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(54) HUB SYSTEM, METHOD AND DEVICE WITH ADJUSTABLE DEADBAND

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(57) **ABSTRACT**

A freewheel hub having a non-zero deadband distance in order to reduce or eliminate pedal kickback. The deadband distance is able to have or be adjusted to a desired length including lengths that enable silent freewheeling operation where the pawls of the freewheel body do not engage or contact the teeth of the ratchet gear thereby eliminating any contact-based freewheeling sound.

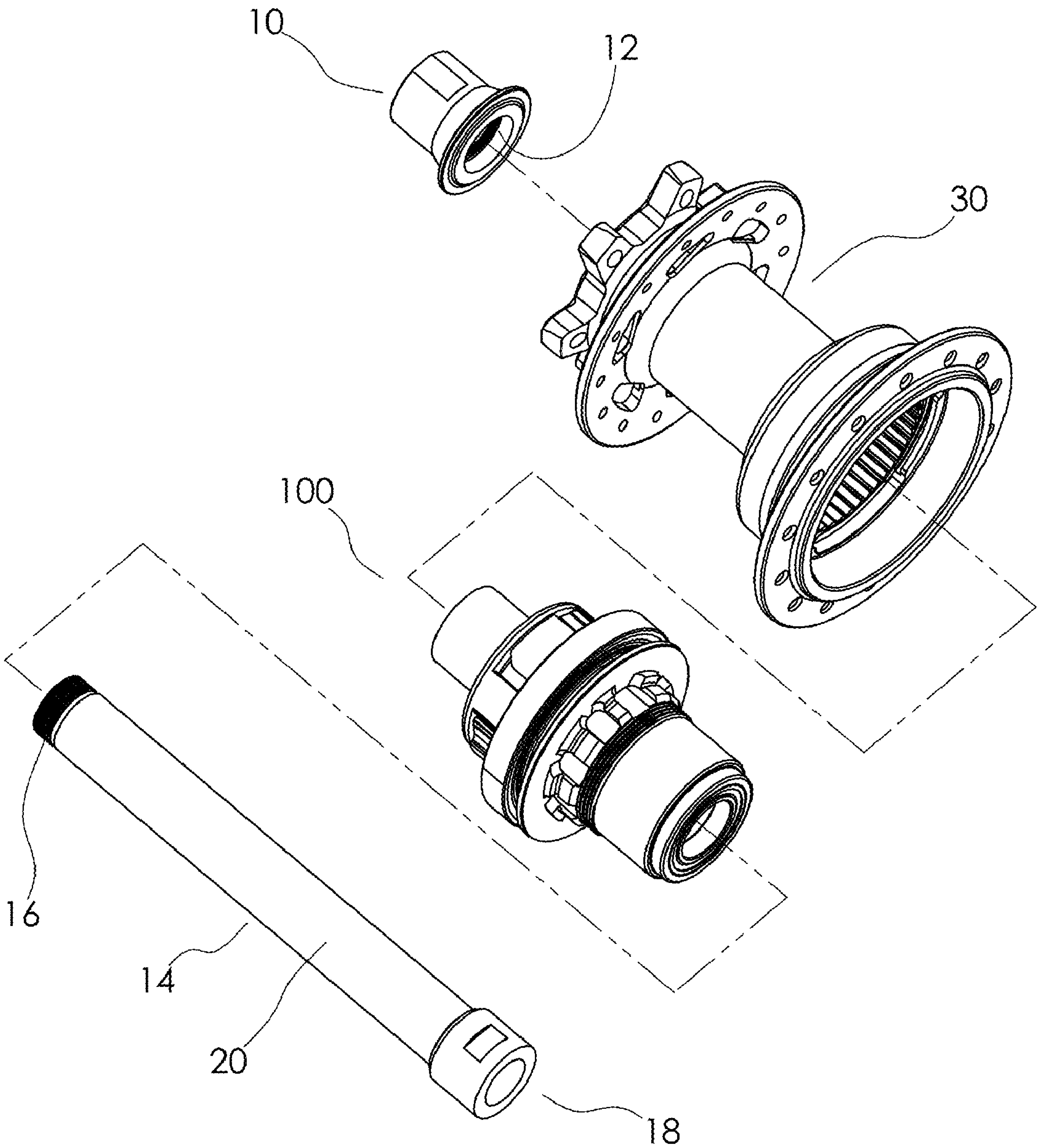


Fig. 1

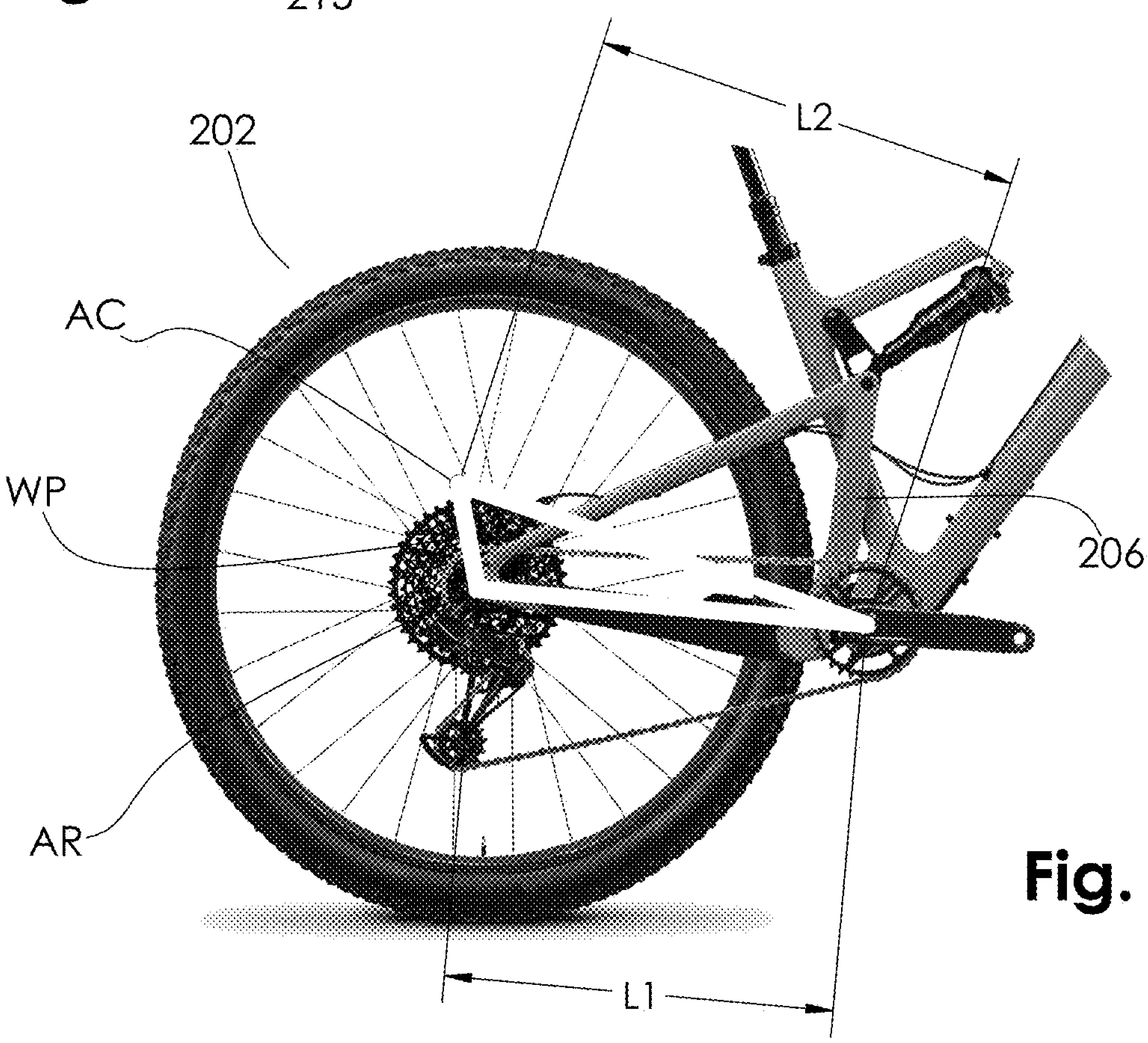


Fig. 2

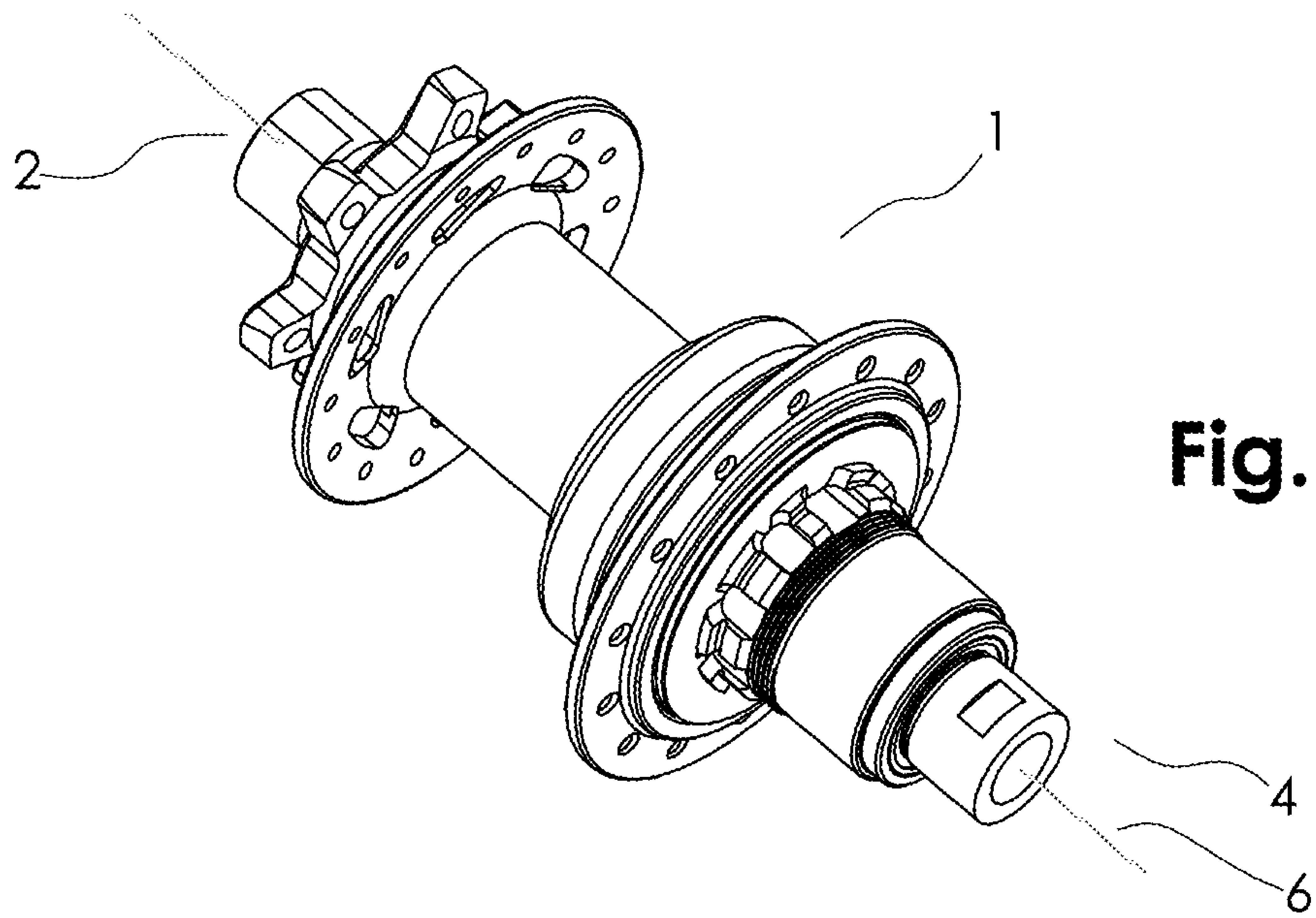


Fig. 3

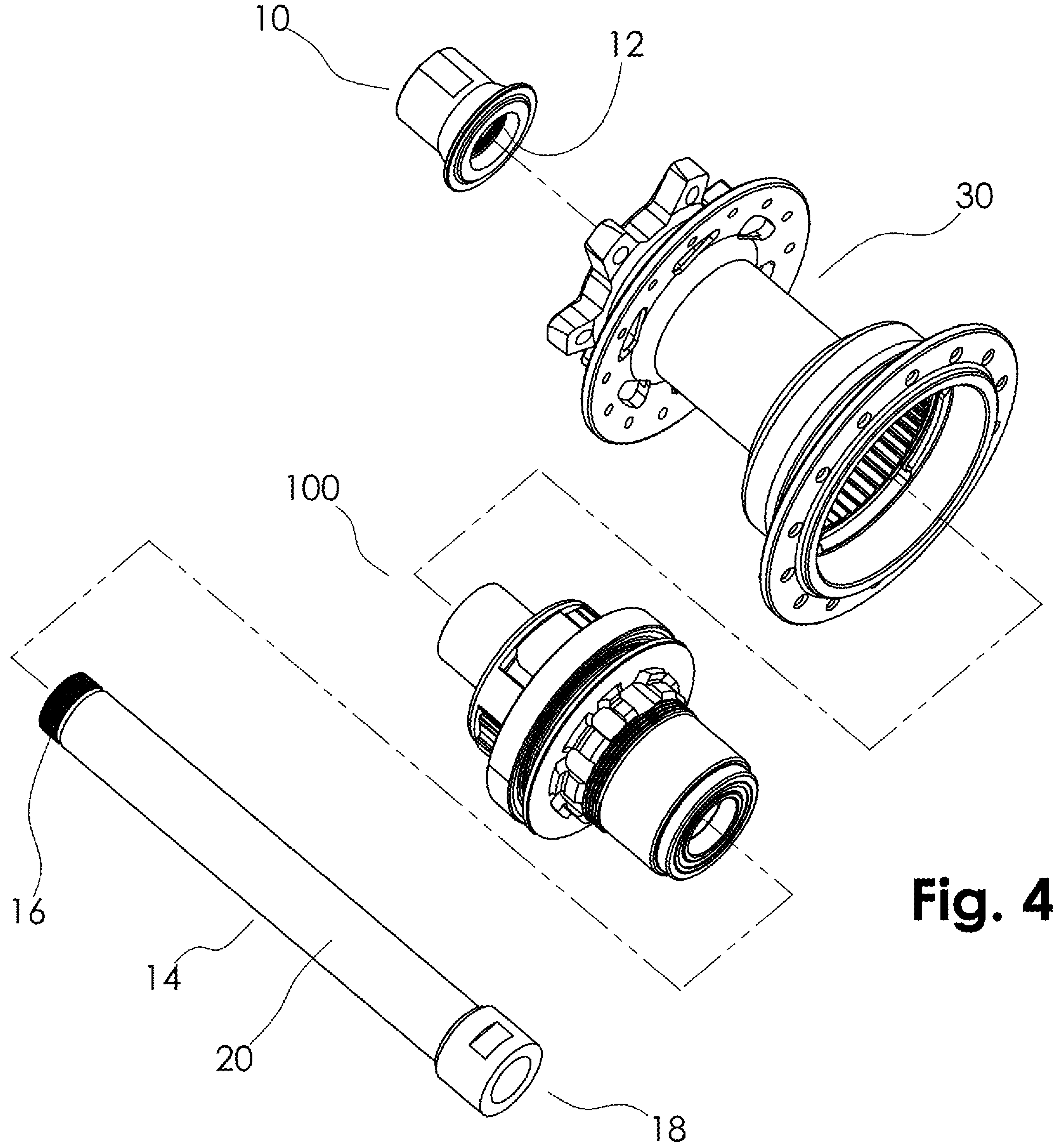


Fig. 4

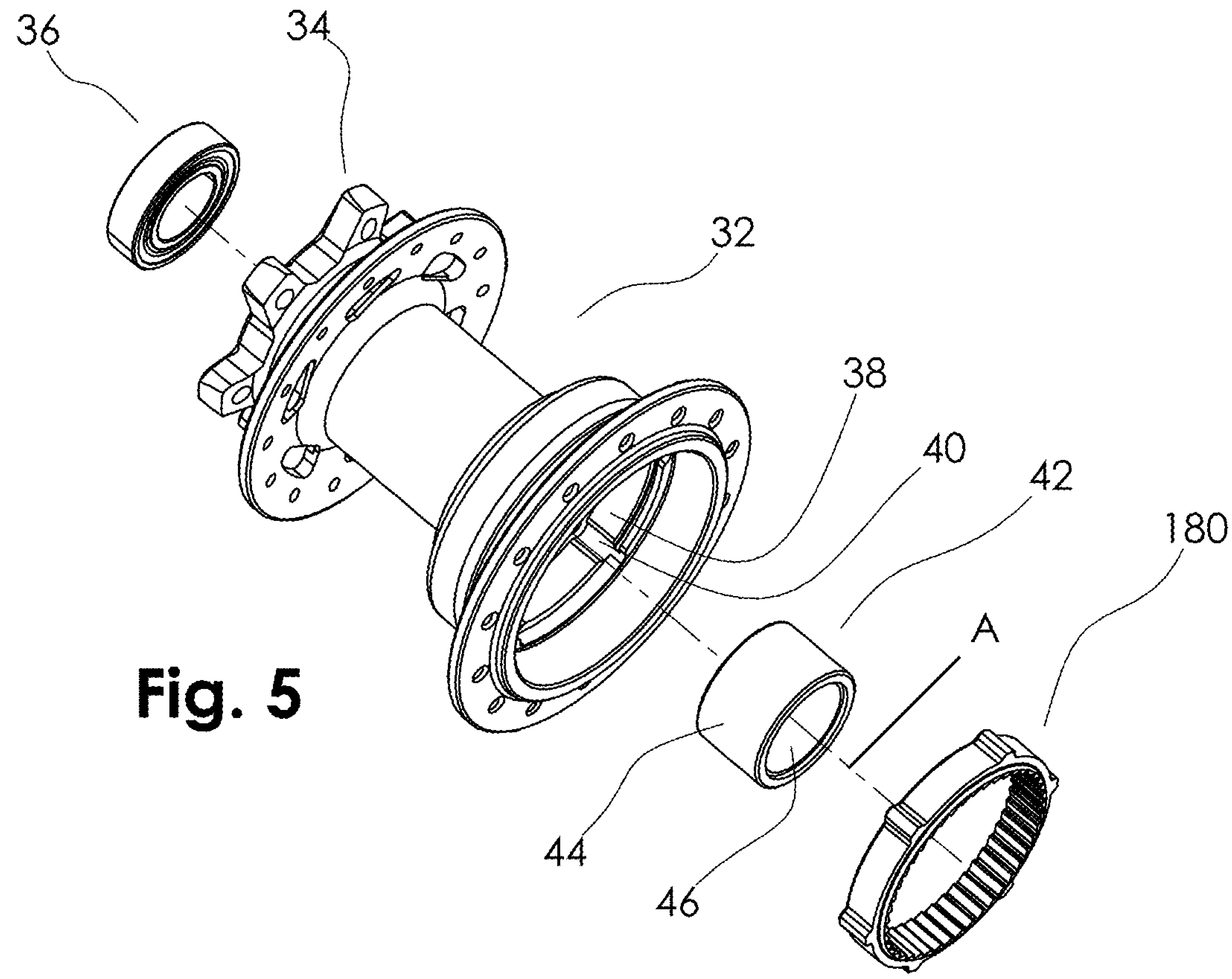


Fig. 5

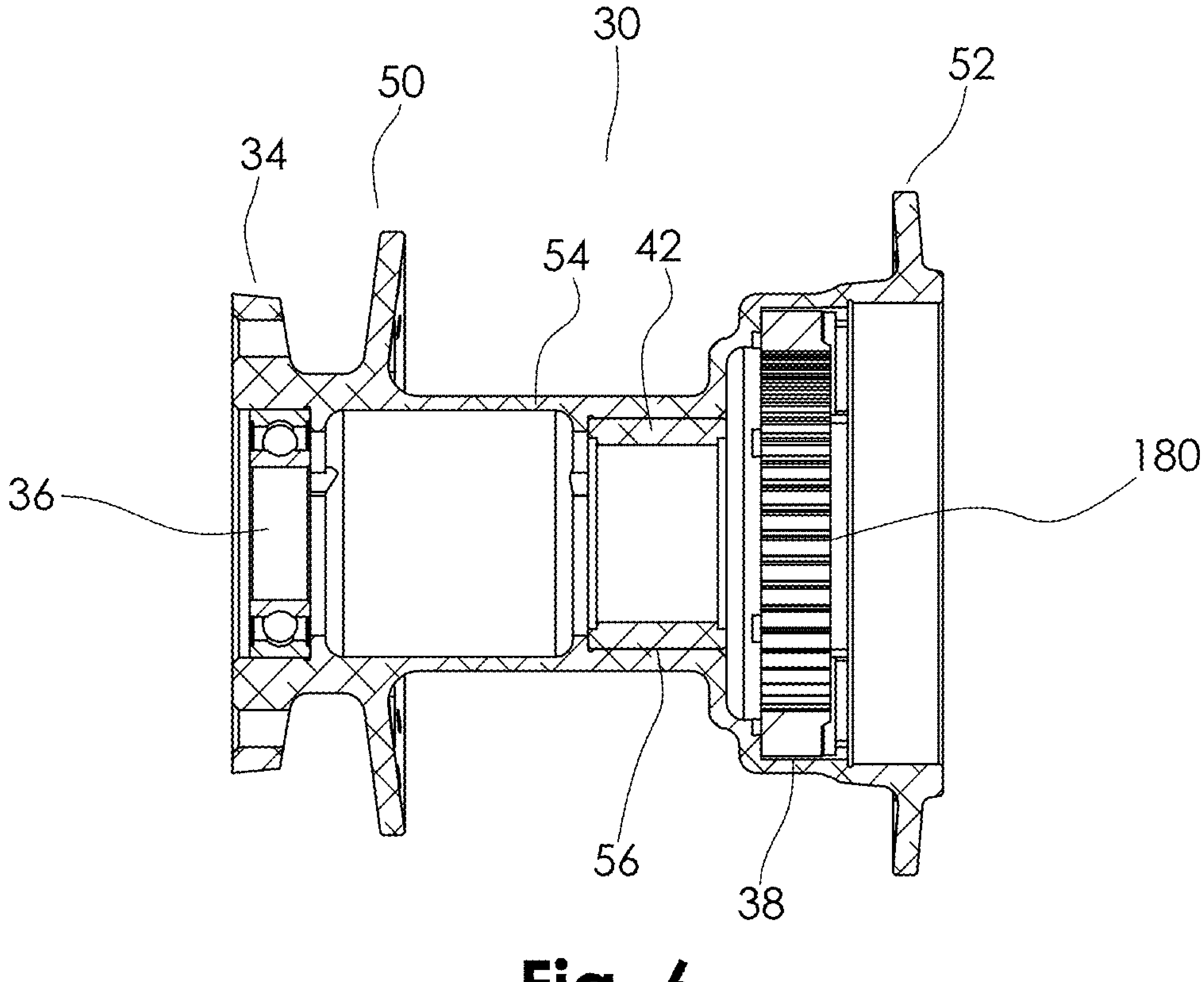


Fig. 6

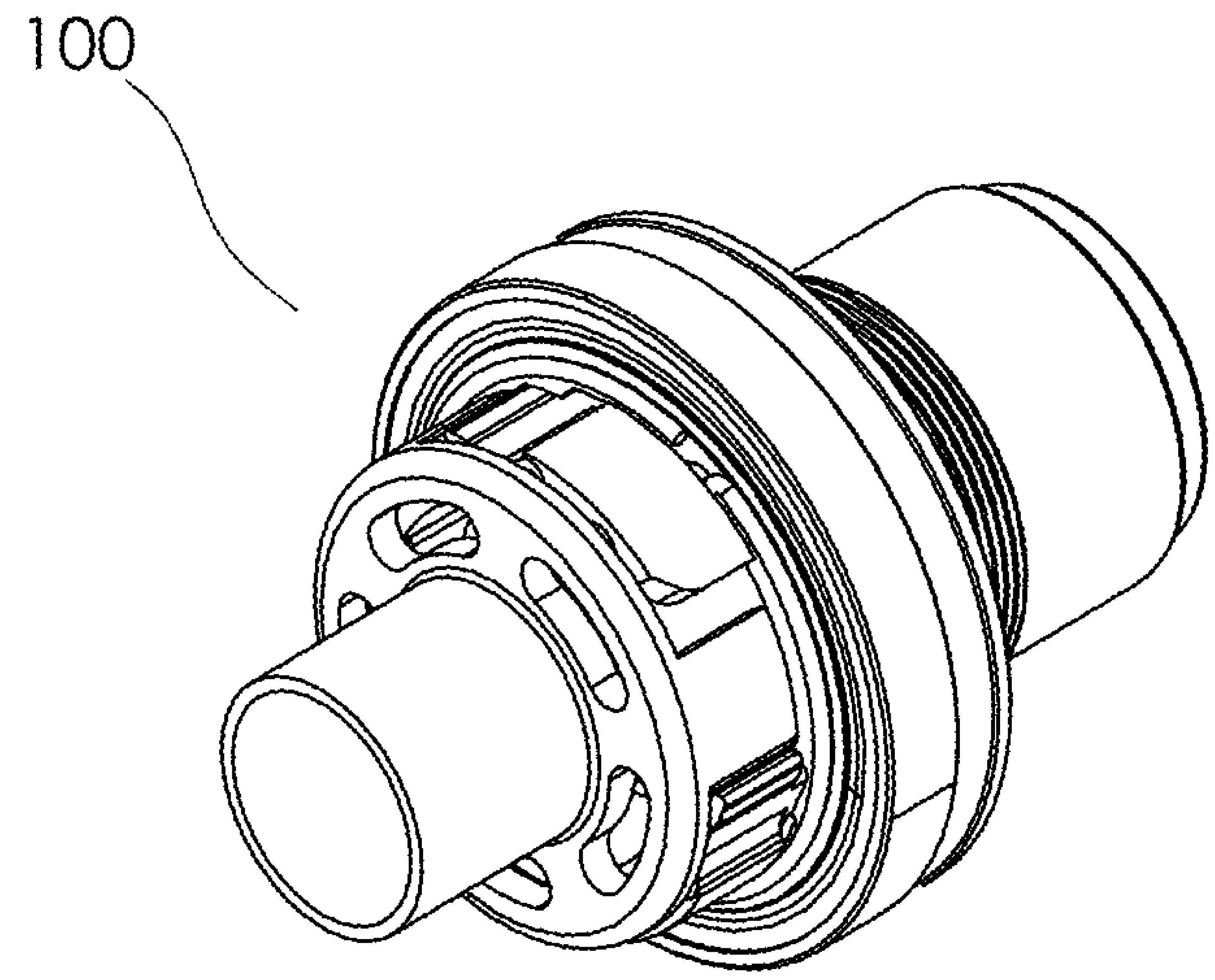


Fig. 7

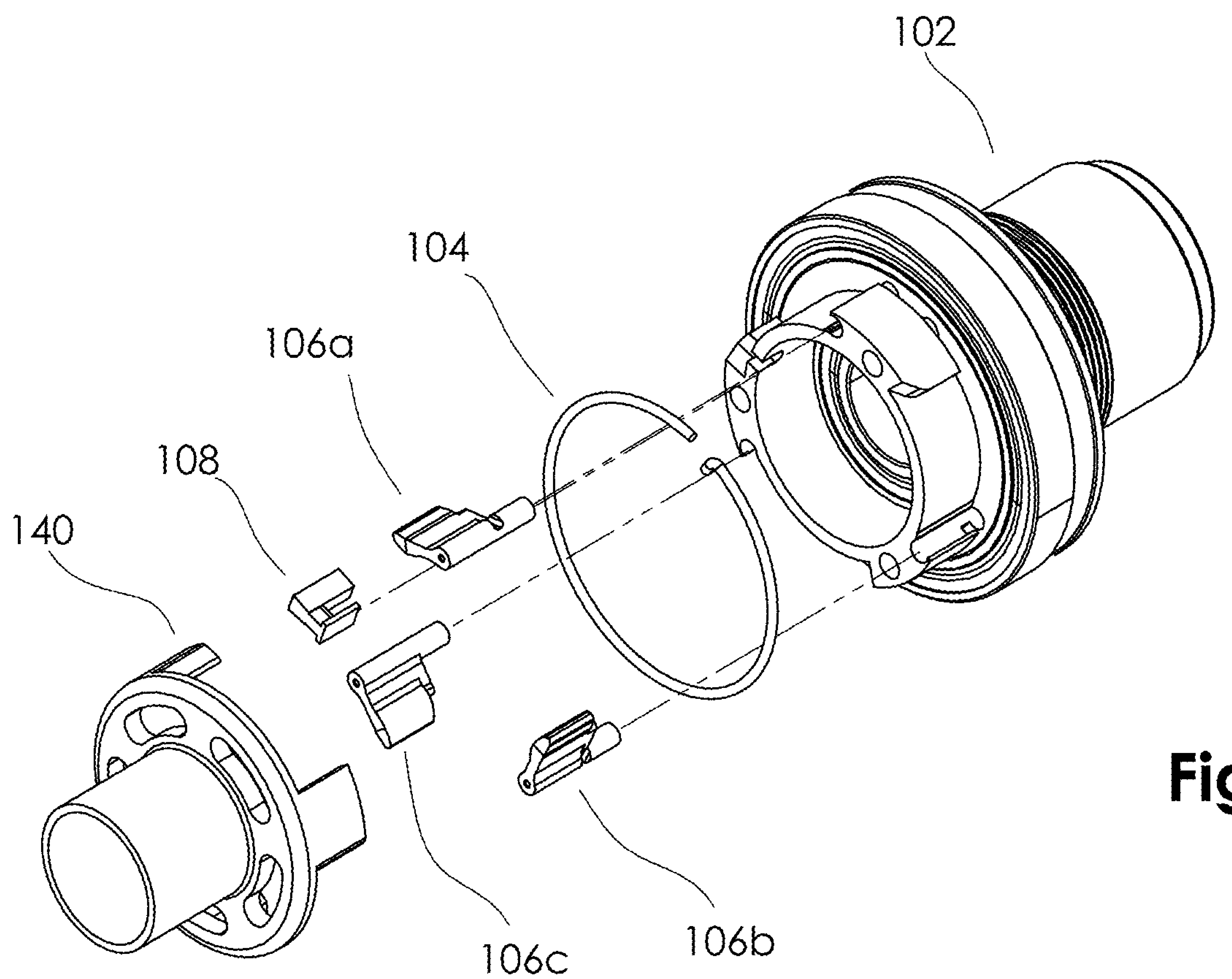
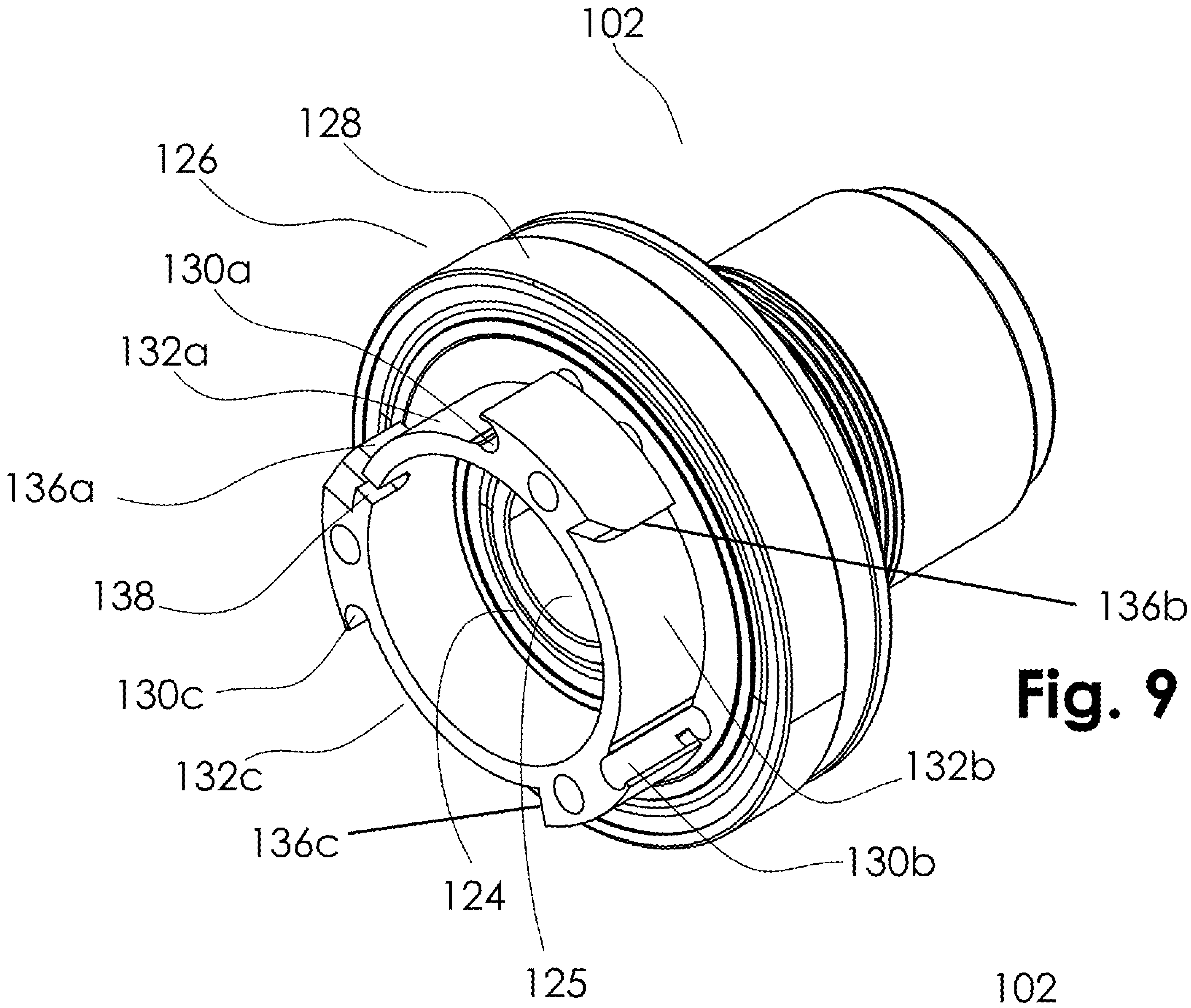


Fig. 8


102
128
126
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132a
136a
138
130c
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124
125
136b
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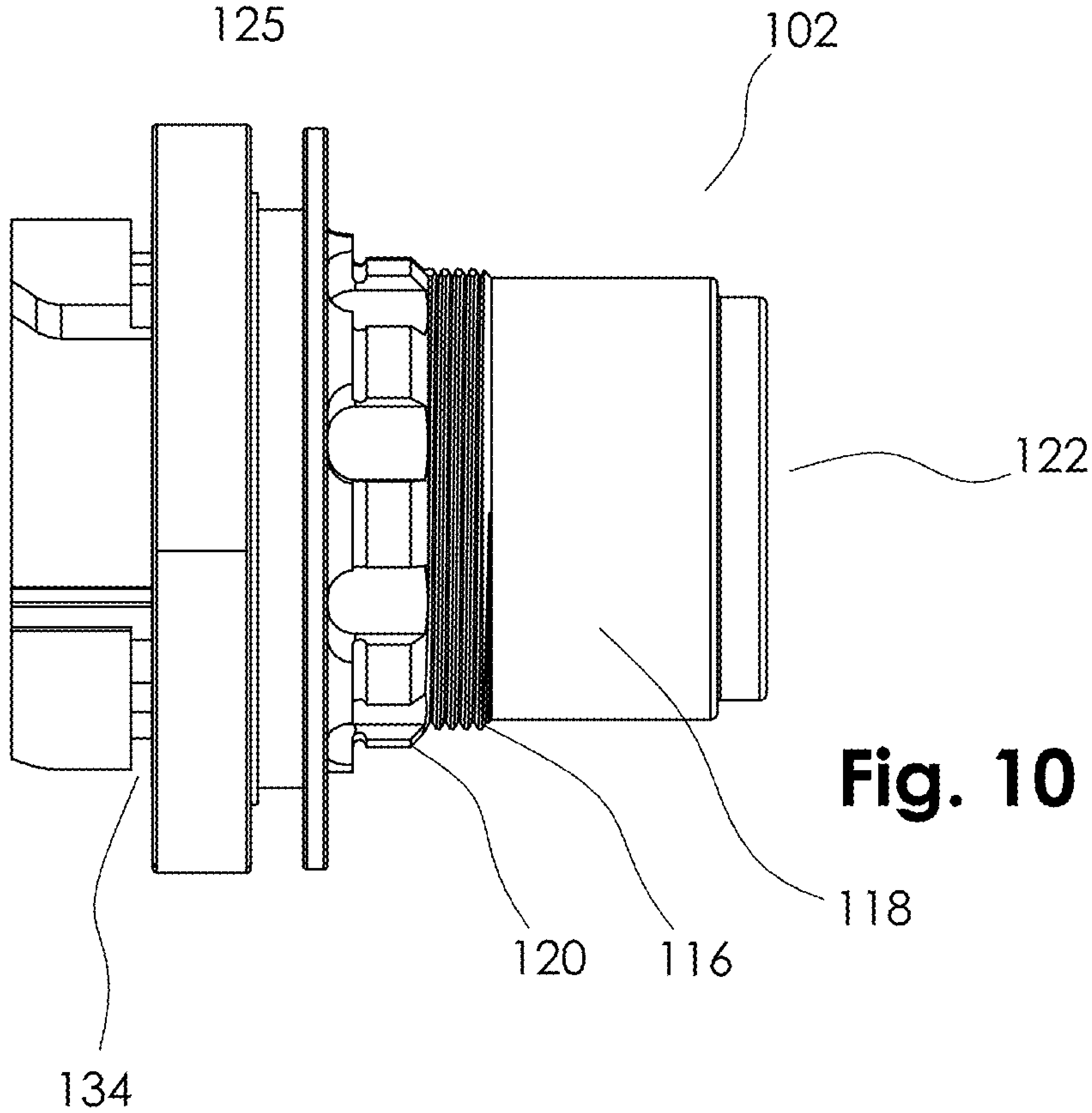
Fig. 9


102
122
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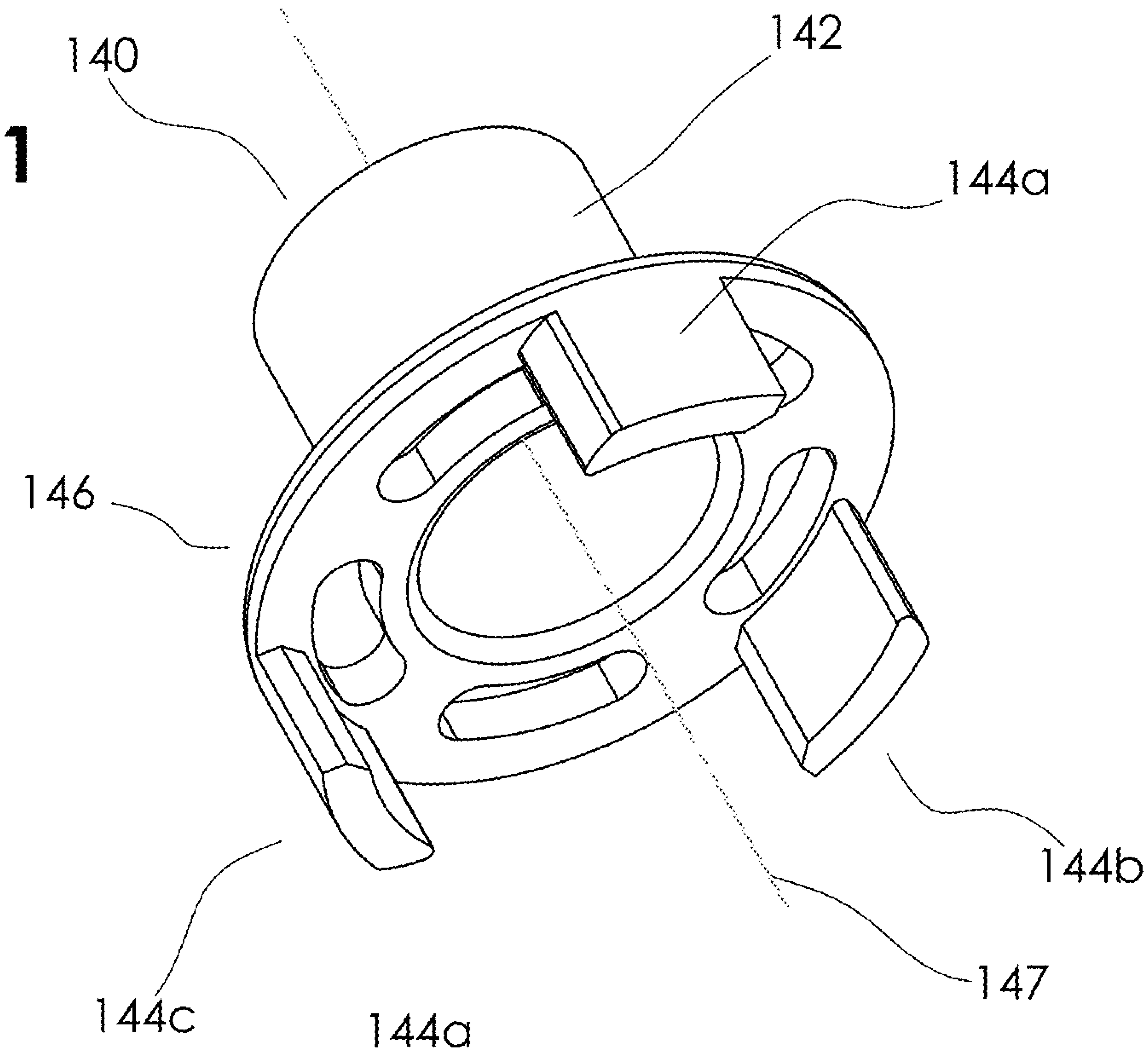
120
116
118

Fig. 10

Fig. 11



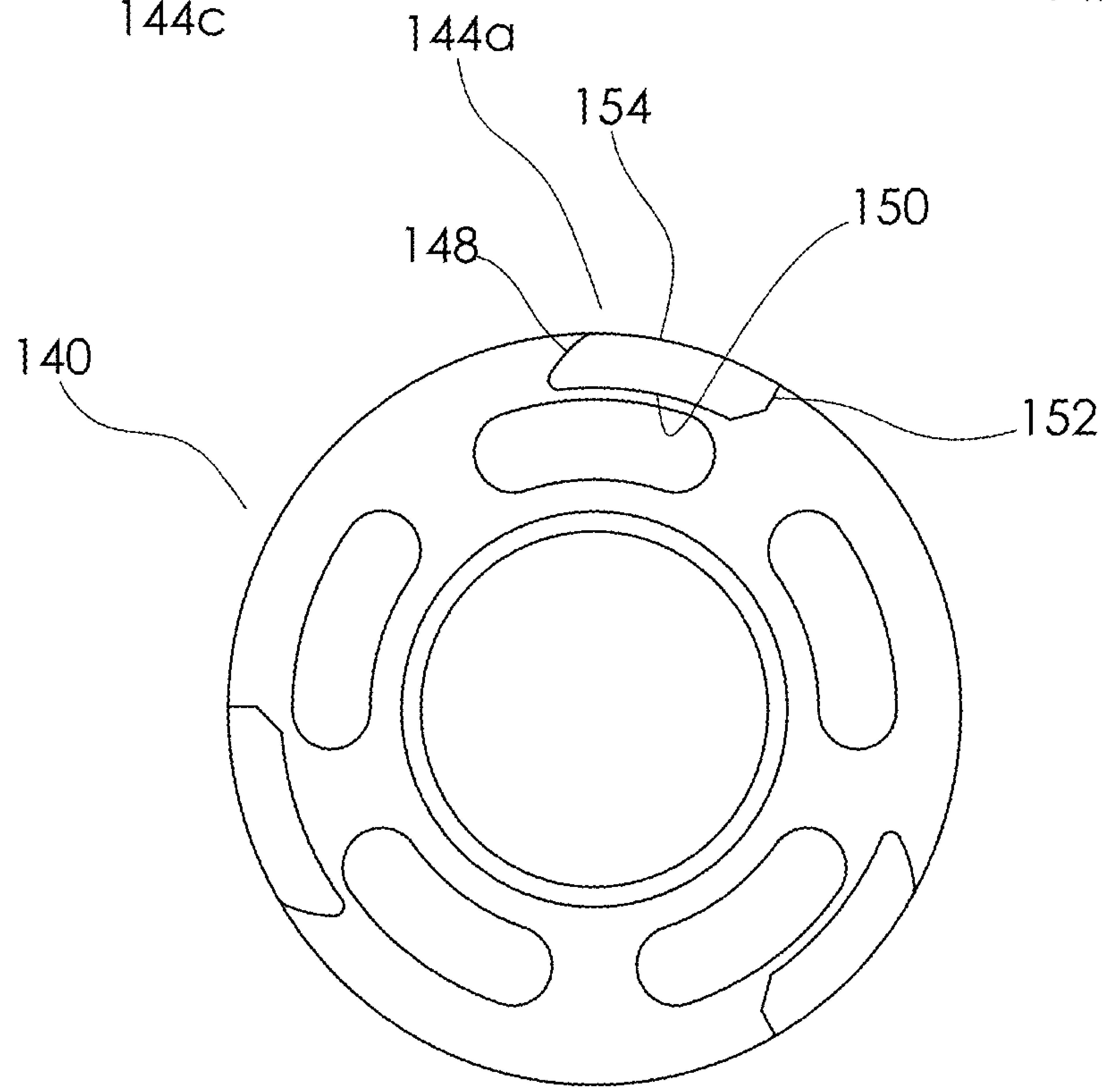


Fig. 12

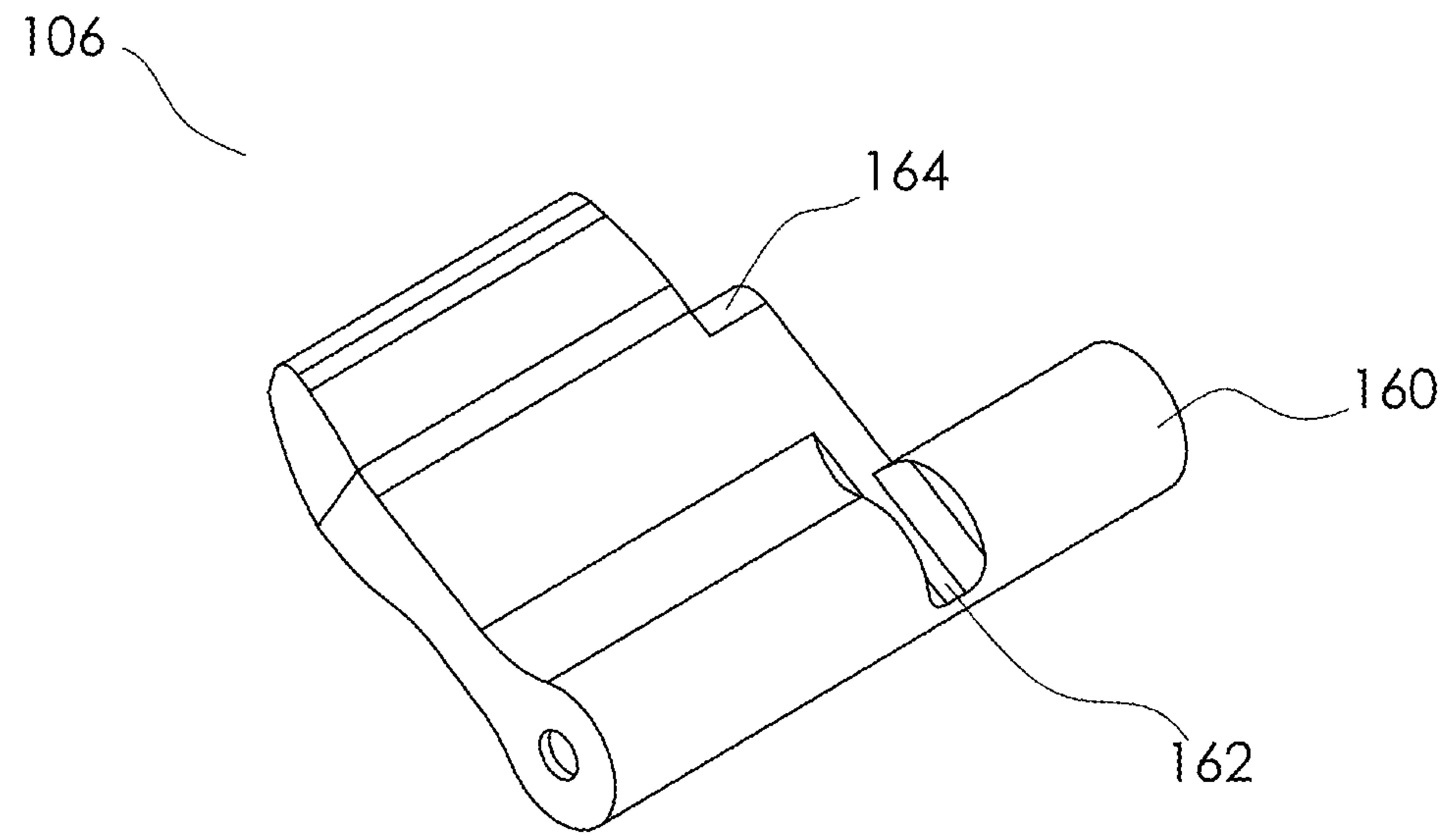


Fig. 13

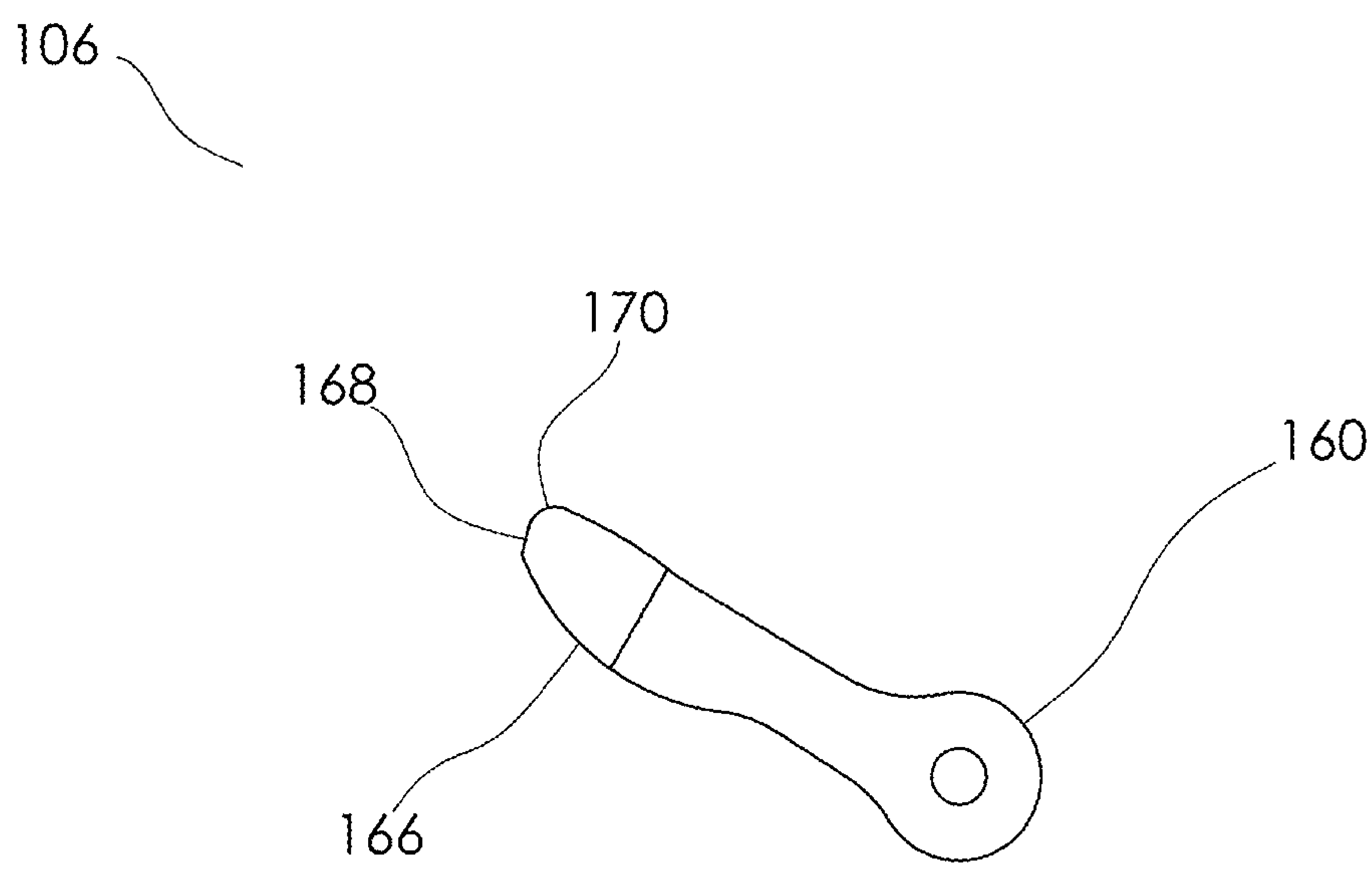


Fig. 14

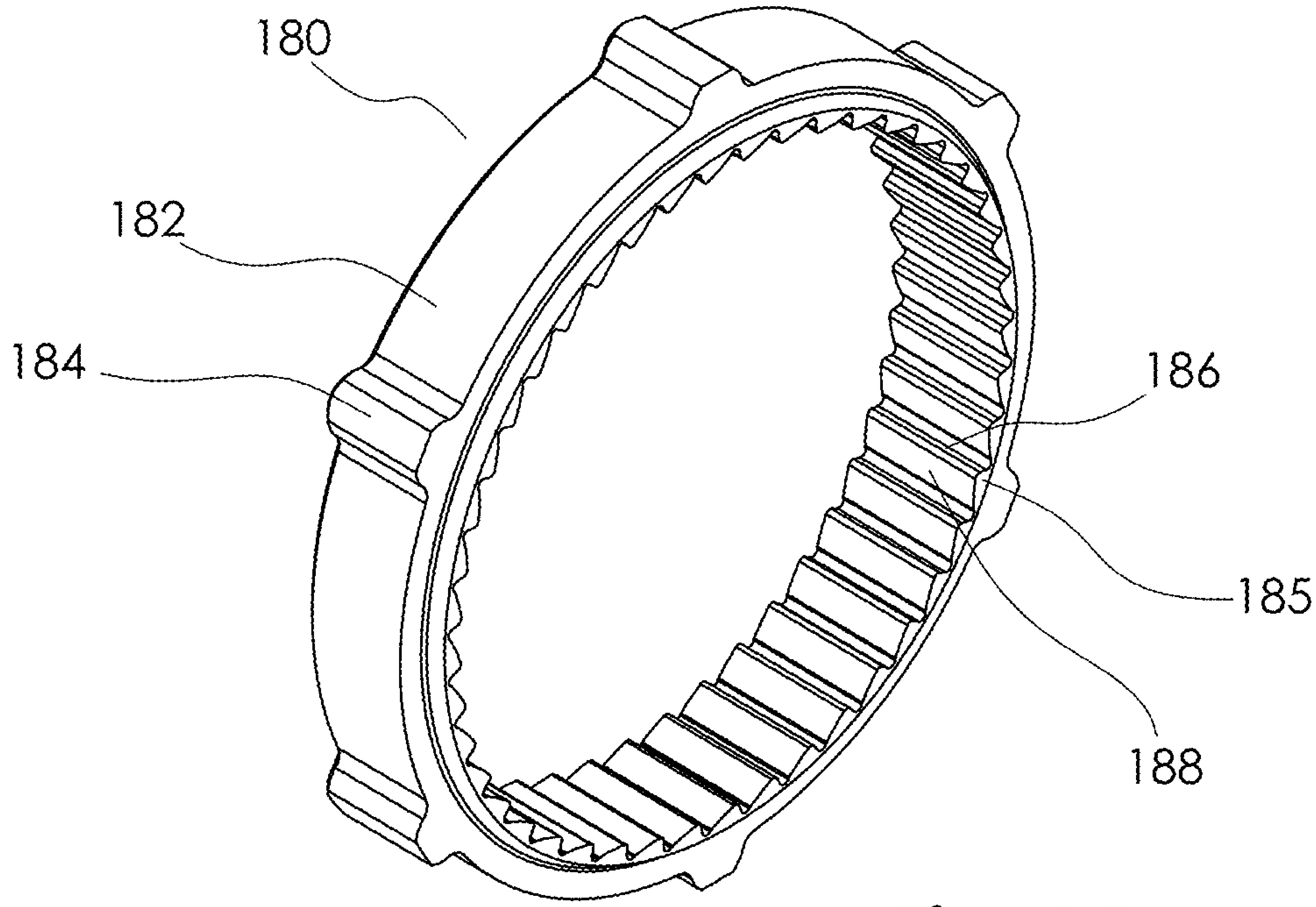


Fig. 15

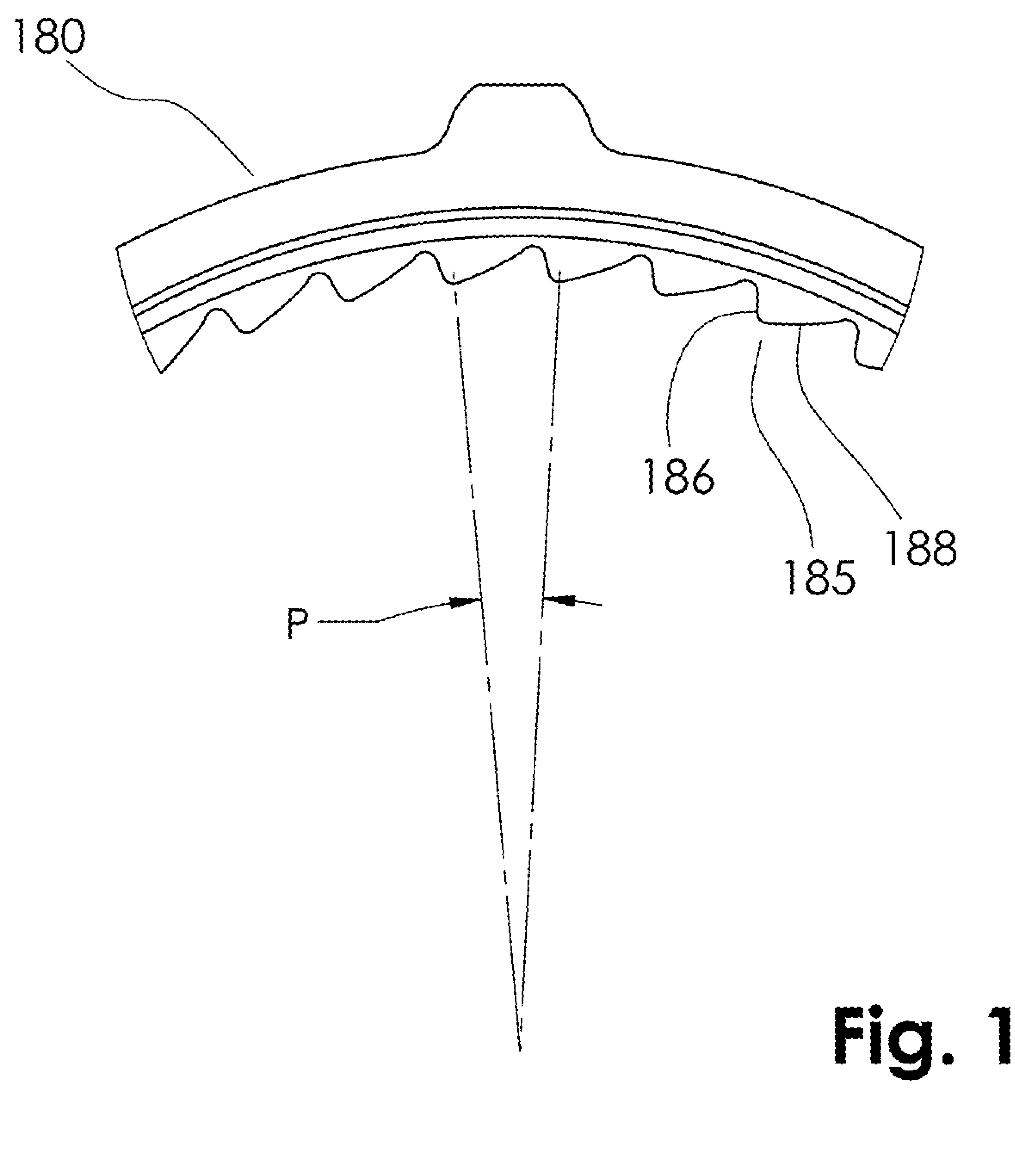


Fig. 16

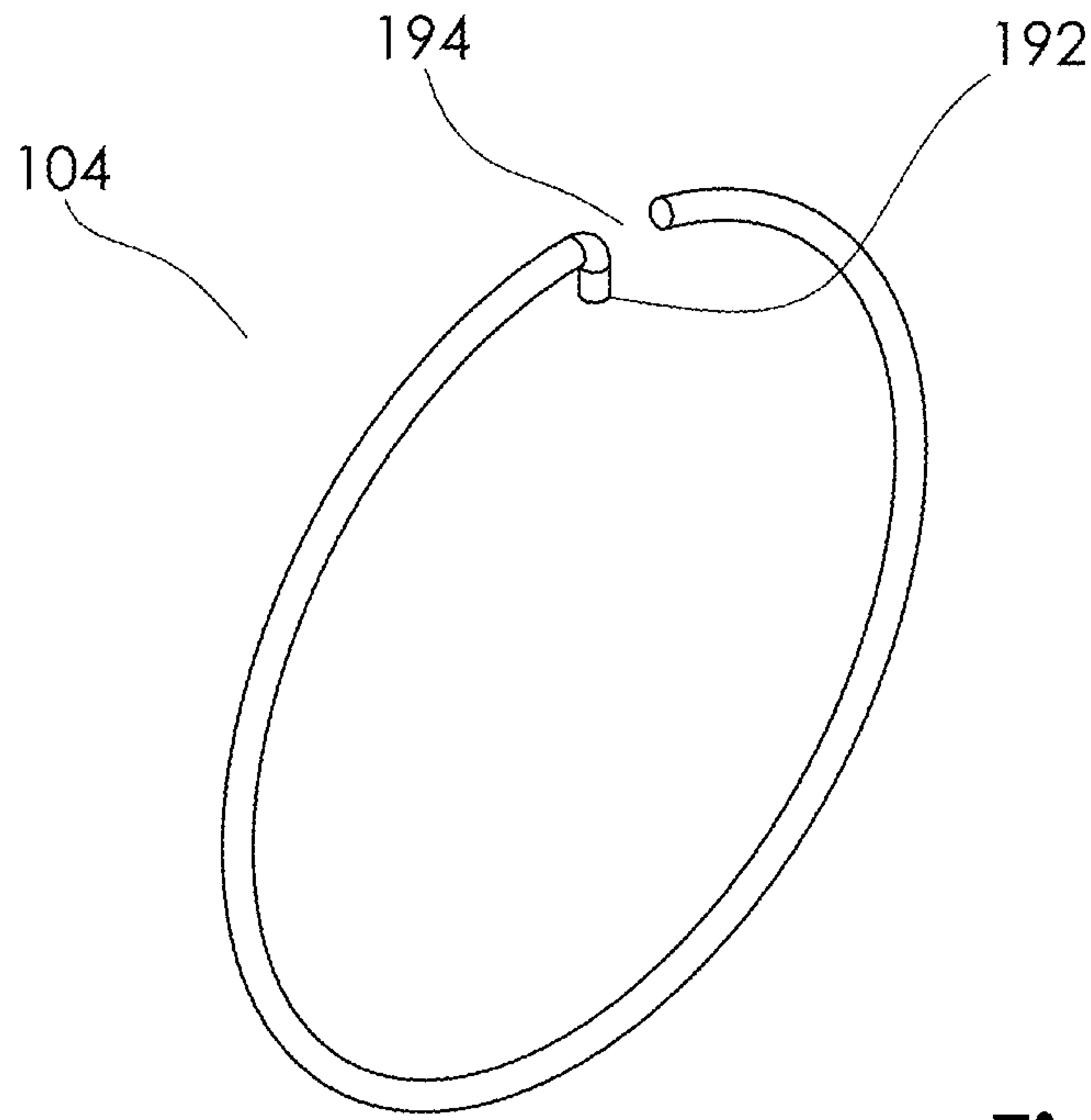


Fig. 17

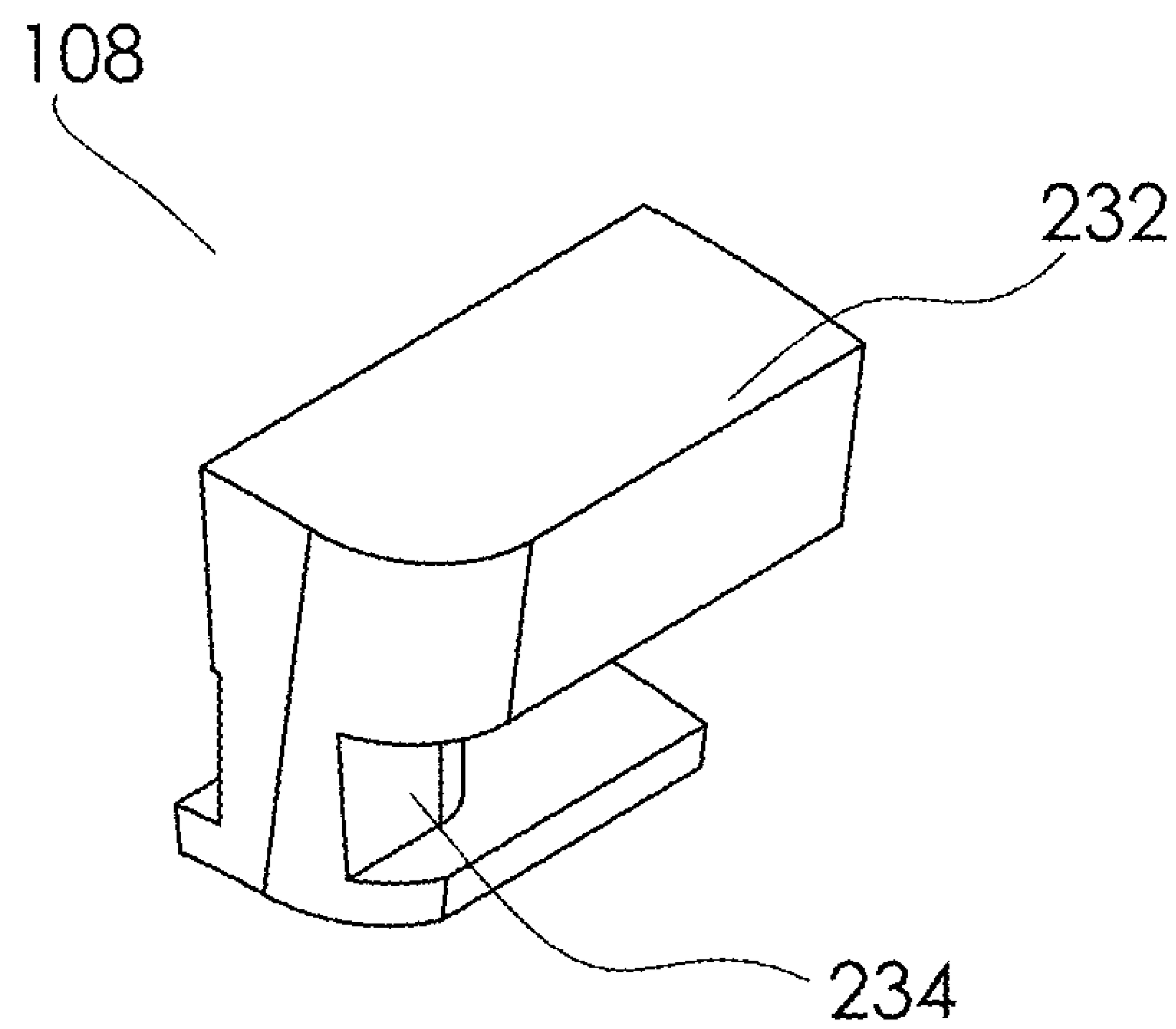


Fig. 18

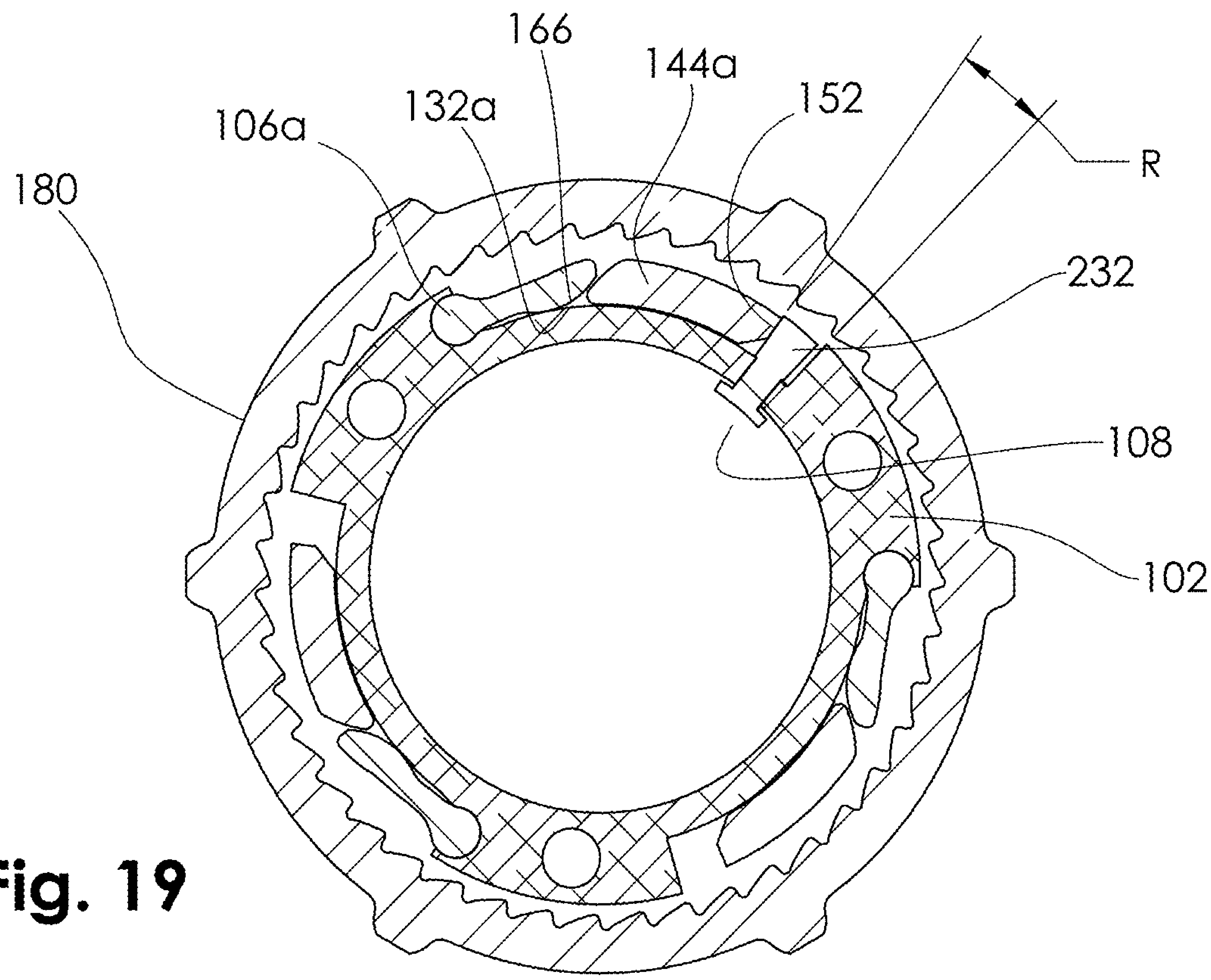


Fig. 19

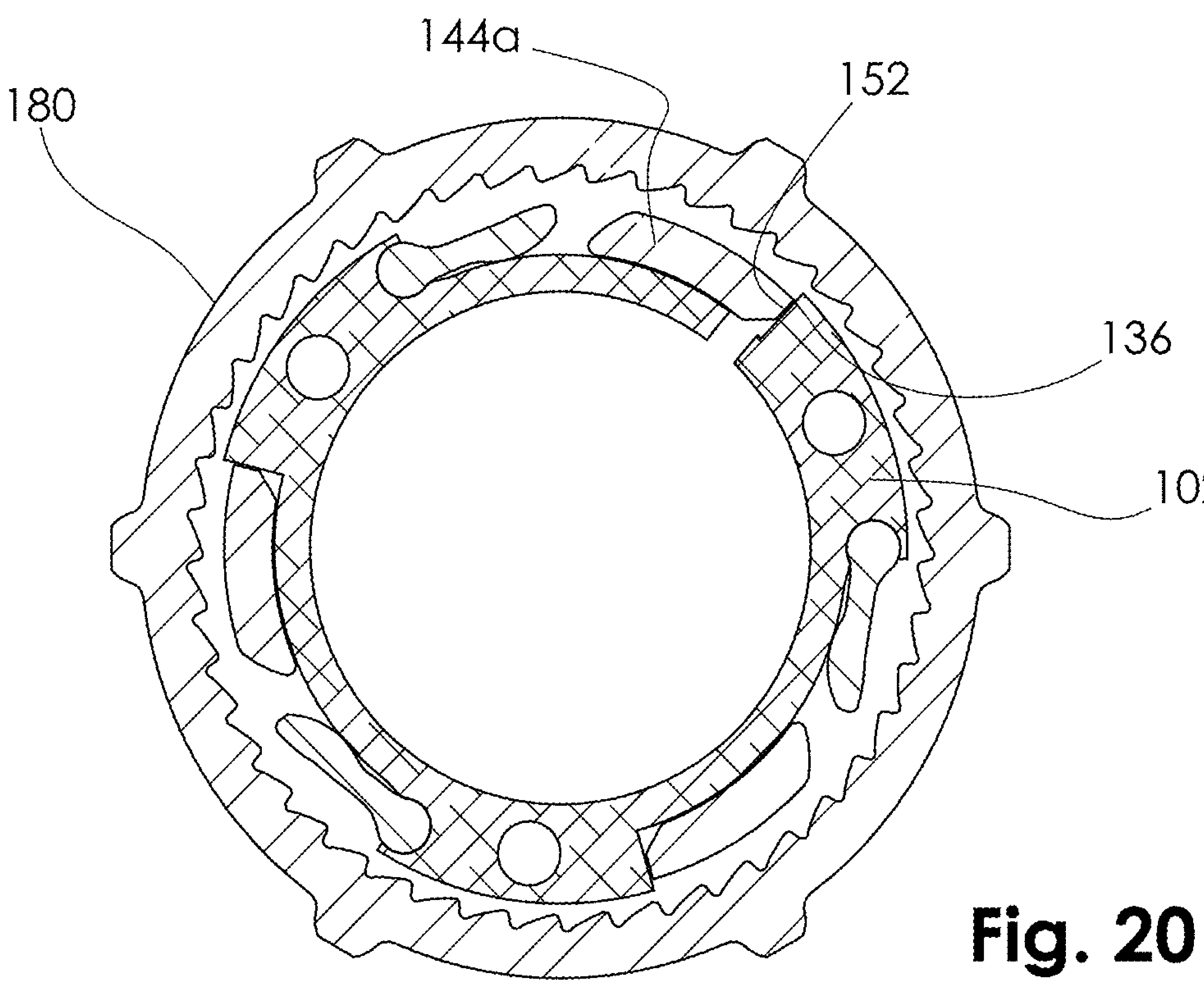


Fig. 20

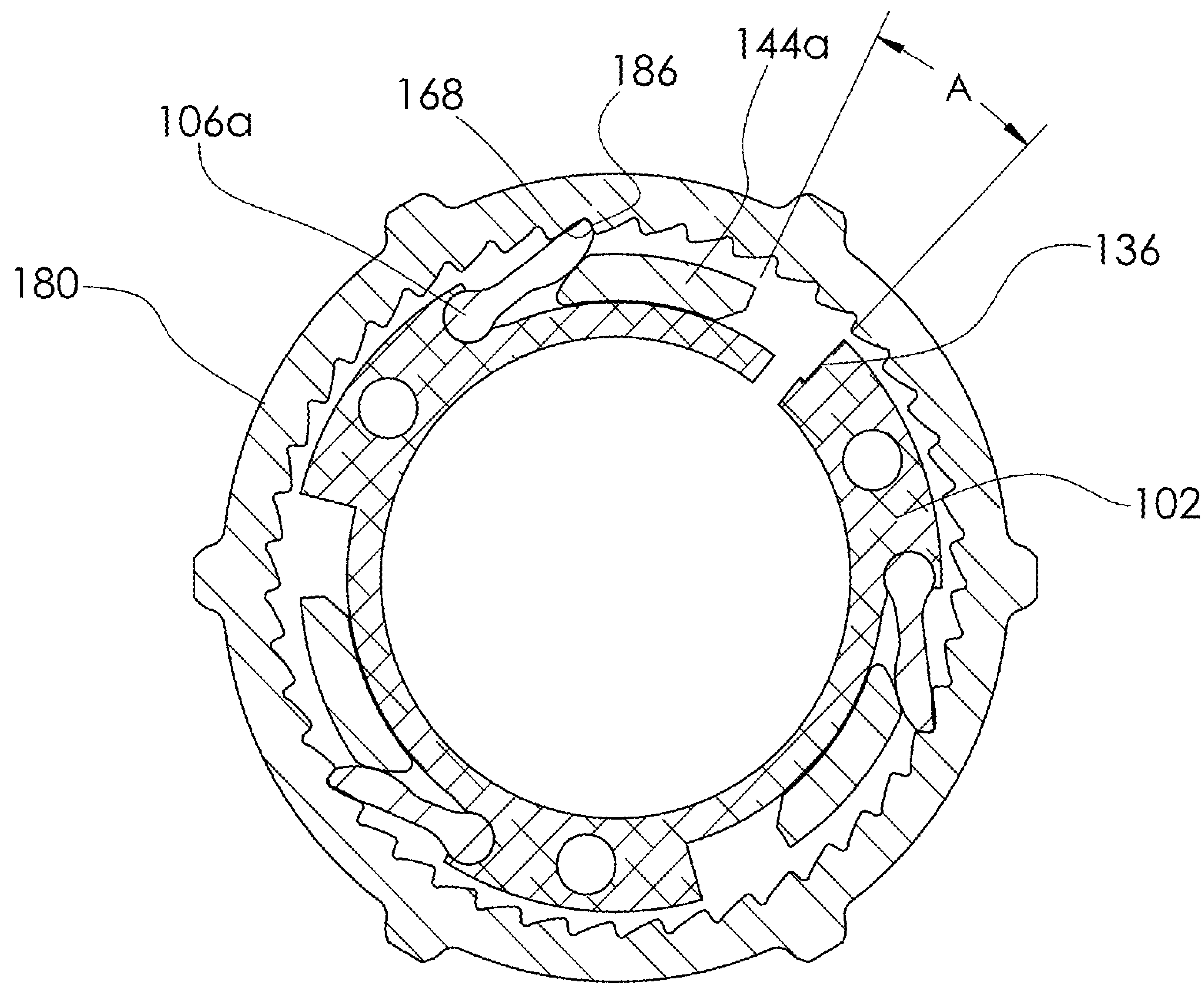


Fig. 21

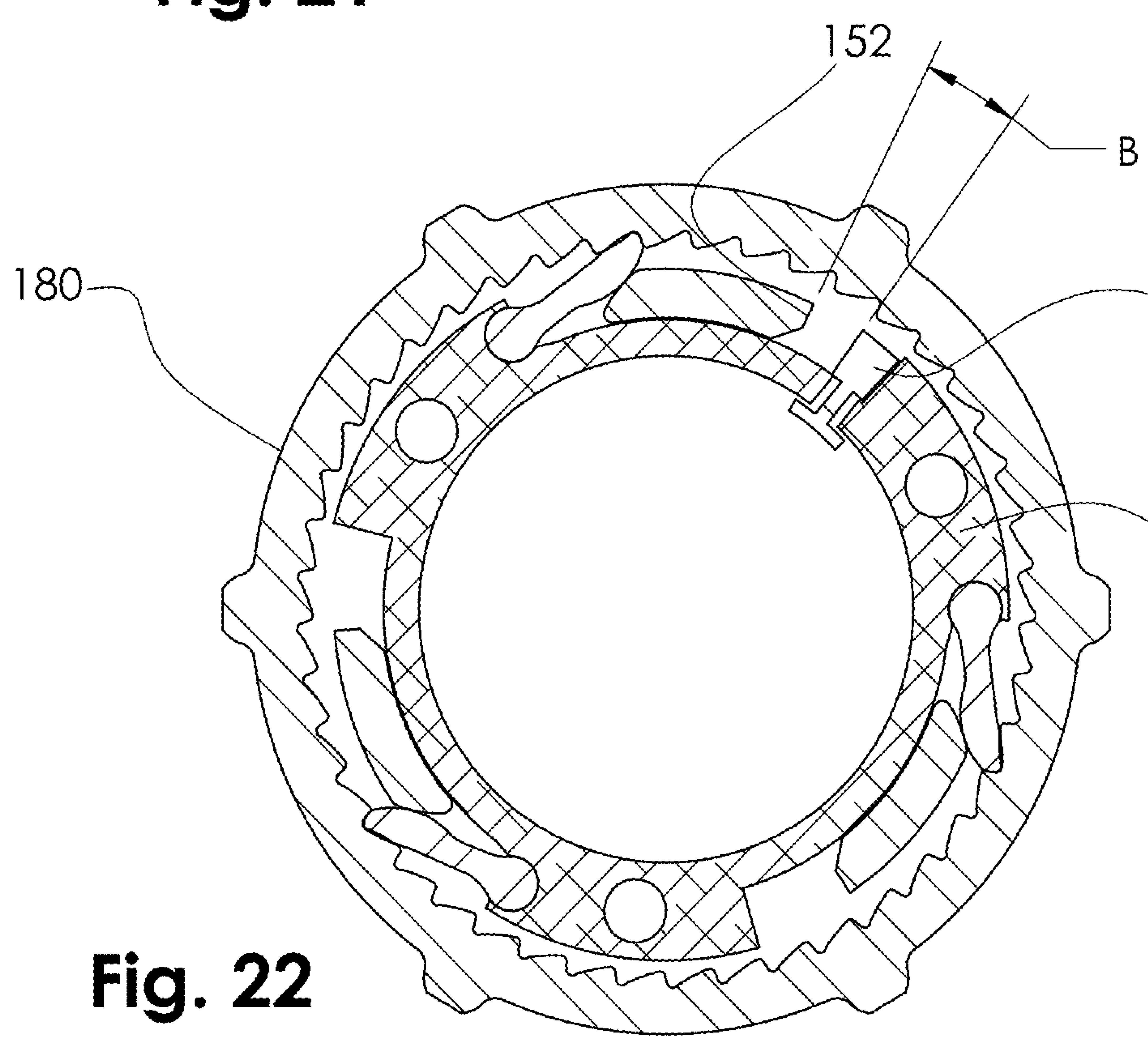


Fig. 22

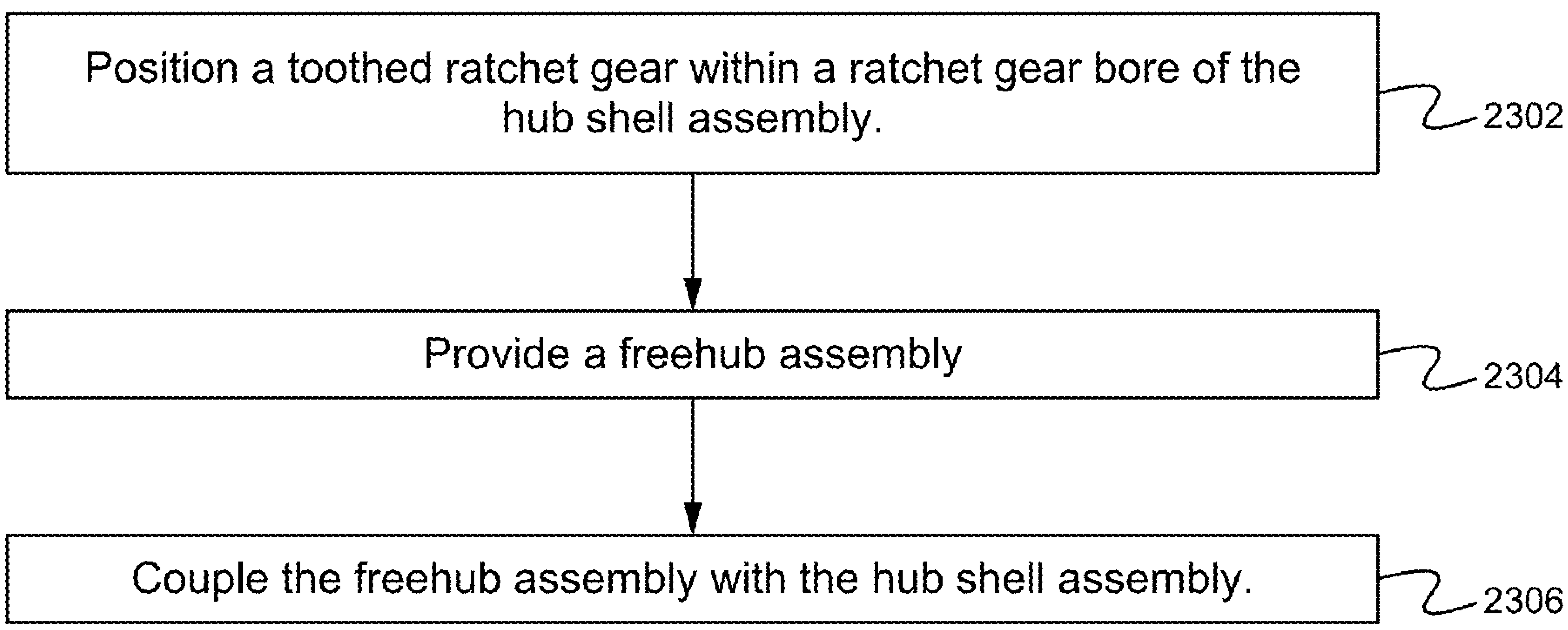

Position a toothed ratchet gear within a ratchet gear bore of the hub shell assembly.
2302
Provide a freehub assembly
2304
Couple the freehub assembly with the hub shell assembly.
2306

Fig. 23

HUB SYSTEM, METHOD AND DEVICE WITH ADJUSTABLE DEADBAND

RELATED APPLICATIONS

[0001] This patent application claims priority under 35 U.S.C. 119(e) of the co pending U.S. Provisional Patent Application No. 63/425,251, filed Nov. 14, 2022, entitled "SILENT BICYCLE FREEWHEEL HUB WITH ADJUSTABLE ENGAGEMENT DEADBAND," which is hereby incorporated by reference.

FIELD OF THE INVENTION

[0002] The present invention is generally directed to freewheel hubs. More specifically, the present invention is directed to a freewheel hub whose deadband is able to be adjusted as desired.

BACKGROUND OF THE INVENTION

[0003] Most bicycles today utilize a freewheel hub in the rear wheel to allow the rear wheel to "freewheel" or roll forward without requiring the rest of the bicycle drivetrain to move continuously. A typical freewheel hub uses one or more spring-loaded pawls mounted to a freehub body, moving inside a toothed ratchet gear attached to the hub shell. As the bicycle rolls forward, the pawls "ratchet" across the teeth of the toothed ratchet gear, disconnecting the bicycle cassette, chain, sprocket and cranks from the rear wheel.

[0004] When the rider resumes forward pedaling, there will be a certain amount of relative movement between the freehub body and the hub shell prior to a spring loaded pawl engaging with the toothed ratchet gear. This relative motion and/or a distance thereof is the deadband of the ratchet mechanism. Specifically, the deadband is able to be the mechanical distance the freehub body may move and/or rotate relative to the toothed ratchet gear before hub engagement occurs. In a traditional freewheel hub, this deadband distance is dependent on the number of teeth in the toothed ratchet gear. Typical toothed ratchet gears have between 12 and 70 teeth, sometimes more. In this traditional hub design, the deadband distance can often be zero or close to zero based on the number of ratchet teeth. Depending on when and how fast the rider begins pedaling (and thus begins rotating the freehub in the engagement direction), and how fast the rider is coasting at the time, there will be a time delay before torque is transferred from the bicycle cassette to the bicycle wheel (due to the engagement of the pawls of the freewheel with the ratchet gear of the hub shell. However, the contribution to that time from the freehub design can most easily be considered in mechanical terms, and the mechanical deadband is a direct input to this time delay.

[0005] A drawback of the freehubs having a zero or close to zero deadband is observed in the form of pedal kickback, in particular when a freewheel hub is used with a full-suspension bicycle. A full-suspension bicycle mounts the rear wheel on a swingarm or linkage, which allows the rear wheel to move up and down as the bicycle traverses bumps in the road or trail. Typical full suspension linkages include a certain amount of chainstay length growth as the suspension moves through its travel, where the chainstay length is the distance between the rear hub axle and the bicycle crankset spindle. As the suspension compresses, this distance grows, and since the bicycle chain traverses this distance from the crank chainring to the bicycle cassette, the chain will have tension applied to it as the chainstay length grows.

[0006] Under certain circumstances, a rider might be coasting with their weight on the bicycle pedals when a particularly large and abrupt compression is induced in the suspension, for instance if the rider rides their bicycle over a large bump at high speed, or lands off a jump and the suspension must absorb a large amount of energy quickly. Under these circumstances, the chain tension from chainstay length growth will rotate the freewheel forward quickly with great force, and may cause the freewheel ratchet mechanism to engage. If the rear wheel is in contact with the ground, the chain force will counteract the suspension movement and will reduce the efficiency of the suspension system in absorbing bump force. The chain force will also apply a reversing torque to the bicycle pedal crank, which may be felt by the rider as "pedal kickback," wherein pedal kickback denotes both the sensation of pedal movement felt by the rider, as well as the reduction in suspension efficiency owing to the momentary chain load in the system.

[0007] The likelihood of pedal kickback in this scenario is increased by an increase in the number of ratchet teeth in the freewheel hub ratchet because it reduces the deadband distance of the system. Thus, traditional freewheel hubs have the drawback of the rider being likely to experience pedal kickback which is only exacerbated when combined with a full-suspension bicycle. Indeed, certain hubs use a sprag-clutch engagement mechanism instead of ratchet pawls, and indeed they reduce the deadband distance to zero. These hubs would therefore be most likely to experience pedal kickback under rapid suspension movements. Bicycles with more suspension travel and large chainstay length growths will also be more likely to experience pedal kickback. Also it should be obvious that the number of teeth on the toothed crank sprocket and the toothed cassette sprocket in use on rapid suspension movement will have an effect on pedal kickback force, since the resting position of the chain is controlled by the relative sizes of these sprockets.

SUMMARY OF THE INVENTION

[0008] A freewheel hub having a non-zero deadband distance in order to reduce or eliminate pedal kickback. This allows the freehub body to always move through a prescribed free motion before hub engagement, regardless of the relative position of the freehub body and the hub shell, and regardless of the number of teeth in the freehub ratchet mechanism. The deadband distance is able to have and/or be adjusted to a desired length including lengths that enable silent freewheeling operation where the pawls of the freewheel body do not engage or contact the teeth of the ratchet gear thereby eliminating any contact-based freewheeling sound. For example, the rider is able to adjust the hub deadband by adding and including an adjustable deadband key to the freewheel body that changes the deadband length and may allow the rider to reduce or eliminate pedal kick-back and improve suspension function on certain bicycles under certain riding conditions, to their own liking and comfort level. Further, if adjusted to a sufficiently long deadband length, in addition to improving suspension function, the rider is able to eliminate the clicking noise inherent in using spring-loaded pawls in the ratchet mechanism. Instead, the freehub pawls are only pressed against the ratchet teeth when the rider pedals forward and engages the hub. This allows silent coasting on the bicycle, which many riders find to be a pleasant experience.

[0009] A first aspect is directed to a bicycle hub system. The system comprises a bicycle wheel including a hub shell assembly, the hub shell assembly having a central aperture for receiving an axle, a ratchet gear bore and a toothed ratchet gear positioned within the ratchet gear bore and a freehub assembly including an outer hub sprocket attachment feature, a pawl support member having a plurality of pawl pivot channels, a plurality of pawls pivotably coupled within the pivot channels, and a biasing member that applies a biasing force to the plurality of pawls that resists the pivoting of the plurality of pawls away from a deadband surface of the pawl support member, wherein the pawl support member is positioned within the toothed ratchet gear such that when the freehub assembly is rotated in a first direction with respect to the hub shell assembly, the plurality of pawls are able to pivot away from the pawl support member until the plurality of pawls engage teeth of the toothed ratchet gear causing the hub shell assembly to rotate with the freehub assembly in the first direction.

[0010] In some embodiments, the biasing member is a spring that impedes the pivoting of the plurality of pawls away from the pawl support member. In some embodiments, each the plurality of pawls include a groove for receiving the biasing member. In some embodiments, when fully rotated toward the deadband surface, the plurality of pawls are unable to contact the teeth of the toothed ratchet gear. In some embodiments, the system further comprises a pawl pusher having a plurality of pushing fingers positioned along the deadband surface of the pawl support member. In some embodiments, when the freehub assembly is rotated in the first direction with respect to the hub shell assembly, the pushing fingers slide along the deadband surface of the pawl support member and push against tips of the plurality of pawls and thereby forcing the plurality of pawls to pivot away from the deadband surface of the pawl support member. In some embodiments, the hub shell assembly further comprises a one-way clutch that is operatively coupled with the pawl pusher such that the clutch prevents rotation of the pushing fingers in the first direction with respect to the hub shell assembly and thereby causes the pushing fingers to slide along the deadband surface when the freehub assembly is rotated in the first direction with respect to the hub shell assembly. In some embodiments, the deadband surface extends between each of the pivot channels and a corresponding stop wall of a plurality of stop walls of the pawl support member thereby forming a plurality of deadband cavities adjacent to the deadband surface.

[0011] In some embodiments, a different pair of one of the plurality of pawls and one of the plurality of pushing fingers is positioned at least partially within each of the deadband cavities when the plurality of pawls are fully rotated against the deadband surface. In some embodiments, when the freehub assembly rotates with respect to the hub shell assembly in a second direction opposite the first direction, each of the pushing fingers slides along the deadband surface until the pushing finger abuts one of the stop walls. In some embodiments, the freehub assembly further comprises a deadband adjustment key configured to selectively couple to a key slot of the pawl support member, the key slot positioned adjacent to one of the deadband recesses. In some embodiments, when coupled within the key slot, a block of the deadband adjustment key extends into the one of the deadband recesses adjacent to the stop wall such that when the freehub assembly rotates with respect to the hub shell assembly in the second direction, each of the pushing fingers slides along the deadband surface until one of the pushing fingers abuts the block of the deadband adjustment key. In some embodiments, the outer hub sprocket attachment feature is an outer cassette spline for coupling with one or more sprockets.

[0012] A second aspect is directed to a bicycle hub assembly. The bicycle hub assembly comprises a toothed ratchet gear having a plurality of teeth and a freehub assembly including a pawl support member having a plurality of pawl pivot channels, a plurality of pawls pivotably coupled within the pivot channels, and a biasing member that applies a biasing force to the plurality of pawls that resists the pivoting of the plurality of pawls away from a deadband surface of the pawl support member, wherein the pawl support member is positioned within the toothed ratchet gear such that when the freehub assembly is rotated in a first direction with respect to the toothed ratchet gear, the plurality of pawls are able to pivot away from the pawl support member until the plurality of pawls engage the teeth of the toothed ratchet gear causing the toothed ratchet gear to rotate with the freehub assembly in the first direction.

[0013] In some embodiments, the biasing member is a spring that impedes the pivoting of the plurality of pawls away from the pawl support member. In some embodiments, each the plurality of pawls include a groove for receiving the biasing member. In some embodiments, when fully rotated toward the deadband surface, the plurality of pawls are unable to contact the teeth of the toothed ratchet gear. In some embodiments, the assembly further comprises a pawl pusher having a plurality of pushing fingers positioned along the deadband surface of the pawl support member. In some embodiments, when the freehub assembly is rotated in the first direction with respect to the toothed ratchet gear, the pushing fingers slide along the deadband surface of the pawl support member and push against tips of the plurality of pawls and thereby forcing the plurality of pawls to pivot away from the deadband surface of the pawl support member. In some embodiments, the assembly further comprises a one-way clutch that is operatively coupled with the pawl pusher such that the clutch prevents rotation of the pushing fingers in the first direction with respect to the toothed ratchet gear and thereby causes the pushing fingers to slide along the deadband surface when the freehub assembly is rotated in the first direction with respect to the toothed ratchet gear.

[0014] In some embodiments, the deadband surface extends between each of the pivot channels and a corresponding stop wall of a plurality of stop walls of the pawl support member thereby forming a plurality of deadband cavities adjacent to the deadband surface. In some embodiments, a different pair of one of the plurality of pawls and one of the plurality of pushing fingers is positioned at least partially within each of the deadband cavities when the plurality of pawls are fully rotated against the deadband surface. In some embodiments, when the freehub assembly rotates with respect to the toothed ratchet gear in a second direction opposite the first direction, each of the pushing fingers slides along the deadband surface until the pushing finger abuts one of the stop walls. In some embodiments, the freehub assembly further comprises a deadband adjustment key configured to selectively couple to a key slot of the pawl support member, the key slot positioned adjacent to one of the deadband recesses. In some embodiments, when coupled within the key slot, a block of the deadband adjustment key extends into the one of the deadband recesses adjacent to the stop wall such that when the freehub assembly rotates with respect to the toothed ratchet gear in the second direction, each of the pushing fingers slides along the deadband surface until one of the pushing fingers abuts the block of the deadband adjustment key. In some embodiments, the freehub assembly includes an outer hub sprocket attachment feature for coupling with one or more sprockets.

[0015] A third aspect is directed to a method of providing a bicycle hub system. The method comprises providing a hub shell assembly including a toothed ratchet gear positioned within a ratchet gear bore, the hub shell assembly for coupling with a bicycle wheel rim via a plurality of spokes and providing a freehub assembly including an outer hub sprocket attachment feature, a pawl support member having a plurality of pawl pivot channels, a plurality of pawls pivotably coupled within the pivot channels, and a biasing member that applies a biasing force to the plurality of pawls that resists the pivoting of the plurality of pawls away from a deadband surface of the pawl support member and coupling the freehub assembly with the hub shell assembly such that the pawl support member is positioned within the toothed ratchet gear and when the freehub assembly is rotated in a first direction with respect to the hub shell assembly, the plurality of pawls are able to pivot away from the pawl support member until the plurality of pawls engage teeth of the toothed ratchet gear causing the hub shell assembly to rotate with the freehub assembly in the first direction.

[0016] In some embodiments, the biasing member is a spring that impedes the pivoting of the plurality of pawls away from the pawl support member. In some embodiments, each the plurality of pawls include a groove for receiving the biasing member. In some embodiments, when fully rotated toward the deadband surface, the plurality of pawls are unable to contact the teeth of the toothed ratchet gear. In some embodiments, the freehub assembly further comprises a pawl pusher having a plurality of pushing fingers positioned along the deadband surface of the pawl support member. In some embodiments, when the freehub assembly is rotated in the first direction with respect to the hub shell assembly, the pushing fingers slide along the deadband surface of the pawl support member and push against tips of the plurality of pawls and thereby forcing the plurality of pawls to pivot away from the deadband surface of the pawl support member. In some embodiments, the hub shell assembly further comprises a one-way clutch that is operatively coupled with the pawl pusher such that the clutch prevents rotation of the pushing fingers in the first direction with respect to the hub shell assembly and thereby causes the pushing fingers to slide along the deadband surface when the freehub assembly is rotated in the first direction with respect to the hub shell assembly.

[0017] In some embodiments, the deadband surface extends between each of the pivot channels and a corresponding stop wall of a plurality of stop walls of the pawl support member thereby forming a plurality of deadband cavities adjacent to the deadband surface. In some embodiments, a different pair of one of the plurality of pawls and one of the plurality of pushing fingers is positioned at least partially within each of the deadband cavities when the plurality of pawls are fully rotated against the deadband surface. In some embodiments, when the freehub assembly rotates with respect to the hub shell assembly in a second direction opposite the first direction, each of the pushing fingers slides along the deadband surface until the pushing finger abuts one of the stop walls. In some embodiments, the freehub assembly further comprises a deadband adjustment key configured to selectively couple to a key slot of the pawl support member, the key slot positioned adjacent to one of the deadband recesses. In some embodiments, the method further comprises sliding the deadband adjustment key into the key slot such that a block of the deadband adjustment key extends into the one of the deadband recesses adjacent to the stop wall and when the freehub assembly rotates with respect to the hub shell assembly in the second direction, each of the pushing fingers slides along the deadband surface until one of the pushing fingers abuts the block of the deadband adjustment key. In some embodiments, the outer hub sprocket attachment feature is an outer cassette spline for coupling with one or more sprockets.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] Several example embodiments are described with reference to the drawings, wherein like components are provided with like reference numerals. The example embodiments are intended to illustrate, but not to limit, the invention. The drawings include the following figures:

[0019] FIG. **1** illustrates a side view of a bicycle assembly according to some embodiments.

[0020] FIG. **2** illustrates a detailed view of a rear triangle of a bicycle assembly according to some embodiments.

[0021] FIG. **3** illustrates a perspective view of a hub assembly according to some embodiments.

[0022] FIG. **4** illustrates an exploded view of the hub assembly according to some embodiments.

[0023] FIG. **5** illustrates an exploded view of a hub shell assembly according to some embodiments.

[0024] FIG. **6** illustrates a cross-section view of the hub shell assembly along line A shown in FIG. **5** according to some embodiments.

[0025] FIG. **7** illustrates a perspective view of a freehub body assembly according to some embodiments.

[0026] FIG. **8** illustrates a partially exploded view of the freehub body assembly according to some embodiments.

[0027] FIG. **9** illustrates a perspective view of a freehub bearing assembly according to some embodiments.

[0028] FIG. **10** illustrates a side view of the freehub bearing assembly according to some embodiments.

[0029] FIG. **11** illustrates a perspective view of a pawl pusher according to some embodiments.

[0030] FIG. **12** illustrates a right end view of the pawl pusher according to some embodiments.

[0031] FIG. **13** illustrates a perspective view of a ratchet pawl according to some embodiments.

[0032] FIG. **14** illustrates an end view of the ratchet pawl according to some embodiments.

[0033] FIG. **15** illustrates a perspective view of a ratchet gear ring according to some embodiments.

[0034] FIG. **16** illustrates a side detail view of the ratchet gear ring according to some embodiments.

[0035] FIG. **17** illustrates a perspective view of a biasing element according to some embodiments.

[0036] FIG. **18** illustrates a perspective view of a deadband adjustment key according to some embodiments.

[0037] FIG. **19** illustrates a side cross-sectional view of a freehub bearing assembly including a coupled deadband adjustment key within a ratchet gear ring with the pawls retracted according to some embodiments.

[0038] FIG. **20** illustrates a side cross-sectional view of a freehub bearing assembly without a deadband adjustment key within a ratchet gear ring with the pawls retracted according to some embodiments.

[0039] FIG. **21** illustrates a side cross-sectional view of a freehub bearing assembly without a deadband adjustment key within a ratchet gear ring with the pawls extended according to some embodiments.

[0040] FIG. **22** illustrates a side cross-sectional view of a freehub bearing assembly including a coupled deadband adjustment key within a ratchet gear ring with the pawls extended according to some embodiments.

[0041] FIG. **23** illustrates a method of providing a hub assembly according to some embodiments.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0042] Embodiments of the application are directed to a bicycle and/or a freewheel hub having a non-zero deadband distance in order to reduce or eliminate pedal kickback. This allows the freehub body to always move through a prescribed free motion before hub engagement, regardless of the relative position of the freehub body and the hub shell, and regardless of the number of teeth in the freehub ratchet mechanism. The deadband distance is able to have and/or be adjusted to a desired length including lengths that enable silent freewheeling operation where the pawls of the freewheel body do not engage or contact the teeth of the ratchet gear thereby eliminating any contact-based freewheeling sound.

[0043] Reference will now be made in detail to implementations of a bicycle and/or freewheel hub, such as illustrated in the accompanying drawings. The same reference indicators will be used throughout the drawings and the following detailed description to refer to the same or like parts. In the interest of clarity, not all of the routine features of the implementations described herein are shown and described. It will be appreciated that in the development of any such actual implementation, numerous implementation-specific decisions can be made in order to achieve the developer's specific goals, such as compliance with application and business related constraints, and that these specific goals will vary from one implementation to another and from one developer to another. Moreover, it will be appreciated that such a development effort might be complex and time-consuming, but would nevertheless be a routine undertaking of engineering for those of ordinary skill in the art having the benefit of this disclosure.

[0044] FIG. **1** illustrates a bicycle assembly **200** according to some embodiments. As shown in FIG. **1**, the bicycle assembly **200** comprises a bicycle rear wheel **202** (including a hub assembly **1**), a bicycle front triangle **204** and a bicycle rear triangle **206** coupled with the front triangle **204**. The bicycle front triangle **204** and bicycle rear triangle **206** are coupled together via a bicycle suspension link **216**, which compresses a bicycle rear shock absorber **210** that is coupled between the front triangle **204** and the suspension link **216**. The assembly **200** further comprises a bicycle crank **208** operably coupled with a bicycle chainring **209** engaged with a bicycle chain **212**. A bicycle cassette **214** is mounted to the bicycle rear wheel **202**, which is engaged to said bicycle chain **212**. A bicycle rear derailleur **215** is engaged to said chain **212** and mounted to said rear triangle **206** proximate said rear wheel **202**. Alternatively, one or more of the above components are able to be omitted. Further, although only the components above are described in detail, it is understood that the bicycle assembly **200** is able to comprise one or more other components well known in the art that are not described herein for the sake of brevity.

[0045] FIG. **2** illustrates a detailed view of the bicycle rear triangle **206** and bicycle rear wheel **202** according to some embodiments. As shown in FIG. **2**, overlaid geometry shows the Axle Position Resting AR, Axle Position Compressed AC, Wheel Path WP, Bicycle Chainstay Length L**1** and Bicycle Chainstay Length L**2**. In particular, this geometry is overlaid to demonstrate the change to the bicycle frame geometry under suspension compression. When not under significant compression, the axle is at position AR and the chainstay length is equal to L**1**. When under compression, the axle moves along path WP to position AC thereby increasing the chainstay length to L**2**. As described above, this increase in chainstay length can abruptly rotate the freewheel body with respect to the freewheel shell and thereby cause pedal kickback if the deadband is zero or minimal.

[0046] FIG. **3** illustrates a perspective view of the hub assembly **1** according to some embodiments. As shown in FIG. **3**, the hub assembly **1** comprises first end **2**, second end **4**, and hub central axis **6**. FIG. **4** illustrates a perspective exploded view of the hub assembly **1** according to some embodiments. As shown in FIG. **4**, the hub assembly comprises a hub shell assembly **30**, a freehub body assembly **100**, a hub axle **14** and a hub axle cap **10**. Both the hub shell assembly **30** and the freehub body assembly **100** are able to slide onto the hub axle **14** such that they are located on a hub axle bearing surface **20**. The hub axle cap **10** is able to be threaded onto said axle **14** with a hub axle cap thread **12** threading onto a hub axle thread **16**, such that the hub axle right end **18** is opposite said end cap **10** with the assemblies **30**, **100** in between.

[0047] FIG. **5** illustrates an exploded perspective view of the hub shell assembly **30** according to some embodiments. As shown in FIG. **5**, the hub shell assembly **30** comprises a hub shell **32**, a hub shell disc flange **34**, a hub shell bearing **36**, a hub shell ratchet gear bore **38**, one or more hub shell ratchet gear spline slots **40**, a one-way clutch **42** having an outer race **44** and an inner bore **46**, and a toothed ratchet gear **180**. In some embodiments, the one-way clutch is a sprag clutch. Alternatively, the one-way clutch **42** is able to be other types of over-running or one-way clutches, including but not limited to a roller clutch, a pawl clutch, a wound-spring type clutch, a face-gear clutch, and/or other similar clutches. Some of these clutches would not allow for silent hub operation, but they would allow for the same adjustable deadband operation of the hub **1**.

[0048] FIG. **6** illustrates a cross-section view of the hub shell assembly **30** at section line according to some embodiments. As shown in FIG. **6**, the hub shell **32** comprises a hub shell body **54**, hub shell disc flange **34** (e.g. for coupling with a brake rotor), hub shell left spoke flange **50** and hub shell right spoke flange **52** (e.g. both for coupling with one or more spokes (not shown)). Further, as shown in FIG. **6**, the hub shell bearing **36** is able to be positioned within a bearing cavity within the flange **34** (e.g. for receiving axle **14**), the one-way clutch **42** is able to be fitted into hub shell clutch bore **56** (e.g. for receiving the stem **142** of the pusher **140**, and the ratchet gear **180** is able to be positioned within the hub shell ratchet bore **38**. In particular, when positioned within the hub shell ratchet bore **38**, each of a plurality of ratchet ring spline teeth **184** (see FIG. **15**) of the ratchet ring **180** extend into a different one of the hub shell ratchet spline slots **40**. As a result, when the ratchet ring **180** is rotated, the ratchet ring spline teeth **184** apply a force to the ratchet spline slots **40** thereby causing the hub shell **32** to similarly rotate. Additionally, the outer surface of the stem **142** of the pusher **140** is able to contact the inner bore **46** of the one-way clutch **42** such that the inner bore **46** rotates with the pusher **140** in a first direction of rotation, but resists and/or stops rotation of the pusher **140** in the opposite direction (e.g. via friction between the outer surface of the stem **142** and the inner bore **46**).

[0049] FIGS. **7** and **8** illustrates perspective and partially exploded perspective views, respectively, of the freehub body assembly **100** according to some embodiments. As shown in FIGS. **7** and **8**, the freehub body assembly **100** comprises a bearing assembly (or pawl support member) **102**, a pawl pusher **140**, a deadband adjustment key **108**, one or more ratchet pawls **106***a-c*, and a pawl biasing element **104**. In some embodiments, the biasing element **104** is a wire spring. Alternatively, the biasing element **104** is able to be other types of biasing elements including, but not limited to, one or a combination of one or more leaf springs, one or more coil springs, one or more rubber bands, one or more magnets (e.g. placed in the freehub body under steel pawls **106**), and/or any other kind of spring loading mechanism.

[0050] FIGS. **9** and **10** illustrate perspective and side views, respectively, of the bearing assembly **102** according to some embodiments. As shown in FIGS. **9** and **10**, the bearing assembly **102** comprises a freehub end bearing **122** (e.g. for receiving the axle **14**), a freehub external bearing **126** with an external bearing outer race **128**, a freehub internal bearing **124** with an internal bearing inner race **125** (e.g. for receiving the axle **14**), a cassette spline **120**, a cassette mounting thread **116**, a cassette mounting boss **118**, a biasing element slot **134**, one or more pawl cylinder slots **130***a-c*, one or more deadband surfaces **132***a-c*, one or more pusher stop surfaces **136***a-c*, and a deadband adjustment key slot **138**. The cassette spline **120** and/or cassette mounting boss **118** is able to receive a splined cassette (not shown) in order to coupled with a drive assembly of the bicycle **200** (e.g. the bicycle crank **208**, the bicycle chainring **209**, the bicycle chain **212**, the derailleur **215** and/or other components). A cassette locking bolt (not shown) is able to threadably couple to the cassette mounting thread **116** to secure the cassette onto the spline **120**. Although as shown in FIGS. **9** and **10**, the bearing assembly **102** comprises three pawl cylinder slots **130***a-c*, deadband surfaces **132***a-c* and pusher stop surfaces **136***a-c*, and a single deadband reducer slot **138**, more or less pawl cylinder slots **130***a-c*, deadband surfaces **132***a-c*, pusher stop surfaces **136***a-c*, and deadband reducer slots **138** are contemplated.

[0051] Similarly, although as shown in FIGS. **7** and **8**, the freehub body assembly **100** comprises a pawl pusher **140** having three fingers **144**, a single deadband adjustment key **108**, three ratchet pawls **106***a-c* and a single pawl biasing element **104**, a pawl pusher **140** having more or less fingers **144**, more or less deadband adjustment keys **108**, more or less ratchet pawls **106***a-c* and/or more or less pawl biasing elements **104** are contemplated. In particular, the number of deadband adjustment keys **108** is able to correspond to the number of deadband adjustment key slots **138**, and the number of fingers **144**, cylinder slots **130***a-c*, deadband surfaces **132***a-c* and stop surfaces **136***a-c* is able to correspond to the number of pawls **106***a-c*. The space defined between each of the pawl cylinder slots **130***a-c*, the corresponding stop surface **136***a-c* and the corresponding deadband surface **132***a-c*, is able to form a plurality of deadband cavities that are filled by the fingers **144** of the pusher **140**, the pawls **106***a-c* (at least in a fully retracted position) and the deadband adjustment key **108** (when coupled within the deadband adjustment key slot **138**).

[0052] FIGS. **11** and **12** illustrate perspective and front views, respectively, of the pawl pusher **140** according to some embodiments. As shown in FIGS. **11** and **12**, the pawl pusher **140** comprises a central cavity **147** (for receiving the axle **14**), a stem or clutch cylinder **142**, a finger flange **146** and one or more pawl fingers **144***a-c*. Each of the fingers **144** comprise finger pawl surface **148**, finger outside diameter **154**, finger locating cylinder **150**, and pusher freewheel stop **152**. In operation, the locating cylinder **150** of the pawl fingers **144** is able to slide along the deadband surface **132***a-c* within the deadband cavities between the pawls **106***a-c* and the stop walls **136***a-c* or an inserted key **108**. As a result, the pawl surface **148** is able to slide under the pawl pusher cam surface **166** (see FIG. **14**) in order to cause the pawls **106***a-c* to pivot from the retracted position to the extended position. When slide in the opposite direction, the pusher freewheel stop **152** is able to contact the stop walls **136***a-c* and/or the inserted key **108** (thereby defining the deadband distance).

[0053] FIGS. **13** and **14** illustrate perspective and end views, respectively, of a ratchet pawl **106***a-c* according to some embodiments. As shown in FIGS. **13** and **14**, the ratchet pawl **106***a-c* comprises a pawl cylinder **160**, a pawl biasing element groove **162**, a pawl spring pad **164**, a pawl pusher cam surface **166**, a pawl driving surface **168** and a pawl tip radius **170**. The pawl pusher cam surface **166** is for sliding over the pusher fingers **144** as described above. The pawl driving surface **168** is configured to engage the ratchet tooth receiving face **186** and/or the pawl tip radius **170** is configured to fit within the valleys between the teeth **185** of the ratchet gear **180** (thereby engaging and causing the gear **180** to rotate with the freehub assembly **100**).

[0054] The pawl cylinder **160** of each of the pawls **106***a-c* is able to slidably fit within one of the pawl cylinder slots **130***a-c*. When positioned within one of the slots **130***a-c*, the pawls **106***a-c* are able to pivot about a central axis of the slot **130** between a retracted position adjacent to the respective deadband surface **132***a-c* and an extended position away from the deadband surface **132***a-c*. The biasing element **104** is able to fit withing the gap **134** (see FIG. **10**) at least partially surrounding or blocking the pivoting of pawls **106***a-c* away from the deadband surface **132***a-c*. In particular, the biasing element **104** is able to be positioned within the pawl biasing element groove **162** and adjacent to or around the pawl spring pad **164** of each of the pawls **106***a-c* in order to resist the pivoting away from the deadband surface **132***a-c* and/or bias the pawls **106***a-c* in the retracted position. Indeed, by providing a shortened pad **164**, the pawls **106***a-c* enable the biasing element **104** to have a smaller diameter and/or size and be closer to the deadband surface **132***a-c*.

[0055] When in the extended position (see FIGS. **21** and **22**), the pawls **106***a-c* are pivoted away from the deadband surface **132***a-c* such that they are able to engage the teeth **185** of the ratchet gear **180** (e.g. contact a ratchet tooth receiving face **186** and/or a bottom of the valley between teeth **185**). In some embodiments, when in the retracted position the pawls **106***a-c* are able to contact the deadband surface **132***a-c* and/or be positioned fully within the corresponding deadband cavity (e.g. when the corresponding pusher finger **144** is able to slide to be adjacent to a stop wall **136***a-c* or able to slide to be adjacent to the inserted key **108**, but still does not impede or block the pivoting of the corresponding pawl **106***a-c* (see FIGS. **19** and **20**)). Alternatively, when in the retracted position the pawls **106***a-c* are able to be at least partially blocked from contacting the deadband surface **132***a-c* and/or from being positioned fully within the corresponding deadband cavity (e.g. when despite being fully slide against an inserted key **108**, the corresponding pusher finger **144** impedes or blocks the pivoting of the corresponding pawl **106***a-c* toward the deadband surface **132***a-c*). In particular, by inserting and/or selecting a size of the key **108**, a user is able to adjust the retracted position by adjusting how close the fingers **144** are to the pawls **106***a-c* and/or the extent that the fingers **144** block the inward pivoting of the pawls **106***a-c*.

[0056] FIGS. **15** and **16** illustrate perspective and detail views, respectively, of the toothed ratchet gear **180** according to some embodiments. As shown in FIG. **15**, the toothed ratchet gear **180** comprises a ring-shaped body having an outside surface **182**, one or more outer splines **184** protruding from the outside surface **182** of the body, and a plurality of inner teeth **185** protruding from an inner surface of the body. Each of the inner teeth **185** have a ratchet tooth receiving face **186** and a ratchet tooth sliding face **188** with a valley formed where the sliding face **188** of each tooth meets the receiving face **186** of the adjacent tooth **185**. A ratchet tooth pitch angle P is shown as the angle between two adjacent teeth **185**. The sliding face **188** is able to be longer and/or make a smaller angle with respect to the adjacent inner surface of the body than the receiving face **186**. Additionally, the shape, contour and/or size of the pawl driving surface **168** and the pawl tip radius **170** of each of the pawls **106***a-c* is able to compliment the shape of the valleys and/or curvature of the sliding face **188**.

[0057] As a result, when the pawls **106***a-c* are extended such that they contact the teeth **185** and moved/rotated in a direction from the valley in between teeth **185** along the adjacent sliding face **188**, the smaller angle enables the pawls **106***a-c* to slide over the teeth **185** without engaging the teeth **185**. In contrast, when moved/rotated in the opposite direction from the valley in between teeth **185** along the adjacent receiving face **186**, the larger/steeper angle causes the pawl driving surface **168** and/or the pawl tip radius **170** to catch against the receiving face **186** and/or within the valleys thereby engaging the teeth **185** and forcing the ring to rotate in the same direction as the pawls **106***a-c*. Alternatively, the sliding and receiving faces **186**, **188** are able to be the same length and/or angle.

[0058] FIG. **17** illustrates a perspective view of the biasing element **104** according to some embodiments. As shown in FIG. **17**, the biasing element **19** comprises an elongated body shaped to surround each of the pawls **106***a-c*, the body having a gap **194** enabling the body to flex to fit around the pawls **106***a-c* before springing back to shape, and a tang **192** to catch on one or more of the pawls **106***a-c* and thereby prevent the biasing element **104** from rotating with respect to the pawls **106***a-c*. The biasing element **104** is able to comprise a flexible material or combination of materials including, but not limited to, rubber, metal, plastic or other flexible material known in the art. As described above, the biasing element **104** is able to fit withing the gap **134** (see FIG. **10**) at least partially surrounding or blocking the pivoting of pawls **106***a-c* away from the deadband surface **132***a-c*. In particular, the biasing element **104** is able to be positioned within the pawl biasing element groove **162** and adjacent to or around the pawl spring pad **164** of each of the pawls **106***a-c* in order to resist the pivoting away from the deadband surface **132***a-c* and/or bias the pawls **106***a-c* in the retracted position. Indeed, by providing a shortened pad **164**, the pawls **106***a-c* enable the biasing element **104** to have a smaller diameter and/or size and be closer to the deadband surface **132***a-c*. Additionally, the pad **164** provides a surface for the tang **192** to catch/grip and thereby prevent the biasing element **104** from rotating with respect to the pawls **106***a-c*.

[0059] FIG. **18** illustrates a perspective view of the deadband adjustment key **108** according to some embodiments. As shown in FIG. **18**, the deadband adjustment key **108** comprises an adjustment block **232** and a coupling member **234**. The coupling member **234** is able to have a trunk configured to fit within the deadband adjustment key slot **138** and a holding sheet that extends below an inside of the slot thereby keeping the trunk/key from falling out of the slot **138**. The adjustment block **232** is able to extend from the slot **138** into the adjacent deadband recess next to the stop wall **136** of that recess (see FIGS. **19** and **22**). As a result, when inserted into the slot **138**, the adjustment block **232** reduces the size of the deadband recess by reducing the maximum distance that the pusher finger **144** of that recess (and all the other pusher fingers **144** because they are coupled together) is able to slide away from the pawl **106***a-c* of that recess. Indeed, although FIG. **18** illustrates an adjustment block **232** having a first width (e.g. width R shown in FIG. **19**), it is understood that the adjustment block **232** is able to have larger or smaller widths and/or that the system is able to include multiple keys **108** having blocks **232** of different widths such that the user is able to select a key **108** having a desired width as a manner of adjusting the deadband distance of the system. Alternatively, the bearing assembly **102** is able to have a plurality of slots **138** along one of the deadband recesses such that deadband distance is able to be adjusted by inserting the key **108** in one of the slots **138** that is a desired distance from the stop wall **136** and/or pawl **106***a-c* of that recess.

[0060] FIG. **19** is a section view of hub assembly **1** with the freehub body assembly **100** inserted (e.g. concentrically nested) within the toothed ratchet gear **180** according to some embodiments. As shown in FIG. **19**, the pawls **106***a-c* are in the retracted position (e.g. due to the force applied by the biasing element **104**) with the block **232** of the inserted deadband adjustment key **108** reducing the distance between the pawls **106***a-c* and the fingers **144***a-c*. As a result, the hub assembly **1** is in a freewheeling configuration where the hub shell assembly **30** (e.g. the gear **180**) is able to rotate clockwise with respect to the freehub body assembly **100** (e.g. the pawls **106***a-c*). Indeed, because the pawls **106***a-c* are able to retract such that they do not contact the gear **180**, the hub assembly **1** is in a silent freewheeling configuration where the hub assembly **1** does not make a clicking noise found in traditional assemblies due to the contact of the pawls **106***a-c* with the gear **180**. As shown in FIG. **19**, in this configuration the pawl **106***a* is positioned so that the pawl pusher cam surface **166** is in contact with the deadband surface **132***a* and/or within the deadband cavity. Further, the pusher freewheel stop **152** is in contact with the block **232**, therefore the deadband reduction angle R is developed between said pusher freewheel stop **152** and the stop surface **136**.

[0061] FIG. **20** is another section view of hub assembly **1** with the freehub body assembly **100** inserted (e.g. concentrically nested) within the toothed ratchet gear **180** according to some embodiments. However, unlike FIG. **19**, in FIG. **20** the key **108** is not inserted in the slot **138** such that the deadband distance remains at its maximum. In particular, the pawls **106***a-c* are in the retracted position (e.g. due to the force applied by the biasing element **104**) with the fingers **144***a-c* slid against the stop walls **136** away from the pawls **106***a-c*. As a result, the hub assembly **1** is in again in a silent freewheeling configuration where the hub shell assembly **30** (e.g. the gear **180**) is able to rotate clockwise with respect to the freehub body assembly **100** (e.g. the pawls **106***a-c*). However, unlike the configuration in FIG. **19**, the longer deadband distance in FIG. **20** will increase the time required for the fingers **144***a-c* to push the pawls **106***a-c* to the extended position and thus increase the time required for the pawls **106***a-c* to engage the gear **180** thereby reducing the likelihood of pedal kickback.

[0062] FIG. **21** is another section view of hub assembly **1** with the freehub body assembly **100** inserted (e.g. concentrically nested) within the toothed ratchet gear **180** according to some embodiments. As shown in FIG. **21**, the pawls **106***a-c* are in the extended position due to the extending force applied to the pawls **106***a-c* by the fingers **144***a-c* overcoming the biasing force applied by the biasing element **104**. In particular, as the freehub body assembly **100** begins to rotate clockwise (e.g. due to pedaling), the one-way clutch **42** provides a drag or stopping force to the stem **142** of the pusher **140** such that the fingers **144***a-c* move counterclockwise with respect to the pawls **106***a-c* (and the remainder of the assembly **100**). As a result, the fingers **144***a-c* slide along the deadband surface **132***a-c* toward the pawls **106***a-c* and eventually contact the pawls **106***a-c*, sliding under the tip **168** and the surface **166** thereby causing the pawls **106***a-c* to pivot away from the deadband surface **132***a-c* toward the teeth **185** of the ratchet gear **180** and into the extended position. When in the extended position, the pawls **106***a-c* contact/engage the teeth **185** of the ratchet gear **180** so that pedaling torque applied to the freehub body assembly **100** is transferred to the hub shell assembly **30** via the pawls **106***a-c* pressing against the teeth **185** of the ratchet gear **180** (which presses against the hub shell assembly **30**). In this extended position, the ratchet pawls **106***a-c* are positioned so that pawl driving surface **168** is pressing against ratchet tooth receiving face **186**. Engagement deadband angle/length A is shown as the free movement of the fingers **144***a-c* of the pawl pusher **140** before the ratchet pawl **106***a* is in complete contact with ratchet gear **180**. Indeed, because the key **108** is not inserted in the key slot **138**, the pawl pushers **140** must move the maximum deadband distance in order to cause the pawls **106***a-c* to fully extend and/or engage the ratchet gear **180**.

[0063] As described above, when transitioning from the extended position to the retracted position, as they move counterclockwise with respect to the gear **180**, the pawls **106***a-c* slide against the sliding face **188** of the teeth **185** without engaging the teeth **185** thereby enabling the gear **180** to rotate clockwise independent of the freehub body assembly **100**. In contrast, when transitioning from the retracted position to the extended position, as they move clockwise with respect to the gear **180**, once the pawls **106***a-c* pivot such that they are able to contact the gear **180**, the pawls **106***a-c* catch/engage with one of the receiving faces **186** of the teeth **186** thereby causing the gear **180** to rotate clockwise due to the force of the clockwise rotation of the freehub body assembly **100**.

[0064] FIG. **22** is another section view of hub assembly **1** with the freehub body assembly **100** inserted (e.g. concentrically nested) within the toothed ratchet gear **180** according to some embodiments. In particular, FIG. **22** is substantially similar to FIG. **21** except that the deadband adjustment key **108** is inserted into the key slot **138** thereby reducing the deadband distance. As a result, as illustrated by the reduced length B, instead of moving the longer length/angle A as shown in FIG. **21**, the pawl pushers **140** only need to move the less than maximum deadband distance/angle B in order to cause the pawls **106***a-c* to fully extend and/or engage the ratchet gear **180**. Thus, the hub assembly **1** provides the advantage of enabling the deadband distance to be adjusted and/or configured for silent freewheeling. In particular, the combination of the biasing element **104** causing the pawls **106***a-c* to automatically retract into the retracted position and the one-way ratchet **42** and/or pusher **140** causing the pawls **106***a-c* to extend when the assembly **100** is rotated in a drive direction (e.g. clockwise) enable the assembly to be customized to reduce pedal kickback and/or to a responsiveness level desired by the rider.

[0065] In operation, as described above the hub **1** is able to operate in two modes. In the first mode, "freewheeling," the hub **1** freewheels when the bicycle **200** is rolling forward and the pedal crank **208** remains stationary. The cranks **208**, chain **212**, cassette **214** and freehub body assembly **100** remain motionless relative to the bicycle frame **204**, **206**, while the rear wheel rotates forward. In the second mode, the hub **1** drives the bicycle **200** forward when the pedal cranks **208** are pedaled forward by the bicycle rider. The chainring **209** rotates and applies tension to the bicycle chain **212**, rotating the bicycle cassette **214** and freehub body assembly **100**, and the freehub body assembly **100** applies torque to the hub shell assembly **30**, rotating the wheel and driving the bicycle **200** forward. In this manner the rider propels the bicycle **200** forward by rotating the pedals.

[0066] In further detail, as described above, the hub assembly **1** freewheels when the ratchet pawls **106***a-c* are in the retracted position towards the bearing assembly **102**, as depicted in FIG. **19**. Under freewheeling conditions, the hub shell assembly **30** rotates clockwise relative to the hub center axis **6**, while the freehub body assembly **100** remains stationary. The one-way clutch **42** is therefore also rotating clockwise relative to the pusher stem **142**. The one-way clutch **42** is able to be specified and installed such that it allows the pusher stem **142** to rotate freely in the drive (e.g. forward pedaling or clockwise direction), but locks and resists or stops rotation in the opposite direction (e.g. counter-clockwise direction). Thus, as the hub shell assembly **30** freewheels, the residual drag in the clutch **42**, which owing to the physics of any free-running clutch cannot be zero, is able to continuously rotate the pawl pusher **140**

clockwise relative to the pawl pusher center axis **147**, which is nominally identical to the hub center axis **6**.

[0067] During freewheeling, the biasing element **104** contacts the pawl pads **164** and presses the pawls **106***a-c* inward towards the center of the hub **100**, allowing the ratchet gear **180** to rotate freely around the ratchet pawls **106***a-c* with no contact, and consequently no sound. In particular, as described above, the biasing element **104** is able to be sized such that it provides a constant inward force towards the hub center axis **6** on the pawl spring pads **164** throughout the entire free range of the pawls **106***a-c* within the assembly **1**. This force may be controlled by sizing the resting diameter of the shape of the elongated body of the biasing element **104**, by choosing the strength/flexibility of the material of the biasing element **104** and/or the diameter of the body of the biasing element **104**.

[0068] Depending on how the hub deadband distance has been configured, the pusher stop wall **152** is able to be pressed against either the freehub stop surface **136** or the deadband adjustment key block **232** (if the deadband adjustment key **108** is installed in the hub **100**). If the deadband adjustment key **108** is not installed, the parts of the hub will be resting in the configuration shown in FIG. **20**. If the deadband adjustment key **108** is installed, the parts will be resting in the configuration shown in FIG. **19**.

[0069] The deadband of the hub **1** is developed as the rider transitions from coasting to moving the pedal cranks **208** and actively pedaling the bicycle **200** forward. As the pedal cranks **208** begin moving, the freehub bearing assembly **102** begins rotating clockwise relative to the hub center axis **6**, until the speed of the freehub bearing assembly **102** matches the rolling speed of the hub shell assembly **30**. Once these rotational velocities match, the pusher stem **142** is stationary relative to the one-way clutch **42**, and therefor as the one-way clutch **42** begins to develop a torque against the pusher stem **142**, and thus the pawl pusher **140** begins to rotates in the opposing direction (e.g. counter-clockwise) relative to the freehub bearing assembly **102**. As this rotation occurs, the pusher cam surface **166** of the pawls **106***a-c* moves towards and comes into contact with the pawl surface **148** of the pusher fingers **144***a-c*. Once this happens the ratchet pawls **106***a-c* begin to pivot about the pawl cylinder **160**, such that the pawl tip radius **170** moves outward towards the ratchet gear **180**. Since the ratchet gear **180** may still be rotating relative to the freehub bearing assembly **102**, the pawl tip radius **170** contacts the ratchet gear **180** in a random location based on when the pedal stroke is started, the speed of the wheel, and other factors. Once this contact occurs, the pawl tip radius **170** slides over the ratchet tooth sliding face **188** until the pawl driving surface **168** contacts the ratchet tooth receiving face **186**. Once this contact occurs, torque is transferred from the freehub bearing assembly **102** to the hub shell assembly **30** via the ratchet pawls **106***a-c* in compression against the teeth **185**.

[0070] Once underway, the rider may cease pedaling to resume freewheeling. When torque is no longer applied to the freehub bearing assembly **102**, the ratchet gear **180** resumes (e.g. clockwise) rotation relative to the freehub bearing assembly **102**, and the ratchet pawl **106** is forced away from the ratchet ring **180** as the pawl tip radius **170** slides back down the ratchet tooth sliding face **188** (and/or due to the inward biasing force applied by the biasing element **104**). Simultaneously, the pawl pusher **140** is free to rotate (e.g. clockwise) with the hub shell assembly **30**, and is able to be helped along by the sliding contact between the pawl surface **148** of the pusher **140** and the pusher cam surface **166** of the pawls **106***a-c*. Once the ratchet pawls **106***a-c* have moved to the retracted position, the pawl pusher **140** continues rotating clockwise relative to the freehub bearing assembly **102** owing to the parasitic free-running drag between the pusher stem **142** and the one-way clutch **42**.

[0071] FIG. **23** illustrates a method of providing a hub assembly **1** according to some embodiments. As shown in FIG. **23**, a toothed ratchet gear **180** is positioned within a ratchet gear bore **38** of the hub shell assembly **30** at the step **2302**. The ratchet gear **180** is able to be aligned within the bore **38** such that splines **184** slide into corresponding hub shell spine channels **40** thereby preventing rotation of the gear **180** within the bore **38** with respect to the hub shell assembly **30**. A freehub assembly **100** is provided at the step **2304**. The freehub assembly **100** is coupled with the hub shell assembly **30** at the step **2306**. In some embodiments, the coupling is able to comprise positioning an inner side of the pawl support member **102** is positioned the toothed ratchet gear **180** such that when the freehub assembly **100** is rotated in a first direction with respect to the hub shell assembly **30**, the plurality of pawls **106** are able to pivot away from the pawl support member **102** (e.g. away from the deadband surface and/or the deadband recesses **132**) until the plurality of pawls **106** engage teeth **185** of the toothed ratchet gear **180** causing the hub shell assembly **30** to rotate with the freehub assembly **100** in the first direction. In some embodiments, the method further comprises selectively inserting or removing a deadband adjustment key **108** within a deadband adjustment key slot **138** and/or selecting a deadband adjustment key **108** having a block **232** of a desired size. In particular, the method is able to comprise sliding trunk **234** of the deadband adjustment key **108** into the key slot **138** such that the block **232** of the deadband adjustment key **108** extends into the one of the deadband recesses **132** adjacent to one of the stop walls **136**. Thus, when the freehub assembly **100** rotates with respect to the hub shell assembly **30** in a second direction, each of the pushing fingers **144** slide along the deadband surface until one of the pushing fingers **144** abuts the block **232** of the deadband adjustment key **108** (thereby reducing the size of the deadband within the hub assembly **1**).

[0072] As a result, the method provides the advantage of providing a hub assembly having pawls **106** biased away from the ratchet gear **180** thereby ensuring a non-zero deadband length (regardless of the relative position of the pawls **106** and the teeth **185**) and/or a silent hub assembly. Further, the method provides the advantage of enabling adjustment of a deadband length/amount of the hub assembly via a deadband adjustment key (to reduce or adjust kickback and/or sound produced by the hub) as desired by the user.

[0073] The system, method and device described herein has numerous advantages. In particular, the system, method and device provide the advantage of providing a hub assembly having pawls biased away from the ratchet gear thereby ensuring a non-zero deadband length (regardless of the relative position of the pawls and the teeth). Further, the system, method and device provides the advantage of enabling adjustment of a deadband length/amount of the hub assembly via a deadband adjustment key (to reduce or adjust kickback and/or sound produced by the hub) as desired by the user. Additionally, the system, method and device provide the advantage of enabling the deadband distance to be adjusted and/or configured for silent freewheeling.

[0074] The present invention has been described in terms of specific embodiments incorporating details to facilitate the understanding of the principles of construction and operation of the invention. Such references, herein, to specific embodiments and details thereof are not intended to limit the scope of the claims appended hereto. It will be apparent to those skilled in the art that modifications can be made in the embodiments chosen for illustration without departing from the spirit and scope of the invention. For example, although the hub assembly **1** is described herein with respect to a bicycle wheel, it is understood that the assembly **1**, hub shell assembly **30** and/or the freehub assembly **100** are able to operate in the same manner and be incorporated into other vehicles or devices to provide a ratchet mechanism/function. Further, although the assembly **1** is described herein with respect to a rear wheel, it is understood that the assembly **1**, hub shell assembly **30** and/or the freehub assembly **100** are able to operate in the same manner and be incorporated into other wheels and/or non-wheels using axle/rotation based mechanisms the require a ratcheting function.

What is claimed is:

1. A bicycle hub system, the system comprising:

a bicycle wheel including a hub shell assembly, the hub shell assembly having a central aperture for receiving an axle, a ratchet gear bore and a toothed ratchet gear positioned within the ratchet gear bore; and

a freehub assembly including an outer hub sprocket attachment feature, a pawl support member having a plurality of pawl pivot channels, a plurality of pawls pivotably coupled within the pivot channels, and a biasing member that applies a biasing force to the plurality of pawls that resists the pivoting of the plurality of pawls away from a deadband surface of the pawl support member;

wherein the pawl support member is positioned within the toothed ratchet gear such that when the freehub assembly is rotated in a first direction with respect to the hub shell assembly, the plurality of pawls are able to pivot away from the pawl support member until the plurality of pawls engage teeth of the toothed ratchet gear causing the hub shell assembly to rotate with the freehub assembly in the first direction.

2. The system of claim **1**, wherein the biasing member is a spring that impedes the pivoting of the plurality of pawls away from the pawl support member.

3. The system of claim **2**, wherein each the plurality of pawls include a groove for receiving the biasing member.

4. The system of claim **1**, wherein when fully rotated toward the deadband surface, the plurality of pawls are unable to contact the teeth of the toothed ratchet gear.

5. The system of claim **1**, further comprising a pawl pusher having a plurality of pushing fingers positioned along the deadband surface of the pawl support member.

6. The system of claim **5**, wherein when the freehub assembly is rotated in the first direction with respect to the hub shell assembly, the pushing fingers slide along the deadband surface of the pawl support member and push against tips of the plurality of pawls and thereby forcing the plurality of pawls to pivot away from the deadband surface of the pawl support member.

7. The system of claim **6**, wherein the hub shell assembly further comprises a one-way clutch that is operatively coupled with the pawl pusher such that the clutch prevents rotation of the pushing fingers in the first direction with respect to the hub shell assembly and thereby causes the pushing fingers to slide along the deadband surface when the freehub assembly is rotated in the first direction with respect to the hub shell assembly.

8. The system of claim **5**, wherein the deadband surface extends between each of the pivot channels and a corresponding stop wall of a plurality of stop walls of the pawl support member thereby forming a plurality of deadband cavities adjacent to the deadband surface.

9. The system of claim **8**, wherein a different pair of one of the plurality of pawls and one of the plurality of pushing fingers is positioned at least partially within each of the deadband cavities when the plurality of pawls are fully rotated against the deadband surface.

10. The system of claim **9**, wherein when the freehub assembly rotates with respect to the hub shell assembly in a second direction opposite the first direction, each of the pushing fingers slides along the deadband surface until the pushing finger abuts one of the stop walls.

11. The system of claim **10**, wherein the freehub assembly further comprises a deadband adjustment key configured to selectively couple to a key slot of the pawl support member, the key slot positioned adjacent to one of the deadband recesses.

12. The system of claim **11**, wherein when coupled within the key slot, a block of the deadband adjustment key extends into the one of the deadband recesses adjacent to the stop wall such that when the freehub assembly rotates with respect to the hub shell assembly in the second direction, each of the pushing fingers slides along the deadband surface until one of the pushing fingers abuts the block of the deadband adjustment key.

13. The system of claim **1**, wherein the outer hub sprocket attachment feature is an outer cassette spline for coupling with one or more sprockets.

14. A bicycle hub assembly, the bicycle hub assembly comprising:

a toothed ratchet gear having a plurality of teeth; and

a freehub assembly including a pawl support member having a plurality of pawl pivot channels, a plurality of pawls pivotably coupled within the pivot channels, and a biasing member that applies a biasing force to the plurality of pawls that resists the pivoting of the plurality of pawls away from a deadband surface of the pawl support member;

wherein the pawl support member is positioned within the toothed ratchet gear such that when the freehub assembly is rotated in a first direction with respect to the toothed ratchet gear, the plurality of pawls are able to pivot away from the pawl support member until the plurality of pawls engage the teeth of the toothed ratchet gear causing the toothed ratchet gear to rotate with the freehub assembly in the first direction.

15. The assembly of claim **14**, wherein the biasing member is a spring that impedes the pivoting of the plurality of pawls away from the pawl support member.

16. The assembly of claim **15**, wherein each the plurality of pawls include a groove for receiving the biasing member.

17. The assembly of claim **14**, wherein when fully rotated toward the deadband surface, the plurality of pawls are unable to contact the teeth of the toothed ratchet gear.

18. The assembly of claim **14**, further comprising a pawl pusher having a plurality of pushing fingers positioned along the deadband surface of the pawl support member.

19. The assembly of claim **18**, wherein when the freehub assembly is rotated in the first direction with respect to the toothed ratchet gear, the pushing fingers slide along the deadband surface of the pawl support member and push against tips of the plurality of pawls and thereby forcing the plurality of pawls to pivot away from the deadband surface of the pawl support member.

20. The assembly of claim **19**, further comprising a one-way clutch that is operatively coupled with the pawl pusher such that the clutch prevents rotation of the pushing fingers in the first direction with respect to the toothed ratchet gear and thereby causes the pushing fingers to slide along the deadband surface when the freehub assembly is rotated in the first direction with respect to the toothed ratchet gear.

21. The assembly of claim **18**, wherein the deadband surface extends between each of the pivot channels and a corresponding stop wall of a plurality of stop walls of the pawl support member thereby forming a plurality of deadband cavities adjacent to the deadband surface.

22. The assembly of claim **21**, wherein a different pair of one of the plurality of pawls and one of the plurality of pushing fingers is positioned at least partially within each of the deadband cavities when the plurality of pawls are fully rotated against the deadband surface.

23. The assembly of claim **22**, wherein when the freehub assembly rotates with respect to the toothed ratchet gear in a second direction opposite the first direction, each of the pushing fingers slides along the deadband surface until the pushing finger abuts one of the stop walls.

24. The assembly of claim **23**, wherein the freehub assembly further comprises a deadband adjustment key configured to selectively couple to a key slot of the pawl support member, the key slot positioned adjacent to one of the deadband recesses.

25. The assembly of claim **24**, wherein when coupled within the key slot, a block of the deadband adjustment key extends into the one of the deadband recesses adjacent to the stop wall such that when the freehub assembly rotates with respect to the toothed ratchet gear in the second direction, each of the pushing fingers slides along the deadband surface until one of the pushing fingers abuts the block of the deadband adjustment key.

26. The assembly of claim **14**, wherein the freehub assembly includes an outer hub sprocket attachment feature for coupling with one or more sprockets.

27. A method of providing a bicycle hub system, the method comprising:

providing a hub shell assembly including a toothed ratchet gear positioned within a ratchet gear bore, the hub shell assembly for coupling with a bicycle wheel rim via a plurality of spokes; and

providing a freehub assembly including an outer hub sprocket attachment feature, a pawl support member having a plurality of pawl pivot channels, a plurality of pawls pivotably coupled within the pivot channels, and a biasing member that applies a biasing force to the plurality of pawls that resists the pivoting of the plurality of pawls away from a deadband surface of the pawl support member; and

coupling the freehub assembly with the hub shell assembly such that the pawl support member is positioned within the toothed ratchet gear and when the freehub assembly is rotated in a first direction with respect to the hub shell assembly, the plurality of pawls are able to pivot away from the pawl support member until the plurality of pawls engage teeth of the toothed ratchet gear causing the hub shell assembly to rotate with the freehub assembly in the first direction.

28. The method of claim **27**, wherein the biasing member is a spring that impedes the pivoting of the plurality of pawls away from the pawl support member.

29. The method of claim **28**, wherein each the plurality of pawls include a groove for receiving the biasing member.

30. The method of claim **27**, wherein when fully rotated toward the deadband surface, the plurality of pawls are unable to contact the teeth of the toothed ratchet gear.

31. The method of claim **27**, wherein the freehub assembly further comprises a pawl pusher having a plurality of pushing fingers positioned along the deadband surface of the pawl support member.

32. The method of claim **31**, wherein when the freehub assembly is rotated in the first direction with respect to the hub shell assembly, the pushing fingers slide along the deadband surface of the pawl support member and push against tips of the plurality of pawls and thereby forcing the plurality of pawls to pivot away from the deadband surface of the pawl support member.

33. The method of claim **32**, wherein the hub shell assembly further comprises a one-way clutch that is operatively coupled with the pawl pusher such that the clutch prevents rotation of the pushing fingers in the first direction with respect to the hub shell assembly and thereby causes the pushing fingers to slide along the deadband surface when the freehub assembly is rotated in the first direction with respect to the hub shell assembly.

34. The method of claim **31**, wherein the deadband surface extends between each of the pivot channels and a corresponding stop wall of a plurality of stop walls of the pawl support member thereby forming a plurality of deadband cavities adjacent to the deadband surface.

35. The method of claim **34**, wherein a different pair of one of the plurality of pawls and one of the plurality of pushing fingers is positioned at least partially within each of the deadband cavities when the plurality of pawls are fully rotated against the deadband surface.

36. The method of claim **35**, wherein when the freehub assembly rotates with respect to the hub shell assembly in a second direction opposite the first direction, each of the pushing fingers slides along the deadband surface until the pushing finger abuts one of the stop walls.

37. The method of claim **36**, wherein the freehub assembly further comprises a deadband adjustment key configured to selectively couple to a key slot of the pawl support member, the key slot positioned adjacent to one of the deadband recesses.

38. The method of claim **37**, further comprising sliding the deadband adjustment key into the key slot such that a block of the deadband adjustment key extends into the one of the deadband recesses adjacent to the stop wall and when the freehub assembly rotates with respect to the hub shell assembly in the second direction, each of the pushing fingers slides along the deadband surface until one of the pushing fingers abuts the block of the deadband adjustment key.

39. The method of claim **27**, wherein the outer hub sprocket attachment feature is an outer cassette spline for coupling with one or more sprockets.

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