 or to Claim 2 wherein said flow channel comprises a radially recessed portion formed on the main body directly below each stabilizer lug.
4. A drill bit according to any one of Claims 1 to 3 comprising a plurality of polycrystalline diamond inserts mounted within the surface of each stabilizer leg.
5. A drill bit according to Claim 4 wherein each polycrystalline diamond insert has a flat bearing surface substantially co-extensive to the surface of the stabilizing leg.
6. A drill bit according to Claim 4 wherein each polycrystalline diamond insert has a rounded bearing surface extending beyond the surface of the



stabilizer lug.

7. A method of manufacturing a rotary drill bit comprising the steps of, forging a plurality of elements each having an upper body portion with a
5 stabilizing lug extending outwardly and a lower leg portion, each lug having a lesser circumferential extent than the body portion of which it forms part; machining each element to form a shirttail portion located on the lower leg portion; machining each
10 element to form a journal on the lower leg portion; providing a cutter to be rotatably mounted on each journal; orienting and securing the elements into a unitary structure such that the cutters have an outer extent defining the outer diameter of the tool, and
15 the stabilizing lugs extend radially outwardly to substantially the same diameter as the cutter extensions directly above the respective shirttail portion.

8. A method according to Claim 7 including the
20 steps of, drilling a plurality of bores into the surface of each stabilizing lug, and providing a polycrystalline diamond insert in each bore.

9. A drill bit substantially as hereinbefore described with reference to the accompanying
25 drawings.

10. A method of making a drill bit substantially as hereinbefore described with reference to the accompanying drawings.
