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(54) **GOUGING CUTTER STRUCTURE AND DRILL BIT MADE THEREWITH**

(57) A gouging cutter (18) includes a cutting element (18B) having a cutting end (118) and a mounting feature displaced from the cutting end (118) and a cutter body affixable to a drill bit body (11). The cutter body has a corresponding mounting feature arranged to cooperate with the mounting feature on the cutting element (118) to retain the cutting element (118) to the cutter body so as to enable rotation of the cutting element (118) therein. A drill bit may include a bit body (11) having features to enable connection to a drill string and at least one of the foregoing gouging cutters (18) mounted to the bit body (11).

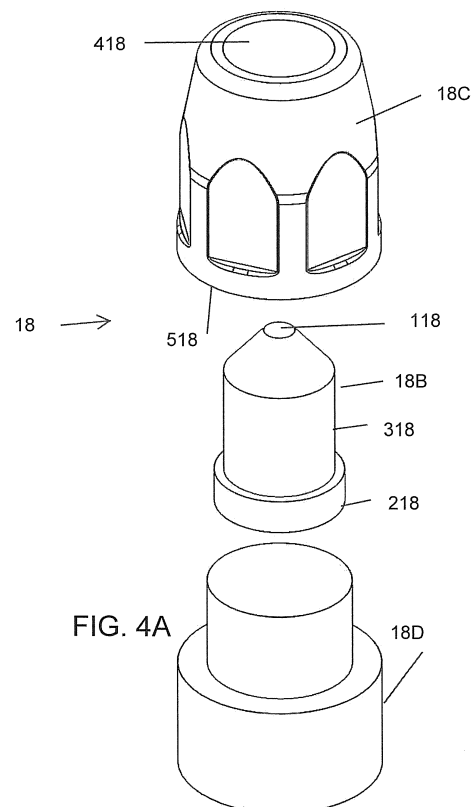


FIG. 4A

Description

BACKGROUND

[0001] This disclosure relates generally to the field of rotary drill bits. More specifically, the disclosure relates to drill bits having "gouging" type cutters and structures for such cutters.

[0002] Fixed cutter bits known in the art include polycrystalline diamond compact ("PDC") bits, wherein a plurality of PDC cutters are affixed to a bit body in a selected arrangement on one or more blades formed in the bit body.

[0003] Gouging type cutters are used in drill bits for drilling mine shafts or tunnels, among other uses. Such bits are known in the art as "claw" bits, one example of which is sold under the trademark QUI-KLAW, which is a trademark of Drillhead, Inc. Such bits are known to be useful in drilling clay, unconsolidated sand, loose rock and gravel.

[0004] U.S. Patent No. 8,505,634 issued to Lyons et al. describes a drill bit having gouging cutting elements disposed adjacent to shearing cutting elements on a blade on the bit body. The shearing cutting elements have a planar cutting face, while the gouging cutting elements have a non-planar cutting face, e.g., dome shaped or cone shaped.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005]

FIG. 1 is an oblique view on an example drill bit according to the present disclosure.

FIG. 2 shows a side view of an example blade of the bit shown in FIG. 1.

FIG. 3 shows one example of a shear cutter.

FIG. 4A shows an exploded view of one example of a gouging cutter.

FIG. 4B shows the example gouging cutter as fully assembled.

FIG. 4C shows another example embodiment of a gouging cutter.

FIG. 4D shows an assembled view of another embodiment of a gouging cutter.

FIG. 4E shows an exploded view of the embodiment shown in FIG. 4D.

FIG. 4F shows another embodiment of a gouging cutter.

FIG. 4G shows an exploded view of another example embodiment of a gouging cutter.

FIG. 5 shows another example of a drill bit according to the present disclosure.

FIG. 6 shows an oblique view of blades according to the example bit shown in FIG. 5.

FIG. 7 shows an example blade having shear cutters with gouging cutters disposed rotationally ahead of the shear cutters.

FIG. 8 shows an example blade having gouging cutters disposed rotationally behind gouging cutters.

DETAILED DESCRIPTION

[0006] An example drill bit according to the present disclosure is shown in oblique view at 10 in FIG. 1. The bit 10 may include a bit body 11 having a tool joint section 11A for coupling the bit body 11 to a drill string (not shown) and a cutting section 11B which may include a plurality of circumferentially spaced apart blades 12. The bit body 11 may be formed from steel and have an abrasion resistant coating such as tungsten carbide applied to certain wear susceptible areas (not shown) on the bit body 11. The bit body may also be made, for example, from carbide matrix of compositions known in the art. Each of the blades 12, in some embodiments, may extend from a selected distance proximate the axial center of the bit body 11, radially outwardly to a gage portion 13 having a diameter approximately equal to the diameter of a wellbore to be drilled by the bit 10. The gage portion 13 of each blade 12 may include gage cutters 14 made, for example, from a hard or superhard material such as polycrystalline diamond, cubic boron nitride, diamond impregnated tungsten carbide or tungsten carbide. The present example includes six, circumferentially equally spaced apart blades 12, but the number of blades and the circumferential spacing therebetween are not limits on the scope of the present disclosure.

[0007] At least one or each blade 12 may define a stepped, dual "profile" or curved shape. In the present example, a forward (with respect to direction of rotation of the bit) step of at least one or all of the blades 12 may be longitudinally lower or behind (further back or rearward with respect to the direction the bit will drill) than a rearward step of blade 12, as will be further explained below with reference to FIG. 2. Lower in the present context means further from the drilling surface defined by the profile of the blades 12. The forward step of the profile may include a plurality of pick type or gouging cutters 18 spaced in a row along the forward step. The gouging type cutters 18 will be further explained below. The rearward step of the profile may in some examples include a plurality of shear cutters 16, such as, for example, polycrystalline diamond compact (PDC) cutters, tungsten carbide cutters, or cubic boron nitride cutters of any type known in the art. The foregoing arrangement of blades and cutters is only meant to service as an example of a drill bit made with gouging cutters according to the present disclosure and is not intended to limit the scope of the present disclosure.

[0008] The shear cutters 16 may be mounted on the blade 12 at a selected backrake angle. The gouging cutters 18 may be mounted in openings (18A in FIG. 2) at a selected forward rake angle. In some examples, the tips (FIG. 4) of the gouging cutters 18 may extend longitudinally ahead of (in the direction the bit will drill) a cutting surface defined by the shear cutters 16 by about 0.5 inch-

es (13 mm). The foregoing dimensions are only an example, and are not intended to limit the scope of the present disclosure.

[0009] A space between circumferentially adjacent blades 12 may form a flow path or waterway to enable space for cuttings generated by the bit 10 to be disposed until they are forced out by the action of drilling fluid pumped through one or more nozzles or "jets" 20 inserted into the bit body 11 as shown in FIG. 1.

[0010] FIG. 2 shows a side view of one of the blades 12 without the cutters (16, 18 in FIG. 1) to better illustrate some of the blade's features. The blade 12 in the present example may define a forward (with respect to direction of rotation of the bit) step 22 that traverses a curved profile. The forward step 22 may extend radially inwardly to a predetermined position (i.e., a selected distance from the center of rotation of the bit body) enabling convenience of placement of the gouging cutters (18 in FIG. 1) in substantially cylindrically shaped pockets 18A. The curvature of the profile may substantially match the curvature of a corresponding portion of a rearward step 24 on the blade 12, or may have a different curvature. The rearward step 24 may be elevated (or extended longitudinally in the direction of drilling) by a selected distance H at one or more lateral positions along the blade 12. In the present example, the distance H may be about 0.5 inches (13 mm). As previously explained, such dimension and step type blade structure are not limits on the scope of the present disclosure, but are meant only to illustrate and example structure for a drill bit using gouging cutters as will be further explained below with reference to FIGS. 4A and 4B. The rearward step 24 (if such blade structure is used) may define a profile that extends radially outward to the gage surface 13 and may extend radially inward to a selected distance from the axis of rotation of the bit body (11 in FIG. 1) somewhat more or somewhat less than the forward step 22. The rearward step 24 shown in FIG. 2 may in some examples include pockets 16A for mounting the shear cutters (16 in FIG. 1). The curvature of the profile defined by the rearward step 24 may be any profile known to be used with fixed shear cutter drill bits. The distance by which the tips of the gouging cutters (18 in FIG. 1) extend beyond the rearward step 24 or a cutting surface defined by the shear cutters (16 in FIG. 1), if used, will be related to the length of the gouging cutters (18 in FIG. 1) and the selected distance H. However, it should be clearly understood that other embodiments of a drill bit made using gouging cutters according to the present disclosure may use blade profiles suitable for use of only gouging type cutters. It is also within the scope of the present disclosure to use gouging cutters as will be explained below on one or more roller cones of a roller cone type drill bit.

[0011] In other examples, the rearward step 24 or any or all of the blades 12 may omit the mounting pockets 16A and the shear cutters (16 in FIG. 1). In some examples, the blades (12 in FIG. 1) may only include a single profile surface that extends a selected distance from the

rotational axis of the bit to the gage surface (13 in FIG. 1) and the gouging cutters (18 in FIG. 1) are mounted to the bit body (11 in FIG. 1) so that the tips thereof are disposed at a selected longitudinal distance ahead of the blade profile surface.

[0012] An example shear cutter 16 is shown in side view in FIG. 3. The example shown in FIG. 3 is a PDC cutter, although other types of shear cutters may be used in other implementations of a bit according to the disclosure. The shear cutter 16 may include a substrate 30 such as may be made from tungsten carbide or other material known in the art for such use in PDC cutters. A diamond table 32 may be affixed to an upper surface of the substrate 30. The diamond table 32 may be made from polycrystalline diamond using processes known in the art. Any known configuration of interface between the diamond table 32 and the substrate 30 may be used. The diamond table may have an exposed substantially planar surface 32A, which may have a chamfer 32B at its edge. The substrate 30 may be brazed to the bit body (11 in FIG. 1) on one of the pockets (16A in FIG. 2) using techniques known in the art. In other examples, the shear cutters 16 may be made from materials such as tungsten carbide, diamond impregnated tungsten carbide or cubic boron nitride. The shape of the shear cutters is not intended to limit the scope of the present disclosure.

[0013] FIG. 4A shows an exploded view of one of the gouging cutters 18 according to the present disclosure as it would be mounted in one of the pockets (18A in a blade 12 in FIG. 2). The gouging cutter 18 may include a substantially circular cross section cutter mount body 18D made from steel or similar high strength metal. The cutter mount body 18D may also be made from materials such as sintered tungsten carbide. The cutter mount body 18D may be brazed to the bit body (11 in FIG. 1) in a respective one of the pockets (18A in FIG. 2) or may be interference fit therein so that the cutter mount body 18D is retained in the bit body. In some embodiments the cutter mount body 18D is inserted into the pocket (18A in FIG. 2). In some embodiments, the gouging cutter 18 may be removed from the respective pocket 18A for servicing or replacement. The manner of mounting the cutter mount body 18D in the pocket (18A in FIG. 2) is not intended to limit the scope of the present disclosure.

[0014] The present embodiment, and additional example embodiments to be described in more detail below enable the cutter mount body 18D to be affixed to the bit body, while enabling replacement of a gouging cutting element. The gouging cutting element may be mounted within the cutter mount body 18D or to the cutter mount body 18D so that it is free to rotate with respect to the cutter mount body 18D.

[0015] A gouging cutting element 18B may be made from, for example, tungsten carbide, cubic boron nitride, polycrystalline diamond or any other material known in the art for making a gouging cutter cutting surface. The gouging cutting element 18B may be substantially round in cross section. In the present example embodiment, a

main diameter portion 318 may have a diameter selected to be smaller than an internal diameter of the cutter mount body 18D. An outer end 118 of the cutting element 18B may be shaped substantially conically as shown in FIG. 4A, but may have any other shape known in the art for gouging type cutters. An inner end 218 of the cutting element 18B may have a substantially round cross section and a diameter selected to substantially match the interior diameter of the gouging cutter mount body 18D. A retainer 18C may have an interior opening 418 having an internal diameter selected to enable free passage of the main diameter portion 318 of the cutting element 18B therethrough, and a mounting surface 518 having an outer diameter selected to fit within the interior diameter of the gouging cutter mount body 18D. The retainer 18C may be affixed to the gouging cutter mount body, for example, by threading, welding, brazing, using a snap ring or any other mounting device known in the art.

[0016] When the retainer 18C is affixed to the gouging cutter mount body 18D, the cutting element 18B may be retained in place within the gouging cutter mount body 18D while free to rotate with respect thereto. If the cutting element 18B should be worn or damaged during use of a drill bit using such gouging cutters 18, it may be possible to replace only the cutting element 18B in the present example embodiment by removing the retainer 18C. Thus, in some examples, the gouging cutter mount body 18D may be permanently or semi permanently affixed to the bit body (11 in FIG. 1). The relative diameters of the main portion 318, the interior diameter of the cutter mount body 18D and the opening 418 in the retainer 18C may be selected so that the cutting element 18B may rotate freely in the cutting element body 18D. In other embodiments, the cutting element body 18D may be mounted in the pocket (18A in FIG. 2) so that it may freely rotate. Such mounting may include, for example, snap rings or the like. It will be appreciated by those skilled in the art that a length of the main diameter portion may be selected so that the outer end 118 of the cutting element protrudes through the opening 418 in the retainer 18C.

[0017] FIG. 4B shows the gouging cutter 18 fully assembled as it would be affixed in a corresponding pocket (18A in FIG. 2) in the bit body (11 in FIG. 1).

[0018] Embodiments to be described below with reference to FIGS. 4C through 4F may provide means for releasably mounting a gouging cutting element to a gouging cutter mount body, wherein the gouging cutting element may rotate freely with respect to the cutter mount body. The following embodiments may include an opening formed on a longitudinal end of the cutting element (which may or may not include a separate rotating cutter body), wherein a groove is formed on an interior surface of the opening. The cutter mount body may have a feature which mates with the opening. An exterior surface of the feature on the cutter mount body may include a corresponding groove that cooperates with the groove on the interior surface of the opening when a locking element is disposed in both grooves. In some embodiments, the

locking element may comprise ball bearings or locking balls. In some embodiments, the locking element may comprise a snap ring. In some embodiments, the locking feature may comprise a set screw.

[0019] FIG. 4C shows a cross section of another example embodiment of a gouging cutter 220. The example shown in FIG. 4C is assembled. A gouging cutting element 118A may be brazed or interference fit, for example, into a gouging cutting element rotating body 118B. The gouging cutting element 118A may be made from materials as explained with reference to the previously described embodiment and may be similarly shaped at a cutting surface end thereof. The gouging cutting element rotating body 118B may be made from steel or sintered tungsten carbide, as non-limiting examples. The assembled gouging cutting element 118A and gouging cutting element rotating body 118B may be rotatably mounted to another embodiment of a gouging cutter mount body 18D. The present embodiment of the gouging cutter mount body 18D may be substantially cylindrically shaped and include a reduced diameter portion having a ball retaining groove therein. Retaining balls 118D, which may be made from steel or other high strength material may be urged into the groove and also be urged into a corresponding retaining groove 118G formed in a portion (e.g., an opening such as a cylindrical opening) as shown in the cutting element rotating body 118B. A retaining sleeve 118C may be disposed radially externally to the retaining balls 118D, the gouging cutter mount body 18D and the gouging cutting element rotating body 118B so that the retaining balls retain the gouging cutting element rotating body 118B to the gouging cutter mount body 18D while enabling free relative rotation therebetween. A spring 118F or similar biasing device may hold the retaining sleeve 118C in the position shown in FIG. 4C. To enable removal of the gouging element rotating body 118B from the cutter mount body 18D, the retaining sleeve 118C may be urged downwardly against the biasing force of the spring 118F so that the retaining balls 118D are enabled to move into a release groove 118E on the interior surface of the retaining sleeve 118C. The gouging cutting element rotating body may then be removed by pulling it away from the gouging cutter mount body 18C axially. A replacement assembly including a gouging cutting element 118A and gouging cutting element holding fixture 118B may be inserted into the retaining sleeve 118C, and the retaining sleeve 118C may be subsequently released. Thus, the replacement assembled gouging cutting element and gouging cutting element holding fixture may be locked to the gouging cutter mount body 18D while enabled to rotate freely with respect thereto. In the present embodiment, it may thus be possible to replace the gouging cutting element 118A without removing the cutter mount body 18D from the bit body (11 in FIG. 1).

[0020] FIG. 4D shows another example embodiment of a gouging cutter 222. The present embodiment may include a gouging cutting element 118A and a gouging

cutting element holding fixture 118B substantially as in the embodiment described with reference to FIG. 4C. In the present embodiment, a snap ring retaining groove 222B may be formed on an inner surface of a cylindrical bore in the gouging cutting element holding fixture 118B. A corresponding snap ring groove 222C may be formed on an exterior surface of a reduced diameter portion of the gouging cutter mount body 18C. A snap ring 222A may be inserted into the groove 222B prior to assembly of the gouging cutting element holding fixture 118B to the gouging cutter mount body 18D. When assembled, the snap ring 222A retains the gouging cutting element holding fixture 118B to the cutter mount body 18D while enabling free relative rotation therebetween. A release provision, such as a hole or other opening (not shown) through the gouging cutting element holding fixture 118B may enable use of a pin or similar release tool to compress the snap ring 222A to enable release of the gouging cutting element holding fixture 118B from the cutter mount body 18D to enable replacement of the former (with its assembled gouging cutting element 118A). An exploded view of the embodiment of FIG. 4D is shown in FIG. 4E. In the present embodiment, it is also possible to release / remove gouging cutting element holding fixture 118B simply by pulling on it with a tool such as a slide hammer. The groove on the outer surface of the gouging cutting element holding fixture 118B may be configured for a tool that slides into the groove and attaches to the end of the slide hammer.

[0021] FIG. 4F shows an cross section of another embodiment of a gouging cutter fully assembled. In the present embodiment, a gouging cutter 118A and gouging cutter holding fixture 118B may be formed and assembled as explained with reference to the embodiments described with reference to FIGS. 4C and 4D. In the present embodiment, an interior surface of a cylindrical opening in the bottom of the gouging cutting element holding fixture 118B may include a retaining groove 118J formed therein. A radius of the retaining groove 118J may be selected to enable close tolerance, yet free rolling fit of a plurality of ball bearings 118H therein. A mating cylindrical post on the cutter mount body 18D may include a similar retaining groove 118K on its exterior surface. When the gouging cutting element holding fixture 118B is positioned on the cutter mount body 18D, ball bearings 118H may be inserted into a toroidal opening created by positioning the respective grooves 118J, 118K as shown in FIG. 4F. After the toroidal opening is substantially filled with ball bearings 118H through a fill port 118M in the gouging cutter holding fixture 118B, the fill port 118M may be sealed with a plug 118L. The plug 118L may be brazed or interference fit into the fill port 118M. Replacement of the gouging cutter 118A may be performed by removing the plug 118L and removing the ball bearings 118H through the fill port 118M, thus releasing the gouging cutter rotating body 118B from the cutter mount body 18D. Replacement may be performed similarly to the original assembly procedure explained above.

[0022] FIG. 4G shows an exploded view of another example embodiment of a gouging cutter. The present example gouging cutter 226 may include a gouging cutting element 118A affixed to a rotating cutter body 118B as in the previous embodiments. A cutter mount body 18D may include a groove 118K on an exterior surface thereof as shown. A set screw 118L may be inserted through an opening 118M in the rotating cutter body 118B such that when fully inserted therein, an end of the set screw 118L is disposed in the groove 118K, thus rotatably locking the rotating cutter body 118B to the cutter mounting body 18D.

[0023] The foregoing example embodiments of a gouging cutter for a drill bit have in common that the gouging cutter is replaceably mounted to a cutter mount body, such that the gouging cutter may freely rotate with respect to the cutter mount body. While the embodiments shown in FIGS. 4C, 4D, 4E and 4F include a separate cutting element and rotating cutter body, other embodiments may have the cutting element and rotating cutter body formed integrally as a single component.

[0024] Referring again to FIG. 4F, in some embodiments an aspect ratio of the gouging cutter may be limited. The aspect ratio in the present context means the ratio of the overall length of the gouging cutter, shown at L with respect to its overall diameter, shown at D. In some embodiments, the aspect ratio may be at most 2.5. The same limitation on the aspect ratio may be applied to any of the other embodiments shown in and explained with reference to FIGS. 4A, 4B, 4C, 4D, 4E and 4G. Limiting the aspect ratio may reduce breakage of the gouging cutter during use.

[0025] It should also be clearly understood that while the example cutter mount bodies shown in and described with reference to FIGS. 4A through 4E are affixable to a bit body, they may also be integrally formed with the bit body while including features to enable replaceable retention of the cutting element while allowing free rotation of the cutting element with respect to the cutter mount body.

[0026] FIG. 5 shows another example of a drill bit according to the present disclosure in which the gouging cutters 18 are mounted to the bit body 11 so as to be disposed rotationally behind the shear cutters 16. In the example of FIG. 5, the tips of the gouging cutters 18 may extend a selected distance beyond a cutting surface defined by the shear cutters 16.

[0027] FIG. 6 shows an enlarged view of the bit body of FIG. 5 wherein pockets 16A for the shear cutters (16 in FIG. 5) are disposed at locations along the blade 12, and the pockets 18A for the gouging cutters (18 in FIG. 5) are shown disposed rotationally behind the blade 12. In the example of FIG. 6, the tips of the gouging cutters (18 in FIG. 5) may extend a selected longitudinal distance ahead of the cutting surface defined by the shear cutters (16 in FIG. 5) when mounted in the pockets 18A.

[0028] FIG. 7 shows another example wherein the blade 12 only comprises mounting for the shear cutters

16. The gouging cutters 18 may be mounted rotationally ahead of the shear cutters 16 in pockets that are not on the blade top. In the example of FIG. 7, the tips of the gouging cutters 18 may extend a selected longitudinal distance ahead of the cutting surface defined by the shear cutters 16.

[0029] FIG. 8 shows another example wherein at least one of the blades 12 includes gouging cutters 18 mounted therein and shear cutters 16 mounted on the blade 12 rotationally ahead of the gouging cutters 18. The tips of the gouging cutters 18 may extend a selected distance longitudinally ahead of a cutting surface defined by the shear cutters 16.

[0030] In other examples, gouging cutters may be mounted on one or more blades and shear cutters may be mounted on one or more blades. In such examples, as in the other examples described above, the gouging cutters and shear cutters may be affixed to the blades within the stated respective ranges of rake angles, and the gouging cutters may extend longitudinally ahead of the cutting surface defined by the shear cutters by the distances described above.

[0031] In the examples of FIGS. 5 through 8, the gouging cutters and shear cutters may have rake angles, structures and compositions substantially as set forth with reference to the examples described with reference to FIGS. 1 through 3. It should be clearly understood that the examples described herein including both gouging type cutters and shear cutters is not a limitation on the scope of the present disclosure. Other embodiments may use only gouging type cutters made as explained with reference to FIGS. 4D and 4E.

[0032] Drill bits made according to the present disclosure may have gouging cutters that may be more readily serviceable than gouging type cutters known in the art. Other possible benefits of a drill bit made according to the present disclosure may include that a rotatable gouging cutter is much more robust (less prone to loss or breakage) and can be much made smaller than gouging cutters known in the art prior to the present disclosure.

[0033] While the invention has been described with respect to a limited number of embodiments, those skilled in the art, having benefit of this disclosure, will appreciate that other embodiments can be devised which do not depart from the scope of the invention as disclosed herein. Accordingly, the scope of the invention should be limited only by the attached claims.

Claims

1. A gouging cutter (18), comprising:

a cutting element (18B) having a cutting end (118) and a mounting feature displaced from the cutting end (118); and
a cutter mount body (18D) configured to be affixed to a drill bit body (11) and having a corre-

sponding mounting feature configured to cooperate with the mounting feature on the cutting element (18B) to retain the cutting element (18B) to the cutter mount body (18D) so as to enable rotation of the cutting element (18B) with respect thereto.

2. The gouging cutter of claim 1, wherein the cutting element (18B) comprises at least one of tungsten carbide, cubic boron nitride and polycrystalline diamond.
3. The gouging cutter of claim 1 or 2, wherein the cutter mount body (18D) comprises steel.
4. The gouging cutter of any one of claims 1 to 3, wherein the cutter mount body (18D) is rotatably mounted in a corresponding pocket (18A) in the drill bit body.
5. The gouging cutter of any one of claims 1 to 3, wherein the cutting end (118) is substantially conical.
6. The gouging cutter of any one of claims 1 to 5, wherein the mounting feature on the cutting element (18B) comprises the cutting element (18B) having a cutting end (118), a main diameter portion (318) having a selected outer diameter, and an inner end (218) having a selected outer diameter larger than the outer diameter of the main diameter portion (318), the cutter mount body (18D) having an internal diameter selected to enable movement therein of the inner end (218) of the cutting element (118), and a retainer (18C) having an internal opening (418) selected to enable movement therethrough of the main diameter portion (318) and a mounting surface (518) having an external diameter selected to substantially match an internal diameter of the cutter mount body (18D).
7. The gouging cutter of any one of claims 1 to 5, wherein the mounting feature on the cutting element (18B) comprises a first groove formed on an inner surface of an opening in a longitudinal end of the cutting element opposed to the cutting end, the groove cooperating with a second groove formed on an end of the cutter mount body (18D) shaped to fit within the opening, and a locking element disposed in the first groove and the second groove.
8. The gouging cutter of claim 7, wherein the cutting element comprises a separate cutting element (118A) affixed to a rotating cutter body (118).
9. The gouging cutter of claim 7, wherein the locking element comprises ball bearings (118D, 118H).
10. The gouging cutter of claim 9, wherein the ball bearings (118H) are adapted to be inserted into the first groove and the second groove through a fill port

(118M) extending radially through the first groove.

11. The gouging cutter of claim 9, wherein the ball bearings (118D) are releasably retained in the first groove and the second groove by a retaining sleeve (118C) having a groove on an internal surface thereof. 5
12. The gouging cutter of claim 7, wherein the locking element comprises at least one of a snap ring (222A) and a set screw (118L). 10
13. The gouging cutter of any one of claims 1 to 12, wherein a ratio of an overall length of the gouging cutter to an overall diameter of the gouging cutter is at most 2.5. 15
14. A drill bit (10), comprising:
 - a bit body (11) having features thereon to enable connection to a drill string; and 20
 - at least one feature for retaining at least one gouging cutter (18) according to any one of claims 1 to 13 on the bit body.
15. The drill bit of claim 14, wherein a cutter mount body (18D) of the at least one gouging cutter is permanently affixable to a corresponding pocket (18A) in the bit body (11). 25
16. The drill bit of any one of claims 13 or 14, wherein the bit body (11) comprises a plurality of blades (12) and the at least one gouging cutter is at least one of mounted rotationally ahead of the plurality of blades and on one of the plurality of blades. 30

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17. The drill bit of any one of claims 14 to 16, further comprising at least one shear cutter (16) affixed to the bit body.
18. The drill bit of any one of claims 14 to 17, wherein the at least one feature comprises a pocket. 40

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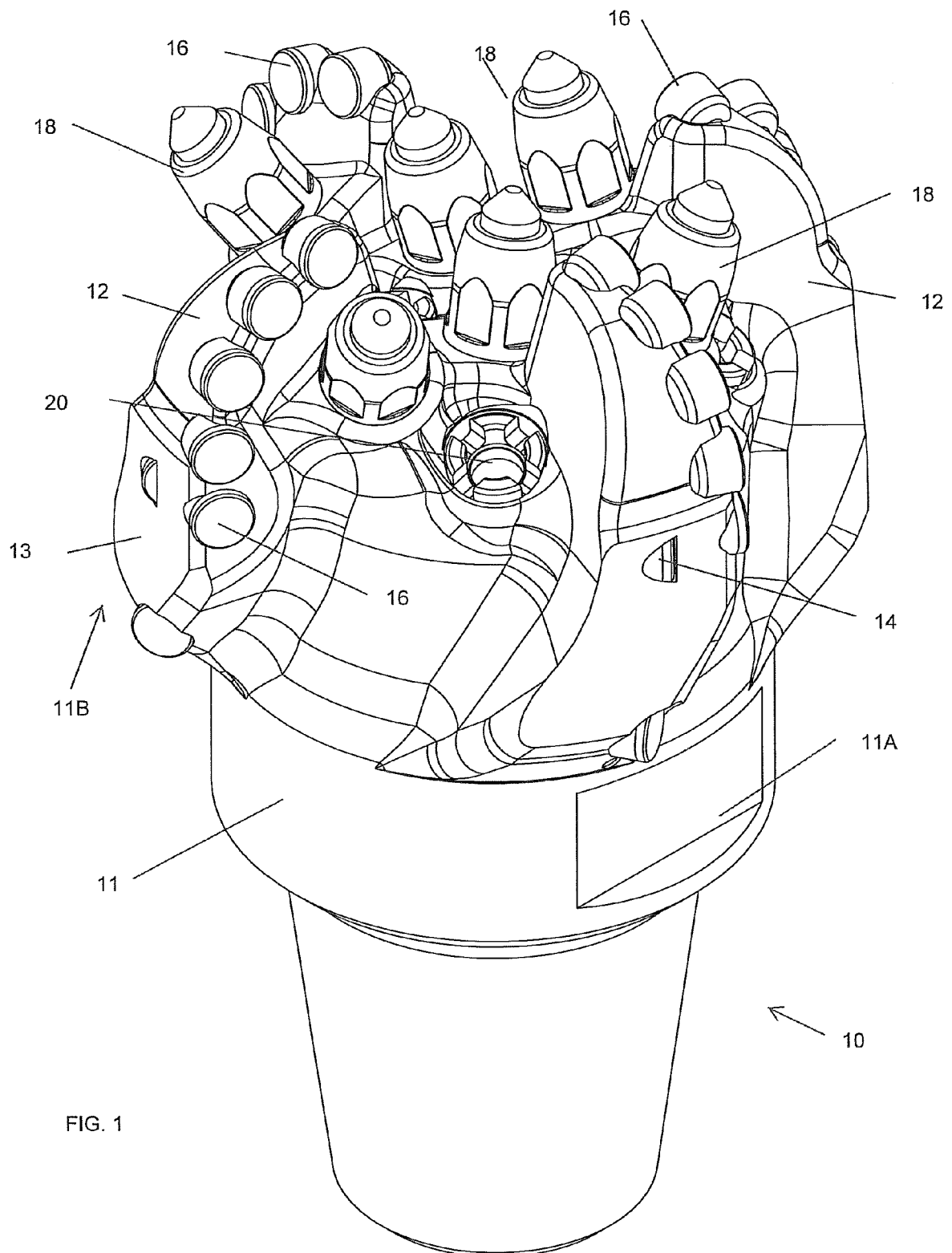


FIG. 1

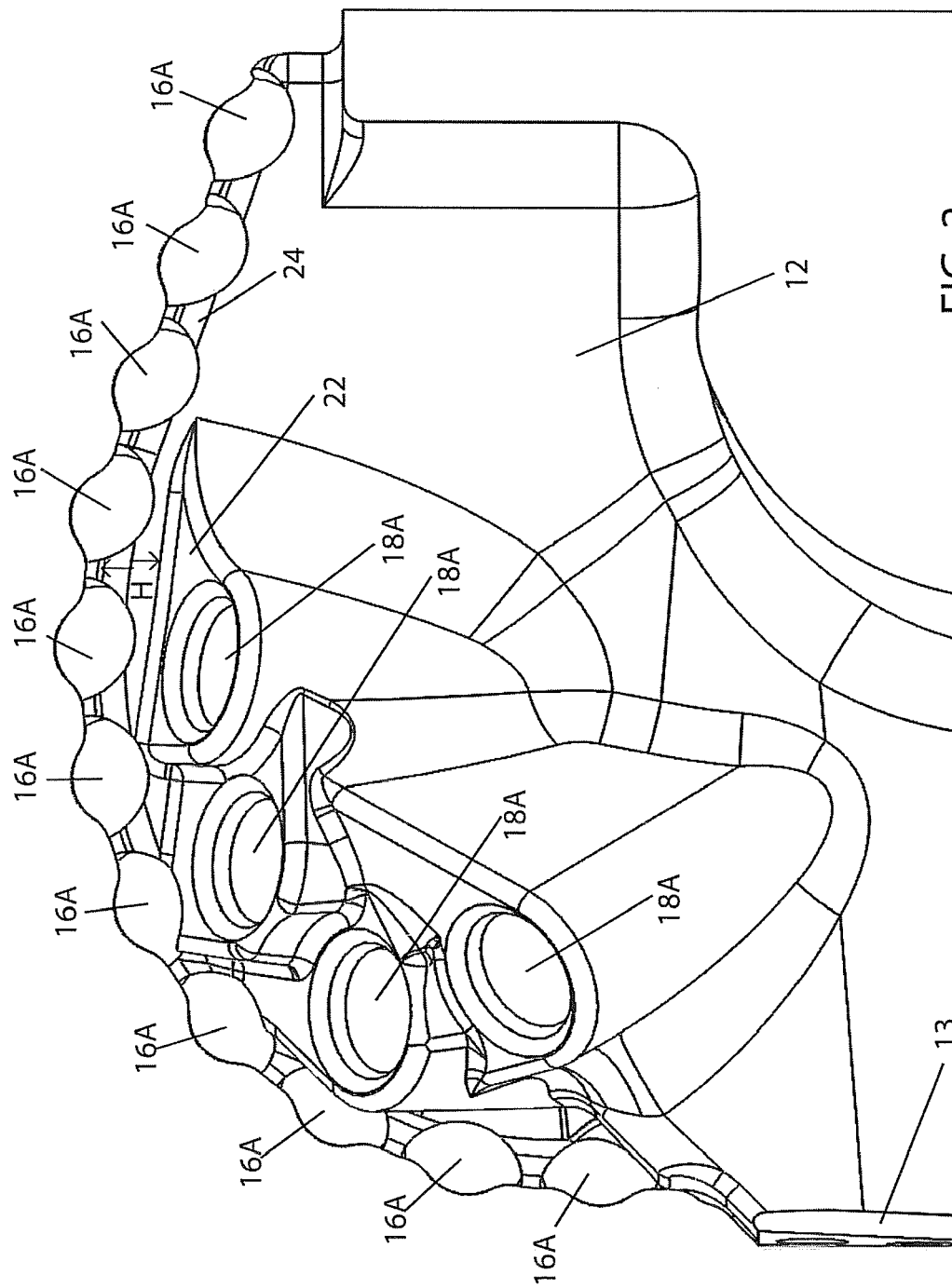


FIG. 2

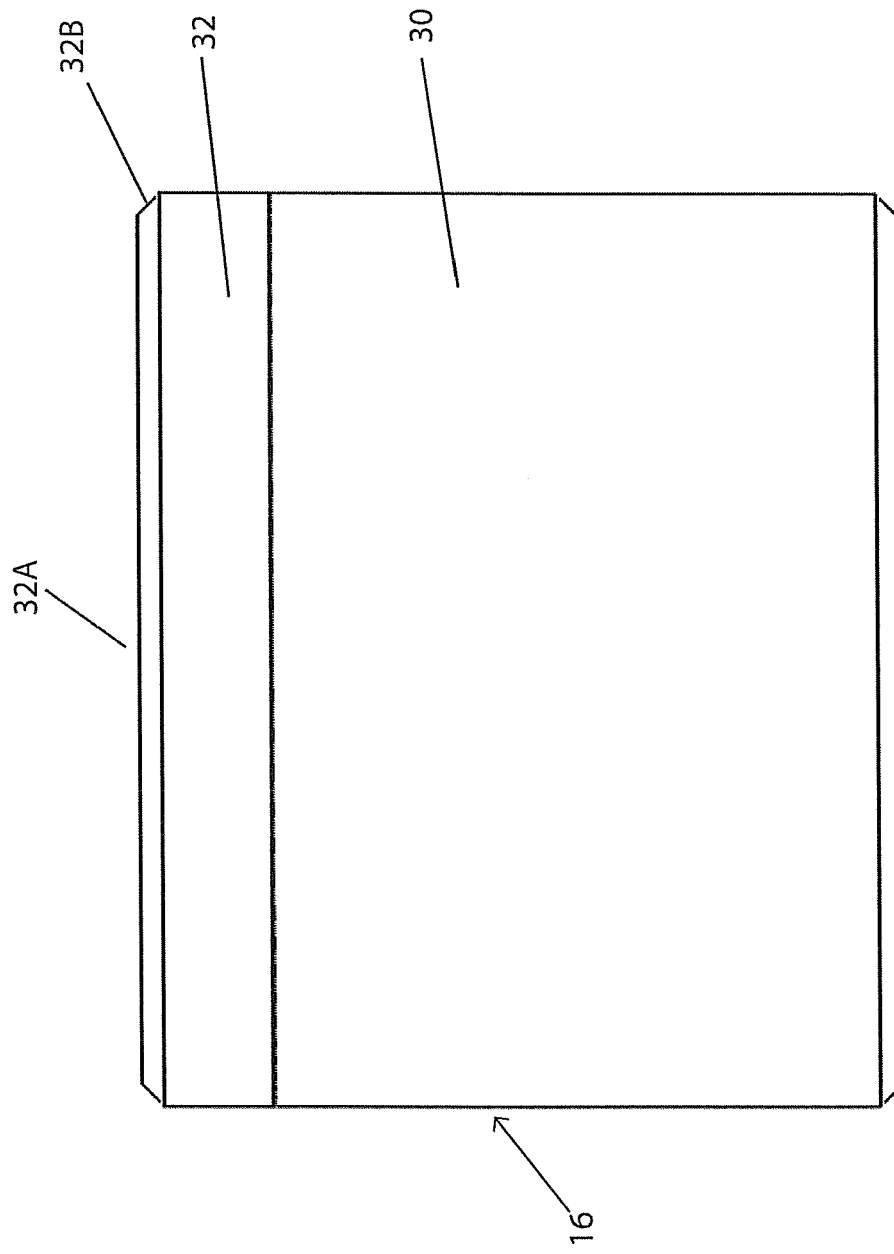
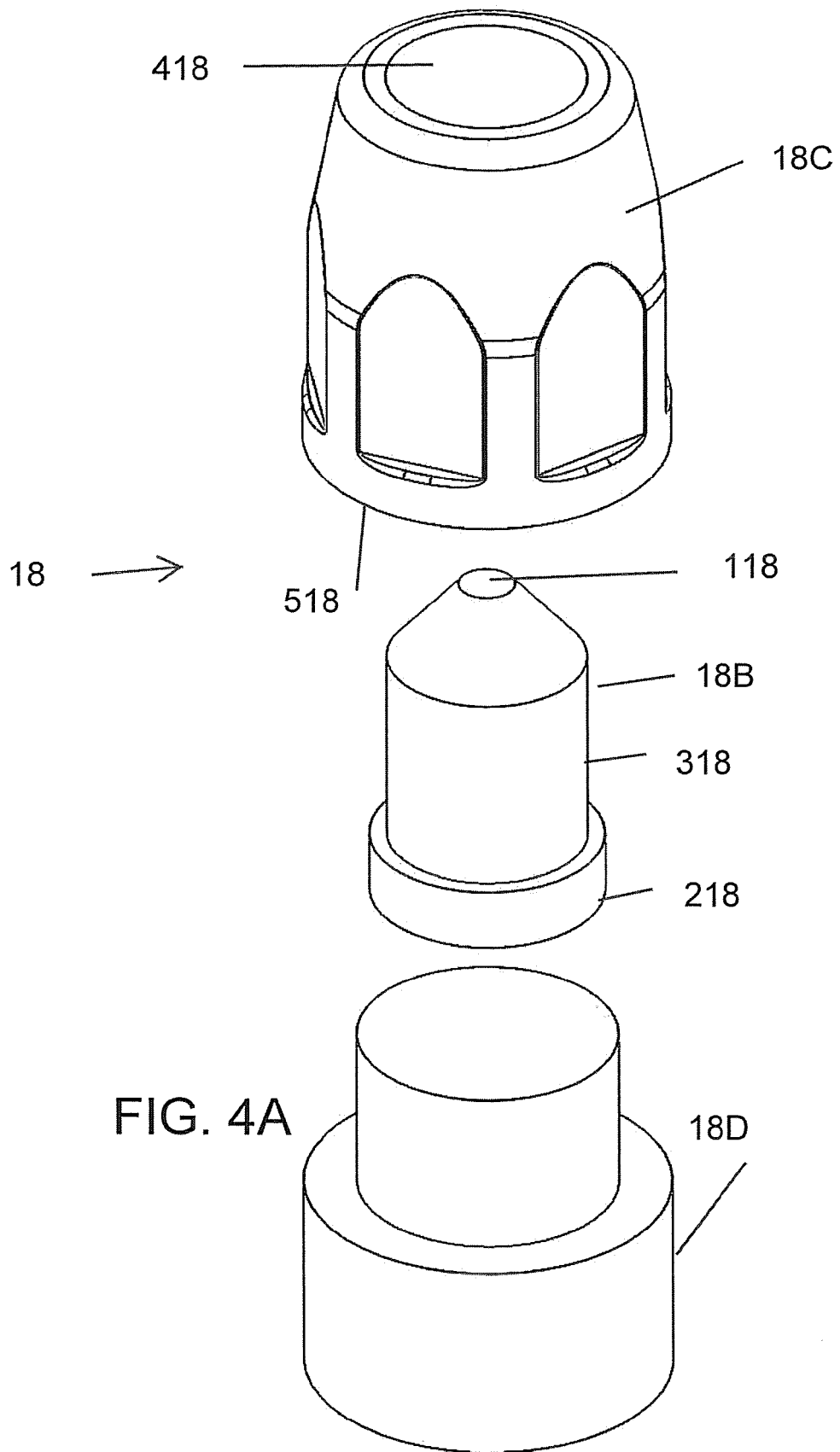


FIG. 3



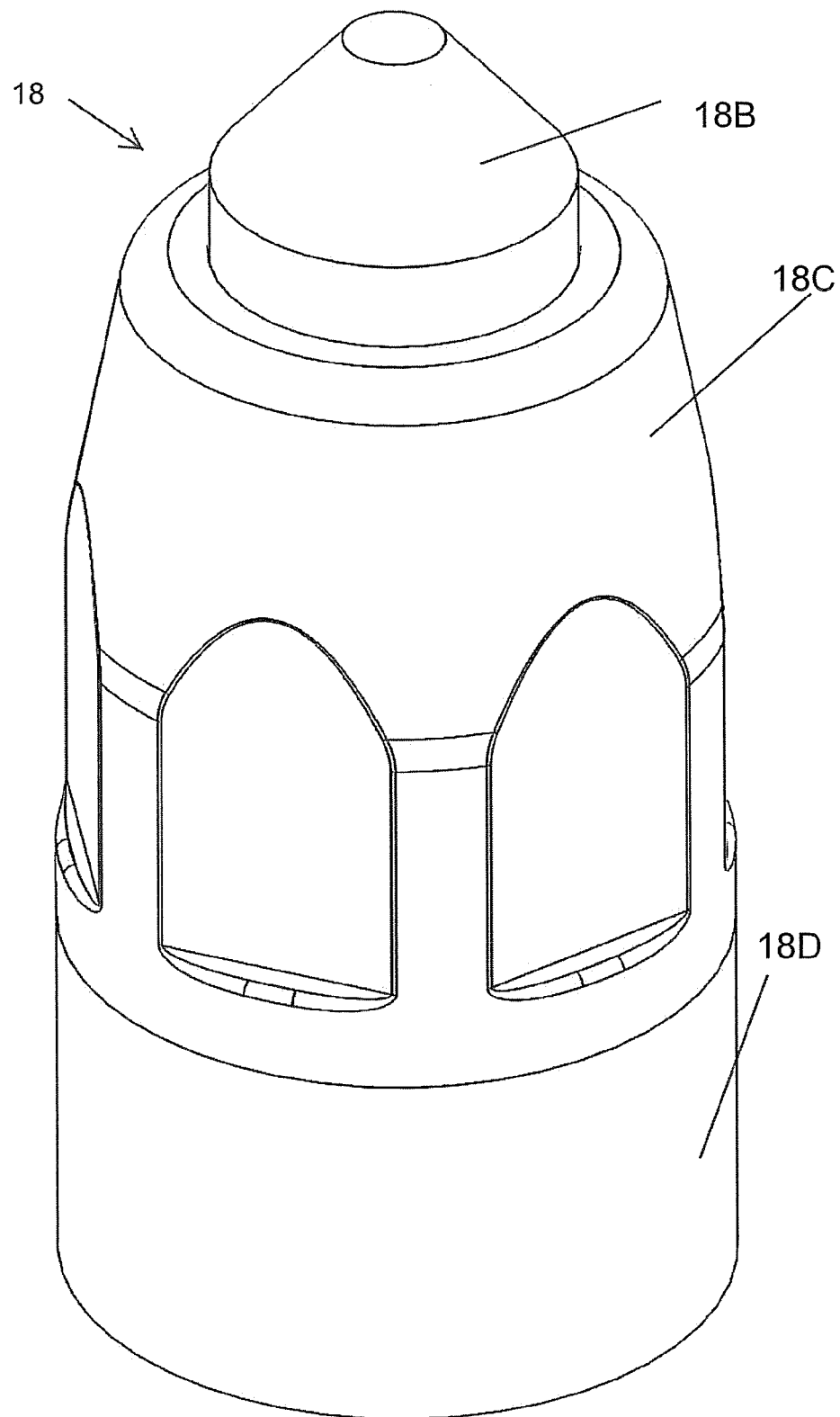


FIG. 4B

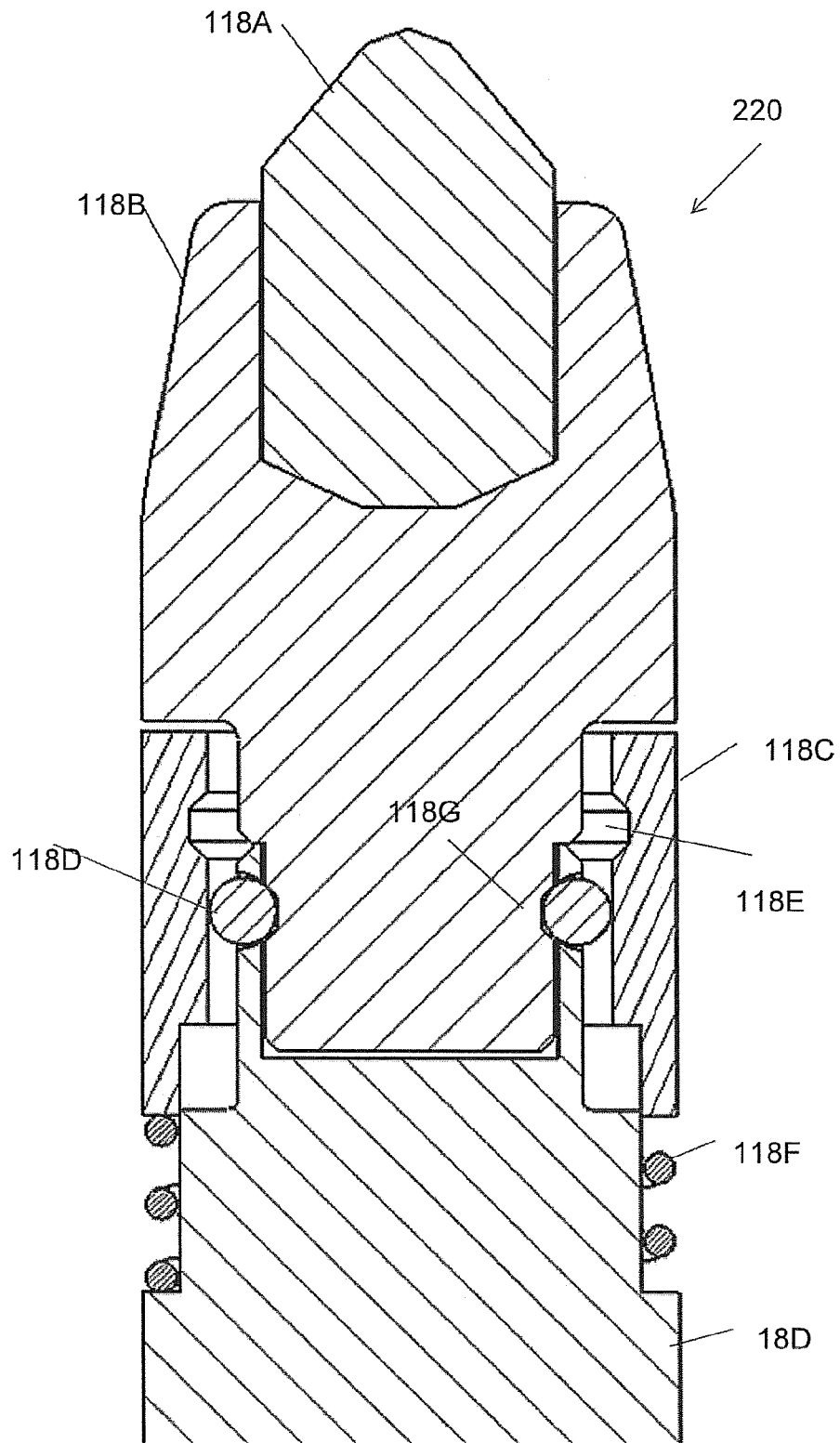


FIG. 4C

FIG. 4D

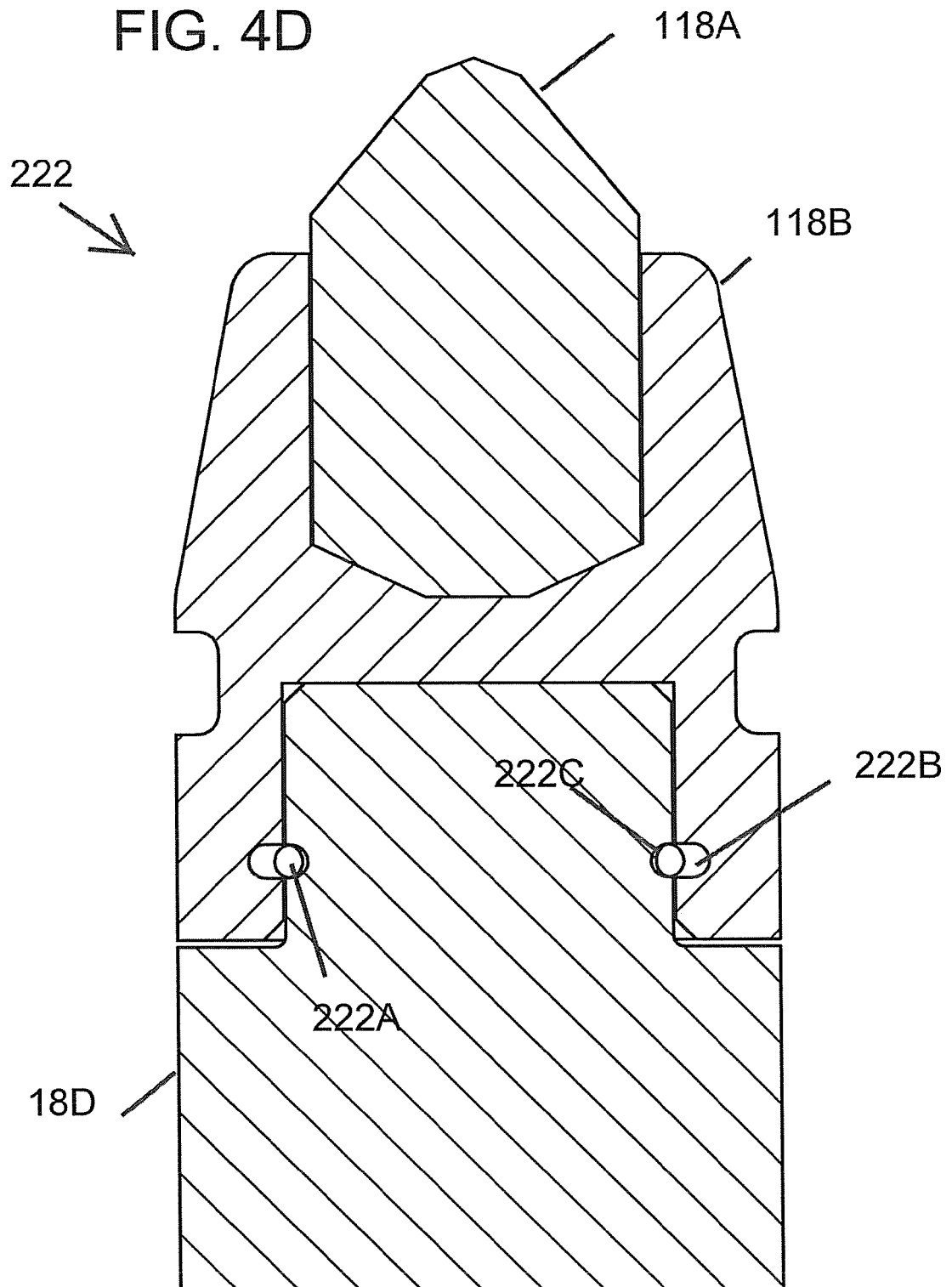
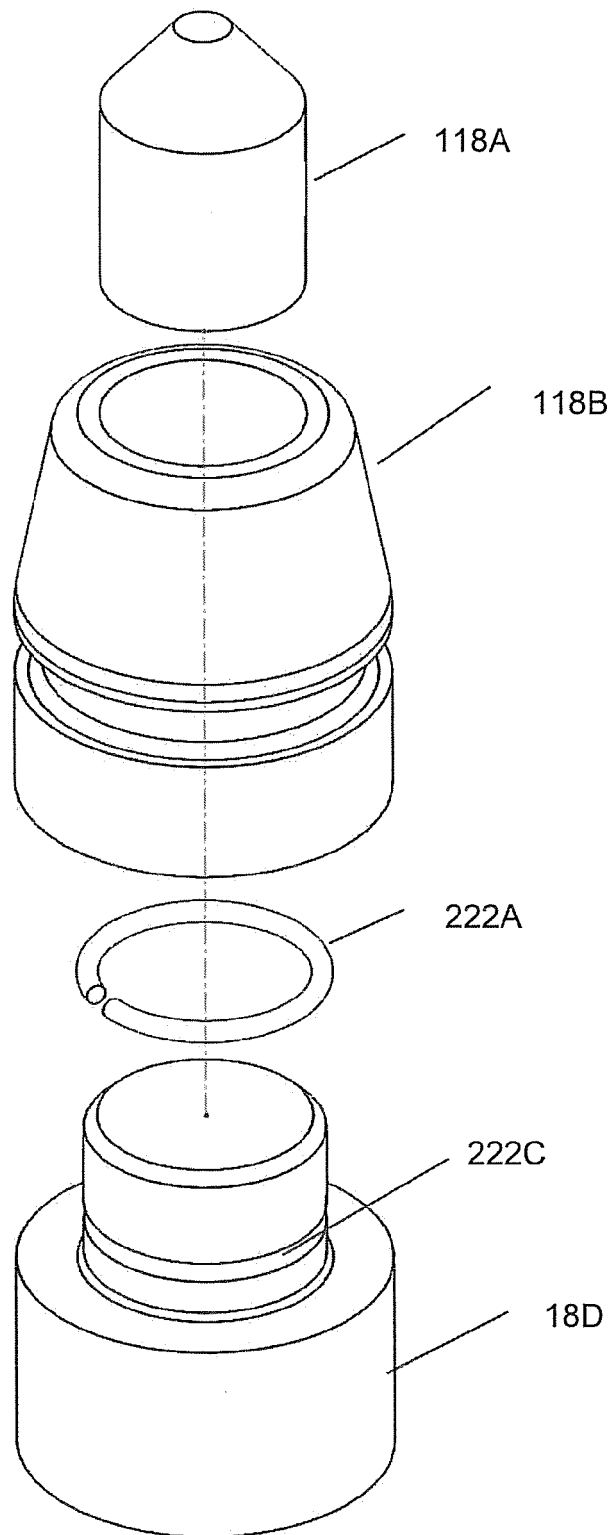
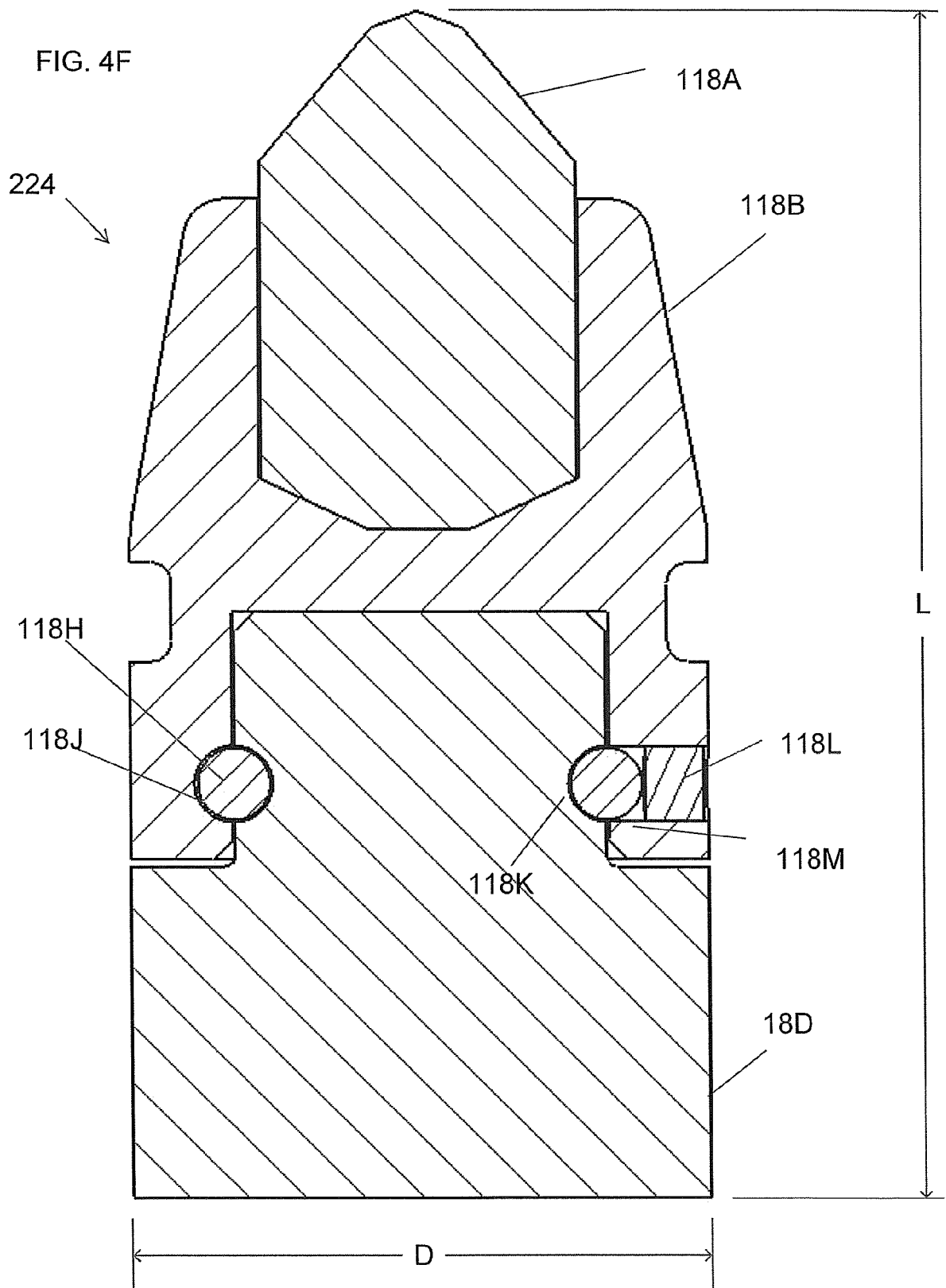
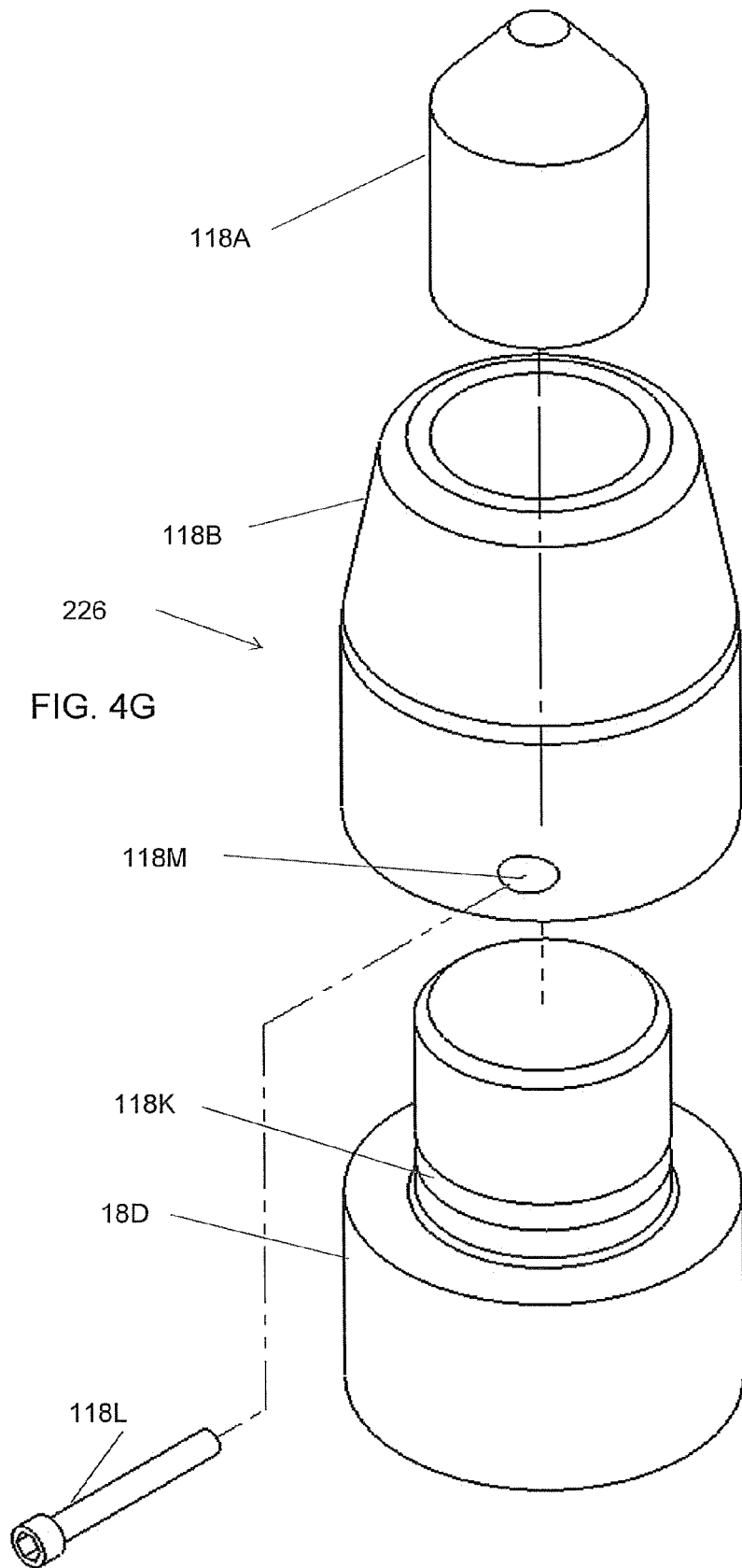


FIG. 4E







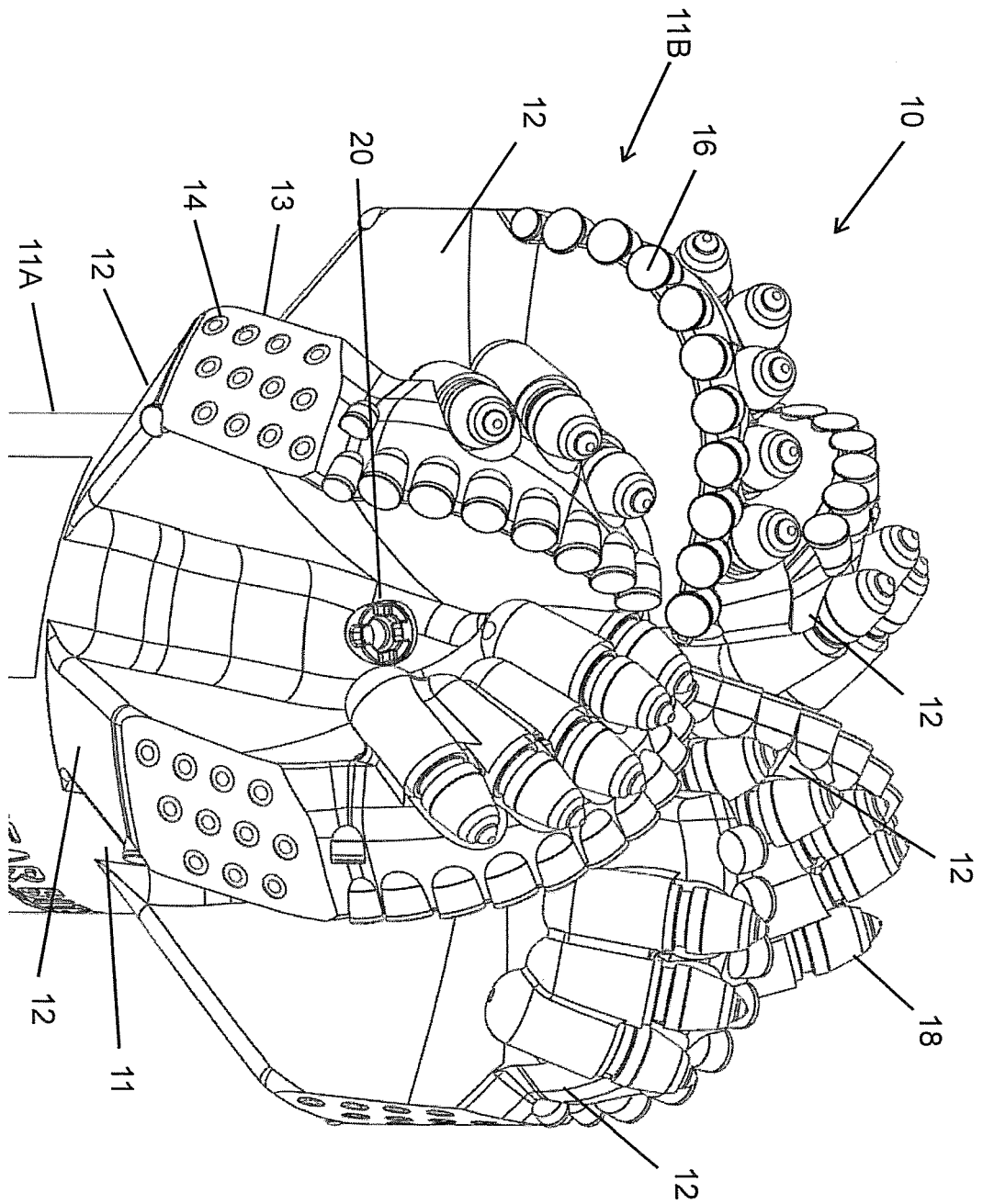
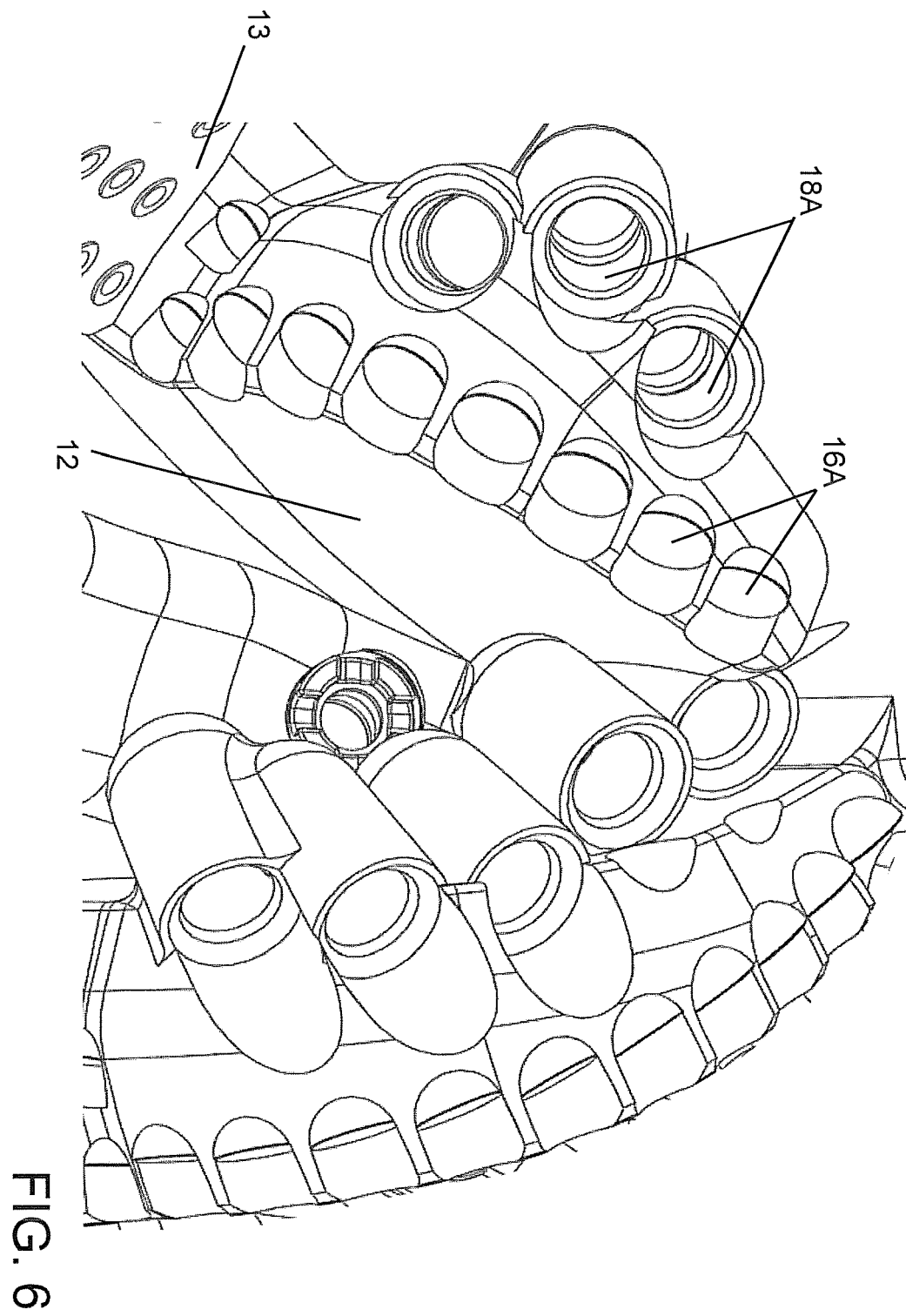


FIG. 5



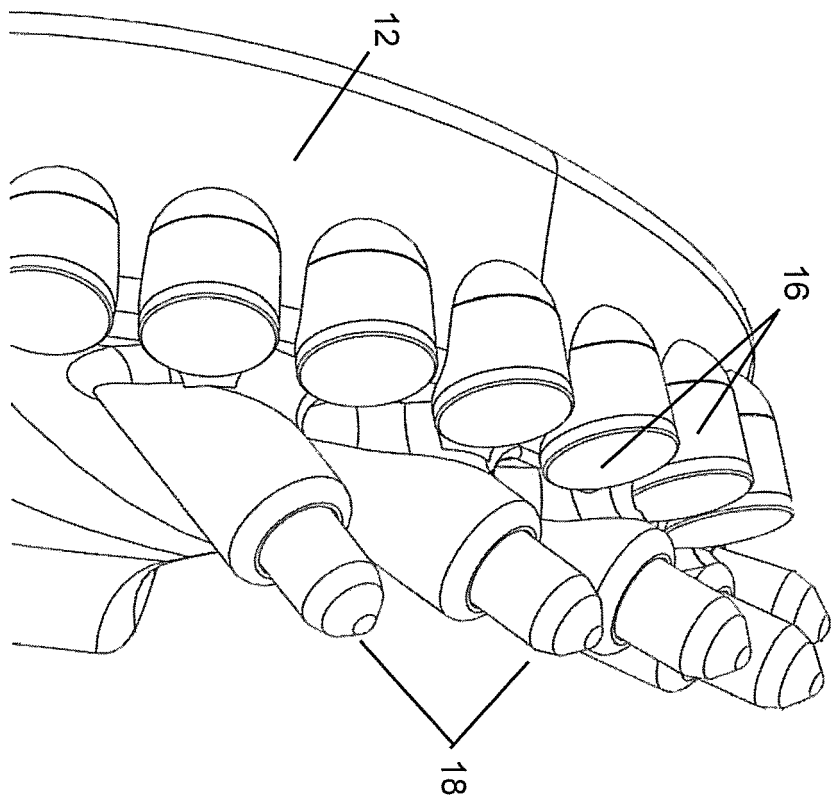


FIG. 7

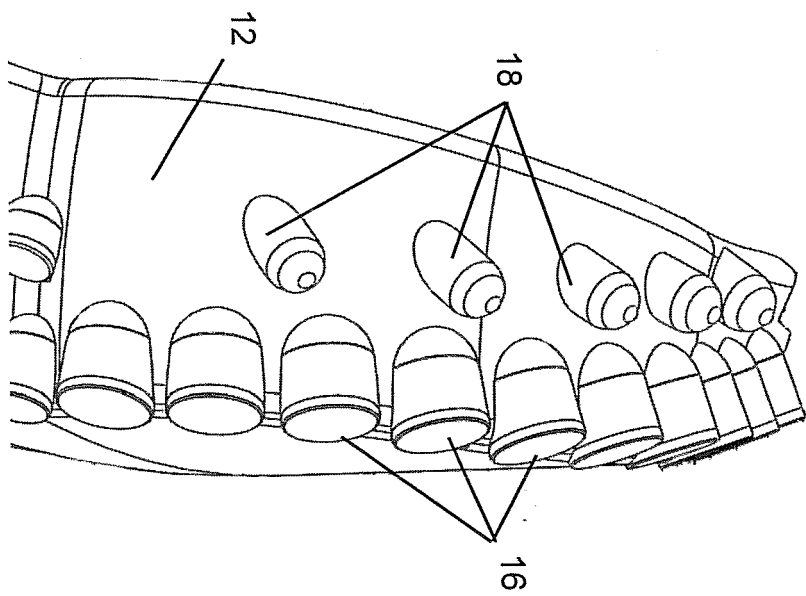


FIG. 8



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Application Number
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Munich		28 January 2016	Morrish, Susan
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