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(54) DRILL BIT

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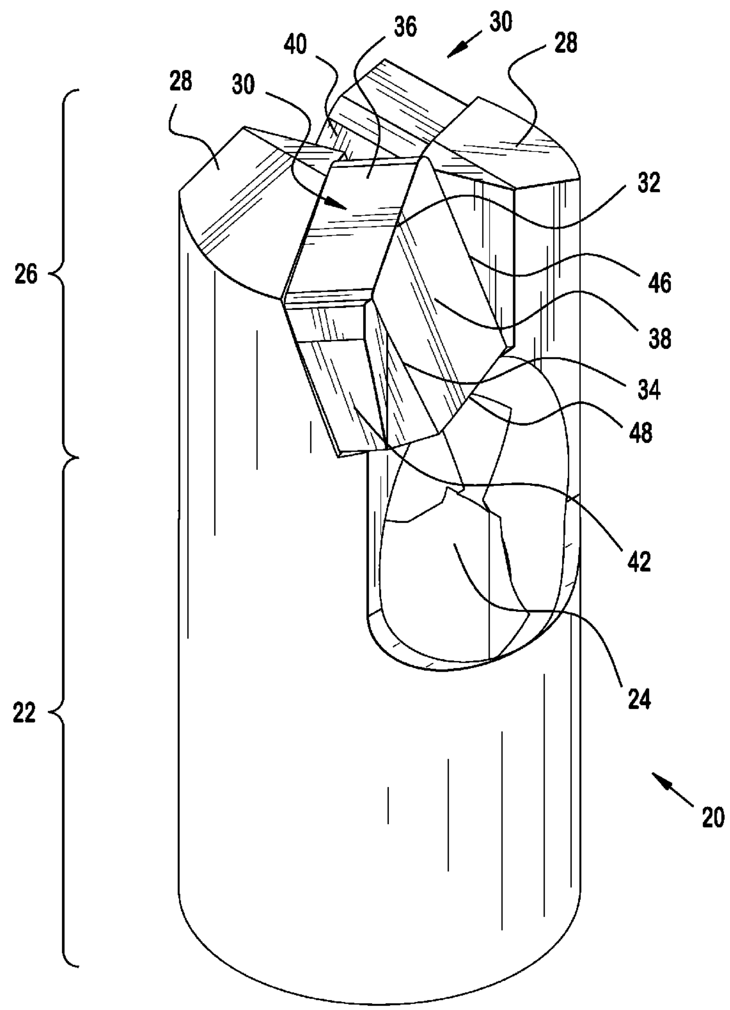
(57) **ABSTRACT**

A drill bit features a head portion and a connecting portion for attachment to a drilling device. The head portion includes at least two insert pockets, which can contain inserts, with cutting edges that extend from an inner position offset radially from the rotational axis of the bit to an outer cutting edge. The cutting edge is formed by the intersection of a top surface and a wear surface of the insert pocket or insert. The top surface is linear, but may be planar or non-planar.



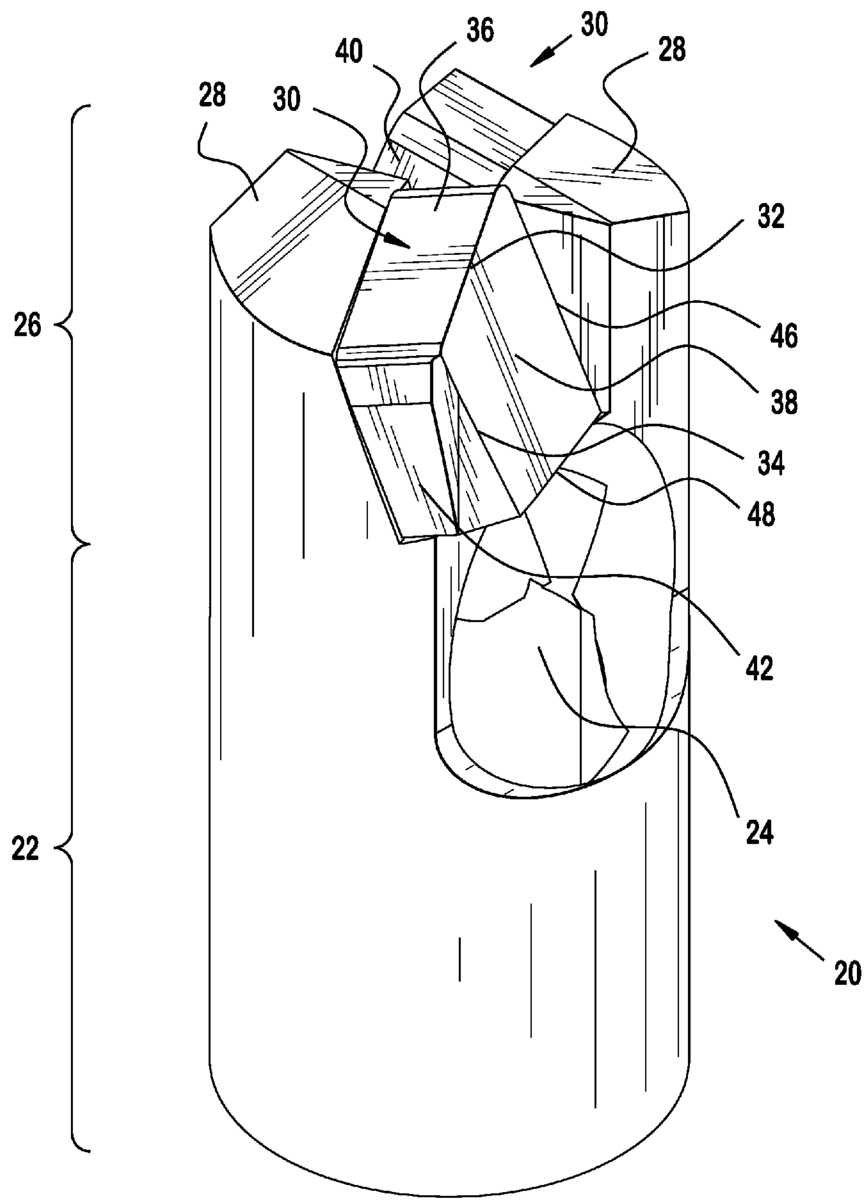


FIG. 1

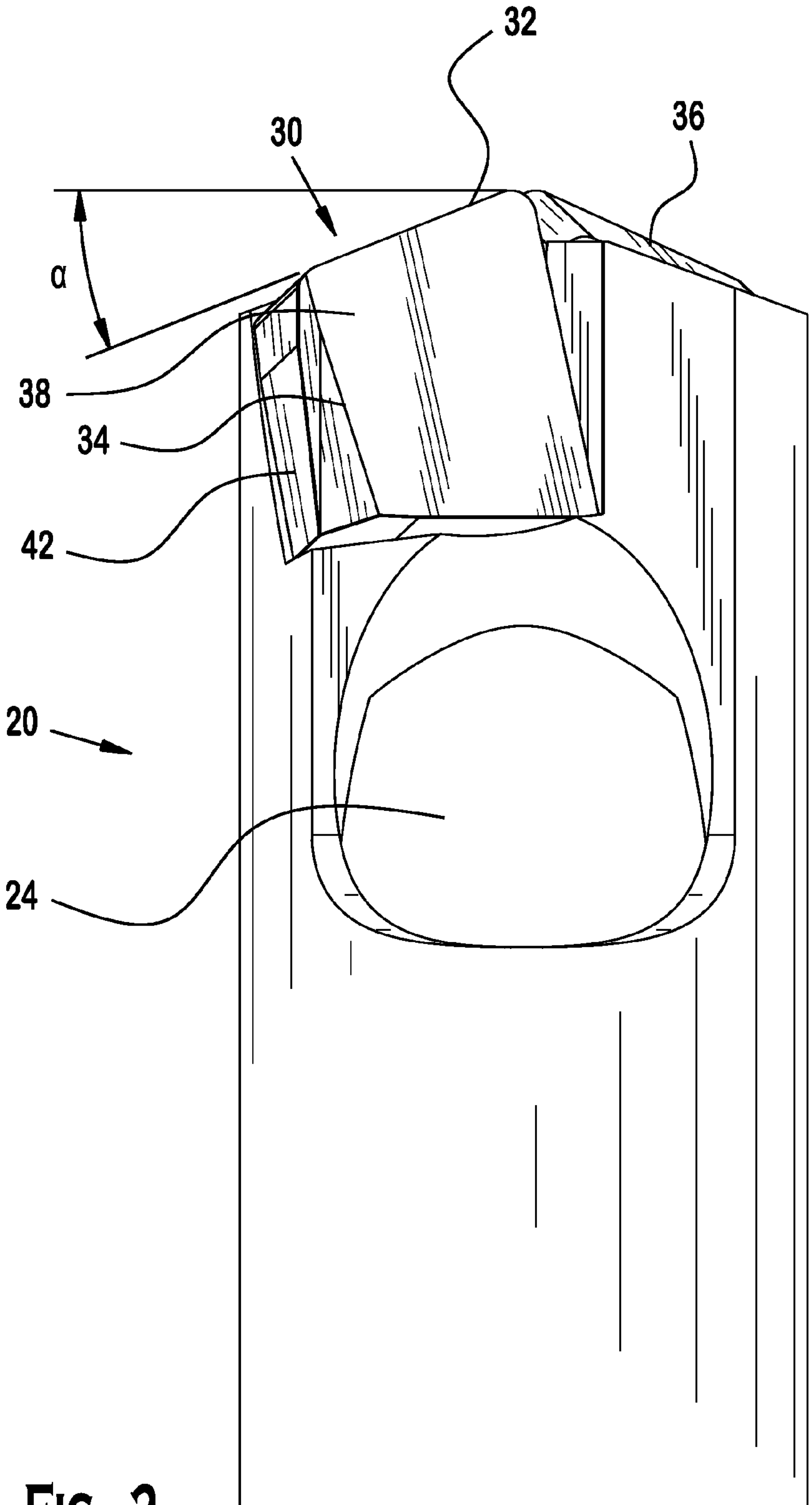


FIG. 2

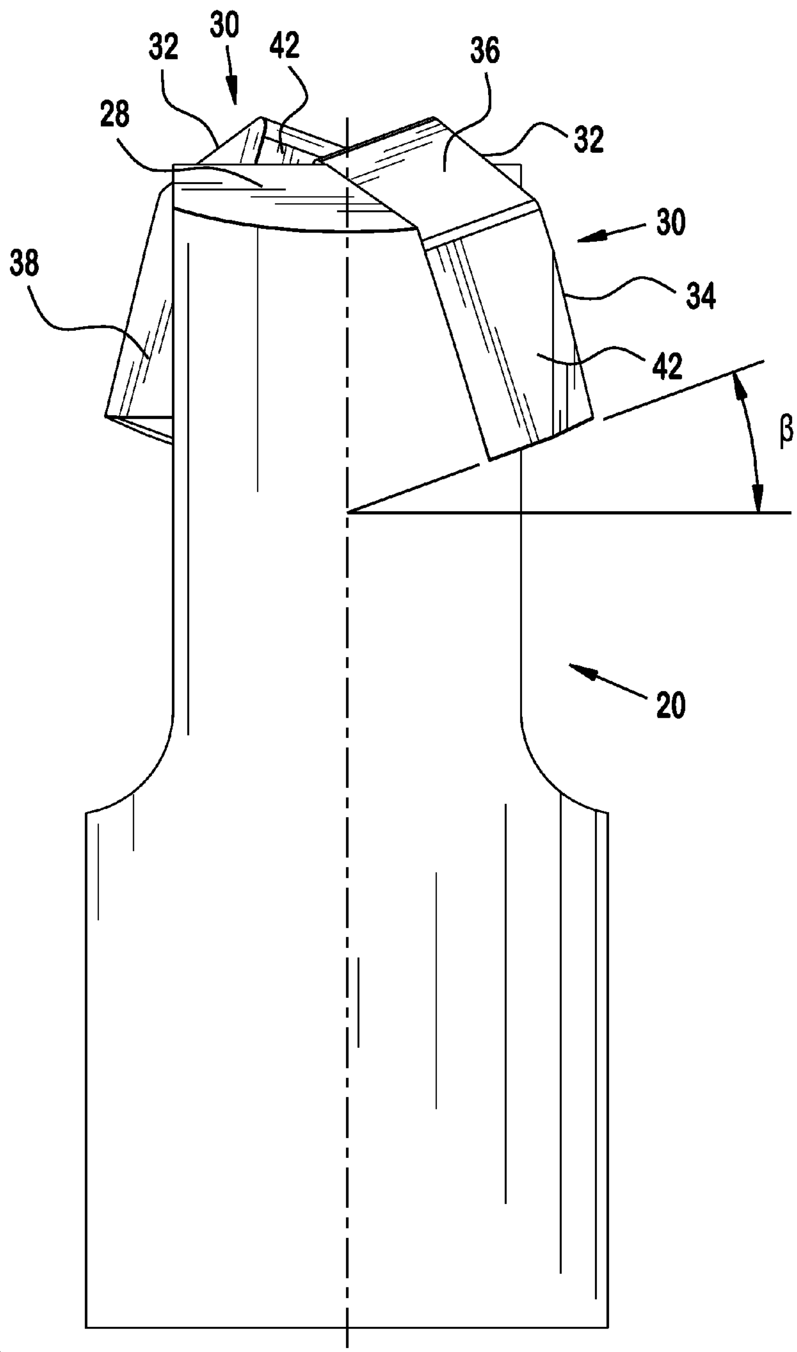


FIG. 3

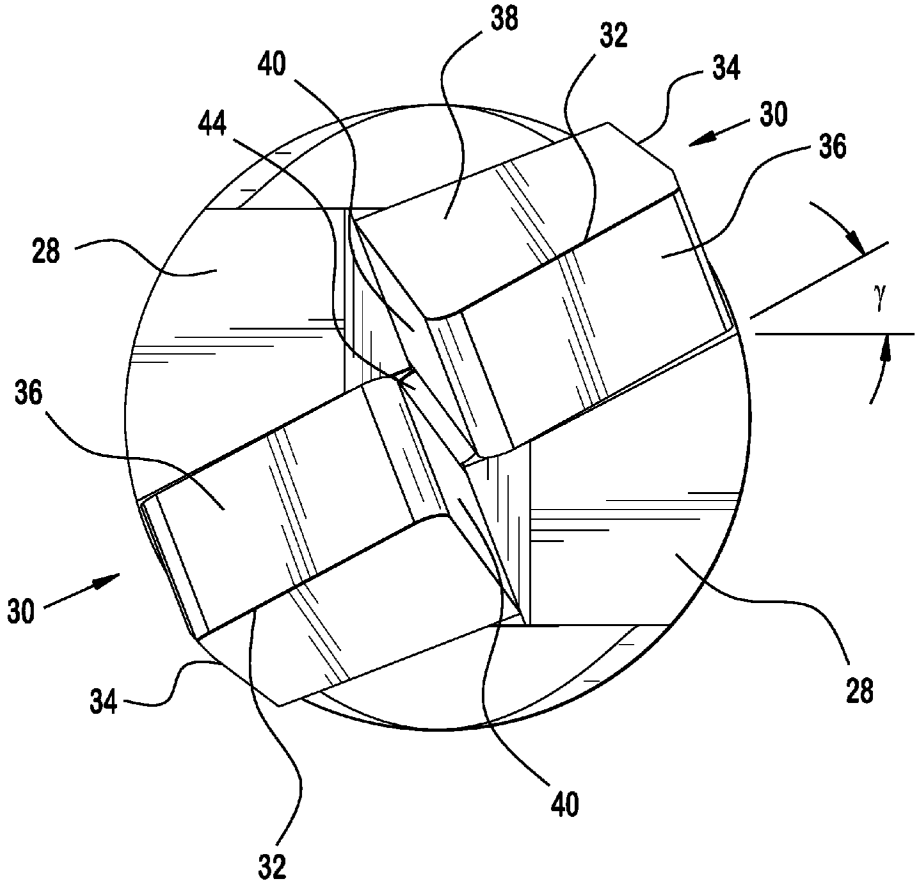


FIG. 4

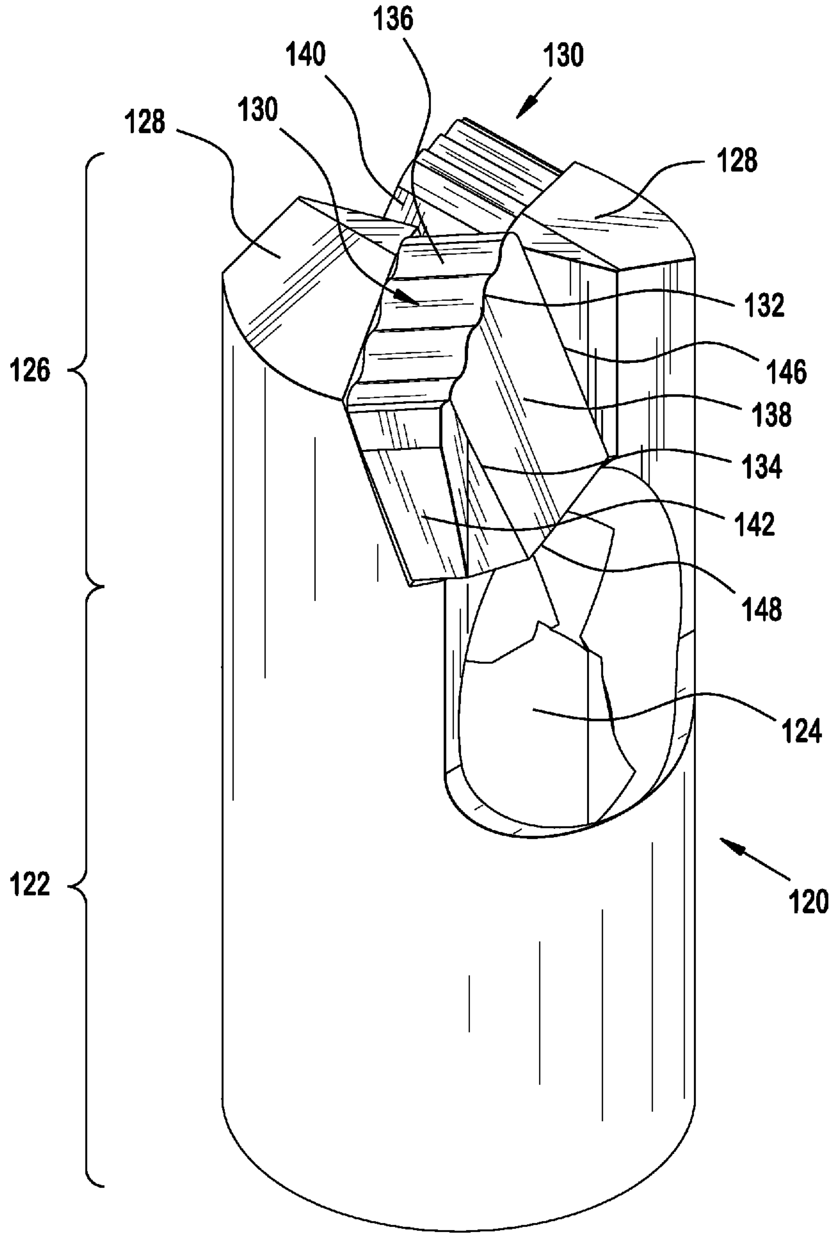


FIG. 5

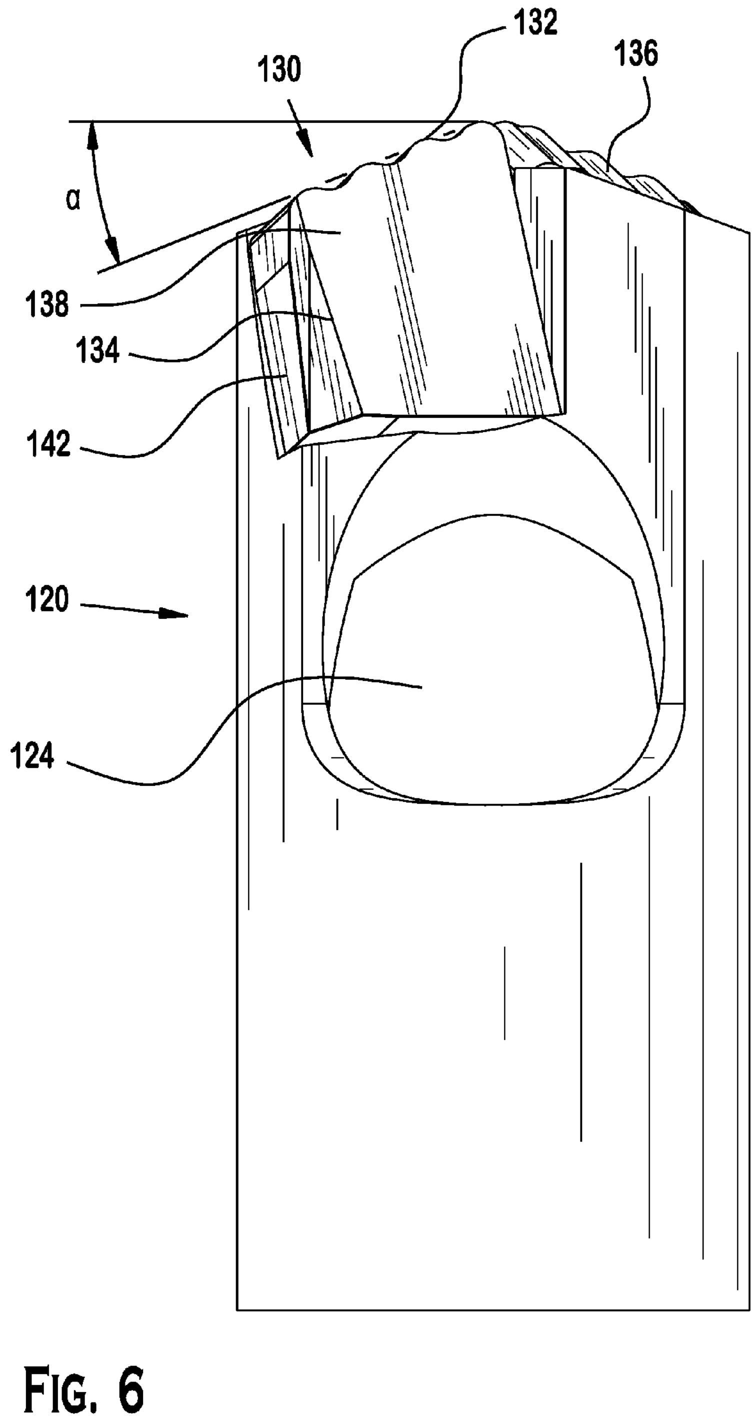


FIG. 6

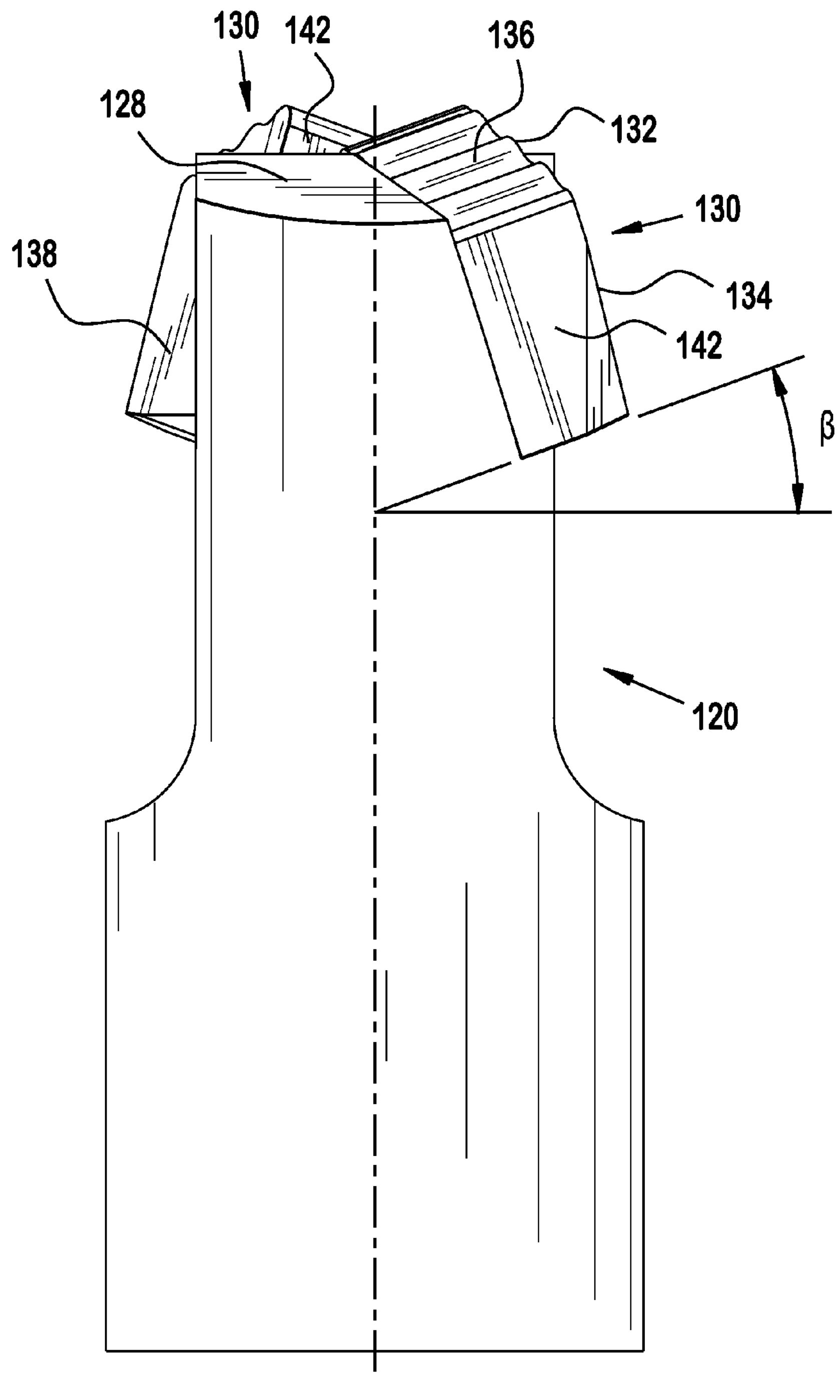


FIG. 7

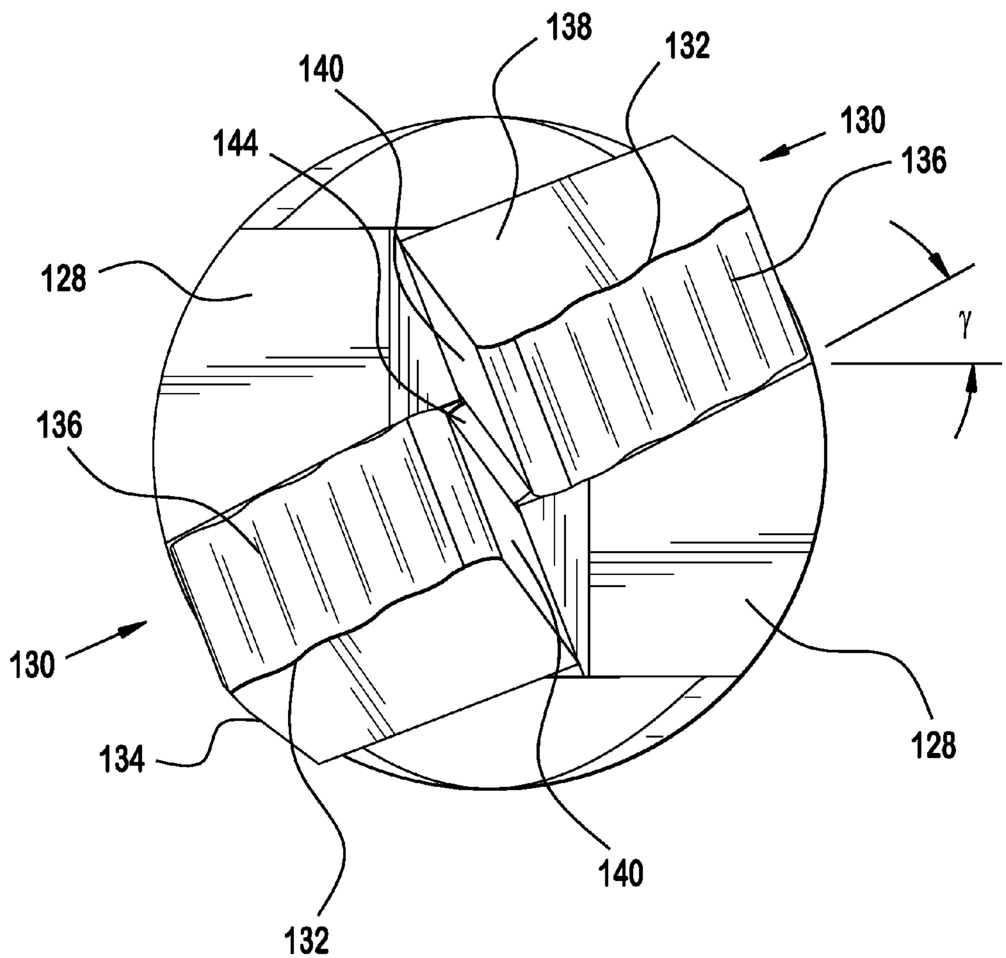


FIG. 8

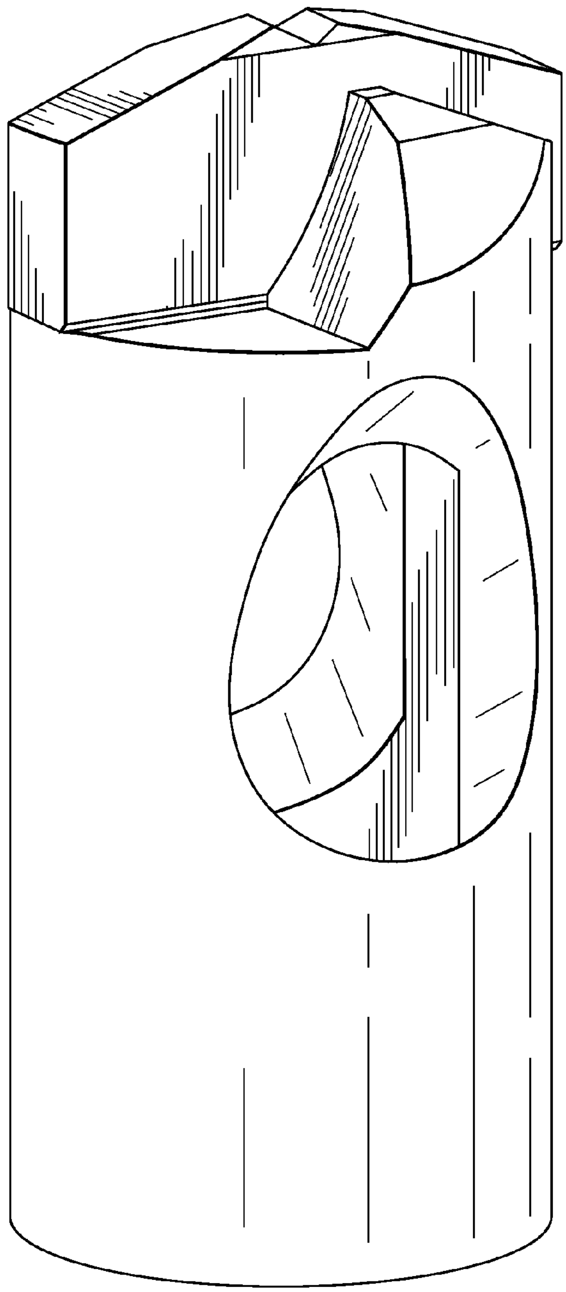


FIG. 9
(PRIOR ART)

DRILL BIT

FIELD

[0001] The present disclosure relates to a drill bit and a drilling device including the drill bit. The drill bit includes at least two insert pockets with cutting edges that extend from an inner position offset radially from the rotational axis of the bit to a linear outer cutting edge. More particularly, the disclosure relates to drill bits for boring and drilling in mining and construction.

BACKGROUND

[0002] In the discussion of the background that follows, reference is made to certain structures and/or methods. However, the following references should not be construed as an admission that these structures and/or methods constitute prior art. Applicant expressly reserves the right to demonstrate that such structures and/or methods do not qualify as prior art.

[0003] In the past, drill bits used in mining and construction have been constructed with sintered carbide inserts to prolong the operative life of the tool. In particular during mining operations, the roof of the mine must be supported. This has traditionally been accomplished by bolting support plates to the roof, the bolts being installed in pre-drilled holes in the mine roof. It has been conventional to drill the bolt-receiving holes by using a drill bit on which is mounted a cutting insert.

[0004] A principal problem encountered in these prior art tools has been the rapid wear and high cost of replacement along with machine down-time. It is believed that a primary and inherent contributing factor in tool wear and breakage has been the conventional design of such drill bits, including the blade geometry and the compositions used. To improve the tool wear and breakage properties of the tools, tougher compositions for the bit inserts have been used, such as superhard material.

[0005] Existing drill bits include either a non-coring substantially continuous curved cutting edge extending from its high entry point beyond the outer gauge-cutting margins or a coring-type rotary drill bit having non-linear type working surfaces.

[0006] FIG. **9** shows a non-coring drill bit with a continuous planar cutting edge extending from its high entry point in both directions to the outer margin. Cutting inserts may be positioned in insert pockets open to opposite sides of the drill bit.

[0007] Examples of drill bits are shown in U.S. Pat. Nos. 5,383,526, 5,535,839, and 5,375,672. None of these references contain enhanced blade geometry and use of superhard materials that can lead to improved wear resistance and longer tool life.

SUMMARY

[0008] To improve the wear resistance and tool life of the drill bits used in mining and construction, a new drill bit was designed having a new blade geometry. The new blade geometry enables the formation of drill bits having the benefit of a superhard material with a geometry that extends the life of the inserts and drill bit.

[0009] An exemplary drill bit includes a head portion and a connecting portion for attachment to a drilling device. The head portion includes at least two insert pockets each including an insert with cutting edges that extend from an inner position offset radially from the rotational axis of the bit to a linear outer cutting edge.

[0010] A further exemplary drill bit includes a head portion and a connecting portion for attachment to a drilling device. The head portion includes at least two insert pockets each including an insert with cutting edges that extend from an inner position offset radially from the rotational axis of the bit to a linear outer cutting edge. The inserts have a top surface that is non-planar extending along a linear path.

[0011] A yet further exemplary drill bit includes a head portion and a connecting portion for attachment to a drilling device. The head portion includes at least two insert pockets each including an insert with cutting edges that extend from an inner position offset radially from the rotational axis of the bit to a linear outer cutting edge. The inserts are raked back with a rake angle of about 10° to about 30°, skewed with a skew angle of about 1° to about 20°, and leaned with a lean angle of about 10° to about 30°

[0012] An exemplary drilling device includes a drill bit according to any of the embodiments described above.

[0013] It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] The following detailed description can be read in connection with the accompanying drawings in which like numerals designate like elements and in which:

[0015] FIG. **1** shows a perspective view of an exemplary embodiment of a drill bit containing two inserts offset radially from the rotational axis of the bit.

[0016] FIG. **2** shows a front view of the drill bit illustrated in FIG. **1**.

[0017] FIG. **3** shows a side view of the drill bit illustrated in FIG. **1**.

[0018] FIG. **4** shows a top view from the upper side of the drill bit illustrated in FIG. **1**.

[0019] FIG. **5** shows a perspective view of another exemplary embodiment of a drill bit containing two inserts offset radially from the rotational axis of the bit.

[0020] FIG. **6** shows a front view of the drill bit illustrated in FIG. **5**.

[0021] FIG. **7** shows a side view of the drill bit illustrated in FIG. **5**.

[0022] FIG. **8** shows a top view from the upper side of the drill bit illustrated in FIG. **5**.

[0023] FIG. **9** illustrates a prior art drill bit containing a continuous cutting edge extending from a leading cutting edge in both directions to the outer margins of the drill bit.

DETAILED DESCRIPTION

[0024] An exemplary embodiment of a drill bit containing two insert pockets offset radially from the rotational axis of the bit is shown in FIGS. **1-4**. The drill bit is designed to rotate about the rotational axis of the bit. The drill bit **20** includes a head portion **26** and a connecting portion **22** for attachment to a drilling device (not shown). The connecting portion **22** can include a bolt hole **24** or other connecting structure for attachment.

[0025] The head portion **26** contains at least two insert pockets **28**, which contain inserts **30**. In further embodiments, the head portion **26** may contain three, four or more insert pockets and respective inserts. The inserts are distributed evenly around an open core. For example, if the head portion contains two inserts, the inserts are approximately 180° apart. Similarly, for example, if three inserts, then they are each approximately 120° apart, and if four inserts, then they are each approximately 90° apart.

[0026] Each insert **30** includes at least a cutting edge **32**, outer cutting edge **34**, top surface **36**, wear surface **38**, inner surface **40**, and outer surface **42**. With particular reference to FIG. **4**, the inner surface **40** of each insert **30** faces the open core **44** located at the rotational axis of the drill bit **20**. The wear surface **38** and top surface **36** intersect to form the cutting edge **32**, and the wear surface **38** and outer surface **42** intersect to form the outer cutting edge **34**. The wear surface **38** serves as a chip face for the cutting edge **32**, because it faces the direction of the rotation of the drill bit.

[0027] In FIGS. **1-4**, the inserts **30** are set in insert pockets **28** to form the wear surface. The inserts **30** are polygonal in shape with linear, planar cutting edges **32**, **34** and angular corners. The inserts may be set in the insert pockets by chemical or mechanical attachment, including, for example, brazing, using a set screw or clamp, or adhesively bonding using a structural adhesive.

[0028] The inserts may be formed of a superhard material or of a cemented carbide base with a superhard material fused to the base as a working wear surface. The cemented carbide is preferably tungsten carbide. The superhard material may be diamond, cubic boron nitride, or any other material with similar hardness properties. Exemplary hardness properties for suitable superhard materials have a Knoop hardness number greater than 2000 HK. Specifically, the superhard material may be polycrystalline diamond.

[0029] In certain embodiments, the superhard material covers the top surface **36**, wear surface **38**, outer surface **42**, and/or inner surface **40**. During drilling operations, the top surface **36** of the insert **30** will be the leading entry surface in contact with the rock or other material to be drilled. Similarly, the outer surface **42** contacts the rock or other material to be drilled by being the outermost surface in contact with the radial extent of the drilled hole. The inner surface **40** will contact and help break up the core of rock or other material to be drilled formed by the gap in the rotational sweep of the top surface **36** of each insert formed by the inserts being offset from the rotational axis. Further, the wear surface **38** functions as the chip face. Therefore, any of the four surfaces may contain a superhard material to extend tool life. Further, in other embodiments, all surfaces of the inserts may be covered with superhard material, which can be beneficial in simplifying the manufacturing steps.

[0030] In other embodiments, other parts of the head portion **26** may also be formed of a similar substrate covered by a superhard material. In some embodiments, the insert pockets, especially top surfaces and/or outer surfaces of the insert pockets, may be covered by a superhard material to add strength and wear resistance to the wear surfaces for reasons similar to their use on corresponding surfaces of the inserts. Further, in other embodiments, the entire head portion may be covered by the superhard material.

[0031] FIGS. **5-8** illustrate another exemplary embodiment of a drill bit **120** similar to the drill bit illustrated in FIGS. **1-4**. The drill bit **120** includes a head portion **126** and a connecting portion **122** for attachment to a drilling device (not shown). The connecting portion **122** can include a bolt hole **124** or other connecting structure for attachment.

[0032] The head portion **126** contains at least two insert pockets **128**, which contain inserts **130**. The head portion **126** may also include additional insert pockets and inserts in similar manner as head portion **26** illustrated in FIGS. **1-4**.

[0033] Each insert **130** contains four linear edges with angular corners including cutting edge **132**, outer cutting edge **134**, top surface **136**, wear surface **138**, inner surface **140**, and outer surface **142**. The top **136**, wear **138**, inner **140**, and outer **142** surfaces each extend substantially along a linear path, but at least the top surface **136** is linear but non-planar. The non-planar surfaces may include a wavy, serrated, notched, or stepped surface. In the embodiment of FIGS. **5-8**, the top surface **136** includes a wavy surface. In a particular embodiment, the top surfaces include offset waves, where the waves of a top surface on one insert is 180° out of phase with the top surface of the other insert. Similar designs can be applied when more than two insert pockets are included in the head portion. For example, if there are three insert pockets, then the waves of the top surface of each insert and insert pocket is 120° out of phase with the other two insert pockets.

[0034] In further embodiments, other surfaces of the insert may be non-planar. For example, the inner surface of the insert may include a non-planar surface to help break out the core produced during the drilling operations. Similarly, the outer surface of the insert may include a non-planar surface to help score out the hole being drilled. The top, inner, and outer surfaces may include any alternative design including waves, serrations, notches or steps, where the design on each insert is arranged on the respective surface such that the designs are in-line or offset when rotating during drilling operations. Preferably, the designs are offset so as to evenly distribute the cutting forces across each of the inserts.

[0035] It was discovered that another factor leading to extended tool life, is how the at least two inserts are positioned in relation to the overall drill bit. The positioning of the inserts can be defined by the rake angle, skew angle, and lean angle. As illustrated in FIGS. **2** and **6**, respectively, the rake angle (α, α') is the angle to which the linear path of the top surface of the insert is raked back from being perpendicular to the axial direction of the drill bit. In certain embodiments, the rake angle is from about 10° to about 30°. In specific embodiments, the rake angle is from about 15° to about 25°. In more specific embodiments, the rake angle is about 20°.

[0036] As illustrated in FIGS. **4** and **8**, respectively, the skew angle (γ, γ') is the angle to which the back surface of the insert connected to the insert pocket is skewed from a radius of the drill bit. For example, in embodiments in which there are two inserts, the skew angle is the angle to which the two insert pockets are skewed from being parallel to each other. In other embodiments in which there are more than two insert pockets, the skew angle would include the angle to which the insert pockets are skewed from being parallel with radii evenly spaced around the drill bit. For example, in embodiments in which there are three insert pockets, the skew angle would include the angle to which each insert pocket is skewed from its complementary radius, wherein each complementary radius is 120° apart. The skew angle may be positive or negative. A positive skew is in the direction opposite the rotation of the drill bit. A negative skew is in the direction of the rotation of the drill bit. At least when the skew angle has a small absolute value, a positive skew brings the cutting edge and wear face closer to the rotational axis of the drill bit, and a negative skew takes the cutting edge and wear face further from the rotational axis of the drill bit. In certain embodiments, the skew angle is from about −20° to about +20°. In specific embodiments, the skew angle is positive. In more specific embodiments, the skew angle is from about +1° to about +20°. In yet more specific embodiments, the skew angle is from about +5° to about +15°. In further specific embodiments, the skew angle is from about +5° to about +10°.

[0037] As illustrated in FIGS. **3** and **7**, the lean angle (β, β') is the angle to which the wear surface is leaned back from parallel to the axial direction. In certain embodiments, the lean angle is from about 10° to about 30°. In specific embodiments, the lean angle is from about 15° to about 25°. In more specific embodiments, the lean angle is from about 18 to about 22°. In yet a more specific embodiment, the lean angle is about 20°.

[0038] Because the insert pockets are offset with certain rake, skew, and lean angles, the inserts are positioned a certain distance from each other. This distance between the inserts adjacent the top surfaces can be from about 25% to about 75% of the total diameter of the drill bit. In certain embodiments, the distance is from about 25% to about 60%. In further embodiments, the distance is from about 25% to about 40%. In yet further embodiments, the distance is from about 30% to about 35%.

[0039] The distance between the inserts often times can be shorter when measured at the portion of the head portion closest to the connecting portion of the drill bit. The distance between the inserts at the portion of the head portion closest to the connection portion can be from about 2% to about 30%. In certain embodiments, the distance is from about 5% to about 20%. In further embodiments, the distance is from about 10% to about 15%. In yet further embodiments, the distance is from about 5% to about 10%.

[0040] Although described in connection with preferred embodiments thereof, it will be appreciated by those skilled in the art that additions, deletions, modifications, and substitutions not specifically described may be made without departure from the spirit and scope of the invention as defined in the appended claims.

What is claimed is:

1. A drill bit comprising a head portion and a connecting portion for attachment to a drilling device, the head portion comprises at least two insert pockets each including an insert with cutting edges that extend from an inner position offset radially from the rotational axis of the bit to a linear outer cutting edge, wherein the inserts are skewed in relation to radii of the drill bit.

2. The drill bit according to claim **1**, wherein the inserts are raked back with a rake angle of about 10° to about 30°.

3. The drill bit according to claim **1**, wherein the inserts are skewed with a skew angle of about −20° to about +20°.

4. The drill bit according to claim **3**, wherein the inserts are skewed with a positive skew angle.

5. The drill bit according to claim **1**, wherein the inserts are skewed with a skew angle of about 1° to about 20°.

6. The drill bit according to claim **1**, wherein the inserts are leaned with a lean angle of about 10° to about 30°.

7. The drill bit according to claim **1**, wherein the inserts are leaned with a lean angle of about 10° to about 30° and are skewed with a skew angle of about 1° to about 20°.

8. The drill bit according to claim **1**, wherein the inserts are skewed with a skew angle of about 1° to about 20° and raked back with a rake angle of about 10° to about 30°.

9. The drill bit according to claim **1**, wherein the inserts are formed of a substrate that is at least partially covered by a superhard material.

10. The drill bit according to claim **9**, wherein the substrate is comprised of cemented carbide.

11. The drill bit according to claim **9**, wherein the superhard material is selected from the group consisting of diamond and cubic boron nitride.

12. The drill bit according to claim **1**, wherein the top surface of the inserts have a non-planar surface.

13. The drill bit according to claim **12**, wherein the non-planar surface includes a wavy surface extending along a linear path.

14. The drill bit according to claim **13**, wherein crests of the wavy surface of one insert are radially offset from the crests of the wavy surfaces of other inserts.

15. The drill bit according to claim **13**, wherein the wavy surface of one insert is 180° out of phase with another insert.

16. A drill bit comprising a head portion and a connecting portion for attachment to a drilling device, the head portion comprises at least two insert pockets each including an insert with cutting edges that extend from an inner position offset radially from the rotational axis of the bit to a linear outer cutting edge, wherein the inserts are skewed in relation to radii of the drill bit, and wherein the inserts have a top surface that is non-planar extending along a linear path.

17. The drill bit according to claim **16**, wherein the top surface includes a wavy surface that extends along a linear path.

18. The drill bit according to claim **16**, wherein crests of the waves on the top surfaces of the inserts are radially offset from the waves on the top surface of any other insert in the drill bit.

19. A drill bit comprising a head portion and a connecting portion for attachment to a drilling device, the head portion comprises at least two insert pockets each including an insert with cutting edges that extend from an inner position offset radially from the rotational axis of the bit to a linear outer cutting edge, wherein the inserts are raked back with a rake angle of about 10° to about 30°, skewed with a skew angle of about 1° to about 20°, and leaned with a lean angle of about 10° to about 30°.

20. The drill bit according to claim **19**, wherein a distance between the cutting edges of the inserts formed by being offset radially from the rotational axis of the bit is from about 25% to about 75% of a total diameter of the drill bit.

* * * * *