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(54) **REAMER WITH BALANCED CUTTING STRUCTURES FOR USE IN A WELLBORE**

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(57) **ABSTRACT**

An earth boring drill bit comprising cones, each cone having rows of inserts, where the inserts are in the form of a pyramid with four sides. The insert includes ridges at the juncture of each adjacent side. The ridges extend to the top of the insert and meet at a crest. Oppositely disposed ridges on the insert lie substantially in the same plane, thereby forming two planes intersecting on the crest. The two planes are substantially perpendicular. The inserts are arranged on the cone such that one plane is substantially parallel with the insert row, and the other is substantially parallel with the cone axis.

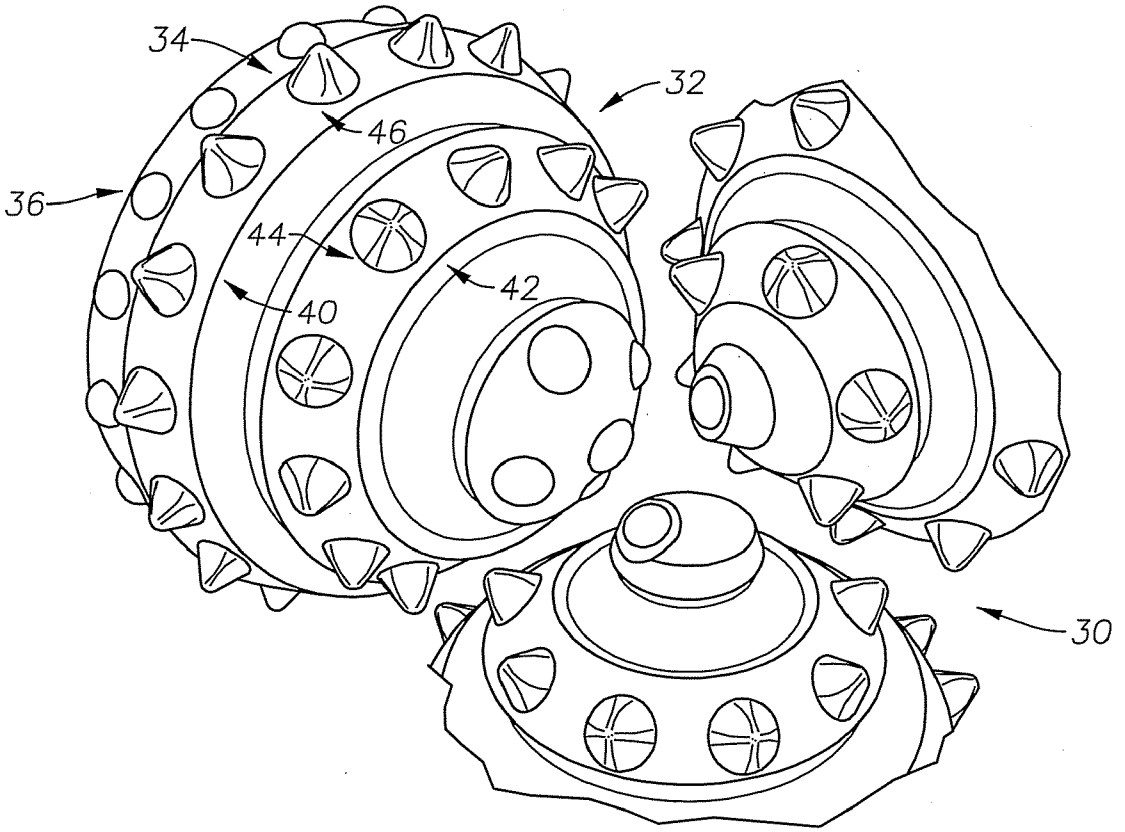
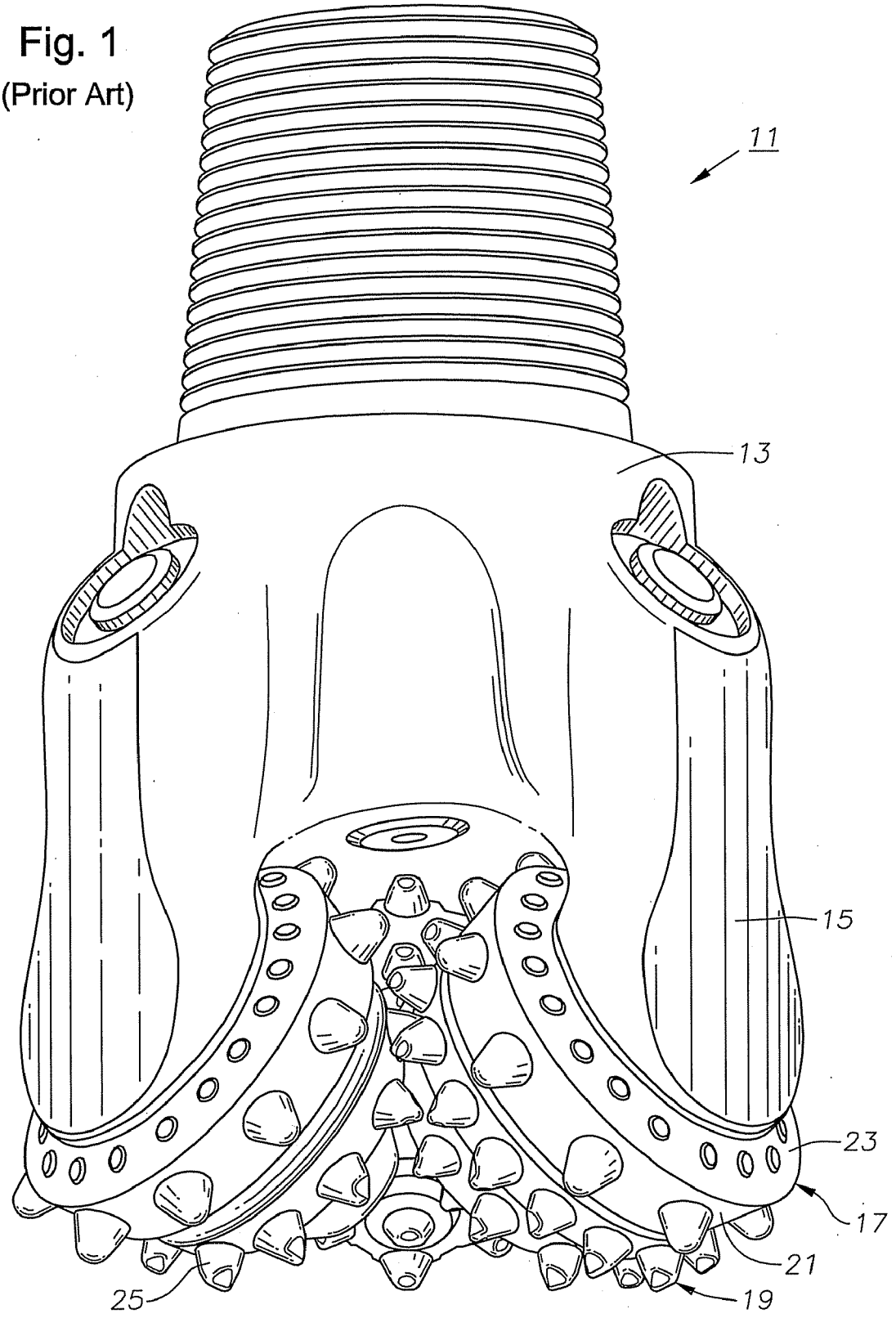


Fig. 1
(Prior Art)



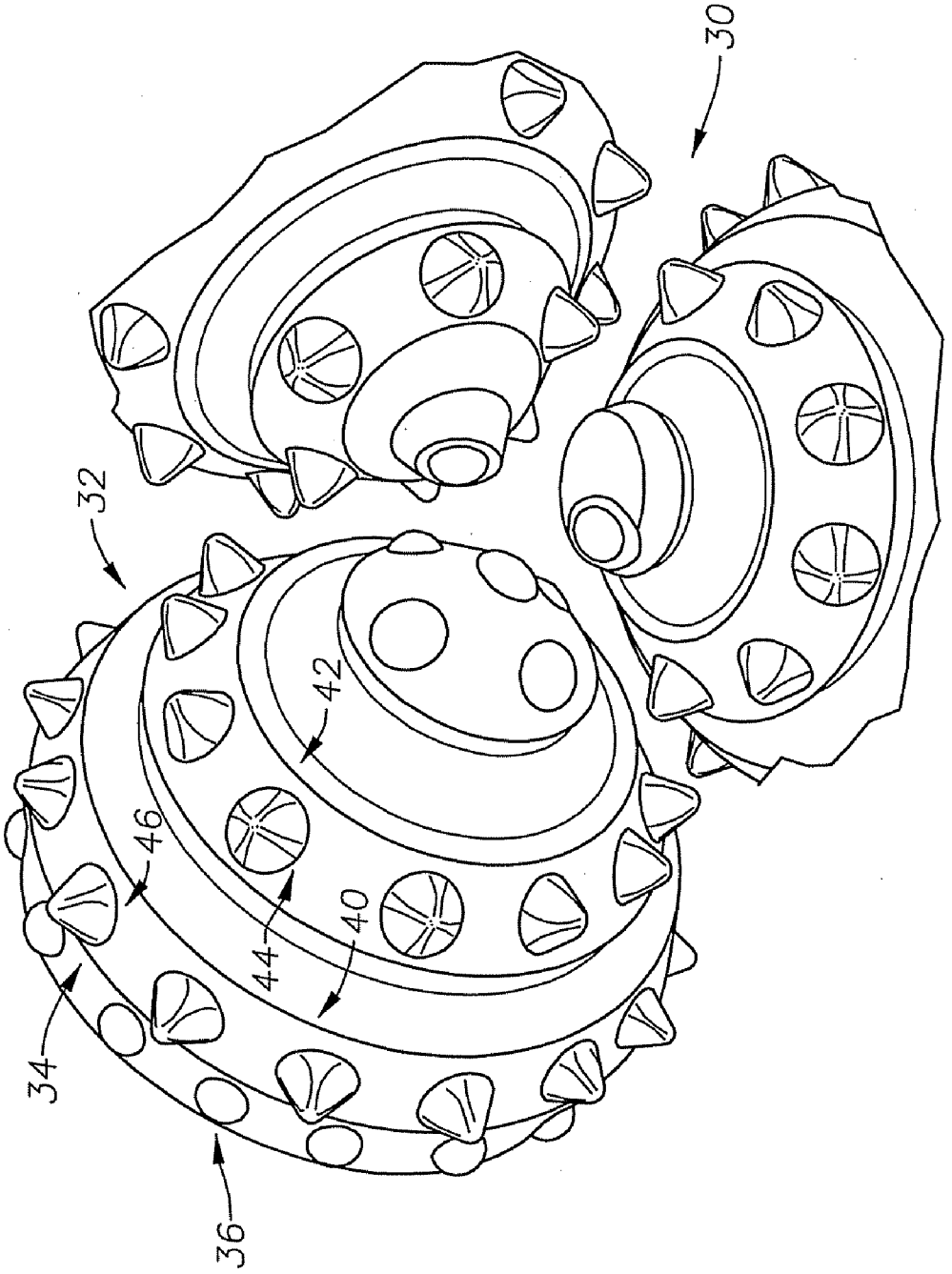


Fig. 2

Fig. 3

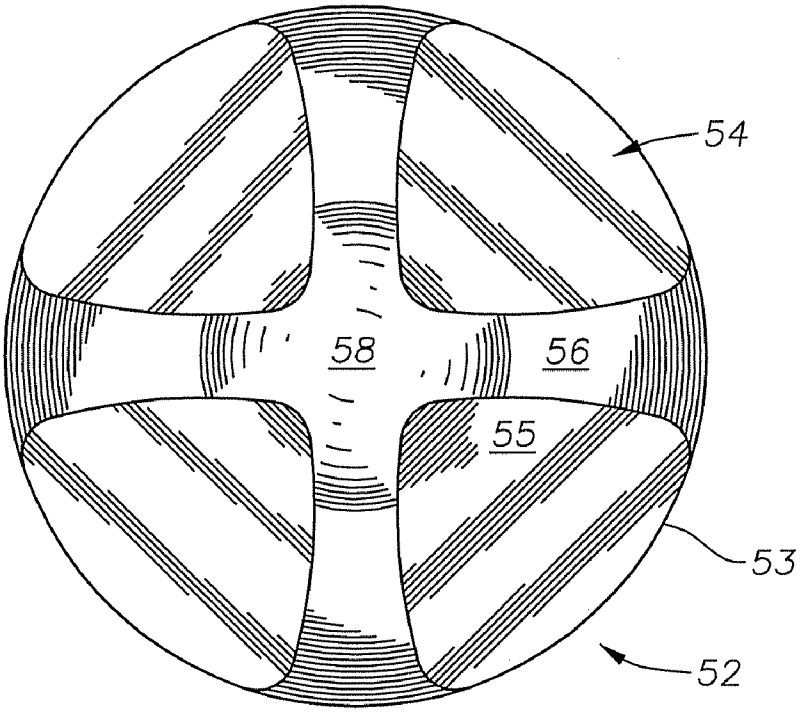


Fig. 4

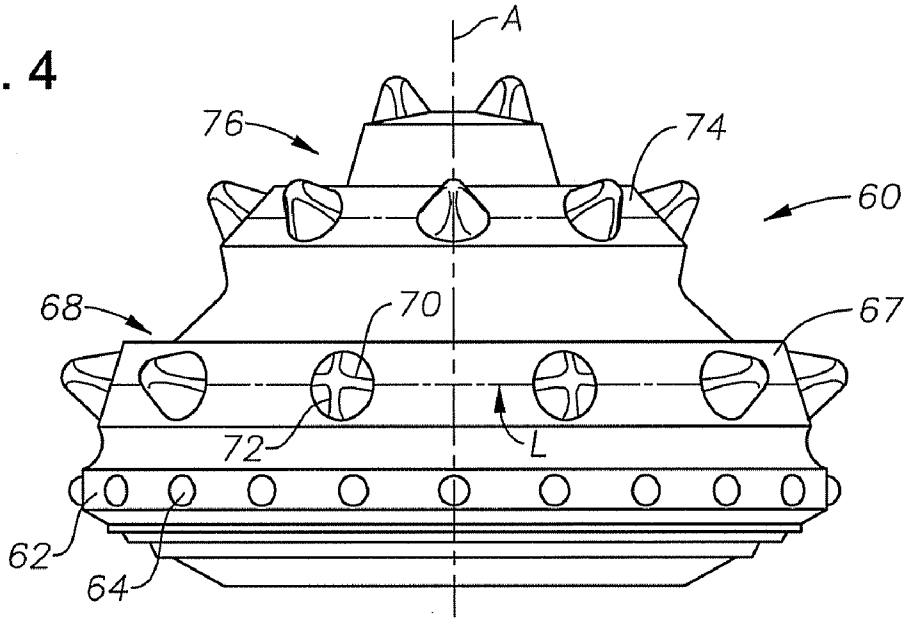
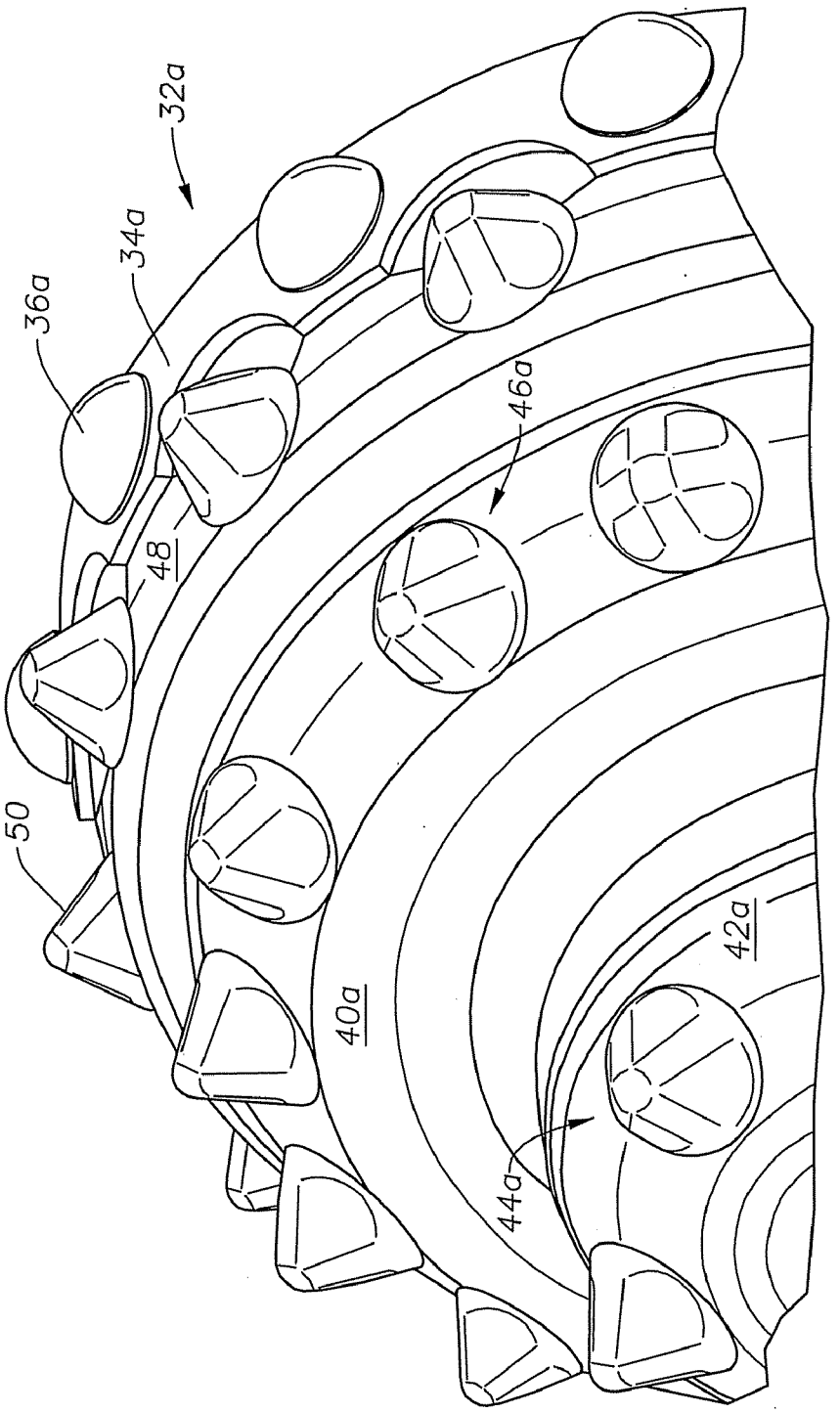


Fig. 5



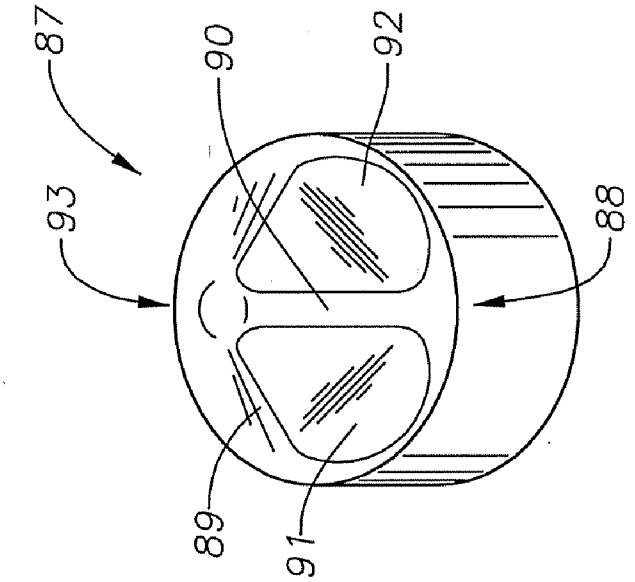


Fig. 8

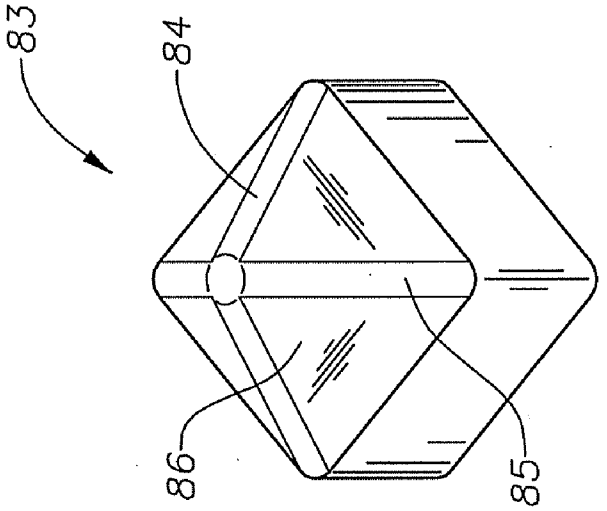


Fig. 7

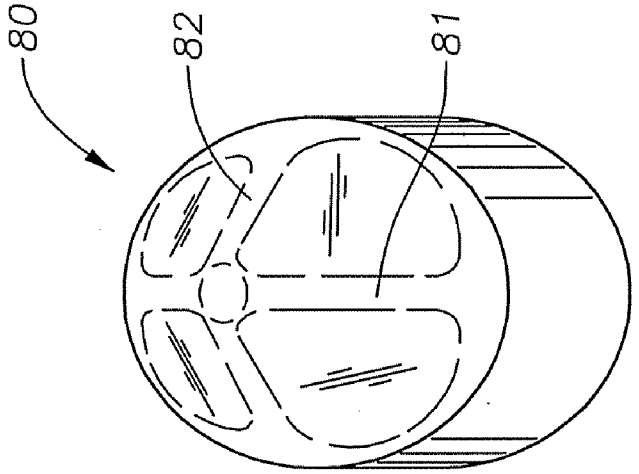


Fig. 6

REAMER WITH BALANCED CUTTING STRUCTURES FOR USE IN A WELLBORE

RELATED APPLICATIONS

[0001] This application claims priority to and the benefit of co-pending U.S. Provisional Application Ser. No. 61/016,243, filed Dec. 21, 2007, the full disclosure of which is hereby incorporated by reference herein.

BACKGROUND

[0002] 1. Field of Invention

[0003] The disclosure herein relates in general to rolling cone earth boring bits, and in particular to the shape and orientation of compacts used on the cones.

[0004] 2. Description of Prior Art

[0005] Drilling systems having earth boring drill bits are used in the oil and gas industry for creating wells drilled into hydrocarbon bearing substrata. Drilling systems typically comprise a drilling rig (not shown) used in conjunction with a rotating drill string wherein the drill bit is disposed on the terminal end of the drill string and used for boring through the subterranean formation.

[0006] Drill bits typically are chosen from one of two types, either drag bits or roller cone bits. Rotating the bit body with the cutting elements on the outer surface of the roller cone body crushes the rock and the cuttings may be washed away with drilling fluid. A rolling cone earth boring bit has a bit body with typically three legs. A bearing pin depends from each leg and a cone mounts rotatably to each bearing pin. The cones have rows of cutting teeth on the outer surface of the cone. In one type, the cutting elements comprise teeth machined into the surface of the cone. In another type, the cutting elements comprise carbide compacts or inserts that are pressed-fitted into mating holes in the cone surface.

[0007] Compacts generally have a cylindrical base that is inserted into a hole and a protruding cutting tip. The cutting tips may have chisel, hemispherical, ovoid or other shapes. Particularly on the heel row, which is located near the gage surface of each cone, the compacts may have asymmetrical shoulder surfaces for engaging the sidewall of the bore hole. Depending upon the formation being drilled, different shapes are utilized for aggressiveness of cutting and durability.

[0008] One example of a roller cone bit is provided in side view in FIG. **1**, which illustrates a bit **11** having a body **13** with a leg **15**. Roller cone bits typically comprise three legs **15**. A cone **17** rotatably mounts to a bearing pin (not shown) of each leg **15**. Each cone **17** has a plurality of inserts **19**, arranged in at least one inner row. A plurality of outer or heel row compacts **21** are adjacent to a gage surface **23** of each cone **17**. In the embodiment shown, heel row compacts **21** are generally ovoid, although different shapes could be used.

SUMMARY OF INVENTION

[0009] Disclosed herein is an earth boring drill bit having a roller cone with cutting inserts on the outer surface of the roller cone. The inserts comprise a generally circular base and a peal. The sides of the inserts comprise four faces that extend from the base to the peak. Each face has a generally triangular configuration wherein a portion of its surface is generally planar. The region where adjacent sides join is rounded thereby defining ridges. The four substantially similar sides form four ridges that meet at the crest. A first set of two ridges form on opposite sides of the base with respect to one another and are substantially parallel. A second set of two ridges also form on opposite sides with respect to one another and are also parallel. The inserts are oriented on the cone in rows so that the first set of ridges is aligned with the cone axis and the second set of ridges is aligned with the row.

BRIEF DESCRIPTION OF DRAWINGS

[0010] Some of the features and benefits of the present invention having been stated, others will become apparent as the description proceeds when taken in conjunction with the accompanying drawings, in which:

[0011] FIG. **1** is a side perspective view of a roller cone bit.

[0012] FIG. **2** provides a bottom view of a roller cone bit having shaped inserts.

[0013] FIG. **3** is an overhead view of an insert for a roller cone bit.

[0014] FIG. **4** shows a side view of a roller cone bit having an embodiment of inserts of the present disclosure.

[0015] FIG. **5** illustrates in a perspective view a roller cone bit having embodiment of an insert of the present disclosure.

[0016] FIGS. **6-8** depict examples of insert embodiments.

[0017] While the invention will be described in connection with the preferred embodiments, it will be understood that it is not intended to limit the invention to that embodiment. On the contrary, it is intended to cover all alternatives, modifications, and equivalents, as may be included within the spirit and scope of the invention as defined by the appended claims.

DETAILED DESCRIPTION OF INVENTION

[0018] The present invention will now be described more fully hereinafter with reference to the accompanying drawings in which embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the illustrated embodiments set forth herein; rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. Like numbers refer to like elements throughout.

[0019] A bottom view of an embodiment of an earth boring bit **30** is provided in FIG. **2**. The bit **30** comprises three cutter cones **32** wherein each cone includes rows of inserts formed thereon. The outermost or heel row is formed on the heel surface **34** and includes heel row teeth **36**. As shown, the heel row teeth **36** have a generally hemispherical configuration. Inner rows **40**, **42** are formed on each cone between the heel row and the nose of each cone **32**. The inner row **40** includes inserts **46** disposed on its outer surface. The inner row **42** proximate to the nose of the cone **32** also includes inserts **44**. In the embodiment shown, the inserts **44**, **46** resemble a four sided pyramid.

[0020] FIG. **3** provides an overhead view of an example of a pyramid shaped insert **52**. As shown, the insert **52** has a generally circular base **53** with its sides **54** extending upward towards a crest **58**. Each side **54** may have substantially the same dimension. The surface **55** of each side **54** can be generally planar, include contours, or have both planar and contoured portions. The respective surfaces **55** of adjacent sides are depicted as being angled roughly 90° to one another. The sides **54** join each adjacent side along a rounded ridge **56**, the ridge **56** extends from the base **53** and terminates at the crest **58**. Here, the circular base **53** is shown with each side **54** (also referred to herein as a face) extending upward in a generally

triangular fashion and terminating at the crest **58**. The insert surface **55** is curved where the adjacent sides **54** meet thereby giving the ridge **56** a curved cross section. Other embodiments exist wherein the ridge **56** cross section is defined by the sides **54** intersecting at an angle.

[0021] FIG. **4**, which illustrates a portion of a cone **60** in side view, provides some examples of the orientation of the inserts on the face of the cone. The cone **60** also comprises a lower row **67** with inserts **68**. The lower row **67** of inserts **68** circumscribes the axis A of the cone **60** and is disposed proximate to the heel row **62**. With reference now to the inserts **68** in the lower row **67**, each insert **68** has a first set of ridges running parallel to the row **67**. The ridges in this first set are referred to as the linear ridge **70**. A reference line L has been provided illustrating the row path. Similarly, a second set of ridges on the insert **68** extend substantially parallel with the axis A of the cone **60** and roughly perpendicular to the reference line L. This second set of ridges is referred to here as the axial ridge **72**. The axis A is provided in dashed outline for reference. Also in the embodiment of FIG. **4**, the inserts **76** disposed on an upper row **74** also include a first and second set of ridges, wherein one set of ridges runs generally parallel with the line defining the path of the upper row **74**, and the other set of ridges on the insert **76** runs generally parallel with the axis of the cone **60**. In an embodiment of a roller cone bit described herein, the inserts on a cone of a roller cone bit comprise four sided pyramid shaped inserts with one set of ridges running generally parallel to its respective row and the other set of ridges running generally parallel with the axis of the cone. For the purposes of discussion herein, generally parallel includes an alignment of up to about 15° from parallel. Additionally, the line defining the path of the upper row **74** coincides with the rotational path of the associated roller cone.

[0022] Aligning the ridges as described herein opens the insert face towards grooves or open space on the cone surface. As the insert penetrates the displaced material, the material is mechanically pushed into the open space and not trapped between adjacent inserts. The material trapped between conventional inserts, such as axially aligned chisels, may cause balling in shale thereby impeding its penetration rate. The axially and circumferentially aligned pyramid inserts also have a more streamlined shape allowing them to better withstand the sliding induced by cone offset and non-true-rolling cone geometry. Additionally, durability is enhanced with the disclosed cutting structure. Optionally, this advantageous result of the pyramid shape may be enhanced by strategically placed grooving between inserts to further enhance material flow. Moreover, inserts disposed proximate to the heel area may comprise a three sided pyramid due to the difficulty of displacement of material toward the gage of the bit.

[0023] A schematic drawing of a side view of an embodiment of a cone cutter **32***a* is provided in FIG. **5**. The cutter cone **32***a* includes an outer heel surface **34***a* on which are formed heel row teeth **36***a*. As shown, the heel row teeth **36***a* are generally hemispherical in shape, but can have other shapes as well. Also included is an adjacent heel row **48** having a pyramid shaped insert **50**. The insert **50** also includes an upward and downward ridge substantially aligned with the adjacent heel row **48** and a corresponding perpendicular ridge substantially parallel to the axis of the cutter cone **32***a*. Inner rows **40***a*, **42***a* are shown coaxially disposed between the adjacent heel row **48** and the nose of the cone **32***a*. Corresponding inserts **44***a*, **46***a* are provided on these inner rows. As shown, the inserts **44***a*, **46***a* also have ridges that are aligned with their corresponding row as well as aligned with the axis of the cone **32***a*.

[0024] Alternative insert embodiments are provided in FIGS. **6** through **8**. In FIG. **6**, an insert **80** is shown in perspective view having a first ridge **81** formed on the insert **80** upper surface. A second ridge **82**, also on the insert **80** upper surface, intersects the first ridge **81** proximate the crest or uppermost portion of the insert **80**. In this embodiment the insert **80** is asymmetric, thus the first and second ridges have different lengths.

[0025] In FIG. **7**, an insert **83** shown in perspective view includes first and second ridges **84**, **85** on its upper surface. Faces **86** are on the upper surface disposed between adjacent ridges **84**, **85** extending between the insert **83** base and its upper crest. The adjacent faces **86** join at an angle to define a ridges **84**, **85** having a cross section with an angled edge. Although shown as a rectangular base, circular and rounded base configurations exist.

[0026] The insert **87** in FIG. **8** includes a leading side **88** and a trailing side **93**. In this embodiment the leading side **88** is oriented to first contact the excavated material. The insert **87** includes a first ridge **89** aligned generally perpendicular to the cone direction of rotation. The first ridge **89** extends over a substantial portion of the insert **87** outer surface. Also included is a second ridge **90** that is generally aligned with or parallel to the cone rotational direction. The second ridge **90** is shown extending from the insert **87** base, along the leading side **88**, and terminating at the first ridge **89**. Faces **91**, **92** are on the leading side **88** between the first ridge **89** and second ridge **90**. The faces **91**, **92** may be planar or have a curved surface. However, the second ridge **90** should protrude outward from the leading side **88** so as to first penetrate formation. The sloping surfaces of the faces **91**, **92** direct the displaced material outward and away from the next following insert. In the embodiment of FIG. **8**, the trailing side **93** is shown having a consistent surface absent ridges or other contours. Accordingly, the present disclosure includes inserts whose a shaped surface is only on the leading side that performs a majority of the cutting or excavating action.

[0027] It is to be understood that the invention is not limited to the exact details of construction, operation, exact materials, or embodiments shown and described, as modifications and equivalents will be apparent to one skilled in the art. For example, the scope of this disclosure includes roller cone bits having different numbers of roller cones as well as inserts comprising pyramids having other than four sides. Additionally, the ridges' intersection is not limited to the embodiments disclosed, but can include intersections on the insert having a large range of radii, including an intersection forming a point on the insert crest. In the drawings and specification, there have been disclosed illustrative embodiments of the invention and, although specific terms are employed, they are used in a generic and descriptive sense only and not for the purpose of limitation. Accordingly, the invention is therefore to be limited only by the scope of the appended claims.

What is claimed is:

1. An earth boring bit comprising:

a bit body:

a cutter cone rotatingly mounted on the bit body;

a row of inserts arranged on the cutter cone along a ringlike path;

a first ridge on the upper surface of each insert and oriented generally parallel with the cone axis; and

a second ridge on the upper surface of each insert oriented generally parallel with the path and intersecting the first ridge.

2. The earth boring bit of claim **1**, further comprising a crest on upper surface of each insert defined where the first and second ridges intersect on the insert and a base on the end of the insert that attaches to the cutter cone, wherein the ridges extend from the crest to the base.

3. The earth boring bit of claim **2** wherein the crest is proximate the midpoints of the first and second ridges.

4. The earth boring bit of claim **2**, wherein planar faces are formed on each insert surface in the area between where the first and second ridges extend from the crest to the base.

5. The earth boring bit of claim **4** wherein the ridge is defined by the border of adjacent faces.

6. The earth boring bit of claim **5**, wherein the ridge is an angle defined by the intersection of adjacent faces.

7. The earth boring bit of claim **5**, wherein the ridge is a curved section defined by the intersection of adjacent faces.

8. The earth boring bit of claim **1**, wherein the first and second ridges have a substantially equal length.

9. The earth boring bit of claim **1**, wherein the first and second ridges have an unequal length.

10. An earth boring bit comprising:

a bit body;

roller cones rotatingly attached to the bit body; and

a row of inserts arranged in a substantially circular path on each roller cone outer surface;

each insert having;

a base on the end where it attaches to the roller cone cutter,

a first ridge on its upper surface extending along a line generally parallel with the cone axis,

a second ridge on its upper surface extending along a line generally parallel with the circular path and intersecting the first ridge, and

faces on the upper surface provided between the first and second ridges extending from where the first and second ridges intersect to the base, the faces joining at an angle, so that material displaced during boring operations is directed by the angled faces to open spaces on the bit and not trapped between inserts.

11. The earth boring bit of claim **10**, wherein the first and second ridges intersect proximate to their respective midpoints.

12. The earth boring bit of claim **10**, wherein the first and second ridges have substantially the same length.

13. The earth boring bit of claim **10**, wherein the first and second ridges are unequal in length.

14. The earth boring bit of claim **10**, wherein at least one of the ridges on an insert has a cross section that includes an edge and the other ridge on the insert has a rounded cross section.

15. An earth boring bit comprising:

a bit body;

a roller cone rotatingly attached to the bit body;

inserts on the roller cone having a leading surface and a trailing surface, the inserts oriented so that during boring operations the leading surfaces are in cutting contact with the material being displaced; and

ridges projecting outward from each leading surface to define faces on the sides of the ridges that lie in a plane oblique to the roller cone axes, so that material displaced during boring operations is urged away from the space between adjacent inserts.

* * * * *