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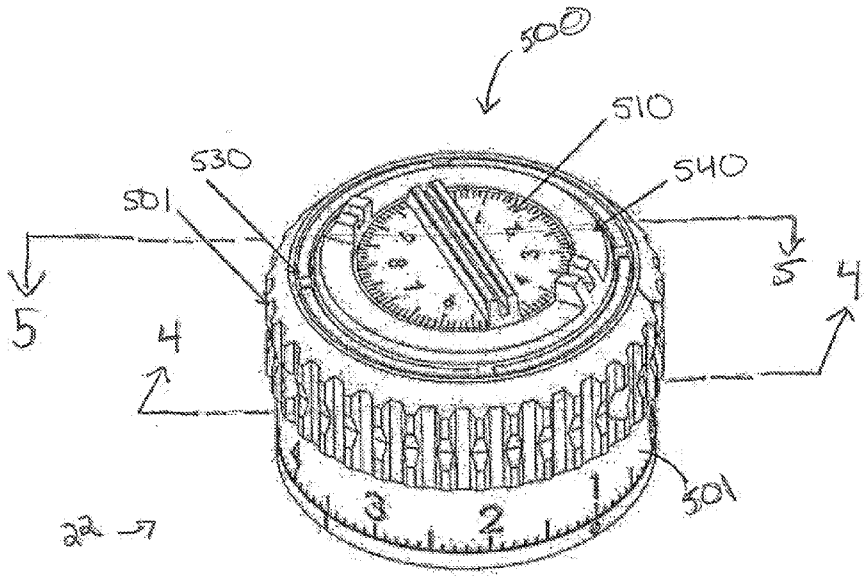


FIG. 3

(57) Abstract: A viewing optic is disclosed. In one embodiment, the viewing optic is a rifle scope having a scope body, a movable optical element defining an optical axis connected to the scope body, a turret and a zero point adjustment subassembly. The turret includes a turret screw, a turret chassis subassembly and a turret cap. The turret screw defines a screw axis and is operably connected to the optical element for adjusting the optical axis in response to rotation of the screw. The turret cap at least partially overlaps the turret chassis subassembly. The zero point adjustment subassembly includes a zero cap connected to the turret screw and a locking mechanism. The locking mechanism releasably secures the zero cap and the turret. The zero point adjustment subassembly permits adjustment of the zero point without the use of tools.

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RIFLE SCOPE TURRET WITH TOOL-FREE ZEROING

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a non-provisional application of and claims priority to U.S. Provisional Patent Application No. 62/789,769 filed January 08, 2019, which is incorporated herein by reference in its entirety.

FIELD

[0001] The disclosure relates to rifle scope turrets, and more particularly to rifle scope turrets with tool-free adjustment capabilities.

BACKGROUND

[0002] In the context of rifle scopes, there are several features of rifle scope turrets that are highly desirable to the user: the ability to lock the turret at a dialed position, the inclusion of a zero stop mechanism, infinitely variable zeroing capabilities, tactile and visible revolution indicators, and clear and positive clicking of turrets between each dialed position.

[0003] It is critical for the user to know exactly how far a reticle has been adjusted. Therefore, clear, tactile and audible clicks of the turret as it travels through each indicator position allows the user to dial the appropriate elevation without the need to read the engraved indicator on a turret cap. Since turret caps can rotate through several revolutions, and the shooter must know the revolution the turret is on so that the reticle's travel relative to zero is known, a tactile and visible revolution indicator is also critical. The tactile revolution indicator and audible clicks make use of senses other than vision, which allows the user to remain in position behind the rifle scope, therefore decreasing the time required to take an accurate shot. Once the correction has been dialed into the turret, locking the turret down to prevent it from inadvertently changing provides the shooter confidence in continuing to handle the rifle without risk of changing the set value. A zero-stop mechanism allows the user to easily return the scope to zero after dialing the corrections into the turret and is another feature greatly desired by the end user.

[0004] In addition to dialing the turret to correct for environmental conditions, another critical task is the zeroing process. Before dialing the turrets from a zero point, as described above, the zero must be established for a given scope, rifle, and ammunition combination. Present turrets that contain one or more of the features mentioned above (*e.g.*, the ability to lock the turret at a dialed position, the inclusion of a zero stop mechanism, infinitely variable zeroing capabilities,

tactile and visible revolution indicators, and clear and positive clicking of turrets between each dialed position) often require complicated methods to zero the scope after mounting it to a rifle. For example, many turrets require removal of components from the turret and additional tools. The removal of components from the turret creates unnecessary ingress points for moisture and debris. Further, the more components are removed, the greater the risk of losing or damaging (*e.g.*, wear and tear) the components. The requirement of additional tools increases the amount of gear a shooter must pack and carry.

[0005] Accordingly, the need exists for a rifle scope turret that permits zeroing without the need for additional tools and/or removal of components, while still retaining the additional features (*e.g.*, the ability to lock the turret at a dialed position, the inclusion of a zero stop mechanism, infinitely variable zeroing capabilities, tactile and visible revolution indicators, and clear and positive clicking of turrets between each dialed position) desired by users.

SUMMARY

[0006] In one embodiment, the disclosure provides rifle scope comprising a turret with a zero point adjustment subassembly. In accordance with embodiments of the disclosure, the rifle scope comprises a scope body; movable optical element defining an optical axis connected to the scope body; a turret comprising (A) a turret screw defining a screw axis and operably connected to the optical element for adjusting the optical axis in response to rotation of the screw, (B) a turret chassis subassembly, and (C) a turret cap at least partially overlapping the turret chassis subassembly; and a zero point adjustment subassembly comprising (A) a zero cap connected to the turret screw, and (B) a locking mechanism releasably securing the zero cap and the turret.

[0007] In accordance with embodiments of the disclosure, a locking mechanism for a zero point adjustment subassembly comprises a lock ring, a cam ring, and a plurality of spring followers. In accordance with further embodiments of the disclosure, a locking mechanism for a zero point adjustment subassembly comprises a lever, a conical wedge and a collet. In accordance with further embodiments of the disclosure, a locking mechanism for a zero point adjustment subassembly comprises a brake disc and a locking ring.

[0008] Other embodiments will be evident from a consideration of the drawings taken together with the detailed description of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. 1 is a side view of an embodiment of a rifle scope in accordance with embodiments of the disclosure.

[0010] FIG. 2 is a cross-sectional view of the turret taken along line 2-2 in accordance with embodiments of the disclosure.

[0011] FIG. 3 is an isometric view of an exemplary turret in accordance with embodiments of the disclosure.

[0012] FIG. 4 is a cross-sectional view of the turret of FIG. 2 taken along line 4-4 in accordance with embodiments of the disclosure.

[0013] FIG. 5 is a cross-sectional view of the turret of FIG. 2 taken along line 5-5 in accordance with embodiments of the disclosure.

[0014] FIG. 6 is a cross-sectional view of a further embodiment of a turret in accordance with embodiments of the disclosure.

[0015] FIG. 7 is an isometric view of a further embodiment of a turret in accordance with embodiments of the disclosure.

[0016] FIG. 8 is a cross-sectional view of the turret taken along line 8-8 in accordance with embodiments of the disclosure.

[0017] FIG. 9 is a cross-sectional view of the turret taken along line 9-9 in accordance with embodiments of the disclosure.

[0018] FIG. 10 is an isometric view of a further embodiment of a turret in accordance with embodiments of the disclosure.

[0019] FIG. 11 is a cross-sectional view of the turret taken along line 11-11 in accordance with embodiments of the disclosure.

[0020] FIG. 12 is a cross-sectional view of the turret taken along line 12-12 in accordance with embodiments of the disclosure.

[0021] FIG. 13 is a top perspective exploded view of a turret screw subassembly in accordance with embodiments of the disclosure.

[0022] FIG. 14 is a top perspective exploded view of the turret screw subassembly and turret housing in accordance with embodiments of the disclosure.

[0023] FIG. 15 is a top perspective view of the turret chassis and indicator in accordance with embodiments of the disclosure.

[0024] FIG. 16A is a top perspective view of the cam disc in accordance with embodiments of the disclosure.

[0025] FIG. 16B is a bottom perspective view of the cam disc in accordance with embodiments of the disclosure.

[0026] FIG. 17 is a top view of the cam disc inserted into the turret chassis in accordance with embodiments of the disclosure with the cam disc rendered partially transparent.

[0027] FIG. 18A is a top perspective exploded view of the turret chassis subassembly in accordance with embodiments of the disclosure.

[0028] FIG. 18B is a side sectional view of the turret chassis subassembly in accordance with embodiments of the disclosure.

[0029] FIG. 19A is a top perspective exploded view of the turret chassis subassembly, turret screw subassembly and turret housing in accordance with embodiments of the disclosure.

[0030] FIG. 19B is a side sectional view of the turret chassis subassembly, turret screw subassembly and turret housing in accordance with embodiments of the disclosure.

DETAILED DESCRIPTION

[0031] The apparatuses and methods disclosed herein will now be described more fully hereinafter with reference to the accompanying drawings, in which embodiments of the disclosure are shown. The apparatuses and methods disclosed herein may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that the disclosure will be thorough and complete and will fully convey the scope of the invention to those skilled in the art.

[0032] It will be appreciated by those skilled in the art that the set of features and/or capabilities may be readily adapted within the context of a standalone weapons sight, front-mount or rear-mount clip-on weapons sight, and other permutations of filed deployed optical weapons sights. Further, it will be appreciated by those skilled in the art that various combinations of features and capabilities may be incorporated into add-on modules for retrofitting existing fixed or variable weapons sights of any variety.

[0033] It will be understood that when an element or layer is referred to as being “on”, “connected to” or “coupled to” another element or layer, it can be directly on, connected or coupled to the other element or layer. Alternatively, intervening elements or layers may be present. In contrast, when an element is referred to as being “directly on,” “directly connected

to" or "directly coupled to" another element or layer, there are no intervening elements or layers present.

[0034] Like numbers refer to like elements throughout. As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items.

[0035] It will be understood that, although the terms first, second, *etc*. may be used herein to describe various elements, components, regions, and/or sections, these elements, components, regions, and/or sections should not be limited by these terms. These terms are only used to distinguish one element, component, region, or section from another element, component, region, or section. Thus, a first element, component, region, or section discussed below could be termed a second element, component, region, or section without departing from the disclosure.

[0036] Spatially relative terms, such as "beneath," "below," "lower," "above," "upper," and the like, may be used herein for ease of description to describe one element or feature's relationship to another element(s) or feature(s) as illustrated in the figures. It will be understood that the spatially relative terms are intended to encompass different orientations of the device in use or operation in addition to the orientation depicted in the figures. For example, if the device in the figures is turned over, elements described as "below," or "beneath" other elements or features would then be oriented "above" the other elements or features. Thus, the exemplary term "below" can encompass both an orientation of above and below. The device may be otherwise oriented (rotated 90° or at other orientations) and the spatially relative descriptors used herein interpreted accordingly.

[0037] All patents, patent applications, and non-patent literature references are incorporated herein in their entireties.

[0038] Definitions

[0039] The numerical ranges in this disclosure are approximate, and thus may include values outside of the range unless otherwise indicated. Numerical ranges include all values from and including the lower and the upper values, in increments of one unit, provided that there is a separation of at least two units between any lower value and any higher value. As an example, if a compositional, physical or other property, such as, for example, molecular weight, viscosity, etc., is from 100 to 1,000, it is intended that all individual values, such as 100, 101, 102, *etc*., and sub ranges, such as 100 to 144, 155 to 170, 197 to 200, etc., are expressly enumerated. For ranges containing values which are less than one or containing fractional numbers greater than

one (*e.g.*, 1.1, 1.5, *etc.*), one unit is considered to be 0.0001, 0.001, 0.01 or 0.1, as appropriate. For ranges containing single digit numbers less than ten (*e.g.*, 1 to 5), one unit is typically considered to be 0.1. These are only examples of what is specifically intended, and all possible combinations of numerical values between the lowest value and the highest value enumerated, are to be considered to be expressly stated in this disclosure. Numerical ranges are provided within this disclosure for, among other things, distances from a user of a device to a target.

[0040] The term "and/or" as used in a phrase such as "A and/or B" herein is intended to include both A and B; A or B; A (alone); and B (alone). Likewise, the term "and/or" as used in a phrase such as "A, B, and/or C" is intended to encompass each of the following embodiments: A, B, and C; A, B, or C; A or C; A or B; B or C; A and C; A and B; B and C; A (alone); B (alone); and C (alone).

[0041] As used herein, an "erector sleeve" is a protrusion from the erector lens mount which engages a slot in the erector tube and/or cam tube or which serves an analogous purpose. This could be integral to the mount or detachable.

[0042] As used herein, an "erector tube" is any structure or device having an opening to receive an erector lens mount.

[0043] As used herein, a "firearm" is a portable gun, being a barreled weapon that launches one or more projectiles often driven by the action of an explosive force. As used herein, the term "firearm" includes a handgun, a long gun, a rifle, shotgun, a carbine, automatic weapons, semi-automatic weapons, a machine gun, a sub-machine gun, an automatic rifle, and an assault rifle.

[0044] As used herein, the term "viewing optic" refers to an apparatus used by a shooter or a spotter to select, identify or monitor a target. The "viewing optic" may rely on visual observation of the target, or, for example, on infrared (IR), ultraviolet (UV), radar, thermal, microwave, or magnetic imaging, radiation including X-ray, gamma ray, isotope and particle radiation, night vision, vibrational receptors including ultra-sound, sound pulse, sonar, seismic vibrations, magnetic resonance, gravitational receptors, broadcast frequencies including radio wave, television and cellular receptors, or other image of the target. The image of the target presented to the shooter by the "viewing optic" device may be unaltered, or it may be enhanced, for example, by magnification, amplification, subtraction, superimposition, filtration, stabilization, template matching, or other means. The target selected, identified or monitored by the "viewing optic" may be within the line of sight of the shooter, or tangential to the sight of the

shooter, or the shooter's line of sight may be obstructed while the target acquisition device presents a focused image of the target to the shooter. The image of the target acquired by the "viewing optic" may be, for example, analog or digital, and shared, stored, archived, or transmitted within a network of one or more shooters and spotters by, for example, video, physical cable or wire, IR, radio wave, cellular connections, laser pulse, optical, 802.11b or other wireless transmission using, for example, protocols such as html, SML, SOAP, X.25, SNA, *etc.*, Bluetooth™, Serial, USB or other suitable image distribution method. The term "viewing optic" is used interchangeably with "optic sight."

[0045] As used herein, the term "outward scene" refers to a real world scene, including but not limited to a target.

[0046] As used herein, the term "shooter" applies to either the operator making the shot or an individual observing the shot in collaboration with the operator making the shot.

[0047] As used herein, "zeroing" refers to aligning the point of aim (what the shooter is aiming at) and the point of impact (where the bullet fired from the firearm is actually hitting) at a specific distance. In one embodiment, zeroing is the process of adjusting a rifle scope to a setting in which accurate allowance has been made for both windage and elevation for a specified range.

[0048] The disclosure relates to viewing optic turrets. In one embodiment, the disclosure relates to rifle scope turrets, and more particularly to rifle scope turrets having zero adjustment mechanisms that do not require tools to make adjustments. Certain preferred and illustrative embodiments of the disclosure are described below. The disclosure is not limited to these embodiments.

[0049] FIGS. 1-2 illustrate a rifle scope **10**, generally, in accordance with embodiments of the disclosure. The rifle scope **10** has a body **12** that encloses a movable optical element **13**, which is an erector tube. The scope body **12** is an elongate tube having a larger opening at its front **14** and a smaller opening at its rear **16**. An eyepiece **18** is attached to the rear of the scope body **12**, and an objective lens **20** is attached to the front of the scope body **12**. The center axis of the movable optical element **13** defines the optical axis **17** of the rifle scope **10**.

[0050] An elevation turret **22** and a windage turret **24** are two knobs in the outside center part of the scope body **12**. They are marked in increments by indicia **34** on their perimeters **30** and **32** and are used to adjust the elevation and windage of the movable optical element **13** for points of

impact change. These knobs **22**, **24** protrude from the turret housing **36**. The turrets **22**, **24** are arranged so that the elevation turret rotation axis **26** is perpendicular to the windage turret rotation axis **28**. Indicia typically include tick marks, each corresponding to a click, and larger tick marks at selected intervals, as well as numerals indicating angle of adjustment or distance for bullet drop compensation.

[0051] The movable optical element **13** is adjusted by rotating the turrets one or more clicks. A click is one tactile adjustment increment on the windage or elevation turret of the rifle scope **10**, each of which corresponds to one of the indicial **34**. In the current embodiment, one click changes the scope's point of impact by 0.1 milliradians (mrad). However, the turrets, systems and concepts disclosed herein can be used with other measures of increments. In other embodiments, the increments can be minutes of angle (MOA) increments.

[0052] Using the turrets **22**, **24** to adjust the elevation and windage of the movable optical element **13** adjusts the elevation and windage relative to a zero point. That zero point must be established, and, in some instances, it is even desirable to adjust the zero point. Each combination of scope, rifle, and ammunition type may have its own zero point. The zero point for each turret **22**, **24** is generally provided as a feature on the given turret. While FIGS. 4-10 illustrate exemplary turrets including a zero point adjustment subassembly **500** in combination with an elevation turret **22**, it will be appreciated that the zero point adjustment subassembly **500** may be used with any adjustment turret, including but not limited to a windage turret or parallax adjustment mechanisms.

[0053] FIGS. 3-12 illustrate exemplary embodiments of a turret **22** having a zero point adjustment subassembly **500**. Generally, a turret **22** includes a turret screw **38**, a turret chassis subassembly **230**, and a turret cap **501**. The turret screw **38** defines a screw axis and is operably connected to the optical element **13** for adjusting the optical element **13** in response to rotation of the screw **38**. The turret chassis subassembly **230** includes a turret chassis **100** and the additional components required to accomplish the elevation (or other) adjustment permitted by the turret **22**. Exemplary turret chassis subassemblies will be described in further detail.

[0054] The turret cap **501** sits over the turret chassis subassembly **230** and is the structure that includes the indicia **34** and, if provided, other visual and/or tactile features. The turret cap **501** has an upper surface **502** that defines a recess **504** (not shown) that is generally circular and centrally located on the turret cap **501**. The recess has an upper surface **506** that is generally flat.

An opening (not shown) runs through the center of the turret cap **501** through which the turret screw **38** protrudes.

[0055] A zero point adjustment subassembly **500**, in accordance with embodiments described herein, includes a zero cap **510** that connects, directly or indirectly, with the turret screw **38**, and a locking mechanism to secure the zero cap **510** to the turret cap **501**. As shown in the FIGS. 3-12, the zero cap **510** is positioned in the recess **504** of the turret cap **501** with at least one component of the locking mechanism positioned between the zero cap **510** and the upper surface **506** of the recess **504**.

[0056] In the representative embodiment shown in FIGS. 3-5, the locking mechanism comprises a lock ring **530**, a cam ring **540**, a plurality of spring followers **550**, and a lock ring lock button **539**. The lock ring **530**, cam ring **540** and zero cap **510** are positioned concentrically within the recess **504** with the cam ring **540** being externally concentric with the zero cap **510** and the lock ring **530** being externally concentric with both the cam ring **540** and zero cap **510**. The zero cap **510** has a downward protruding stem **512** that engages the turret screw **38**. A flange **542** on the cam ring **540** sits on top of the peripheral edge **514** of the zero cap **510** and retains the zero cap **510** in the turret cap **501**. The lock ring **530** sits on top of a second flange **544** of the cam ring **540** and engages the turret cap **501** to retain the cam ring **540**.

[0057] The spring followers **550** are sandwiched between the zero cap **510** and the upper surface **506** of the recess **504**. The spring followers **550** contact the outer surface **516** of the downward protruding stem **512**. In the embodiment shown in FIG. 4, the tails **552** of the spring followers **550** are shown free; however, the tails **552** of the spring followers **550** are generally secured to the underside of the zero cap **510** using a fastener. The fastener is not shown in FIG. 5 for clarity and in order to show the geometry of the spring followers **550**.

[0058] As shown in FIG. 4, the zero point adjustment subassembly **500** is in its locked position. The inner surface **546** of the cam ring **540** has at least two (*e.g.*, in the embodiment shown, three) ramped surfaces **548**. In FIG. 4, each of the spring followers **550** is engaged with the thickest end of the ramped surfaces **548**, meaning the spring followers **550** are applying force to the zero cap **510** and prohibit the zero cap **510** from freely spinning. Turning the cam ring **540** in the counterclockwise direction (relative to the embodiment as shown in FIG. 4) results in the spring followers **550** being aligned with the thinner ends of the ramped surfaces **548**. Thus, less (or no) force is exerted on the zero cap **510** and the zero cap **510** freely spins within the recess **504**.

Rotation of the cam ring **540** in the clockwise direction results in the spring followers **550** realigning with the thickest ends of the ramped surfaces **548** and the zero cap **510** being once again locked in position.

[0059] It will be appreciated that the zero point adjustment subassembly **500** permits adjustment of the zero point without the use of tools. That is, a user can rotate the cam ring **540** and zero cap **510** by hand. This saves time and does not require a user to turn away from the rifle scope to make any zero point adjustments.

[0060] FIG. 6 illustrates a further embodiment of a zero point adjustment subassembly **500'** in accordance with embodiments of the disclosure. In the embodiment shown in FIG. 6, the zero cap **510'** includes a lever **513'** with a pivot point **513a'**. The lever **513'** has a stem **515'** that projects through an opening **511'** in the zero cap **510'** and connects with the turret screw **38**. The locking mechanism includes conical wedge **521'** and a collet **523'**. The conical wedge **521'** is positioned around the turret screw **38** and partially extends through the opening (not shown) of the turret cap **501**. The conical wedge **521'** is operatively connected with the lever **513'** such that actuation of the lever **513'** causes vertical movement of the conical wedge **521'**, as described in further detail below. The collet **523'** also has a central opening and sits in the recess **504** (not shown) of the turret cap **501** externally concentric with the turret screw **38** and conical wedge **521'**.

[0061] As shown in FIG. 6, the zero point adjustment subassembly **500'** is in the locked position. The lever **513'** is flush against the upper surface of the zero cap **510'**. The conical wedge **521'** has an increasing lower radius (wedge-like radius) and, in this locked position, the conical wedge **521'** has been forced upwards by the lever **513'** such that the thicker portion **521a'** of the conical wedge **521'** contacts the flange **523a'** of the collet **523'**, causing the collet **523'** to expand radially outward into the turret cap **501** and lock the zero cap **510'** from freely spinning. To adjust the zero point, the lever **513'** is flipped along its pivot point **513a'**, which lowers the conical wedge **521'**. With the collet **523'** disengaged from the conical wedge **521'**, the zero cap **510'** can spin freely.

[0062] It will be appreciated that the zero point adjustment subassembly **500'** permits adjustment of the zero point without the use of tools. That is, a user can actuate the lever **513'** and rotate the zero cap **510'** by hand. This saves time and does not require a user to turn away from the rifle scope to make any zero point adjustments.

[0063] FIGS. 7-9 illustrate a further embodiment of a zero point adjustment subassembly **500''** in accordance with embodiments of the disclosure. The zero point adjustment subassembly **500''** includes the zero cap **510'''** and the locking mechanism **520''**. The locking mechanism **520''** includes a brake disc **527''** and a lock ring **530''**.

[0064] As shown in FIGS. 7-8, the zero cap **510'''** engages the turret screw **38** and sits in the recess (not shown) of the turret cap **501**. The brake disc **527''** is circular with a central opening and sits over a flange **514''** of the zero cap **510''** in the recess. The brake disc **527''** is keyed to the turret cap **501** via the mating of projections **527a''** on the brake disc **527''** with recesses **501a''** on the inside wall of the turret cap **501**. The brake disc **527''** is therefore prohibited from rotating but is free to translate vertically. The lock ring **530''** is externally concentric to the zero cap **510''** and the brake disc **527''** and rotatably secured with the turret cap **501** via a threaded engagement. As the lock ring **530''** is rotated into a locked position (*e.g.*, clockwise), its vertical translation downward applies a force to the brake disc **527''**. The brake disc **527''** transfers that downward force to the zero cap **510''** that is thereby prohibited from freely spinning. Rotation of the lock ring **530''** in the opposite direction (*e.g.*, counterclockwise) releases the force on the brake disc **527''**, and therefore zero cap **510''**, to allow the zero cap **510''** to freely spin in the turret cap **501**.

[0065] FIGS. 10-12 illustrate a further embodiment of a zero point adjustment subassembly **500'''**, which is a variation of subassembly **500''**, in accordance with embodiments of the disclosure. The zero point adjustment subassembly **500'''** includes the zero cap **510'''** and the locking mechanism **520''** which is composed of the locking ring **530'''**, a brake disc **527'''**, and a lock ring lock button **539'''**. The locking ring **530'''**, brake disc **527'''** and zero cap **510'''** are all positioned concentrically within the recess (not shown) with the brake disc **527'''** being externally concentric with the zero cap **510'''** and the lock ring **530'''** being externally concentric with both the brake disc **527'''** and the zero cap **510'''**. The zero cap **510'''** has a downward protruding stem **512'''** that engages the turret screw **38**. A flange **542** on the brake disc **527'''** sits on top of at least a portion of the upper surface **516'''** of the zero cap **510'''** and retains the zero cap **510'''** in the turret cap **501**. The locking ring **530'''** sits on top of a flange **518'''** of the brake disc **527'''** and engages the turret cap **501**. In the embodiment shown, the locking ring **530'''** is in threaded engagement with the turret cap **501**.

[0066] As shown in FIGS. 10-11, the zero cap **510'''** engages the turret screw **38** and sits in the recess (not shown) of the turret cap **501**. The brake disc **527'''** is circular with a central opening and sits over a flange **514'''** of the zero cap **510'''** in the recess. The brake disc **527'''** is keyed to the turret cap **501** via the mating of projections **527a'''** on the brake disc **527'''** with recesses **501a'''** on the inside wall of the turret cap **501**. The brake disc **527'''** is therefore prohibited from rotating but is free to translate vertically. The lock ring **530'''** is externally concentric to the zero cap **510'''** and the brake disc **527'''** and rotatably secured with the turret cap **501** via a threaded engagement. As the lock ring **530'''** is rotated into a locked position (*e.g.*, clockwise), its vertical translation downward applies a force to the brake disc **527'''**. The brake disc **527'''** transfers that downward force to the zero cap **510'''** that is thereby prohibited from freely spinning. Rotation of the lock ring **530'''** in the opposite direction (*e.g.*, counterclockwise) releases the force on the brake disc **527'''**, and therefore zero cap **510'''**, to allow the zero cap **510'''** to freely spin in the turret cap **501**.

[0067] As shown in FIGS. 10-12, the zero point adjustment subassembly **500'''** further includes a lock ring lock button **539'''**. The lock ring lock button **539'''** includes and outer portion **539a'''** which, in the embodiment shown, is a portion of the turret cap **501** and includes a tactile element different from the surrounding portions of the turret cap **501**. As shown in FIGS. 10-12, the lock ring lock button **539'''** is in its locked position, meaning rotation of the lock ring **530**, and therefore zero cap **510'''** is prohibited. Referring to FIG. 11, the lock ring lock button **539'''** is provided at least one (in the embodiment shown, two) spring-containing guide-rods **539b'''**. Once the upper surface **539c'''** of the button **539'''** is below the level of the lock ring **530'''**, the lock ring **530'''** can be freely rotated. The under surface of the lock ring **530'''** will cover the button **539'''** to prevent the lock ring lock button **539'''** from returning to its locked position while a user is making adjustments. One will appreciate that the springs of the spring-containing guide-rods **539b'''** "automatically" force the button **539'''** back upward into the locked position once the user has rotated the lock ring **530'''** into the rotationally locked position.

[0068] Referring to FIG. 12, the turret cap **501** further includes a groove **539d'''** and the locking ring **530'''** further includes a corresponding protuberance **539e'''**. The groove **539d'''**/protuberance **539e'''** system limits rotation of the locking ring **530'''** while the lock ring lock button **539'''** is depressed. This ensures that the parts of the subassembly **500'''** are captive

in addition to limiting rotation. Since rotation is limited, the locking ring **530'''** cannot be unthreaded and removed from the turret cap **501**.

[0069] It will be appreciated that the zero point adjustment subassemblies **500''** and **500'''** permit adjustment of the zero point without the use of tools. That is, a user can rotate the lock ring **530''/530'''** and zero cap **510''/510'''** by hand and similarly manipulate the other components of the subassemblies **500''** and **500'''** by hand. This saves time and does not require a user to turn away from the rifle scope to make any zero point adjustments.

[0070] While the zero point adjustment subassemblys **500**, **500'**, **500''**and **500'''** described above can be used with many different styles of chassis subassemblies, the exemplary turret chassis subassembly **400** illustrated in FIGS. 3-12 is in accordance with that disclosed in U.S. 8,919,026 which is incorporated herein by reference. Such an exemplary turret chassis subassembly **230** will now be described in further detail.

[0071] As shown in FIG. 13, the turret screw **38** is part of a turret screw subassembly **88**. The turret screw subassembly consists of the turret screw **38**, a turret screw base **60**, a friction pad **86**, and various fasteners. The turret screw **38** in the embodiment shown is a cylindrical body made of brass. The top **40** of the turret screw **38** defines a slot or other feature, such as threads, **40** that engage the zero point adjustment subassembly **500** (not shown). Two opposing cam slots **46** run from the top part way down the side **44**. Two o-ring grooves **50** and **52** are on the side located below the cam slots. The bottom **42** of the turret screw has a reduced radius portion **56** that defines a ring slot **54**. The ring slot **54** receives a retaining ring **84**, and a bore **304** in the bottom receives the shaft **306** of the friction pad **86**. The side of the turret screw immediately below the o-ring groove **52** and above the ring slot **54** is a threaded portion **58**.

[0072] The turret screw base **60** is a disc-shaped body that may also be made of brass. A cylindrical collar **66** rises from the center to the top **62** of the turret screw base. The collar has a turret screw bore **68** with threads **70**. The exterior of the collar defines a set screw V-groove **78** above the top of the turret screw base, an o-ring groove **74** above the o-ring groove **76**, and a ring slot **72** above the o-ring groove **74**. The turret screw base **60** has three mount holes **82** with smooth sides and a shoulder that receives screws **80**.

[0073] The fitting of the turret screw subassembly **88** to the turret housing **36** is shown in FIG. 14. The top **92** of the turret housing defines a recess **94**. Three mount holes **96** with threads **98** and a smooth central bore **508** are defined in the top of the turret housing within the recess. The

threads **70** of the turret screw bore **68** are such that the turret screw bore may receive the threads **58** on the turret screw **38**. The retaining ring **84** limits upward travel of the turret screw **38** so that the turret screw **38** cannot be inadvertently removed from the turret screw bore.

[0074] When the turret screw subassembly **88** is mounted on the turret housing **36**, screws **80** are inserted into the mount holes **82** and protrude from the bottom **64** of the turret screw base. The screws are then screwed into the mount holes **96** in the turret housing. Subsequently, the turret screw base remains in a fixed position with respect to the scope body **12** when the elevation turret **22** is rotated. This essentially makes the turret screw base functionally unitary with the scope body, and the turret screw base is not intended to be removed or adjusted by the user. The smooth central bore **508** in the top of the turret housing permits passage of the friction pad **86** and the bottom **42** of the turret screw **38** into the scope body **12**.

[0075] Turning to FIG. 15, the top **110** of the turret chassis **100** has an interior perimeter **102** with a relief cut **240** adjacent to the floor **264**, a toothed surface **108** above the relief cut, a lower click groove **106** above the toothed surface **108**, and an upper click groove **104** above the lower click groove **106**. The relieve cut **240** is for the tool that cuts the toothed surface **108**. The floor defines a smooth central bore **120** and a slot **122**. The smooth central bore **120**permits passage of the friction pad **86** and the bottom **42** of the turret screw **38** through the turret chassis **100**.

[0076] The exterior perimeter **112** of the turret chassis **100** defines an o-ring groove **244**. Near the bottom **116** of the turret chassis, the exterior perimeter widens to define a shoulder **114**. Three holes **118** with threads **158** communicate from the exterior perimeter through the turret chassis to the smooth bore **120**. In the current embodiment, the turret chassis **100** is made of steel.

[0077] The slot **122** in the floor **264** of the turret chassis **100** communicates with a hole **124** in the exterior perimeter **112** of the turret chassis **100**. The hole **124** receives an indicator, such as an elevation indicator **136**.

[0078] The rear **140** of the indicator **136** defines a cam pin hole **154**. The front **138** of the indicator **136** has two stripes **148** and **150** and an o-ring groove **152**. The stripe **148** divides a first position **142** from a second position **144**. The stripe **150** divides a second position **144** from a third position **146**. As shown, the elevation indicator **136** is made of painted black steel and the stripes are white lines that do not glow, but which could be luminous in an alternative embodiment.

[0079] The cam pin hole **154** receives the bottom **134** of a cam pin **126**. In the current embodiment, the cam pin is a cylindrical body made of steel. The top **128** of the cam pin **126** has a reduced radius portion **130** that defines a shoulder **132**. The reduced radius portion of the cam pin protrudes upward through the slot **122** above the floor **264** of the turret chassis **100**.

[0080] FIGS. 16A and 16B illustrate a cam disc **160** with a top face **162** and a bottom face **164**. The top face **162** has a reduced radius portion **166** that defines a shoulder **168** around the exterior perimeter **170** of the cam disc **160**. The top face **162** also defines three mount holes **180** with threads **182**. A reduced radius central portion **176** defines a shoulder **172** and a smooth central bore **178**. The smooth central bore **178** permits passage of the turret screw subassembly **88** through the cam disc **160**.

[0081] A radial clicker channel **186** in the top **162** of the exterior perimeter **170** receives a clicker **188** that reciprocates in the channel **186**, and is biased radially outward. The front, free end **190** of the clicker **186** protrudes from the exterior perimeter **170**. The clicker **186** has a wedge shape with a vertical vertex parallel to the axis of rotation of the turret and is made of steel.

[0082] The bottom **164** of the cam disc **160** is a planar surface perpendicular to the elevation turret rotation axis **26** that defines a recessed spiral channel **184**. The spiral channel **184** terminates in a zero stop surface **198** when traveled in a clockwise direction and terminates in an end of travel stop surface **200** when traveled in a counterclockwise direction. When traveled in a counterclockwise direction, the spiral channel **184** defines a first transition **194** and a second transition **196** when the spiral channel begins to overlap itself for the first time and second time, respectively. The spiral channel **184** is adapted to receive the reduced radius portion **130** of the cam pin **126**. The spiral channel **184** and the stop surfaces **198**, **200** are integral to the cam disc **160** and are not adjustable

[0083] FIG. 17 the cam disc **160** is shown installed in the turret chassis **100**. The spiral channel **184** receives the reduced radius portion **130** of the cam pin **126**. The clicker **188** protrudes from the clicker channel **186** in the exterior perimeter **170** of the cam disc **160**. A spring **202** at the rear **192** of the clicker **188** outwardly biases the clicker **188** such that the clicker **188** is biased to engage with the toothed surface **108** on the interior perimeter **102** of the turret chassis **100**. When the cam disc **160** rotates as the turret **22** is rotated when changing settings (*e.g.*, elevation

settings), the clicker **188** travels over the toothed surface **108**, thereby providing a rotational, resistant force and making a characteristic clicking sound.

[0084] In the embodiment shown, the toothed surface **108** has 100 teeth, which enables 100 clicks per rotation of the elevation turret **22**. The spiral channel **184** is formed of a several arcs of constant radius that are centered on the disc center, and extend nearly to a full circle, and whose ends are joined by transition portions of the channel, so that one end of the inner arc is connected to the end of the next arc, and so on to effectively form a stepped spiral. This provides for the indicator to remain in one position for most of the rotation, and to transition only in a limited portion of turret rotation. In an alternative embodiment the spiral may be a true spiral with the channel increasing in its radial position in proportion to its rotational position. In the most basic embodiment, the channel has its ends at different radial positions, with the channel extending more than 360 degrees, the ends being radially separated by material, and allowing a full 360 degree circle of rotation with the stop provided at each channel end.

[0085] The turret **22** is positioned at the indicium 34 corresponding to 0° of adjustment when the cam pin **126** is flush with the zero stop surface **198**. In an embodiment, the spiral channel **184** holds the cam pin **126** in a circular arc segment at a constant distance from the rotation axis **26** until the elevation turret has rotated 9 mrad (324°). The first transition **194** occurs as the turret **22** rotates counterclockwise from 9 mrad (324°) to 10 mrad (360°). During the first transition, the spiral channel **184** shifts the cam pin **126** towards the exterior perimeter **170** so the spiral channel **184** can begin overlapping itself. As the turret **22** continues its counterclockwise rotation, the spiral channel **184** holds the cam pin **126** in a circular arc segment at a constant further distance from the rotation axis **26** until the elevation turret has rotated 19 mrad (684°). The second transition **196** occurs as the turret **22** rotates counterclockwise from 19 mrad (684°) to 20 mrad (720°). During the second transition, the spiral channel shifts the cam pin **126** even further towards the exterior perimeter **170** so the spiral channel **184** can overlap itself a second time. As the turret **22** continues its counterclockwise rotation, the spiral channel **184** holds the cam pin **126** in a circular arc segment at a constant even further distance from the central bore **178** until the elevation turret has rotated 28.5 mrad (1026°). At that time, the cam pin **126** is flush with the end of travel stop surface **200**, and further counterclockwise rotation of the turret **22** and elevation adjustment are prevented. In the embodiment shown, the first and second transitions **194**, **196** are angled at about 36° (10% of the rotation) to enable adequate wall

thickness between the concentric circular arc segments about the rotation axis **26** of the spiral channel. The cam pin diameter determines the overall diameter of the turret. Because there are three rotations, any increase in diameter will be multiplied by three in how it affects the overall turret diameter. In an embodiment, a cam pin diameter of 1.5 mm provides adequate strength while remaining small enough to keep the overall diameter of the turret from becoming too large.

[0086] FIGS. 18A and 18B illustrate the complete turret chassis subassembly **230**. The turret chassis subassembly **230** is assembled by inserting a locking gear **206** into the turret chassis **100**on top of the cam disc **160**. The turret chassis subassembly **230** is shown in the locked position in FIG. 15B.

[0087] The locking gear **206** has a top **208** and a bottom **210**. The top **208** defines three mount holes **216** with threads **218**. The locking gear **206** also defines three smooth mount holes **220** and a central smooth bore **222**. The bottom **210** of the locking gear **206** defines a toothed surface **214**. The toothed surface **214** extends downward below the bottom **210** of the locking gear **206** to encircle the reduced radius portion **166** of the top **162** of the cam disc **160** when the chassis subassembly **230** is assembled. In the current embodiment, the toothed surface **214** has 100 teeth to mesh precisely with the 100 teeth of the toothed surface **108** on the interior perimeter **102** of the turret chassis **100** when the elevation turret **22** is locked.

[0088] Four ball bearings **226** protrude outwards from bores **232** in the exterior perimeter **212** located between the toothed surface and the top. Springs **400** located behind the ball bearings outwardly bias the ball bearings such that the ball bearings are biased to engage with the upper click groove **104** and lower click groove **106** on the interior perimeter **102** of the turret chassis **100**. When the locking gear rises and towers as the turret **22** is unlocked and locked, the ball bearings **226** travel between the lower and upper click grooves **104**, **106**, thereby providing a vertical, resistant force and making a characteristic clicking sound.

[0089] When the turret chassis subassembly **230** is assembled, screws **224** are inserted into the mount holes **220** and protrude from the bottom **210** of the locking gear **206**. The screws **224** are then screwed into the mount holes **180** in the top **162** of the cam disc **160** to mount the locking gear **206** to the cam disc **160**. Subsequently, the locking gear **206** remains in a fixed rotational position with respect to the cam disc **160** when the turret **22** is unlocked and rotated. The heads **234** of the screws **224** are thinner than the depth of the mount holes **220** from the top **208** of the locking gear **206** to the shoulders **236**. The screws **224** have shoulders **228** that contact the top

162 of the cam disc **160** when the screws are secured. As a result, the locking gear **206** is free to be raised until the heads **234** of the screws **224** contact the shoulders **236** and to be lowered until the bottom of the locking gear **206** contacts the top **162** of the cam disc **160**. This vertical movement is sufficient for the toothed surface **214** of the locking gear **206** to be raised above the toothed surface **108** of the turret chassis **100**, thereby enabling the elevation **22** turret to be unlocked and free to rotate.

[0090] FIGS. 19A and 19B illustrate the turret chassis subassembly **230**, screw subassembly **88**, and turret housing **36**. More particularly, the turret chassis subassembly **230** is shown assembled and in the process of being mounted on the turret screw subassembly **88** in FIG. 19A and mounted on the turret screw subassembly in FIG. 19B.

[0091] When the turret chassis subassembly **230** is mounted on the turret screw subassembly **88**, the top **40** of the turret screw **38** and the collar **66** of the turret screw base **60** pass upwards through the smooth central bore **120** of the turret chassis **100**, the smooth central bore **178** of the cam disc **160**, and the smooth central bore **222** of the locking gear **206**. A retaining ring **246** is received by the ring slot **72** in the collar **66** to prevent the turret chassis subassembly **230** from being lifted from the turret screw subassembly **88**. Three recesses **245** in the bottom **116** of the turret chassis **100** receive the heads of the screws **80** that protrude from the top **62** of the turret screw base **60** so the bottom **116** of the turret chassis **100** can sit flush against the top **92** of the turret housing **36**.

[0092] With the turret chassis subassembly **230** is described above with respect to a turret, which is an elevation turret, one of skill in the art will appreciate that similar designs may be used for turrets that make other adjustments, such as windage turrets. Further, the turret chassis subassembly **230** described above is described with respect to a zero point adjustment subassembly in accordance with embodiment **500**. It will be appreciated that the turret chassis subassemblies **230** described herein can be implemented with any embodiment of the zero point adjustment subassembly **500**, **500'**, **500''**, **500'''** or combination of embodiments described herein.

[0093] Various modifications and variations of the described compositions and methods of the invention will be apparent to those skilled in the art without departing from the scope and spirit of the invention. One skilled in the art will recognize at once that it would be possible to construct the present invention from a variety of materials and in a variety of different ways.

Although the invention has been described in connection with specific preferred embodiments, it should be understood that the invention should not be unduly limited to such specific embodiments. While the preferred embodiments have been described in detail, and shown in the accompanying drawings, it will be evident that various further modification are possible without departing from the scope of the invention as set forth in the appended claims. Indeed, various modifications of the described modes for carrying out the invention which are obvious to those skilled in marksmanship or related fields are intended to be within the scope of the following claims.

WHAT IS CLAIMED IS:

1. A rifle scope comprising:

a scope body;

a movable optical element defining an optical axis connected to the scope body;

a turret comprising

(A) a turret screw defining a screw axis and operably connected to the optical element for adjusting the optical axis in response to rotation of the screw,

(B) a turret chassis subassembly, and

(C) a turret cap at least partially overlapping the turret chassis subassembly; and

a zero point adjustment subassembly comprising

(a) a zero cap connected to the turret screw, and

(b) a locking mechanism releasably securing the zero cap and the turret.

2. The rifle scope of claim 1, wherein the locking mechanism comprises a brake disc and a locking ring.

3. The rifle scope of claim 2, wherein the upper surface of the turret cap defines a recess, and the zero cap, brake disc and lock ring are concentrically positioned in the recess.

4. The rifle scope of claim 3, wherein the locking mechanism further includes a lock ring lock button.

5. The rifle scope of claim 4, wherein the lock ring lock button is formed in the turret cap and comprises at least one spring-containing guide-rod.

6. The rifle scope of claim 1, wherein the locking mechanism comprises a lock ring, a cam ring and a plurality of spring followers.

7. The rifle scope of claim 6, wherein the upper surface of the turret cap defines a recess, and the zero cap, cam ring and lock ring are concentrically positioned in the recess.

8. The rifle scope of claim 7, wherein the plurality of spring followers are sandwiched between the zero cap and an upper surface of the recess.

9. The rifle scope of claim 1, wherein the locking mechanism comprises a lever, a conical wedge, and a collet.

10. The rifle scope of claim 9, wherein the lever is connected to the turret screw.

11. The rifle scope of claim 10, wherein the conical wedge is positioned around the turret screw.

12. The rifle scope of claim 11, wherein the upper surface of the turret cap defines a recess, and the zero cap is positioned in the recess.

13. The rifle scope of claim 12, wherein the zero cap has a central opening through which the lever connects to the turret screw.

14. The rifle scope of claim 13, wherein the collet is sandwiched between the zero cap and an upper surface of the recess.

15. The rifle scope of claim 1, wherein the turret chassis subassembly comprises:

a spiral cam mechanism having a cam pin engaged thereto, the spiral cam mechanism defining a first stop surface and a second stop surface, each positioned for engagement by the stop element,

wherein the first stop surface and send stop surface are connected by a channel which at least partially overlaps itself.

16. The rifle scope of claim 15 further comprising a rotation indicator connected to the stop element.

17. The rifle scope of claim 1, wherein the turret is an elevation turret.

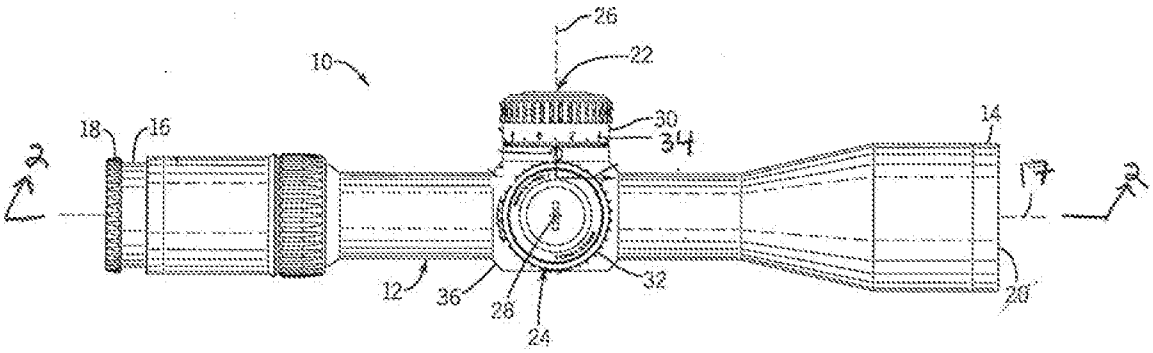


FIG. 1

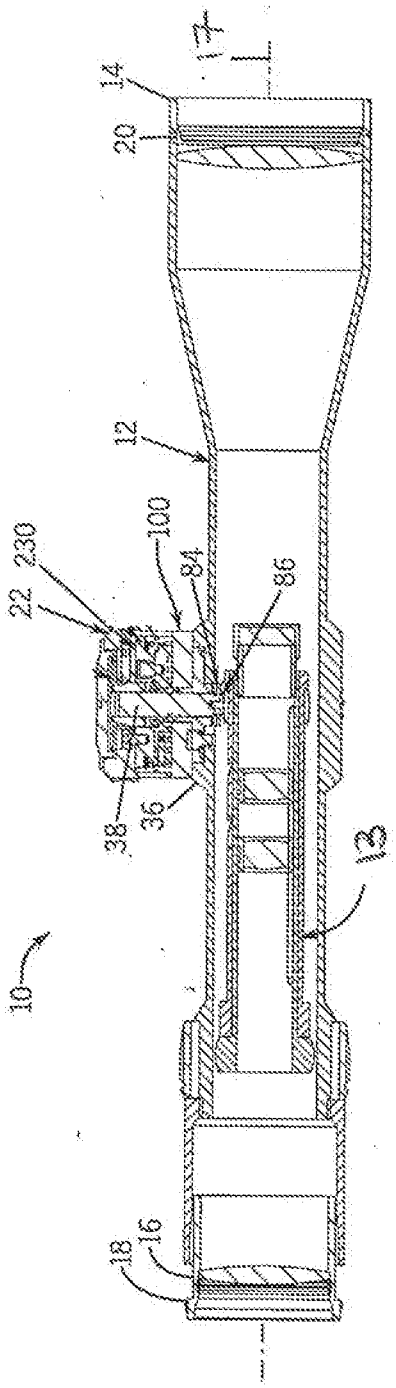


FIG. 2

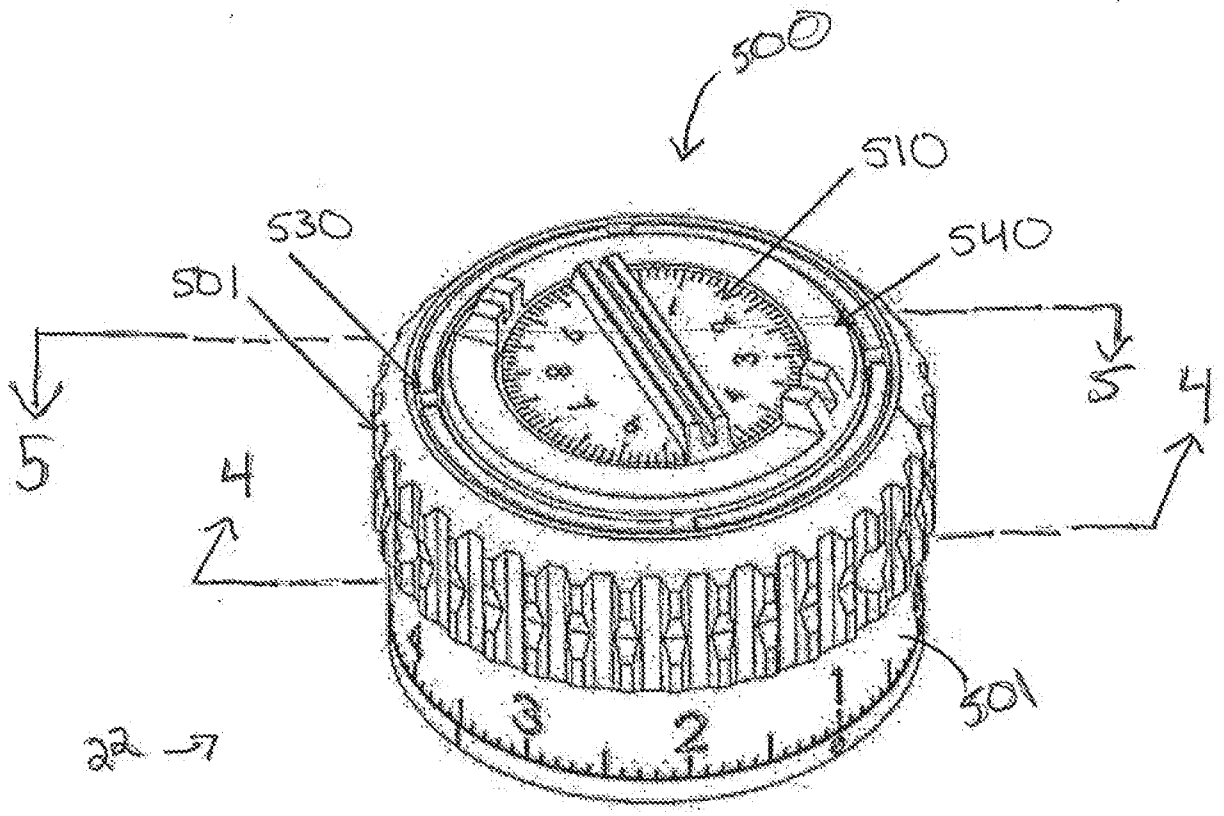


FIG. 3

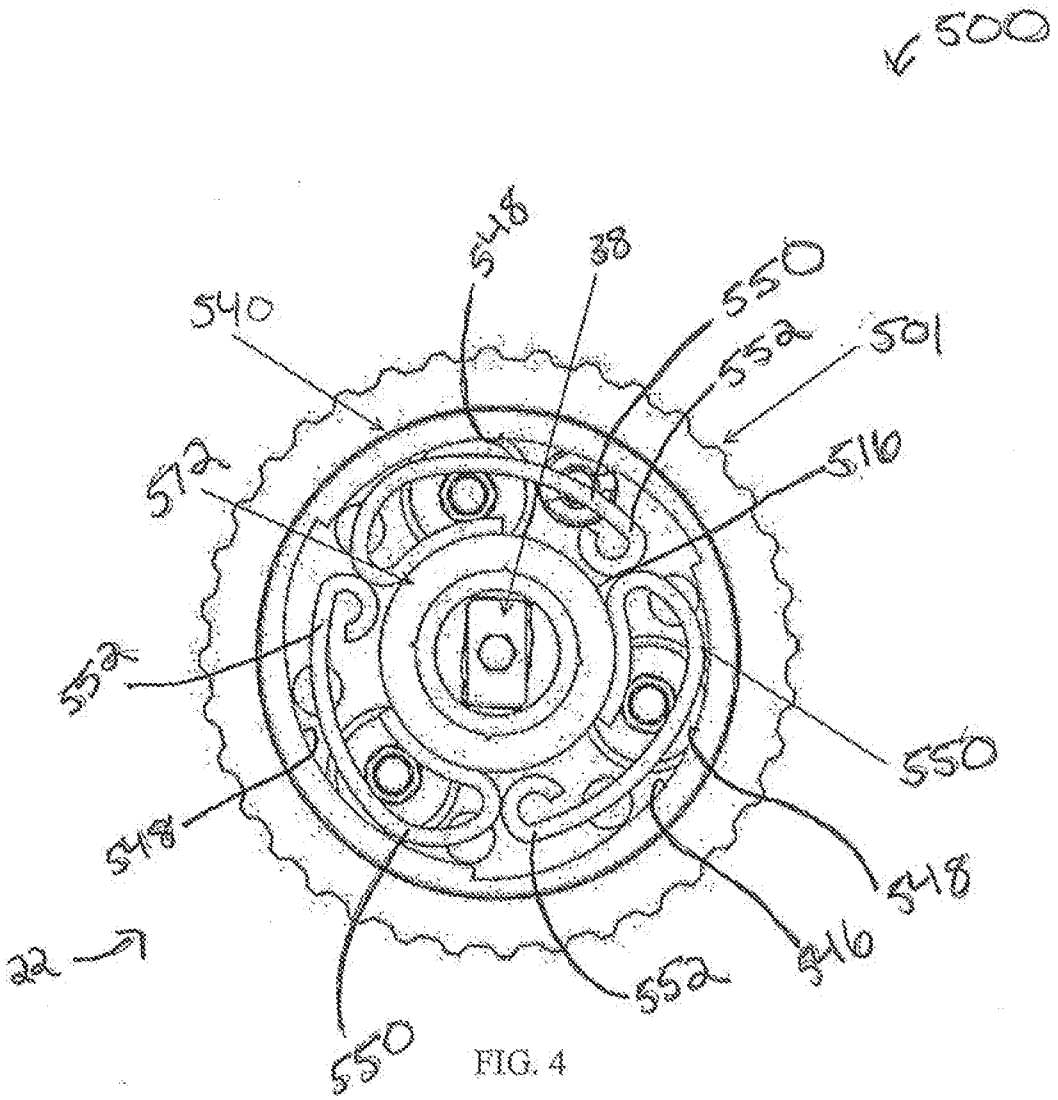


FIG. 4

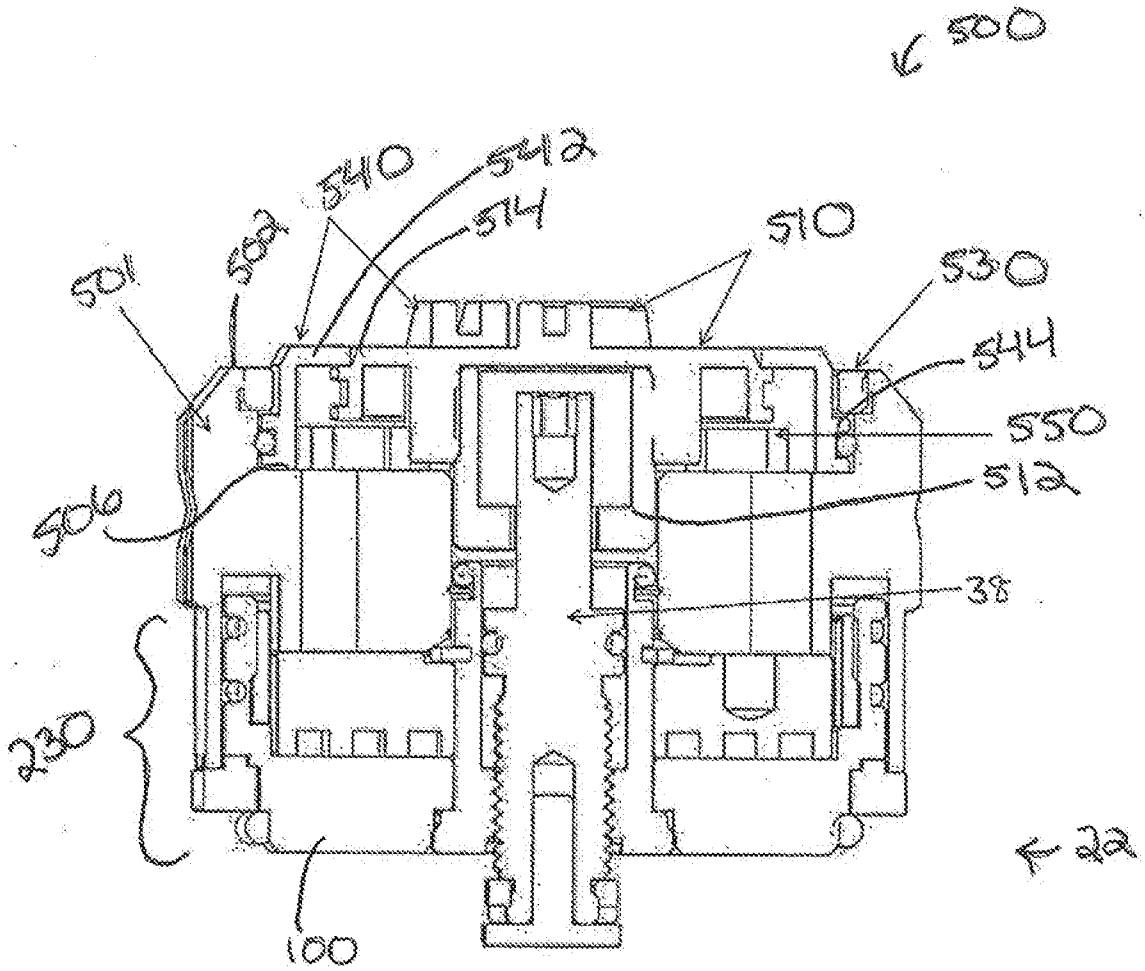


FIG. 5

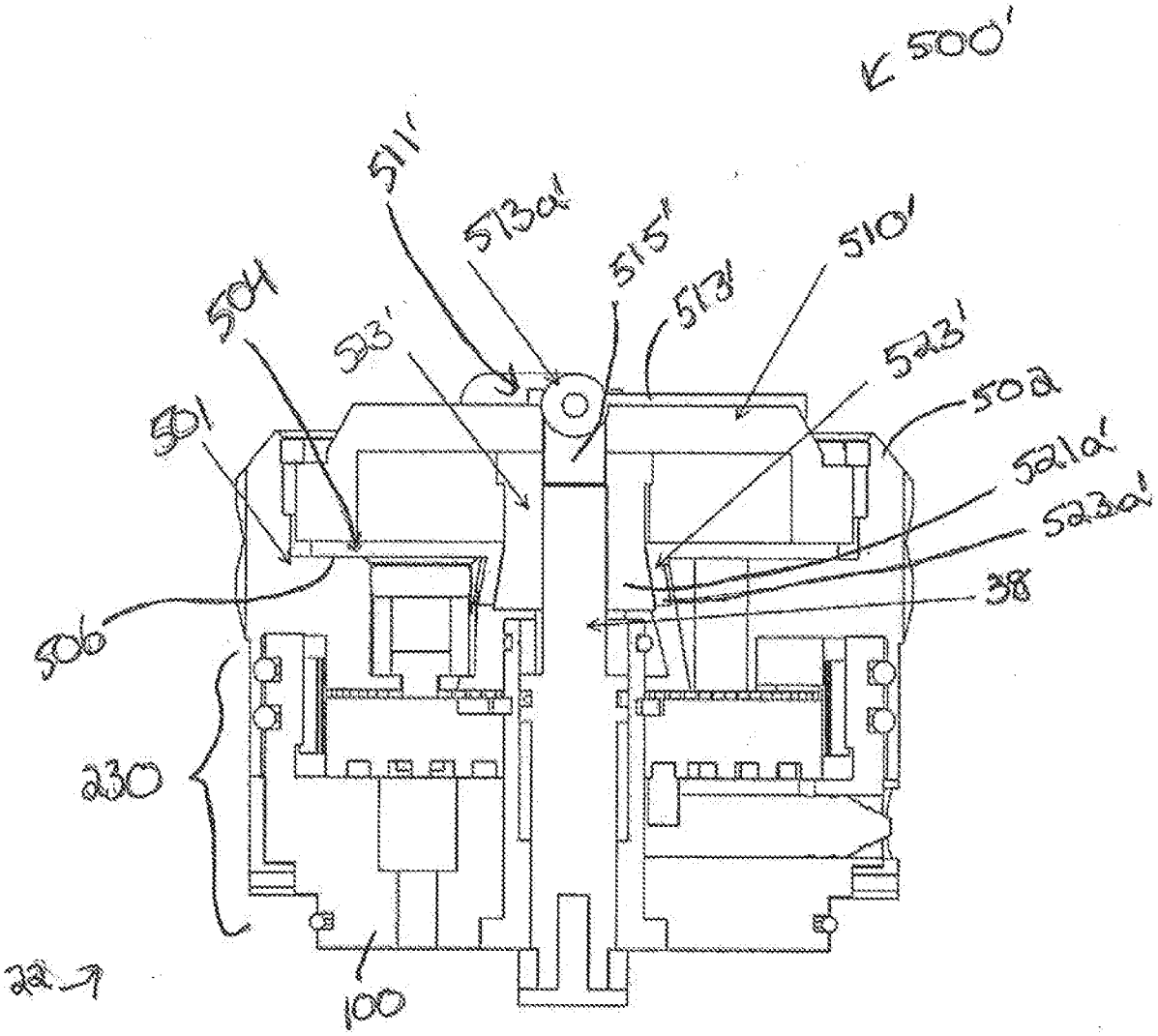

500'
511'
513a'
515'
513'
510'
504
53'
523'
501
502
521a'
523a'
38
506
230
32
100

FIG. 6

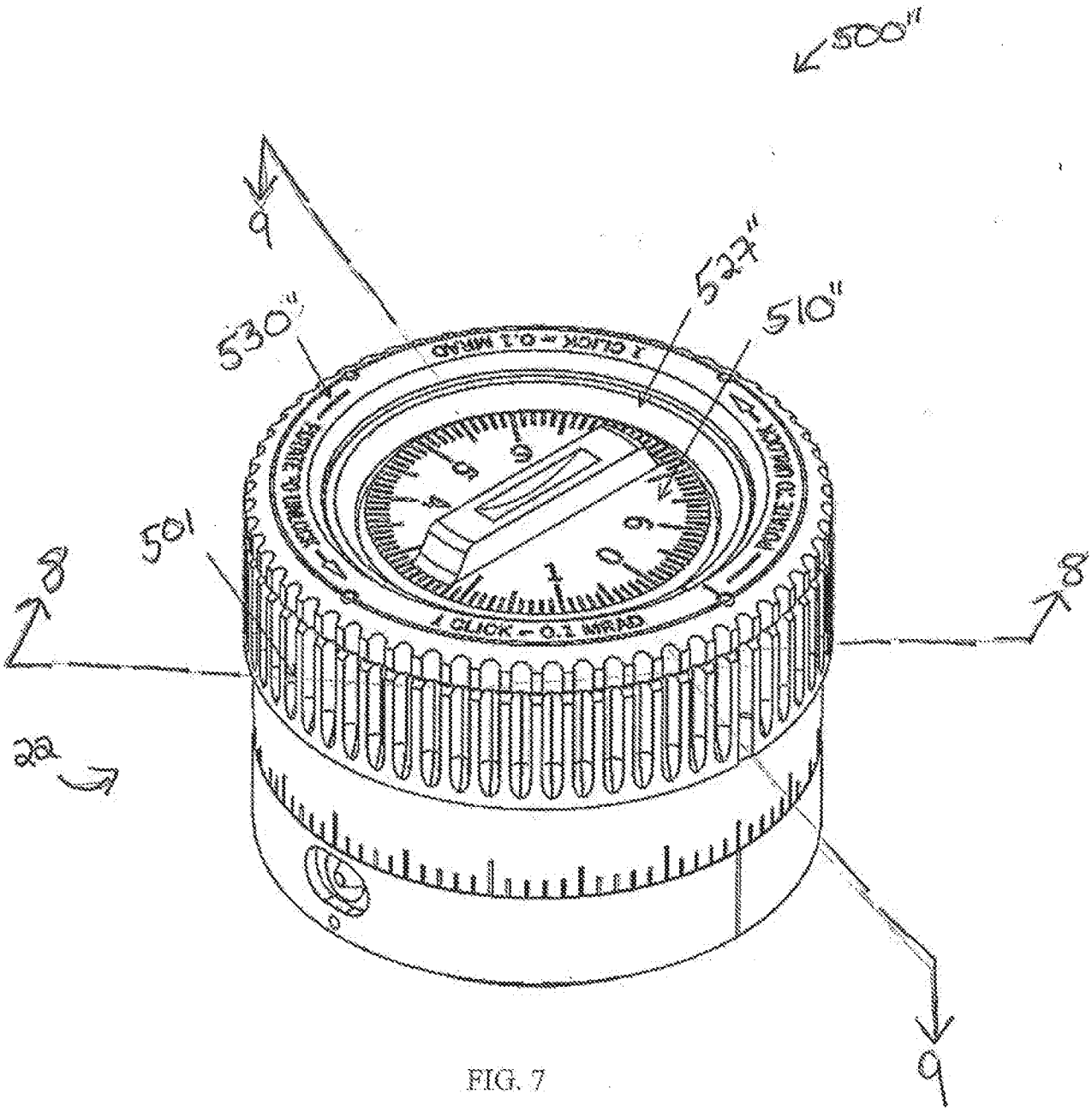


FIG. 7

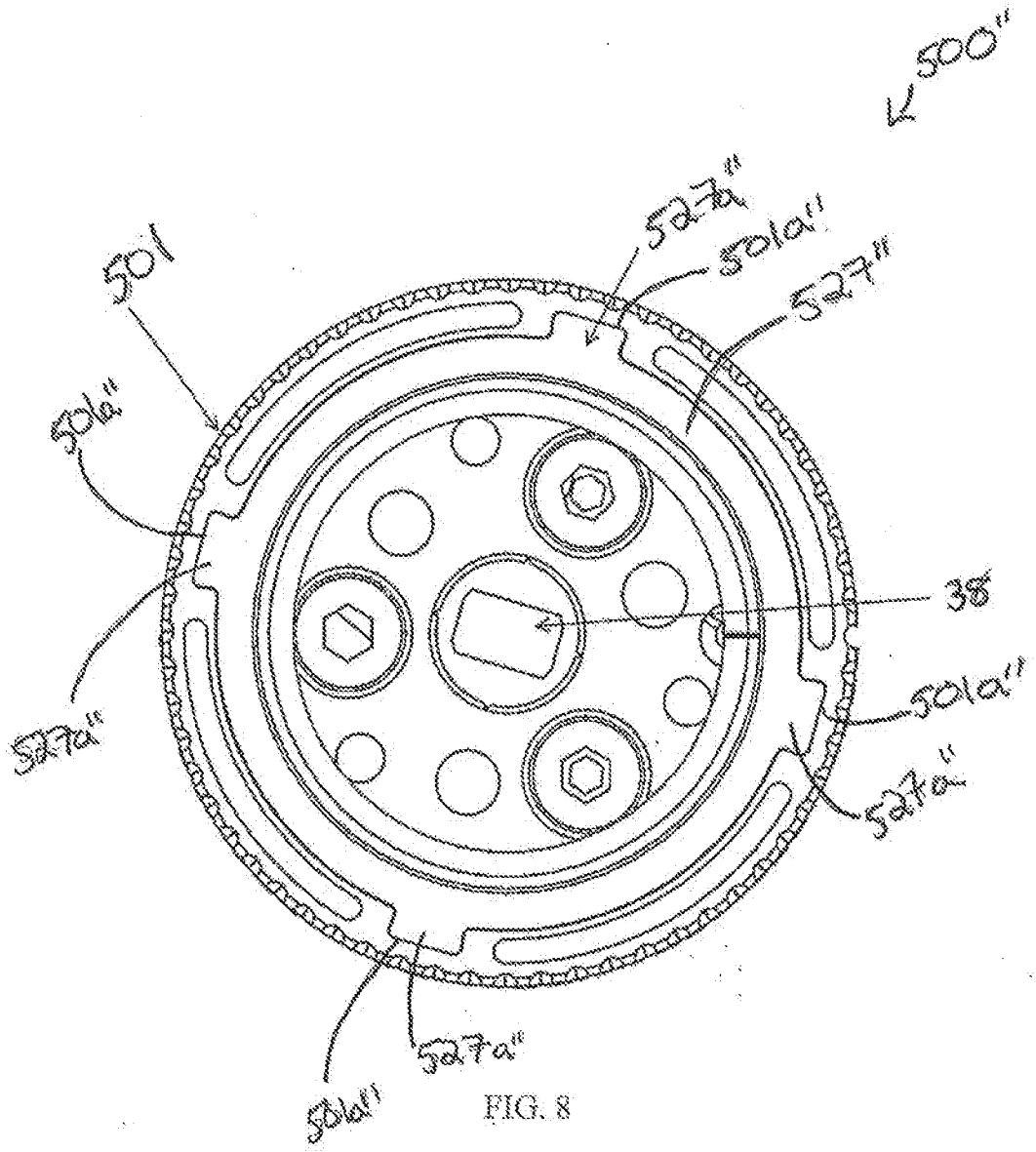


FIG. 8

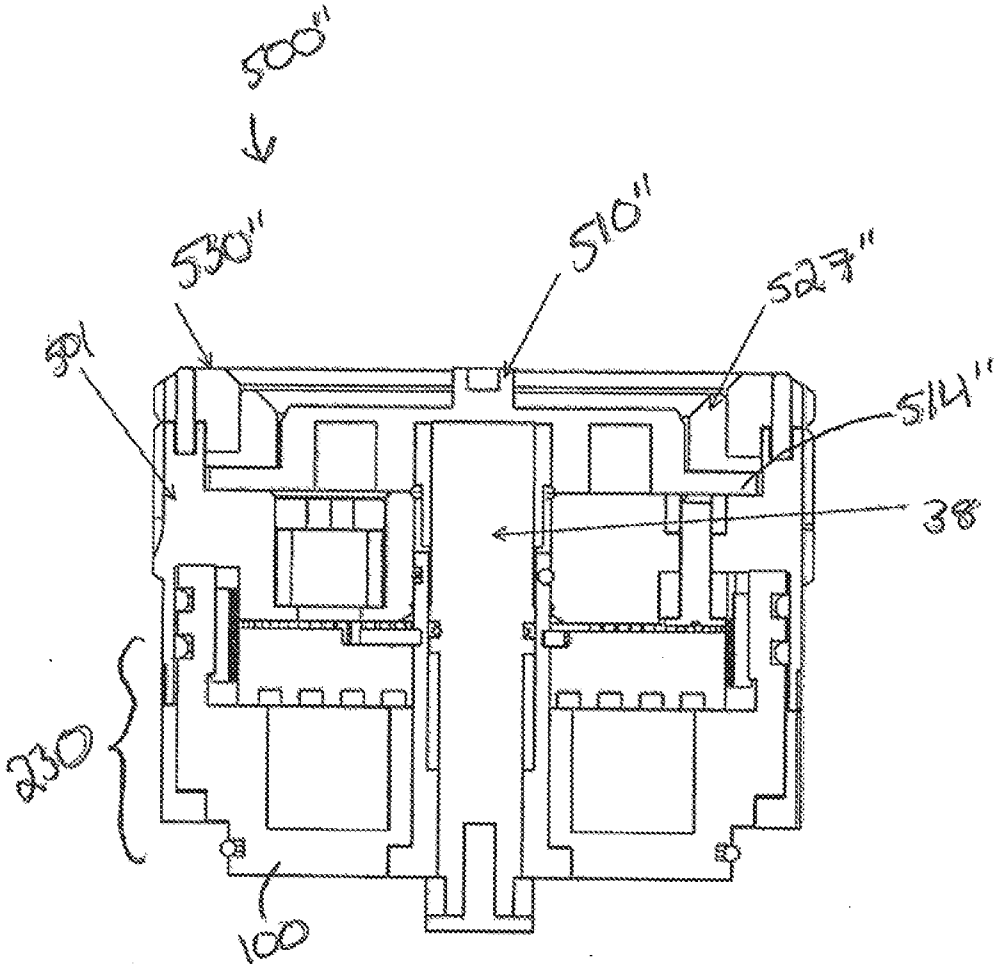


FIG. 9

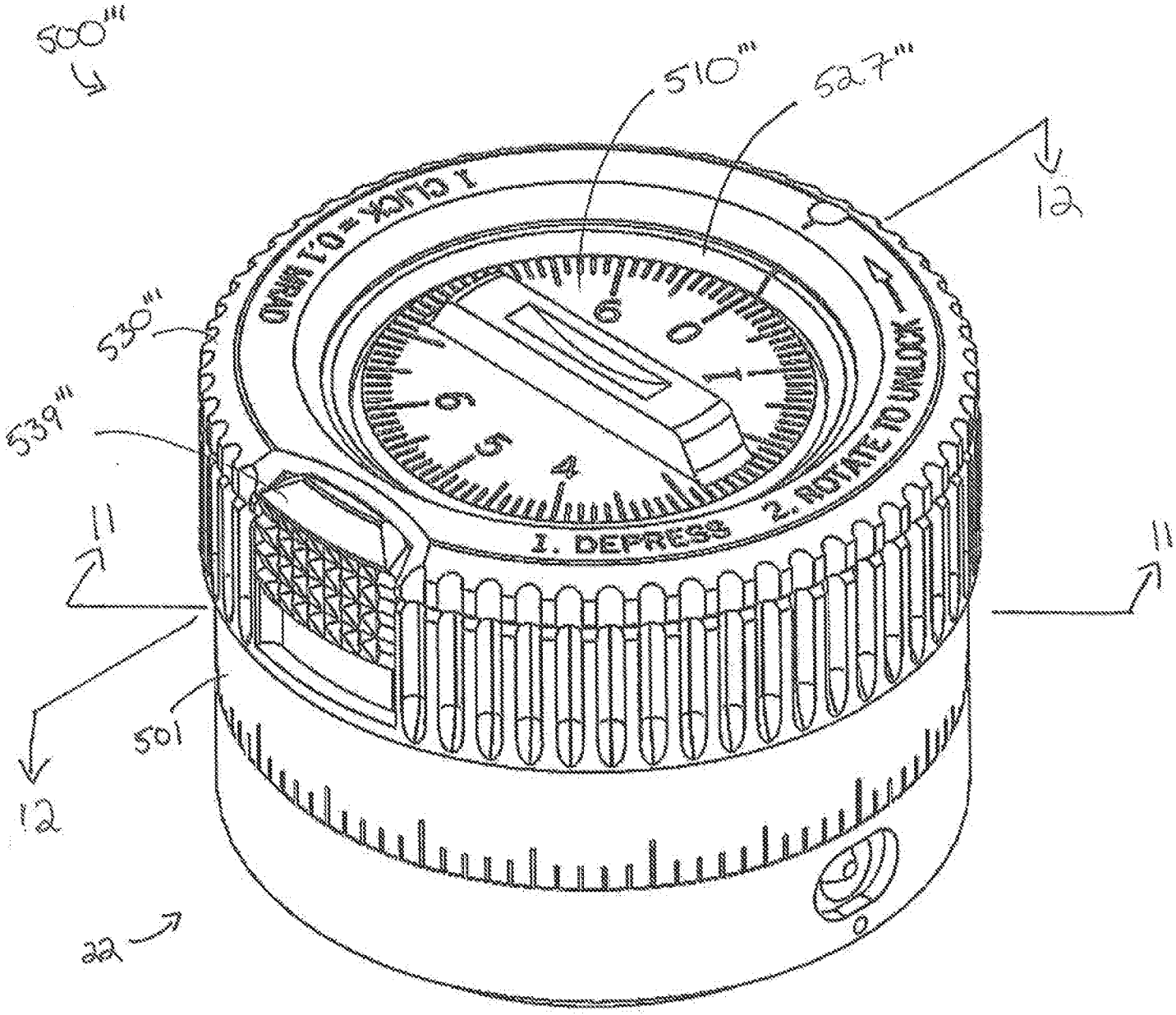

500'''
510'''
527'''
12
530'''
539'''
11
11
501
12
32
1. DEPRESS
2. ROTATE TO UNLOCK
1 CLICK = 0.1 MMO

FIG. 10

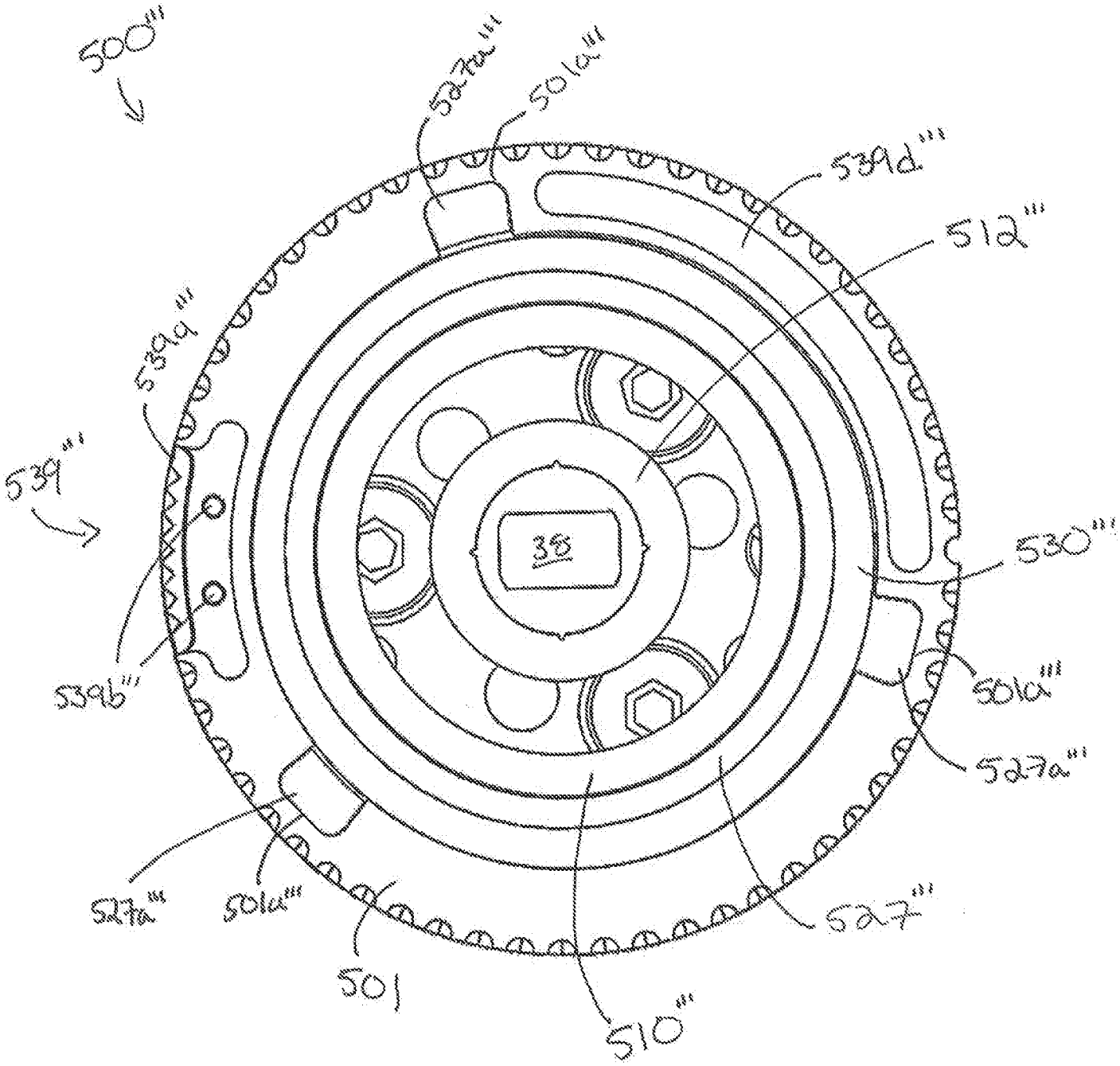

500'''
527a'''
501a'''
539d'''
512'''
539c'''
539'''
530'''
539b'''
501a'''
527a'''
527a'''
501a'''
527'''
501
510'''

FIG. 11

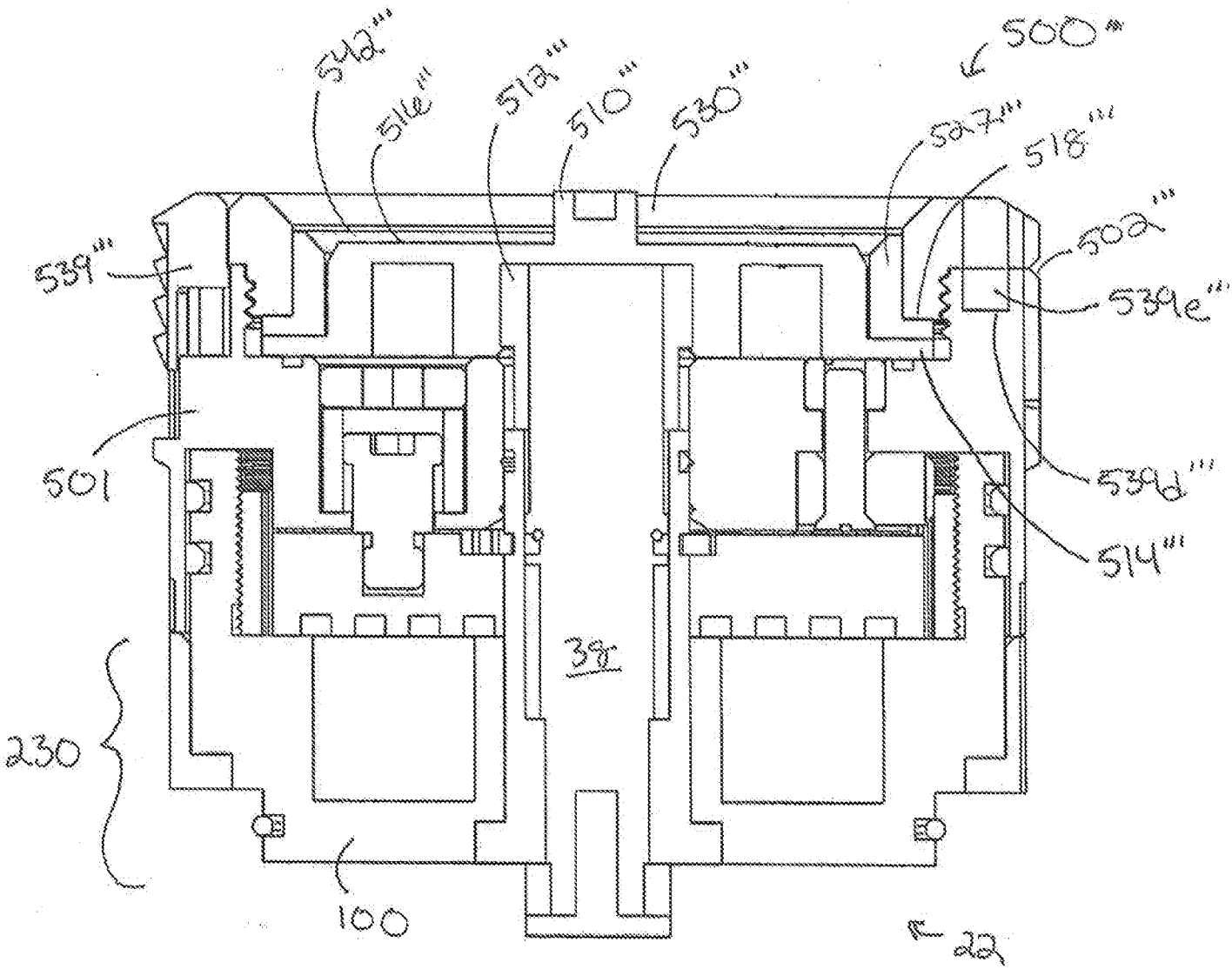

542'''
516'''
512'''
510'''
530'''
500'''
527'''
518'''
502'''
539'''
539e'''
501
539d'''
514'''
39
230
100
22

FIG. 12

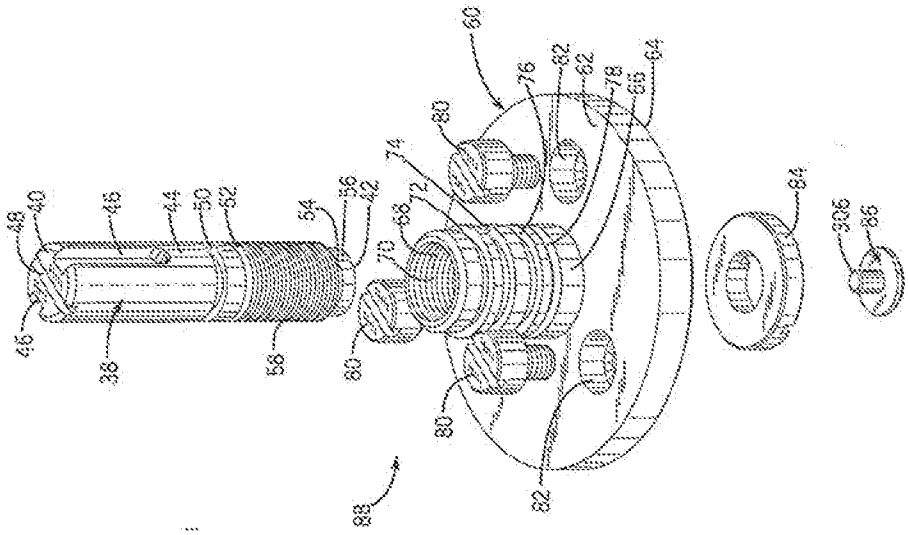

60
76
82
62
78
66
64
80
74
72
68
70
84
86
48
40
46
44
50
52
54
56
42
46
38
58
60
80
82
88

FIG. 13

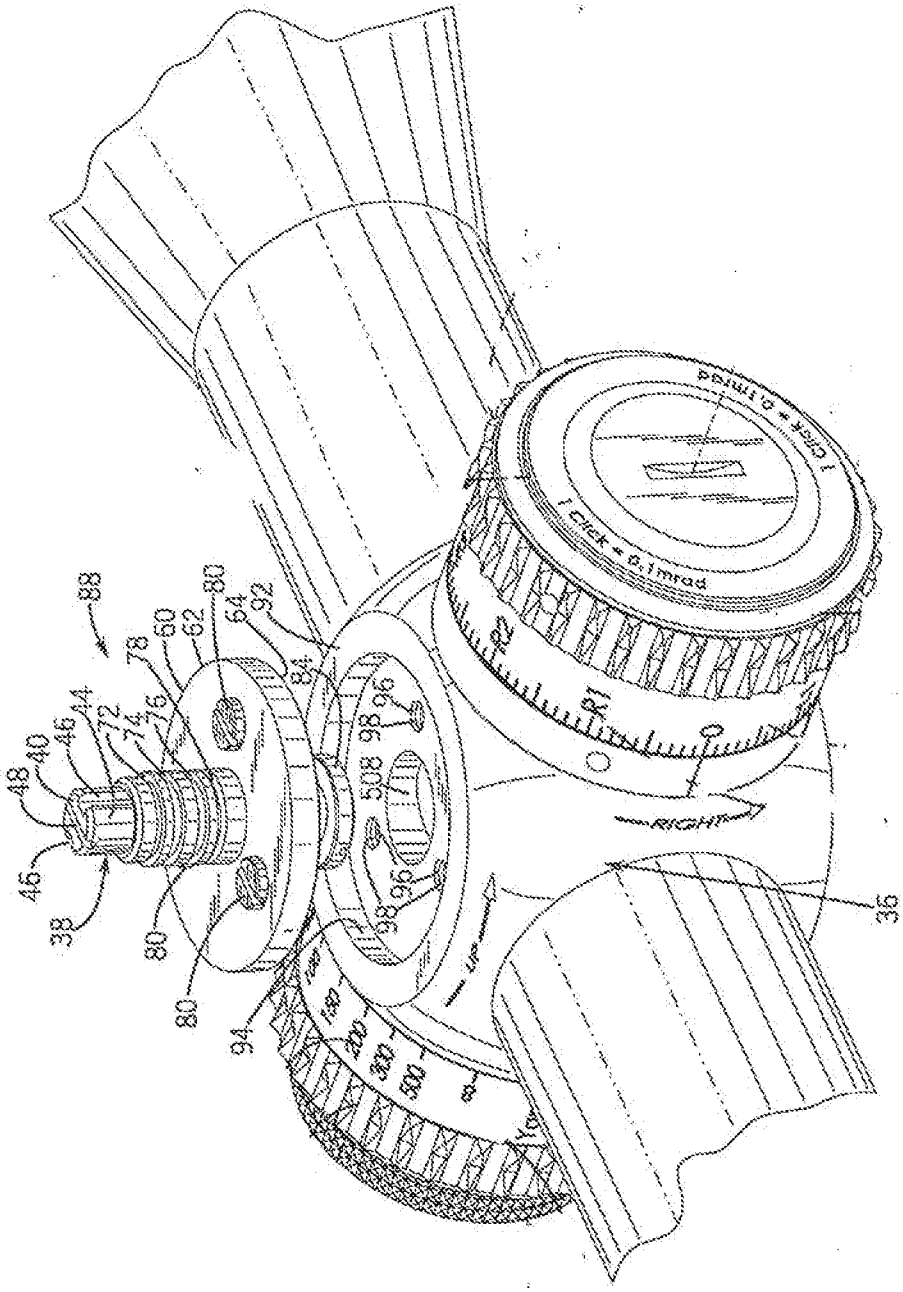

88
80
64
92
60
62
78
84
44
72
74
76
40
46
48
96
98
508
46
38
80
80
94
36
1 Click = 0.1mrad
1 Click = 0.1mrad

FIG. 14

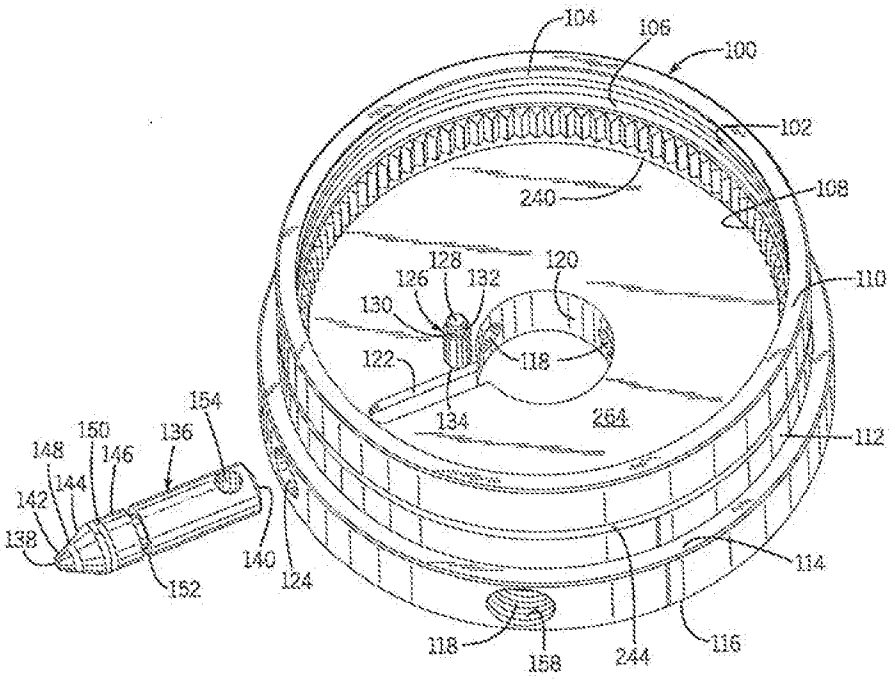
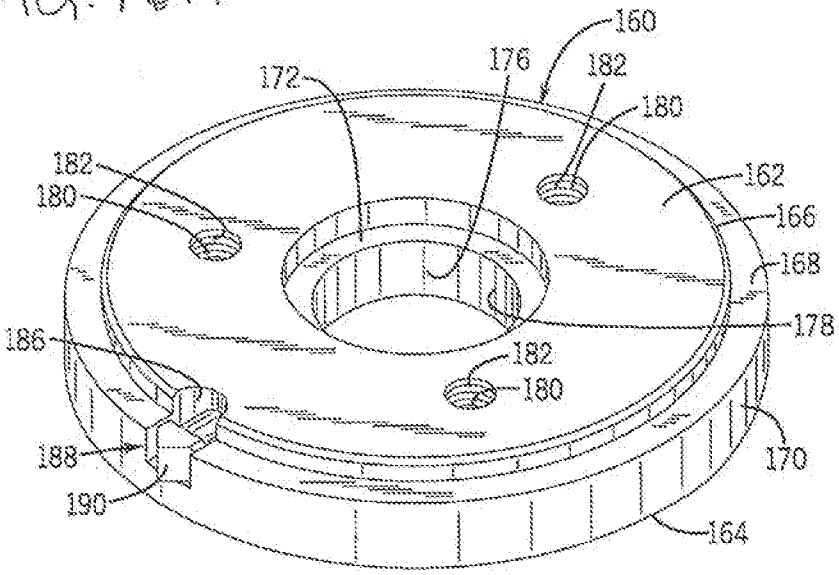

104
106
100
102
240
108
128
120
126
132
110
130
122
118
134
264
112
154
150
136
148
146
144
142
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114
118
158
244
116

FIG. 15

FIG. 16A



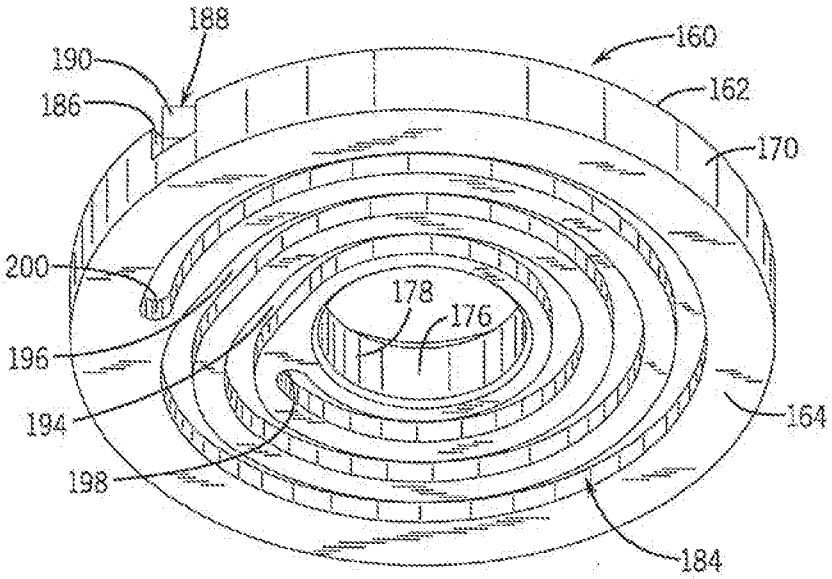


FIG. 16B

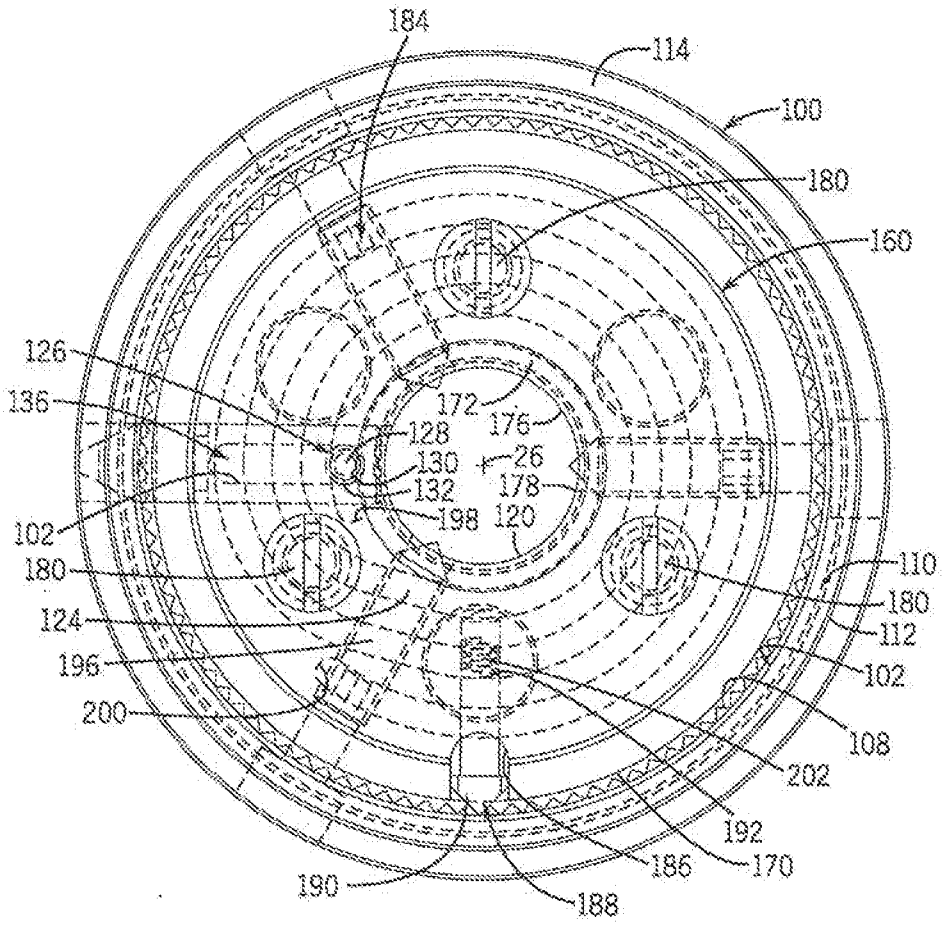

184
114
100
180
160
126
136
172
176
128
130
26
132
178
198
120
102
180
110
180
124
112
196
102
200
108
202
192
186
170
190
188

FIG. 17

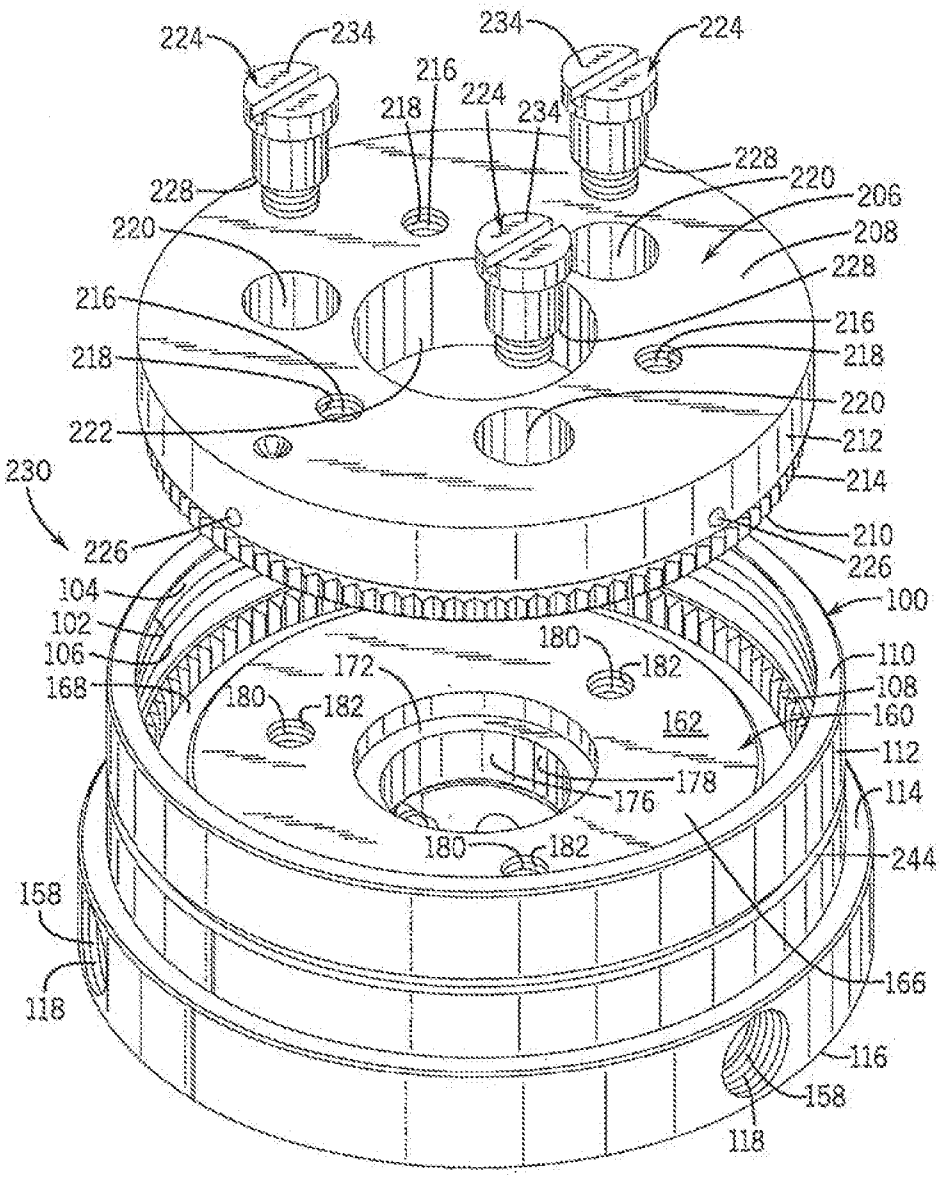

224
234
216
218
224
234
234
224
228
220
206
208
228
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222
212
214
230
226
210
226
104
102
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168
100
180
182
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118
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182
166

FIG. 18A

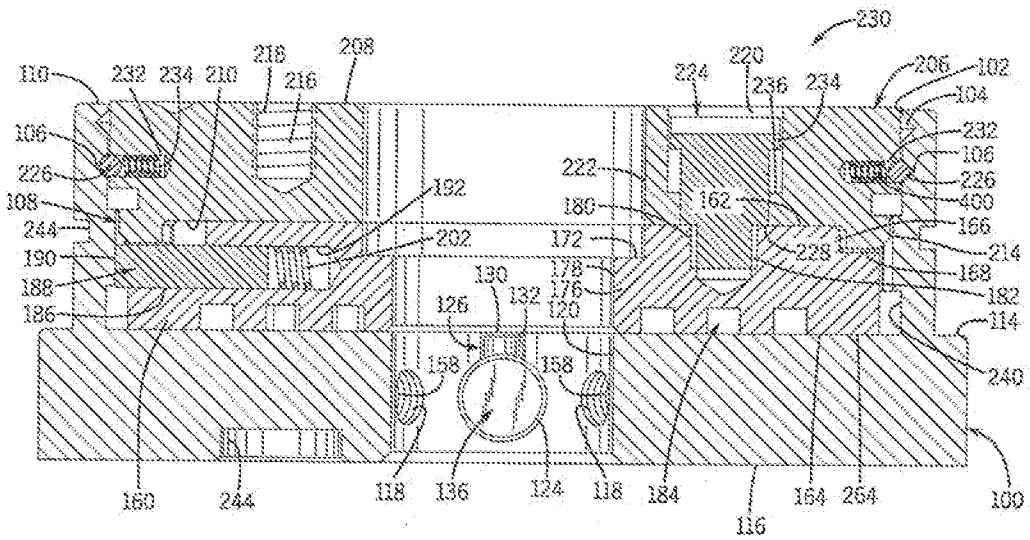
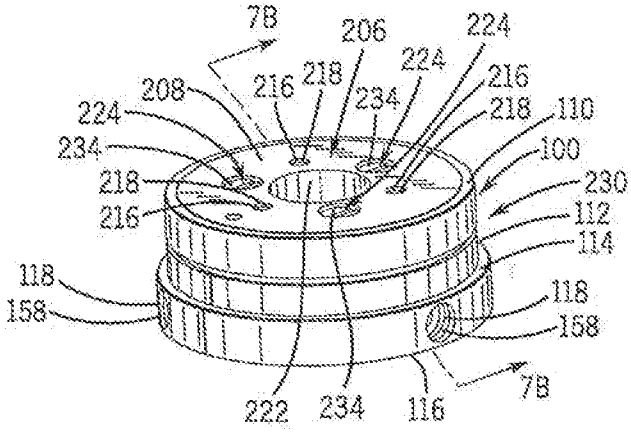

230
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232
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210
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216
208
220
224
236
234
206
102
104
232
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226
400
166
214
168
182
114
240
106
226
108
244
190
188
186
192
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222
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162
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160
244
118
136
124
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184
116
164
264
100

FIG. 18B


7B
206
224
224
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216
218
234
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218
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224
234
100
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230
216
112
114
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158
222
234
116
7B

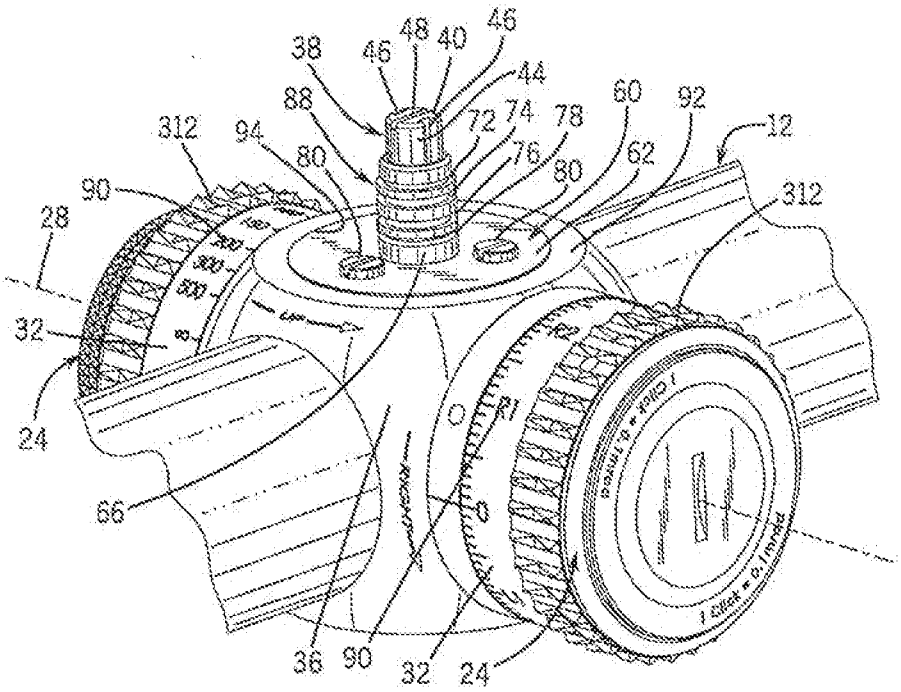

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24

FIG. 19A

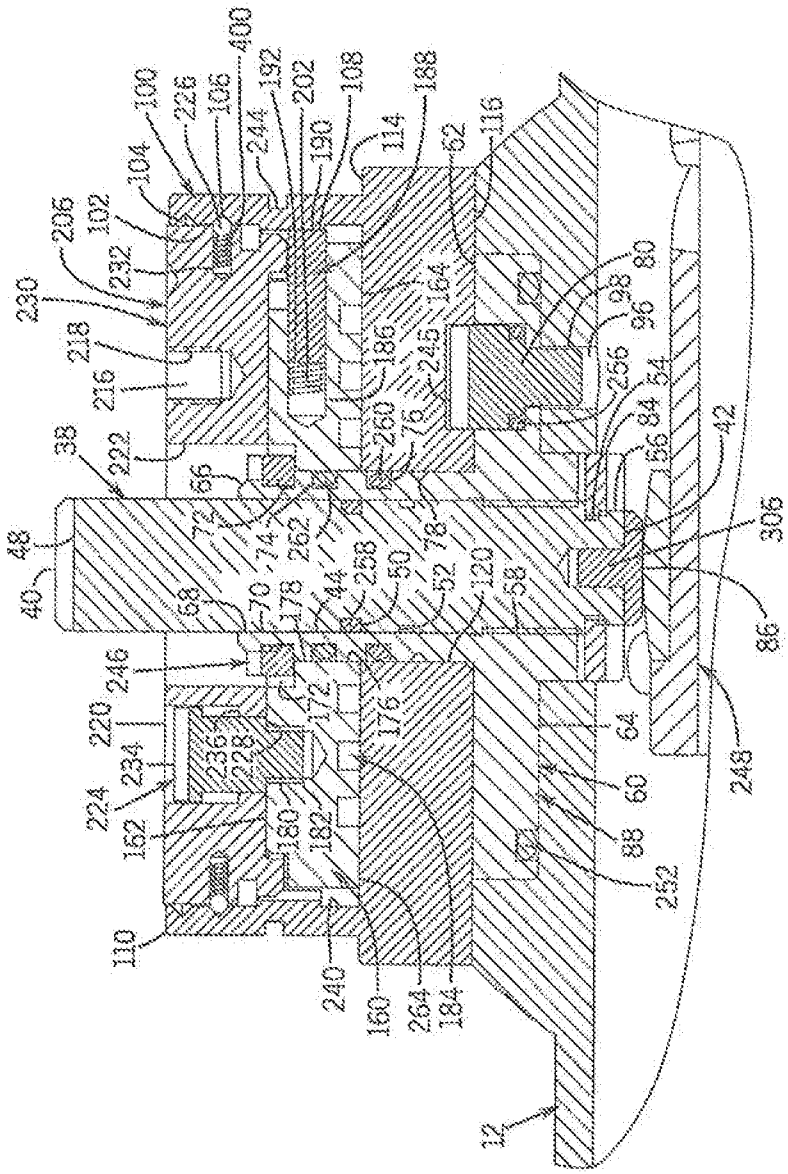

400
192
202
108
188
100
226
106
244
190
114
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104
102
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232
230
218
216
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245
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256
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260
76
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178
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64
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248
234
236
228
224
60
162
180
182
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252
110
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160
264
184
12

FIG. 19B