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DRILL BIT AND INSERTS THEREFOR

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ABSTRACT OF THE DISCLOSURE

A rotary drill bit including a rolling cutter having sintered metallic carbide inserts located in the cutter surface. The inserts include a plurality of alternate ridges and valleys on the side surface thereof that are sized to engage the walls of the holes in the rolling cutter whereby the inserts are retained in the rolling cutter against both longitudinal and rotational movement relative to the cutter.

This invention relates generally to drill bits of the rolling cutter type. In particular, this invention relates to bits of this type, which employ hard, wear resistant, inserts for cutting elements and wear resistant surfaces, and to an improved insert for such bits.

For example, bits of the type to which this invention relates, see U.S. Patent Nos. 2,687,875, 2,774,570, and 2,774,571. As shown in these patents, inserts of hard, wear resistant material, such as sintered tungsten carbide, are attached to the rolling cutters of the bit to engage the bottom of the hole for drilling away the rock beneath the bit. They are also positioned to engage the side walls of the drilled hole to keep it in gauge.

One method of attaching the inserts is to mount them with an interference fit in holes in the outer surface of the rolling cutters. Since the inserts usually are made of a sintered metallic carbide, which is very brittle as well as hard and wear resistant, the amount of interference between the insert and its mounting hole must be closely controlled. For if the interference is too small, there will not be enough friction developed between the insert and the hole to hold the insert in place during drilling operations. If the interference is too great, the hole and/or the insert will be damaged when the insert is forced therein. Therefore, the dimensions of the holes and the inserts are held to such close tolerances that, usually, the holes must be reamed after they are drilled. Reaming all of the mounting holes requires a considerable amount of machine and man hours.

SUMMARY OF THE INVENTION

An improved insert for use in conjunction with rolling cutters for drill bits comprising a generally cylindrical body of a hard, wear-resistant, sintered metallic carbide having a side surface and two end surfaces with one of the end surfaces adapted to be exposed when the insert is installed in the rolling cutter. The side surface of the body includes a series of alternate ridges and valleys extending generally parallel to the longitudinal axis of the insert. The ridges being arranged to engage the wall of the rolling cutter whereby the insert is retained in the cutter against rotational and longitudinal movement by the interference therebetween.

It is an object of this invention to eliminate the need for reaming the mounting holes provided in a drill bit for inserts of hard, wear resistant, material.

It is another object of this invention to provide an insert for a rolling cutter type of drill bit that can be mounted with a satisfactory interference fit in a mounting hole that may vary in diameter as much as an ordinary drilled hole.

It is another object of this invention to provide a rolling cutter for a drill bit having inserts of hard, wear resistant, material mounted with an interference fit in unreamed holes in its outer surface.

Heretofore, inserts mounted in round holes were held against rotation by the frictional forces developed between the outer surface of the insert and the wall of the hole by the interference fit provided therebetween.

It is another object of this invention to provide a rolling cutter for a drill bit having inserts mounted in holes in the outer surface of the cutter to provide cutting elements for the cutter wherein the inserts are held against rotation in the mounting holes by ridges on the inserts that engage grooves formed on the walls of the mounting holes.

Another object of this invention is to provide an insert that will form grooves in the wall of the mounting hole in the rolling cutter of a drill bit as the insert is forced into the mounting hole with an interference fit thereby providing interlocking grooves and ridges between the insert and the wall of the mounting hole to hold the insert against rotation relative to the mounting hole.

It is important to keep the section thickness of the cone below the insert as thick as possible. Therefore, the depth of the mounting holes should be kept to a minimum. Also, there are places on the bit where the mounting holes are of varying diameter. It would be desirable to use inserts to resist wear, such as on the shank tail portion of the arms supporting the rolling cutters.

Therefore, it is another object of this invention to provide an improved insert for drill bits that provides a substantial increase in the forces holding the insert in its mounting hole thereby allowing the length of the insert and the depth of the mounting hole to be substantially reduced over the type of insert herebefore employed.

These and other objects, advantages and features of the invention will be apparent to those skilled in the art from a consideration of this specification and attached drawings.

The invention will now be described in detail in connection with the attached drawings in which:

FIGURE 1 is a view partially in elevation and partially in vertical section of a rolling cutter type of drill bit equipped with inserts of hard, wear resistant material on the gauge surface of the cutters and on the shank tail of the bit;

FIGURE 2 is a bottom view of a rolling cutter type drill bit with inserts providing the cutting elements;

FIGURE 3 is a side view of the preferred embodiment of the improved insert of this invention;

FIGURE 4 is an end view of the insert of FIGURE 3; and

FIGURES 5A, 5B and 5C are isometric views showing the insert of this invention provided with ground engaging end surfaces of various shapes.

The drill bit of FIGURE 1 includes a body 10, which has an upper threaded portion 11 for connecting the bit to the lower end of a string of drill pipe 12. Depending arms 13 and 14 are connected to the body for supporting the rolling cutters. In the type bit shown in FIGURE 1, three depending arms are employed. Only arms 13 and 14 are shown in FIGURE 1. Each arm rotatably supports a rolling cutter in the manner shown by the section taken through the lower end of arm 13 and cutter 15 in FIGURE 1. Thus, depending arm 13 has a shaft portion 13a upon which is rotatably mounted rolling cutter 15. Roller bearings 16 and ball bearings 17 are located in the conventional manner to support the cutter on the shaft of the arm.

All of the cutters are similarly shaped. Each has a portion of its outer surface conically shaped like surface portion 15a of cutter 15 on which cutting elements 16 are mounted to engage the bottom surface of the hole being drilled. Each cutter also is provided with a conically shaped outer surface portion like portion 15b on cutter
3 and \( \frac{29b}{} \) of cutter \( 29 \) upon which cutting elements \( 18 \) are mounted to engage the walls of the hole being drilled, as shown in FIGURE 1. This last described surface on a rolling cutter is referred to as the gage surface, since it maintains the hole to the desired diameter.

In the type bit shown in FIGURE 1, the cutting elements on the gage surfaces of the cutters are of the insert type. The cutting elements on the bottom engaging portion of the chisels or tooth shaped and they are integrally connected to the cutters. This latter type of cutting elements is employed for digging soft to medium hard formations.

FIGURE 2 illustrates a three cutter type drill bit having cutters \( 19 \) equipped with inserts \( 20 \) of hard, wear resistant material for cutting elements. This type bit is used for drilling hard formations. The gage surfaces (not shown) of cutters \( 20 \) also are provided with inserts of hard, wear resistant material to maintain the hole in gage.

Referring again to FIGURE 1, the vertical section through arm 13 illustrates how the thickness of the arm diminishes at skirt tail portion \( 15b \). The skirt tail of the bit is subject to considerable wear when drilling in an abrasive formation and/or where the drilling fluid contains abrasive materials. To prolong the life of these thin sections of the arms and to keep them from wearing away too fast, inserts \( 21 \) of hard, wear resistant material are mounted in a way too fast provided in the skirt tail. Skirt tail \( 14b \) of arm \( 14 \) shows a typical arrangement for such inserts. Obviously, the shorter the insert, the closer it can be located to the lower end of the skirt tail where it can do the most good.

Thus, inserts of hard, wear resistant material are used as cutting elements to engage the bottom of the hole being drilled and to engage the walls of the hole being drilled to maintain it in gage. Also they can be used simply to protect portions of the bit from being worn or eroded away.

FIGURES 3 and 4 show side and end views, on an enlarged scale, of an insert constructed in accordance with the preferred embodiment of this invention. The particular insert shown in these views is one particularly adapted for use on either the gage surface of the roller cutter or to protect the skirt tail from wear. Therefore, this insert has a flat first end surface \( 18c \) which is adapted to be exposed when the insert is installed in a mounting hole. Usually, the length of the insert and the depth of the mounting hole is such that surface \( 18c \) will be approximately flush with the surface in which it is mounted. The insert has a second end surface \( 18b \), which faces the bottom of the mounting hole, and a side surface \( 18d \) which engages the wall of the mounting hole. As shown in FIGURE 4, side surface \( 18c \) is formed of a continuous series of alternate ridges \( 22 \) and valleys \( 23 \). These alternate ridges and valleys extend generally in the direction of insertion of the insert into the mounting hole. In the embodiment shown, they are parallel to the longitudinal axis of the insert. By providing the mounting hole with a radius that falls between the radial distance, \( R \), from the longitudinal axis of the insert to the outer edge of the ridges \( 22 \) and radial distance, \( r \), from the same axis to the bottom of valleys \( 23 \), the surface area of the insert in contact with the wall of the hole is reduced. This allows greater interference to be tolerated between the insert and the mounting hole since the valleys provide a space for the displaced metal from the wall of the hole to enter.

Preferably, the metal adjacent to the walls of the hole is displaced into these valleys, rather than being cut away by the ridges as the insert is forced into the hole. Therefore, preferably, the edge formed by side surface \( 18c \) and end surface \( 18b \) of the insert are broken as by beveling as shown in FIGURE 3. This not only reduces the tendency of the ridges to broach grooves in the walls of the hole, but it also provides a lead-in taper to help guide the insert as it first enters the mounting hole. Preferably, the bevel is such that the maximum diameter of end surface \( 18b \) is less than the diameter of the mounting hole so that a portion of the insert will extend into the mounting hole before the insert engages the walls thereof. Instead of beveling the side surface adjacent surface \( 18b \) as shown, it can be rounded to break its sharp edge and to also provide a lead-in taper. End surface \( 18b \) can be rounded also to make the insert more resistant to chipping.

As an alternate method of mounting the inserts in a mounting hole, the end of the ridges adjacent end surface \( 18b \) can be left unbeveled and relatively sharp cornered and they will broach grooves in the wall of the mounting hole as the insert is forced therethrough. If a true running operation occurs, a normal force between the insert and the wall of the hole sufficient to hold the insert in the hole may not be obtained. When this occurs the insert should be attached to the drill bit arm or roller cutter, as the case may be, by brazing or welding.

Even with the beveled end, the ridges may do some broaching of the walls of the hole, particularly where there is considerable interference between the insert and the hole. In either event, the ridges on the side surface of the insert will be located in grooves formed in the wall of the mounting hole. Often, even with the aids to the formation and installed in a mounting hole, will be firmly held against rotation relative to the hole. This is particularly important in the case of inserts located on the gage surface of the bit. Although all inserts probably are subjected to some forces that tend to rotate them, these forces are particularly severe and noticeable on inserts on the gage surface, or on inserts, such as illustrated in FIGURE 5C when used as bottom hole cutting elements.

The inserts used on drilling bits usually are made of one of the very hard metallic carbides, such as cobalt sintered tungsten and tantalum carbides. These materials are very hard and wear resistant, but they are relatively brittle and have a fairly high degree of notch sensitivity. This being the case, it was thought that an insert formed with alternate ridges and grooves on its side surface, would shatter under the severe impact forces that occur under normal drilling conditions. It was found, however, that the inserts did not shatter and that the frequency of impact breakage was no greater than that which occurred on these materials when inserted and retained by previous accepted methods.

It was thought that an insert formed with alternate ridges and grooves on its side surface would shear its way into a mounting hole and leave insufficient residual interference fit to retain it during operation. It was discovered, however, that not only did the inserts not shatter or fracture or break, but they could be inserted in mounting holes having a wide range of diameters and sufficient friction would be provided between the hole and the insert to adequately hold the insert for drilling operation. Such inserts can, in fact, easily tolerate the range of diameters of drilled holes, thereby eliminating the need to ream the mounting holes to close tolerance dimensions.

For example, in one embodiment of the invention, the outside diameter of the insert was .332" minus .00 plus .003" and the drilled hole was .312" minus .00 plus .005". Thus, the interference between the insert and the mounting hole varied from .015" to .025" and satisfactory results were obtained. In fact, the interference with this type of insert can range from .008" to .035" with satisfactory results. Thus, obviously the close tolerance heretofore required to be held is no longer necessary.

As an example of the improved holding power of the insert of this invention over the heretofore employed inserts, a cylindrically shaped insert \( \frac{3}{8} " \) in diameter by \( \frac{3}{16} " \) long and having a smooth side wall, was installed in a mounting hole with .004" interference. It took 5300 lbs. of force to push the insert into the hole and 2800 lbs. to push it out. An insert provided with alternate ridges and grooves on its side surface, in accordance with this invention, which had a \( \frac{7}{16} " \) outside diameter and was \( \frac{3}{4} " \)
long, was pushed into a mounting hole with .020" interference. It took 9000 lbs. to push it in and 4000 lbs. to push it out. As this test shows, even though the first insert was larger in diameter, it required much less force to push it out than the compact constructed in accordance with this invention. Further, a compact having smooth side walls could not possibly be installed with .020" interference without shearing the side walls of the hole as the compact goes in, thereby destroying the interference fit necessary to hold it in place.

FIGURES 5A, 5B and 5C show alternate configurations of inserts constructed in accordance with this invention. These inserts are particularly adapted for engaging the bottom of the hole and crushing the rock as the bit is rotated. Inserts 31 and 32 shown in FIGURES 5A and 5B are for use in extremely hard formations. Insert 30 in FIGURE 5C has end surface 30a formed into a chisel or tooth shape much like teeth 16 formed on rolling cutters 15 of the drill bit shown in FIGURE 1. This insert could be used in place of these integrally formed teeth. Here the ability of the insert of this invention to resist rotation is particularly advantageous, since the chisel shaped cutting end of the insert would be subjected to a certain amount of torsion as the cutter is rotated on the bottom of the hole.

From the foregoing, it will be seen that this invention is well adapted to attain all of the ends and objects hereinabove set forth, together with other advantages which are obvious and which are inherent to the apparatus and structure.

It will be understood that certain features and sub-combinations are of utility and may be employed without reference to other features and sub-combinations. This is contemplated by and is within the scope of the claims.

As many possible embodiments may be made of the invention without departing from the scope thereof, it is to be understood that all matter herein set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

The invention having been described, what is claimed is:

1. An insert for use in conjunction with rolling cutters for drill bits comprising a generally cylindrical body of hard, wear resistant, sintered metallic carbide having a side surface and two end surfaces with one of said end surfaces adapted to be exposed when the insert is installed in a hole in a rolling cutter, said side surface being formed of a continuous series of alternate ridges and valleys extending generally parallel to the longitudinal axis of the cylindrical body with said ridges being arranged to interfere with said cutter when the insert is inserted in the hole.

2. The insert of claim 1 in which the edge between the side surface and the end surface not adapted to be exposed is chamfered to reduce the tendency of the ridges to breach the wall of a hole into which it is to be inserted.

3. The insert of claim 1 made of cobalt sintered tungsten carbide.

4. The insert of claim 1 in which said end surface adapted to be exposed is chisel shaped.

5. A rolling cutter for drill bits comprising a body having a plurality of holes in its outer surface, a plurality of inserts each including a generally cylindrical body of hard, wear resistant sintered metallic carbide having a side surface and two end surfaces, one of said inserts being located in a corresponding one of said holes, each insert having alternate ridges and valleys formed in its side surface and extending generally parallel to the longitudinal axis of said body and in the direction of insertion of the insert into the hole in which the insert is located, said ridges engaging the walls of said holes in an interference fit whereby said inserts are retained in said holes against rotation relative to said cutter.

6. The rolling cutter of claim 5 in which the maximum radial distance from the longitudinal axis of each said insert to the ridges on its side surface is greater than the radius of the hole in which the insert is located and the minimum radial distance from the longitudinal axis of the insert to the valleys is less than the radius of said hole.

7. The rolling cutter of claim 6 in which the interference between the insert and the hole is between .008 and .035 inch, whereby said inserts will be retained in unreamed, drilled holes.

8. The rolling cutter of claim 6 in which each said insert is made of cobalt sintered tungsten carbide.

9. The rolling cutter of claim 6 in which the ridges on the inserts breach grooves in the walls of the holes in which they are inserted to receive the ridges on the inserts and hold the inserts against rotation in the holes.

10. The combination of claim 9 in which the inserts are chamfered on the edge joining the side surface and unexposed end surface to reduce the tendency of the inserts to breach the walls of the holes whereby the unexposed end surface engages the bottom wall of the holes.

11. A drill bit comprising a body having depending arms having an outer surface facing the walls of a hole being drilled by the bit, a plurality of rolling cutters, each arm rotatably supporting one of said cutters, one or more holes in said outer surface on each arm, each hole having an insert of hard, wear resistant sintered metallic carbide mounted therein, each of said inserts including a generally cylindrical body having a surface with alternate ridges and valleys thereon extending generally parallel to the longitudinal axis of said body and in the direction of insertion of the insert into the hole, said ridges engaging the walls of said holes in an interference fit whereby said inserts are retained in said cutters against rotational and longitudinal movement relative to said cutters.

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