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Gerhardt et al.

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(54) **CASSETTE DRIVER FOR A FREEWHEEL HUB**

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(51) **Int. Cl.**

F16D 41/28	(2006.01)
B60B 27/02	(2006.01)
B60B 27/04	(2006.01)

(52) **U.S. Cl.**

CPC ***F16D 41/28*** (2013.01); ***B60B 27/023*** (2013.01); ***B60B 27/047*** (2013.01); *B60B 2320/10* (2013.01); *B60B 2360/104* (2013.01); *B60B 2900/111* (2013.01)

(58) **Field of Classification Search**

CPC ... F16D 41/28; B60B 27/023; B60B 2900/11; B60B 2360/10; B60B 2360/104

USPC 301/110.5; 403/359.1, 359.6; 474/152, 474/902

See application file for complete search history.

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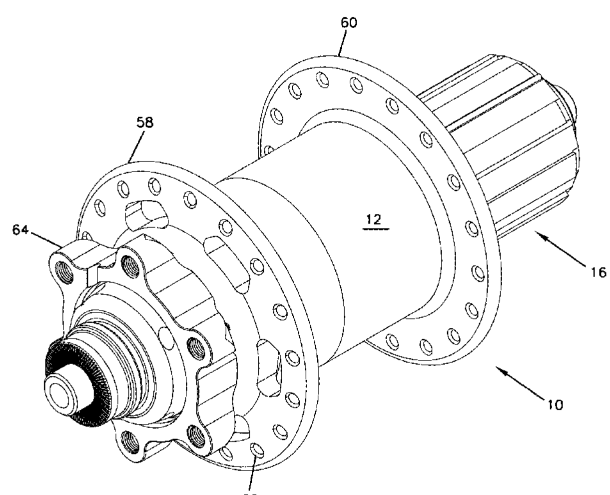
(57) **ABSTRACT**

Forward movement of a bicycle results when force is transfer from the chain or belt to a sprocket on a cassette. The cassette is splined to the cassette driver and causes the wheel of the bike to rotate when torque is applied from the cassette to the cassette driver. The cassette driver is typically made of a strong hard material such as steel to withstand the forces in parted thereon by the cassette. The present disclosure provide a hub configuration and method that enables the cassette driver to be made with construction of a lighter weight material such as aluminum yet still withstand the toque applied thereto.

19 Claims, 17 Drawing Sheets



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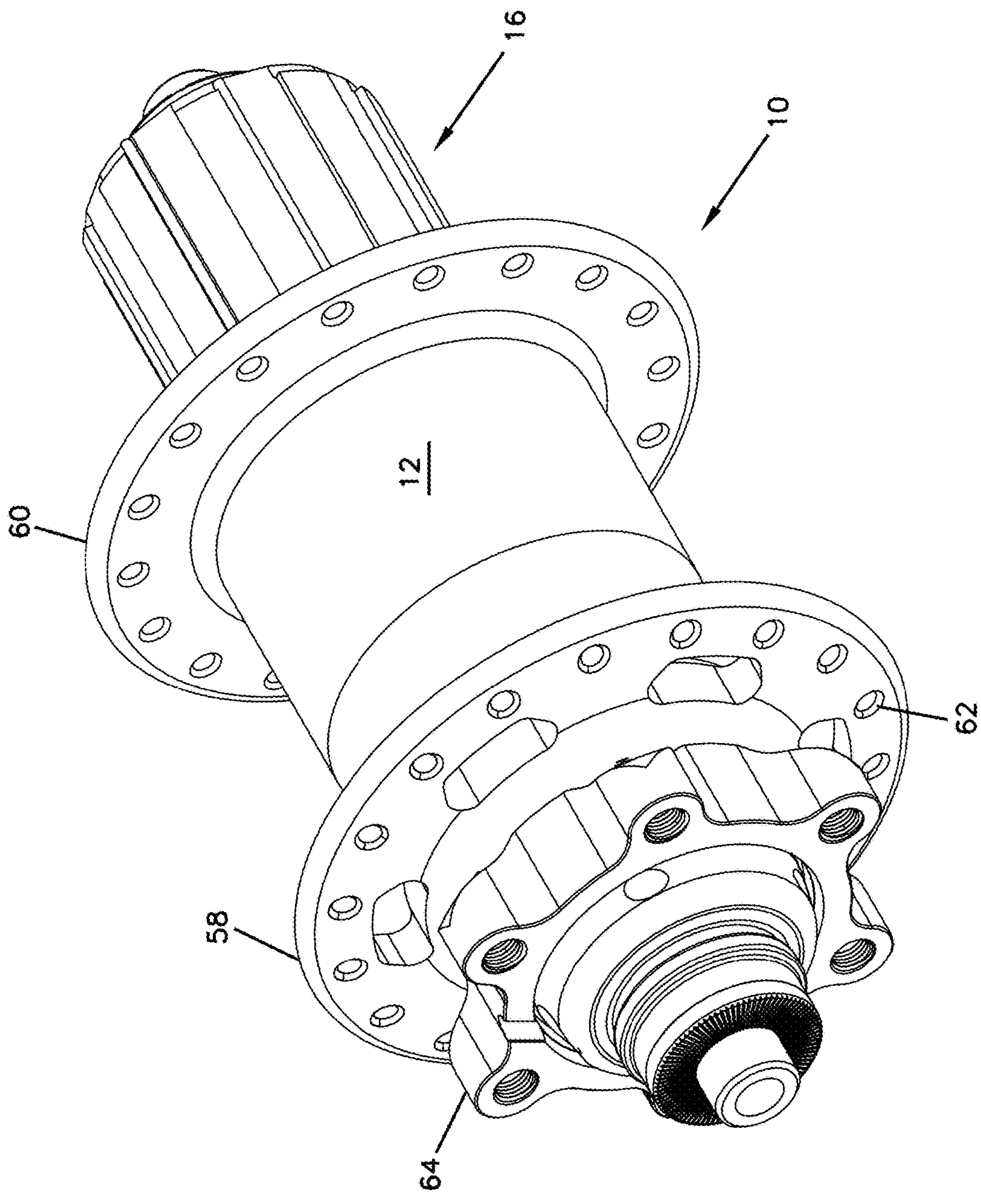

FIG. 1

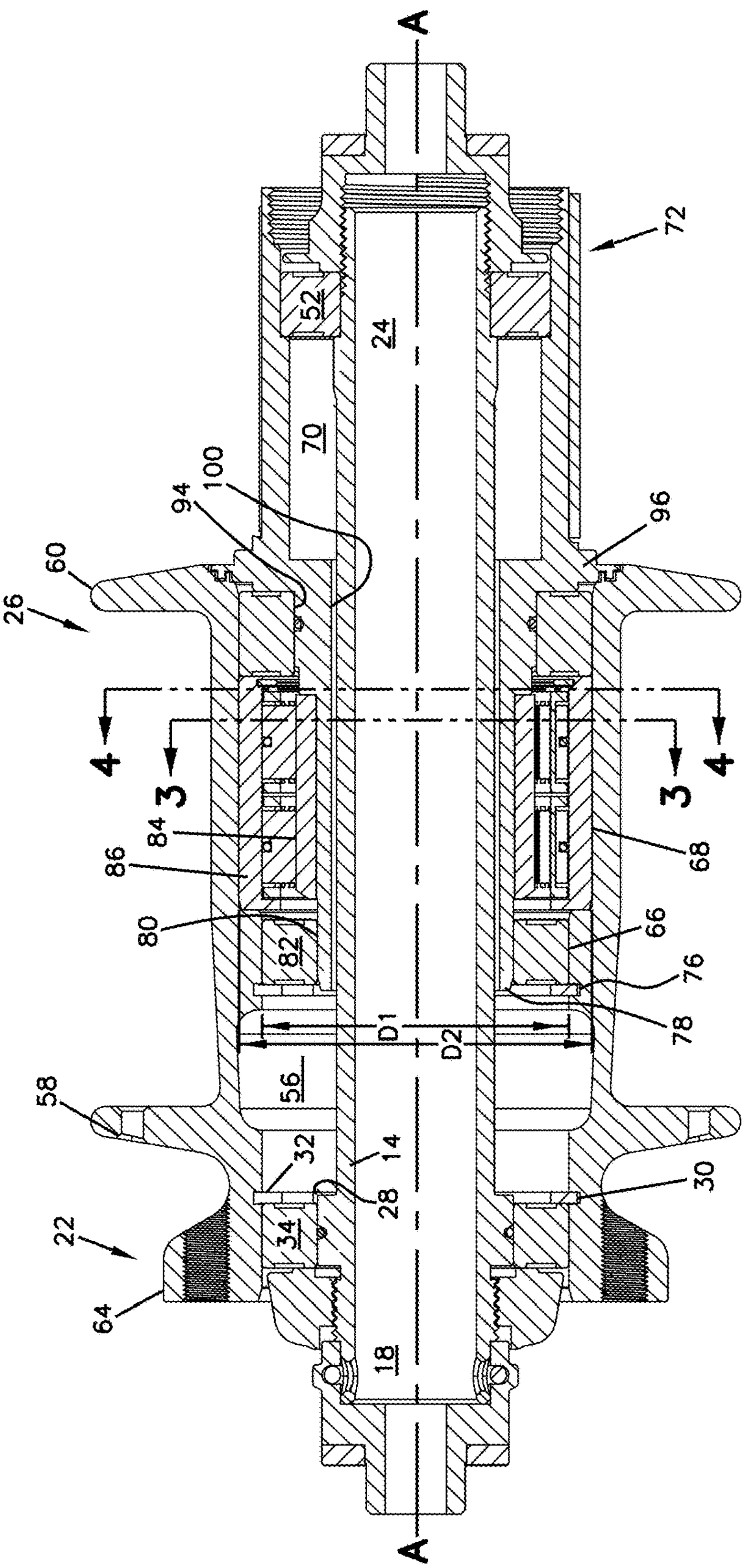
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FIG. 2

FIG. 3

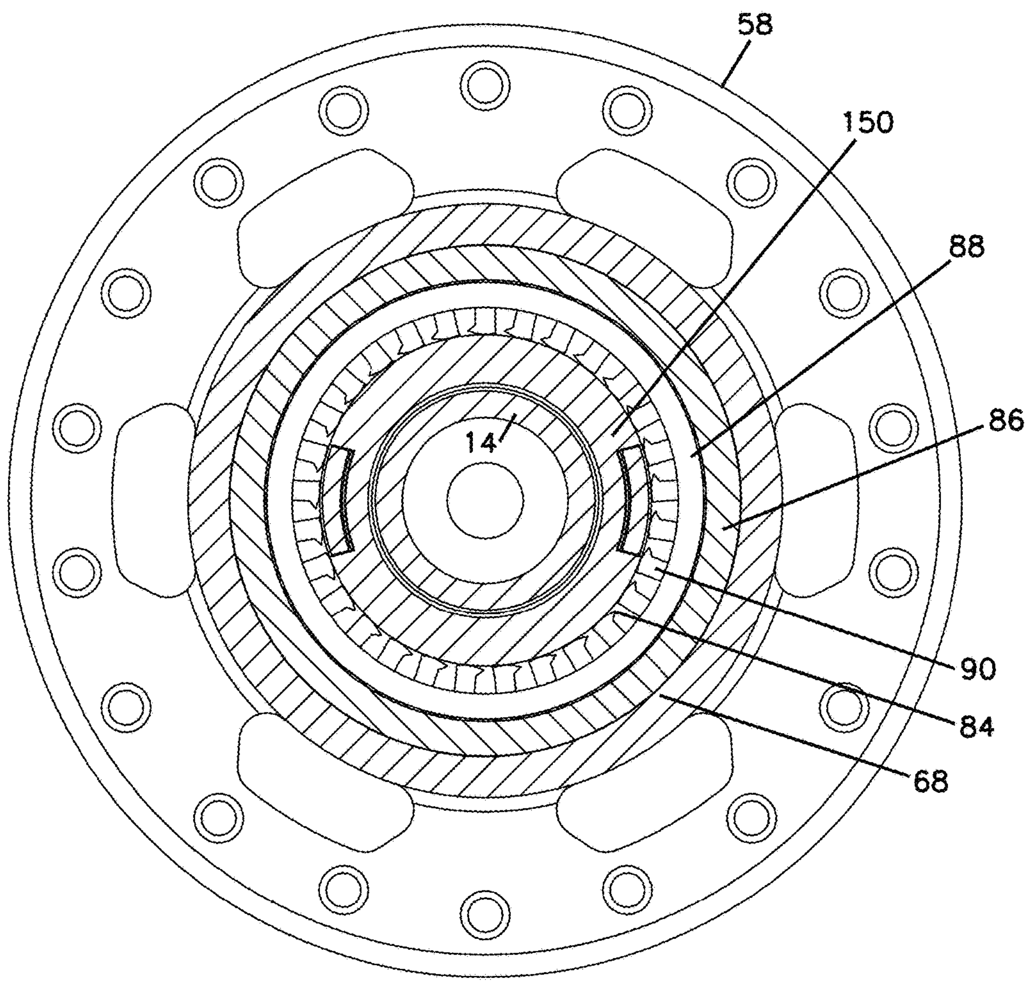
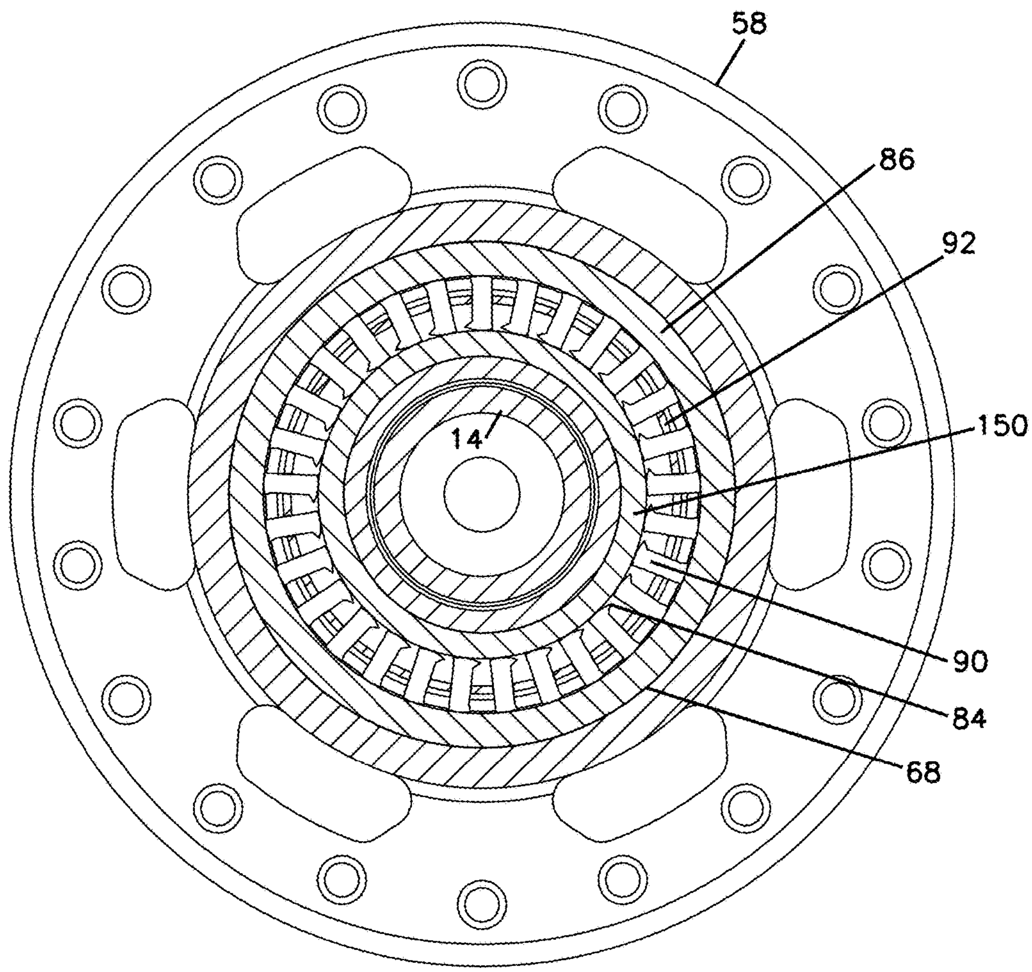


FIG. 4



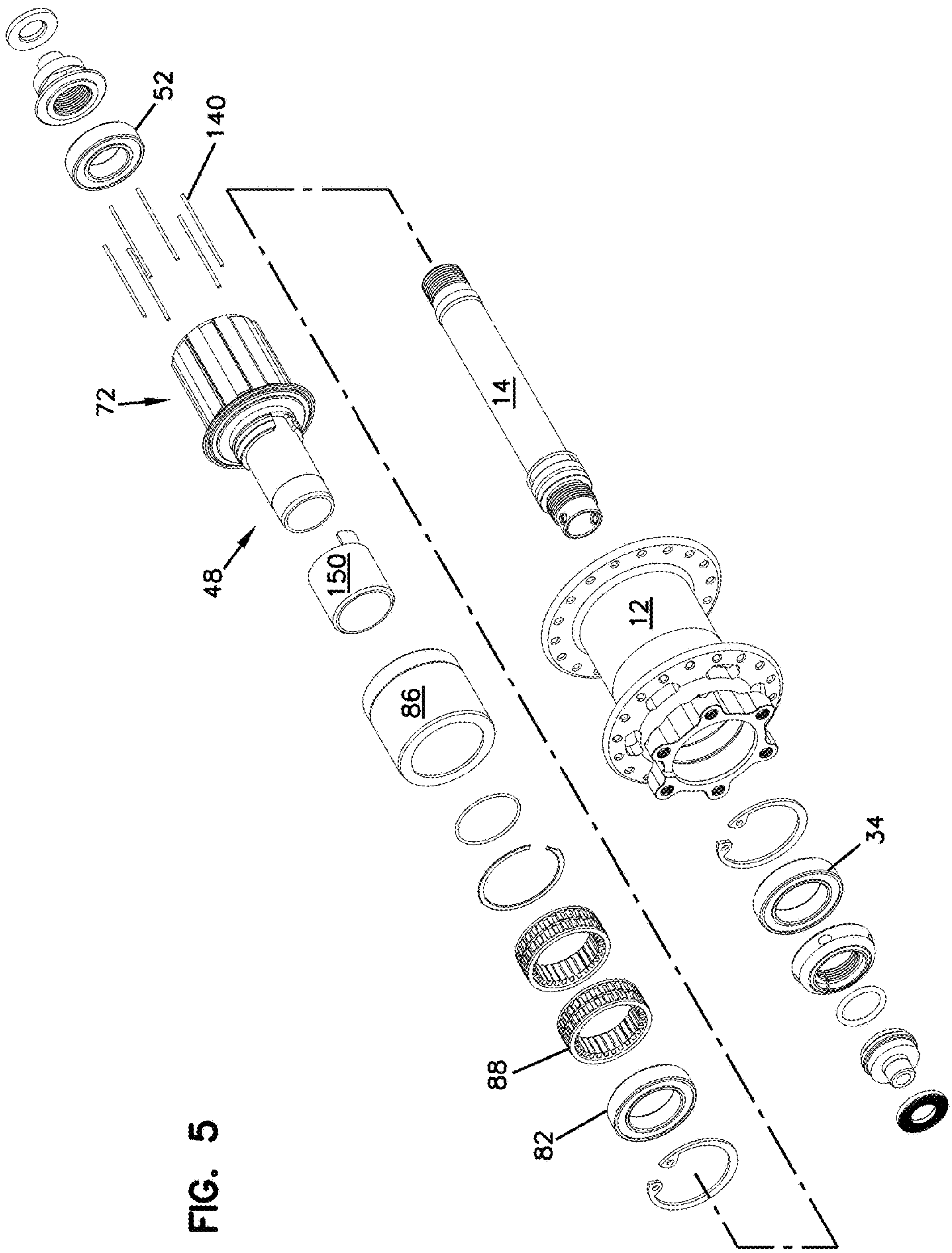


FIG. 5

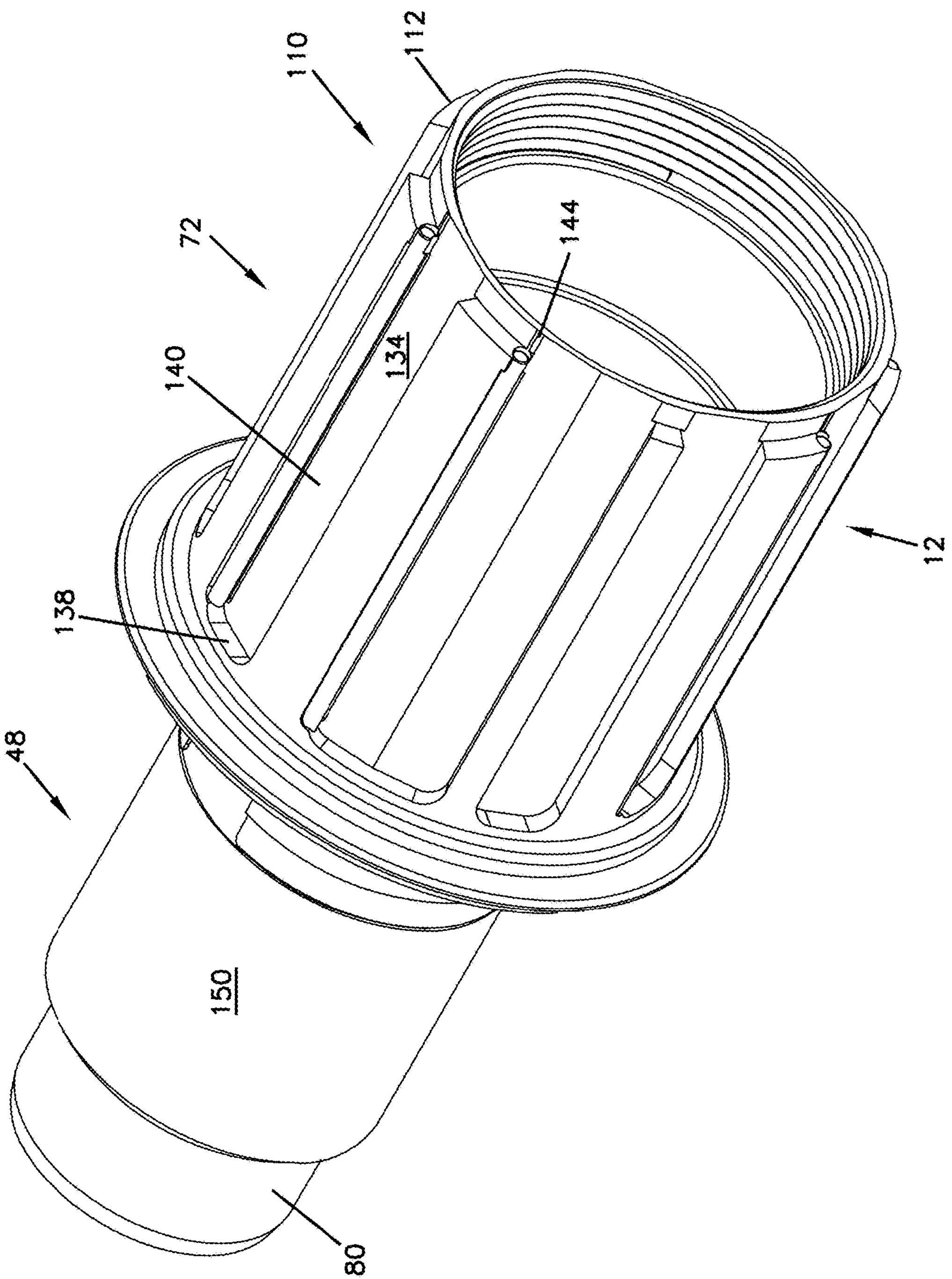


FIG. 6

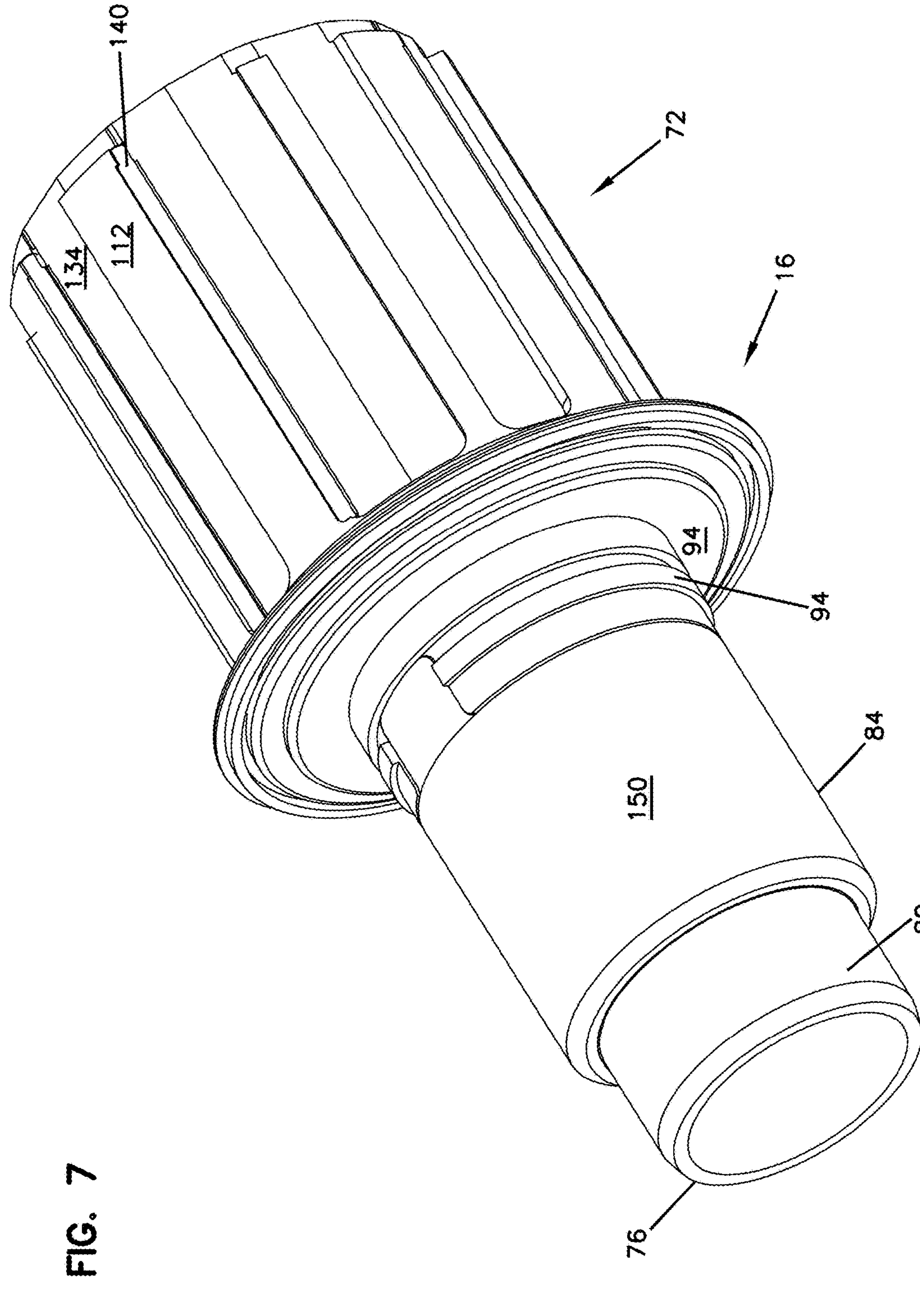


FIG. 7

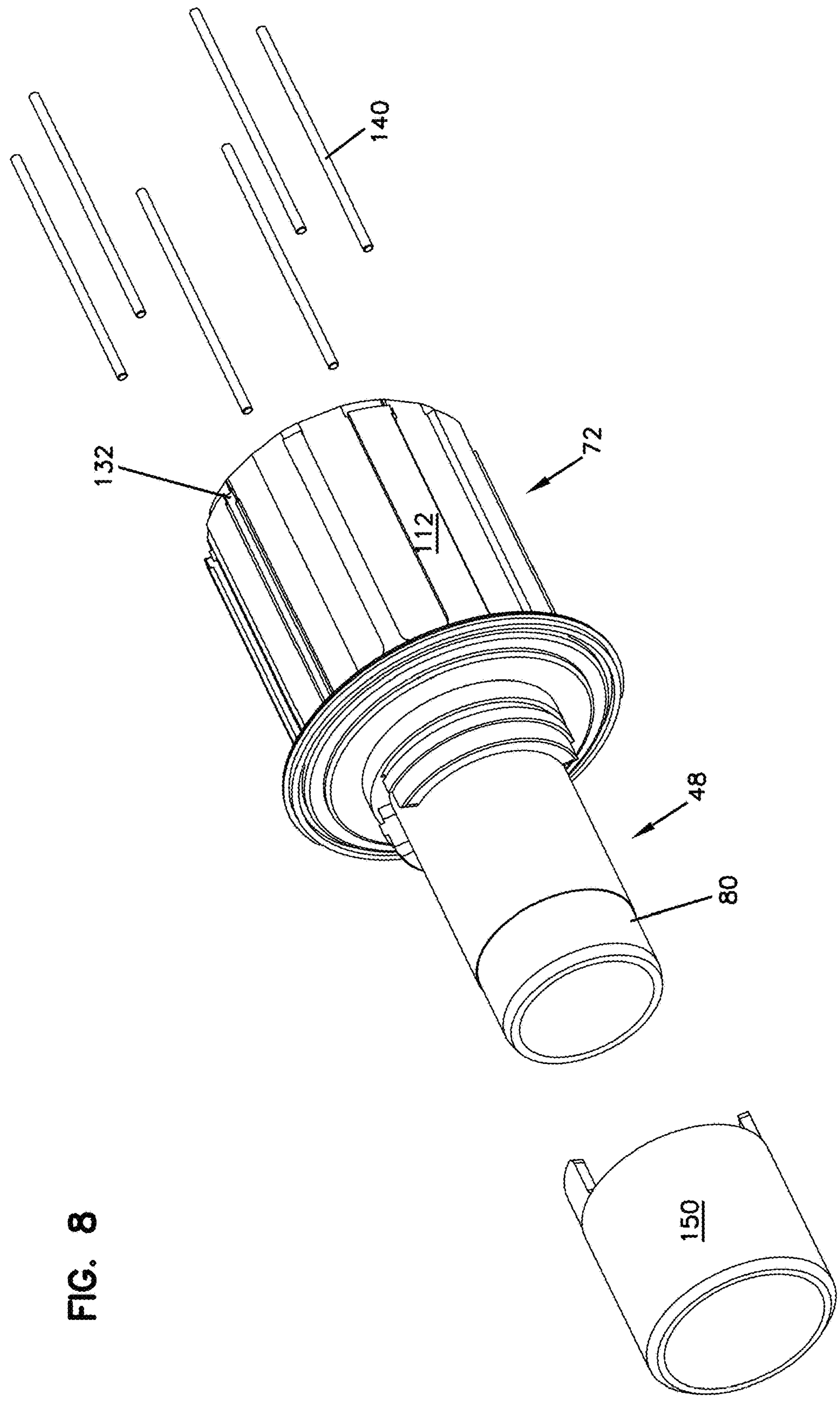


FIG. 8

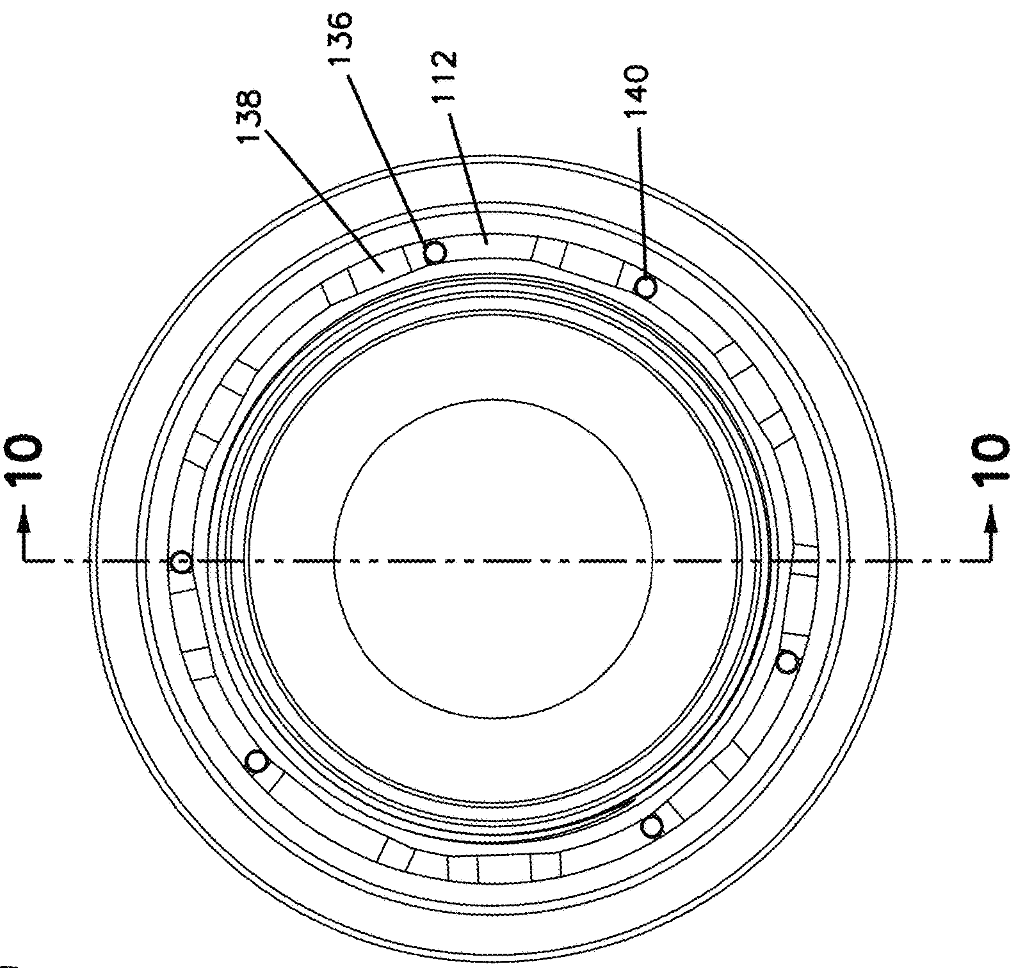


FIG. 9

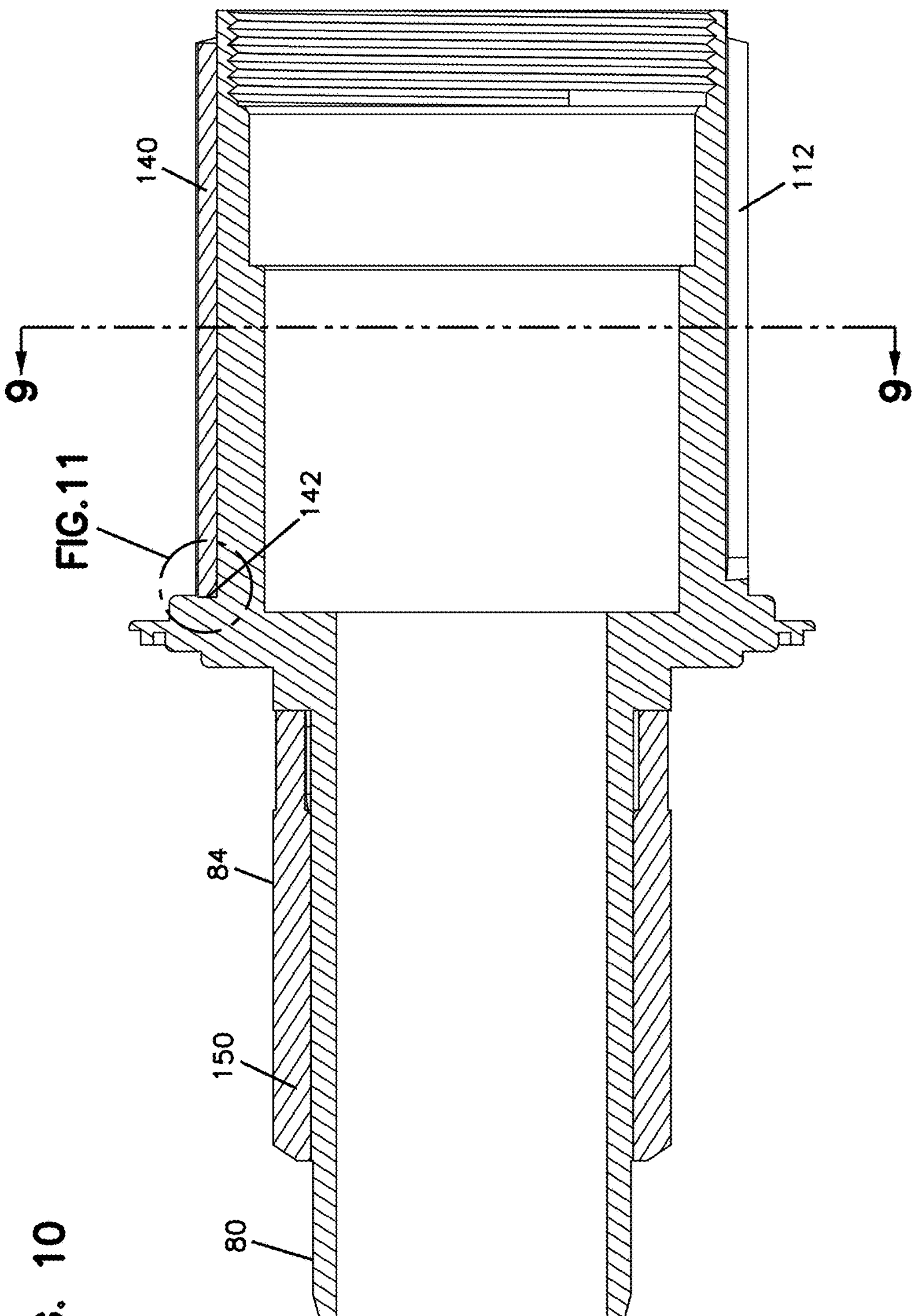


FIG. 10

FIG. 11

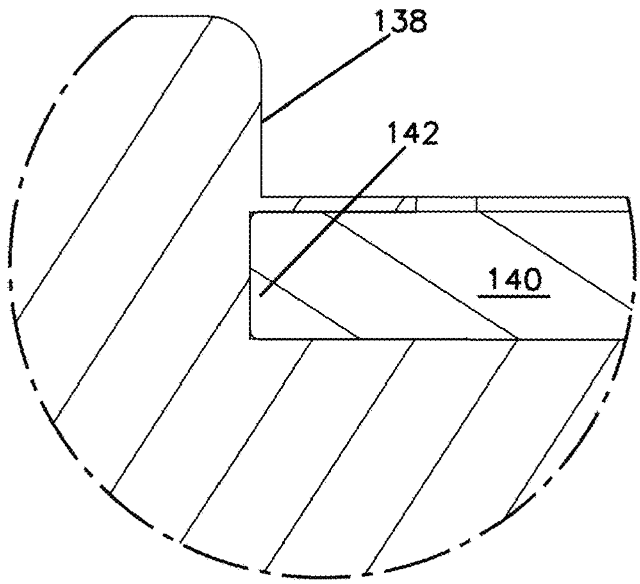
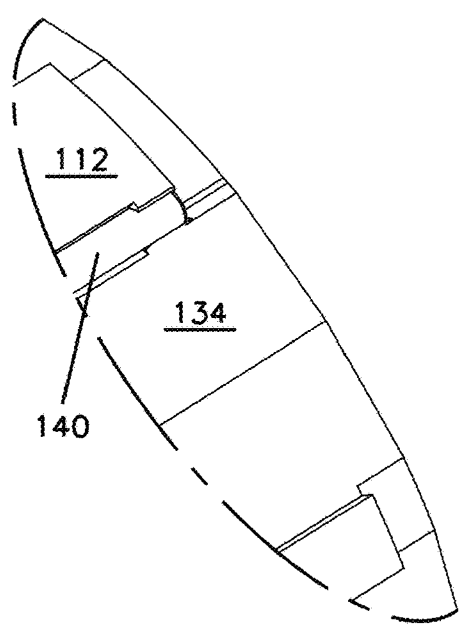


FIG. 12



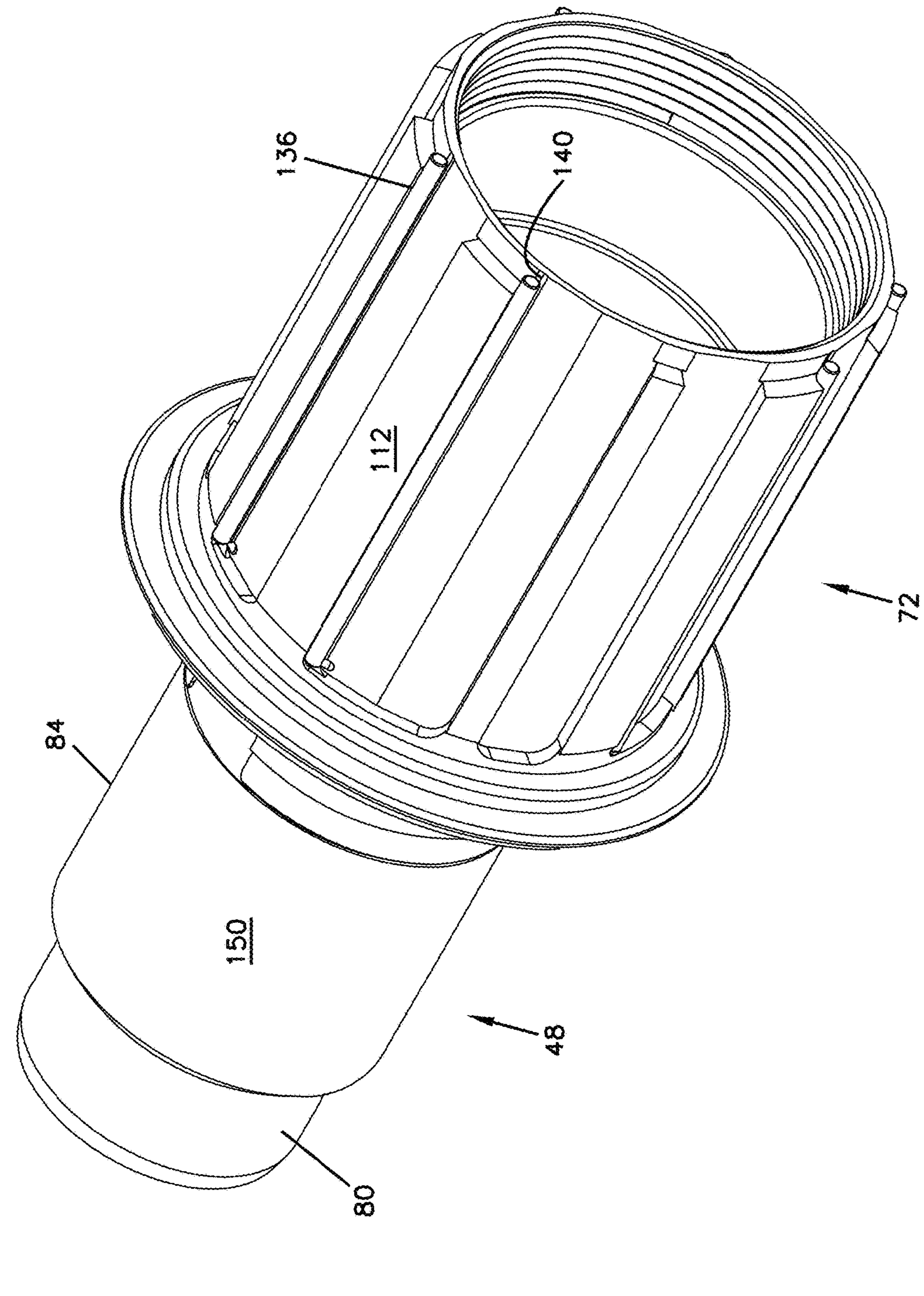


FIG. 13

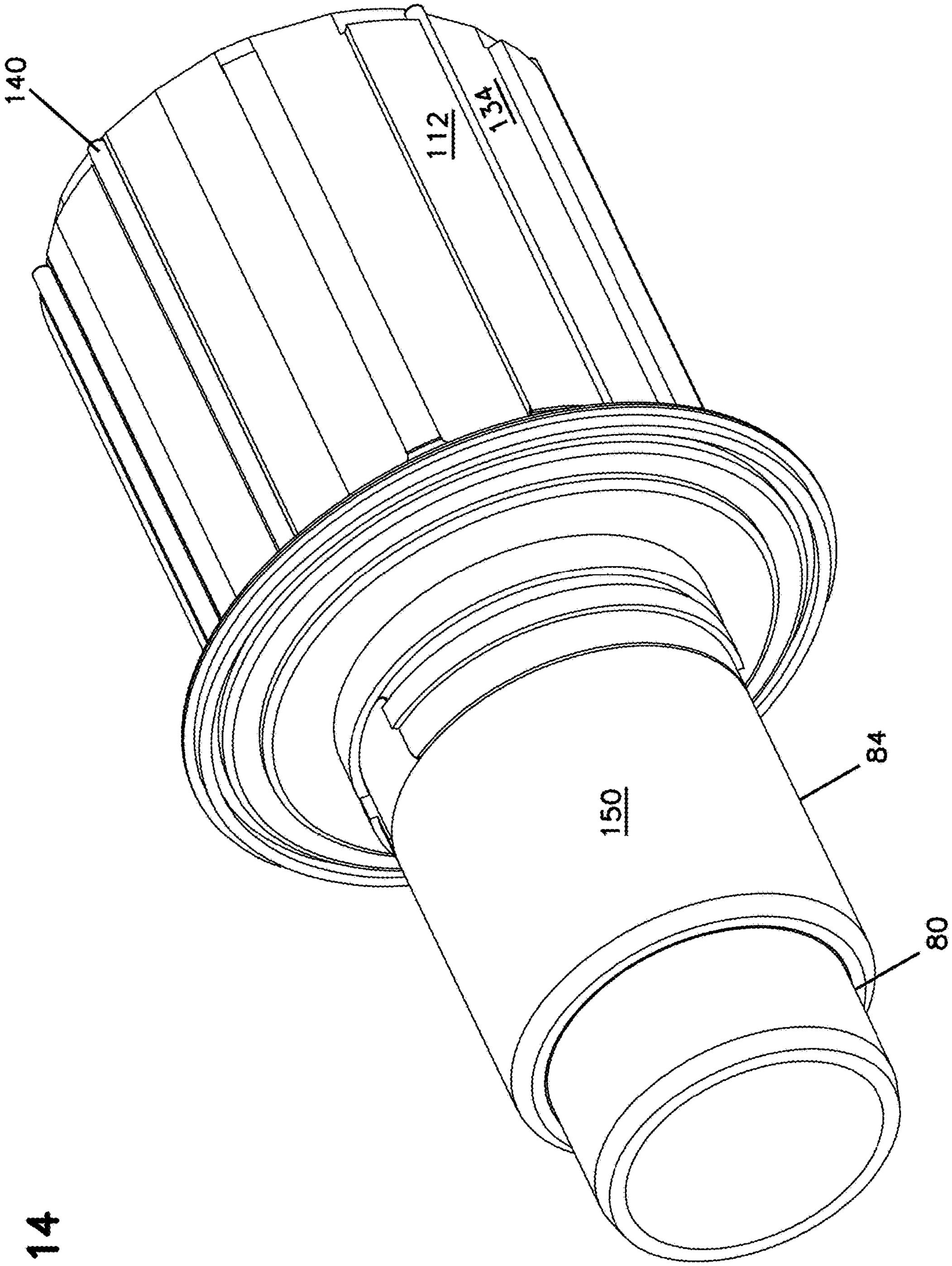


FIG. 14

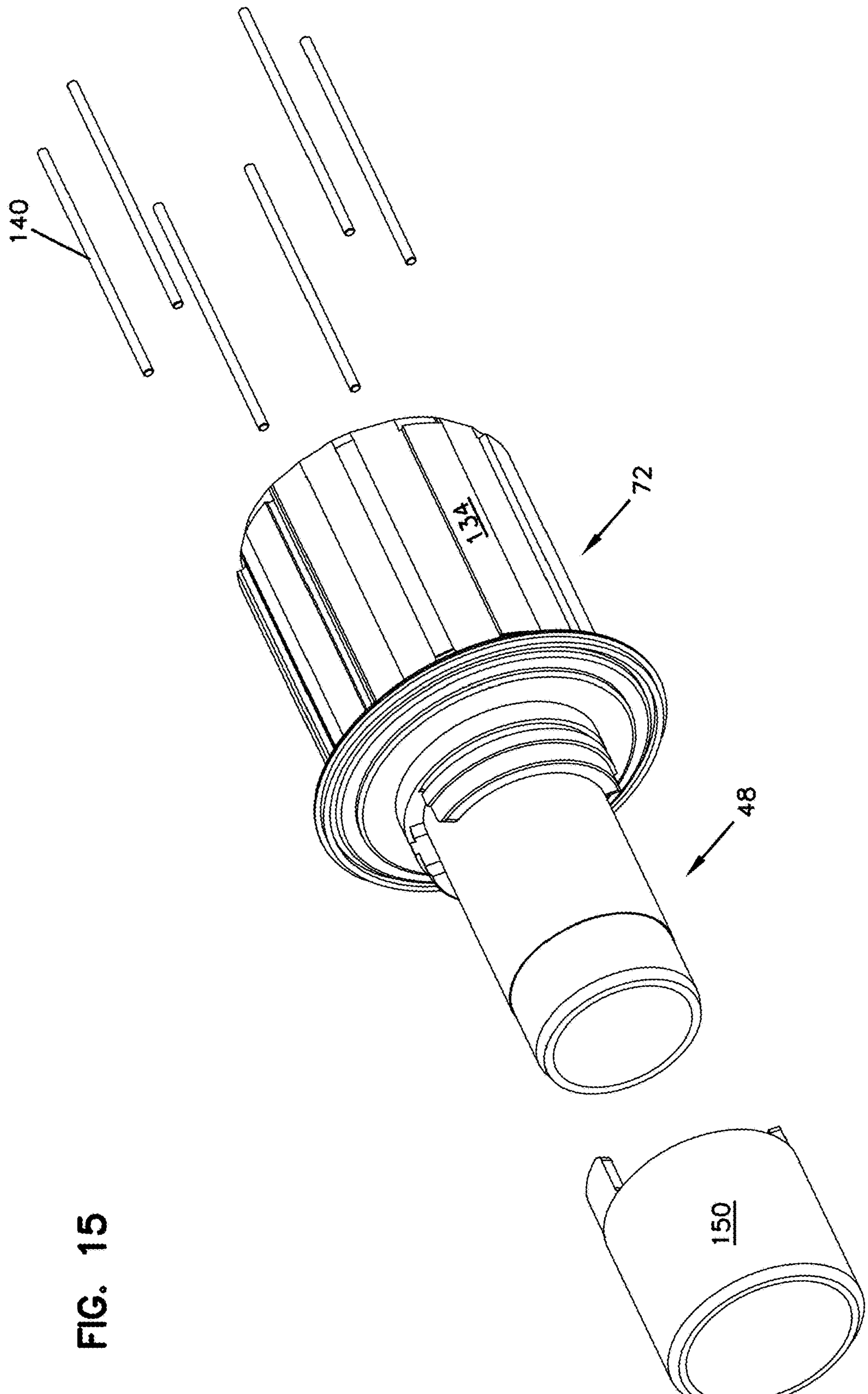
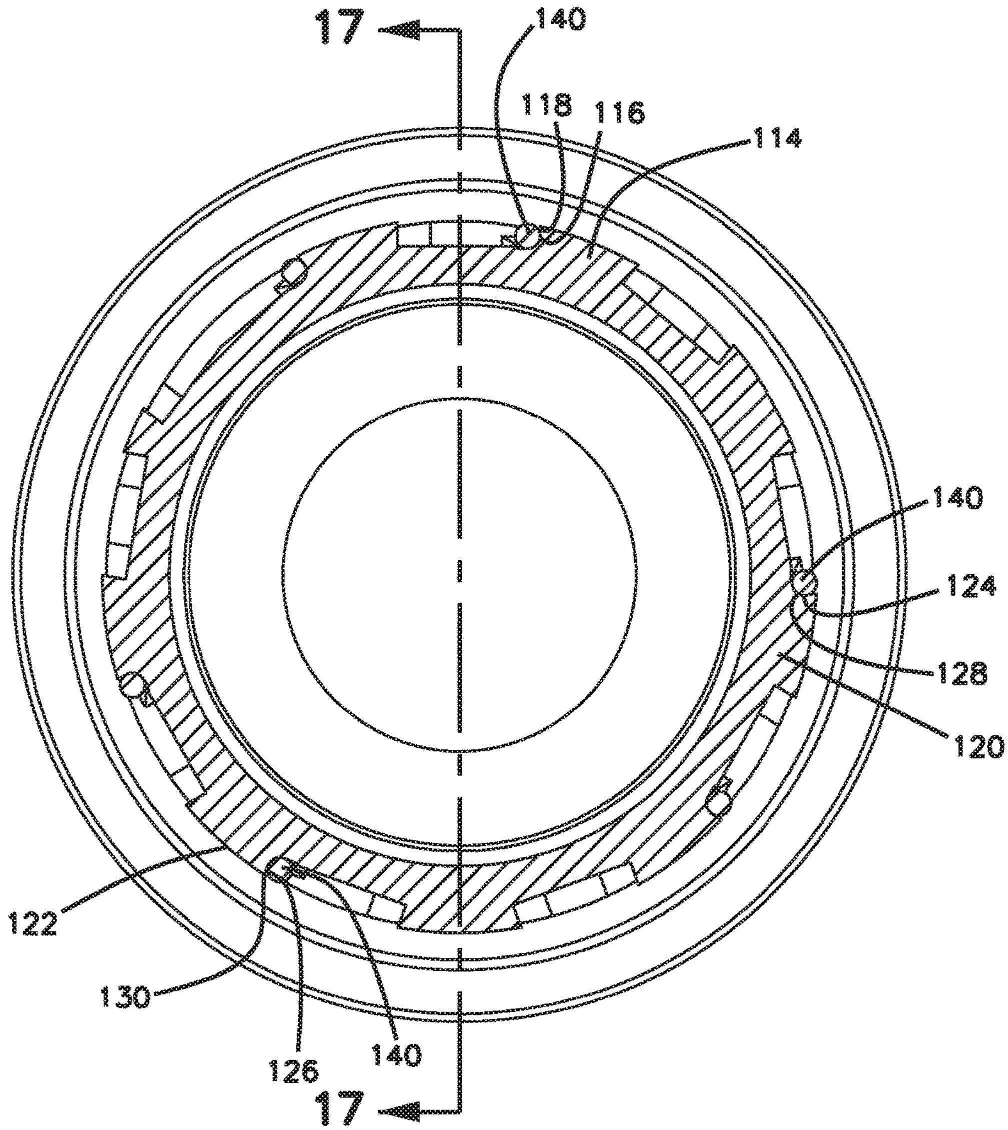


FIG. 15

FIG. 16



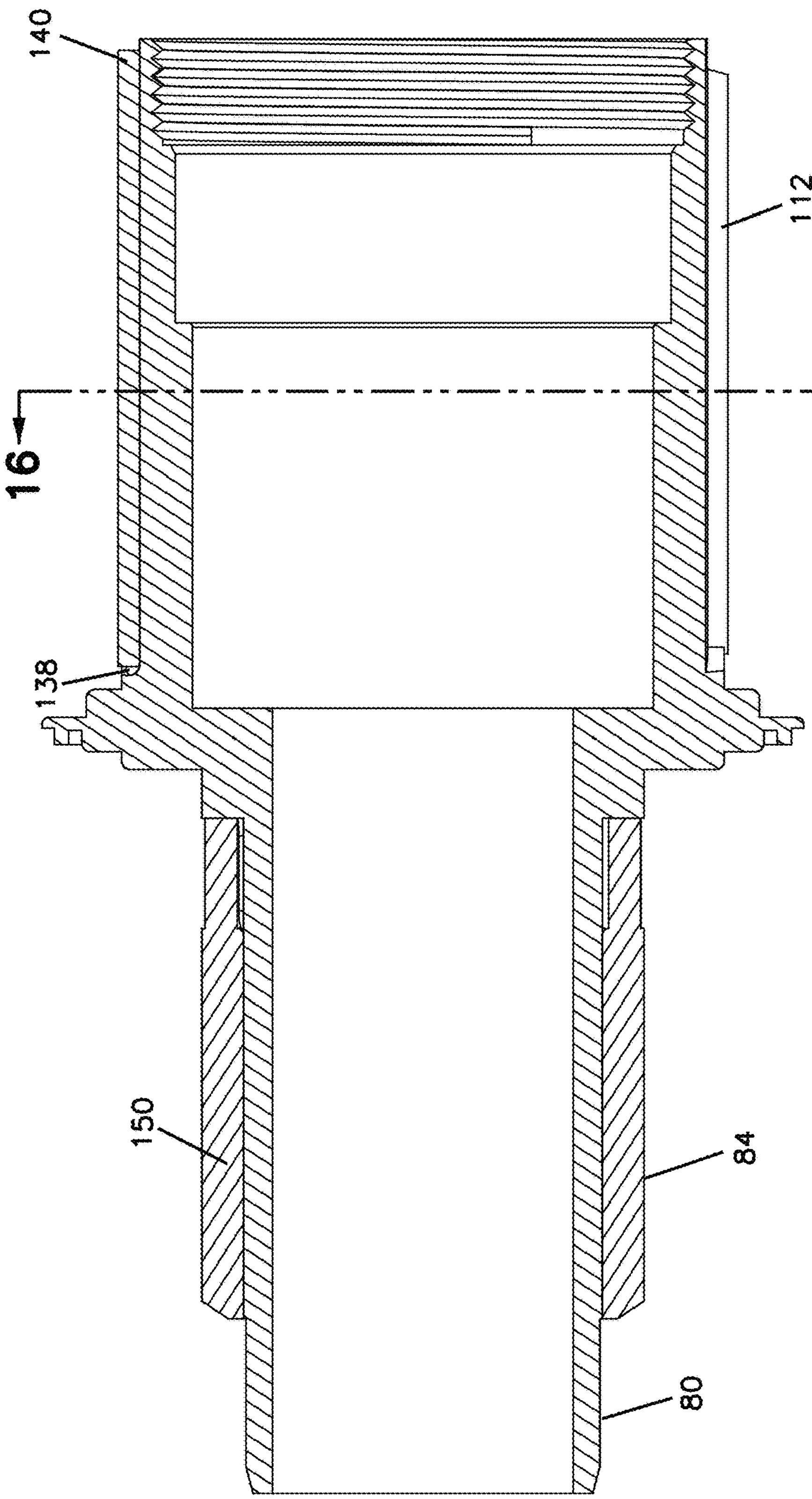
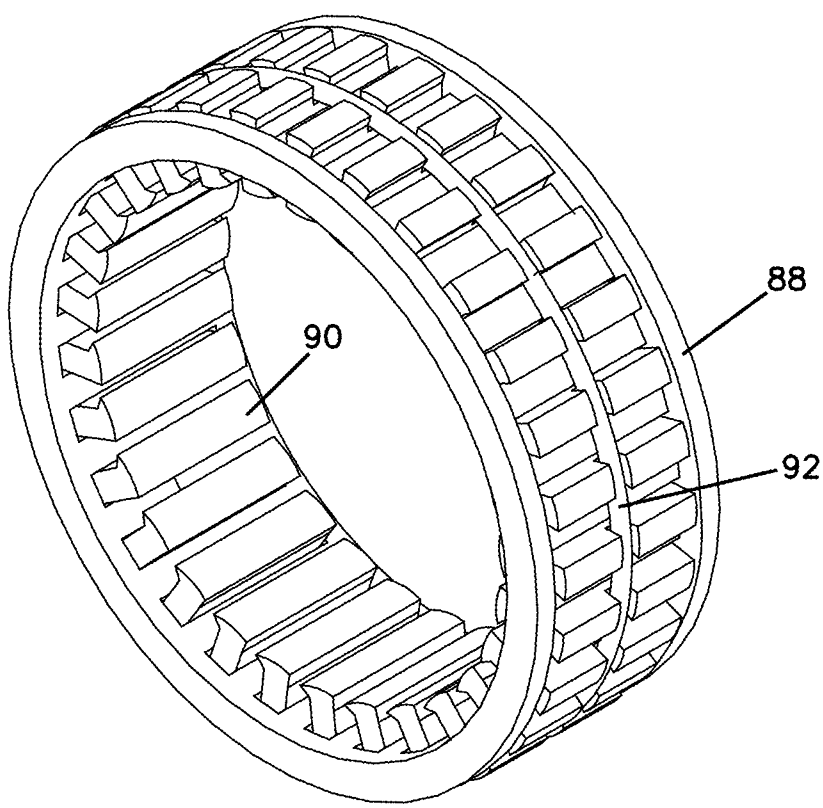


FIG. 17

FIG. 18



CASSETTE DRIVER FOR A FREEWHEEL HUB

TECHNICAL FIELD

A cassette driver for a freewheel hub.

BACKGROUND

Freewheeling bicycle hubs are generally known. For example, U.S. Pat. No. 2,211,548 to Frank W. Schwinn issued on Jun. 24, 1940 is directed to a freewheeling bicycle hub configuration. Freewheeling bicycle hubs are configured to enable rotation of the pedals to drive the rotation of the wheels while also allowing the wheels to rotate independently of the rotation of the pedals. This functionality enables the pedals of the bike to be held stationary while the wheels rotate as the bike coasts. Often freewheeling hubs are configured for geared applications that include a rear cassette. A cassette driver is a portion of the hub that supports a cassette and drives the rotation of the cassette.

SUMMARY

Forward movement of a bicycle results when force is transferred from the chain or belt to a sprocket on a cassette. The cassette is splined to the cassette driver and causes the wheel of the bike to rotate when torque is applied from the cassette to the cassette driver. The cassette driver is typically made of a strong hard material such as steel to withstand the forces imparted thereon by the cassette. The present disclosure provides a hub configuration and method that enables the cassette driver to be constructed of a lighter weight material such as aluminum yet still withstand the torque applied thereto.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an isometric view of a hub according to the principles of the present disclosure;

FIG. **2** is a longitudinal cross-sectional view of the hub of FIG. **1**;

FIG. **3** is a cross-sectional view of the hub along line **3-3** of FIG. **2**;

FIG. **4** is a cross-sectional view of the hub along line **4-4** of FIG. **2**;

FIG. **5** is an exploded assembly view of the hub of FIG. **1**;

FIG. **6** is a first perspective view of a first embodiment of the cassette driver;

FIG. **7** is a second perspective view of the embodiment of the cassette driver of FIG. **6**;

FIG. **8** is an assembly view of the first embodiment of the cassette driver of FIG. **6**;

FIG. **9** is a cross sectional view of the cassette driver of FIG. **6** along line **9-9** of FIG. **10**;

FIG. **10** is a cross sectional view of the cassette driver of FIG. **6** along line **10-10** of FIG. **9**;

FIG. **11** is an enlarged view of a portion of FIG. **10**;

FIG. **12** is an enlarged view of a portion of FIG. **8**;

FIG. **13** is a first perspective view of a second embodiment of the cassette driver;

FIG. **14** is a second perspective view of the embodiment of the cassette driver of FIG. **13**;

FIG. **15** is an assembly view of the first embodiment of the cassette driver of FIG. **13**;

FIG. **16** is a cross sectional view of the cassette driver of FIG. **13** along line **16-16** of FIG. **17**;

FIG. **17** is a cross sectional view of the cassette driver of FIG. **13** along line **17-17** of FIG. **16**; and

FIG. **18** is a perspective view of a component of a hub shown in FIG. **2** according to the present disclosure.

DETAILED DESCRIPTION

Referring to FIG. **1**, a first embodiment of a hub according to the present disclosure is shown. In the depicted embodiment, the hub **10** includes a hub body **12**, an axle **14**, and cassette driver **16**. In the depicted embodiment, the hub **10** is configured to freewheel. In other words, a cassette driver **16** rotates with the hub body **12** when the wheel is driven by the cassette driver **16** and the cassette driver **16** rotates relative to the hub body **12** when the wheel is coasting (rotating and not being driven).

Referring to the FIGS. generally, the configuration of hub **10** is described in greater detail. In the depicted embodiment, the hub **10** is configured for use with multiple speed bicycles (e.g., road bikes, mountain bikes, etc.) that utilize an external cassette driven by a chain. In the depicted embodiment, the axle **14** is co-axially arranged within the hub body **12**. In particular, the axle **14** extends through the hub body **12**. The axle **14** includes a first end portion **18** that is positioned within a first end portion **22** of the hub body **12** and a second opposed end portion **24** that includes a portion that extend outwardly from a second end **26** of the hub body **12**. It should be appreciated that the principles of the present disclosure can alternatively be integrated into a single speed bicycle.

In the depicted embodiment, the first end portion **18** of the axle includes a shoulder **28**. The hub body **12** includes a snap ring groove **30** aligned with the shoulder **28** in a radial direction such that a snap ring **32** and the shoulder **28** cooperatively limit the axial movement of a bearing set **34** in a direction toward the second end **26** of the hub body **12**. The bearing set **34** engages an exterior surface of the axle and an interior surface of an internal cavity **56** of the hub body **12**.

In the depicted embodiment, the second end portion **24** of the axle **14** is co-axially arranged within both the hub body **12** and a drive end portion **48** of the cassette driver **16**. In the depicted embodiment, a portion of the second end portion **24** of the axle **14** extends into a driven end of the cassette. In the depicted embodiment, the second end of portion **24** of the axle **14** interfaces with the cassette driver **16** via bearing set **52**.

In the depicted embodiment, the hub body **12** includes a one-piece construction. The hub body **12** is machined from a single piece of aluminum (e.g., aluminum 7075T651). The hub body **12** defines a longitudinal rotational axis A-A. The hub body **12** includes the internal cavity **56** that receives the axle **14** as well as the drive end portion **48** of the cassette driver **16**. The hub body **12** includes a first radially extending flange **58** located at the first end portion **22** of the hub body **12**, and a second radially extending flange **60** located at the second end **26** of the hub body **12**. Each of the radially extending flanges **58**, **60** includes a plurality of spaced apart through apertures **62** that are configured to secure spokes. Adjacent the first radially extending flange **58** is a disk brake mount flange **64** configured to support a disk of a disk brake system. The external cylindrical body of the hub body **12** tapers from the second flange **60** towards the first flange **58**. In other words, the exterior diameter of the hub body **12** adjacent the second flange **60** is greater than the exterior diameter of the hub body **12** adjacent the first flange **58**.

In the depicted embodiment, the wall thickness of the hub body **12** is greater in the portion that radially overlaps the drive end portion **48** of the cassette driver **16** as compared to the portion that does not overlap the cassette driver **16**. In the depicted embodiment, the internal cavity **56** of the second end portion **26** of the hub body defines two internal cylindrical surfaces. A first cylindrical surface **66** is defined as being a distance D**1** from the longitudinal rotational axis A-A, and a second cylindrical surface **68** is defined as being a distance D**2** from the longitudinal rotational axis A-A. In the depicted embodiment, D**2** is greater than D**1** and the first surface **66** is closer to the first end portion **22** of the hub body **12** than the second cylindrical surface **68**. In the depicted embodiment, the hub body is machined in a process whereby the hub body is not removed from a spindle until both the first and second cylindrical surfaces **66**, **68** are machined.

In the depicted embodiment, the cassette driver **16** includes an internal cavity **70** that extends from a drive end portion **48** to an opposed driven end portion **72**. The cavity receives the axle **14**, which extends into the drive end portion **48** of the cassette driver **16**. The cassette driver **16** defines a longitudinal axis of rotation that is coaxial and coincident with the axis of rotation A-A of the hub body **12**.

In the depicted embodiment, the drive end **48** of the cassette driver **16** includes a plurality of coaxial cylindrical surfaces that are positioned within the hub body **12** opposite the internal cylindrical surfaces **66**, **68** of the hub body **12**. In the depicted embodiment, an annular snap ring groove **76** is located in the first cylindrical surface **66** of the inner cavity **56** of the hub body **12** opposite an end face **78** of the drive end portion **48** of the cassette driver **16**. A first cylindrical surface **80** extends from the end face **78** of the cassette driver towards the driven end **72** of the cassette driver **16**. The first cylindrical surface **80** of the drive end **48** together with the first cylindrical surface **66** defines a first annular cavity that receives bearing set **82** that interfaces between the drive end **48** of the cassette driver **16** and the hub body **12**.

In the depicted embodiment, a second cylindrical surface **84** having a larger diameter than the first cylindrical surface **80** extends from the first cylindrical surface **80** towards the driven end **72** of the cassette driver **16**. The second cylindrical surface **84** of the drive end **48** together with the second cylindrical surface **68** defines an annular cavity that receives a sprag clutch assembly. In the depicted embodiment, the surface finish of the second cylindrical surface **84** is less than or equal to Rz of 2.5 micrometers and has a HRC hardness of at least 56 (e.g., between 58 to 62). In the depicted embodiment, the second cylindrical surface **84** has a diameter of greater than 22 mm (e.g., 29 mm). In the depicted embodiment, the second cylindrical surface is constructed of stainless steel.

In the depicted embodiment, the sprag clutch assembly includes a sprag sleeve **86**, a sprag retaining cage **88**, sprags **90**, and a tensioning band **92**. In the depicted embodiment, the surface finish of the inside surface of the sprag sleeve is less than or equal to Rz of 2.5 micrometers and the inside surface of the sprag sleeve has a HRC hardness of at least 56 (e.g., between 58 to 62). In the depicted embodiment, the sprag sleeve **86** has a diameter of less than 40 mm (e.g., 37 mm). The sprag sleeve has a height dimension that is greater than the height dimension of the sprag retaining cage **88**. The sprag sleeve **86** includes a snap ring groove that receives a snap ring that limits the axial movement of the sprag retaining cage **88** in the axial direction towards the driven end **72** of the cassette driver.

In the depicted embodiment, the sprag sleeve is constructed of a 5210 bearing race type steel which is pressed fit/interference fit into the second cylindrical surface **68** of the hub body **12**. The construction of the sprag sleeve **86** and the hub body **12** cooperatively provide the structural stiffness needed for reliable and long lasting operation of the hub despite the strong radial forces that are generated by the sprags **90**. The sprags and sprag cages used in the depicted embodiment are currently available commercially from GMN Paul Müller Industrie GmbH & Co. KG.

In the depicted embodiment, a third cylindrical surface **94** extends coaxially from the second cylindrical surface **84** towards the driven end **72** of the cassette driver **16**. The third cylindrical surface **94** has a diameter that is greater than the diameter of the second cylindrical surface **84**. A shoulder **96** is provided on the cassette driver **16** between the third cylindrical surface **94** and the driven end **72** of the cassette driver **16**. The third cylindrical surface **94** of the drive end **48** of the cassette driver **16** together with the second cylindrical surface **68** defines a first annular cavity that receives bearing set **98** that interfaces between the drive end **48** of the cassette driver **16** and the hub body **12**. The shoulder **96** limits axial movement of the bearing set **98** in the direction towards the driven end **72** of the cassette driver **16**. An end face of the sprag sleeve **86** limits axial movement of the bearing set **98** on the axial direction towards the first cylindrical surface **80** of the drive end **48** of the cassette driver **16**. In the depicted embodiment the third cylindrical surface **94** includes an annular o-ring groove configured to receive an o-ring that seals the interface between the third cylindrical surface **94** and the bearing set **98**.

In the depicted embodiment, the internal cavity of the drive end **48** of the cassette driver includes a first cylindrical surface **100** defined by a first diameter that is greater than the diameter of the axle. The configuration results in further weight savings and strength of the cassette driver and facilitates precision manufacturing thereof.

In the depicted embodiment the configuration results in a high performance hub as it has the strength and durability to withstand intense use while also being lightweight and smooth in operation. The hub body **12** is constructed of lightweight, relatively softer aluminum material, and it is designed so that it can be manufactured with high precision as the above-referenced cylindrical surfaces **66**, **68** can be machined without detaching the hub body **12** from the chuck that holds the part during machining. The hard and robust sprag sleeve **86** is pressed into the softer aluminum. The pressing process creates a tight interference fit between the sprag sleeve **86** and cylindrical surface **68**. This interface allows the hub body **12** to work together to resist the radial forces generated by the sprags. The sprag sleeve **86** provides the hardened surface that interfaces with the sprags and also provides additional structural strength to the hub. The hub of the depicted embodiment does not require rebuilding and can operate in extreme environments including environments as cold as −50 degrees Fahrenheit.

In the depicted embodiment, the sprag retaining cage **88** moves with the cassette driver **16**. The tensioning member (e.g., spring) on the sprag retaining cage **88** biases the individual sprags against the cylindrical surface **84** of the cassette driver **16** resulting in the sprag retaining cage **88** being essentially tension mounted to cassette driver **16**. The internal ends of the sprags contact the second external surface **84** of the cassette driver and are biased radially outwardly against a spring and extend radially slightly beyond the periphery edge of the sprag retaining cage **88**. This configuration results in little and light contact between the sprags and the sprag sleeve **86** during coasting, which results in a very low friction configuration as the clutch configuration is disengaged during coasting. The non-drive forces applied between the hub body **12** and the cassette driver **16** are transferred through the bearing sets **82**, **98** that sandwich the sprag clutch assembly.

In the depicted embodiment, as soon as the driven end **72** is rotated in the drive direction at a rotational speed that exceeds the rotational speed in the drive direction of the hub body **12**, the sprags engage and lock against the sprag sleeve **86** and transfer torque from the cassette driver **16** to the hub body **12**. In the depicted embodiment, the sprag clutch assembly transfers torque to drive the hub forward. However, the sprag clutch assembly is not relied on as a bearing set to support the relative rotation between the cassette driver **16** and the hub body **12**. This configuration results in a clutch configuration that immediately engages when the driven end is driven. For example, in the depicted configuration the driven end cannot be rotated relative to the hub body in the drive direction more than a small amount before it fully engages and transfers torque from the cassette driver **16** to the hub body **12**, thereby causing the hub body to rotate with the cassette driver **16**. The amount of relative rotation in the drive direction, commonly referred to as play or slop, can be less than five degrees (e.g., less than two degrees, less than one degree, or one half of a degree).

In the depicted embodiment, the driven end portion **72** is connected to the drive end portion. As discussed above, the drive end portion includes a plurality of coaxial cylindrical surfaces. In the depicted embodiment, the driven end portion **72** is formed of aluminum and includes a cylindrical body portion **110** with a plurality of axially extending raised splines **112** spaced apart on the cylindrical body portion **110**. In the depicted embodiment, adjacent splines define channels **134** therebetween. In the depicted embodiment the splines extend axially from a back wall **138** located at an end portion of the cylindrical body portion. The splines **112** are configured to engage a cassette comprised of sprockets and spacers. It should be appreciated that in alternative embodiments, the driven end portion is not integral connected to the drive end portion (e.g., they are separate components).

In the depicted embodiment, at least one of the splines is integrally formed on the surface of the cylindrical body portion **110** of the cassette driver. The at least one spline **114** includes a drive side **116**, which including a reinforcement engagement member **118**. In the depicted embodiment, at least three of the splines **114**, **120**, **122** are integrally formed on the surface of the driven end portion of the cassette driver. In the depicted embodiment, all of the splines are integrally formed on the surface of the cassette driver. However, many other alternative are also possible.

In the depicted embodiment, the at least three splines each include a drive side **116**, **124**, **126**. Each of the drive sides of the splines includes a reinforcement engagement member **118**, **128**, **130**. The reinforcement engagement members can include a portion having a radius surface **132** (see FIG. **8**). Additionally or alternatively, the reinforcement engagement member can include an undercut surface **136** on the drive side of the spline (see FIG. **9**). Also, additionally or alternatively, the reinforcement engagement members can be at least partially recessed into grooves **144** in the channel **134** between adjacent splines (see FIG. **6**). Additionally or alternatively, the reinforcement engagement member can include a round pin receiving aperture **142** configured to receive an end of a round pin (see FIGS. **10** and **11**). Additionally or alternatively, the reinforcement engagement member is configured to receive a reinforcement member radially and secure the reinforcement member adjacent the drive side of the spline (see FIG. **8**). Alternatively, the reinforcement engagement member is configured to receive a reinforcement member axially and secure the reinforcement member adjacent the drive side of the spline (see FIGS. **10** and **11**). It should be appreciated that many configurations are possible.

In the depicted embodiment, the drive end portion of the cassette drive includes at least one reinforcement member **140**. In the depicted embodiment, the reinforcement member has a HRC hardness of at least at least 56 (e.g., between 58 to 62) and is engaged with the reinforcement engagement member. In the depicted embodiment, the reinforcement member is a round steel pin. In some embodiments, the round pin can be snapped into engagement with the reinforcement engagement member (FIG. **8**). In some embodiments, the end of the reinforcement member (e.g., round pin) is pressed into an aperture **142** on the back wall **138** (FIGS. **10** and **11**). In the depicted embodiment, the distance from a rotational axis to a far edge of the reinforcement member does not exceed the distance from the rotational axis to a top surface of the spline (i.e., the reinforcement member is flush with or less than flush with the top of the spline).

The present disclosure also provides a method of manufacturing a hub. The method includes the step of machining a cassette driver from an aluminum body. The step of machining includes forming a drive end portion **48** and a driven end portion **72**, wherein the drive end portion includes a plurality of coaxial cylindrical surfaces and the driven end portion includes a cylindrical body portion including a plurality axially extending raised splines **112** spaced apart on the cylindrical body portion **110**, wherein the splines define a plurality of channels **134** between adjacent spline. In the depicted embodiment, at least one spline includes a drive side, the drive side including a reinforcement engagement member **118**.

The method can further include the step of securing a reinforcement member to the reinforcement engagement member. The method can further include connecting a steel insert **150** over the drive end portion of the cassette driver and machining the steel insert thereafter. The step of connecting the steel insert can include the step of pressing the steel insert into engagement with the drive end portion of the cassette driver or threading the insert thereon. The step of connecting the steel insert can include the step of axially aligning tangs with notches in the drive end of the cassette driver. The tangs once engaged with the notches prevent relative rotation of the steel insert relative to the cassette driver. In the depicted embodiments the steel insert includes two tangs which are opposed and have curved exterior and interior surfaces. It should be appreciated that many other configurations are possible including for example configuration with more or less tangs (e.g., four tangs). The step of machining the steel insert after connecting it to the steel driver can be used to ensure its concentricity with the other cylindrical surface of the drive end portion **48** of the cassette driver. Many other connection methods are also possible.

The above specification, examples and data provide a complete description of the manufacture and use of the composition of the invention. Since many embodiments of the invention can be made without departing from the spirit and scope of the invention, the invention resides in the claims hereinafter appended.

What is claimed is:

1. A cassette driver comprising:

a cylindrical body portion;

a plurality of axially extending raised splines spaced apart on the cylindrical body portion;

a drive end portion connected to the cylindrical body portion, the drive end portion including a plurality of coaxial cylindrical surfaces, wherein the drive end portion and cylindrical body portion are integrally formed;

wherein at least one of the splines is integrally formed on the surface of the cylindrical body portion of the cassette driver; and

wherein the at least one spline includes a drive side, the drive side including a reinforcement engagement member.

2. The cassette driver of claim 1, wherein the reinforcement engagement member is an undercut surface on the drive side of the spline.

3. The cassette driver of claim 1,

wherein at least three of the splines are integrally formed on the surface of the cylindrical body portion of the cassette driver; and

wherein the at least three splines include a drive side, the drive side including a reinforcement engagement member, the reinforcement engagement member including a portion having a radius surface.

4. The cassette driver of claim 1, further comprising a reinforcement member having a hardness of at least HRC 56, the reinforcement member engaged with the reinforcement engagement member.

5. The cassette driver of claim 4, wherein adjacent splines define a channel therebetween, and wherein the reinforcement member is at least partially recessed into the channel.

6. The cassette driver of claim 5, wherein the distance from a rotational axis to a far edge of the reinforcement member does not exceed the distance from the rotational axis to a top surface of the spline.

7. The cassette driver of claim 1, further comprising a back wall, wherein the splines extend axially from the back wall, wherein the back wall includes a round pin receiving aperture configured to receive an end of a round pin.

8. The cassette driver of claim 7, further comprising a round pin having an end pressed into the pin receiving aperture.

9. The cassette driver of claim 1, wherein the reinforcement engagement member is configured to receive a reinforcement member axially and secure the reinforcement member adjacent the drive side of the spline.

10. The cassette driver of claim 1, wherein the reinforcement engagement member is configured to receive a reinforcement member radially and secure the reinforcement member adjacent the drive side of the spline.

11. The cassette driver of claim 10, wherein the reinforcement member is a round pin and the round pin is snapped into engagement with the reinforcement engagement member.

12. The cassette driver of claim 1, wherein the drive end portion and the cylindrical body portion are integrally formed of aluminum.

13. A hub assembly comprising:

a drive end portion of a cassette driver, wherein the drive end portion includes:

a plurality of coaxial cylindrical surfaces; and

a radially extending flange;

a driven end portion of the cassette driver connected to the drive end portion, wherein the driven end portion includes:

a cylindrical body portion integrally extending from the flange to a distal end of the cassette driver; and

a plurality axially extending raised splines spaced apart on the cylindrical body portion, wherein the splines define a plurality of channels between adjacent splines;

wherein at least one of the splines is integrally formed on the surface of the driven end portion of the cassette driver; and

wherein the at least one spline includes a drive side, the drive side including a reinforcement engagement member.

14. The hub assembly of claim 13, further comprising a hub body including an annular internal cavity that extends from a first end of the hub body to a second end of the hub body, wherein the plurality of coaxial cylindrical surfaces of the driven end portion of the cassette driver are positioned within the annular internal cavity of the hub body.

15. The hub assembly of claim 14, further comprising a plurality of sprags located between the annular internal cavity of the hub body and drive end portion of the cassette driver.

16. The hub assembly of claim 13, further comprising a plurality of reinforcement members engaged with the reinforcement engagement member of the cassette driver.

17. The hub assembly of claim 13, further comprising:

a one-piece hub body defining a longitudinal rotational axis, the hub body including an internal cavity that extends from a first end of the hub body to an opposed second end of the hub body, the hub body including a first radially extending spoke support flange located at the first end of the hub body and a second radially extending spoke support flange located at the second end of the hub body;

an axle including a first end portion and a second end portion, the axle extending through the internal cavity of the hub body in a coaxial arrangement;

a first bearing set located at the first end portion of the axle configured to interface between the axle and the hub body to facilitate relative rotation between the axle and the hub body;

wherein the cassette driver includes a longitudinal rotational axis arranged coaxially with the longitudinal rotational axis of the hub body, the cassette driver including an internal cavity that extends from a drive end to an opposed driven end, wherein the drive end includes:

an annular opening positioned within the hub body between the first and second radially extending spoke support flanges, the second end portion of the axle extending through the annular opening;

a first external cylindrical surface located at a first diameter from the longitudinal rotational axis of the cassette driver;

a second external cylindrical surface located at a second diameter from the longitudinal rotational axis of the cassette driver, the second diameter being larger than the first diameter, the second external cylindrical surface being closer to the driven end of the cassette driver than the first external cylindrical surface; and

a third external cylindrical surface located at a third diameter from the longitudinal rotational axis of the cassette driver, the third diameter being larger than the second diameter, the third external cylindrical surface being closer to the driven end than the second external cylindrical surface;

a second bearing set located at the second end portion of the axle, the second bearing set configured to interface between the axle and the internal cavity of the cassette driver to facilitate relative rotation between the axle and the cassette driver;

a third bearing set located between the first external cylindrical surface of the driven end of the cassette driver and the internal cavity of the hub body to facilitate relative rotation between the cassette driver and the hub body;

a fourth bearing set located between the third external cylindrical surface of the driven end of the cassette driver and the internal cavity of the hub body configured to facilitate relative rotation between the cassette driver and the hub body;

a sprag sleeve pressed into the hub body in radial alignment with a portion of the second external cylindrical surface of the driven end of the cassette driver, wherein the sprag sleeve has an internal surface that is harder than the surface of the internal cavity of the hub body; and

an annular sprag retaining cage having a plurality of sprags that are tension biased against the second external cylindrical surface of the driven end of the cassette driver and radially aligned with the sprag sleeve.

18. A cassette driver comprising:

a cylindrical body portion;

a plurality of axially extending raised splines spaced apart on the cylindrical body portion;

wherein at least one of the splines is integrally formed on the surface of the driven end portion of the cassette driver,

wherein the at least one spline includes a drive side, the drive side including a reinforcement engagement member, and

wherein the distance from a rotational axis to a far edge of the reinforcement member does not exceed the distance from the rotational axis to a top surface of the at least one spline.

19. The cassette driver of claim **18**, further comprising a reinforcement member being constructed of a material that has a hardness that is greater than a hardness of the cassette driver, the reinforcement member engaged with the reinforcement engagement member, wherein adjacent splines define a channel therebetween, and wherein the reinforcement member is at least partially recessed into the channel.

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