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(54) **HYBRID BIT WITH BLADES AND DISCS**

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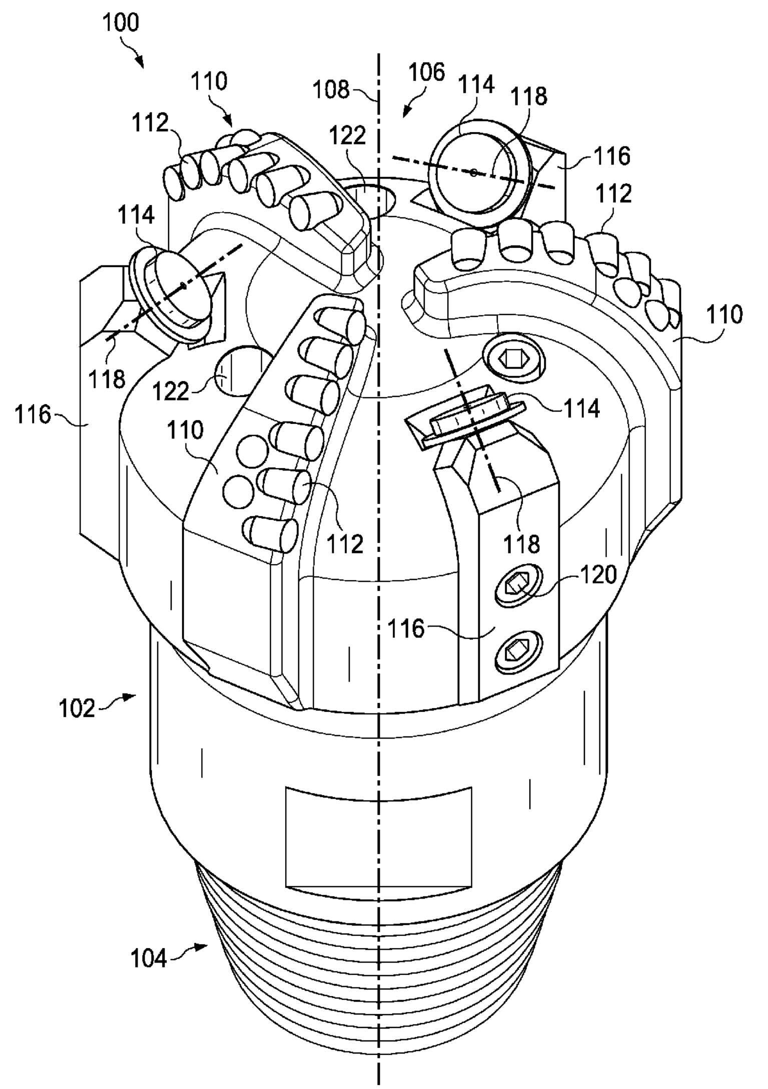
(57) **ABSTRACT**

A hybrid drill bit includes a bit body having a central bit body axis at a center of the bit body, a blade on the bit body extending from an end of the bit body, and a roller disc rotatably coupled to the bit body about the end of the bit body to rotate on a roller disc axis. The roller disc axis extends toward the central bit body axis, and the blade includes a plurality of fixed cutting elements.



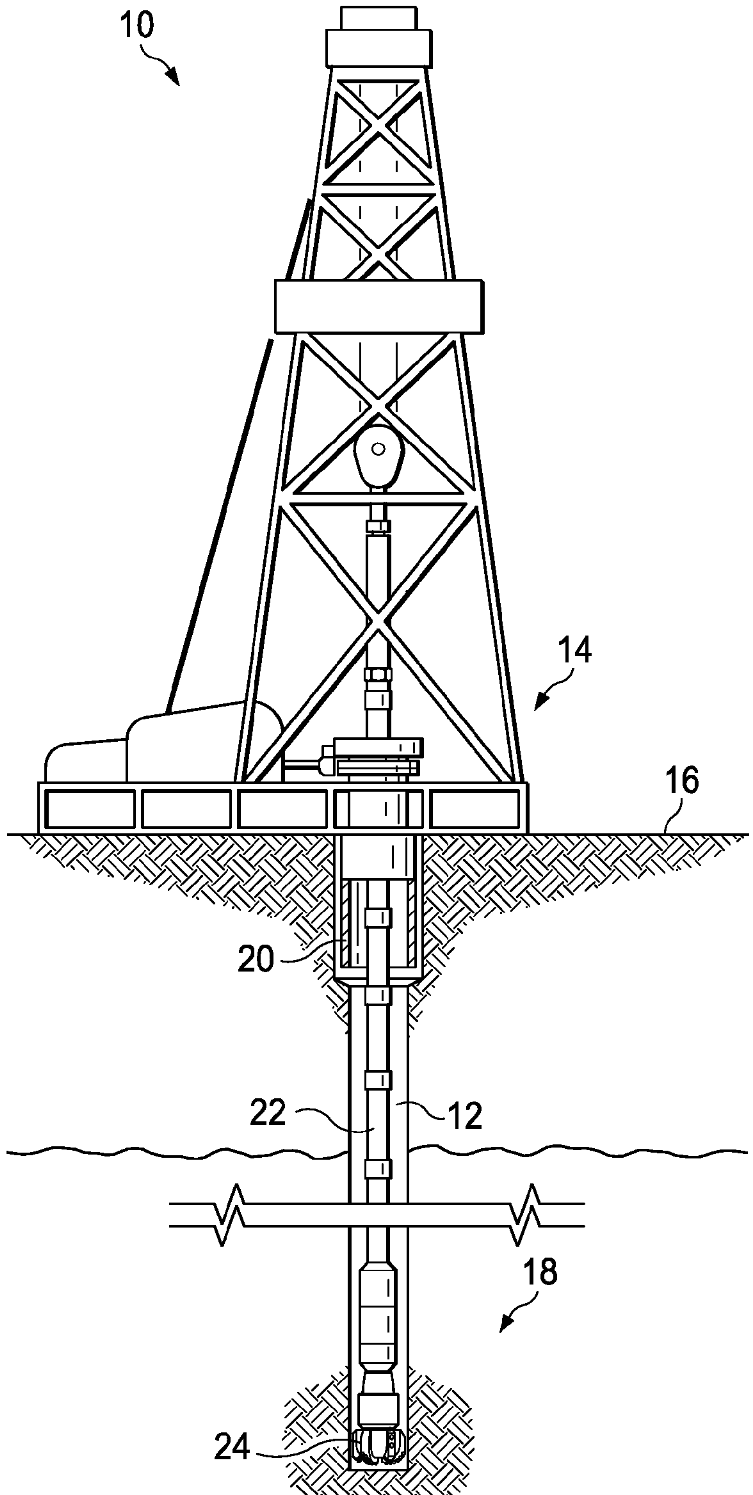


FIG. 1

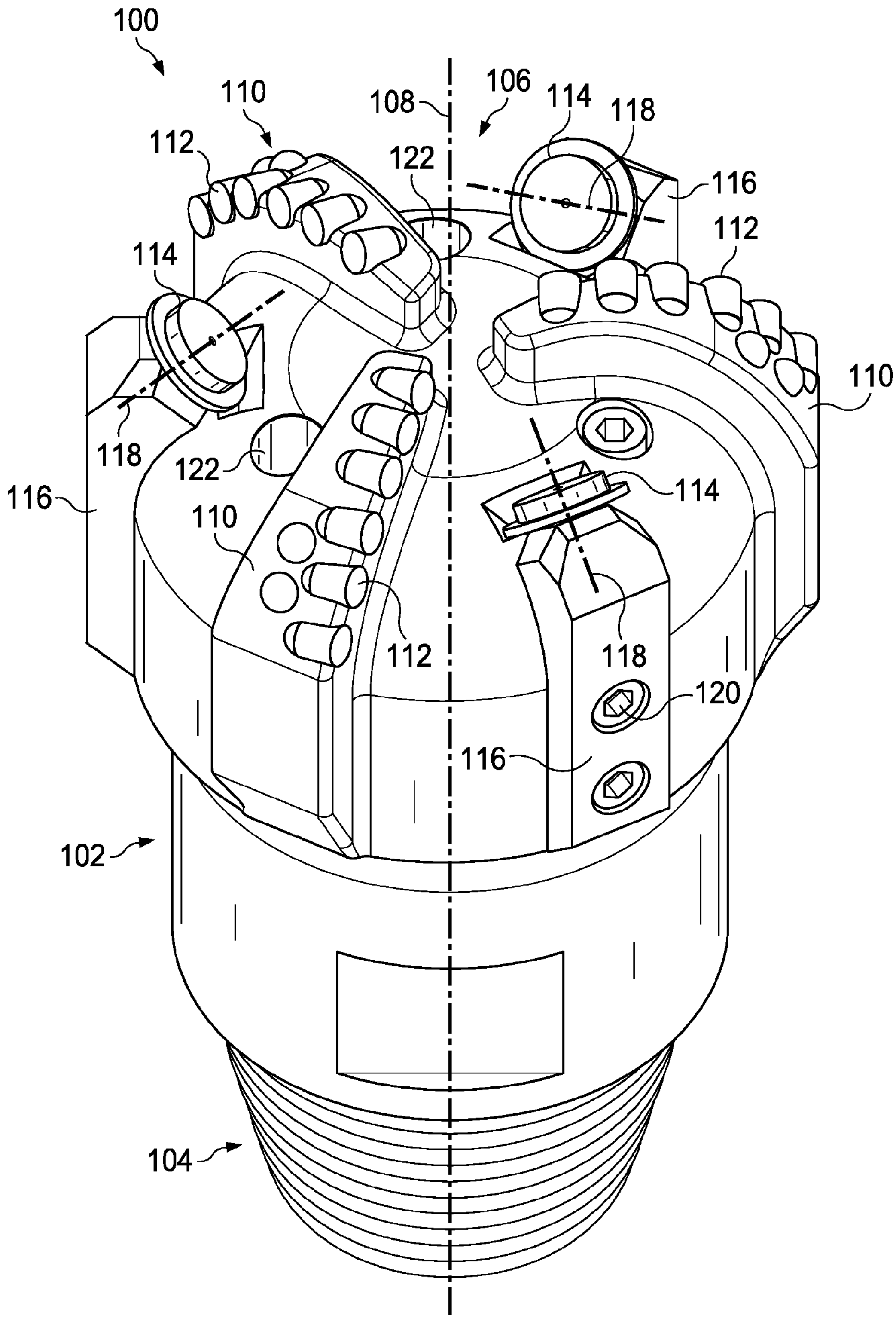

100
110
112
108
106
114
118
116
122
112
114
110
118
122
116
110
114
112
118
120
116
102
104

FIG. 2

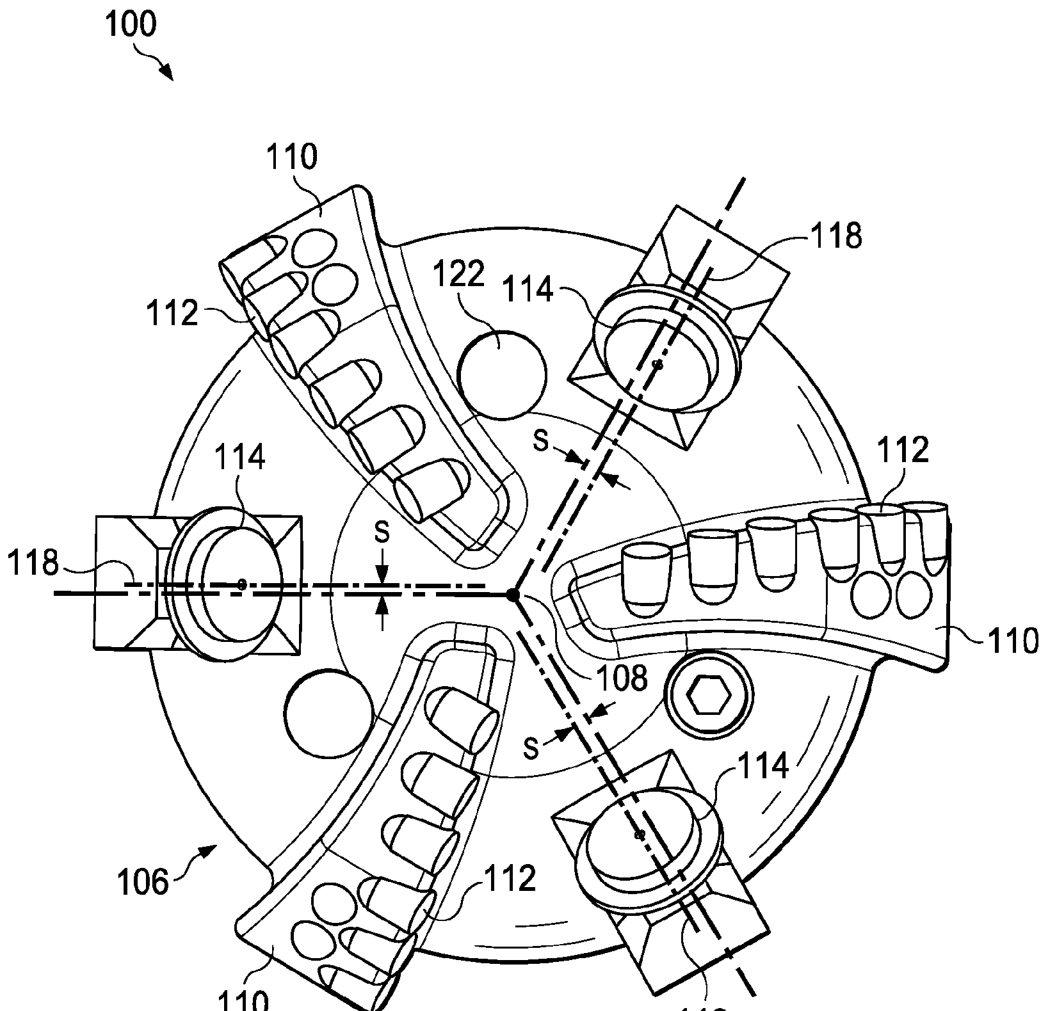

100
110
112
122
114
118
S
S
114
112
118
S
110
108
114
106
112
110
118

FIG. 3A

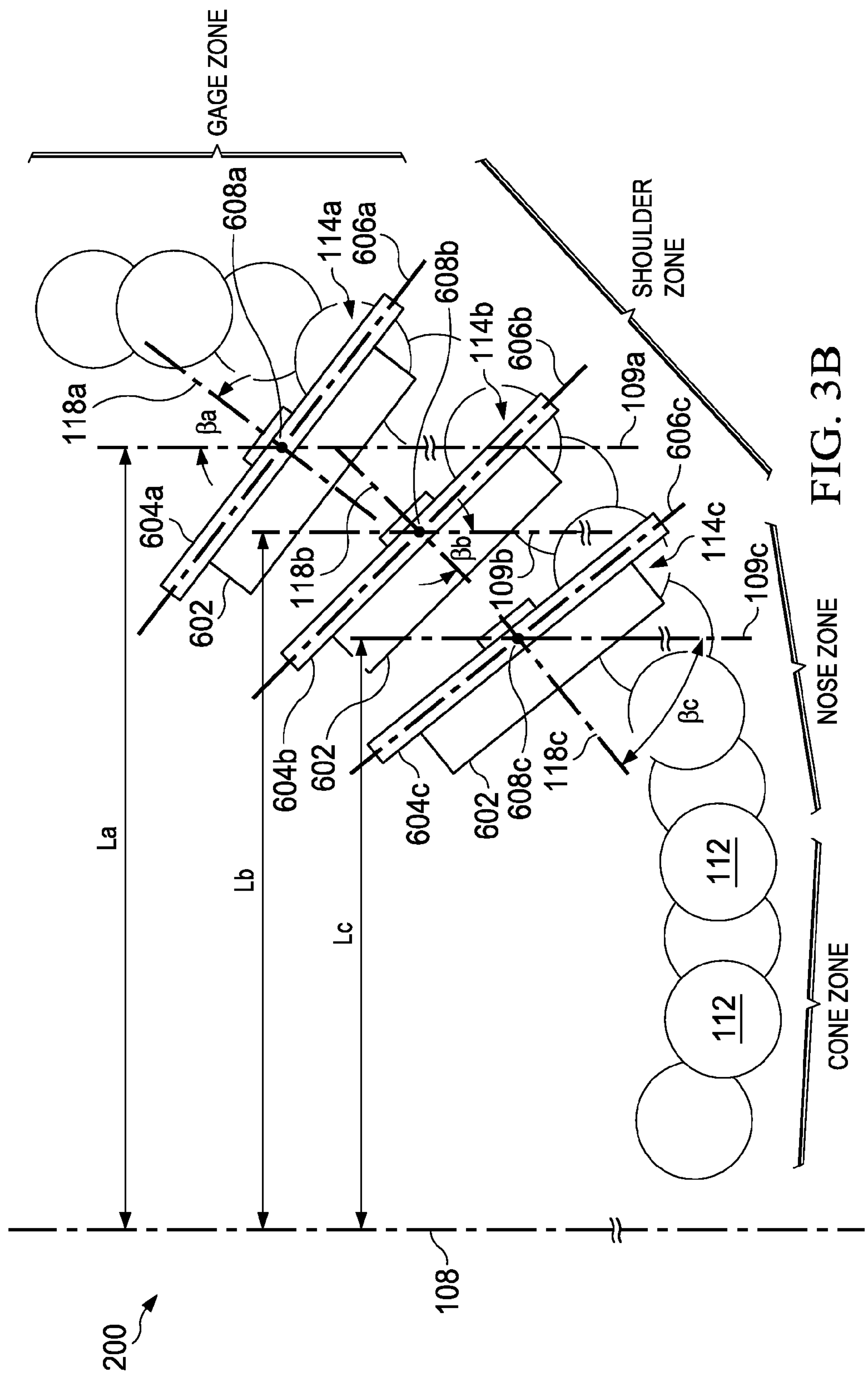

GAGE ZONE
SHOULDER ZONE
NOSE ZONE
CONE ZONE
608a
114a
606a
608b
114b
606b
109a
118a
βa
604a
602
118b
βb
606c
114c
109b
109c
604b
602
604c
602
608c
118c
βc
112
112
La
Lb
Lc
108
200

FIG. 3B

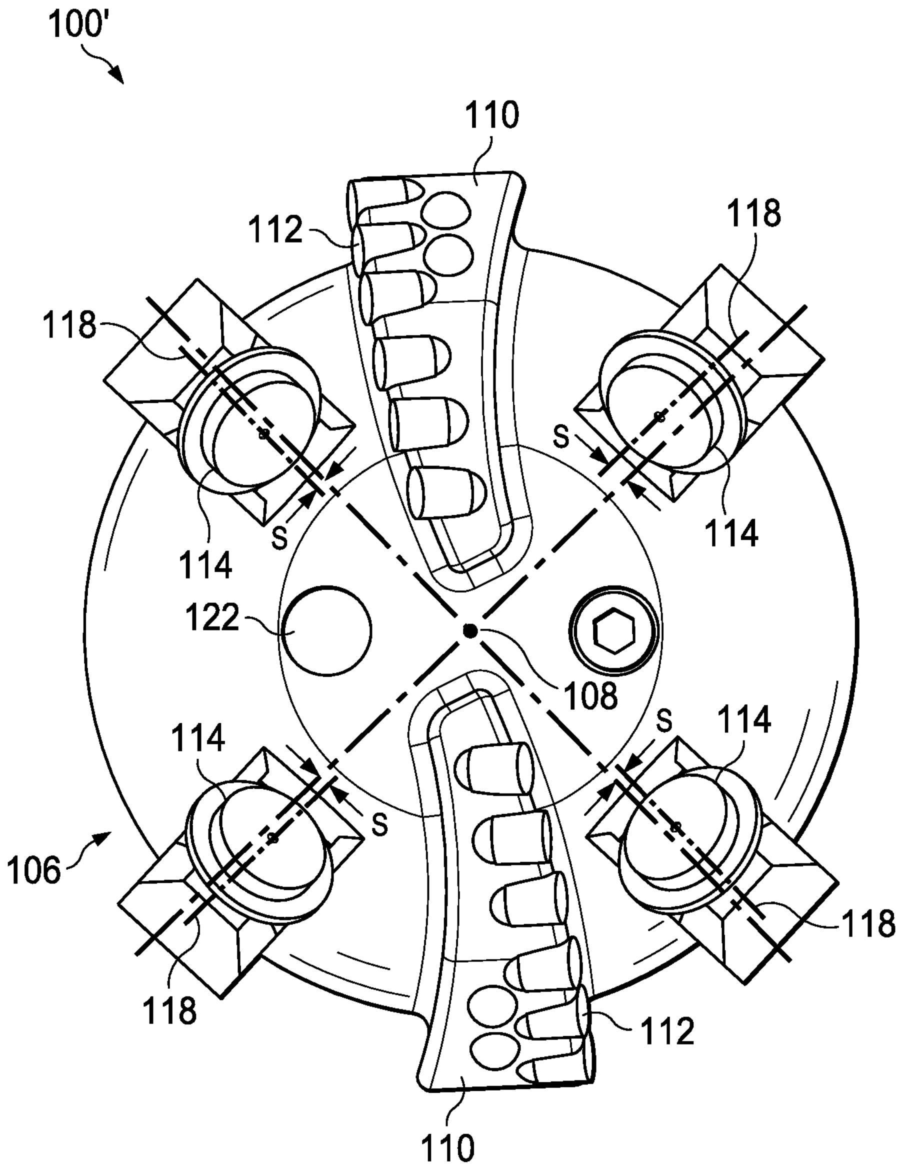

100'
110
112
118
118
S
S
114
114
122
108
S
114
114
S
106
118
118
112
110

FIG. 4A

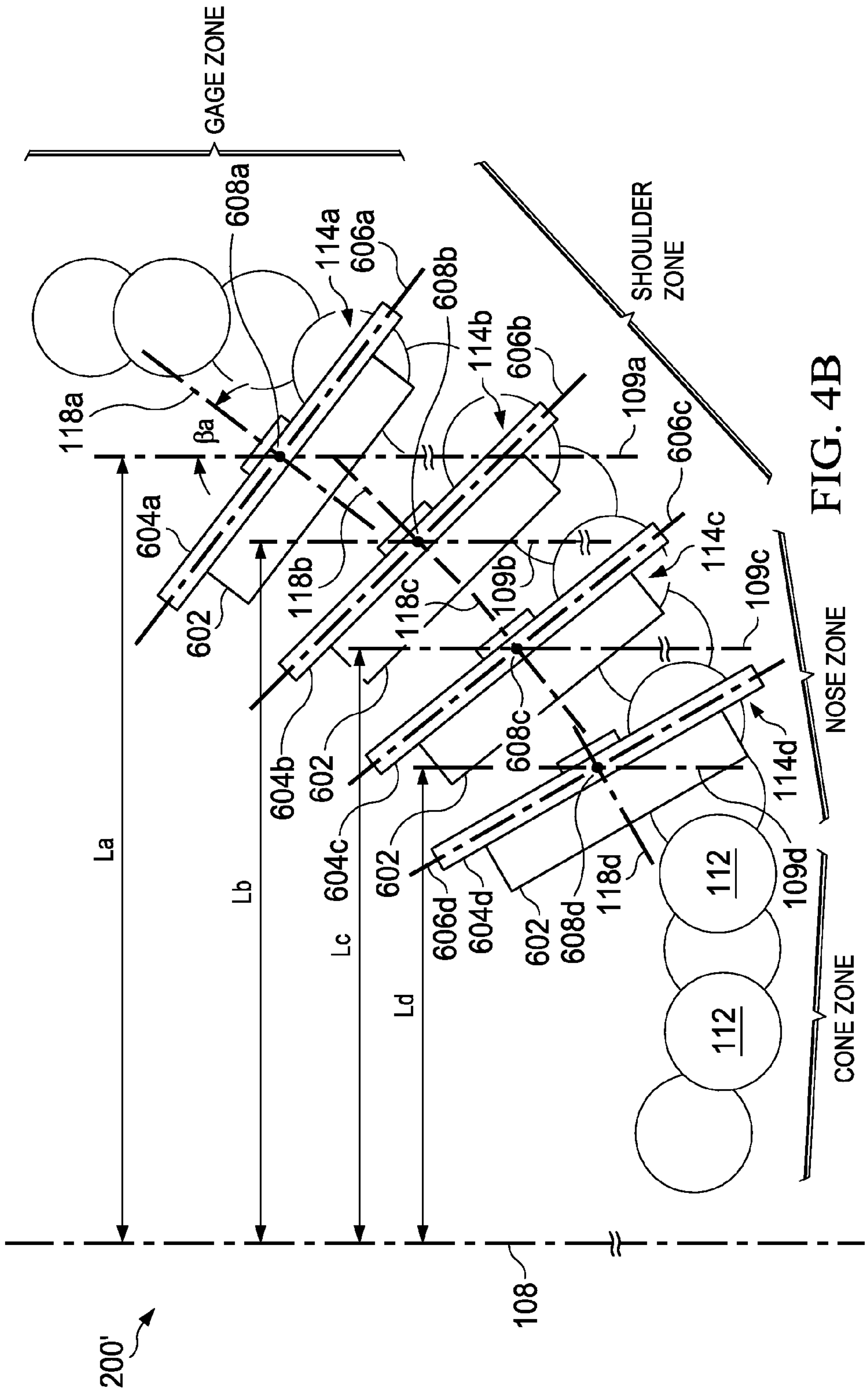

GAGE ZONE
SHOULDER ZONE
NOSE ZONE
CONE ZONE
608a
114a
606a
608b
114b
606b
109a
118a
βa
606c
604a
118b
118c
109b
114c
109c
602
604b
608c
114d
602
604c
602
606d
604d
602
608d
118d
112
112
109d
La
Lb
Lc
Ld
108
200'

FIG. 4B

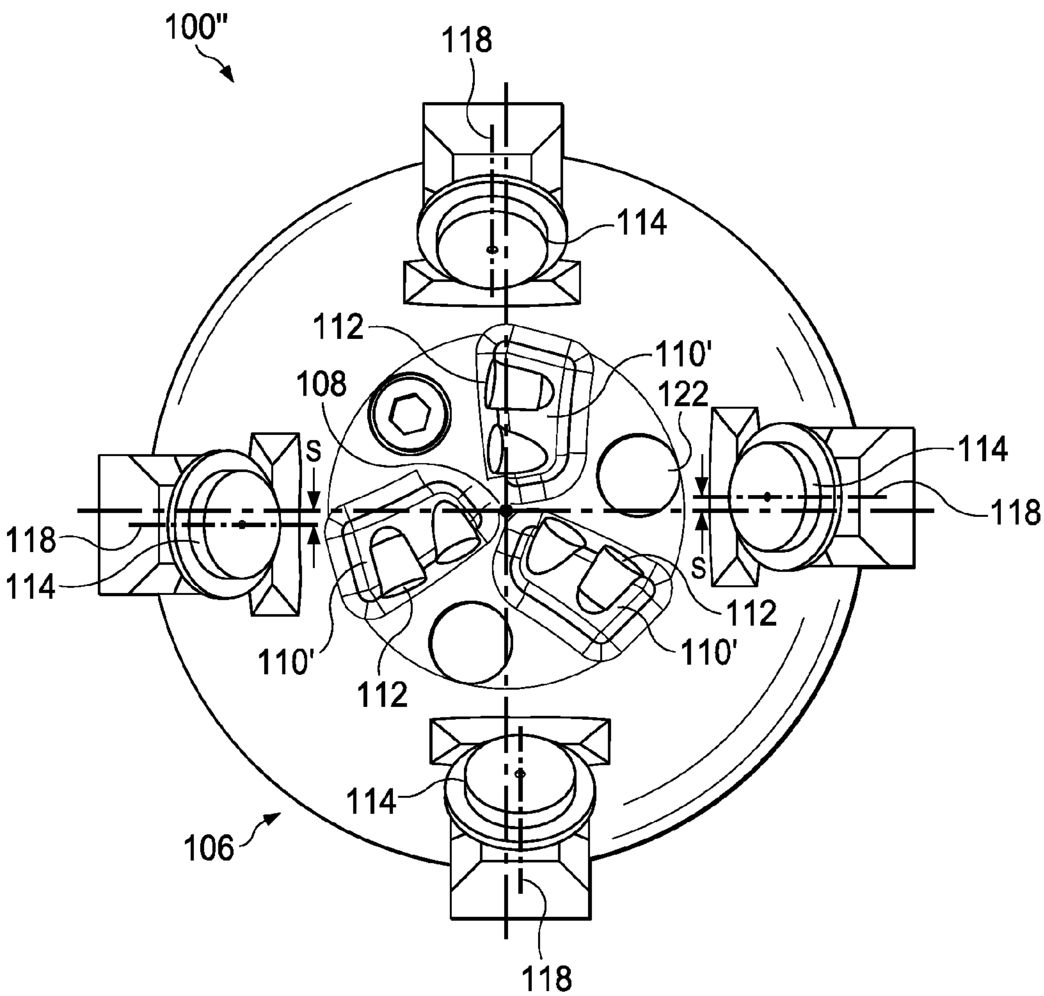

100"
118
114
112
110'
108
122
114
118
S
118
114
S
112
110'
110'
112
114
106
118

FIG. 5A

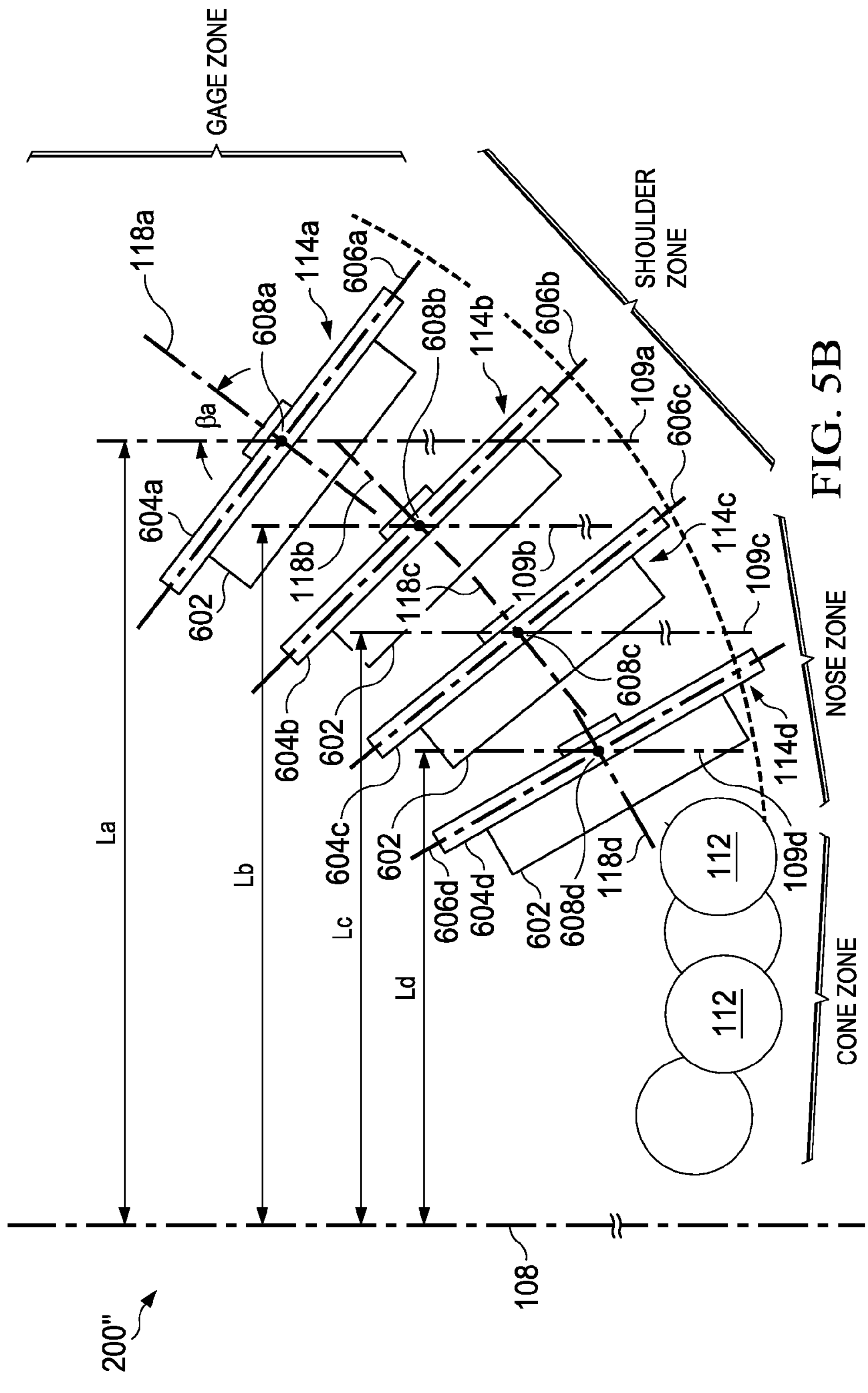
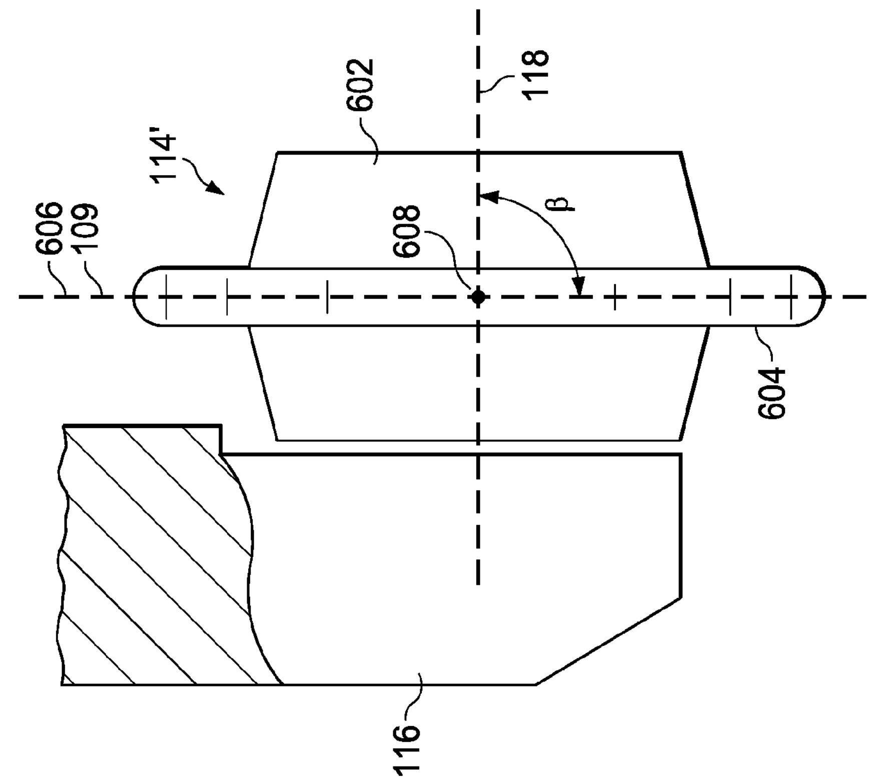
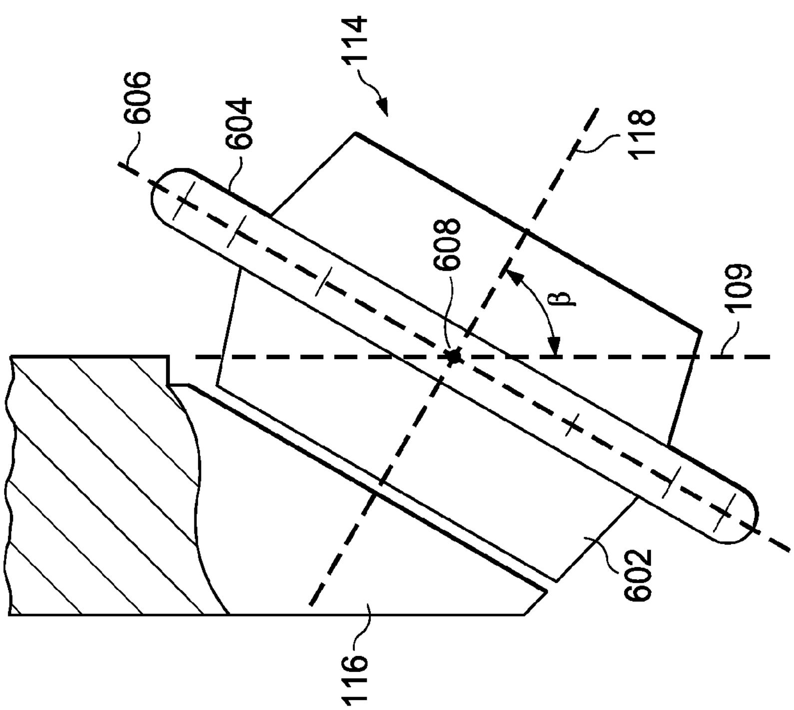

GAGE ZONE
SHOULDER ZONE
NOSE ZONE
CONE ZONE
118a
114a
606a
608a
608b
114b
606b
109a
606c
114c
109c
βa
604a
602
118b
118c
109b
608c
604b
602
604c
602
114d
109d
118d
608d
602
604d
606d
112
112
La
Lb
Lc
Ld
108
200"

FIG. 5B



114'
602
118
606
109
608
β
604
116

FIG. 7



114
606
604
118
608
109
β
602
116

FIG. 6

HYBRID BIT WITH BLADES AND DISCS

BACKGROUND

[0001] The present disclosure relates to hybrid drill bits for drilling a wellbore in a formation, and more particularly to hybrid drill bits with blades and roller discs.

[0002] Hybrid drill bits can be used to drill a wellbore in a formation through rotation of the hybrid drill bits about a longitudinal axis. A drill bit generally includes cutting elements and cutting structures at a drill end of the drill bit. A hybrid drill bit generally includes more than one type of cutting structure or cutting element at a drill end of the hybrid drill bit. Cutting elements and cutting structures typically form a wellbore in a subterranean formation by shearing, crushing, cracking, or a combination of shearing, crushing, and cracking portions of the formation during rotation of the drill bit.

DESCRIPTION OF DRAWINGS

[0003] FIG. **1** is a schematic partially cross-sectional view of an example well system.

[0004] FIG. **2** is a schematic perspective view of an example hybrid drill bit.

[0005] FIG. **3**A is a schematic end view of an example hybrid drill bit.

[0006] FIG. **3**B is a schematic side view of an example hybrid drill bit profile.

[0007] FIG. **4**A is a schematic end view of an example hybrid drill bit.

[0008] FIG. **4**B is a schematic side view of an example hybrid drill bit profile.

[0009] FIG. **5**A is a schematic end view of an example hybrid drill bit.

[0010] FIG. **5**B is a schematic side view of an example hybrid drill bit profile.

[0011] FIG. **6** is a schematic partially cross-sectional side view of an example roller disc.

[0012] FIG. **7** is a schematic partially cross-sectional side view of an example roller disc.

[0013] Like reference symbols in the various drawings indicate like elements.

DETAILED DESCRIPTION

[0014] Referring first to FIG. **1**, a well system **10** generally includes a substantially cylindrical wellbore **12** that extends from a wellhead **14** at the surface **16** downward into the Earth into one or more subterranean zones of interest **18** (one shown). The subterranean zone **18** can correspond to a single formation, a portion of a formation, or more than one formation accessed by the well system **10**, and a given well system **10** can access one, or more than one, subterranean zone **18**. A portion of the wellbore **12** extending from the wellhead **14** to the subterranean zone **18** is lined with lengths of tubing, called casing **20**. The depicted well system **10** is a vertical well, with the wellbore **12** extending substantially vertically from the surface **16** to the subterranean zone **18**. The concepts herein, however, are applicable to many other different configurations of wells, including horizontal, slanted or otherwise deviated wells, and multilateral wells with legs deviating from an entry well.

[0015] A drill string **22** is shown as having been lowered from the surface **16** into the wellbore **12**. In some instances, the drill string **22** is a series of jointed lengths of tubing coupled together end-to-end and/or a continuous (i.e., not jointed) coiled tubing. The drill string **22** includes one or more well tools, including a bottom hole assembly **24**. The bottom hole assembly **24** can include, for example, a hybrid drill bit. In the example shown, the wellbore **12** is being drilled. The wellbore **12** can be drilled in stages, and the casing **20** may be installed between stages.

[0016] Referring to FIG. **2**, an example hybrid drill bit **100** that can be used in the bottom hole assembly **24** of the well system **10** of FIG. **1** is shown in a perspective view. The example hybrid drill bit **100** includes a bit body **102** with a pin end **104** on one longitudinal end of the bit body **102**, a drill end **106** on another longitudinal end of the bit body **102** opposite the pin end **104**, and a center longitudinal axis through the center of the bit body **102** that defines a central bit body axis **108**. In some instances, the pin end **104** is male and is threaded to mate with a female box at a tubing end of a drill string. The hybrid drill bit **100** includes blades **110** with fixed cutting elements **112**, the blades **110** extending longitudinally from the drill end **106** of the bit body **102**, and roller discs **114** rotatably coupled to arms **116** extending generally along the central bit body axis **108** and beyond the drill end **106** of the bit body **102**. Each of the roller discs **114** rotate about a rotational axis that defines a roller disc axis **118** extending toward (directly or substantially) the central bit body axis **108**. The hybrid drill bit **100** has more than one type of cutting structure and/or cutting element, for example, blades **110** with fixed cutting elements **112** and roller discs **114** configured to rotate, such that the example drill bit **100** is considered a hybrid drill bit.

[0017] Various types of cutting elements and cutting structures may be provided on a hybrid drill bit. In the example shown in FIG. **2**, the hybrid drill bit **100** includes three blades **110** and three roller discs **114**. The example hybrid drill bit **100** can include additional or different features and components. For example, the number of roller discs **114** and blades **110** can vary. In some instances, a hybrid drill bit can have one or more discs and one or more blades. For example, a hybrid drill bit can have one blade and one roller disc, one blade and a plurality of roller discs, a plurality of blades and one roller disc, or a plurality of blades and a plurality of roller discs.

[0018] The arms **116** attach to the bit body **102** with fasteners **120** such that the arms **116** are removable from the bit body **102**. In some instances, the arms **116** are an extension of the bit body **102**, are welded to the bit body **102**, and/or the arms **116** are connected to the bit body **102** in another way. In other instances, the roller discs **114** are rotatably coupled to the bit body **102** about the drill end. For example, the roller discs **114** can attach to the bit body **102** about the drill end **106** without arms **116**.

[0019] In some instances, the roller discs **114** rotate on spindles (not shown) extending from the bit body **102** or arms **116** along the roller disc axes **118**. The roller discs **114** can attach to the spindles via a bearing system to allow rotation of the roller discs **114** about the roller disc axes **118**. The bearing system can include, for example, a seal, ball bearings, a lubrication system, and/or a pressure compensation system.

[0020] The roller discs **114** can operate at a number of positions and configurations. In the example shown, the roller discs **114** are radially disposed near an outer lateral periphery of the drill end **106**. In some instances, the roller discs **114** are disposed more inward toward the central bit body axis **108**, more outward from the central bit body axis **108**, or in a different position than shown in FIG. **2**. In some instances, the roller disc axes **118** of the roller discs **114** intersect the central bit body axis **108**, for example, to allow true rolling of the roller discs **114** against a rock formation as the example hybrid drill bit **100** rotates about its central bit body axis **108**. True rolling occurs when the roller disc axes **118** intersect the central bit body axis **108**, and a radial vector of each roller disc **114** points in the direction of rotation of the drill bit. In other instances, the roller disc axes **118** of the roller discs **114** do not intersect the central bit body axis **108**, and the roller disc axes **118** are non-radial from the central bit body axis **108**. The roller discs **114** can approximate true rolling, for example, near-true rolling with some shearing against a formation as the example hybrid drill bit **100** rotates about its central bit body axis **108**. Near-true rolling occurs when the roller disc axes **118** do not intersect the central bit body axis **108**, and a radial vector of each roller disc **114** points slightly offset the direction of rotation of the bit body **102**, for example, when the roller disc axis **118** is slightly offset from the central bit body axis **108**. The slight offset causes the roller disc **114** to rotate with some skidding (i.e. shearing) against the formation. In certain instances, a hybrid drill bit can have at least two roller discs, where a first roller disc has a roller disc axis that intersects a central bit body axis, and a second roller disc has a roller disc axis that does not intersect the central bit body axis.

[0021] In the example shown in FIG. **2**, the blades **110** are disposed extending substantially linearly on the drill end **106** from the central bit body axis **108** toward the outer lateral periphery of the drill end **106**. The outer lateral periphery of the drill end **106** has a radiused edge, and the blades **110** curve longitudinally along the radiused edge of the outer lateral periphery of the drill end **106**. The fixed cutting elements **112** extend in a row along the blade, such that the fixed cutting elements form a line along each blade **110** from an end of the blade **110** closest to the central bit body axis **108** to an end of the blade **110** closest to the outer lateral periphery of the drill end **106**. In some instances, the blades **110** and fixed cutting elements **112** are disposed in a different way. For example, the blades **110** can extend in a lateral curve from the central bit body axis **108** toward the outer lateral periphery, the fixed cutting elements **112** can extend in a curved row along the blades **110**, and/or the fixed cutting elements **112** can be disposed in multiple rows along each of the blades **110**. In the example shown, the three blades **110** are the same in shape and size. In other instances, one or more of the blades on a hybrid drill bit are a different shape or size from each other. The fixed cutting elements **112** are shown as being cylindrical polycrystalline diamond compact (PDC) cutters partially embedded into the blade **110**. In some instances, the fixed cutting elements are different, for example, natural diamond inserts, thermally stable PDC cutters, tungsten carbide inserts, metal inserts, milled cutters or teeth, or another hard and abrasive material.

[0022] In some instances, the bit body **102** includes nozzles **122** at the drill end **106** to provide drilling fluid to the hybrid drill bit **100** during drilling.

[0023] Referring to FIG. **3**A, the example hybrid drill bit **100** is shown in an end view, specifically, showing the drill end **106**. The roller disc axes **118** of the roller discs **114** extend toward the central bit body axis **108**. Each roller disc **114** is positioned with a pin angle defined by the angle between the roller disc axis **118** and a plane perpendicular to the central bit body axis **108**.

[0024] In the example shown in FIG. **3**A, the roller disc axes **118** are non-radial from the central bit body axis **108**. If non-radial, an offset, S, between each roller disc axis **118** and the central bit body axis **108** is less than or equal to 0.5 inches in a 10.5 inch size or smaller hybrid bit. For example, the offset S can be 1/16 inch, 1/14 inch, 1/2 inch, or another dimension. The offset S is the shortest distance between the central bit body axis **108** and the roller disc axis **118**. In other words, the offset S can be defined as a distance between the roller disc axis **118** and a plane through the central bit body axis **108**, where the plane is parallel to the roller disc axis **118**. In some instances, the offset S is the same for each roller disc **114**. In other instances, the offset S is different for one or more or each roller discs **114**.

[0025] In some instances, the offset S is small such that while the hybrid drill bit **100** rotates about the central bit body axis **108** and the drill end **106** is against a formation, the roller discs **114** rotate in near-true rolling with a small amount of shear or skidding relative to rolling. In instances with a small offset S, the near-true rolling with a small amount of shear or skid facilitates drilling into a formation, for example, in drilling into a soft formation. In other instances, the offset S is zero such that as the hybrid drill bit **100** rotates about a central bit body axis **108** and the drill end **106** is against a formation, the roller discs **114** rotate in true-rolling without shear against the formation. In instances with a zero offset S, the true-rolling of the roller discs **114** facilitates drilling into a formation, for example, in directional drilling and drilling into a hard formation.

[0026] Referring to FIG. **6**, roller disc **114** is shown in a side view on arm **116**. The roller disc **114** includes a disc body **602** and a generally ring-shaped cutting row **604** radially disposed about the disc body **602**. The roller disc **114** includes one cutting row **604**. The cutting row **604** defines a rotational plane **606** through the center of the cutting row, where the roller disc axis **118** is normal to the rotational plane **606**. The center **608** of the roller disc **114** is the intersection of the roller disc axis **118** and the rotational plane **606**.

[0027] The cutting row **604** can take many forms. In some instances, the cutting row **604** includes a continuous carbide disc radially disposed on the disc body **602**. In the example shown in FIG. **6**, a cross section of the cutting row **604** is a linear protrusion with a substantially circular outer tip. In some instances, the cross section of the cutting row is a triangular protrusion with a sharp tip, a trapezoidal protrusion with a straight tip, a rectangular protrusion with a straight tip, a domed protrusion with a blunt tip, a combination of these, or another configuration. For example, a configuration of the cross-section can be determined by a specific rock formation type. In other instances, the cutting row **604** includes a discontinuous disc configuration. For example, the cutting row can include a plurality of diamond inserts disposed about the disc body **602**. The diamond inserts can be partially embedded into the disc body **602**, coupled to the disc body **602** through welding, with fasteners, or bonded, and/or otherwise disposed about the disc body **602**.

[0028] The pin angle of the roller disc **114** is defined by the angle between the roller disc axis **118** and a plane perpendicular to the central bit body axis **108**. The pin angle is a complement to an angle β between the roller disc axis **118**

and a longitudinal axis **109**. The angle β is the smallest angle between the roller disc axis **118** and the longitudinal axis **109**, where the longitudinal axis **109** is parallel to the central bit body axis **108** of the bit body **102** and intersects the center **608** of the roller disc **114**. In the example shown in FIG. **6**, the angle β is about 60 degrees. The angle β can be different, for example, β can be 0 degrees, 90 degrees, an angle between 0 and 90 degrees, or another angle.

[0029] Referring to FIG. **7**, an example roller disc **114'** is shown in a side view. The example roller disc **114'** is like the roller disc **114** of FIG. **6**, but the example roller disc **114'** is oriented differently on the arm **116** than example roller disc **114**. For example, roller disc **114'** has an angle β of about 90 degrees.

[0030] Referring back to FIG. **3**A, fixed placement of the roller discs **114** on the bit body **102** can vary between each of the roller discs **114**. The roller discs **114** are at a distance L from the central bit body axis **108**. The distance L is the shortest distance between the roller disc center **608** and the central bit body axis **108**. In some instances, the distance L can be the same for each roller disc **114**. In other instances, the distance L is different for one or more or each roller disc **114**.

[0031] FIG. **3**B shows an example hybrid drill bit profile **200** corresponding to the example hybrid drill bit **100** of FIG. **3**A. The example hybrid drill bit profile **200** includes the shape cut by the hybrid drill bit **100** of FIG. **3**A, showing each associated cutting element of the bit **100** transposed on a plane. In the example shown in FIG. **3**B, the hybrid drill bit profile **200** is defined by three roller discs **114***a,* **114***b,* and **114***c,* and the fixed cutting elements **112** of the blades **110** projected onto a vertical plane passing through the central bit body axis **108** of the bit body **102**. Each roller disc **114***a,* **114***b*, and **114***c* can include components and features of the roller disc **114** shown in FIG. **6**, including a disc body **602**, a cutting row **604**, a rotational plane **606**, a roller disc center **608**, and a longitudinal axis **109** that intersects the center of the roller disc **114** and is parallel to the central bit body axis **108** of the bit body **102**.

[0032] Each roller disc **114***a,* **114***b,* and **114***c* has a roller disc axis **118***a,* **118***b*, and **118***c,* respectively, that is offset from the central bit body axis **108** at distances Sa, Sb, and Sc, respectively. Distances Sa, Sb, and Sc are fixed, but can be different. For example, distances Sa, Sb, and Sc can all be the same, two or more can be the same, or each can be different. In some instances, the offset is the same for each roller disc **114***a*, **114***b*, and **114***c,* in that distances Sa, Sb, and Sc are equal.

[0033] Each roller disc **114***a,* **114***b,* and **114***c* is at a distance La, Lb, and Lc, respectively, from the central bit body axis **108**. Distances La, Lb, and Lc are fixed, but can be different. For example, distances La, Lb, and Lc can all be the same, two or more can be the same, or each can be different.

[0034] Each roller disc axis **118***a,* **118***b,* **118***c* is at a respective pin angle from a plane perpendicular to the central bit body axis **108**. Thus, each roller disc axis **118***a*, **118***b,* **118***c* is at an angle βa, βb, and βc, respectively, from a longitudinal axis **109***a*, **109***b,* **109***c,* respectively, that is parallel to the central bit body axis **108** and intersects the roller disc centers **608***a,* **608***b,* **608***c,* respectively. Angles βa, βb, and βc are fixed angles, but can be different. For example, angles βa, βb, and βc can all be the same, two or more angles can be the same, or each angle can be different.

[0035] In the example hybrid bit profile **200** shown in FIG. **3**B, each respective rotational plane **606***a,* **606***b,* **606***c* through the roller discs **114***a,* **114***b,* **114***c* is perpendicular (precisely or substantially) to a periphery of the example hybrid bit profile **200**. For example, each respective rotational plane **606***a,* **606***b,* **606***c* can be at an angle between 80 degrees and 100 degrees from the periphery of the example profile **200**. In other instances, the rotational planes **606***a,* **606***b,* **606***c* are not generally perpendicular to the profile **200**. The example profile **200** illustrates the cutting rows **604***a,* **604***b,* **604***c* of the roller discs **114***a,* **114***b,* **114***c* engaging a shoulder zone of the example profile **200**. In some instances, the cutting rows **604***a,* **604***b,* **604***c* engage a cone zone, a nose zone, a gage zone, and/or the shoulder zone. The cutting rows **604***a,* **604***b,* **604***c* of the roller discs **114***a,* **114***b,* **114***c* do not engage a cone zone of the example profile **200**. The gage zone is associated with the cylindrical sidewall of a wellbore, such that engaging the gage zone includes cutting only the cylindrical sidewall of the wellbore. The shoulder zone, nose zone, and cone zone are associated with a downhole end of the wellbore (i.e. bottom of hole). The nose zone extends farther beyond the drill end of a bit body than the cone and shoulder zones, and the shoulder zone bridges the nose zone and the gage zone. The cone zone is in the lateral center of the drill bit on the longitudinal drill end.

[0036] The cutting rows **604***a,* **604***b,* **604***c* extend further in the profile **200** than the fixed cutting elements **112** of the blades **110**. The cutting rows **604***a,* **604***b,* **604***c* lead the fixed cutting elements **112** of the blades **110** in cutting a formation such that the cutting rows **604***a,* **604***b,* **604***c* prefracture the formation during drilling. The blades **110** can also support the roller discs **114***a,* **114***b,* **114***c* during drilling by limiting the contact stress between the cutting rows **604***a,* **604***b,* **604***c* and the formation. For example, the fixed cutting elements **112** contact the formation as the cutting rows **604***a,* **604***b,* **604***c* are partially engaged into the formation. In some instances, one or more of the fixed cutting elements **112** of the blades **110** extends further in the profile **200** than the cutting rows **604***a,* **604***b,* **604***c*. In other instances, the cutting rows **604***a,* **604***b,* **604***c* and the fixed cutting elements **112** extend into the profile **200** evenly. In other instances, one or more fixed cutting elements **112** can extend further than one or more of the cutting rows **604***a,* **604***b,* **604***c,* and another subset of cutting rows **604***a,* **604***b,* **604***c* can extend further than other fixed cutting elements **112**. For example, a cutting row profile of a first roller disc can extend further than a fixed cutting element profile, and the fixed cutting element profile can extend further than a profile of a second roller disc.

[0037] Referring to FIG. **4**A, an example hybrid drill bit **100'** is shown in an end view. The example hybrid drill bit **100'** is like the example hybrid drill bit **100** of FIG. **3**A, except the hybrid drill bit **100'** includes four roller discs **114** and two blades **110**.

[0038] FIG. **4**B shows an example hybrid drill bit profile **200'** corresponding to the example hybrid drill bit **100'** of FIG. **4**A. The example hybrid drill bit profile **200'** is like the example hybrid drill bit profile **200** of FIG. **3**B, except the example hybrid drill bit profile **200'** includes four roller discs **114***a,* **114***b,* **114***c,* and **114***d,* and fixed cutting elements **112** from two blades **110**.

[0039] Referring to FIG. **5**A, an example hybrid drill bit **100"** is shown in an end view. The example hybrid drill bit

100" is like the example hybrid drill bit **100** of FIG. **3**A, except the hybrid drill bit **100"** includes four roller discs **114** and three blades **110'**. The blades **110'** of the example hybrid drill bit **100"** radially extend from the central bit body axis **108** less than the roller discs **114**. For example, the blades **110'** are more radially inward than the roller discs **114** with respect to the central bit body axis **108** of the bit body **102**.

[0040] FIG. **5**B shows an example hybrid drill bit profile **200"** corresponding to the example hybrid drill bit **100"** of FIG. **5**A. The example hybrid drill bit profile **200"** is like the example hybrid drill bit profile **200** of FIG. **3**B, except the example hybrid drill bit profile **200"** includes four roller discs **114***a*, **114***b*, **114***c*, **114***d* and fixed cutting elements **112** from the three blades **110** from FIG. **5**A.

[0041] Hybrid drill bits, such as the example hybrid drill bits **100**, **100'**, and **100"**, can be configured to rotate about a central bit body axis with a drill end against a formation in a wellbore. Roller discs disposed about the drill end crush or crack a formation in a substantially or wholly rotating action, while fixed cutting elements on a blade scrape against the formation in a shearing action. The rotating action of the roller discs can include true rolling or near-true rolling with partial scraping or shearing of the formation. In some instances, the roller discs prefracture the formation such that the fixed cutting elements scrape the prefractured cuttings of formation.

[0042] In view of the discussion above, certain aspects encompass, a hybrid drill bit including a bit body having a central bit body axis at a center of the bit body, a blade on the bit body extending from an end of the bit body, and a roller disc rotatably coupled to the bit body about the end of the bit body to rotate on a roller disc axis. The roller disc axis extends toward the central bit body axis. The blade includes a plurality of fixed cutting elements.

[0043] Certain aspects encompass, a well drilling system including a well head, a drill string connected to the well head, and a hybrid drill bit connected to the drill string. The hybrid drill bit includes a bit body having a central bit body axis at a center of the bit body, a blade on the bit body extending from an end of the bit body, and a roller disc rotatably coupled to the bit body about the end of the bit body to rotate on a roller disc axis. The roller disc axis extends toward the central bit body axis. The blade includes a plurality of fixed cutting elements.

[0044] Certain aspects encompass, a method of cutting a formation in a wellbore. The method includes rotating a drill bit in a formation in a wellbore, crushing or cracking the formation in a rotating action using a roller disc on the drill bit, and scraping the formation in a shearing action using fixed cutting elements on a blade on the drill bit.

[0045] The aspects above can include some, none, or all of the following features. The hybrid drill bit includes an arm coupled to the bit body extending generally along the central bit body axis and beyond the end of the bit body. The roller disc is rotatably coupled to the arm. The roller disc axis of the roller disc intersects the central bit body axis. The roller disc axis of the roller disc is non-radial from the central bit body axis. The shortest distance S between the central bit body axis and the roller disc axis is less than 0.5 inches. The roller disc includes a disc body and a generally ring-shaped cutting row radially disposed about the disc body, and the roller disc includes only one cutting row. The cutting row defines a rotational plane through the center of the cutting row, and the rotational plane is normal to the roller disc axis. The rotational plane of the roller disc is generally perpendicular to a periphery of a corresponding bit profile, and a center of the roller disc is the intersection of the roller disc axis and the rotational plane. The roller disc is in a shoulder zone of the bit profile. The hybrid bit includes a plurality of discs and a plurality of blades. The plurality of discs is a different distance L from the central bit body axis, where the distance L is the shortest distance between a center of the respective roller disc and the central bit body axis. The plurality of roller discs may not be in the cone zone of a corresponding bit profile. Each roller disc axis of the plurality of discs is at a different angle β from the central bit body axis, where the angle β is the angle of the respective roller disc axis from the central bit body axis. The plurality of blades are more radially inward than the plurality of discs with respect to the central bit body axis of the bit body. The cutting row of the roller disc extends further from the end of the bit body than the fixed cutting elements of the blade. The hybrid drill bit includes an arm coupled to the bit body extending generally along the central bit body axis and beyond the end of the bit body, and the roller disc is rotatably coupled to the arm. The roller disc includes a disc body and a generally ring-shaped cutting row radially disposed about the disc body, and the roller disc comprises only one cutting row. Crushing or cracking the formation in a rotating action using a roller disc includes prefracturing the formation using the roller disc, where the roller disc is deeper into the formation than the fixed cutting elements of the blade. Scraping the formation in a shearing action using fixed cutting elements on a blade includes scraping prefractured cuttings of formation. Crushing or cracking the formation in a rotating action using a roller disc on the drill bit includes a roller disc configured to roll against the formation with small shear.

[0046] A number of embodiments have been described. Nevertheless, it will be understood that various modifications may be made. Accordingly, other embodiments are within the scope of the following claims.

What is claimed is:

1. A hybrid drill bit, comprising:

a bit body defining a central bit body axis;

a blade on the bit body extending from an end of the bit body, the blade comprising a plurality of fixed cutting elements; and

a roller disc rotatably coupled to the bit body about the end of the bit body to rotate on a roller disc axis, the roller disc axis extending toward the central bit body axis.

2. The hybrid drill bit of claim **1**, comprising an arm coupled to the bit body extending generally along the central bit body axis and beyond the end of the bit body; and

where the roller disc is rotatably coupled to the arm.

3. The hybrid drill bit of claim **1**, where the roller disc axis of the roller disc intersects the central bit body axis.

4. The hybrid drill bit of claim **1**, where the roller disc axis of the roller disc is non-radial from the central bit body axis.

5. The hybrid drill bit of claim **4**, where a shortest distance S between the central bit body axis and the roller disc axis is less than 0.5 inches.

6. The hybrid drill bit of claim **1**, where the roller disc comprises a disc body and a generally ring-shaped cutting row radially disposed about the disc body; and

where the roller disc comprises only one cutting row.

7. The hybrid drill bit of claim **6**, where the cutting row defines a rotational plane through the center of the cutting row, the rotational plane being normal to the roller disc axis;

where the rotational plane of the roller disc is generally perpendicular to a periphery of a corresponding bit profile; and

where a center of the roller disc is the intersection of the roller disc axis and the rotational plane.

8. The hybrid drill bit of claim **7**, where the roller disc is in a shoulder zone of the bit profile.

9. The hybrid drill bit of claim **1**, comprising a plurality of roller discs and a plurality of blades.

10. The hybrid drill bit of claim **9**, where each disc of the plurality of roller discs is a different distance L from the central bit body axis, where the distance L is a shortest distance between a center of the respective roller disc and the central bit body axis.

11. The hybrid drill bit of claim **9**, where the plurality of roller discs are not in a cone zone of a corresponding bit profile.

12. The hybrid drill bit of claim **9**, where each roller disc axis of the plurality of discs is at a different angle β from the central bit body axis, where the angle β is the angle of the respective roller disc axis from the central bit body axis.

13. The hybrid drill bit of claim **9**, where the plurality of blades are more radially inward than the plurality of discs with respect to the central bit body axis of the bit body.

14. The hybrid drill bit of claim **7**, where the cutting row of the roller disc extends further from the end of the bit body than the fixed cutting elements of the blade.

15. A well drilling system, comprising:

a well head;

a drill string connected to the well head;

a hybrid drill bit connected to the drill string, the hybrid drill bit comprising:

a bit body having a central bit body axis at a center of the bit body;

a blade on the bit body extending from an end of the bit body, the blade comprising a plurality of fixed cutting elements; and

a roller disc rotatably coupled to the bit body about the end of the bit body to rotate on a roller disc axis, the roller disc axis extending toward the central bit body axis.

16. The well drilling system of claim **15**, where the hybrid drill bit further comprises:

an arm coupled to the bit body extending generally along the central bit body axis and beyond the end of the bit body; and

where the roller disc is rotatably coupled to the arm.

17. The well drilling system of claim **15**, where the roller disc comprises a disc body and a generally ring-shaped cutting row radially disposed about the disc body; and

where the roller disc comprises only one cutting row.

18. A method of cutting a formation in a wellbore, the method comprising:

rotating a drill bit in a formation in a wellbore;

crushing or cracking the formation in a rotating action using a roller disc on the drill bit; and

scraping the formation in a shearing action using fixed cutting elements on a blade on the drill bit.

19. The method of claim **18**, where crushing or cracking the formation in a rotating action using a roller disc comprises prefracturing the formation using the roller disc, where the roller disc is deeper into the formation than the fixed cutting elements of the blade; and

where scraping the formation in a shearing action using fixed cutting elements on a blade comprises scraping prefractured cuttings of formation.

20. The method of claim **18**, where crushing or cracking the formation in a rotating action using a roller disc on the drill bit comprises a roller disc configured to roll against the formation with small shear.

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