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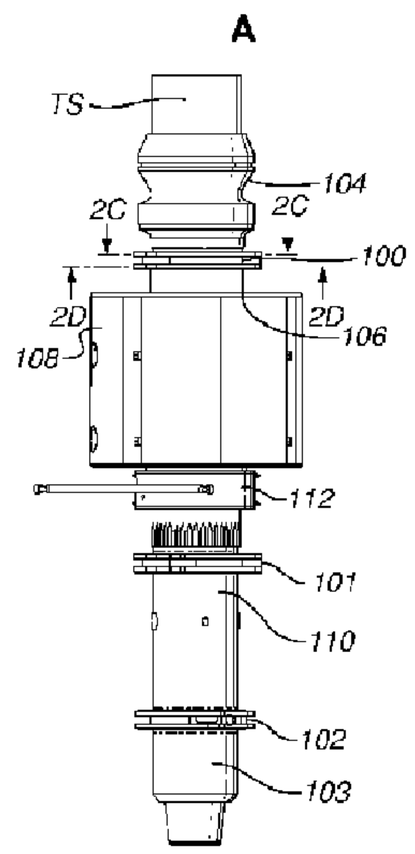


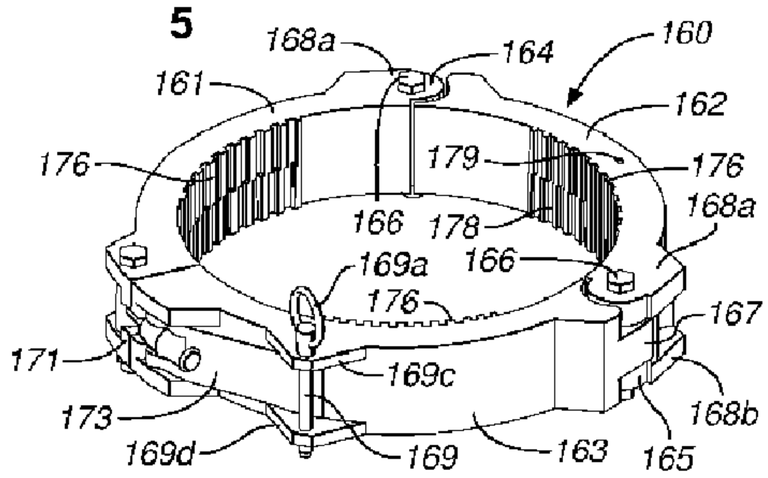


(57) Abrégé/Abstract:
A method and apparatus for clamping together a rotor of a top drive (TS) and an item threaded thereto to inhibit relative rotation between the two tubulars, the method comprising the steps of clamping the rotor to the item 5 (108) with a clamp (100), the rotor

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(57) Abrégé(suite)/Abstract(continued):
(50) having a projection (122) and the item (90,103,106,110) having a further projection (121) and the clamp (100,101,102) having a receiver (178) to receive the projection (122) and further projection (121) to inhibit rotation bet ween (10) the rotor (50) and the item (90,103,106,110).

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*[Continued on next page]*

**(54) Title:** A TOP DRIVE APPARATUS

Fig. 2A

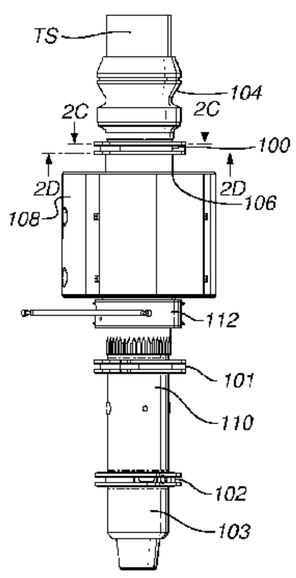
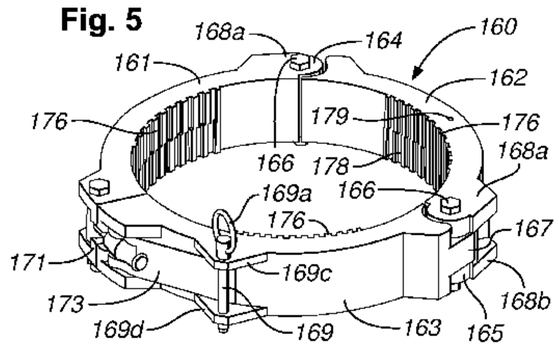



Fig. 5




**(57) Abstract:** A method and apparatus for clamping together a rotor of a top drive (TS) and an item threaded thereto to inhibit relative rotation between the two tubulars, the method comprising the steps of clamping the rotor to the item 5 (108) with a clamp (100), the rotor (50) having a projection (122) and the item (90,103,106,110) having a further projection (121) and the clamp (100,101,102) having a receiver (178) to receive the projection (122) and further projection (121) to inhibit rotation bet ween (10) the rotor (50) and the item (90,103,106,110).

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# A TOP DRIVE APPARATUS

The present invention relates to a top drive apparatus, to a clamp therefor and a method for clamping together a rotor and an item threadedly connected items and particularly, but not exclusively, to clamping together a rotor of a wellbore top drive apparatus and another item, for example a mud saver, a saver sub or an internal blowout preventer. The clamp may be used to clamp together a mud saver and a saver sub.

In the drilling of a borehole in the construction of an oil or gas well, a drill bit is arranged on the end of a drill string, which is rotated to bore the borehole through a formation. A drilling fluid known as "drilling mud" is pumped through the drill string to the drill bit to lubricate the drill bit. The drilling mud is also used to carry the cuttings produced by the drill bit and other solids to the surface through an annulus formed between the drill string and the borehole. The density of the drilling mud is closely controlled to inhibit the borehole from collapse and to ensure that drilling is carried out optimally. The density of the drilling mud effects the rate of penetration of the drill bit. By adjusting the density of the drilling mud, the rate of penetration changes at the possible detriment of collapsing the borehole. The drilling mud contains expensive synthetic oil-based lubricants and it is normal therefore to recover and re-use the used drilling mud, but this requires the solids to be removed from the drilling mud.

A top drive apparatus for drilling bore holes, such as oil and gas wells, is one of two common types of apparatus for drilling bore holes, the other being a rotary table apparatus. A top drive apparatus generally

comprises a main body which houses a motor for rotating a drive shaft which has a sub connectable to a single, stand or string of tubulars. The tubulars may be any of: drill pipe, casing, liner, premium tubular or any other such tubular used in the construction, maintenance and repair of wellbores, such as oil and gas wells. A top drive apparatus is generally arranged on a substantially vertical track on a derrick of a rig. The top drive apparatus is lifted and lowered on the track with a line over a crown block on a travelling block connected to the top drive apparatus. The line is reeled in and let out using a winch commonly known as a drawworks. The top drive apparatus can thus be used to trip tubulars in and out of the wellbore; turn the drill string to facilitate drilling the wellbore; and turn a single or stand of tubulars in relation to a string of tubulars hung in the wellbore to threadly connect or disconnect tubulars from a string of tubulars in the drill string to lengthen or shorten the string of tubulars. An elevator generally depends on links attached to the top drive to facilitate handling of tubulars and alignment with the sub for connection and disconnection therewith. A top drive apparatus may also be used in conjunction with a passive or active spider and/or with rotary tongs to facilitate connection and disconnection of tubulars from the string of tubulars.

The prior art discloses a variety of apparatus for clamping together a top drive shaft or part of a tubular string depending from a top drive threadedly connected to another item, for example a top drive shaft connected to a mud saver or a mud saver and another item, for example a saver sub. A prior art clamping apparatus is disclosed in co-owned U.S. Patent No. 7,188,686 which shows

clamping apparatus for clamping together, for example a top drive apparatus threadedly connected with another item. U.S. Patents 4,458,768; 5,433,279; 6,276,450; 4,813,493; 6,705,405; 4,800,968; 4,878,546; 4,872,577; 4,753,300; 6,536,520; 6,679,333 disclose various top drive apparatuses.

In accordance with the present invention, there is provided a top drive apparatus comprising a motor, a rotor and an item threadedly connected to said rotor, the top drive apparatus further comprising a clamp for inhibiting rotation between said rotor and said item, wherein said rotor has a projection and said item has a further projection and said clamp has a receiver to receive said projection and further projection to inhibit rotation between said rotor and said item characterised in that said receiver comprises at least a first set of teeth for contacting said projection and a second set of teeth for contacting said further projection.

Preferably, the projection and the further projection are each a tooth. Advantageously, the projection and the further projection are each a plurality of teeth. The rotor and item preferably have circular ends having a flow path therethrough for the passage of liquid, the plurality of teeth arranged on the circular ends and running substantially perpendicular to the circular end and in line with an axis of the rotor and item. Preferably, the rotor has an outer diameter, the projection projects from a portion of the rotor which has a smaller diameter than the outer diameter. Alternatively, the projection projects from the smaller diameter to a diameter smaller than the outer diameter. Alternatively, the projection projects from the smaller

diameter to a diameter equal to the outer diameter. Alternatively, the projection projects from the smaller diameter to a diameter greater than the outer diameter.

Preferably, the number of projections of the second set of teeth differs from the number of projections of the second set of teeth differs from the number of projections of the second set of teeth by one.

Preferably, the set of teeth form a spline, which allows vertical movement, but resists rotational movement between the rotor and the item. Preferably, the first set of teeth lie in a first plane and the second set of teeth lie in a second plane, the first plane above the second plane.

Advantageously, the first and second set of teeth are arranged on a main body for resisting torque between the rotor and the item. Preferably, the main body is made from a cast metal. Advantageously, the main body has a generally circular inner face, the main body comprising at least two segments movable to open a throat into which the rotor and item may sit. Preferably, thye main body comprises three segments or more. Preferably, the clamp comprisies lock apparatus for releasably locking together two adjacent clamp segments of the plurality of clamp segments.

Advantageously, the main body is generally circular. Preferably, the first set of teeth circums a portion of the main body, advantageously, thirty degrees. Preferably, the first set of broken into three thirty degree sections all lying in the first plane spaced substantially equally about an inner face of the main body. Advantageously, the second set of broken into three thirty degree sections all lying in the second plane.

Preferably, the main body comprises at least two segments and preferably three segments and advantageously, hingeably attached to one another.

Preferably, the rotor is a drive shaft. Advantageously, the rotor comprises an IBOP. Preferably, the item is an IBOP. It may be desired to use two IBOP's or more to shut off or reduce flow through the rotor of the top drive apparatus. Advantageously, the item comprises a saver-sub.

The present invention also provides a method for clamping together a rotor of a top drive and an item threaded thereto to inhibit relative rotation therebetween, the method comprising the steps of clamping the rotor to the item with a clamp, said rotor having a projection and said item having a further projection and said clamp having a receiver to receive said projection and further projection to inhibit rotation between said rotor and said item, said receiver comprising at least a first set of teeth for contacting said projection and a second set of teeth for contacting said further projection

Preferably, the projection and the further projection are each a plurality of teeth and the receiver comprises at least a first set of teeth for contacting the projection and a second set of teeth for contacting the further projection, the method further comprising the step of meshing the first and second set of teeth with the plurality of teeth of the rotor and the item.

The clamp of the invention can be changed out faster than prior art clamps and also weighs substantially less than prior art clamps. The weight is critical to improve health and safety standards and manipulation is made easier, storage and transportation is also a lot easier,

which is especially useful for use on oil rigs and platforms in remote, inhospitable and inaccessible locations.

The present invention also provides a clamp of the top drive apparatus of the invention, the clamp comprises a main body having an inner, generally circular face having at least a first set of teeth for contacting said projection of said rotor and a second set of teeth for contacting said further projection of said item.

The present invention, in certain aspects, discloses a top drive apparatus with a drive shaft threadedly connected to a mud saver or internal blowout preventer. The drive shaft is clamped to the internal blowout preventer with a clamping apparatus in accordance with the present invention. In certain aspects the two items to be connected each have at least one external projection (or a series of them or multiple spaced-apart series of them) which is held by structure of a clamp apparatus. The clamp apparatus clamps around a first projection (one; or more than one projection) on a first item and around a second projection (one; or more than one projection) in a second item so that relative rotation of the two items is inhibited (depending on the amount of play or "slop" between the clamp and the projections) or substantially prevented when there is substantially no such play or "slop." Viewed another way, in accordance with the present invention a tubular (or tubulars) to be threadedly connected together has a recess, hole, or indentation (for example a space between two projections) and a projection of a clamp is received and held therein.

For a better understanding of the present invention, reference will now be made, by way of example, to the accompanying drawings, in which:

Figure 1A is a perspective view of a top drive apparatus in accordance with the present invention;

Figure 1B is a side view of the apparatus as shown in Figure 1A;

Figure 2A is a side view of an apparatus in accordance with the present invention, the apparatus comprising a clamp apparatus;

Figure 2B is a side view that shows the apparatus shown in Figure 2A with the clamp apparatus removed;

Figure 2C is a cross-section view taken along line 2C-2C of Figure 2A;

Figure 2D is a cross-section view taken along line 2D-2D of Figure 2A;

Figure 3A is a side view of parts of the apparatus shown in Figure 2A shown threadedly disconnected;

Figure 3B is a perspective view of the parts shown in Figure 3A threadedly connected;.

Figure 3C is a side view of two connected tubulars of an apparatus in accordance with the present invention;

Figure 4A is a perspective view of a clamp apparatus in accordance with the present invention;

Figure 4B is a perspective view of part of the apparatus shown in Figure 4A;

Figure 5 is a perspective view of a clamp apparatus in accordance with the present invention;

Figure 6A is a perspective view of a clamp apparatus in accordance with the present invention;

Figure 6B is a top view of the clamp apparatus shown in Figure 6A;

Figure 6C is an enlarged view of part of the clamp

apparatus shown in Figure 6A with part of an internal blowout preventer fitted in a lower set of teeth of the clamp;

Figure 7A is a perspective view of a clamp in accordance with the present invention;

Figure 7B is an exploded view of the clamp shown in Figure 7A;

Figure 8A is a cross-section view of an item in accordance with the present invention;

Figure 8B is a cross-section view of an item in accordance with the present invention;

Figure 8C is a cross-section view of an item in accordance with the present invention;

Figure 8D is a cross-section view of an item in accordance with the present invention;

Figure 8E is a cross-section view of an item in accordance with the present invention;

Figures 1A and 1B show a top drive apparatus TD in accordance with the present invention which is suspended with links 14 from a support such as a becket (not shown) and a travelling block (not shown).

A motor or motors 30 are coupled to a gear system 20. Any suitable motor or motors may be used; for example, but not limited to, a commercially available alternating current hollow bore permanent magnet motor.

The motor(s) 30 have an output shaft which drivingly meshes with the gear system 20 which mates with a main drive shaft 50. Links 72 suspend an elevator (not shown) from a link adapter 70.

A clamping apparatus 10 in accordance with the present invention clamps together the main drive shaft 50 and an internal blowout preventer assembly 90 (or a mud saver) to maintain a threaded connection between the main

shaft 50 and the internal blowout preventer assembly ("IBOP") 90. The IBOP assembly 90 may serve a mud saver function. Optionally, another clamping apparatus 10 in accordance with the present invention clamps together the IBOP assembly 90 and a saver sub 92. A gripper assembly 40 is connected to torque legs 16 (two in this case) which in turn are connected to a pipe handler having sub plate 18 below a pipe handler bearing 19.

The clamping apparatus 10 clamps together the main drive shaft 50 and the IBOP assembly 90 and provides a positive releasable lock of the main drive shaft 50 to the IBOP assembly 90. With the clamping apparatus 10 in place, the top drive cannot unscrew the IBOP assembly 90 from the main drive shaft 50. Thus joints can be made and broken with the top drive apparatus TD without the main drive shaft 50 separating from the IBOP assembly 90 nor can the top drive apparatus overtorque the connections. After the joint has been torqued to a desired make-up torque an additional torque above the make-up torque must be applied to change the torque setting. The joint clamp will absorb this additional torque so that it can not be transmitted to the joint, regardless of the direction of the additional torque. This is true regardless of the position of the joint on the IBOP stack (group of items with the IBOP).

Figure 2A shows clamps 100, 101, and 102 in accordance with the present invention. The clamp 100 clamps together a main shaft 104 of a top drive apparatus TS (shown schematically) to an upper internal blowout preventer 106. The upper internal blowout preventer 106 is actuated, for example, but not limited to, by using an actuator 108. In this embodiment, an air swivel 112 transfers control fluid for the upper internal blowout

preventer's actuator 108 (for example from a non-rotating pipe handler (not shown) to the rotating upper internal blowout preventer 106. The swivel 112 can be connected to a support of a gripper (not shown). The clamp 101 clamps together the upper internal blowout preventer 106 and a lower internal blowout preventer 110. The clamp 102 clamps together the lower internal blowout preventer 110 and a saver sub 103. Figure 2B shows the items of Figure 2A with the clamps 100, 102, 102 removed.

Each of two tubulars or items to be clamped together with a clamp apparatus has a series of teeth formed of an end thereof. The clamp apparatus has corresponding teeth which mesh with the teeth of the tubulars or of the items. With the teeth of the tubulars meshed with the teeth of the clamp apparatus, relative rotation of two threadedly connected tubulars or items is inhibited.

As shown in Figures 3A and 3B, the drive shaft 104 has a series of teeth 114 around its lower end 116 and the upper internal blowout preventer 106 has a series of teeth 118 around its upper end 119. Figure 3B shows the shaft 104 threadedly connected to the upper internal preventer 106 prior to the installation of a clamp apparatus.

It is within the scope of the present invention for the teeth on a tubular to project radially outwardly beyond the surface of the tubular; for example, see the teeth 122 on the tubular 124 and the teeth 121 on the tubular 123 (see Figure 3C). Optionally, as shown in Figures 3A and 3B, the teeth of a tubular can be positioned with respect to the outer surface of the tubular so that the teeth not project radially beyond the tubular's exterior surface. The teeth 114 project to, but not outwardly beyond, a surface 117 of the main shaft

104; and the teeth 118 do not project beyond a surface 115 of the upper internal blowout preventer 106. Such recessed teeth are less likely to be contacted by other objects and apparatuses; for example, tong jaws or tong dies will be inhibited from contacting these teeth.

Figures 4A and 4B show a clamp apparatus 130 in accordance with the present invention (which may be used as the clamp apparatuses in any system in accordance with the present invention and in the embodiments shown in Figures 1A, 2, and 3A). The clamp apparatus 130 has three segments 131, 132, 133 which are pinned together with pins 141a, 141b; 142a, 142b; and 143a, 143b which extend through holes 131c, 131d; 132c, 132d; 133c, 133d in pairs of block holders 131a, 131b; 132a, 132b; 133a, 133b and through corresponding holes in connection blocks 134. In one method in accordance with the present invention the segments 131 - 133 are emplaced against tubulars (or items) to be clamped together so that splines (teeth) on the segments engage splines (teeth) on the tubulars and then the segments are connected together.

The clamp apparatus 130 has an upper series of teeth or splines 136 and a lower series of teeth or splines 138. The teeth 136 mesh with corresponding teeth of an upper tubular which is threadedly connected to a lower tubular. The lower tubular has teeth which correspond to and mesh with the lower series of teeth 138. With the clamping apparatus 130 clamped onto two threadedly-connected tubulars, with the teeth 136 meshed with corresponding teeth of an upper tubular and the teeth 138 meshed with corresponding teeth of a lower tubular, relative rotation between the upper and lower tubular is inhibited. Lugs 139 protect a locking structure 171

(described below).

Figure 5 shows a clamping apparatus 160 in accordance with the present invention which may be used as the clamping apparatus in any apparatus in accordance with the present invention and in the embodiments shown in Figures 1A, 2 and 3A. The clamping apparatus 160 has three hingedly connected segments 161, 162, 163 connected with hinge structures 164, 165. There is an upper series of teeth 176 and a lower series of teeth 178. Each hinge structure 164, 165 has a pin 166 which extends through a member 167 on one segment and through spaced-apart members 168a, 168b on an adjacent segment. A locking structure 171 releasably holds together the segments 161 and 163. A pin 169 with a pull ring 169a extends through lugs 169b, 169c (like the lugs 139, Figure 4A) and prevents a toggle clamp lever 173 of the locking structure 171 from rotating out from a latched position. Removal of the pin 169 permits this rotation so the clamping apparatus 160 can be removed from two items that have been clamped together. It is within the scope of the present invention for there to be teeth all around the segments in Figures 4A, 4B, and 5, or, optionally, as shown to have teeth radially dispersed on the segments (in certain aspects, to facilitate unclamping, with the radial dispersion not exceeding the pressure angle of the splines or teeth).

The radial positions of two threadedly-connected tubulars is determined by the make-up torque used to connect the two tubulars together. In certain embodiments of the present invention, this means that the tubulars cannot necessarily be connected together to line up the teeth on one tubular with the teeth on another tubular; for example, if both tubulars of the same outer

diameter had the same number of similar teeth, upon connecting the two tubulars to a desired make-up torque the teeth of one tubular might not be aligned with the teeth of the other tubular. Once two tubulars have been threadedly connected to a desired make-up torque, they cannot be further rotated to align teeth on each tubular. In certain embodiments to achieve the alignment of at least one tooth on one tubular with a tooth (or pair of spaced-apart teeth) on another tubular, no matter what the final position of the tubulars, a different number of teeth are used on the tubulars, insuring that at least one tooth on one tubular will align with one tooth (or pair of spaced-apart teeth) on the other tubular when a number N teeth are used on one tubular and a number N-1 teeth are used on the other tubular. By similarly using a different number of teeth for the two series of teeth on the clamp, the teeth of the clamp can mesh relatively easily with the teeth on the tubulars and the clamp will more easily clamp onto the tubulars. For example, referring to Figure 3A, if the top drive shaft 104 has a number N of teeth 114 and the upper internal blowout preventer 106 has a number N-1 (N minus 1) teeth 118; and a clamp apparatus as in Figure 4A has a number N teeth 136 and a number N-1 teeth 138, then at the location of alignment of one of the teeth 114 with one of the teeth 118, the clamp can be clamped onto the two tubulars 104, 106 (or, referring to the clamp apparatus 160, Figure 5, if there are N teeth 176 and N-1 teeth 178). In certain embodiments if the circumferential arc angle of the segment does not exceed twice the pressure angle of the spline (or tooth), then it is possible to have the splines (or teeth) extend all the way around the clamp. For a 30 degree pressure angle spline results in six

segments. In certain embodiments, the length of segment arc which represent the length of the spline forms per segment, corresponds to a central angle of the segment. To facilitate consistent correct installation and removal of the clamp the central angle of the segment s=does not exceed two times the pressure angle of the spline. Also by thus using, for example a 30 degree pressure angle spline (or other suitable angle) the splines (or projections or teeth) of the clamp will not dig into (and possibly lock into) the splines of the tubulars inhibiting or preventing removal of the clamp from the tubulars.

Optionally, a visual indicator may be used on a clamp in accordance with the present invention to indicate where on the clamp there are two aligned teeth (one tooth of an upper series of teeth aligned with one tooth of a lower series of teeth); for example a line 140, Figure 4A or a dot 179, Figure 5).

In other aspects, to achieve tubulars with X number of teeth aligned when the tubulars are threadedly connected to a desired make-up torque, N teeth are provided on one tubular and N - X (N minus X) teeth are provided on the other tubular. For example, to achieve two aligned teeth, one tubular has N teeth and the other tubular has N - 2 teeth; to achieve three aligned teeth, one tubular has N teeth and the other tubular has N - 3 teeth; and so forth. In the N - 2 teeth case, the two pairs of aligned teeth occurs with the pairs diametrically opposed.

Figures 6A to 6C show a clamp apparatus 200 in accordance with the present invention which has pinned together segments 201, 202 pinned together with pins 205, 206 and pinned together segments 201, 203 pinned together

with pins 207, 208. The segments 202, 203 are releasably locked together with a locking structure 210 which includes a latch bar 211 rotatably mounted with a pin 212 to the segment 203 and a movable lock member 213 which is movable on and securable to the latch bar 211. With the segments 202, 203 in position (as shown in Figure 6A) the latch bar is rotated so that the movable lock member can be pushed against a recess 214 and secured in place.

Viewed as a whole, the segments 201 to 203 have N upper teeth 220 and N-1 lower teeth 222. One upper tooth, tooth 220a, is aligned with the lower tooth, tooth 222a. A visual indicator, for example a circle 224, indicates the location of the two aligned teeth.

Figure 6C shows an upper part of an internal blowout preventer 210' fitted in the lower set of teeth 222 of the clamp apparatus 200. It should be noted that a set of teeth 240 circums the top portion of the internal blowout preventer 210'. The teeth 240 comprise a land having a shallow sloped side leading up to a land from a valley and a sharp sloped side leading up from the valley to the land.

Figures 7A and 7B show a clamp 300 in accordance with the present invention which has three connectible segments 301, 302, 303. A link 304 and pins 305 hold together segments 301 and 303 and segments 302 and 303. Each segment has a top series of teeth (301a, 302a, 303a) and a bottom series of teeth (301b, 302b shown), all teeth projecting out from interior surfaces of their respective segments.

A releasable lock mechanism 320 releasably secures the segment 301 to the segment 302. Optionally, a safety cable or wire 306 extends around the clamp 300 and its ends are held within recess 307 of a holder 308.

Rotating a bolt 309 clamps the cable ends in the holder 308. A castle nut 310 holds the bolt 309 and secures it in place and a cotter pin 311 holds the castle nut 310 in place.

The lock mechanism 320 includes a swing bolt 321 which is pivotably mounted to the segment 301 with a pin 322. A movable locking sleeve 323 encompasses a threaded end 324 of the swing bolt 321. Upon assembly of the segments 301, 302, 303, the movable locking sleeve 323 is moved into recesses 325 of plates 302c, 302d of the segment 302 and a castle nut 326 is threadedly engaged on and rotated on the threaded end 324 of the swing bolt 321 to releasably hold the swing bolt 321 in place, locking together the segments 301, 302. A cotter pin 329 holds the castle nut 326 in place.

It is within the scope of the present invention to use a projection or projections (tooth, teeth, spline, splines, nub, nubs, finger, fingers, protruding shape or shapes) extending out from the exterior surface of shaft, a cylinder, a tubular, an item which is to be clamped together with another item etc. so that there is limited or no relative rotation between the two items etc. The projection or projections can be of any suitable desired shape or cross-section.

As shown in Figure 8A an item 400 has a single projection 401. As shown in Figure 8B, an item 402 has a single projection 403. Figure 8C shows an item 404 with two projections 405. Figure 8D shows an item 406 with four projections 407. Figure 8E shows an item 410 with a projection 412 which is used with corresponding structure on a clamp. Any item in accordance with the present invention may have one, two, three four or more of any projection shown herein. A clamp in accordance with the

present invention to be used with the items of Figures 8A - 8E will have a corresponding projection or projections for abutting the projection or projections of the item.

In certain aspects clamps in accordance with the present invention and parts thereof, for example projections, are intentionally made with clearance tolerances to facilitate application of a clamp to tubulars in at least one position (radially), regardless of the final makeup position of the tubulars.

The present invention, therefore, provides in at least certain embodiments, a clamp for clamping two tubulars, for example any two threadedly-connected tubulars or each of the two tubulars being a component of a top drive apparatus, the two tubulars threadedly connected together, the clamp for inhibiting relative rotation of the two tubulars, each of the two tubulars having at least one tubular projection projecting therefrom, the clamp including: a clamp body having an interior surface; a plurality of clamp projections projecting inwardly from the interior surface of the clamp body for abutting the at least one tubular projection projecting from each of the two tubulars to inhibit rotation between the two tubulars. Such a system may have one or some (in any possible combination) of the following: wherein the two tubulars include a first tubular and a second tubular, the first tubular has a first tubular projection, the second tubular has a second tubular projection, and the clamp includes the plurality of clamp projections including a first plurality of clamp projections for positioning adjacent the first tubular projection, a second plurality of clamp projections for positioning adjacent the second tubular projection, and the first plurality of clamp projections above the second

plurality of clamp projections; wherein the two tubulars include a first tubular and a second tubular, the at least one projection on the first tubular is a first tubular series of projections, the at least one projection on the second tubular is a second tubular series of projections, the clamp further including the clamp body having a first level and a second level, a first clamp series of projections on the first level, a second clamp series of projections on the second level, the first clamp series of projections for location adjacent and meshing with the first tubular series of projections, and the second clamp series of projections for location adjacent and meshing with the second tubular series of projections; wherein the number of projections of the second clamp series differs from the number of projections of the first clamp series by one; wherein the clamp body is a plurality of clamp segments releasably secured together; lock apparatus for releasably locking together two adjacent clamp segments of the plurality of clamp segments; the two tubulars including a first tubular and a second tubular, the first tubular being a top drive shaft, and the second tubular being an internal blowout preventer; the two tubulars include a first tubular and a second tubular, the first tubular being a mud saver, and the second tubular being a saver sub; and/or the clamp body having an exterior surface, and the plurality of clamp projections projecting outwardly not beyond the exterior surface.

The present invention, therefore, provides in at least certain embodiments, a clamp for clamping two tubulars, each of the two tubulars being a component of a top drive apparatus, the two tubulars threadedly connected together, the clamp for inhibiting relative

rotation of the two tubulars, each of the two tubulars having at least one tubular projection projecting therefrom, the clamp including: a clamp body having an interior surface; a plurality of clamp projections projecting inwardly from the interior surface of the clamp body for abutting the at least one tubular projection projecting from each of the two tubulars; wherein the two tubulars include a first tubular and a second tubular, the at least one projection on the first tubular is a first tubular series of projections, the at least one projection on the second tubular is a second tubular series of projections; the clamp body having a first level and a second level; a first clamp series of projections on the first level; a second clamp series of projections on the second level; the first clamp series of projections for location adjacent and meshing with the first tubular series of projections; the second clamp series of projections for location adjacent and meshing with the second tubular series of projections; wherein the number of projections of the second clamp series differs from the number of projections of the first clamp series by one; wherein the clamp body has a plurality of clamp segments releasably secured together; and lock apparatus for releasably locking together two adjacent clamp segments of the plurality of clamp segments. In such a clamp, the first tubular can be a top drive shaft, and the second tubular can be an internal blowout preventer; or the first tubular can be a mud saver, and the second tubular can be a saver sub.

The present invention, therefore, provides in at least certain embodiments, a clamp apparatus for clamping two tubulars which are threadedly connected together to inhibit relative rotation of the two tubulars, each of

the two tubulars having at least one projection projecting therefrom, the clamp apparatus including: a clamp body having an interior surface; and a plurality of projections projecting inwardly from the interior surface of the clamp body for abutting the at least one projection of each of the two tubulars.

The present invention, therefore, provides in at least certain embodiments, a method for clamping together two tubulars to inhibit relative rotation between the two tubulars, each of the two tubulars being a threaded component of a top drive apparatus, the two tubulars threadedly connected together, the method including clamping the two tubulars with a clamp, the clamp having a clamp body having an interior surface, a plurality of clamp projections projecting inwardly from the interior surface of the clamp body for abutting the at least one tubular projection projecting from each of the two tubulars. Such a method may have one or some (in any possible combination) of the following: wherein the two tubulars include a first tubular and a second tubular, the at least one projection on the first tubular is a first tubular series of projections, the at least one projection on the second tubular is a second tubular series of projections, the plurality of clamp projections includes a first clamp series of projections and a second clamp series of projections, the method further including meshing the first clamp series of projections with the first tubular series of projections, and meshing the second clamp series of projections with the second tubular series of projections; the two tubulars including a first tubular and a second tubular, the first tubular is a top drive shaft, and the second tubular is an internal blowout preventer; the two tubulars including a

first tubular and a second tubular, the first tubular is a mud saver, and the second tubular is a saver sub; the at least one projection on the first tubular is a first series of tubular projections, the at least one projection on the second tubular is a second series of tubular projections, the clamp body having a first level and a second level, a first clamp series of projections on the first level, a second clamp series of projections on the second level, the first clamp series of projections for location adjacent and meshing with the first tubular series of projections, and the second clamp series of projections for location adjacent and meshing with the second tubular series of projections, the method further including meshing the first clamp series of projections with the first tubular series of projections, and meshing the second clamp series of projections with the second tubular series of projections; wherein the number of projections of the second clamp series differs from the number of projections of the first clamp series by one, wherein the number of projections of the first tubular series is the same as the number of projections of the first clamp series by one, and wherein the number of projections on the second tubular series is the same as the number of projections on the second clamp series; and/or the clamp is a plurality of connectible segments, the method further including releasably locking together two of the plurality of connectible segments to releasably lock the clamp to the two tubulars.

**CLAIMS:**

1. A top drive apparatus comprising a motor, a rotor and an item threadedly connected to said rotor, the top drive apparatus further comprising a clamp for inhibiting rotation between said rotor and said item, wherein said rotor has a projection and said item has a further projection and said clamp has a receiver to receive said projection and further projection to inhibit rotation between said rotor and said item characterised in that said receiver comprises at least a first set of teeth for contacting said projection and a second set of teeth for contacting said further projection.

2. The top drive apparatus as claimed in Claim 1, wherein said projection and said further projection are each a tooth.

3. The top drive apparatus as claimed in Claim 1, wherein said projection and said further projection are each a plurality of teeth.

4. The top drive apparatus as claimed in Claim 1, wherein said rotor has an outer diameter, said projection projects from a portion of said rotor which has a smaller diameter than said outer diameter.

5. The top drive apparatus as claimed in Claim 4, wherein said projection projects from the smaller diameter to a diameter smaller than the outer diameter.

6. The top drive apparatus as claimed in Claim 4, wherein said projection projects from the smaller diameter to a diameter equal to the outer diameter

7. The top drive apparatus as claimed in Claim 4, wherein said projection projects from the smaller diameter to a diameter greater than the outer diameter.

8. The top drive apparatus as claimed in any one of Claims 1 to 7, wherein the number of projections of said second set of teeth differs from the number of projections of the second set of teeth by one.

9. The top drive apparatus as claimed in any one of Claims 1 to 8, wherein said first and second set of teeth are arranged on a main body for resisting torque between said rotor and said item.

10. The top drive apparatus as claimed in Claim 9, wherein said main body has a generally circular inner face, said main body comprising at least two segments movable to open a throat into which said rotor and item may sit.

11. The top drive apparatus as claimed in Claim 10, further comprising lock apparatus for releasably locking together two adjacent clamp segments of the plurality of clamp segments.

12. The top drive apparatus as claimed in any one of Claims 1 to 11, wherein the rotor comprises any one of: a drive shaft, an IBOP and a mud saver.

13. The top drive apparatus as claimed in any one of Claims 1 to 12, wherein said item comprises any one of: an IBOP, a mud saver, and a saver sub.

14. A clamp of the top drive apparatus as claimed in any one of Claims 1 to 13, wherein the clamp comprises a main

body having an inner, generally circular face having at least a first set of teeth for contacting said projection of said rotor and a second set of teeth for contacting said further projection of said item.

15. A method for clamping together a rotor of a top drive and an item threaded thereto to inhibit relative rotation therebetween, the method comprising the steps of clamping the rotor to the item with a clamp, said rotor having a projection and said item having a further projection and said clamp having a receiver to receive said projection and further projection to inhibit rotation between said rotor and said item, said receiver comprising at least a first set of teeth for contacting said projection and a second set of teeth for contacting said further projection.

16. The method in accordance with Claim 15, wherein said projection and said further projection are each a plurality of teeth, the method further comprising the step of meshing the first and second set of teeth with said plurality of teeth of said rotor and said item.

Fig. 1A

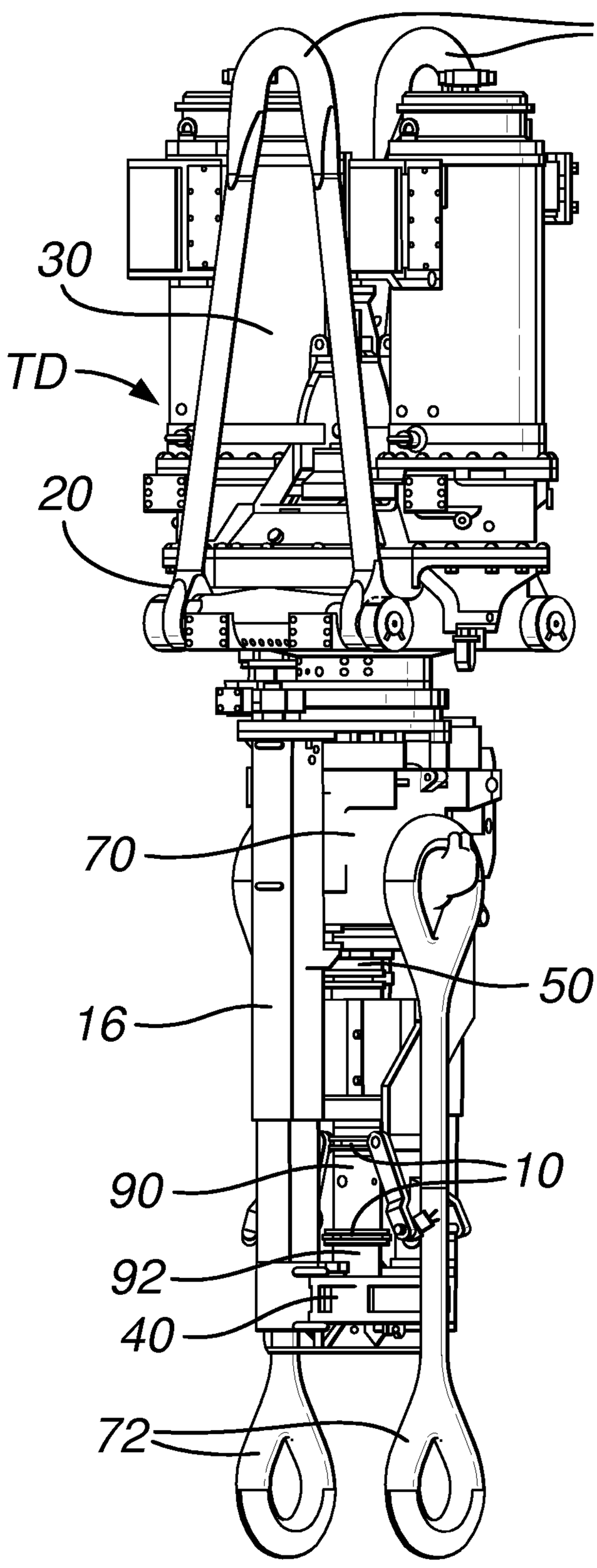



Fig. 1B

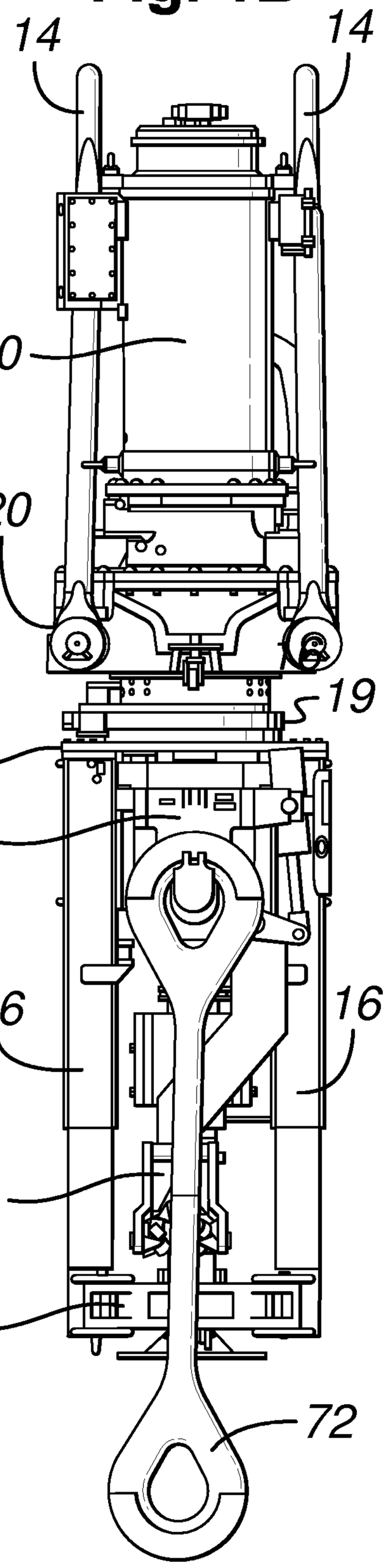
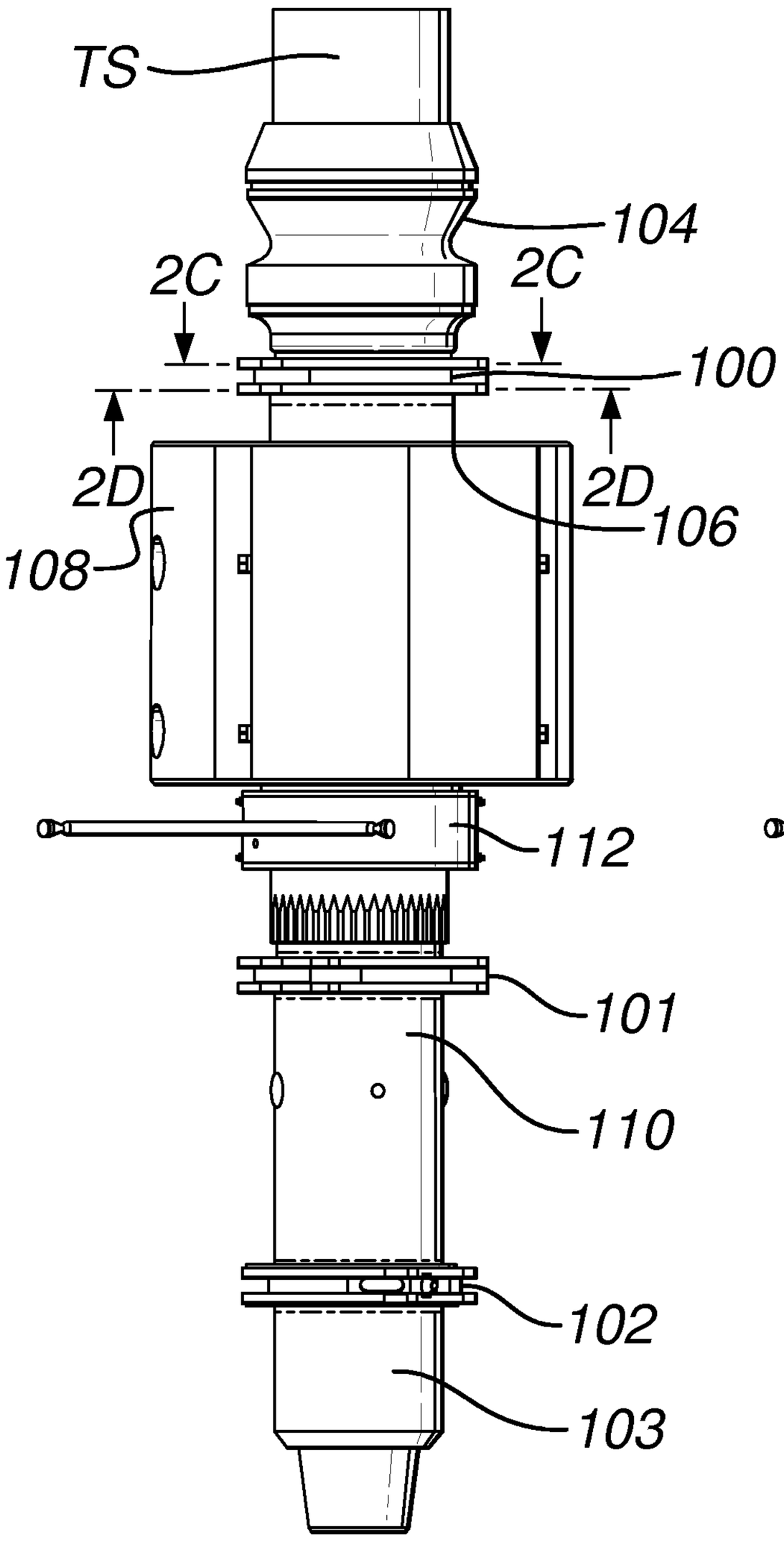


Fig. 2A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103

Fig. 2B

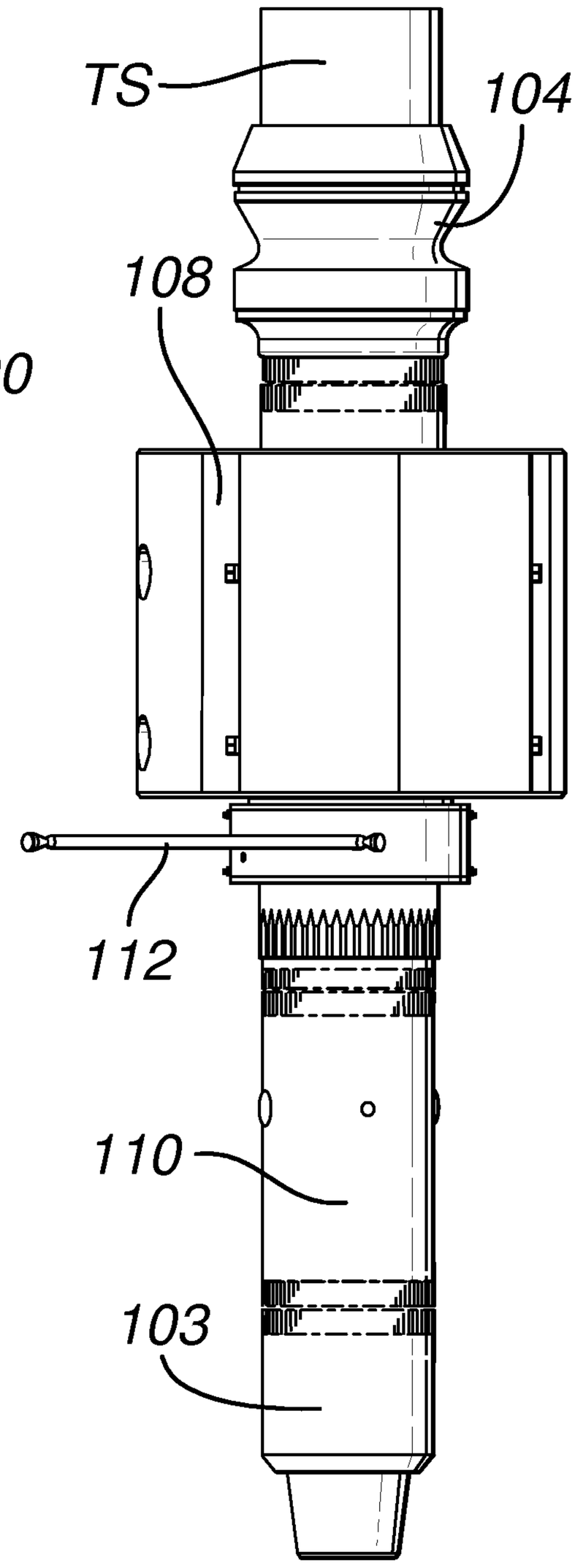
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Fig. 2C

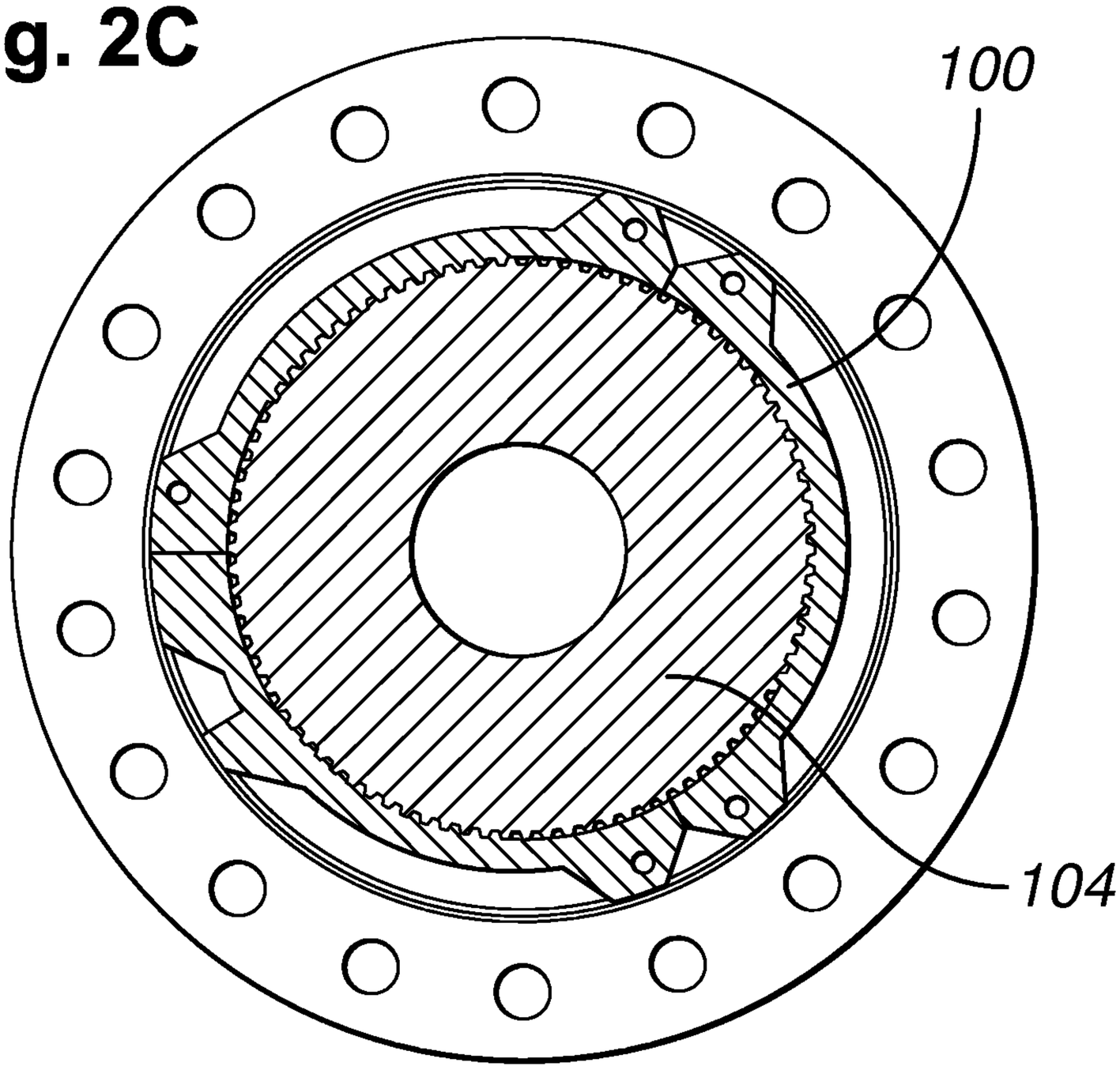



Fig. 2D

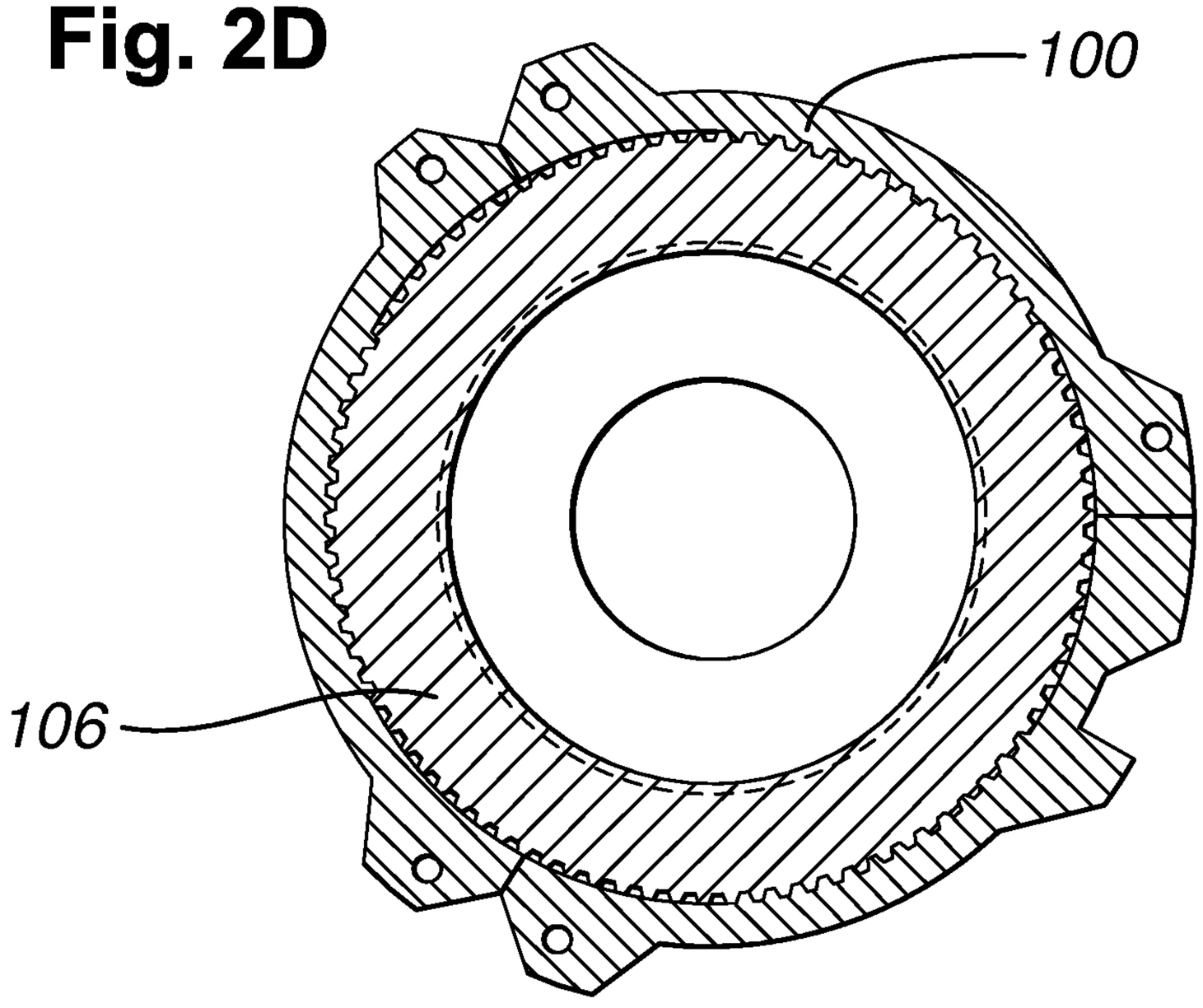
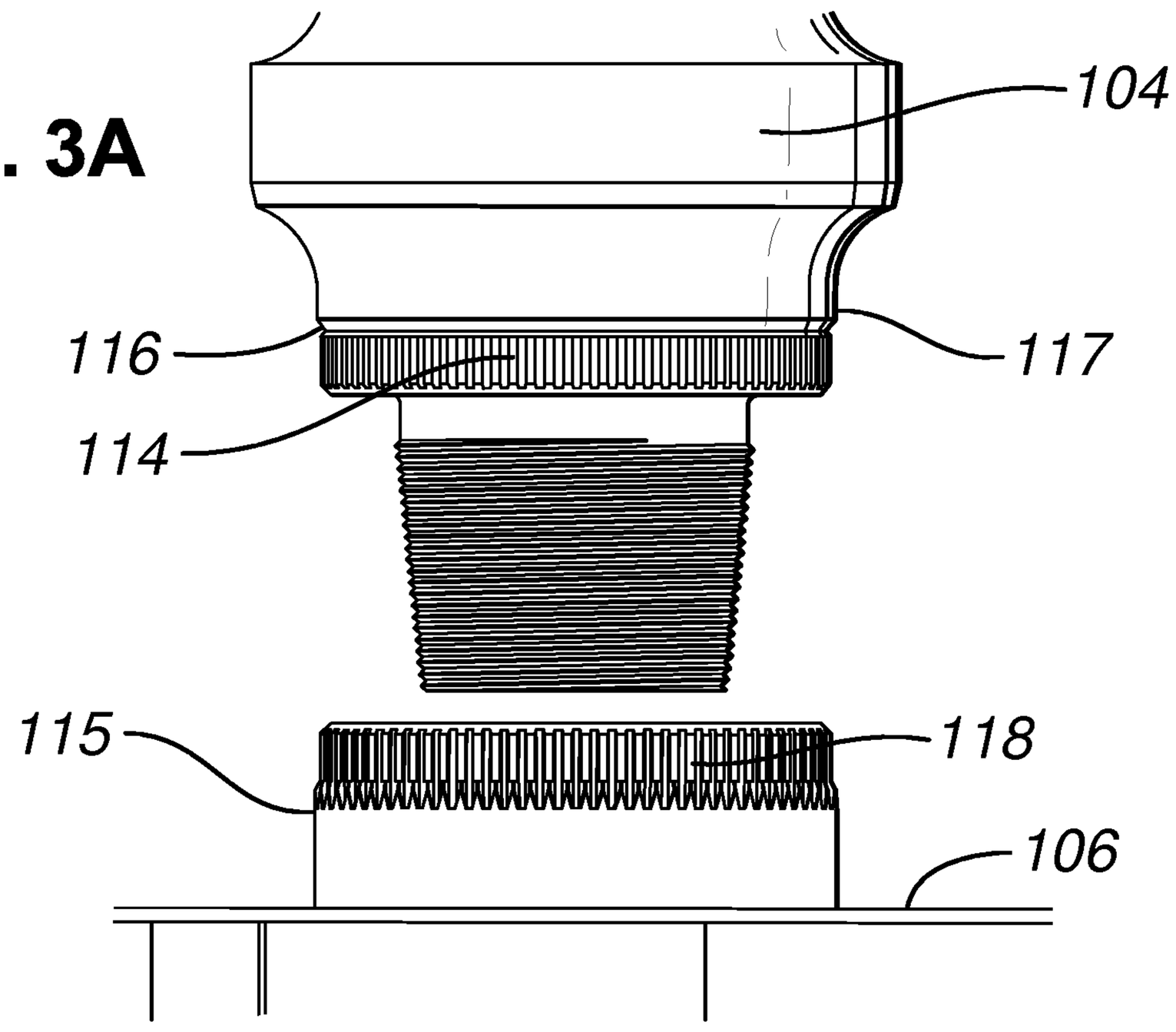


Fig. 3A



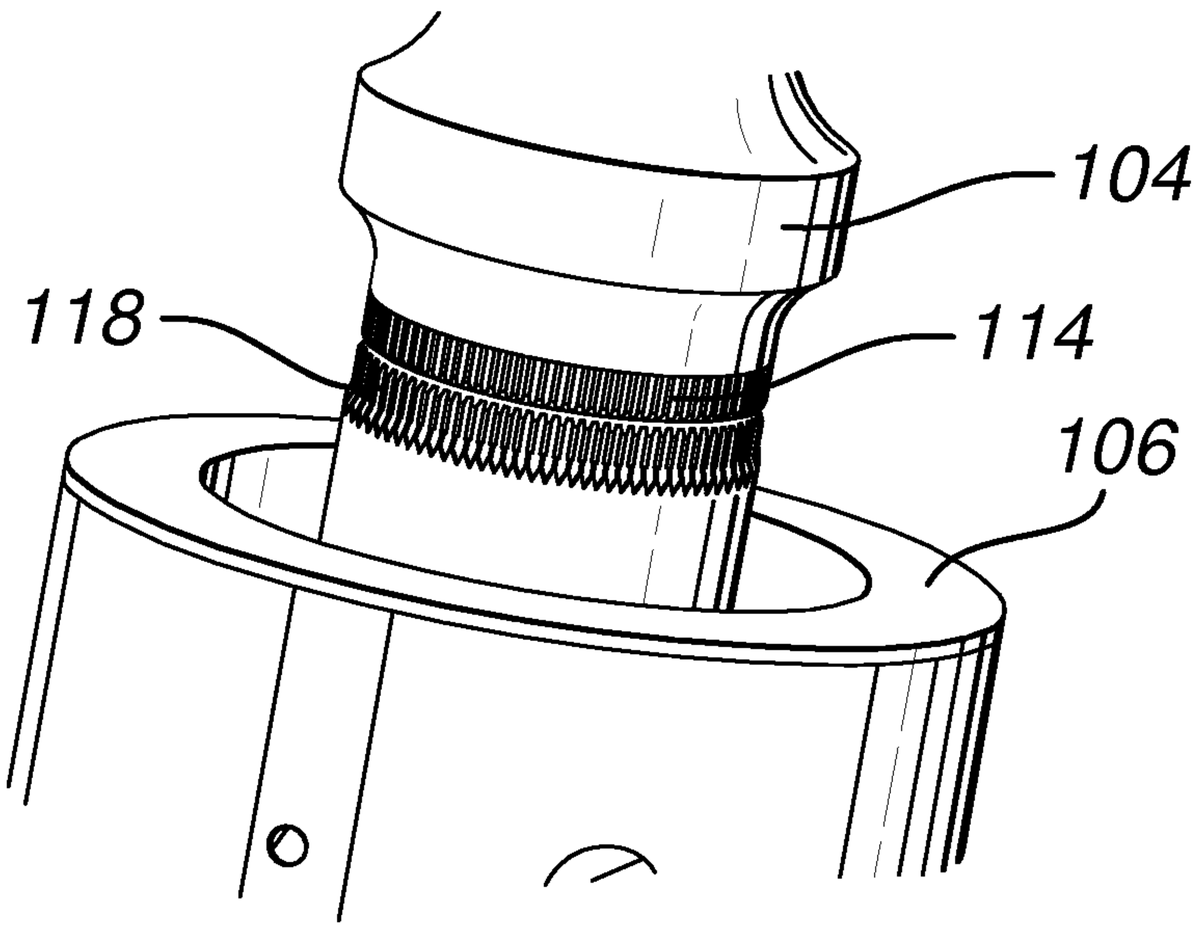




Fig. 3B

Fig. 3C

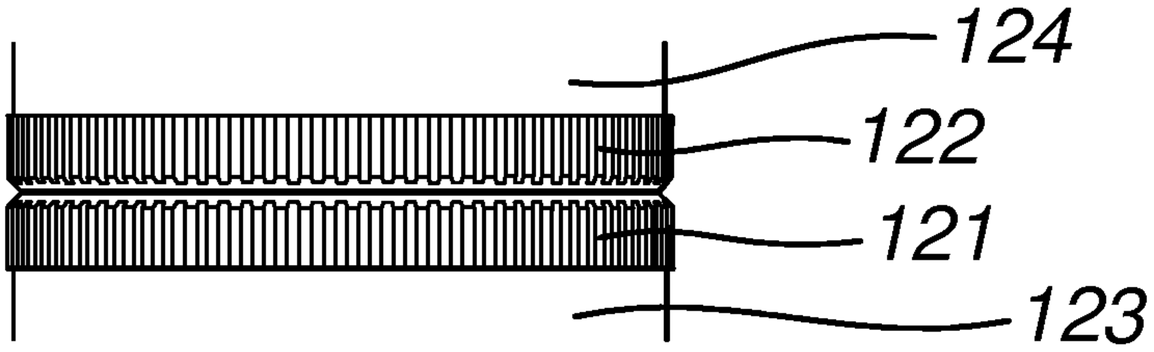


Fig. 4A

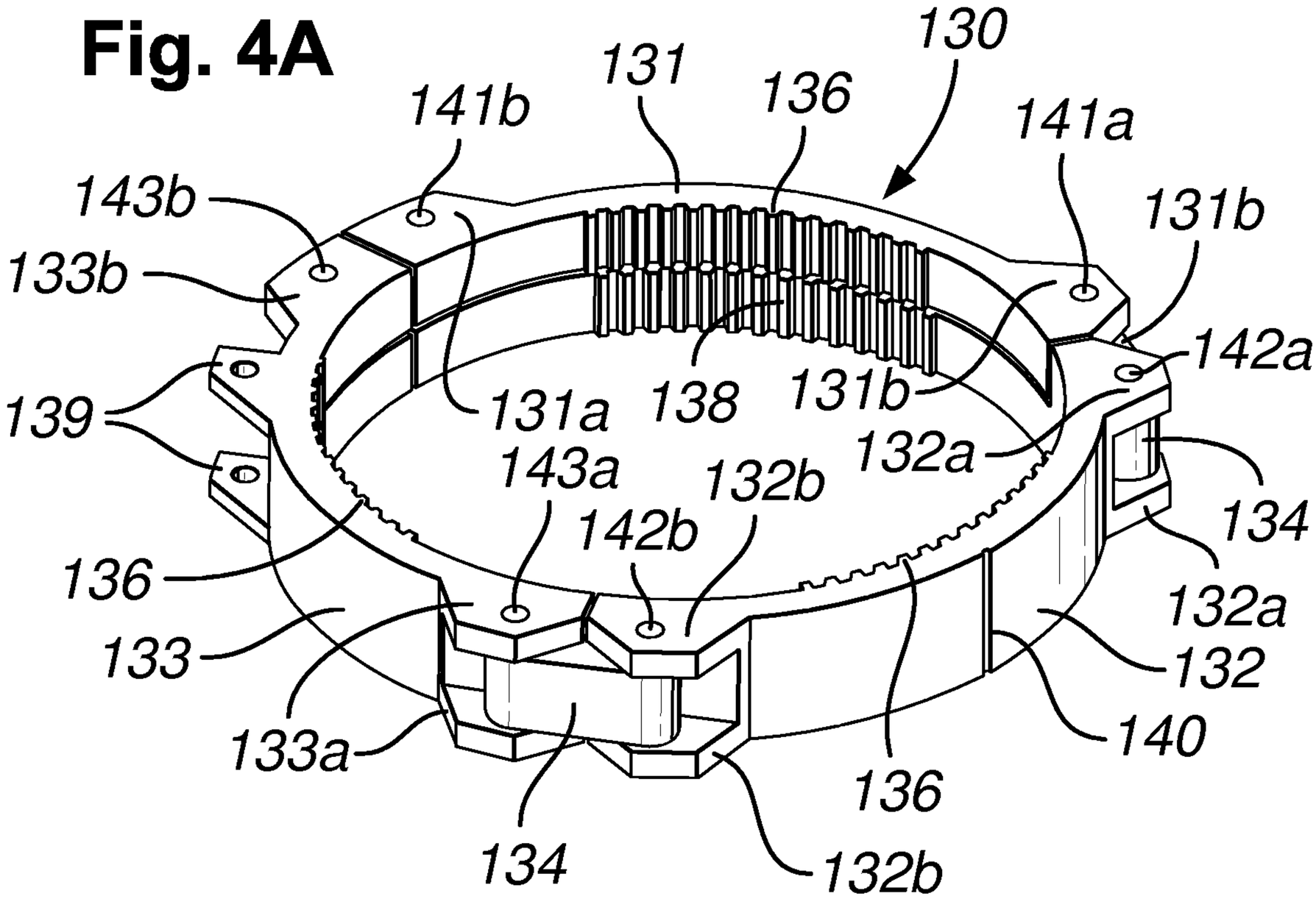

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Fig. 4B

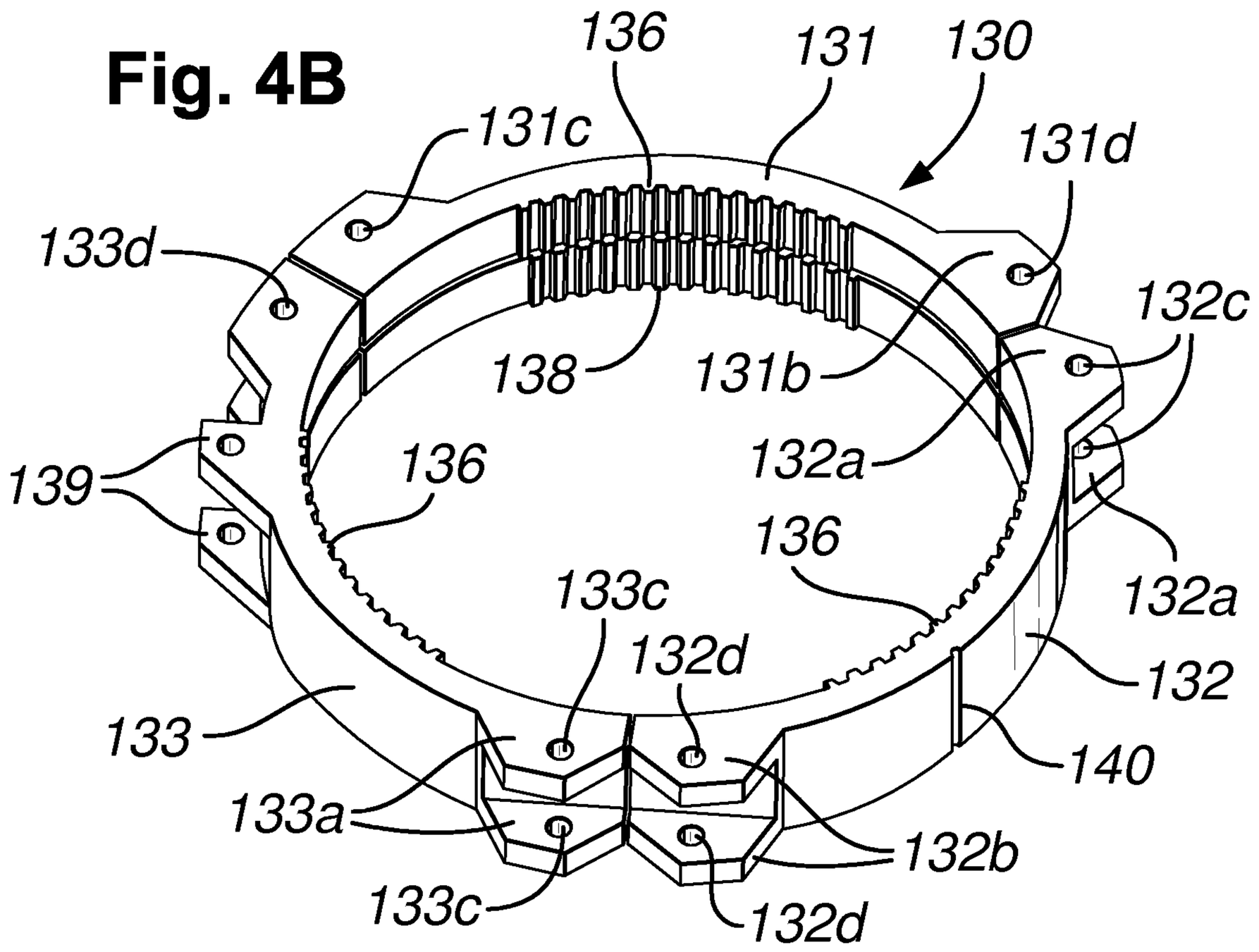
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Fig. 5

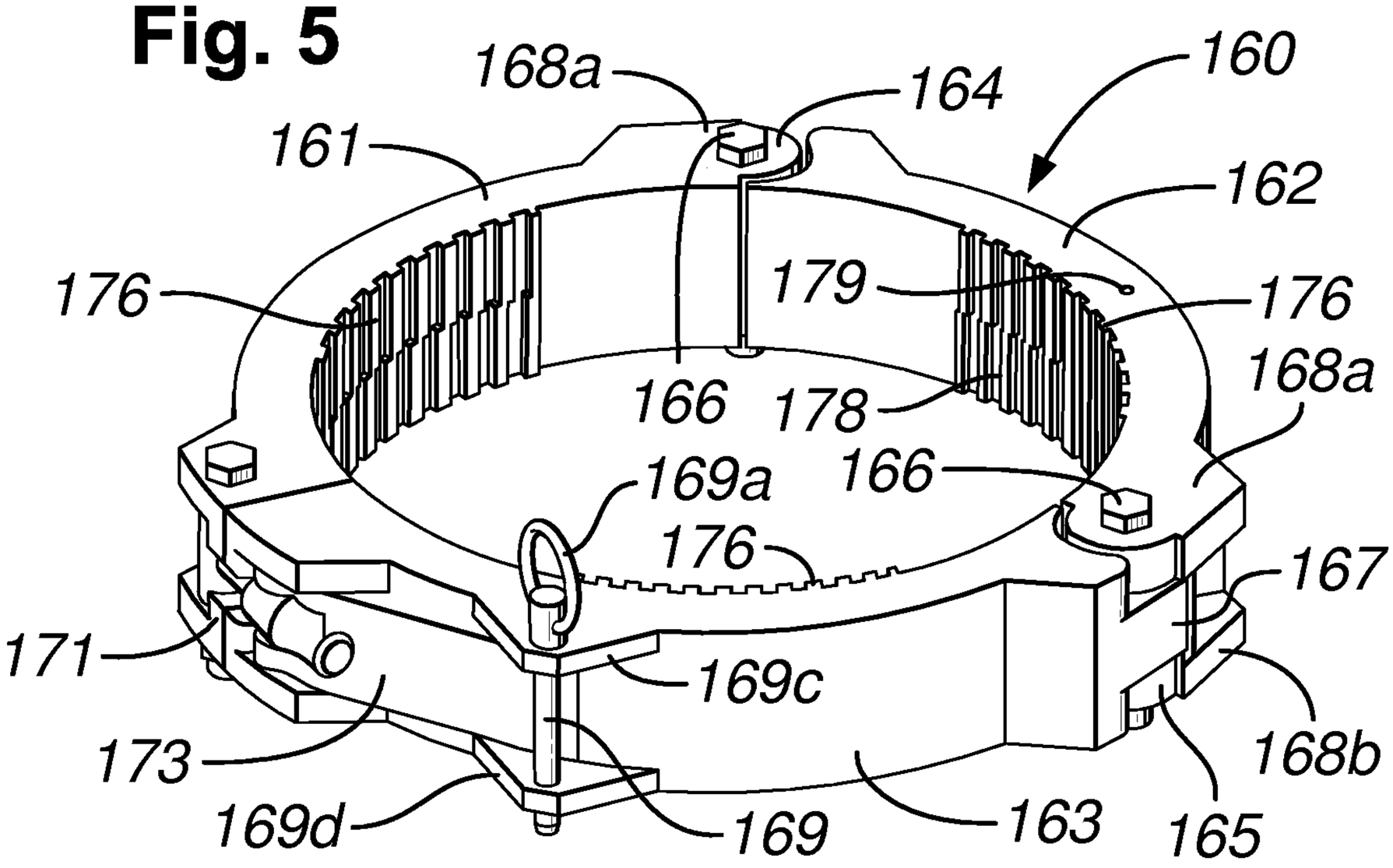


Fig. 6C

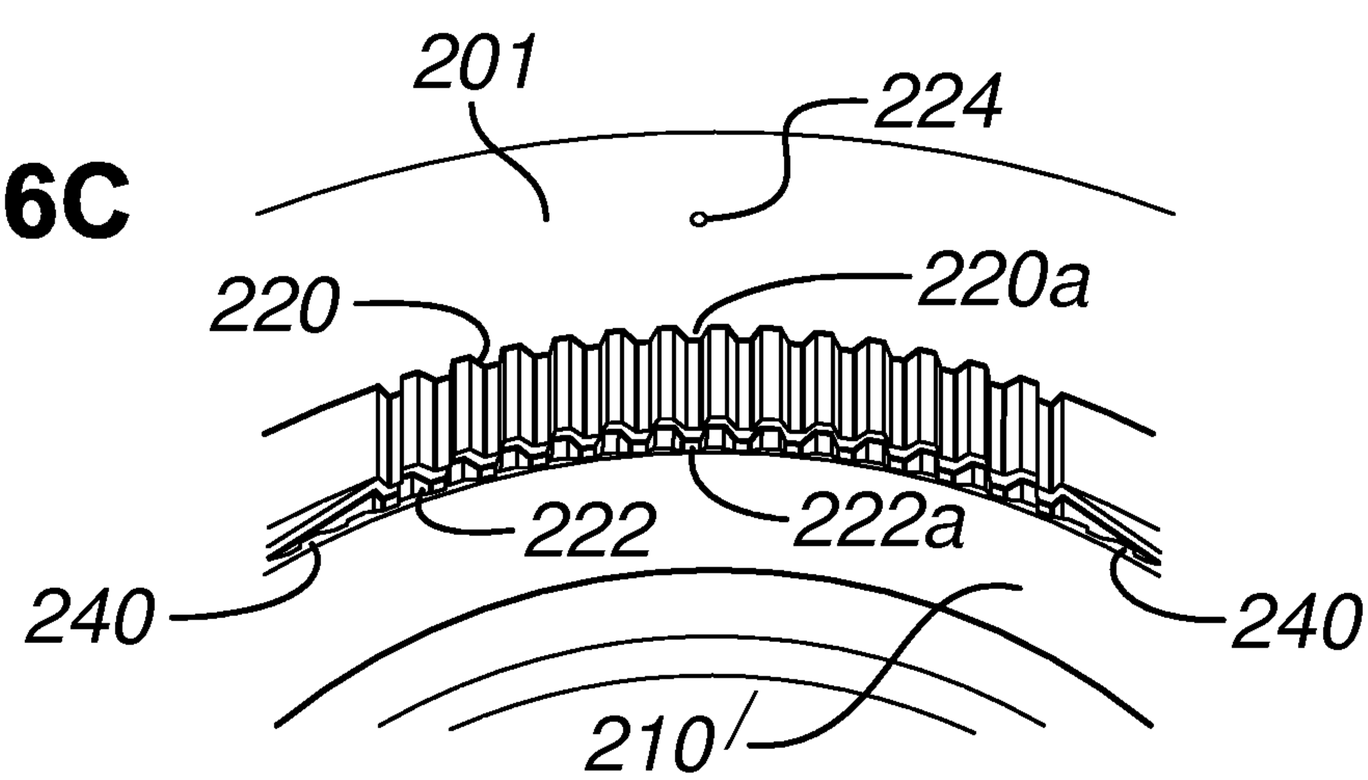


Fig. 8A

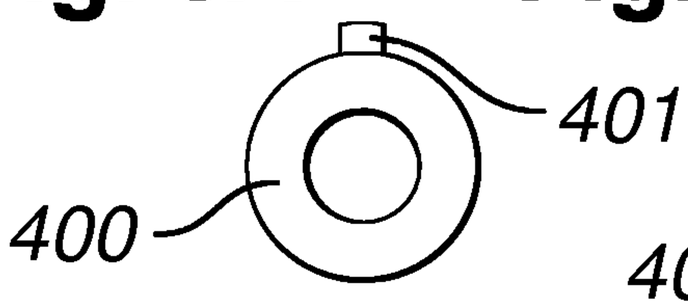


Fig. 8B

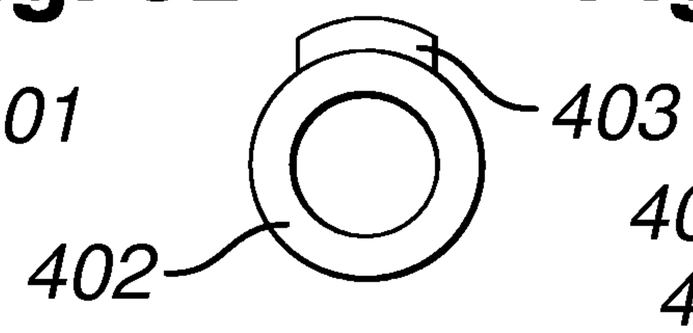


Fig. 8C

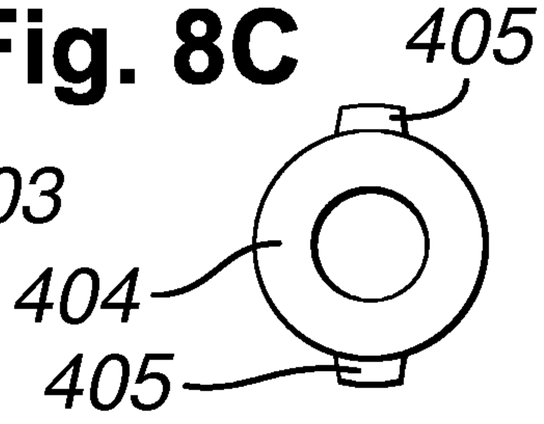


Fig. 8D

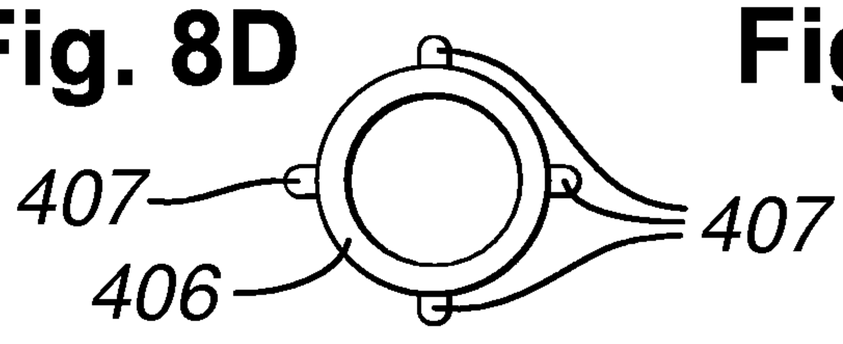


Fig. 8E

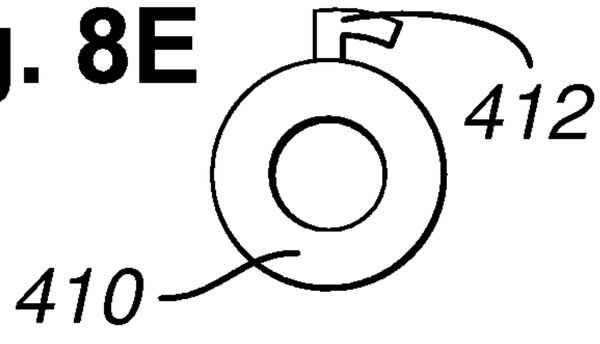

Fig. 6A

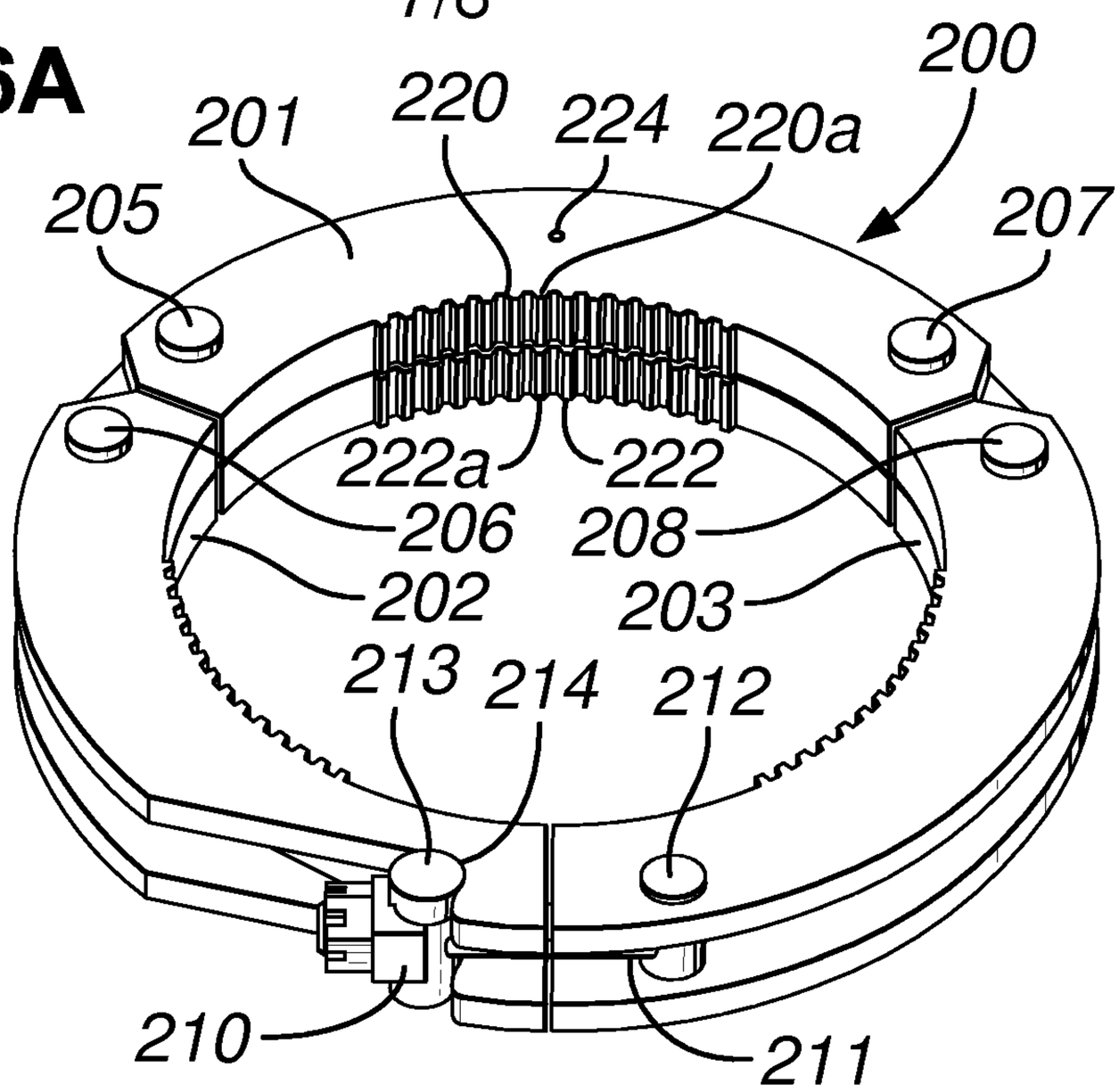
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Fig. 6B

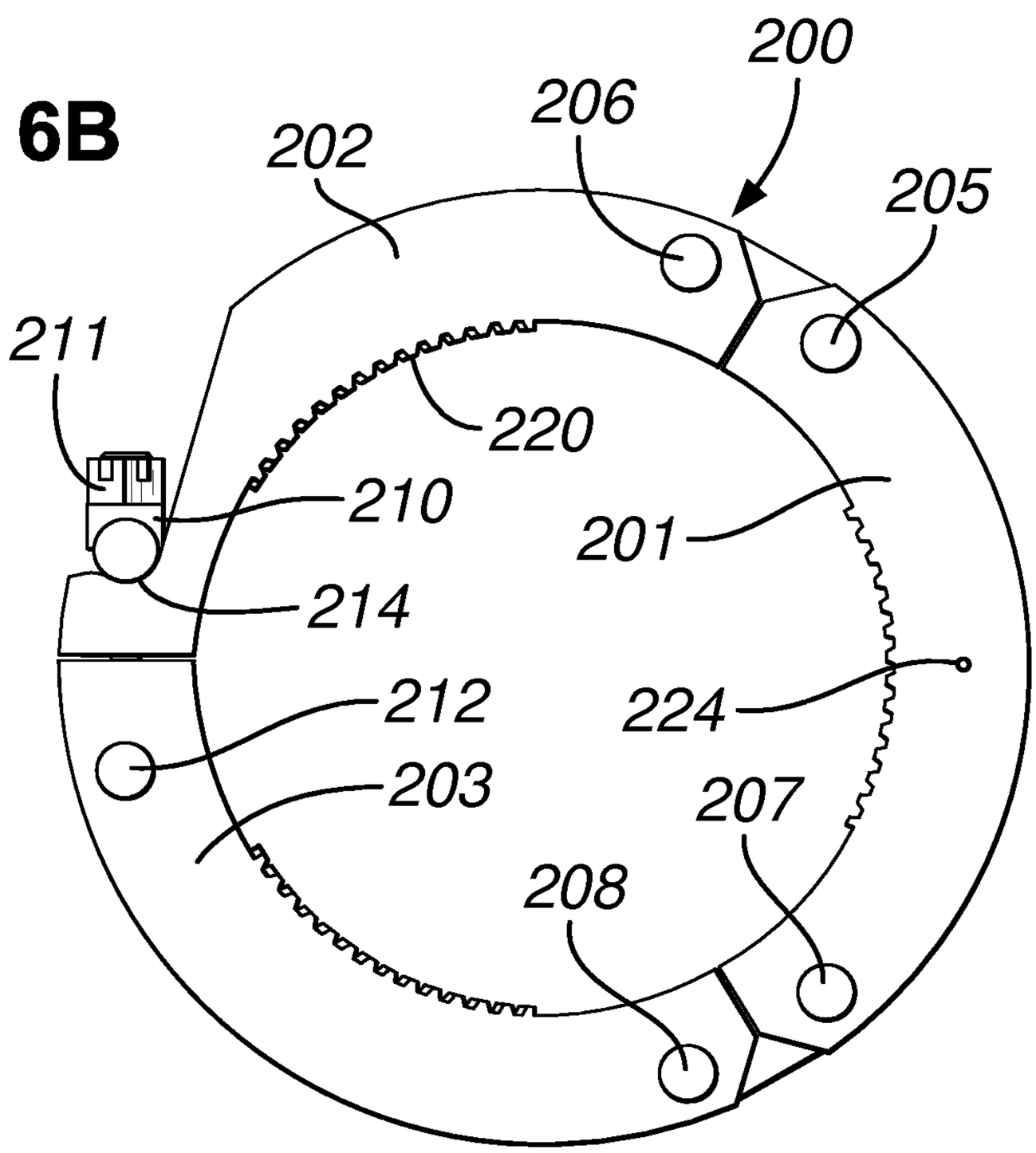
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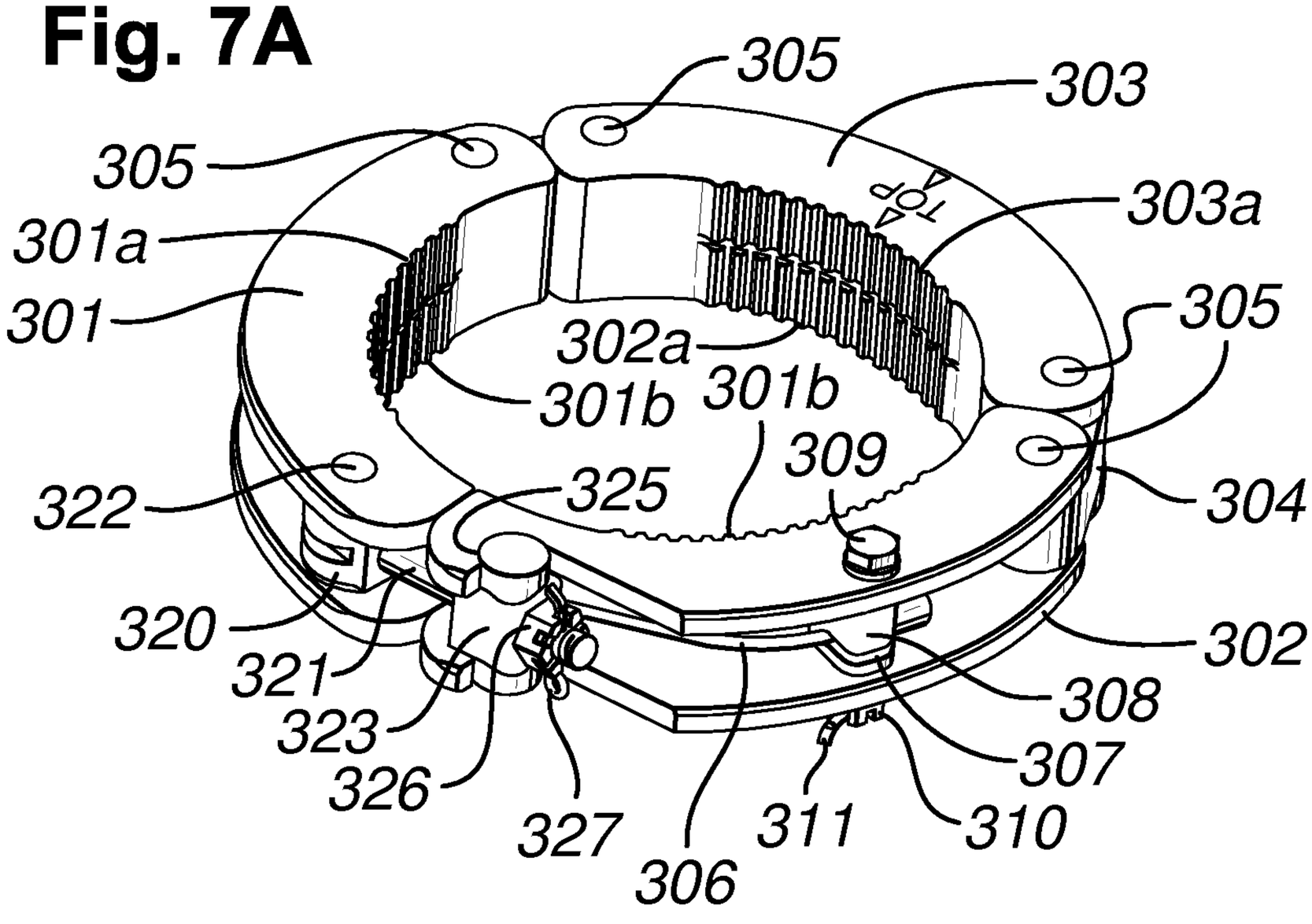
Fig. 7A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301b
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307
326
311
310
327
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Fig. 7B


304
305
305
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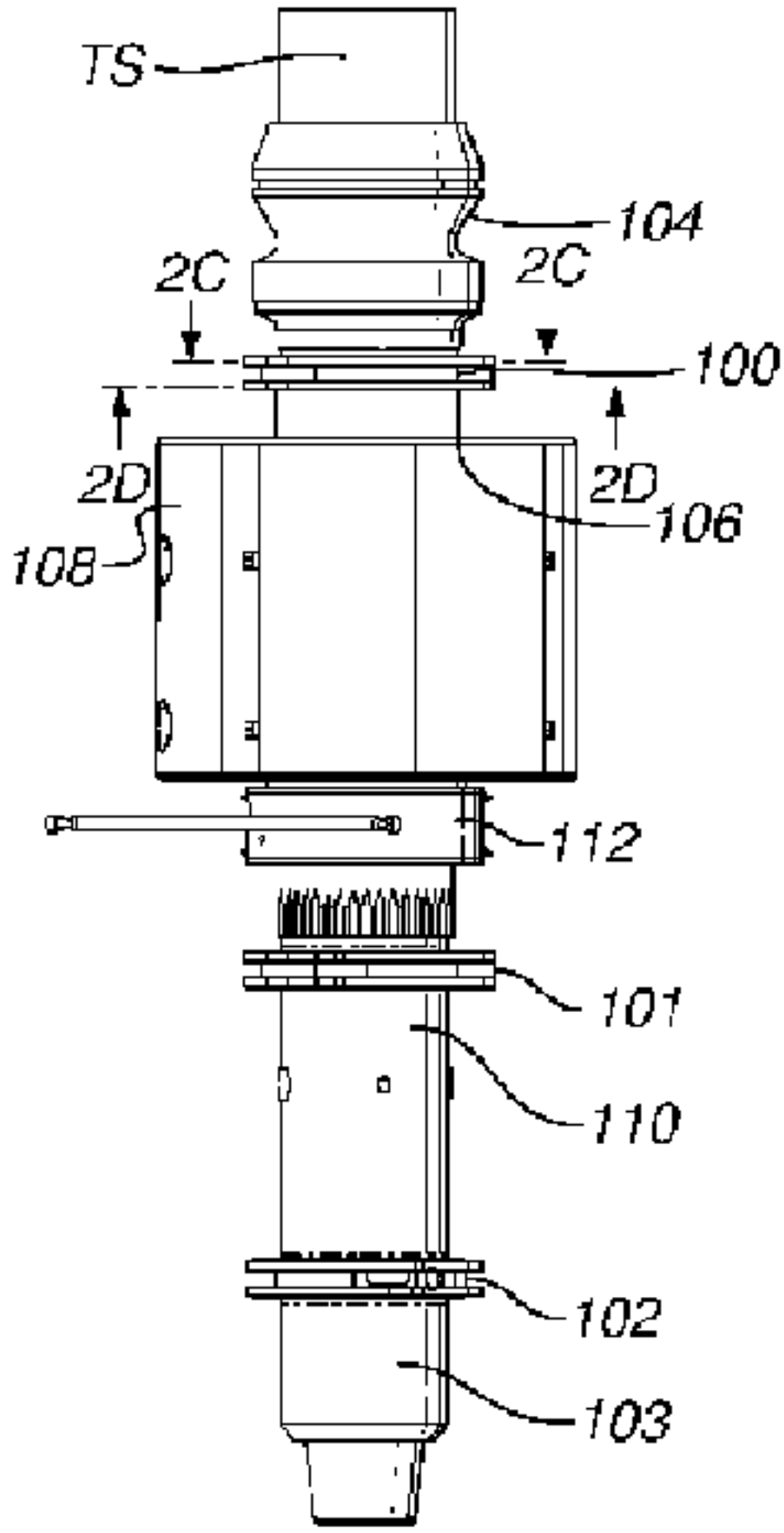
A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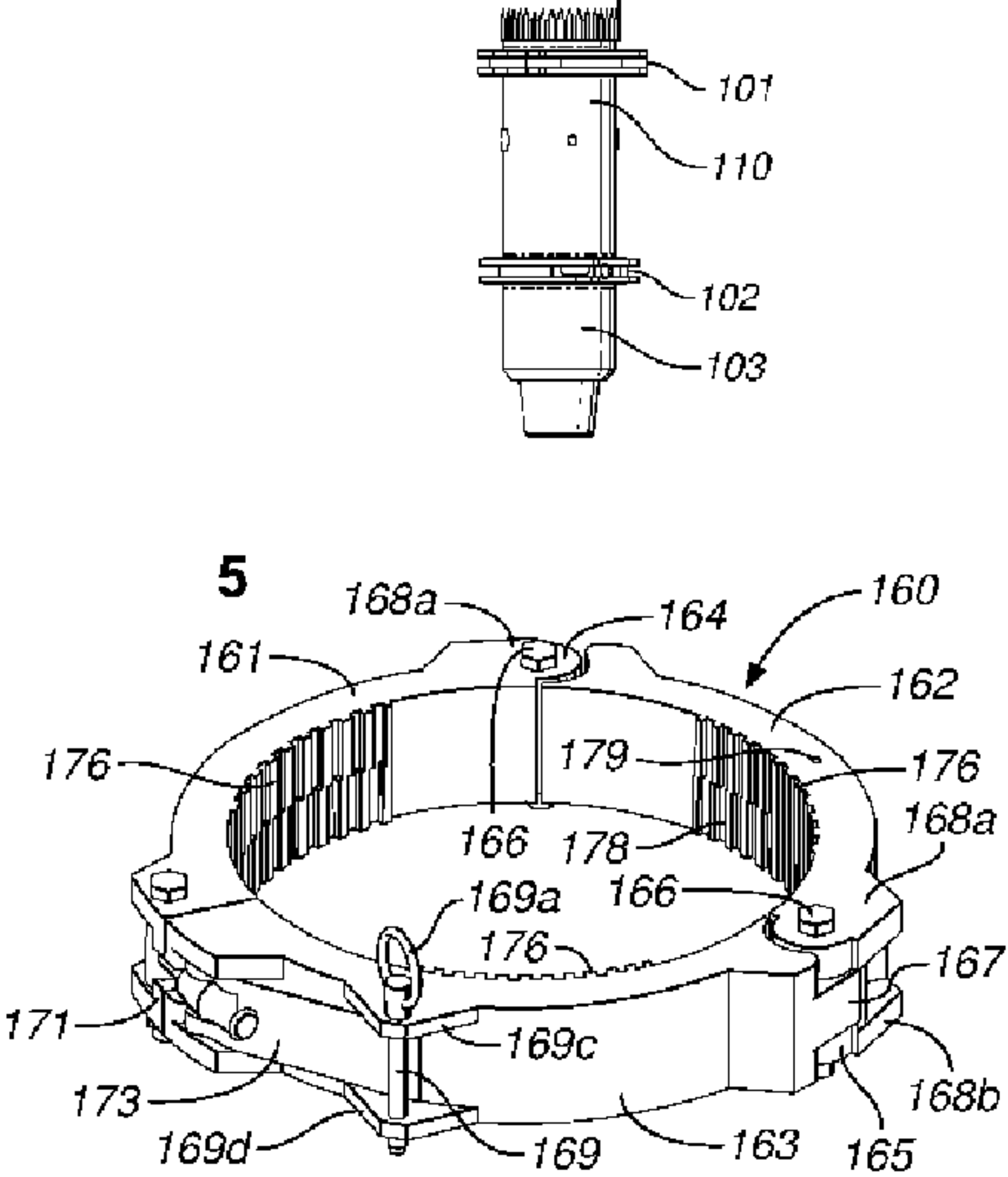
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