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APPARATUS TO ALIGN PRESS FORMING TOOLS

(57)

Methods, apparatus, systems, and articles of manufacture are disclosed. An example apparatus includes an alignment retainer and a profile retainer, where the profile retainer is movably coupled to the alignment

retainer. A biasing element is positioned between the alignment retainer and the profile retainer to enable movement of the alignment retainer relative to the profile retainer.

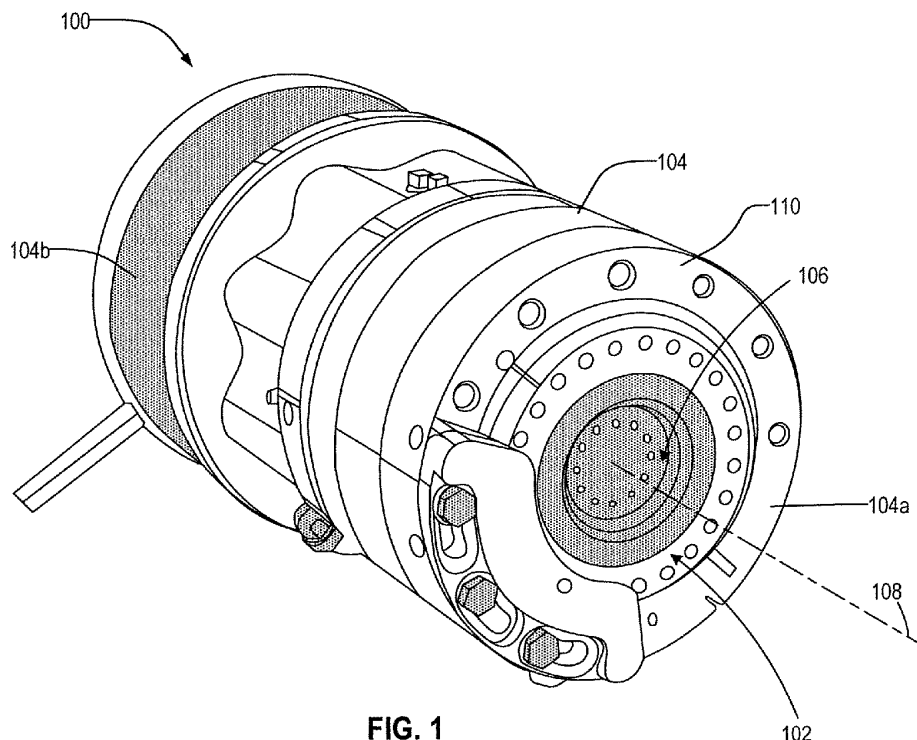


FIG. 1

Description

FIELD OF THE DISCLOSURE

[0001] This disclosure relates generally to press forming machinery and, more particularly, to apparatus to align press forming tools.

BACKGROUND

[0002] Bodymakers or wall ironers are often employed to manufacture metal food or beverage container pre-forms. The bodymakers typically employ an ironing press or metal forming process resulting in an elongated volumetric cylinder of a shaped metallic container body, pre-form or metallic hollow body. Such containers typically include an ironed, or reduced contoured wall, which forms a thin-wall cylinder. Additionally, doming machines or presses (e.g., domers) are often employed to form a contoured base or domed profile at a base or bottom of the thin-walled cylinder. Typically, the domer works in conjunction with the bodymaker to form the domed profile during a completion of a machine stroke of the bodymaker. The domed profile is formed at an end of a single machine stroke of the bodymaker resulting in an individual container being produced with each full stroke of the bodymaker.

BRIEF DESCRIPTION OF THE DRAWINGS

[0003]

FIG. 1 is a perspective view of an example domer apparatus including an example clamp apparatus in accordance with teachings disclosed herein.

FIG. 2 is a cross-sectional view of the example domer apparatus of FIG. 1 taken along a longitudinal axis of the example domer apparatus.

FIG. 3A is a cross-sectional, exploded view of the example clamp apparatus of FIGS. 1-2.

FIG. 3B is a top view of the example clamp apparatus of FIGS. 1-2.

FIG. 4A is a cross-sectional view of the example clamp apparatus of FIGS. 1-2 shown in an example first position.

FIG. 4B is a cross-sectional view of the example clamp apparatus of FIGS. 1-2 shown in an example second position.

FIG. 5 is a partial, cross-sectional side view of an example press forming system including the example domer of FIGS. 1, 2, 3A, 3B, 4A and 4B, where the press forming system is shown in an example first stage in FIG. 5.

FIG. 6A is a partial, cross-sectional side view of the example press forming system of FIG. 5 shown in an example second stage.

FIG. 6B is a partial, enlarged view of FIG. 6A.

FIG. 7A is a partial, cross-sectional side view of the

example press forming system of FIG. 5 shown in an example third stage.

FIG. 7B is a partial, enlarged view of FIG. 7A.

FIG. 8A is a partial, cross-sectional side view of the example press forming system of FIG. 5 shown in an example fourth stage.

FIG. 8B is a partial, enlarged view of FIG. 8A.

FIG. 9 is a partial, cross-sectional side view of the example press forming system of FIG. 5 shown in an example first misaligned position.

FIG. 10 is a partial, cross-sectional side view of the example press forming system of FIG. 5 shown in an example second misaligned position.

FIG. 11 is a partial, cross-sectional side view of the example press forming system of FIG. 5 shown in an example aligned position.

FIG. 12A is a bottom view of another example clamp apparatus disclosed herein that can implement the example domer apparatus of FIG. 1.

FIG. 12B is a cross-sectional, side view of the example clamp apparatus of FIG. 12A shown in an example first position.

FIG. 12C is a cross-sectional, side view of the example clamp apparatus of FIG. 12A shown in an example second position.

FIG. 13A is a top view of an example profile retainer of the example clamp apparatus of FIGS. 12A and 12B.

FIG. 13B is a cross-sectional side view of the example profile retainer of FIG. 13A.

FIG. 13C is a bottom view of the example profile retainer of FIG. 13A.

FIG. 14A is a top view of an example alignment retainer of the example clamp apparatus of FIGS. 12A and 12B.

FIG. 14B is a cross-sectional side view of the example alignment retainer of FIG. 14A.

FIG. 14C is a bottom view of the example alignment retainer of FIG. 14A.

FIG. 15A is a partial, cross-sectional view of a conventional press forming system shown in a first condition.

FIG. 15B is a partial, cross-sectional view of the conventional press forming system of FIG. 15A shown in a second condition.

[0004] As used in this patent, stating that any part (e.g., a layer, film, area, region, or plate) is in any way on (e.g., positioned on, located on, disposed on, or formed on, etc.) another part, indicates that the referenced part is in contact with the other part with one or more intermediate part(s) located therebetween.

[0005] As used herein, connection references (e.g., attached, coupled, connected, and joined) may include intermediate members between the elements referenced by the connection reference and/or relative movement between those elements unless otherwise indicated. As such, connection references do not necessarily infer that

two elements are directly connected and/or in fixed relation to each other. As used herein, stating that any part is in "contact" with another part is defined to mean that there is no intermediate part between the two parts.

[0006] Unless specifically stated otherwise, descriptors such as "first," "second," "third," etc., are used herein without imputing or otherwise indicating any meaning of priority, physical order, arrangement in a list, and/or ordering in any way, but are merely used as labels and/or arbitrary names to distinguish elements for ease of understanding the disclosed examples. In some examples, the descriptor "first" may be used to refer to an element in the detailed description, while the same element may be referred to in a claim with a different descriptor such as "second" or "third." In such instances, it should be understood that such descriptors are used merely for identifying those elements distinctly that might, for example, otherwise share a same name.

[0007] As used herein, "approximately" and "about" modify their subjects/values to recognize the potential presence of variations that occur in real world applications. For example, "approximately" and "about" may modify dimensions that may not be exact due to manufacturing tolerances and/or other real world imperfections as will be understood by persons of ordinary skill in the art. For example, "approximately" and "about" may indicate such dimensions may be within a tolerance range of +/- 10% unless otherwise specified in the below description.

[0008] As used herein, a "tool" refers to any mechanical device used in metal stamping to cut, support, or form metallic materials, such as sheet metal. Examples of tools can include jigs, fixtures, drills, cutting blades, or dies. As used herein, a "die" refers to a tool that functionally changes the shape of metallic materials, such as sheet metal. As used herein, a die can refer to the male or female components of a larger tool or press forming machine(s). As used herein, a "punch die" refers to a male die or a female die that is actuated toward a female die or around a male die, respectively. As used herein, when the punch die is a male die, it is said that the metallic material is drawn into the stationary female die. As used herein, when the punch die is female die, it is said that the metallic material is drawn around the stationary male die.

DETAILED DESCRIPTION

[0009] Bodymakers are often employed to form thin walled can bodies for packaging beverages, such as beer, fruit juice or carbonated beverages using methods to draw and iron a sheet metal blank. In a typical manufacturing method for making a drawn and ironed can body, a circular disk or blank is cut from a sheet of light gauge metal (e.g., such as aluminum). The blank is then drawn into a shallow cup using cup forming equipment. The cup is then transferred to a bodymaker where the can shape is formed. The bodymaker redraws and irons

the sidewall of the cup to approximately the desired height of the can body. Specifically, a ram or punch of the bodymaker forces the cup through a series of ironing dies to elongate or shape the puck into a can body and progressively reduce a wall thickness of the can body to obtain the desired size and thickness of the can. Ultimately, the bodymaker also interacts with a domer to form a dome and other features on the bottom of the can. The dome and other features on the bottom of the can are referred to herein as the "bottom profile" of a drawn and ironed can body.

[0010] For example, the can body that is carried on the ram of the bodymaker interacts with (e.g., contacts) a bottom forming tool or domer to form a dome on a base of the can body. The ram of the bodymaker is typically driven through a link at one end of a pivoted lever. The lever is connected to a driven crankshaft via a connecting rod and converts arcuate motion of the crankshaft into linear motion (e.g., horizontal motion) of the ram. Where the ram motion is horizontal, bearings in a cradle or frame support the ram. A height of a resultant can body is dictated predominantly by a stroke length of the ram of the bodymaker. Thus, the ram of the bodymaker interacts with the domer near or at an end or full stroke position of the ram.

[0011] Typically, to avoid wrinkling, coining or other defects, a ram of the bodymaker and a domed die of the domer should be axially and/or coaxially aligned during the press forming process of the can bottom when forming the bottom profile. However, in some instances, the ram of the bodymaker can become misaligned (e.g., axially and/or coaxially misaligned) with the domed die of the domer during a dome forming operation. In general, misalignments can occur due to wear and/or repeated use of components of the bodymaker that moves the punch tool back and forth. In some instances, such misalignments can occur based on a size (e.g., a diameter and/or length) of a ram of the bodymaker, bending of actuation machine parts, vibration during operation, etc. In some instances, a ram end of the bodymaker, when adjacent the domer in the near or full stroke position, is cantilevered from the bodymaker. As a result, vibration of the ram and/or other factors can cause the ram to offset or misalign relative to a longitudinal centerline of the domer or dome die.

[0012] In some examples, misalignment between the ram of the bodymaker and the domer assembly can cause unwanted deformation or coining to occur in the can bottom. As used herein, the terms "coining" and/or "coin mark" refer to a reduction in material thickness (e.g., a wall thickness of a can body) due to extreme compression or pressure. Coining is a defect in a can body (e.g., between a lip and a dome surface of a bottom profile of a can body) that can cause fracturing in a lip portion and/or the concave portion of the can bottom profile or wall. When the ram or punch tool of a bodymaker is misaligned with a domed die of a domer assembly, a portion of a radial circumference of the can bottom initially con-

tacts the dome die prior to a remaining portion of the radial circumference of the can bottom. The punch tool then transmits the press force to the portion engaged with the dome die, which can cause coining to occur. In general, an amount of misalignment, a magnitude of a press force, and/or a shape of a nose of the ram are some factors that can determine whether coining occurs during dome formation. Furthermore, as the punch tool draws sheet metal around the die, the coined portion is also pulled toward a central axis of the can body.

[0013] For example, FIGS. 15A and 15B are cross-sectional, partial views of a bodymaker and domer assembly 1500 (e.g., a horizontal press forming system). The bodymaker and domer assembly 1500 of the illustrated example includes a domer 1502 and a bodymaker 1504 for forming a can body 1508 having a dome-shaped can end or bottom profile 1506. The bodymaker 1504 includes a tool punch or ram 1510 that draws and irons the can body 1508. The ram 1510 supports the can body 1508 after formation and directs the can body 1508 toward the domer 1502 at an end of stroke position of the ram 1510. The domer 1502 includes a clamp ring 1512 slidably coupled relative to a domer die 1514 that centers the bottom profile 1506 relative to the domer die 1514.

[0014] In some instances, as shown in FIG. 15A, the ram 1510 can be concentrically and/or coaxially misaligned relative to the domer 1502 (e.g., due to vibration). Such misalignment causes a first central axis 1516 of the domer 1502 to be misaligned or offset relative to a second central axis 1518 of the ram 1510 by a displacement 1520 (e.g., a vertical distance in the orientation of FIG. 15A). As a result of such misalignment, a first portion 1522 of a circumference of the bottom profile 1506 of the can body 1508 engages or strikes a profile portion 1524 (e.g., an edge) of the clamp ring 1512 prior to a second portion 1526 of the circumference of the bottom profile 1506 of the can body 1508 striking the profile portion 1524 of the clamp ring 1512. For example, the ram 1510 is cantilevered from a frame of the bodymaker 1504 and can sway relative to the second central axis 1518 due to vibrations.

[0015] When such an initial contact between the profile portion 1524 and the bottom profile 1506 occurs at the first portion 1522 prior to contact between the profile portion 1524 and the second portion 1526, a coining mark 1530 can form at the bottom profile 1506 of the can body 1508. As the press forming process continues to a second stage 1501 as shown in FIG. 15B to form a final dome-shaped end at the bottom profile 1506, the ram 1510 draws the coining mark 1530 inward during doming between a transition of a lip portion 1532 of the bottom profile 1506 and a dome 1534 of the bottom profile 1506 of the can body 1508. For example, the coining mark 1530 is positioned along a chime leg 1535 of the bottom profile. Such drawing of the coining mark 1530 causes the coining mark 1530 to stretch and form a wall thickness (e.g., 0307 of the can body that is too thin, which can cause can body failure when the can body 1508 is filled with pressurized contents and a can end or lid is attached

to the can body 1508. As such, the coining that occurs due to misalignment of press forming tools can lead to significant financial losses for a can manufacturer and/or customer. Furthermore, just a small degree of misalignment (e.g., one degree, five degrees, etc.) or a small displacement 1520 (e.g., 0.010 inches, 0.020 inches, 0.050 inches, etc.) can lead to coining.

[0016] Example systems and apparatus disclosed herein improve alignment between a domer and a bodymaker. Specifically, example apparatus disclosed herein improve alignment between a ram of a bodymaker and a domer die of a domer prior to forming a domed profile of a can body. As used herein, to align press forming tools includes aligning coaxially and/or concentrically a longitudinal axis of the domer die of the domer and a longitudinal axis of the ram and/or the can body during a doming formation process. More specifically, example apparatus disclosed herein enable a can body to be coaxially and/or concentrically aligned with longitudinal axis of a domer die of a domer and a longitudinal axis of a ram of the bodymaker when the can end is clamped or positioned between (e.g., directly engaged with) the domer die and the ram. Specifically, the example systems and apparatus disclosed herein can align a first central axis of a ram or ram die with a second central axis of a domer or domer die. The example systems and apparatus disclosed herein can be used to form a bottom of a can that reduces and/or eliminates a frequency of coining. Preventing or reducing the frequency of coining can lead to a significant reduction in can failures and significant cost savings for can manufacturers.

[0017] Example apparatus disclosed herein employ a multi-part clamp assembly. Example multi-part clamp assemblies disclosed herein enable alignment (e.g., coaxial and/or concentric alignment) between a domer assembly (e.g., a domer plug or domer die) and a can end and/or a bodymaker (e.g., a punch nose and/or punch body of a bodymaker) prior to forming a bottom profile (e.g., a domed profile) of a can body. In particular, example apparatus disclosed herein employ a first sleeve or alignment retainer that is movable (e.g., slidably or laterally moveable) relative to a second sleeve or profile retainer. In this manner, example alignment retainers of example apparatus disclosed herein enable alignment of the can bottom relative to the domer die prior to a can bottom striking example profile retainers of the example apparatus. Thus, the press forming systems disclosed herein includes an alignment retainer (e.g., retaining ring, alignment sleeve, means for aligning, etc.) to align a punch tool of a bodymaker relative to a longitudinal axis of a domer die of a domer before a bottom of the can body is formed. Example clamp apparatus disclosed herein improve alignment between a central axis of a bodymaker (e.g., a punch tool) and a central axis of a domer (e.g., a domer die) such that the bottom end of the can body is symmetric relative to the domer die on impact, thereby reducing instances of coining and/or other structural defects.

[0018] An example multi-part clamp assembly or apparatus disclosed herein includes a clamp apparatus. The clamp apparatus is to be coupled to a domer body adjacent a domer die supported by the domer body. The clamp apparatus is to receive at least a portion of the domer die. In some examples, the clamp apparatus includes a first sleeve having a first profile end to concentrically align punch tooling of a ram with the domed die in response to the punch tooling moving toward the domed die. The first profile of the example first sleeve disclosed herein is to radially clamp the can body in fixed alignment with the domed die (e.g., after the first sleeve concentrically aligns the punch tooling with the domed die). Example clamp apparatus disclosed herein include a second sleeve movably coupled relative to the first sleeve. The example second sleeve has a second profile end to shape a lip and/or a bottom profile of a can body. The second profile end is spaced from the first profile end by a first distance when the first profile end and/or the first sleeve concentrically aligns the punch tooling and radially clamps the can body relative to the domer die. The second profile end is spaced from the first profile end by a second distance after the can body is concentrically aligned with the punch tooling and radially clamped relative to the domer die, where the second distance being less than the first distance. In some examples, the first sleeve disclosed herein includes a first central opening to receive the second sleeve at least partially, and the second sleeve includes a second central opening to at least partially receive the domer die.

[0019] Example clamping apparatus disclosed herein include one or more biasing elements positioned between the first sleeve and the second sleeve, the biasing element(s) to enable the first sleeve to move (e.g., axially slide or move) relative to the second sleeve between a first operative position to provide the first distance between the first profile end and the second profile end and a second operative position to provide the second distance between the first profile end and the second profile end. In some examples, the first sleeve is a first cylindrical body and includes a plurality of spring cavities radially spaced relative to a longitudinal axis of the first sleeve. The spring cavities extend partially through the cylindrical body such that respective ends of the spring cavities include threaded bores. In some examples, the second sleeve includes a second cylindrical body and a flange. In some examples, the second cylindrical body is to be at least partially received by the first sleeve. Example clamping apparatus disclosed herein include biasing elements positioned in the spring cavities. Example clamping apparatus disclosed herein include a plurality of fasteners to slidably couple the first sleeve and the second sleeve. In some examples, the fasteners are to threadably couple to the threaded bores of the spring cavities.

[0020] FIG. 1 is a perspective view of an example domer apparatus 100 (e.g., a domer assembly) including a clamp apparatus or clamp assembly 102 in accordance with teachings of this disclosure. The example domer

apparatus 100 of the illustrated example includes a body 104 (e.g., a cylindrical body) having a first end 104a and a second end 104b opposite the first end 104a. The clamp assembly 102 is coupled to the body 104. In particular, the clamp assembly 102 is retained within the body 104 via a retainer 110 (e.g., threadably coupled to the body 104). Specifically, the clamp assembly 102 is coaxially aligned with a domer die assembly 106 and/or a longitudinal axis 108 (e.g., a first central axis) of the body 104. The clamp assembly 102 of the illustrated example is positioned adjacent the first end 104a of the body 104 and interacts with a domer die assembly 106 of the domer apparatus 100. The example domer apparatus 100 of the illustrated example can be employed with a press forming system that includes a bodymaker.

[0021] FIG. 2 is a cross-sectional view of the example domer apparatus 100 of FIG. 1 taken along the longitudinal axis 108 of the domer apparatus 100. The body 104 of the domer apparatus 100 of the illustrated example defines a central opening 202 (e.g., a central through hole or cavity) to receive a piston 204. A first side 204a of the piston 204 and a portion 202a of the central opening 202 between an end cap 206 and the first side 204a of the piston 204 defines a pressure chamber 208. The pressure chamber 208 receives an operating fluid (e.g., pressurized air) via an inlet 210 formed in the end cap 206 (e.g., to receive pressurized fluid from a supply source 246). The piston 204 includes a plurality of pins 212 (e.g., cylindrical pins, posts or rods) radially spaced about the longitudinal axis 108 (e.g., which is coaxially aligned with a center axis of the piston 204). The pins 212 of the illustrated example engage a first side 214a (e.g., a first end) of the clamp assembly 102 oriented toward the pressure chamber 208 that is opposite a second side 214b of the clamp assembly 102 oriented toward the first end 104a of the body 104.

[0022] The domer die assembly 106 of the illustrated example includes a domer die support 216 and a domer die 218 positioned in the central opening 202 of the body 104. Specifically, the domer die support 216 and the domer die 218 of the illustrated example are positioned between the second side 204b of the piston 204 and the first end 104a of the body 104 and/or the retainer 110. The domer die support 216 contains and/or carries the domer die 218 within the body 104 of the domer apparatus 100. For example, the domer die 218 is coupled (e.g., fixed or fastened) to the domer die support 216. The domer die support 216 includes a die support body 220 positioned on the second side 204b of the piston 204 and includes a first end 220a opposite a second end 220b that receives and/or supports the domer die 218. The domer die 218 includes a domer die body 222 (e.g., a punch tool) and a flange 224. The domer die body 222 is at least partially received by a center opening 226 (e.g., pass-through opening) of the clamp assembly 102. Thus, the clamp assembly 102 of the illustrated example encircles or surrounds the domer die body 222. The flange 224 of the illustrated example is positioned between the

first side 214a of the clamp assembly 102 and the first end 220a of the die support body 220. In some examples and/or at various stages of operation as described below, the flange 224 engages the die support body 220 and/or the clamp assembly 102.

[0023] The piston 204 of the illustrated example engages the clamp assembly 102. To enable the piston 204 to engage the clamp assembly 102, the pins 212 of the piston 204 pass through openings 228a and 228b (e.g., apertures or bores) formed in the die support body 220 of the domer die support 216 and the flange 224 of the domer die 218, respectively. In other words, the pins 212 are slidably coupled to the domer die support 216 and the domer die 218 via the openings 228a, 228b. Additionally, the die support body 220 includes an annular wall 230 formed at the second end 220b of the die support body 220 and protrudes from the second end 220b in a direction toward the end cap 206. Thus, the annular wall 230 of the illustrated example extends past the first side 204a of the piston 204.

[0024] As described below, the domer die assembly 106 (e.g., the domer die 218 and/or the domer die support 216) moves (e.g., slides) relative to the body 104 and/or clamp assembly 102 along the longitudinal axis 108 in a first linear direction 232 (e.g., a first horizontal direction) and a second linear direction 234 (e.g., a second horizontal direction). Likewise, the clamp assembly 102 of the illustrated example moves (e.g., slides) along the longitudinal axis 108 relative to the body 104 and/or the domer die assembly 106 in the first linear direction 232 and the second linear direction 234.

[0025] To enable overtravel of the domer die assembly 106 (e.g., the domer die support 216) in the second linear direction 234 toward the end cap 206, the domer apparatus 100 of the illustrated example include a plurality of springs 236 (e.g., donut springs). The springs 236 of the illustrated example are radially spaced relative to the longitudinal axis 108. The springs 236 bias the dome die support 216 in the first linear direction 232 toward the clamp assembly 102. The springs 236 of the illustrated example are positioned between the end cap 206 and a spring seat 238 (e.g., a spring seat ring). The spring seats 238 are positioned between the springs 236 and an end 230a of the annular wall 230. In an overtravel scenario (when a ram provides a force against the domer die body 222 that is greater than a force provided to the piston 204 by the operating fluid in the pressure chamber 208), the domer die support 216 moves toward the springs 236 such that the annular wall 230 moves away from (e.g., disengages or detaches from) a housing 240 that houses the clamp assembly 102. In turn, the springs 236 absorb the force of the ram and cause the domer die support 216 to return to an initial position in which the annular wall 230 engages the housing 240 as shown in FIG. 2 when the ram force is removed from the domer die assembly 106. The end cap 206, the springs 236 (e.g., a spring housing), the annular wall 230, the housing 240 and the retainer 110 define an outer surface 242 of the

body 104.

[0026] FIG. 3A is an exploded, cross-sectional view of the example clamp assembly 102 of FIGS. 1 and 2. FIG. 3B is a top view of the example clamp assembly 102 of FIGS. 1 and 2. The clamp assembly 102 of the illustrated example includes a first body or alignment retainer 302 (e.g., a clamp ring, a first sleeve) and a second body or profile retainer 304 (e.g., a profile ring, a second sleeve). The clamp assembly 102 of the illustrated example also includes biasing elements or springs 306, sleeves 308 and fasteners 310. However, as described below, in some examples, the clamp assembly 102 may not include the sleeves 308 and/or the fasteners 310.

[0027] The alignment retainer 302 (e.g., a first cylindrical body) of the illustrated example includes an outer wall 312 (e.g., an outer body) and a center opening 314 (e.g., a pass-through bore or hole). The center opening 314 of the illustrated example extends between a first end 302a (e.g., or side, end surface, or side surface) of the alignment retainer 302 and a second end 302b (e.g., or side, end surface, or side surface) of the alignment retainer 302 opposite the first end 302a. The center opening 314 of the illustrated example is formed coaxially relative to a center or longitudinal axis 316 of the alignment retainer 302. The center opening 314 has a dimension 314a (e.g., a diameter). The first end 302a of the alignment retainer 302 (e.g., the outer wall 312) defines an alignment/clamp profile 318 (e.g., a first profile end). Specifically, the alignment/clamp profile 318 transitions to the center opening 314 at the first end 302a of the alignment retainer 302. The alignment/clamp profile 318 of the illustrated example has an alignment surface 318a (e.g., a tapered shape) that transitions to a clamp surface 318b. The alignment/clamp profile 318 of the illustrated example includes a first lead-in surface or profile 318c that transitions to the alignment surface 318a. The second end 302b of the alignment retainer 302 (e.g., the outer wall 312) has a second lead-in surface or profile 320 (e.g., a tapered surface) that transitions to the center opening 314 at the second end 302b of the alignment retainer.

[0028] The alignment retainer 302 (e.g., a first sleeve) of the illustrated example includes a plurality of spring cavities 322. The spring cavities 322 of the illustrated example are radially spaced relative to the longitudinal axis 316 of the alignment retainer 302. Additionally, the spring cavities 322 of the illustrated example at least partially extend between a first end 312a and a second end 312b of the outer wall 312. For example, a length 323a of the spring cavities 322 is less than a length 323b of the outer wall 312 in a direction between the first end 302a and the second end 302b of the alignment retainer 302. In the illustrated example, the spring cavities 322 are accessible from (e.g., have an opening at) the second end 302b of the alignment retainer 302 (e.g., and are not accessible from the first end 302a of the alignment retainer 302). The spring cavities 322 of the illustrated example are bores (e.g., cylindrically shaped apertures). However, in some examples, the spring cavities 322 can

have a square shape, a rectangular shape, and/or any other shape(s). Additionally, each of the spring cavities 322 includes has a threaded bore 325 (e.g., a threaded aperture) formed in a bottom surface 327 of the spring cavities 322. The spring cavities 322 of the illustrated example (e.g., longitudinal axes 322a of the spring cavities 322) are oriented substantially parallel relative to the longitudinal axis 316 of the alignment retainer 302. However, in some examples, the spring cavities 322 (e.g., the longitudinal axes 322a) can be oriented non-parallel (e.g., at a 10 degree angle) relative to the longitudinal axis 316 of the alignment retainer 302. The alignment retainer 302 of the illustrated example is a cylindrical structure. However, in other examples, the alignment retainer 302 can be a rectangular structure, a square structure, an oblong structure and/or any other shaped structure.

[0029] The profile retainer 304 (e.g., a second sleeve) includes an inner wall 324 (e.g., an inner body or sleeve) and a flange 326. The inner wall 324 of the illustrated example has an outer dimension 324a (e.g., a diameter). The inner wall 324 is a cylindrical body defining a center opening 328 (e.g., a pass-through bore or hole) that extends between a first side 304a of the profile retainer 304 and a second side 304b of the profile retainer 304 opposite the first side 304a. The center opening 328 is coaxially aligned with a longitudinal axis 330 of the profile retainer 304. The first side 304a of the profile retainer 304 has a profile forming portion 332 (e.g., a second profile end). The profile forming portion 332 of the illustrated example includes a profile forming surface 332a and a lip forming surface 332b. The profile forming surface 332a and the lip forming surface 332b transition to the center opening 328. The profile forming surface 332a transitions into the lip forming surface 332b. The profile forming surface 332a provides a shape to a bottom end of a can body and the lip forming surface 332b forms an annular lip at a bottom end of a can body. In the illustrated example, the profile forming portion 332 (e.g., the profile forming surface 332a and the lip forming surface 332b) has an S-shaped, cross-sectional shape.

[0030] The flange 326 of the profile retainer 304 includes a plurality of apertures or bores 334. The bores 334 of the illustrated example are radially spaced relative to the longitudinal axis 330 of the profile retainer 304 and extend between a first surface 326a of the flange 326 and a second surface 326b of the flange 326 opposite the first surface 326a. The first surface 326a of the flange 326 is oriented toward the second end 302b of the alignment retainer 302. The bores 334 of the flange 326 receive respective ones of the fasteners 310. Each of the bores 334 of the illustrated example includes a countersink bore 334a formed adjacent the second surface 326b of the flange 326 to receive a bolt head 310a of the fasteners 310. Thus, the bolt head 310a is retained within the countersink bore 334a and the bolt head 310a cannot pass through the smaller sized diameter of the bores 334. Additionally, the profile retainer 304 includes a plurality

of bosses 336. The bosses 336 of the illustrated example extend or protrude from the first surface 326a of the flange 326 in a direction toward the first side 304a of the profile retainer 304 (e.g., the inner wall 324). The bores 334 extend through the bosses 336 and each has a longitudinal axis 334b that is parallel relative to the longitudinal axis 330 of the profile retainer 304. The bores 334 of the illustrated example each have a stepped profile 334c (e.g., a stepped wall) provided by the countersink 334a. The flange 326 of the illustrated example includes a retaining lip 326c (e.g., an annular retaining lip) to help guide movement of the profile retainer 304 relative to the alignment retainer 302.

[0031] The fasteners 310 (e.g., bolts) of the illustrated example include the bolt head 310a, a shank portion 310b and a threaded end 310c. The shank portion 310b is positioned between the bolt head 310a and the threaded end 310c. The shank portion 310b is non-threaded or smooth to enable the movement of components along the shank portion 310b. In particular, a length 338 of the shank portions 310b of the fasteners 310 is greater than the length 323a of the spring cavities 322.

[0032] The sleeves 308 of the illustrated example each include an annular wall 340 and a bottom wall 342 defining a sleeve cavity 344. The sleeve cavities 344 are to slidably receive respective ones of the springs 306. The bottom wall 342 includes an aperture 346 to allow at least a shank portion 310b of the fasteners 310 to pass through the sleeve 308. The sleeve 308 of the illustrated example can be made of plastic, metal, alloy and/or any other material(s). The sleeves of the illustrated example protect respective inner surface 322b of the spring cavities 322 from damage and/or reduce friction between the springs 306 and the inner surfaces 322b of the spring cavities 322. The springs 306, although shown schematically in the figures, are coil springs. However, in other examples, the springs 306 can be Belleville springs and/or any other type of biasing elements or springs. The sleeves 308 of the illustrated example have lengths 348 that are substantially similar to (e.g., identical or within 10 percent of) the length 323a of the spring cavities 322.

[0033] Referring to FIGS. 3A-3B, to assemble the clamp assembly 102, the sleeves 308 are positioned at least partially within respective ones of the spring cavities 322. Next, the springs 306 are positioned at least partially within respective ones of the sleeve cavities 344 of the sleeves 308. Specifically, longitudinal axes 308a of the sleeves 308 align (e.g., coaxially and/or concentrically align with respective longitudinal axes 322a of the spring cavities 322. The profile retainer 304 is then positioned or aligned with the alignment retainer 302. Specifically, the longitudinal axis 316 of the alignment retainer 302 aligns (e.g., coaxially and/or concentrically) with the longitudinal axis 330 of the profile retainer 304. For example, at least a portion of the inner wall 324 of the profile retainer 304 is inserted in the center opening 314 from the second end 302b of the alignment retainer 302. Additionally, when the profile retainer 304 is coupled to the alignment

retainer 302, the bores 334 of the flange 326 and/or the bosses 336 align (e.g., coaxially and/or concentrically) with respective ones of the spring cavities 322 of the alignment retainer 302. The fasteners 310 are positioned within the bores 334 (e.g., from the second side 304b of the profile retainer 304) such that the shank portions 310b extend through the spring cavities 322 and the threaded ends 310c of the fasteners 310 are threadably coupled to the threaded bores 325 formed in the bottom surface 327 of the spring cavities 322. The bolt heads 310a of the fasteners 310 engage the stepped profile 334c (e.g., a wall) formed by the countersink bores 334a.

[0034] Additionally, each of the springs 306 of the illustrated example provides approximately 40 pounds per square inch (psi). Thus, collectively, the springs 306 provide a pressure of approximately 320 pounds per square inch (psi). In the illustrated example, the clamp assembly 102 includes eight spring cavities 322, eight sleeves 308, eight springs 306, eight fasteners 310, etc. However, in some examples, the clamp assembly 102 can include more or fewer springs cavities 322, sleeves 308, fasteners 310, etc. (e.g., one, four, six, ten, twelve, etc.).

[0035] In some examples, the clamp assembly 102 does not include the springs 306 and/or the sleeves 308. For instance, in some examples, the spring cavities 322 can receive one or more Belleville springs (e.g., a stack of Belleville springs). In some examples, the clamp assembly 102 does not include the spring cavities 322, the sleeves 308, and/or the bosses 336. In some such examples, a biasing element (e.g., a Belleville spring) can be positioned or provided between the first surface 326a of the flange 326 and the second end 302b of the alignment retainer 302.

[0036] FIG. 4A is a cross-sectional side view of the example clamp assembly 102 of FIGS. 1, 2, 3A and 3B shown in an example first position 402 (e.g., an extended position). FIG. 4B is a cross-sectional side view of the example clamp assembly 102 of FIG. 4A shown in an example second position 404 (e.g., a collapsed position). In other words, the springs 306 enable the alignment retainer 302 to move or slide relative to the profile retainer 304 in the first linear direction 232 and/or the second linear direction 234 between the first position 402 and the second position 404.

[0037] When the clamp assembly 102 is in an assembled state 406 as shown in FIGS. 4A and 4B, the center opening 314 of the alignment retainer 302 and the center opening 328 of the profile retainer 304 define the center opening 226 of the clamp assembly 102. In the illustrated example, at least a portion of the inner wall 324 of the profile retainer 304 is positioned (e.g., slidably positioned) within the center opening 314 of the alignment retainer 302. Specifically, the outer dimension 324a (FIG. 3A) of the inner wall 324 of the profile retainer 304 is smaller than the dimension 314a (FIG. 3B) of the center opening 314 of the alignment retainer 302 to enable the inner wall 324 of the profile retainer 304 to slide relative to the outer wall 312 of the alignment retainer 302 in the

first linear direction 232 and the second linear direction 234. The flange 326 of the profile retainer 304 retains the springs 306 and/or the sleeves 308 within the spring cavities 322 of the alignment retainer 302. In the illustrated example, the bosses 336 of the flange 326 at least partially extend within respective ones of the spring cavities 322 when the profile retainer 304 is coupled with the alignment retainer 302. Thus, the springs 306 are positioned between (e.g., compressed between) the bosses 336 and the bottom walls 342 of the sleeves 308. The fasteners 310 (e.g., the shank portions 310b) extend through the bores 334 and the spring cavities 322 and the threaded ends 310c are threadably coupled to respective ones of the threaded bores 325 of the alignment retainer 302. The bolt heads 310a of the fasteners 310 are retained in the countersink bores 334a formed in the flange 326 of the profile retainer 304 and the shank portions 310b of the fasteners 310 extend within, or are located within, respective ones of the spring cavities 322 (e.g., extend through the springs 306 and/or the sleeves 308). In the first position 402, the alignment retainer 302 moves the fasteners 310 in the first linear direction 232 within the spring cavities 322 to cause the bolt heads 310a to engage respective ones of the stepped profiles 334c formed by the countersink bore 334a. Thus, such arrangement enables the alignment retainer 302 to slidably couple to the profile retainer 304.

[0038] Additionally, the springs 306 bias the profile retainer 304 in a direction away from the alignment retainer 302. As a result, when the clamp assembly 102 is in the assembled state 406, the alignment retainer 302 is offset relative to the profile retainer 304 by a gap or distance 410. Specifically, the second end 302b of the alignment retainer 302 is spaced (e.g., detached or separated) from the first surface 326a of the flange 326 by the distance 410 because the springs 306 impart a force (e.g., a lateral force parallel to the longitudinal axis 108 of the center opening 226) to separate the alignment retainer 302 and the profile retainer 304. The distance 410 of the illustrated example is approximately between 0.01 inches and 0.1 inches. In some examples, the distance 410 is approximately 0.05 inches. As shown in FIG. 4A, the distance 410 between the first surface 326a of the flange 326 and the second end 302b of the outer wall 312 causes the profile forming portion 332 of the profile retainer 304 to be offset relative to the alignment/clamp profile 318 of the alignment retainer by a distance 412. The distance 412 of the illustrated example is approximately between 0.01 inches and 0.1 inches. In some examples, the distance is approximately 0.05 inches. In other words, the distance 412 between the profile forming portion 332 and the alignment/clamp profile 318 can be the same or different from the distance 410 between the first surface 326a of the flange 326 and the second end 302b of the outer wall 312 (e.g., the alignment retainer 302).

[0039] As shown in FIG. 4B, in the second position 404, the springs 306 compress to enable the profile retainer 304 to slide relative to the alignment retainer 302

such that the distance 410 between the first surface 326a of the flange 326 and the second end 302b of the outer wall 312 is reduced or eliminated. Stated differently, in the second position 404, the second end 302b of the outer wall 312 or the alignment retainer 302 directly contacts or engages the first surface 326a of the flange 326. As a result, the inner wall 324 of the profile retainer 304 moves in the first linear direction 232 and/or the alignment retainer 302 moves in the second linear direction 234 to cause the profile forming portion 332 of the profile retainer 304 to move closer (e.g., adjacent) to the alignment/clamp profile 318 of the alignment retainer 302. In other words, the distance 412 between the profile forming portion 332 and the alignment/clamp profile 318 is reduced or eliminated when the clamp assembly 102 is in the second position 404 compared to when the clamp assembly 102 is in the first position 402. For example, the distance 412 between the profile forming portion 332 and the alignment/clamp profile 318 is smaller when the clamp assembly 102 is in the second position of FIG. 4B than the distance 412 between the profile forming portion 332 and the alignment/clamp profile 318 when the clamp assembly 102 is in the first position 402 of FIG. 4A. In the second position 404, the alignment retainer 302 moves the fasteners 310 in the second linear direction 234 within the spring cavities 322 to cause the bolt heads 310a to detach or move apart from the respective stepped profiles 334c formed by the countersink bore 334a. Thus, the fasteners 310 and/or the springs 306 enable the alignment retainer 302 and the profile retainer to move relative to each other between the first position 402 and the second position 404.

[0040] FIGS. 5-8 are partial, cross-sectional side views of a press forming system 500 including the domer apparatus 100 and the bodymaker 502. The press forming system 500 illustrates various press forming stages for forming a can body 504. As described in greater detail below in connection with FIGS. 5-8, the clamp assembly 102 of the illustrated example coaxially and/or concentrically aligns the can body 504 with the longitudinal axis 108 of the domer apparatus 100 prior to formation of a bottom profile of the can body 504 to avoid coining or coin marks on the can body 504.

[0041] Referring to FIG. 5, the press forming system 500 is shown in a first stage 501 prior to engagement between the bodymaker 502 and the clamp assembly 102. The bodymaker 502 includes a punch body or ram 506 that draws and irons the can body 504 to have a thin-walled, side body 508 and a can bottom 510. For example, a circular disk or blank is cut from a sheet of light gauge metal (e.g., such as aluminum) that is then drawn into a shallow cup using a cup forming equipment. The cup is then transferred to the bodymaker 502, which forces the cup through a series of ironing dies to elongate or shape the puck into the can body 504 by progressively reducing a wall thickness of the can body 504 to obtain a desired height and/or wall thickness of the can body 504. Ultimately, the bodymaker 502 interacts with the

domer apparatus 100 to form the can bottom 510. For example, the ram 506 supports a punch nose 512 (e.g., a die) at an end 506a of the ram 506 that forms or shapes the can bottom 510. The punch nose 512 has an annular wall 512a that defines a cavity 512b between the can bottom 510 and a bottom surface 512c of the punch nose 512. The ram 506 of the bodymaker 502 is driven through a link at one end of a pivoted lever that is connected to a driven crankshaft via a connecting rod, which converts arcuate motion of the crankshaft into linear motion (e.g., horizontal motion) of the ram 506. Where the motion of the ram 506 is horizontal along a longitudinal axis 514 of the ram 506, bearings in a cradle or frame support the ram 506. A height of a resultant can body 504 is dictated predominantly by a stroke length of the ram 506 of the bodymaker 502. Thus, the ram 506 of the bodymaker 502 interacts with the domer apparatus 100 near or at an end or full stroke position of the ram 506.

[0042] Referring to FIG. 2 and FIG. 5, in operation, the supply source 246 (e.g., a pressurized fluid tank) provides a pressurized operating fluid (e.g., pressurized air) into the pressure chamber 208 via the inlet 210 formed in the end cap 206. For example, the operating fluid can provide a pressure of approximately between 900 and 1100 pounds per square inch (psi) (e.g., 1000 psi). The operating fluid within the pressure chamber 208 acts on the first side 204a of the piston 204 to cause the piston 204 to move in the first linear direction 232 toward the clamp assembly 102 so that the pins 212 of the piston 204 engage (e.g., directly engage) the clamp assembly 102 to bias the clamp assembly 102 toward the retainer 110 (as shown in FIG. 2). As shown in FIG. 2, the piston 204 and, thus the pins 212, are at an end of stroke position (e.g., the furthest position in) the first linear direction 232. Additionally, the clamp assembly 102 is in the first position 402. In other words, the springs 306 cause the alignment retainer 302 to move relative to the profile retainer 304 by the distance 410 such that the alignment/clamp profile 318 is spaced from the profile forming portion 332 by the distance 412. Thus, prior to engagement between the ram 506 and/or the punch nose 512 of the alignment retainer 302, the alignment/clamp profile 318 is spaced from the profile forming portion 332 at the distance 412 (e.g., a maximum distance). The domer die body 222 is at least partially received within the center opening 226 of the clamp assembly 102 and is positioned adjacent the first end 104a of the body 104.

[0043] FIG. 6A illustrates the press forming system 500 at a second stage 602 (e.g., an alignment phase). FIG. 6B is a partial, enlarged view of FIG. 6A. At the second stage 602, the can body 504 engages the alignment retainer 302 (e.g. and does not engage the profile retainer 304). Specifically the punch nose 512, via the ram 506, causes a transition area 604 (e.g., a tapered or angled edge) of the can body 504 between the side body 508 and the can bottom 510 to engage the alignment retainer 302. Specifically, the transition area 604 of the can body 504 engages the alignment/clamp profile 318 of the align-

ment retainer 302. In some examples, the lead-in profile 318c facilitates or directs engagement between the transition area 604 of the can body 504 and the alignment surface 318a. The alignment surface 318a of the illustrated example is structured to cause or direct the can body 504 (e.g., and/or the ram 506) toward the longitudinal axis 108 (e.g., a center axis) of the domer apparatus 100. Specifically, the alignment surface 318a is an angled annular wall or surface that causes the can body 504 and/or the ram 506 to concentrically and/or coaxially align with the longitudinal axis 108 of the domer apparatus 100 and/or the longitudinal axis 408 (FIG. 4A) of the clamp assembly 102. In other words, the alignment retainer 302 causes the longitudinal axis 514 of the ram 506 to concentrically and/or coaxially align with the longitudinal axis 408 of the clamp assembly 102 and/or the longitudinal axis 108 of the domer apparatus 100.

[0044] Upon initial contact between the transition area 604 and the alignment retainer 302, the springs 306 of the illustrated example provide a reactive and/or resistance force in the first linear direction 232. For example, the springs 306, collectively, generate approximately 300 pounds per square inch of pressure against the can body 504 when the can body 504 engages the alignment retainer 302 via the ram 506. Such reactive force causes the can body 504 to concentrically and/or coaxially align with the longitudinal axis 408 of the clamp assembly 102. After the alignment surface 318a aligns (e.g., coaxially and/or concentrically aligns) the can body 504 and the longitudinal axis 408 of the clamp assembly 102, the clamp surface 318b of the alignment retainer 302 clamps or retains the can bottom 510 of the can body 504 within the center opening 226 of the clamp assembly 102 (e.g., the center opening 314 of the alignment retainer 302).

[0045] During the second stage 602, although the transition area 604 of the can body 504 is in direct engagement or contact with the alignment retainer 302, the transition area 604 and/or the can body 504 is not engaged with (e.g., is spaced apart from) the profile retainer 304. For example, the distance 410 between the alignment retainer 302 and the profile retainer 304 is maintained during the alignment phase of the can body 504 relative to the domer apparatus 100. Thus, the distance 412 (FIG. 4) between the alignment/clamp profile 318 of the alignment retainer 302 and the profile forming portion 332 of the profile retainer 304 is maintained when the transition area 604 engages the alignment retainer 302 and/or until the ram 506 overcomes the pressure provided by the springs 306. In this manner, the profile forming portion 332 does not engage or interact with the can body 504 and/or the can bottom 510 during an alignment phase and/or a clamping phase of the can body 504 and the domer apparatus 100. For example, the can bottom 510 of the can body 504 is in engagement with the alignment/clamp profile 318 of the alignment retainer 302 and the can bottom 510 of the can body 504 is not in engagement with (e.g., is spaced or detached from) the profile forming portion 332 of the profile retainer 304. Thus, be-

cause the profile retainer 304 does not engage the can body 504 during the second stage 602 and/or when the can body 504 is clamped radially relative to the longitudinal axis 108, coining or coining marks are reduced or eliminated.

[0046] FIG. 7A illustrated the press forming system 500 at a third stage 702 (e.g., a profile forming phase). FIG. 7B is a partial, enlarged view of FIG. 7A. After alignment between the can body 504 and the domer apparatus 100, the ram 506 continues to drive the punch nose 512 in the second linear direction 234 toward the domer die body 222 of the domer die 218. After the ram 506 applies sufficient force or pressure to overcome the pressure and/or force generated by the springs 306, the ram 506 causes the can body 504 to move the alignment retainer 302 in the second linear direction 234 toward the profile retainer 304. Specifically, the ram 506 causes the clamp assembly 102 to move to the second position 404. As a result, the distance 410 between the alignment retainer 302 and the profile retainer 304 and, thus, the distance 412 (FIGS. 4A and 6) between the alignment/clamp profile 318 and the profile forming portion 332 is reduced (or eliminated in some examples). For example, the clamp assembly 102 moves to the second position 404 (FIG. 4B). As a result, the can body 504 engages the profile forming portion 332. Specifically, the transition area 604 engages the profile forming portion 332, which starts to shape an annular lip 704 of the can body 504.

[0047] Additionally, the pins 212 of the piston 204 (FIG. 2) maintain a distance 706 between a first surface 708 (e.g., a right or bottom surface) of the flange 224 of the domer die 218 and the first side 214a (e.g., the second surface 326b) of the profile retainer 304. Additionally, at the third stage 702, the domer die body 222 is adjacent the can bottom 510 of the can body 504. In some examples, the domer die body 222 engages the can bottom 510 when the transition area 604 initially engages the alignment/clamp profile 318 to provide a pre-form or pre-dome condition. In some examples, the domer die body 222 is spaced from the can bottom 510 when the alignment/clamp profile 318 initially engages the transition area 604.

[0048] FIG. 8A illustrates the press forming system 500 at a fourth stage 802 (e.g., a dome forming phase). FIG. 8B is a partial, enlarged view of FIG. 8A. Referring to FIG. 2, FIG. 8A, and FIG. 8B, after the transition area 604 engages the profile forming portion 332 of the profile retainer 304, the ram 506 continues to drive the can body 504 in the second linear direction 234. As a result, the can body 504 via the ram 506 causes the clamp assembly 102 to move in the second linear direction 234 such that clamp assembly 102 engages the flange 224 of the domer die 218. Specifically, the flange 326 of the profile retainer 304 directly engages the flange 224 of the domer die 218 to eliminate or reduce the distance 706 (FIG. 7A) between the first surface 708 of the flange 224 of the domer die 218 and the second surface 326b of the flange 326 of the profile retainer 304. To reduce or eliminate the

distance 706 of FIG. 7A, the clamp assembly 102 moves in the second linear direction 234 against the force or pressure of the pins 212 provided by the piston 204. As a result, the piston 204 moves in the second linear direction 234 to cause the clamp assembly 102 to move into engagement with the flange 224 of the domer die 218. As the clamp assembly 102 moves in the second linear direction 234 to eliminate or reduce the distance 706 of FIG. 7A between the clamp assembly 102 and the flange 224 of the domer die 218, the domer die body 222 moves into the cavity 512b of the punch nose 512 to deform the can bottom 510 of the can body 504 between the domer die body 222 and the punch nose 512. Specifically, a first side 804 of the can bottom 510 engages the domer die body 222 and a second side 806 of the can bottom 510 engages the bottom surface 512c of the punch nose 512. Additionally, the annular lip 704 is further formed between the domer die body 222 and the profile forming portion 332 of the profile retainer 304. The domer die body 222 and the punch nose 512 cause a bottom profile 808 to have a domed shape or domed bottom profile. The bottom profile 808 of the illustrated example has a concave profile when looking from the second side 806 of the can body 504 in the orientation of FIG. 8A. To accommodate any overtravel in the second linear direction 234, the domer die support 216 via the annular wall 230 moves in the second linear direction 234 against a force of the springs 236. After formation of the bottom profile 808 (e.g., a domed profile), the ram 506 retracts in the first linear direction 232 to release the can body 504 from the ram 506 and the domer apparatus 100. The springs 236 cause the domer die 218 via the die support body 220 (e.g., the annular wall 230) to move toward the first linear direction 232. The pressurized fluid in the pressure chamber 208 also causes the piston 204 and, thus, the domer die 218 to return to the furthest position toward the first linear direction 232. In turn, the pins 212 separate the flange 224 of the domer die 218 from the clamp assembly 102, and the springs 306 cause the clamp assembly 102 to return to the first position 402.

[0049] FIGS. 9-11 are partial, cross-sectional side views of the press forming system 500 of FIGS. 5-8 illustrating various process forming stages 900-1100 when forming a can body 902. The press forming system 500 of FIG. 9 is shown at a first stage 900, where the can body 902 initially engages or contacts the alignment retainer 302 of the clamp assembly 102. At the first stage 900 of FIG. 9, the can body 902 and/or the ram 506 of the illustrated example is misaligned relative to the longitudinal axis 108 of the domer apparatus 100 and/or the clamp assembly 102. For example, the longitudinal axis 514 of the ram 506 is not concentrically and/or coaxially aligned with the longitudinal axis 108 of the domer apparatus 100. In the illustrated example, the longitudinal axis 514 of the ram 506 is offset (e.g., radially and/or vertically offset) relative to the longitudinal axis 108 of the domer apparatus 100 by a distance 906 (e.g., a vertical distance in the orientation of FIG. 9). The distance

906 of the illustrated example is approximately 0.100 inches. At the first stage 900 of FIG. 9, the can body 902 is in engagement with the alignment/clamp profile 318 of the alignment retainer 302. Specifically, the alignment surface 318a, via the pressure provided by the springs 306, causes or directs the can body 902 to radially move or adjust toward a radial center of the domer apparatus 100. The springs 306 provide a force to maintain the clamp assembly 102 in the first position 402 when the can body 902 is in engagement with the alignment retainer 302.

[0050] Referring to FIG. 10, at a second stage 1000, the clamp assembly 102 is in the first position 402. In the second stage 1000, the alignment surface 318a continues to cause the can body 902 and/or the ram 506 to radially align relative to the longitudinal axis 108 of the domer apparatus 100. For example, a reactive force provided by the springs 306 (FIG. 3) in the first linear direction 232 and a contour or shape of the alignment surface 318a (FIG. 3) causes the can body 902 and/or the ram 506 to radially align relative to the longitudinal axis 108 of the domer apparatus 100 and/or the longitudinal axis 408 of the clamp assembly 102 as the ram 506 moves in the second linear direction 234. For example, as shown in FIG. 10, the longitudinal axis 514 of the ram 506 is offset (e.g., radially offset) relative to the longitudinal axis 108 of the domer apparatus 100 by a distance 1004 (e.g., a vertical distance in the orientation of FIG. 10). The distance 1004 of the illustrated example is approximately 0.070 inches, which is less than the distance 906 of FIG. 9.

[0051] FIG. 11 illustrates the press forming system 500 at a third stage 1100. At the third stage 1100, the clamp assembly 102 is in the second position 404 and the can body 902 is in engagement with the profile retainer 304 to form a bottom, domed profile for the can body 902. Specifically, the ram 506 overcomes the pressure and/or force provided by the springs 306 (FIG. 3) and causes the alignment retainer 302 to move in the second linear direction 234 toward the flange 326 of the profile retainer 304. However, prior to when the can body 902 engages the profile forming portion 332, the alignment retainer 302 causes the can body 902 and/or the ram 506 to concentrically and/or coaxially align with the longitudinal axis 108 of the domer apparatus 100. In this manner, the can body 902 is coaxially and/or concentrically aligned with the longitudinal axis 108 prior to forming the bottom profile of the can body 904, thereby reducing and/or eliminating instances of coining.

[0052] FIG. 12A is a bottom view of another example clamp apparatus 1200 disclosed herein. FIG. 12B is a cross-sectional view taken along a longitudinal axis 1202 of the example clamp apparatus 1200 of FIG. 12A shown in an example first position 1201. FIG. 12C is a cross-sectional view taken along the longitudinal axis 1202 of the example clamp apparatus 1200 of FIG. 12A shown in an example second position 1203. The clamp apparatus 1200 can be used to implement a domer apparatus

such as the domer apparatus 100 of FIG. 1. Many of the components of the example clamp apparatus 1200 of FIGS. 12A-12B are substantially similar or identical to the components described above in connection with FIGS. 1, 2, 3A, 3B, 4A, 4B and 5-8. As such, those components will not be described in detail again below. Instead, the interested reader is referred to the above corresponding descriptions for a complete written description of the structure and operation of such components. To facilitate this process, similar or identical reference numbers will be used for like structures in FIGS. 12A-12B as used in FIGS. 1, 2, 3A, 3B, 4A, 4B and 5-8. For example, the clamp apparatus 1200 includes an alignment/clamp profile 318, a profile forming portion 332, a center opening 226, springs 306, spring cavities 322, sleeves 308, and fasteners 310.

[0053] The clamp apparatus 1200 of the illustrated example includes an alignment retainer 1204 (e.g., a first sleeve) and a profile retainer 1206 (e.g., a second sleeve). Specifically, the alignment retainer 1204 and the profile retainer 1206 of the illustrated example are substantially similar to the alignment retainer 302 and the profile retainer 304 described above except the clamp apparatus 1200 of FIGS. 12A and 12B includes a lock 1208. The lock 1208 of the illustrated example interlocks the alignment retainer 1204 and the profile retainer 1206. The lock 1208 of the illustrated example includes a track 1210 (e.g., an annular lip, an annular wall, etc.) and a plurality of protrusions 1212. The track 1210 of the illustrated example receives respective ones of the protrusions 1212. When the protrusions 1212 are positioned within the track 1210, the springs 306 bias the alignment retainer 1204 away from the profile retainer 1206 along the longitudinal axis 1202 to provide a distance 1214 between a first end 1206a of the alignment retainer 1204 and a first surface 1216a of a flange 1216 of the profile retainer 1206. In operation, the springs 306 enable movement of the clamp apparatus between the first position 1201 and the second position 1203. In the first position 1201, the distance 1214 causes the alignment/clamp profile 318 and the profile forming portion 332 to be spaced apart by an offset distance 1215. In a second position, the distance 1214 is removed or eliminated to reduce the offset distance 1215.

[0054] FIG. 13A is a top view of the example profile retainer 1206 of FIGS. 12A and 12B. FIG. 13B is a cross-sectional view taken along a longitudinal axis 1302 of the example profile retainer 1206 of FIG. 13A. FIG. 13C is a bottom view of the example profile retainer 1206 of FIG. 13A. Referring to FIGS. 13A-13C, the profile retainer 1206 of the illustrated example includes an inner wall 1304 and the flange 1216. The inner wall 1304 is substantially similar to the inner wall 324 of the profile retainer 304. Unlike the flange 326 of the clamp assembly 102 described above, the flange 1216 of the illustrated example does not include the bosses 336 and the retaining lip 326c as shown in FIG. 3A.

[0055] The flange 1216 of the illustrated example in-

cludes the first surface 1216a oriented toward the profile forming portion 332 and a second surface 1310 oriented opposite the first surface 1216a. The flange 1216 of the illustrated example includes the track 1210. The track 1210 of the illustrated example protrudes from the first surface 1216a of the flange 1216 in a direction toward the profile forming portion 332. The track 1210 of the illustrated example is an annular slot. The track 1210 (e.g., an annular track) of the illustrated example has an arcuate shape and is located adjacent a peripheral edge 1312 (e.g., a side surface) of the flange 1216. To provide access to the track 1210, the flange 1216 includes a plurality of access openings 1314 (FIGS. 13A and 13B) that pass through a lip or surface 1308 of the track 1210. The access openings 1314 are radially spaced relative to the longitudinal axis 1302 and/or are circumferentially spaced at different points along the track 1210. The track 1210 extends from the first surface 1216a of the flange 1216 by a distance 1316.

[0056] FIG. 14A is a top view of the example alignment retainer 1204 of FIGS. 12A and 12B. FIG. 14B is a cross-sectional view taken along a longitudinal axis 1402 of the example alignment retainer 1204 of FIG. 14A. FIG. 14C is a bottom view of the example alignment retainer 1204 of FIG. 14A. Referring to FIGS. 14A-14C, the alignment retainer 1204 includes an outer wall 1404 defining a cavity 1405 between a first end 1406 and a second end 1408 opposite the first end 1406. The second end 1408 of the outer wall 1404 includes the protrusions 1212. The protrusions 1212 of the illustrated example are radially spaced relative to the longitudinal axis 1402 of the alignment retainer 1204. Additionally, the protrusions 1212 extend outwardly from a side surface 1410 of the outer wall 1404. For example, the protrusions 1212 extend (e.g., radially outward) in a direction that is perpendicular to the longitudinal axis 1402 of the alignment retainer 1204.

[0057] Referring to FIGS. 12A-12C, 13A-13C and 14A-14C, to couple the alignment retainer 1204 and the profile retainer 1206, the protrusions 1212 of the alignment retainer 1204 are aligned with the respective access openings 1314 of the profile retainer 1206. The alignment retainer 1204 is rotated then about the longitudinal axis 1402 in a first rotational direction (e.g., a clockwise direction) and/or the profile retainer 1206 is rotated about the longitudinal axis 1302 in a second rotational direction (e.g., a counterclockwise direction) opposite the first rotational direction. As a result, the protrusions 1212 are positioned within the track 1210. The track 1210 retains the protrusions 1212 to couple the alignment retainer 1204 and the profile retainer 1206. Thus, the protrusions 1212, the track 1210 and the access openings 1314 provide a keyed configuration to restrain the alignment retainer 1204 and the profile retainer 1206. In the illustrated example, the profile retainer 1206 of the illustrated example includes a single or continuous track 1210 and four access openings 1314. In other examples, the profile retainer 1206 can include any number of tracks (e.g., two

tracks, four tracks, discontinuous tracks) and/or access openings (e.g., one, two, six, twelve, etc.).

[0058] Example clamp apparatus 102 and 1200 can provide example means for forming a bottom profile of a can body. In some examples, the clamp assembly 102, the alignment retainer 302, the alignment retainer 1204 and/or the alignment/clamp profile 318 provides example means for clamping to coaxially align a punch tooling supporting a can body with a domer die and radially fix the punch tooling relative to the domer die after coaxially aligning the punch tooling with the domer die. In some examples, the alignment surface 318a of the alignment/clamp profile 318 provides means for coaxially aligning a punch tooling or ram supporting a can body with a domer die of a domer apparatus. In some examples, the clamp surface 318b of the alignment/clamp profile 318 provides means for clamping (e.g., or radially fixing) the punch tooling or ram relative to the domer die after coaxially aligning the punch tooling with the domer die. In some examples, the alignment/clamp profile 318 includes means for first profiling end. In some examples, the profile retainer 304, profile retainer 1206 and/or the profile retainer 304 provides means for forming or shaping a bottom profile of a can body. In some examples, the profile forming surface 332a provides means for forming the bottom profile with the domer die and the lip forming surface 332b provides means for forming an annular lip of the can body. In some examples, the springs 306 provide means for biasing and/or means for slidably coupling the alignment retainer 302/1204 and the profile retainer 304/1206. In some examples, the fasteners 310 provide means for fastening the alignment retainer 302 and the profile retainer 304. In some examples, the fasteners 310 and/or the springs 306 provide means for slidably coupling the alignment retainer 302 and the profile retainer 304. In some examples, the track 1210 and the protrusions 1212 provide means for fastening the alignment retainer 1204 and the profile retainer 1206. In some examples, the track 1210, the protrusions 1212 and/or the springs 306 provide means for slidably coupling the alignment retainer 1204 and the profile retainer 1206.

[0059] The foregoing examples of the clamp assembly 102 and the clamp apparatus 1200 disclosed herein can be employed with domer systems for use with bodymakers. Although each example of the clamp assembly 102 and the clamp apparatus 1200 disclosed above have certain features, it should be understood that it is not necessary for a particular feature of one example to be used exclusively with that example. Instead, any of the features described above and/or depicted in the drawings can be combined with any of the examples, in addition to or in substitution for any of the other features of those examples. One example's features are not mutually exclusive to another example's features. Instead, the scope of this disclosure encompasses any combination of any of the features.

[0060] Example methods, apparatus, systems, and articles of manufacture to implement clamp apparatus for

use with a domer apparatus are disclosed herein. Further examples and combinations thereof include the following:

Example 1 includes an example apparatus having an alignment retainer and a profile retainer, where the profile retainer is movably coupled to the alignment retainer. A biasing element is positioned between the alignment retainer and the profile retainer to enable movement of the alignment retainer relative to the profile retainer.

Example 2 includes the apparatus of example 1, where the alignment retainer includes a central opening to at least slidably receive a portion of the profile retainer.

Example 3 includes the apparatus of any one of examples 1-2, where the alignment retainer includes a first cylindrical body having a first end and a second end opposite the first end, the first end including an alignment profile.

Example 4 includes the apparatus of any one of examples 1-3, where the alignment profile includes a contoured shape providing an alignment surface and a clamping surface.

Example 5 includes the apparatus of any one of examples 1-4, where the profile retainer includes a second cylindrical body having a first end and a second end opposite the first end, the first end of the profile retainer including a profile forming surface.

Example 6 includes the apparatus of any one of examples 1-5, where the alignment profile of the alignment retainer is positioned adjacent profile forming surface of the profile retainer.

Example 7 includes the apparatus of any one of examples 1-6, where the alignment profile of the alignment retainer is movable relative to the profile forming surface of the profile retainer between a first distance when the apparatus is in a first operative position and a second distance when the apparatus is in a second operative position, the first distance is greater than the second distance.

Example 8 includes the apparatus of any one of examples 1-7, where the second end of the alignment retainer includes a plurality of spring cavities radially spaced relative a longitudinal axis of the alignment retainer.

Example 9 includes the apparatus of any one of examples 1-8, where the profile retainer includes a flange formed at the second end of the profile retainer, the flange including a plurality of bores radially spaced relative to a longitudinal axis of the profile retainer.

Example 10 includes the apparatus of any one of examples 1-9, where the spring cavities and the bores coaxially align when the alignment retainer is coupled to the profile retainer.

Example 11 includes the apparatus of any one of examples 1-10, further including a plurality of

springs, the springs to be at least received by respective ones of the spring cavities.

Example 12 includes the apparatus of any one of examples 1-11, further including a plurality of fasteners, the fasteners to be at least received by respective ones of the spring cavities and the bores.

Example 13 includes the apparatus of any one of examples 1-12, where the fasteners include a shank body and a threaded end, wherein the shank body of the fasteners extend through the bores of the flange and the spring cavities of the alignment retainer and the threaded end of the fasteners to threadably couple to respective threaded bores formed in bottom surfaces of the spring cavities.

Example 14 includes an example apparatus having a body defining a cavity, a domer die positioned in the cavity, the domer die to shape a bottom profile of a can body, and a clamp apparatus coupled to the body adjacent the domer die. The clamp apparatus is to receive at least a portion of the domer die. The clamp apparatus includes a first sleeve having a first profile end to concentrically align a punch tooling of a ram with the domed die in response to the punch tooling moving toward the domed die and radially clamp the can body in fixed alignment with the domed die after the first sleeve concentrically aligns the punch tooling with the domed die. The clamp apparatus having a second sleeve movably coupled relative to the first sleeve. The second sleeve has a second profile end to shape a lip of the can body. The second profile end being spaced from the first profile end by a first distance when the first profile end concentrically aligns the punch tooling and radially clamps the can body relative to the domer die. The second profile end being spaced from the first profile end by a second distance after the can body is concentrically aligned with the punch tooling and radially clamped relative to the domer die. The second distance being less than the first distance.

Example 15 includes the apparatus of example 14, where the first sleeve includes a first central opening to at least partially receive the second sleeve, and the second sleeve includes a second central opening to at least partially receive the domer die.

Example 16 includes the apparatus of any one of examples 14-15, further including a biasing element positioned between the first sleeve and the second sleeve. The biasing element is to enable the first sleeve to move relative to the second sleeve between a first operative position to provide the first distance between the first profile end and the second profile end and a second operative position to provide the second distance between the first profile end and the second profile end.

Example 17 includes the apparatus of any one of examples 14-16, where the first sleeve is a first cylindrical body. The first sleeve includes a plurality of spring cavities radially spaced relative to a longitu-

dinal axis of the first sleeve. The spring cavities extending partially through the cylindrical body. Respective ends of the spring cavities include threaded bores.

Example 18 includes the apparatus of any one of examples 14-16, where the second sleeve includes a second cylindrical body and a flange. The second cylindrical body to be at least partially received by the first sleeve. The clamp apparatus further including biasing elements positioned in the spring cavities and a plurality of fasteners, the fasteners to slidably couple the first sleeve and the second sleeve. The fasteners to threadably couple to the threaded bores of the spring cavities.

Example 19 includes an example apparatus having means for clamping to coaxially align a punch tooling supporting a can body with a domer die and radially fix the punch tooling relative to the domer die after coaxially aligning the punch tooling with the domer die. The apparatus includes means for profiling a bottom of a can body, the means for profiling movably coupled relative to the means for clamping.

Example 20 includes the apparatus of example 19, further including means for fastening the means for clamping and the means for profiling and means for biasing. The means for biasing to enable the means for clamping and the means for profiling to move relative to each other between a first operative position and a second operative position when the means for fastening couples the means for clamping and the means for profiling.

[0061] Although certain example systems, methods, apparatus, and articles of manufacture have been disclosed herein, the scope of coverage of this patent is not limited thereto. On the contrary, this patent covers all systems, methods, apparatus, and articles of manufacture fairly falling within the scope of the claims of this patent.

Claims

1. An apparatus for use with a domer, the apparatus comprising:
 - an alignment retainer;
 - a profile retainer, the profile retainer movably coupled to the alignment retainer; and
 - a biasing element positioned between the alignment retainer and the profile retainer to enable movement of the alignment retainer relative to the profile retainer.
2. The apparatus of claim 1, wherein the alignment retainer includes a central opening to at least slidably receive a portion of the profile retainer.

3. The apparatus of claim 1, wherein the alignment re-
tainer includes a first cylindrical body having a first
end and a second end opposite the first end, the first
end including an alignment profile.
4. The apparatus of claim 3, wherein the alignment pro-
file includes a contoured shape providing an align-
ment surface and a clamping surface.
5. The apparatus of claim 4, wherein the profile retainer
includes a second cylindrical body having a first end
and a second end opposite the first end, the first end
of the profile retainer including a profile forming sur-
face.
6. The apparatus of claim 5, wherein the alignment pro-
file of the alignment retainer is positioned adjacent
profile forming surface of the profile retainer.
7. The apparatus of claim 6, wherein the alignment pro-
file of the alignment retainer is movable relative to
the profile forming surface of the profile retainer be-
tween a first distance when the apparatus is in a first
operative position and a second distance when the
apparatus is in a second operative position, the first
distance is greater than the second distance.
8. The apparatus of claim 5, wherein the second end
of the alignment retainer includes a plurality of spring
cavities radially spaced relative a longitudinal axis
of the alignment retainer.
9. The apparatus of claim 8, wherein the profile retainer
includes a flange formed at the second end of the
profile retainer, the flange including a plurality of
bores radially spaced relative to a longitudinal axis
of the profile retainer.
10. The apparatus of claim 9, wherein the spring cavities
and the bores coaxially align when the alignment re-
tainer is coupled to the profile retainer.
11. The apparatus of claim 10, further including a plu-
rality of springs, the springs to be at least received
by respective ones of the spring cavities.
12. The apparatus of claim 11, further including a plu-
rality of fasteners, the fasteners to be at least re-
ceived by respective ones of the spring cavities and
the bores.
13. The apparatus of claim 12, wherein the fasteners
include a shank body and a threaded end, wherein
the shank body of the fasteners extend through the
bores of the flange and the spring cavities of the
alignment retainer and the threaded end of the fas-
teners to threadably couple to respective threaded
bores formed in bottom surfaces of the spring cavi-
ties.
14. A domer apparatus comprising:
a body defining a cavity;
a domer die positioned in the cavity, the domer
die to shape a bottom profile of a can body; and
a clamp apparatus coupled to the body adjacent
the domer die, the clamp apparatus to receive
at least a portion of the domer die, the clamp
apparatus including:
a first sleeve having a first profile end to con-
centrically align a punch tooling of a ram
with the domed die in response to the punch
tooling moving toward the domed die and
radially clamp the can body in fixed align-
ment with the domed die after the first
sleeve concentrically aligns the punch tool-
ing with the domed die; and
a second sleeve movably coupled relative
to the first sleeve, the second sleeve having
a second profile end to shape a lip of the
can body, the second profile end being
spaced from the first profile end by a first
distance when the first profile end concen-
trically aligns the punch tooling and radially
clamps the can body relative to the domer
die, the second profile end being spaced
from the first profile end by a second dis-
tance after the can body is concentrically
aligned with the punch tooling and radially
clamped relative to the domer die, the sec-
ond distance being less than the first dis-
tance.
15. The apparatus of claim 14, wherein the first sleeve
includes a first central opening to at least partially
receive the second sleeve, and the second sleeve
includes a second central opening to at least partially
receive the domer die.
16. The apparatus of claim 15, further including a biasing
element positioned between the first sleeve and the
second sleeve, the biasing element to enable the
first sleeve to move relative to the second sleeve
between a first operative position to provide the first
distance between the first profile end and the second
profile end and a second operative position to pro-
vide the second distance between the first profile
end and the second profile end.
17. The apparatus of claim 14, wherein the first sleeve
is a first cylindrical body, the first sleeve includes a
plurality of spring cavities radially spaced relative
to a longitudinal axis of the first sleeve, the spring cav-
ities extending partially through the cylindrical body,
wherein respective ends of the spring cavities in-

clude threaded bores.

18. The apparatus of claim 17, wherein the second sleeve includes a second cylindrical body and a flange, the second cylindrical body to be at least partially received by the first sleeve, and the clamp apparatus further including biasing elements positioned in the spring cavities, and further including a plurality of fasteners, the plurality of fasteners to slidably couple the first sleeve and the second sleeve, the fasteners to threadably couple to the threaded bores of the spring cavities.

19. An apparatus comprising:
- means for clamping to coaxially align a punch tooling supporting a can body with a domer die and radially fix the punch tooling relative to the domer die after coaxially aligning the punch tooling with the domer die; and
- means for profiling a bottom of a can body, the means for profiling movably coupled relative to the means for clamping.

20. The apparatus of claim 19, further including:
- means for fastening the means for clamping and the means for profiling; and
- means for biasing, the means for biasing to enable the means for clamping and the means for profiling to move relative to each other between a first operative position and a second operative position when the means for fastening couples the means for clamping and the means for profiling.

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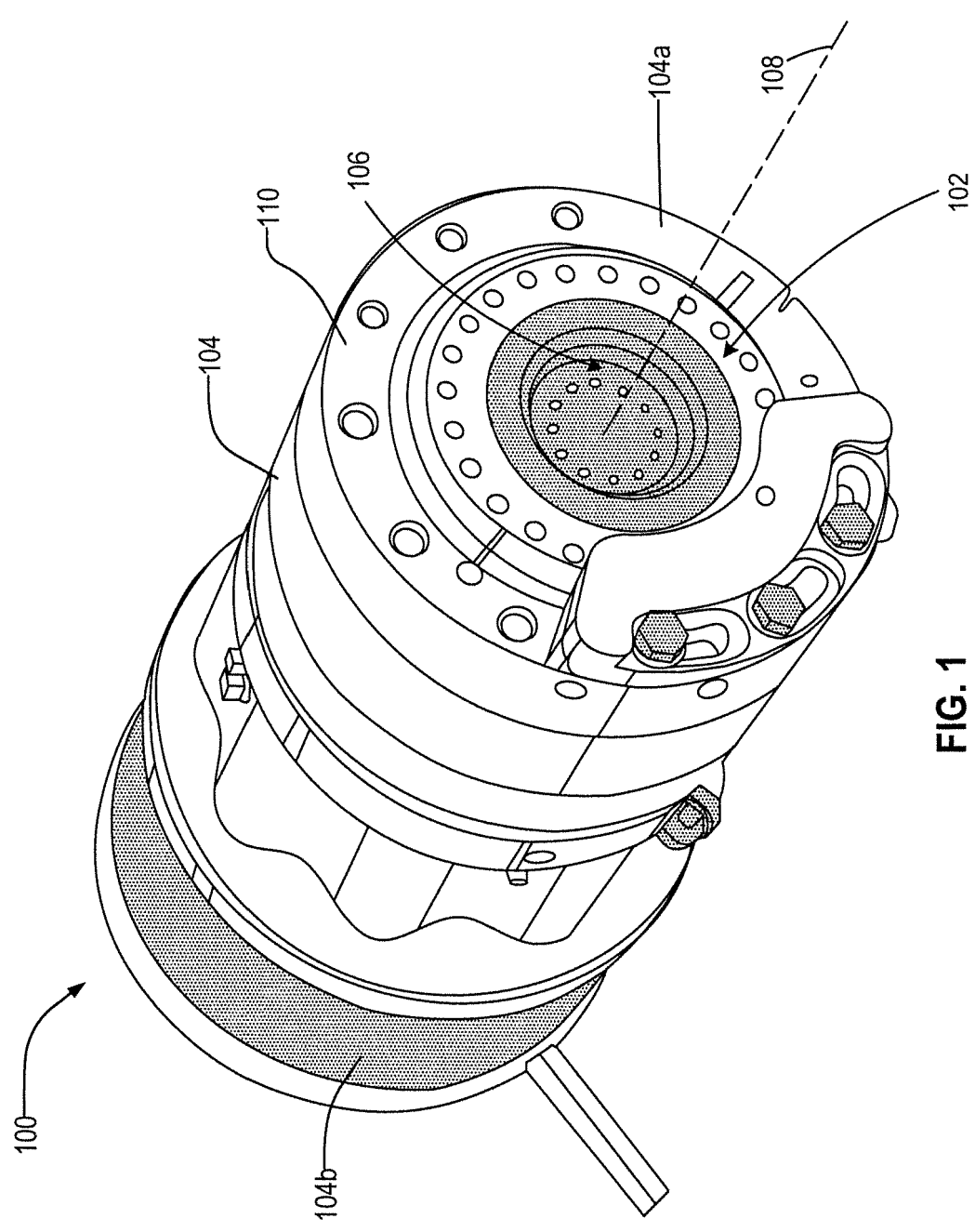
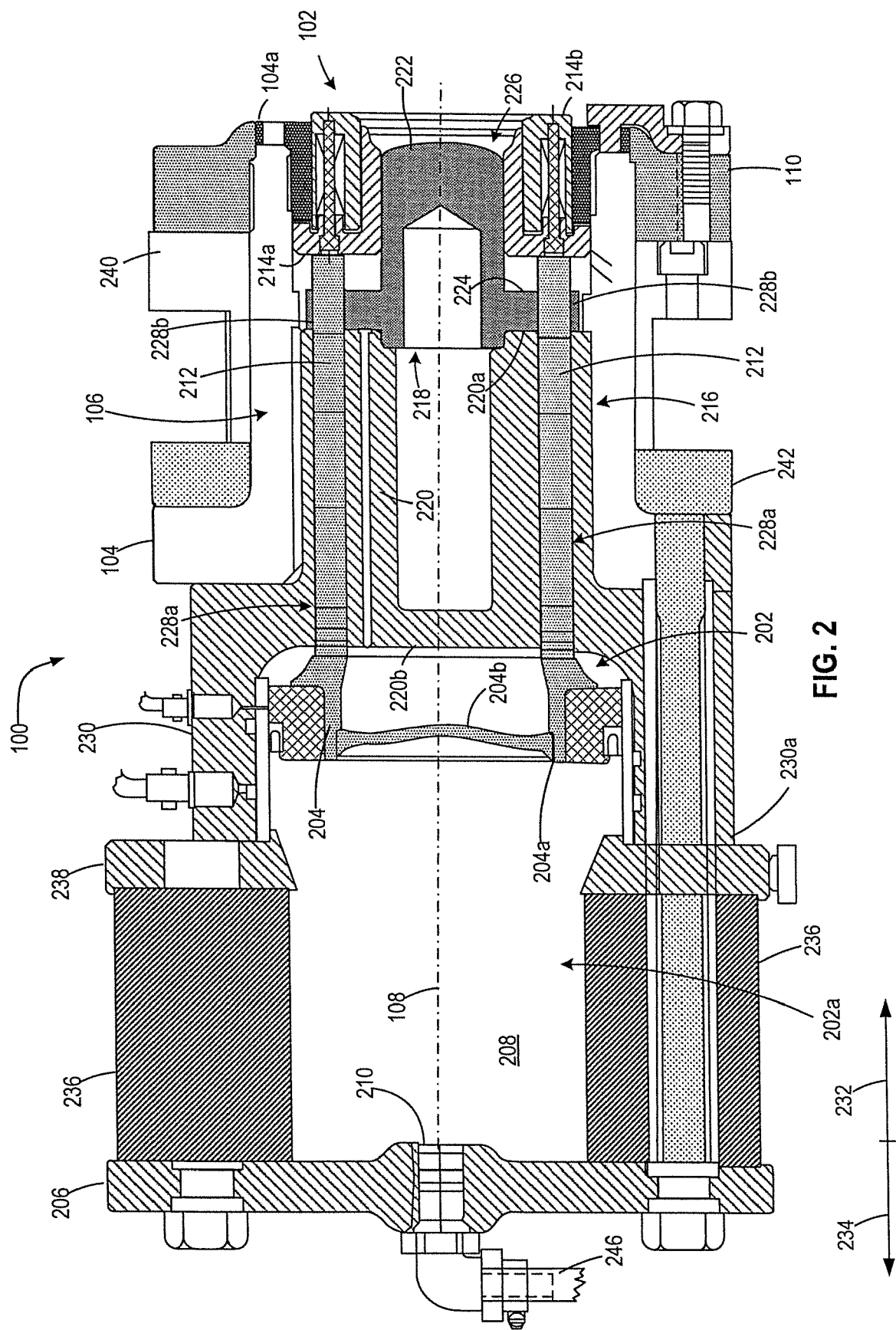


FIG. 1



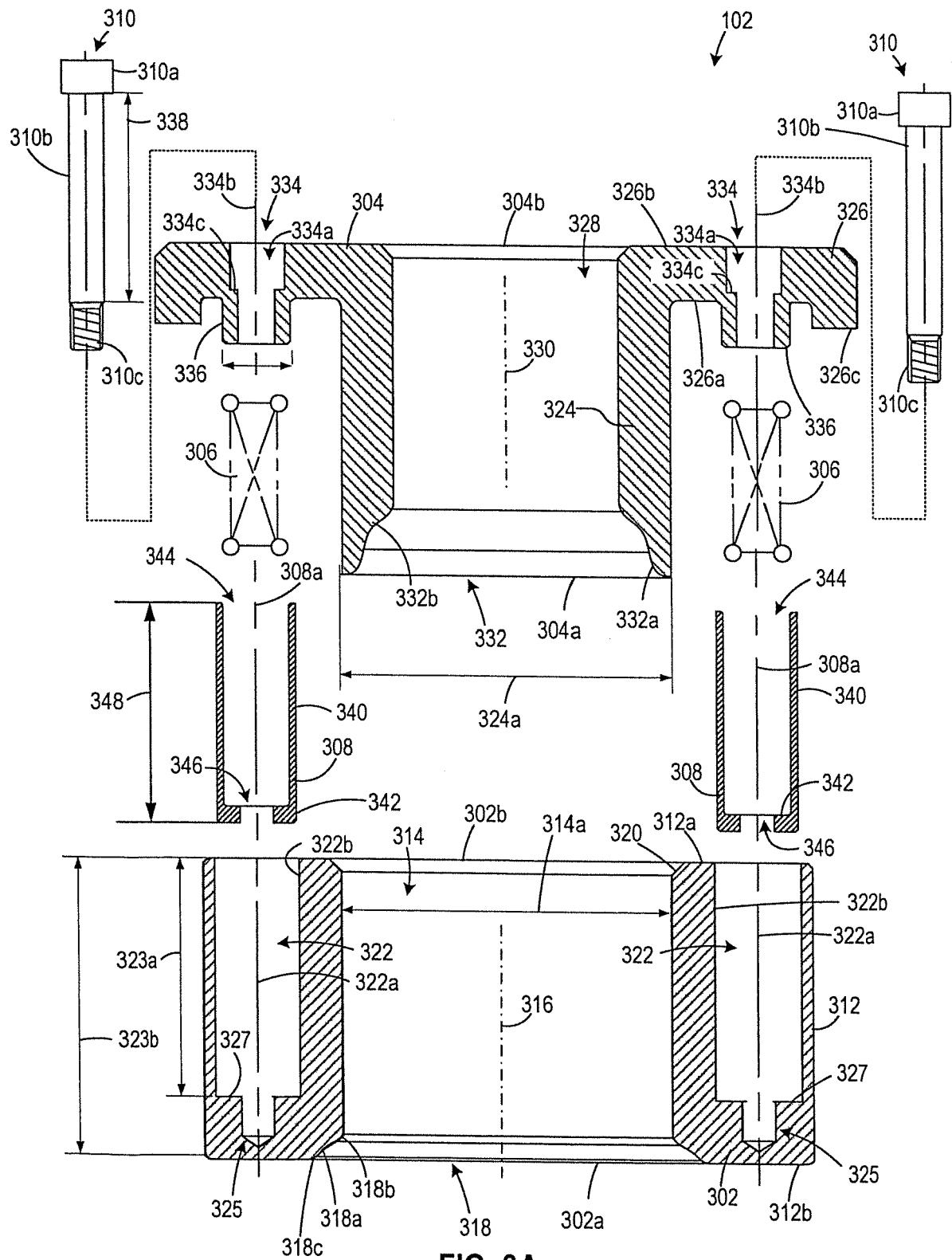


FIG. 3A

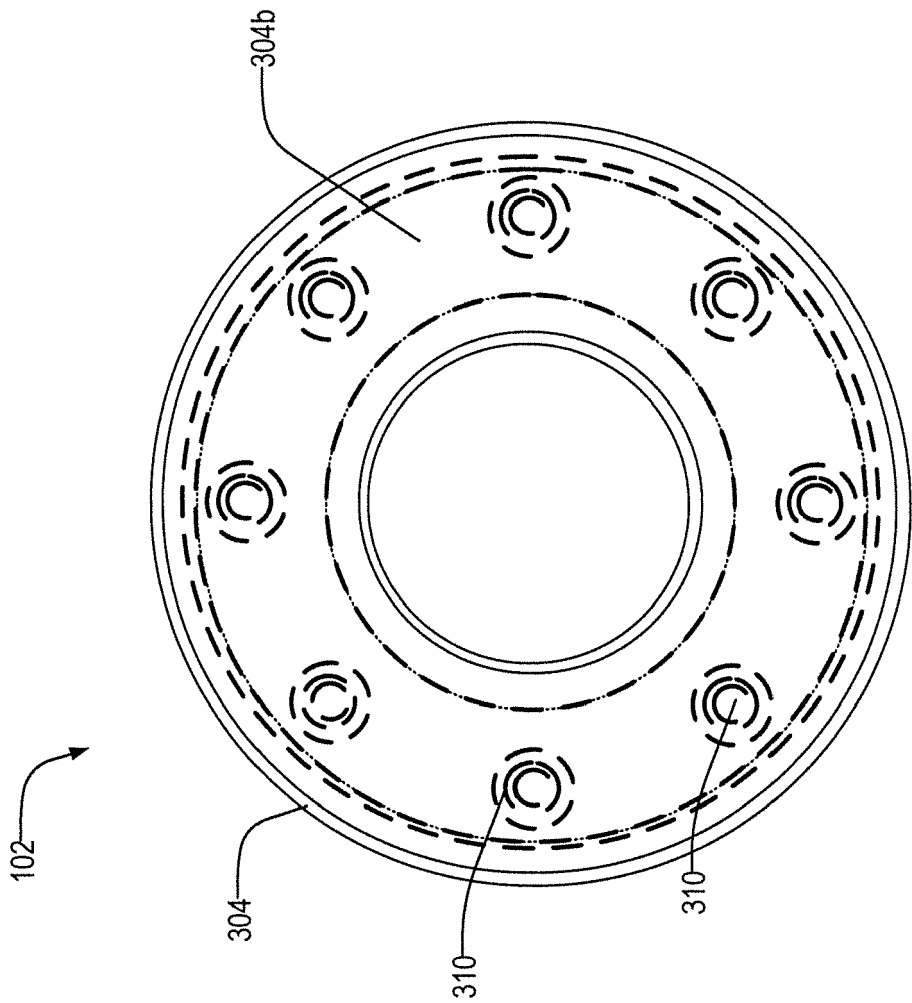
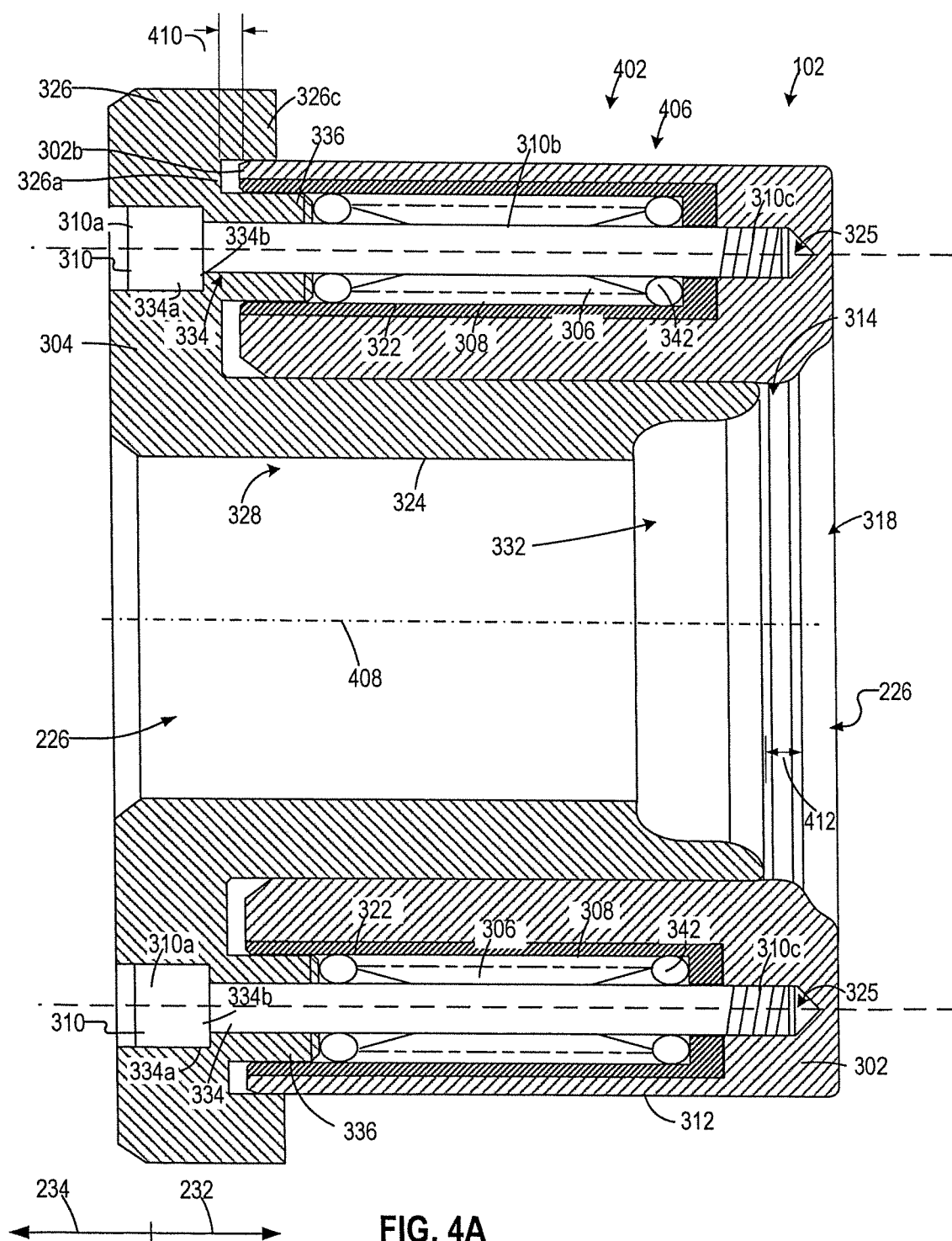


FIG. 3B



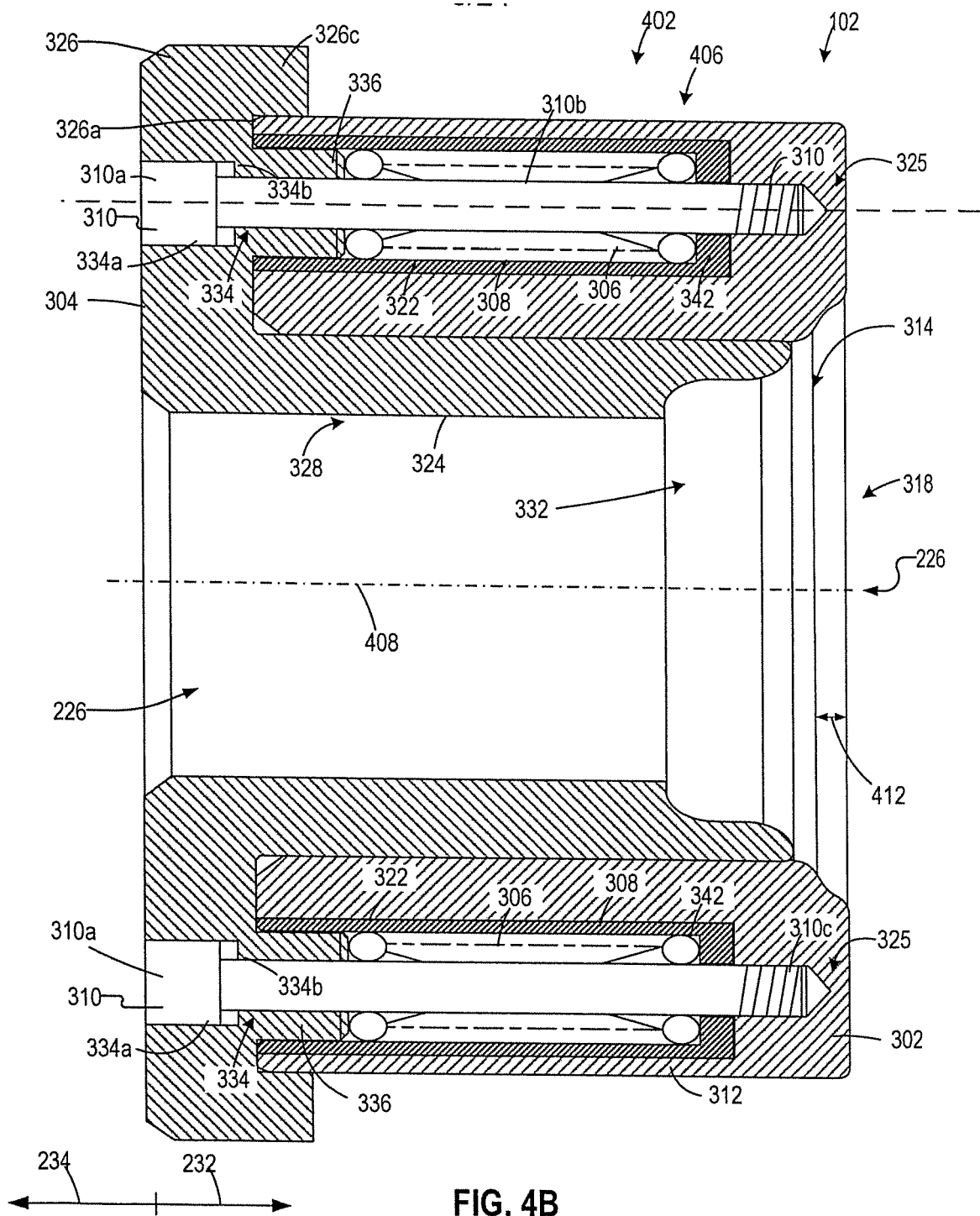


FIG. 4B

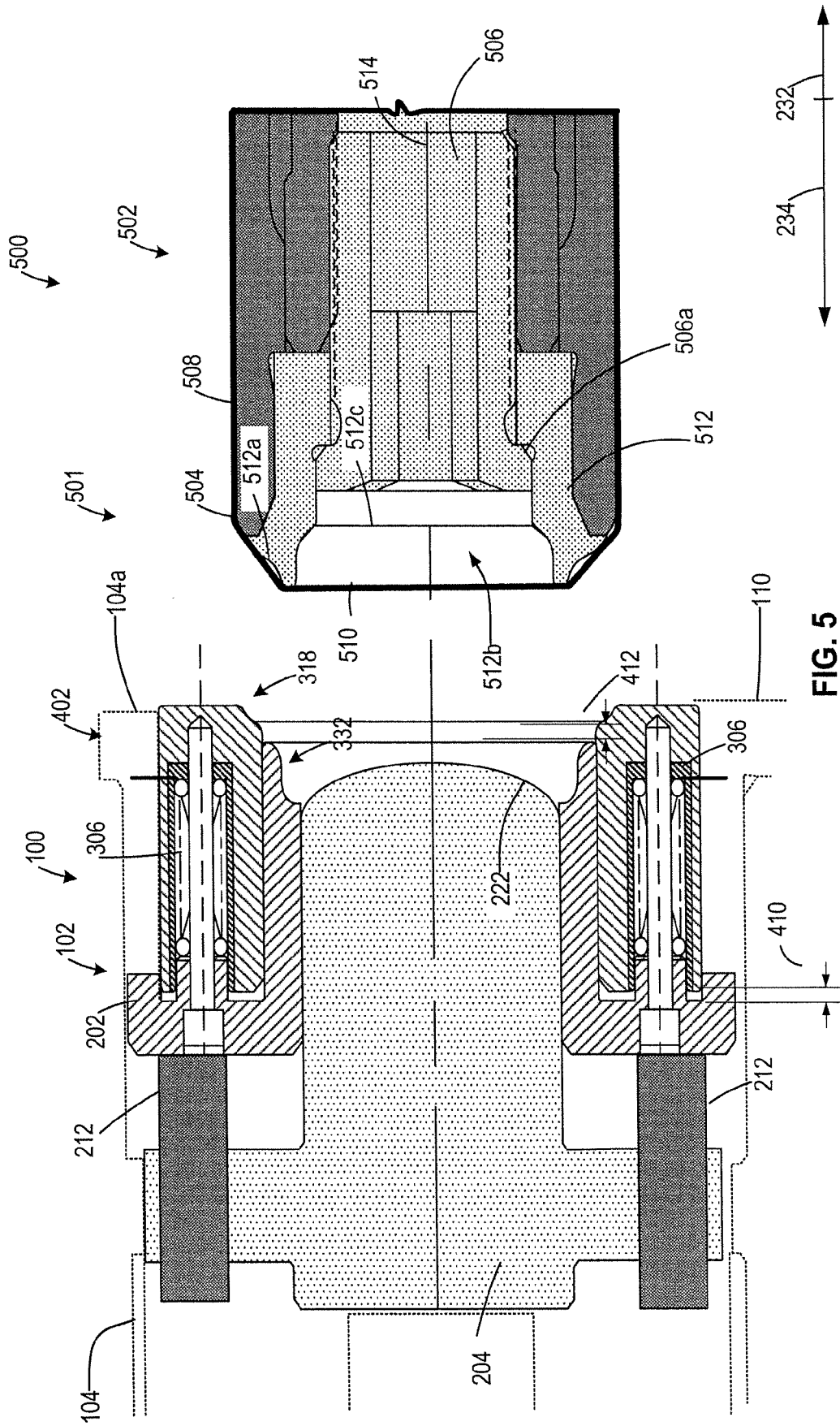
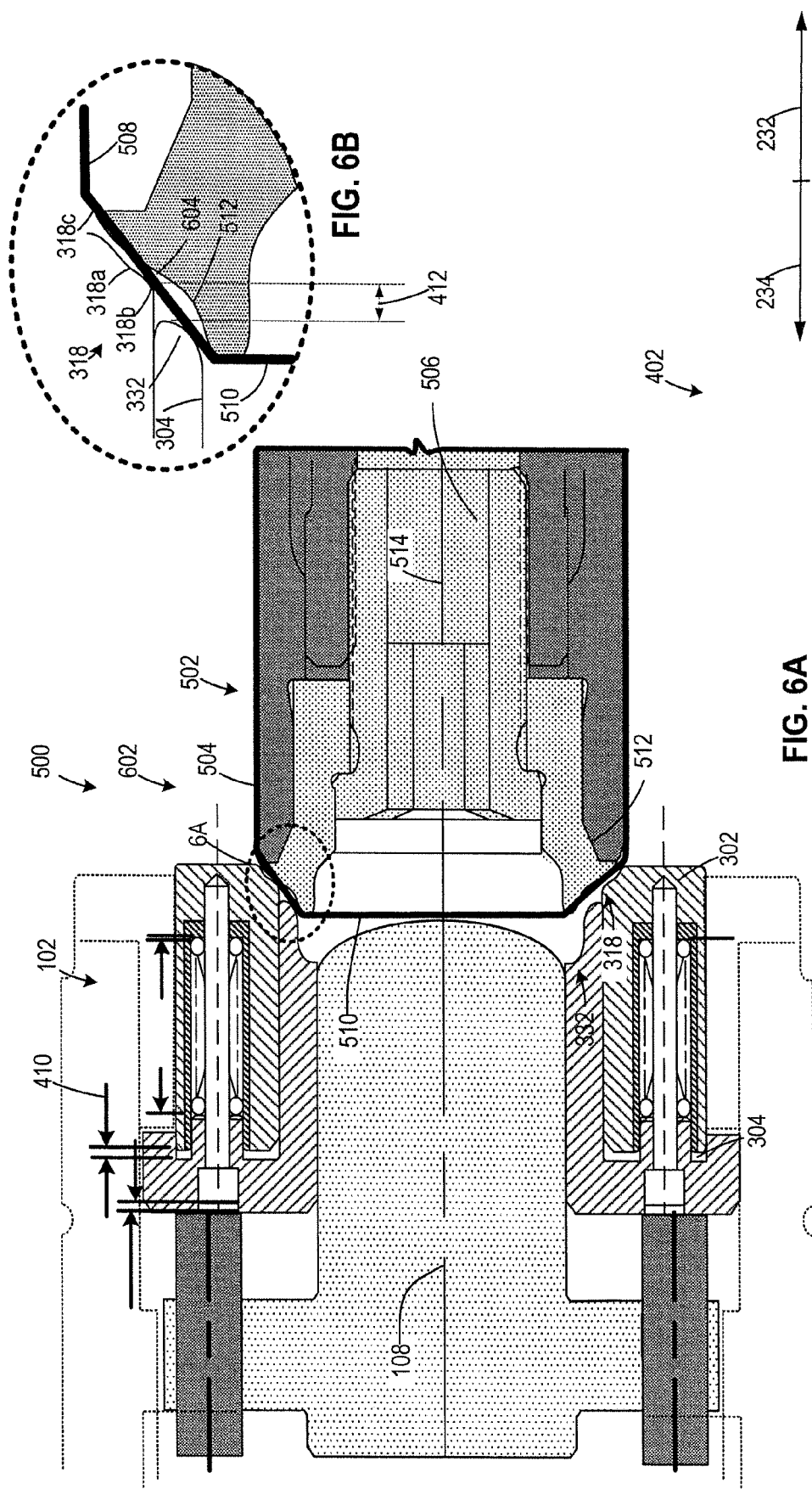
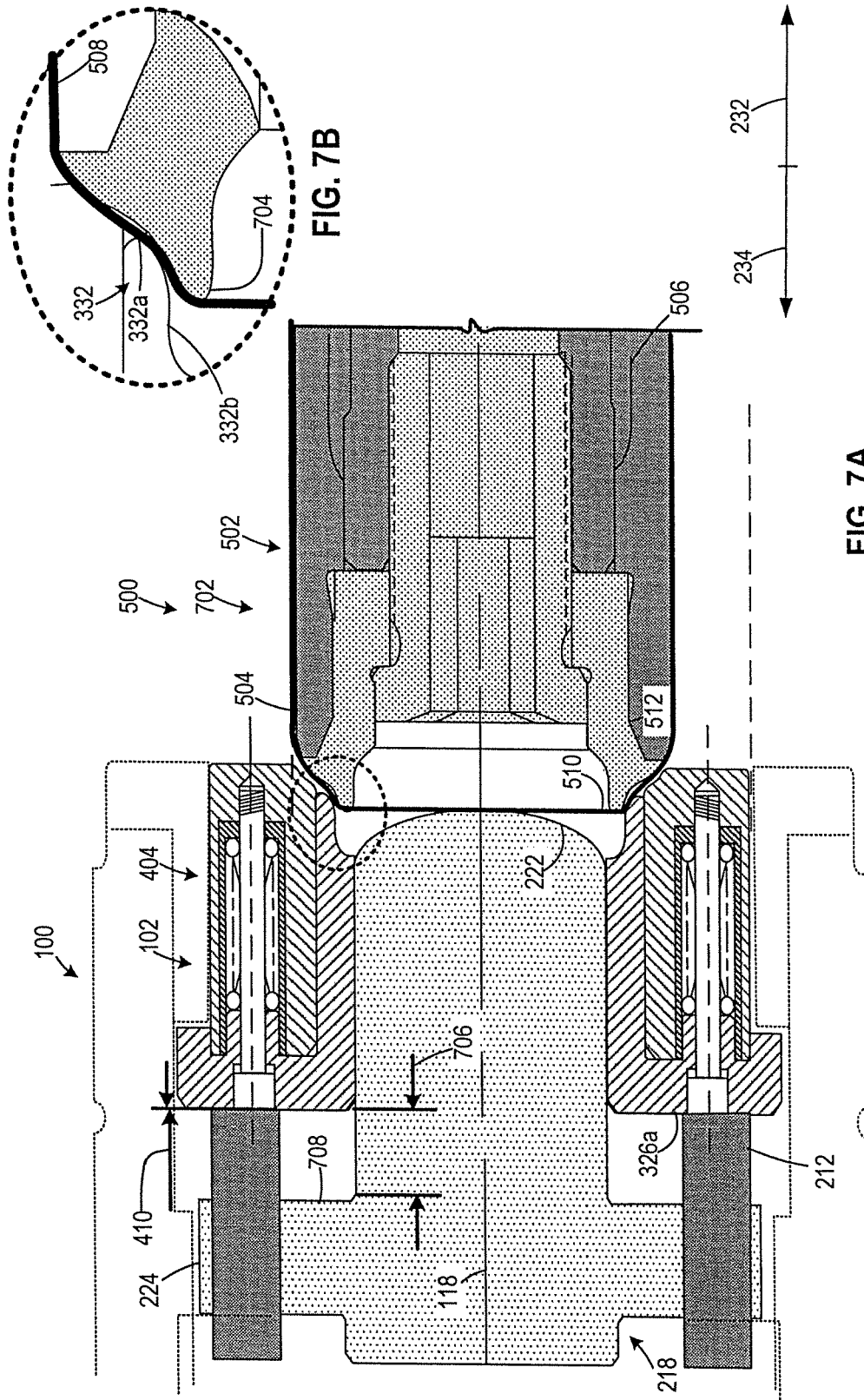


FIG. 5





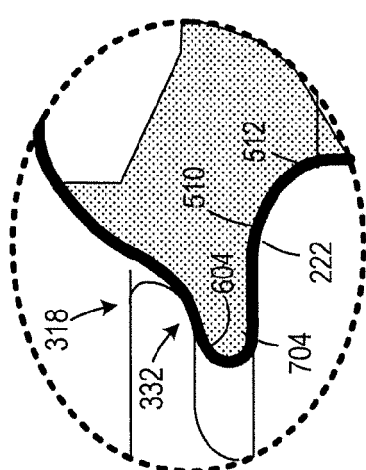


FIG. 8B

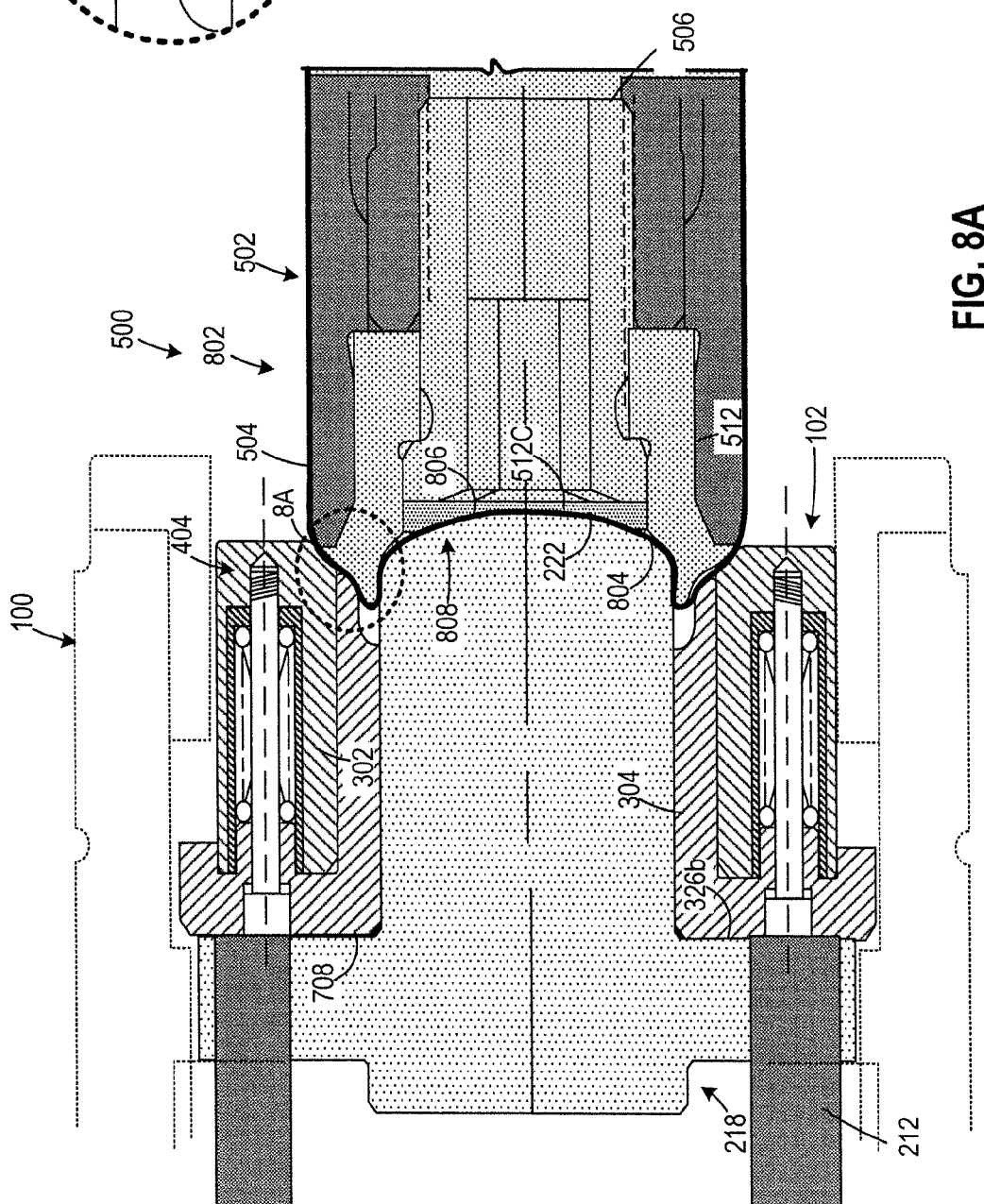
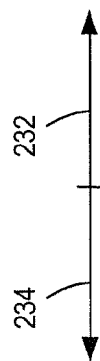


FIG. 8A



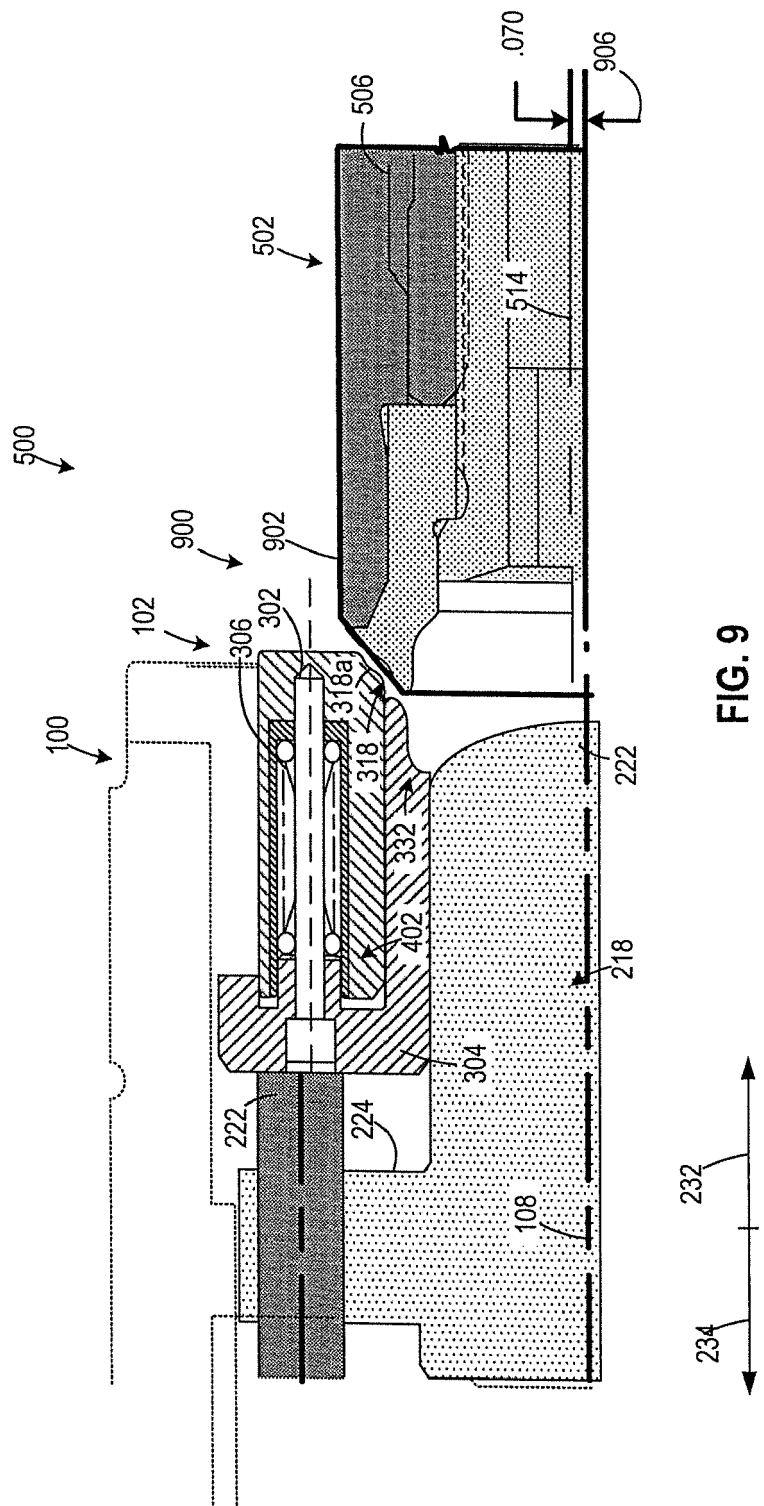


FIG. 9

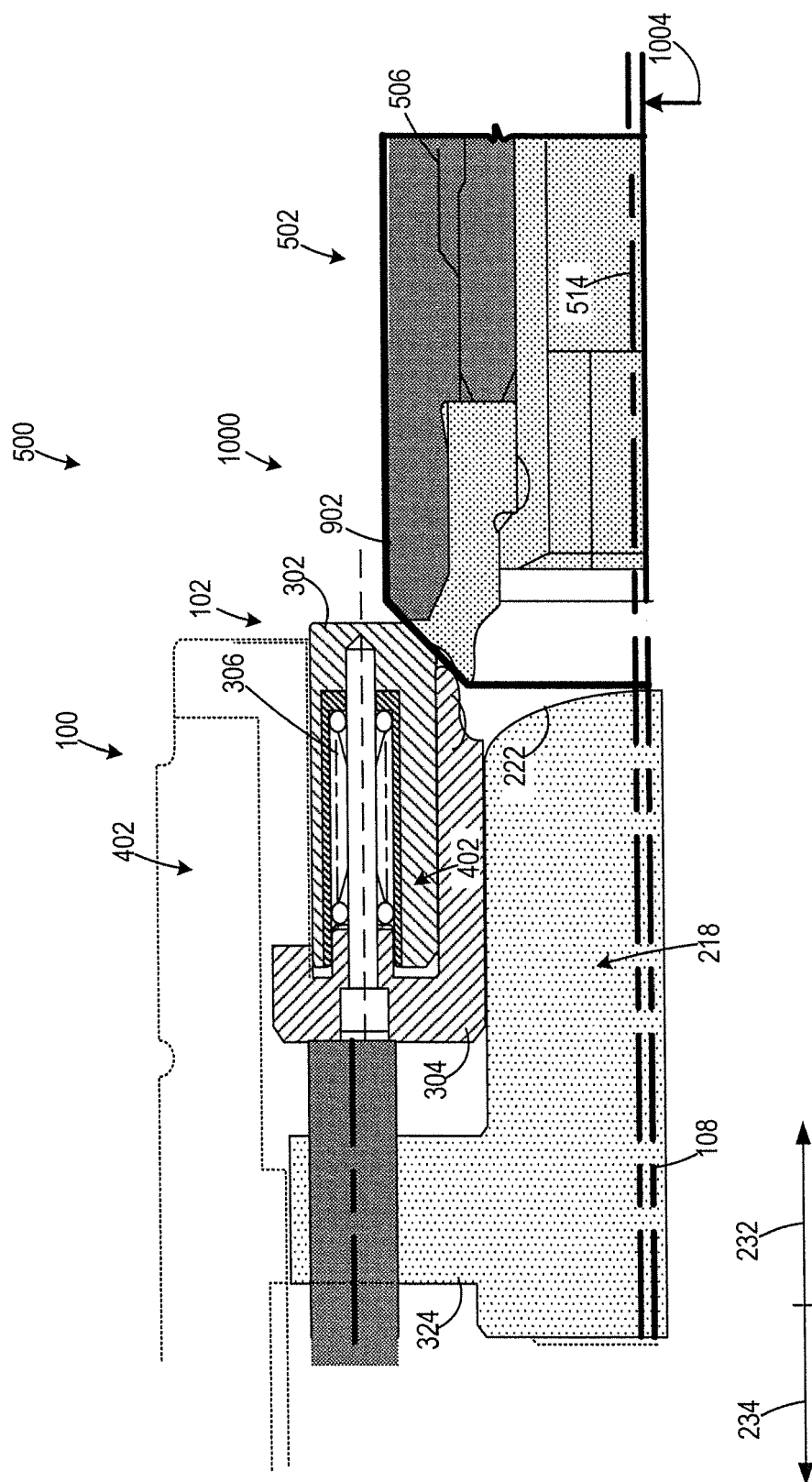


FIG. 10

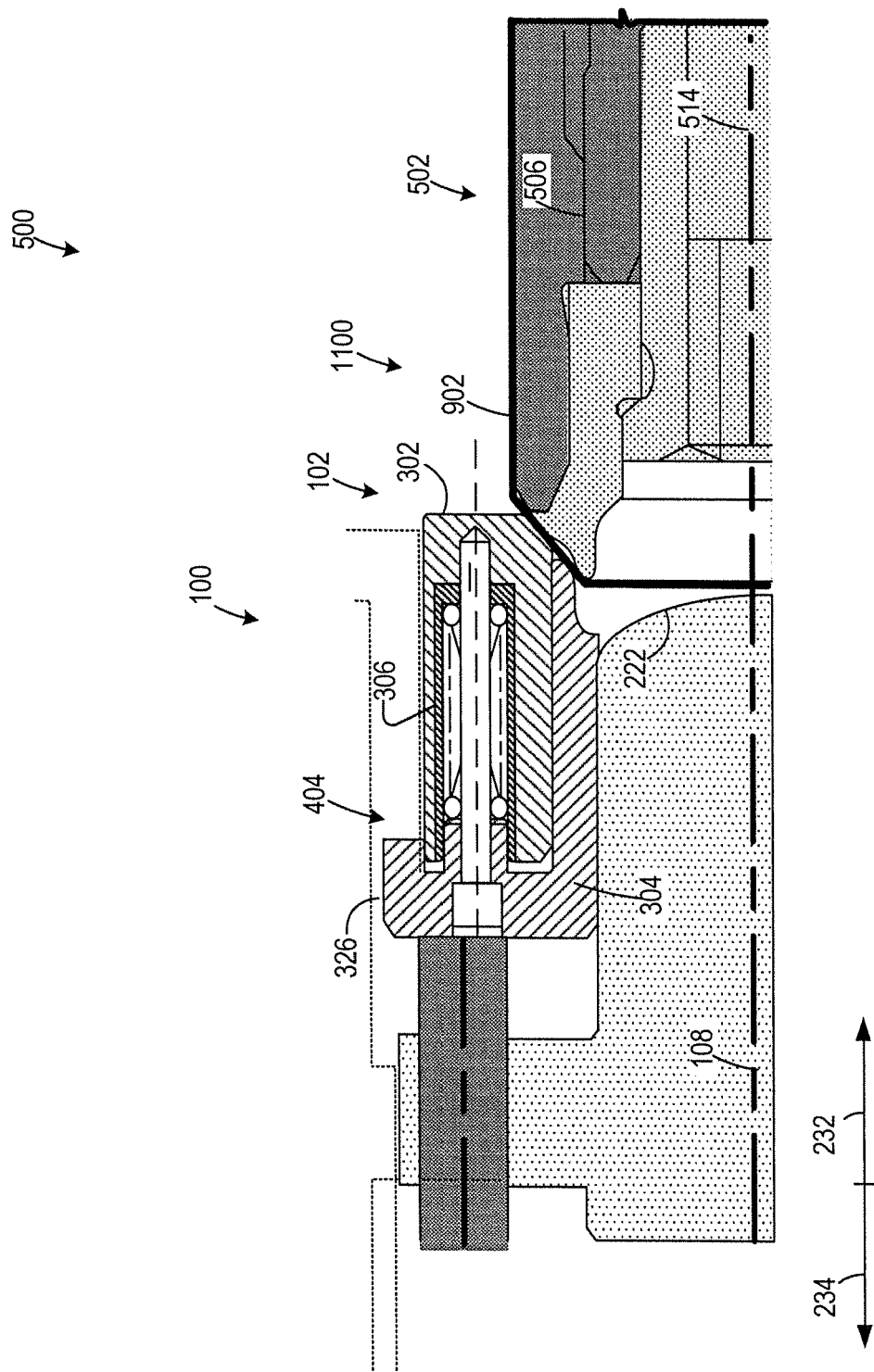


FIG. 11

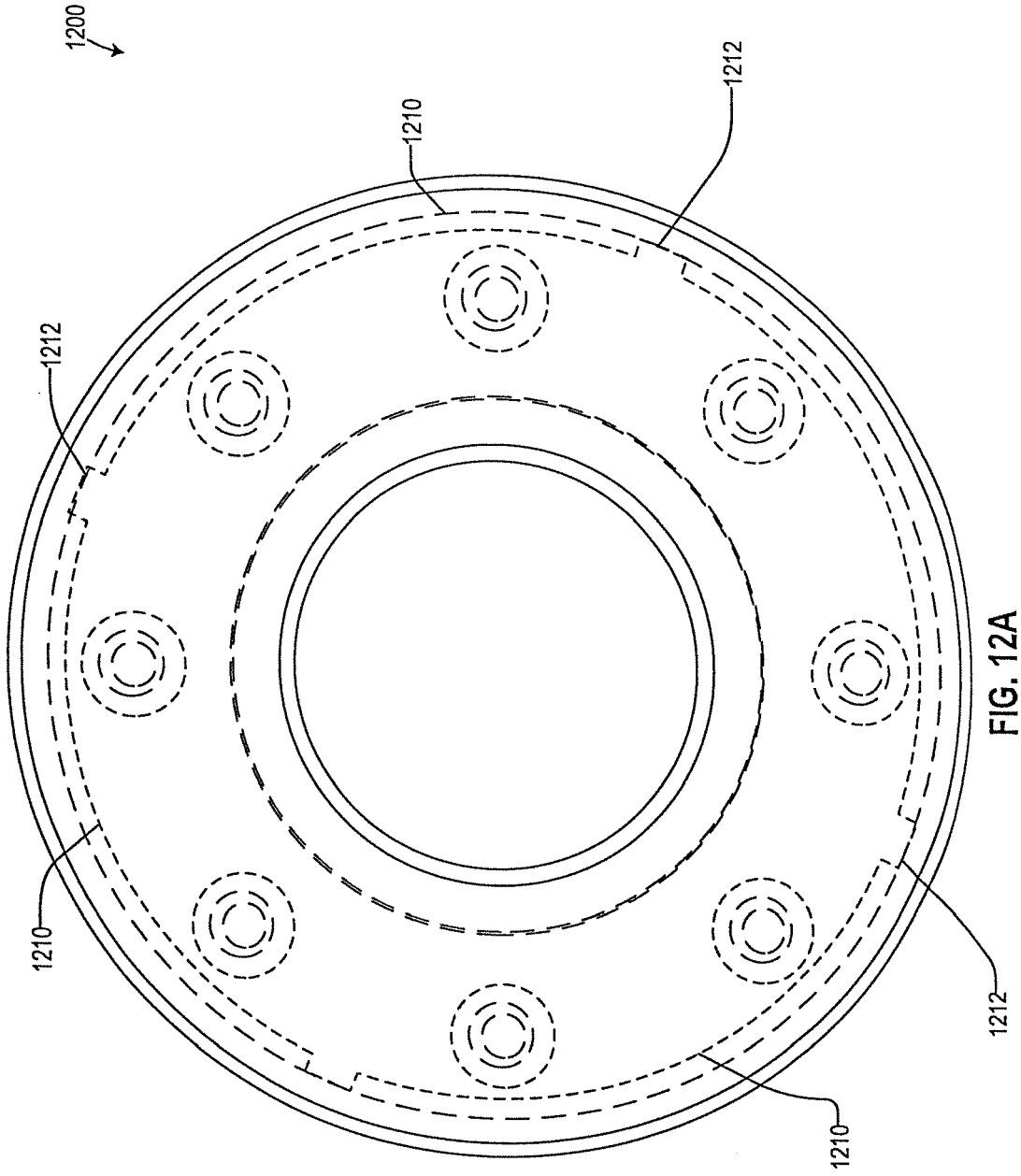


FIG. 12A

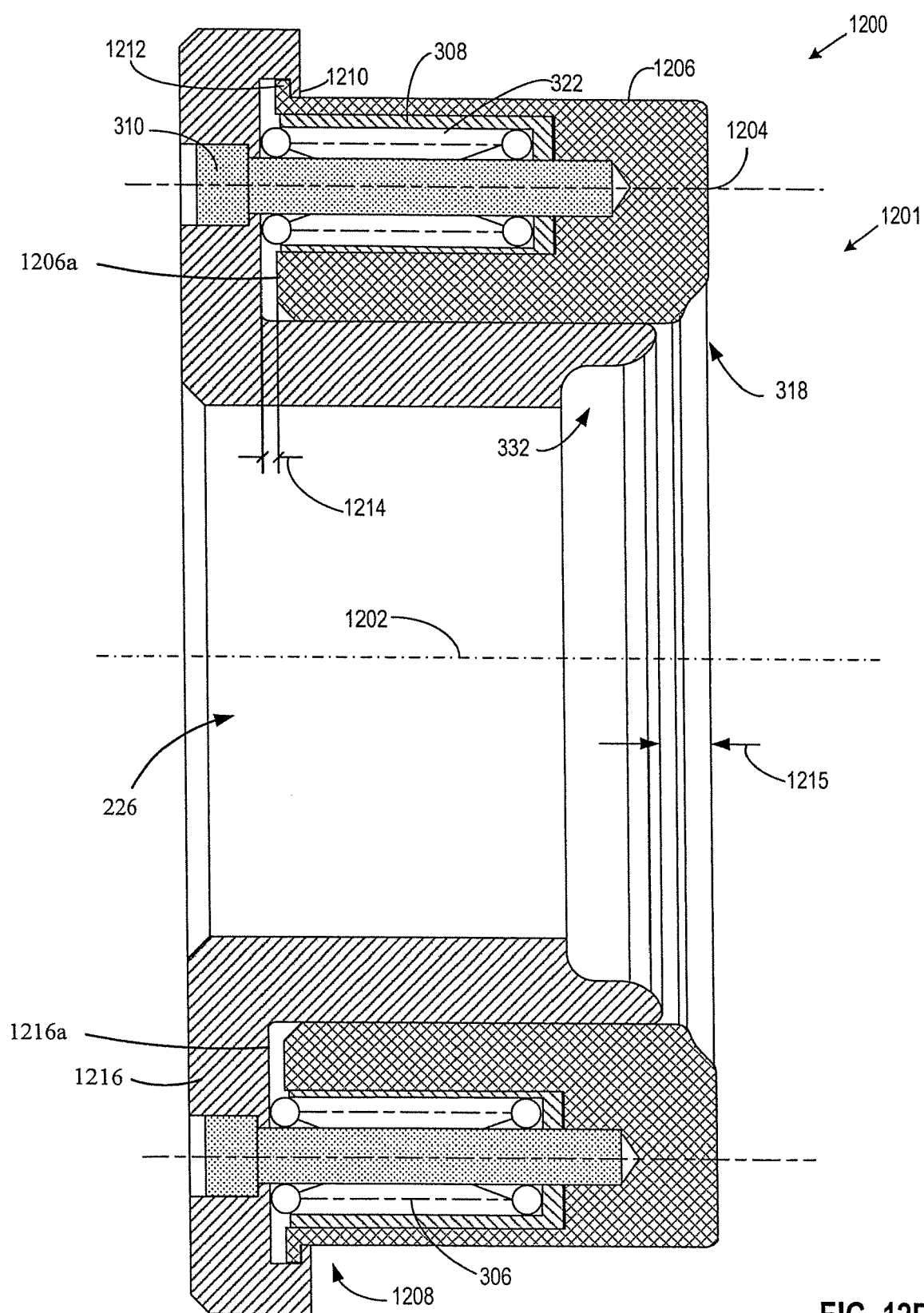


FIG. 12B

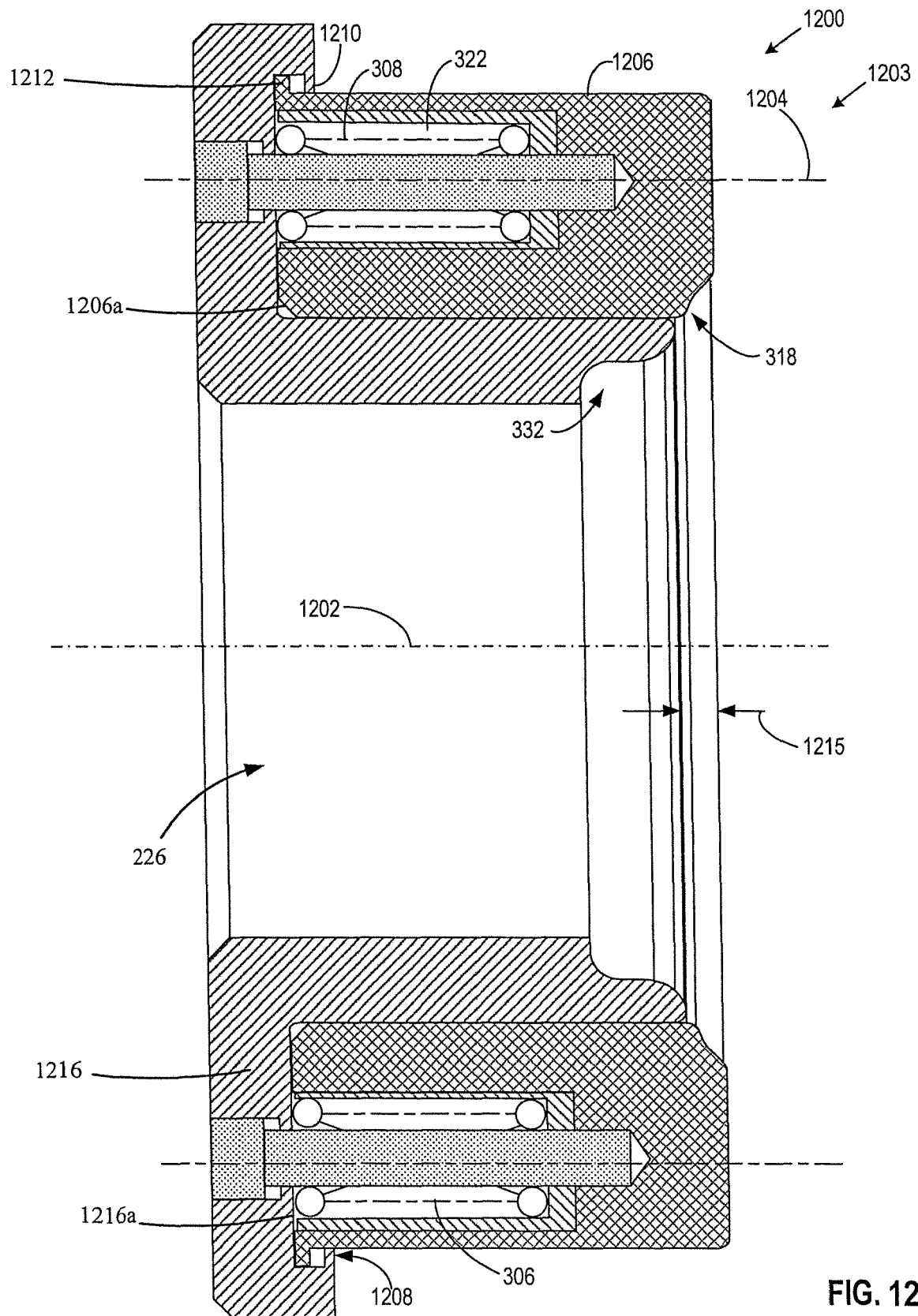


FIG. 12C

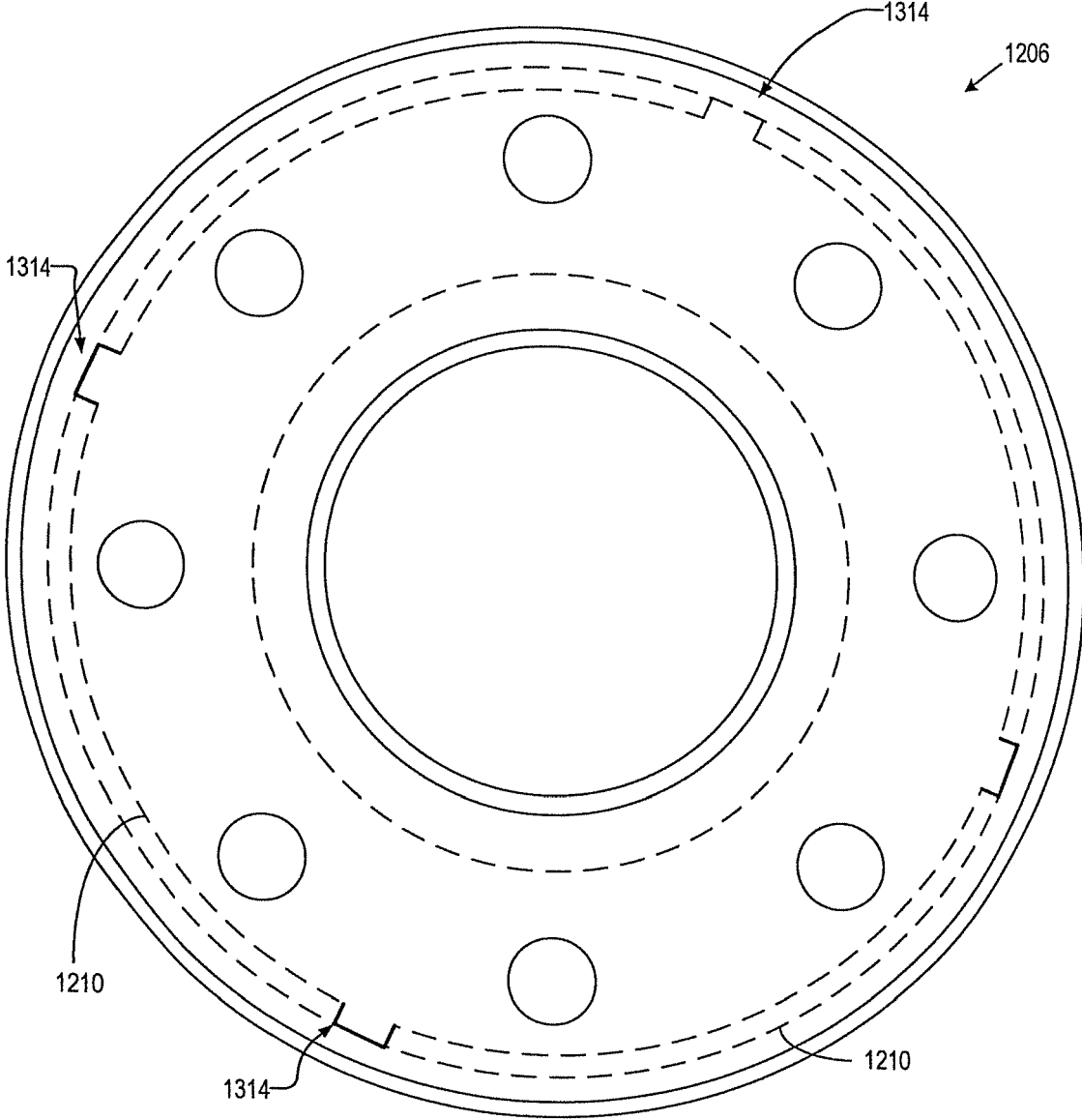


FIG. 13A

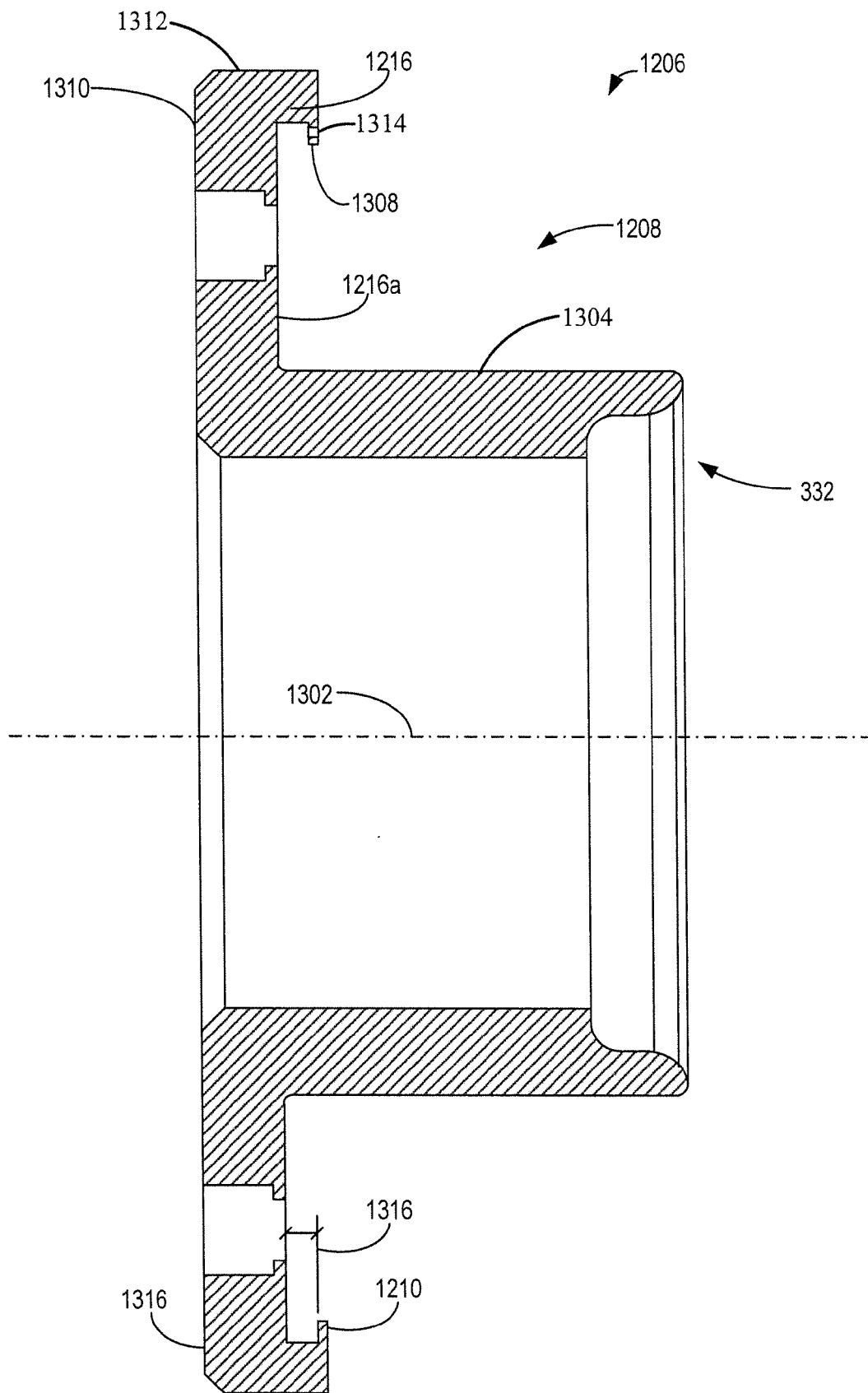


FIG. 13B

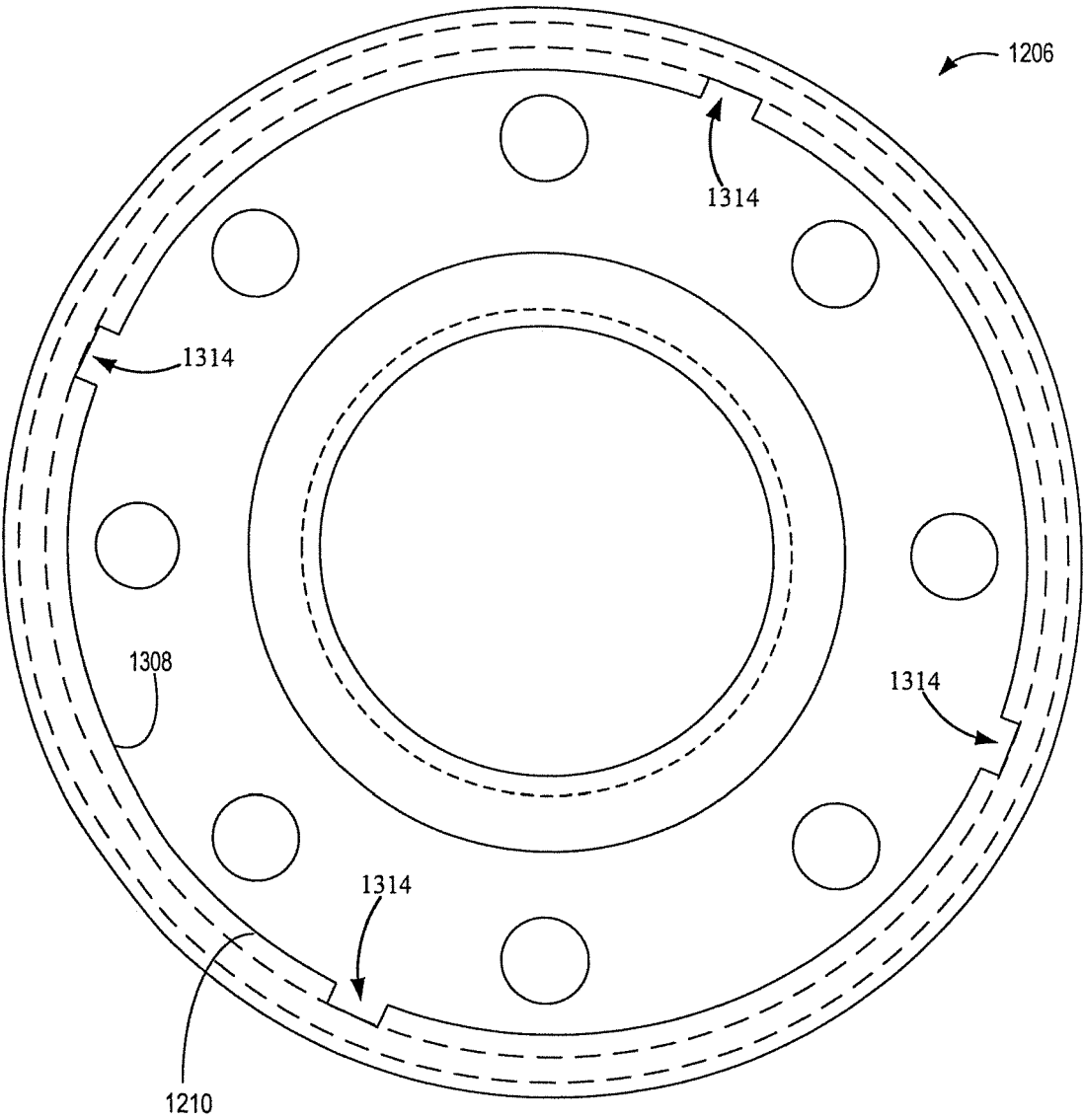


FIG. 13C

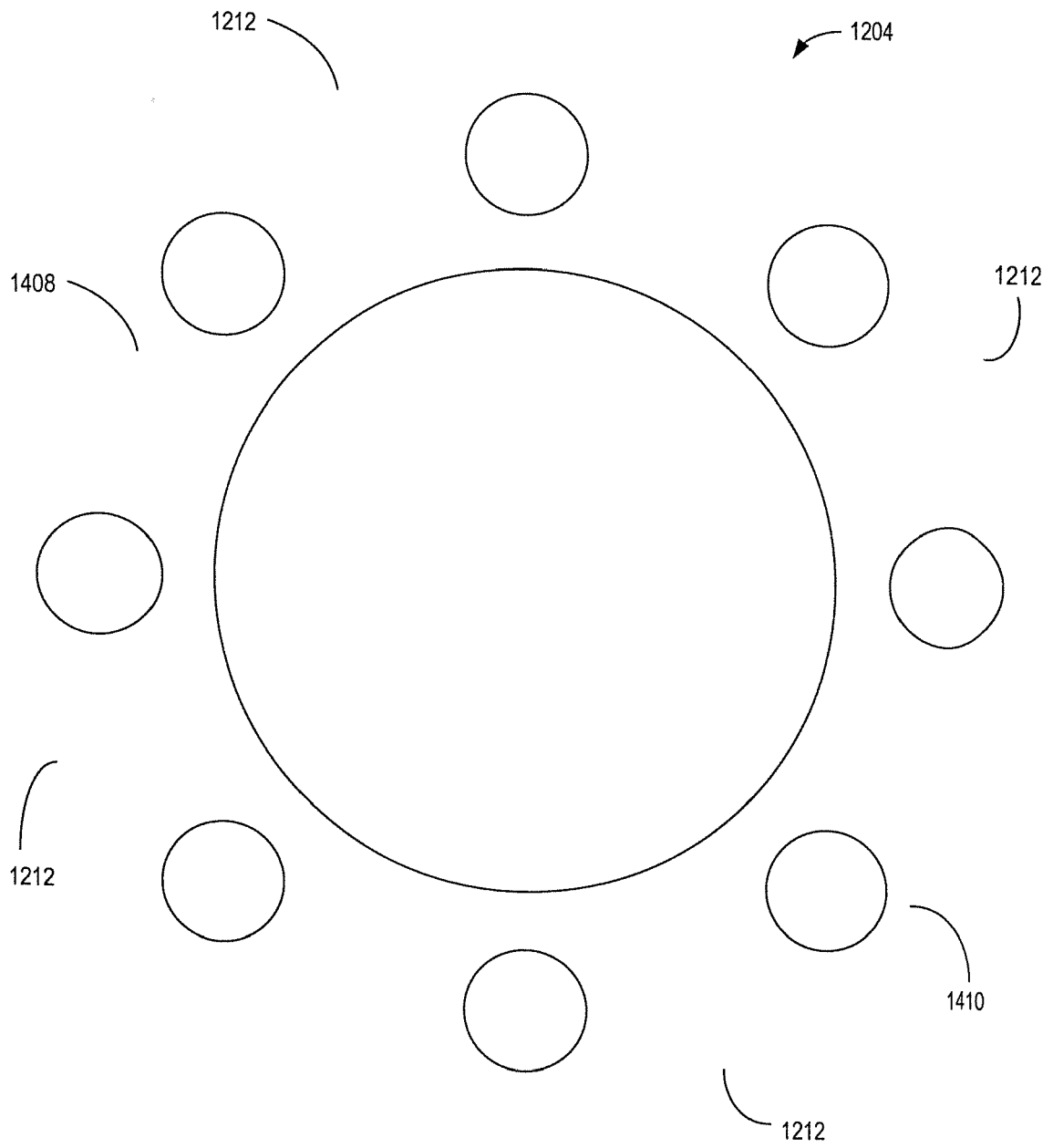
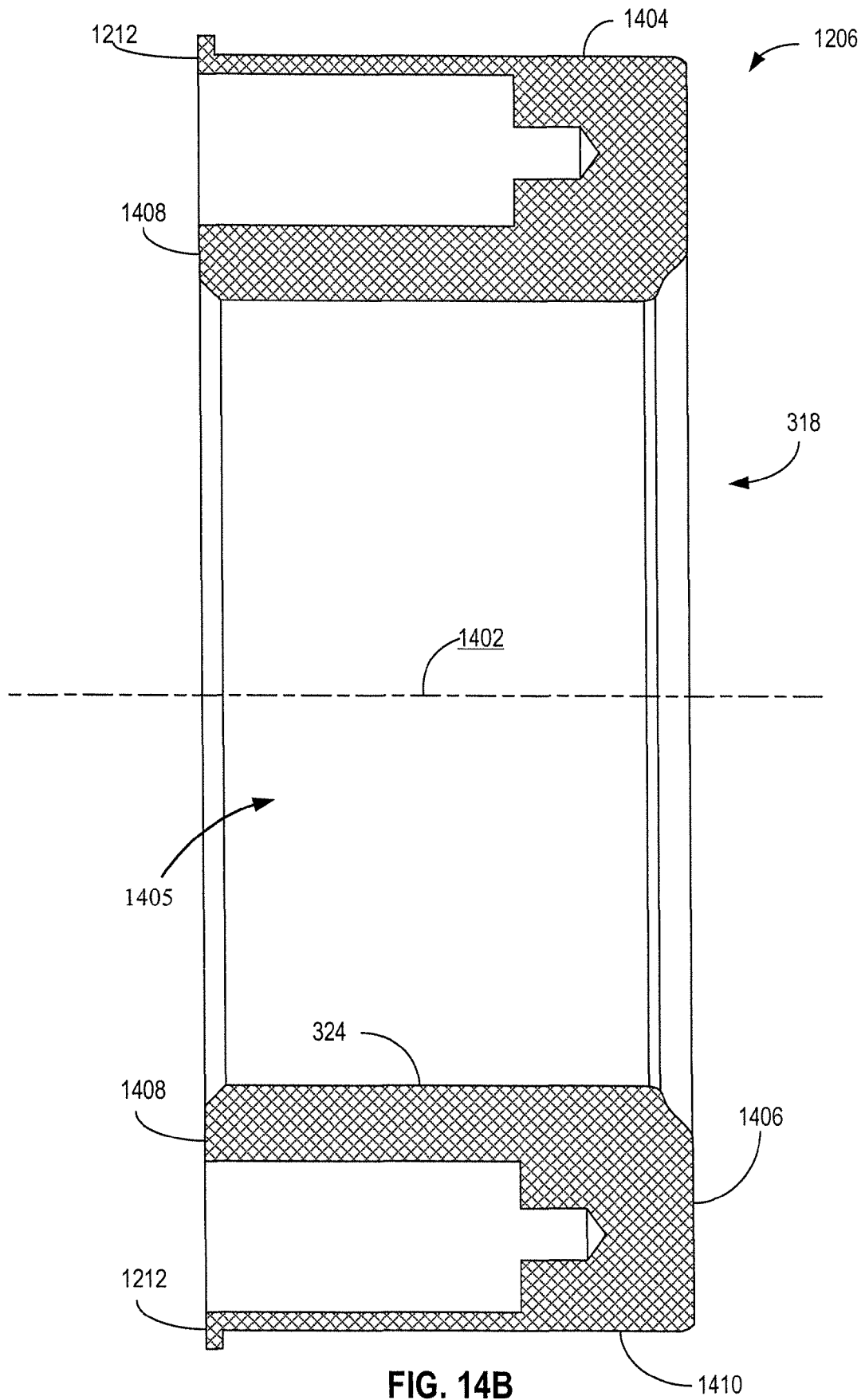


FIG. 14A



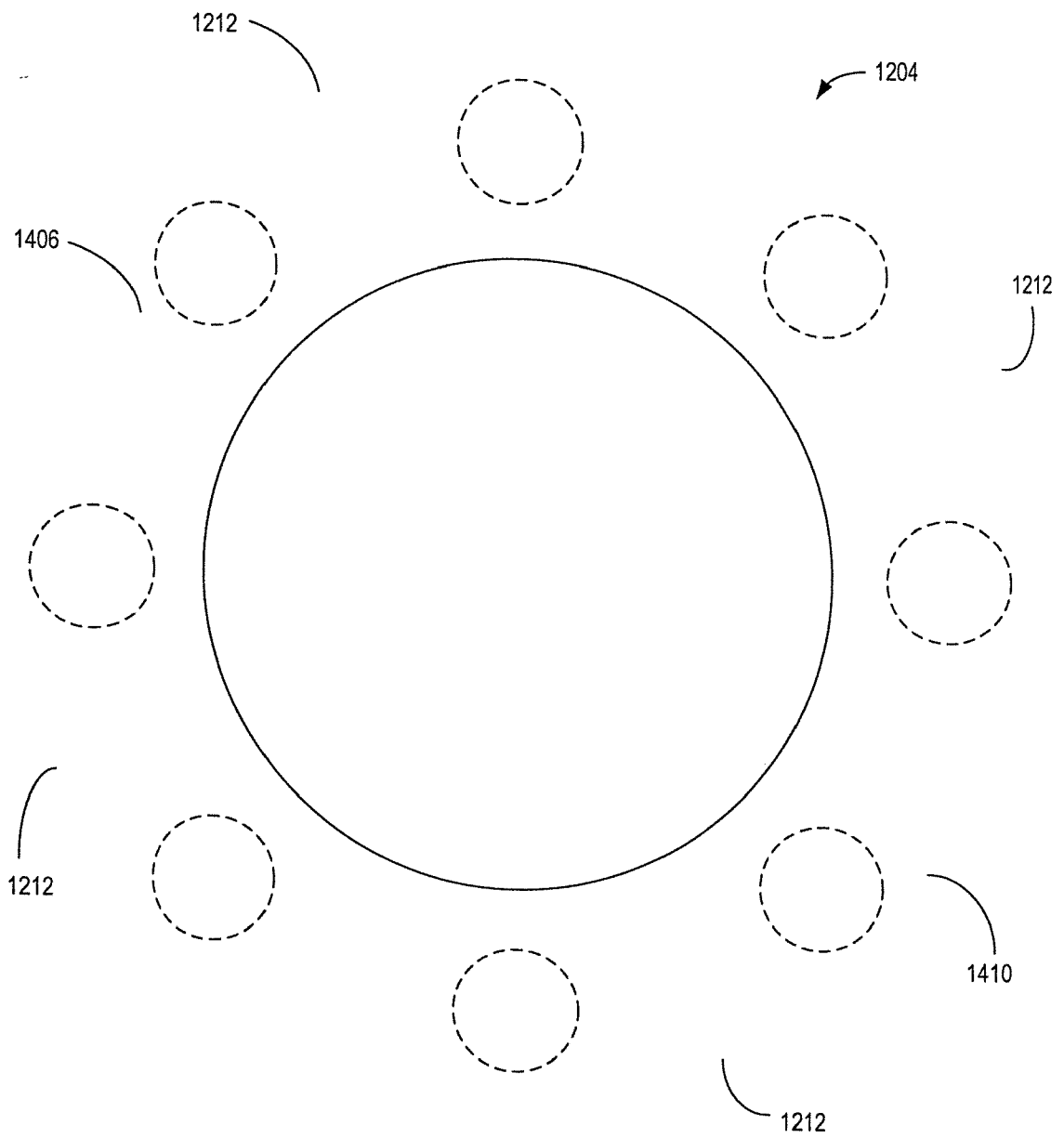


FIG. 14C

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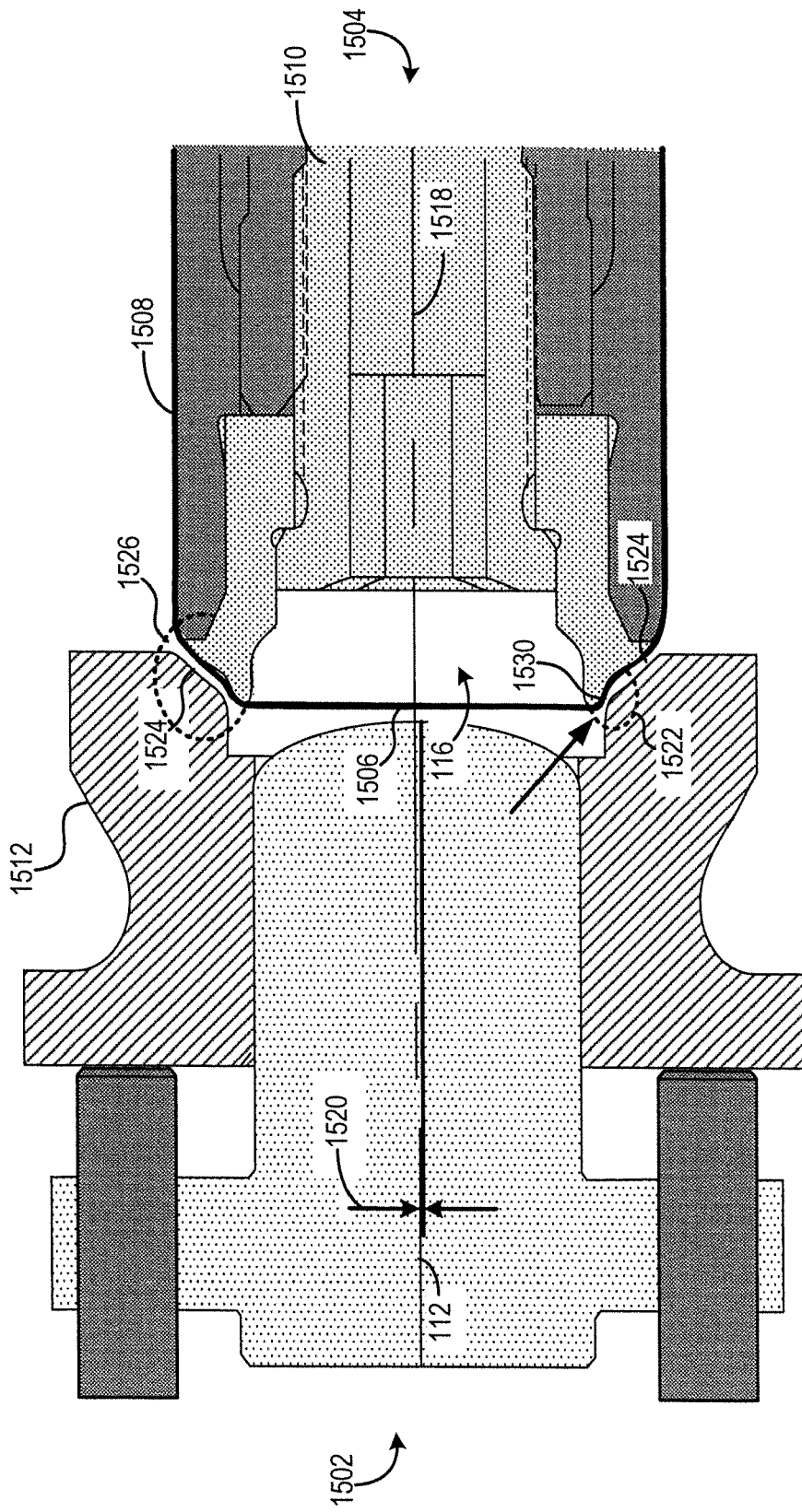


FIG. 15A
(Prior Art)

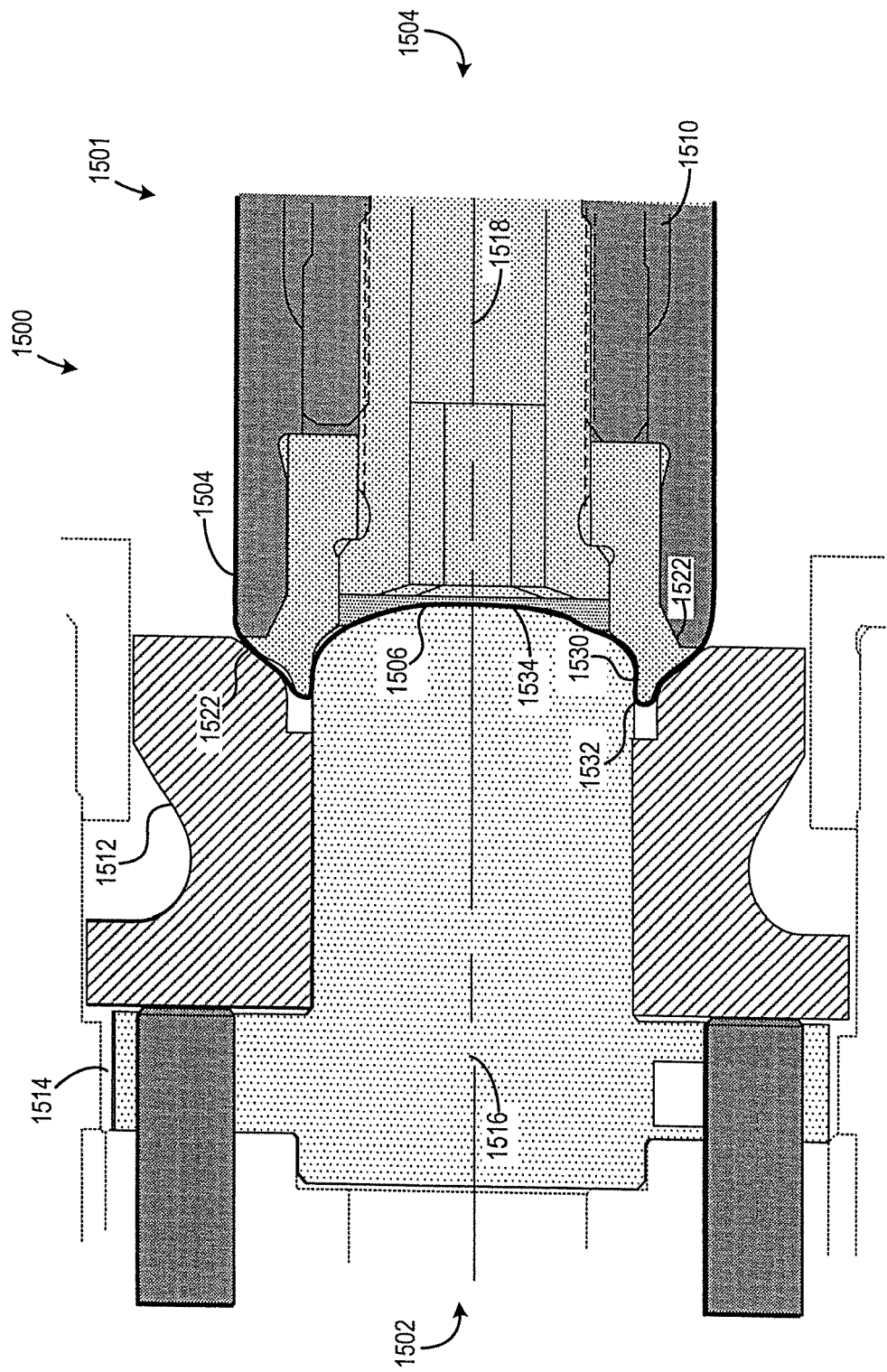


FIG. 15B
(Prior Art)



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Application Number

EP 24 15 2372

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			B21D
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 17 May 2024	Examiner Knecht, Frank
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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The members are as contained in the European Patent Office EDP file on
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