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(54) **Coolant pump**

(57) A coolant pump (90) includes a housing (95) having an internal axis; a bearing (100) disposed on an outside surface of the housing (95); a shaft (120) disposed along the internal axis of the housing (95), wherein the shaft (120) is journaled by the bearing (100) so as to be rotatable; an impeller (130) disposed on the shaft (120) so as to rotate with the shaft (120); and a seal (140) disposed on the shaft (120) at least partially inside of the bearing (100) so that the bearing (100) overlaps the seal (140) along the internal axis of the housing (95), wherein the bearing (100) has an inner diameter, the seal (140) has an outer diameter, and the inner diameter of the bearing (100) is greater than the outer diameter of the seal.

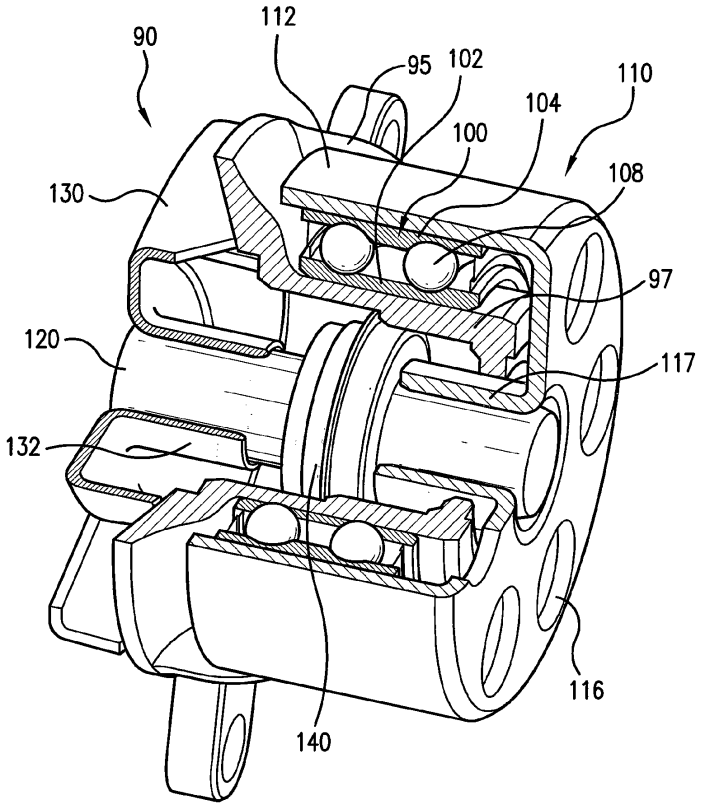

FIG.3

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Description

[0001] The present invention relates to a coolant pump such as may be employed to pump coolant for an internal combustion engine. More particularly, the invention relates to a coolant pump that has its seal located at least partially within the bearing for the pulley actuating the coolant pump.

[0002] In the art of coolant pumps used for industrial applications, especially water pumps for cooling internal combustion engines for automobiles and like vehicles, a conventional water pump 10 having the features shown in Figure 1 is known. The conventional pump 10 includes a pulley 15 disposed on one end of a rotatable shaft 20, wherein the shaft 20 is supported by a bearing 25 pressed into housing 30. Shaft 20 actually forms a part of the bearing 25, and optionally a hub (not shown) may be disposed between the pulley 15 and the shaft 20. On the other end of shaft 20, an impeller 35 is disposed so that when the pulley 15 is rotated by a drive or actuator belt (not shown), the shaft 20 and impeller 35 rotate with the pulley 15. In this way, the impeller 35 is rotated with the pulley so as to cause movement of water or other coolant within the coolant system for the internal combustion engine.

[0003] To prevent coolant from leaking out of the coolant system, the water pump 10 includes a seal 40 that is separated axially from the bearing 25 by a space 45. As is known in the art, the seal 40 is not 100% effective so that some small amount of coolant leaks from the coolant system and contaminates the bearing 25. The conventional water pump 10 has the drawback that the leaked coolant contaminating the bearing 25 collects in space 45 and eventually causes damage to the bearing 25, which shortens the operating life of the bearing 25 and of the pump 10. Bearing contamination occurs despite the fact that space 45 is contiguous with one or more holes or channels for draining out leaked coolant. However, coolant contamination of the bearing still occurs, especially if there is a significant leakage of coolant.

[0004] One recent improvement over the conventional water pump 10 is a so-called external bearing water pump 50 such as shown in Figure 2. The external bearing pump 50 includes a shaft 55 upon which is attached a pulley 60 at one end and an impeller 65 at the other end. The pulley 60 is supported by bearing 70 that is attached to housing 75. Thus, when a drive or actuator belt (not shown) is used to rotate the pulley 60, the shaft 55 and impeller 65 are also rotated so that the impeller 65 causes coolant to move in the coolant system for an internal combustion engine.

[0005] As shown in Figure 2, the external bearing pump 50 also includes a seal 80 and a space 85 located inside the housing. The seal 80, however, is not 100% effective so that some coolant leaks from the coolant system and enters space 85. However, instead of contaminating the bearing 70 the leaked coolant evaporates and then dissipates through holes 62 formed in the pulley 60.

[0006] However, both the conventional water pump 10 and the external bearing pump 50 suffer from the following drawbacks. First, these water pumps are not space efficient. More particularly, the spaces 45 and 85 of pumps 10 and 50, respectively, are underutilized spaces that add to the axial dimension of the pump. Second, with respect to the external bearing pump 50, the pulley 60 located at one end of the pump 50 not only rotates the shaft 55, but due to imperfections in axial alignment may also introduce some degree of runout or wobble of the shaft about its axial axis. Such runout of the shaft 55 about its axial axis creates potential damage of the seal 80 of the pump 50 and the seal 80 does not work under ideal conditions. The farther the seal 80 is located from the point of attachment of the pulley 60 with its shaft 55 the more pronounced the effects to the seal will be due to the misalignment the pulley imparts along the shaft.

[0007] The present invention endeavors to provide an improved coolant pump that maintains the advantages of the external bearing coolant pump while overcoming the disadvantages of the external bearing and conventional coolant pumps. Accordingly, a primary object of the present invention is to overcome the disadvantages of prior art coolant pumps.

[0008] Another object of the present invention is to provide a coolant pump that is practical and cost effective to manufacture, and that is space efficient and compact.

[0009] Another object of the present invention is to provide a coolant pump that is both durable and reliable, and that is less prone to bearing failure due to damage from coolant leakage.

[0010] Another object of the present invention is to provide a coolant pump that is both durable and reliable, and that is less prone to excessive damage to its coolant seal due to the effect of runout about the axial axis of the shaft of the coolant pump.

[0011] In accordance with the above objectives, one embodiment of the present invention provides a coolant pump that includes (1) a housing having an internal axis; (2) a bearing disposed on an outside of the housing; (3) a shaft disposed along the internal axis of the housing, wherein the shaft is journaled by the bearing so as to be rotatable; (4) an impeller disposed on the shaft so as to rotate with the shaft; and (5) a seal disposed on the shaft at least partially inside of the bearing so that the bearing overlaps the seal along the internal axis of the housing, wherein the bearing has an inner diameter, the seal has an outer diameter, and the inner diameter of the bearing is greater than the outer diameter of the seal.

[0012] In accordance with another embodiment of the invention, the coolant pump may be further modified so that the seal is a dynamic seal. In accordance with still other embodiments of the present invention, the coolant pump may be modified so that the seal is a lip seal. In accordance with another embodiment of the present invention, the seal prevents leakage of coolant when the impeller is in contact with coolant from a cooling system of an internal combustion engine.

[0013] In accordance with another embodiment of the present invention, the coolant pump is modified so that the bearing comprises an inner ring defining said inner diameter and an outer ring disposed to rotate on the inner ring, wherein the inner ring is fixed to the housing. In accordance with still another embodiment of the invention, the coolant pump further includes a pulley having an inner surface connected to the outer ring of the bearing so that the outer ring is rotatable with the pulley, wherein the pulley also has a central portion attached to the shaft so that when the pulley is rotated, the pulley, the outer ring of the bearing, the shaft and the impeller rotate together. In accordance with still another embodiment of the present invention, the bearing further comprises one or more tracks of rolling elements sandwiched between the inner ring and the outer ring of the bearing. In accordance with still another embodiment of the present invention, the pulley further comprises a belt engaging portion adapted to engage an actuator belt to rotate the pulley and actuate the coolant pump.

[0014] In accordance with another embodiment of the present invention, the coolant pump further comprises a support member connected to the outer ring of the bearing so that the support member is rotatable with the outer ring, wherein the support member also has a central portion attached to the shaft so that when the outer ring is rotated, the outer ring of the bearing, the support member, the shaft and the impeller rotate together. In accordance with still another embodiment of the present invention, the outer ring of the bearing defines a belt engaging portion adapted to engage an actuator belt to rotate the outer ring and actuate the coolant pump. In accordance with yet another embodiment of the invention, the bearing further comprises one or more tracks of rolling elements sandwiched between the inner ring and the outer ring of the bearing.

[0015] In accordance with another embodiment of the present invention, an internal combustion engine comprises a cooling system connected to a coolant pump, wherein the coolant pump includes: (1) a housing having an internal axis; (2) a bearing disposed on an outside of the housing; (3) a shaft disposed along the internal axis of the housing, wherein the shaft is journaled by the bearing so as to be rotatable; (4) an impeller disposed on the shaft so as to rotate with the shaft; and (5) a seal disposed on the shaft at least partially inside the bearing so that the bearing overlaps the seal along the internal axis of the housing, wherein the bearing has an inner diameter and the seal has an outer diameter, and the inner diameter of the bearing is greater than the outer diameter of the seal.

[0016] Further objects, features and advantages of the present invention will become apparent from the Detailed Description of Illustrative Embodiments, which follows, when considered with the attached drawings.

Figure 1 is a cut away perspective view of a conventional water pump for a automobile engine.

Figure 2 is a cut away perspective view of an external bearing water pump for an automobile engine.

Figure 3 is a cut away perspective view of an embodiment of the coolant pump in accordance with the present invention.

Figure 4 is an exploded view of the embodiment shown in Figure 3.

Figure 5 is a cross-sectional schematic view of a coolant pump of the present invention.

Figure 6 is a schematic cross-sectional view of a dynamic seal.

Figure 7 is a schematic cross-sectional view of another embodiment of the present invention.

[0017] The apparatus of the present invention is a coolant pump as shown in Figures 3, 4, 5 and 7, where like parts are designated by like character references. As shown in Figures 3 and 4, a coolant pump 90, in accordance with the present invention, includes a housing 95 that has a cylindrical portion 97, and a bearing 100 is securely mounted on the outer surface of the cylindrical portion 97 so that the inner ring of the bearing 100 is fixedly and immovably attached to the outer surface of the cylindrical portion 97. The bearing 100 may take on a variety of forms. For example, as shown in Figures 3, 4 and 5, the bearing 100 may be a ring structure including an inner ring 102, an outer ring 104, and one or more tracks 106 containing rolling elements 108, such as ball bearings, rollers, cones, etc. When mounted to the housing cylindrical portion 97, the bearing inner ring 102 is immovably fixed to the housing 95 but the bearing outer ring 104 is mounted so as to be able to rotate about the axis of the cylindrical portion 97 of the housing 95.

[0018] An inner surface of a pulley 110 is mounted on the outer ring 104 of the bearing
100 so that the pulley 110 rotates with the outer ring 104. The pulley 110 includes the inner surface and an outer surface and may have a cup-shape. The outer surface of the pulley 110 includes a belt engaging portion 112 and an end portion 114. The belt engaging portion 112 engages a drive or actuator belt connected to a motor or engine (not shown), which rotates the pulley 110 and actuates the pump 90. The end portion includes a plurality of holes 116 formed therein, and one central lipped portion 117 providing a surface for attaching to the shaft 120. As shown in Figure 5, in an alternate embodiment, the pulley is a pulley 111 that could include both a cup-shaped portion 113 and an extension portion 115, wherein it is the extension portion that provides the surface for engaging the drive or actuator belt 210. The extension portion 115 may also optionally be provided with a sleeve 300. The cup-shaped portion 113 may include a plurality

of holes formed therein and may optionally include one central lipped shaped portion providing a surface for attaching to the shaft 120 by press fit just like the pulley 110. However, as shown in Figure 5, other possible connections between the pulley 111 and the shaft 120 include welding 250. Although not illustrated, other possible connections between pulley 111 and shaft 120 include stamping, pulling in one piece, and different geometries for the pres fit.

[0019] The shaft 120 is fixedly attached, at one end, to the pulley 110 so that the shaft and pulley rotate together as a unit as evident from Figure 3. The shaft 120 may be press fitted, welded, attached by adhesive, stamped, or press fit with a different geometry to the pulley 110, or the pulley 110 may be integrally formed with the shaft 120. An impeller 130 is fixedly attached to the other end of the shaft so that the shaft 120, pulley 110 and impeller 130 are axially aligned and rotate together as a unit. The shaft 120 may be press fitted, welded or attached by adhesive, to a lipped portion 132 of the impeller 130. When assembled, the shaft 120 is located in the housing 95. The impeller 130 can, however, have any suitable structure and is not limited to the preferred, detailed structure shown in the figures. Likewise, housing 95 can have different shapes and is not limited to the structural details shown in the figures. Furthermore, housing 95 may integrate other functions or components, such as but not limited to sealing, thermostat housing, left tensioner support, etc.

[0020] As shown in Figure 3, and also as shown in the embodiment of Figure 5, the pump 90 includes a seal 140 that is disposed on the shaft 120 such that the seal 140 is located at least partially inside of the inner ring 102 of the bearing 100. Thus, there is no axial separation of the seal 140 from the bearing 100 along the axis of the shaft 120 because the bearing at least partially overlaps the seal. Also as shown in Figure 3, the outer diameter of the cylindrical portion 97, and of the inner surface of the bearing 100, exceeds the maximal outer diameter of the seal 140. While the present invention contemplates that the bearing 100 at least partially overlaps the seal 140, it is within the scope of the present invention for the seal 140 to be located wholly within the axial dimensions of the inner ring 102 of the bearing 100.

[0021] The seal 140 provides a seal to prevent coolant 201, such as water, radiator fluid, anti-freeze, and the like, from leaking from the cooling system 200, in which the impeller 130 of the pump 90 is disposed. The cooling system 200 may be that of an internal combustion engine E as indicated by Figure 5. The seal 140 may be a dynamic seal (also known as a "face seal" or a "mechanical seal"), such as disclosed in U.S. Patent 4,650,196 to Bucher et al. and U.S. Patent 5,538,259 to Uhrner et al, or it may be a lip seal, or any other suitable type of seal. Other kinds of dynamic seals, such as may be used in the present invention, are disclosed in U.S. Patent 2,322,834 to Dornhofer, U.S. Patent 2,717,790 to Chambers, Jr. et al, U.S. Patent 2,994,547 to Dolhun et al, U.S. Patent 3,782,735 to Novosad, U.S. Patent 4,415,167 to Gits, U.S. Patent 5,676,382 to Dahlheimer, U.S. Patent 6,145,841 to Maeda, and U.S. Patent 6,789,803 B2 to Radosav. U.S. Patent 4,650,196, U.S. Patent 5,538,259, U.S. Patent 2,322,834, U.S. Patent 2,717,790, U.S. Patent 2,994,547, U.S. Patent 3,782,735, U.S. Patent 4,415,167, U.S. Patent 5,676,382, U.S. Patent 6,145,841, and U.S. Patent 6,789,803 B2. A dynamic seal 150, in accordance with the present invention and as described in U.S. Patent 5,538,259, is schematically illustrated in Figure 6 to include a slide ring 152, a countering 151 and a biasing member 153 (such as a spring) that forces the slide ring against the counterring. The dynamic seal 150 shown in Figure 6 also includes one or more support elements or structural components 157, 158.

[0022] The present invention may be employed without a separate designated pulley structure as shown in Figure 7. In the embodiment of Figure 7, the bearing structure has been modified so that bearing 170 is a ring structure disposed on the cylindrical portion 97 of the housing 95 such that its inner ring 102 is immovably fixed to the housing. However, bearing outer ring 180 is constructed so as to provide a surface 182 for engaging the actuator or drive belt 211. In other words, the actuator or drive belt 211 directly or indirectly engages the outer ring 180 of the bearing 170, which provides surface 182 for engaging with the actuator or drive belt 211. The bearing 170 includes one or more tracks 106 containing rolling elements 108 so that the outer ring 180 is able to rotate about the axis X-X of the shaft 120 or of the cylindrical portion 97 of the housing 95.

[0023] A support 190 is provided to connect the outer ring 180 to the shaft 120.

In this way, the bearing 170 functions as both a bearing ring and a pulley. As shown in Figure 7, the support 190 includes an end portion 192 for connecting the outer ring 180 of the bearing 170. The support 190 also includes a central lipped shaped portion 194 providing a surface for attaching to the shaft 120 just like the pulley 110. Of course, it can be appreciated as shown above that different means of connection shaft and support are also possible within the scope of the invention.

[0024] As shown in Figure 7, the seal 140 is disposed in housing 95 so as to belocated at least partially or wholly inside of the inner surface 172 of the bearing 170. As with the previously described embodiment of the present invention, the seal 140 may be a dynamic seal, or a lip seal, or any other suitable seal. Furthermore, it goes without saying that the housing 95, pulley 110, bearing 100 or 170 (and inner and outer rings), and support 190 may be made of any suitable material, such as steel, aluminum, ceramic, or may be made of any suitable plastic or elastomer material. It is also within the scope of the present invention that the pulley 110 or 111 may be integrally formed as one piece with shaft 120. It is also within the scope of the present invention that the support 190 and the outer ring 180 may be integrally formed as

one piece. It is also within the scope of the present invention that the support 190 and the shaft 120 may be integrally formed as one piece.

[0025] In Figure 7, surface 182 of outer ring 180 is shown as a ribbed surface for engaging a ribbed surface of the drive belt 211. However, it is within the scope of the present invention for the surface 182 of the outer ring 180 to be flat so as to engage a flat actuator or drive belt, or to have any other suitable shape for engaging a drive belt. Likewise, while pulleys 110 and 111 have been illustrated in Figures 3 and 7, respectively, as having a flat surface for engaging actuator or drive belt 210, it is within the scope of the present invention for pulleys 110, 111 to be provided with a flat, ribbed or other suitably shaped surface for engaging a flat, ribbed or other suitably shaped actuator or drive belt.

[0026] While the present invention has been described with reference to certain illustrative embodiments, one of ordinary skill in the art will recognize, that additions, deletions, substitutions and improvements can be made while remaining within the scope and spirit of the invention as defined by the appended claims.

Claims

1. A coolant pump (90) comprising:

a housing (95) having an internal axis;
a bearing (100) disposed on an outside of the housing (95);
a shaft (120) disposed along the internal axis of the housing (95), wherein the shaft (120) is journaled by the bearing (100) so as to be rotatable;
an impeller (130) disposed on the shaft (120) so as to rotate with the shaft (120); and
a seal (140) disposed on the shaft (120) at least partially inside of the bearing (100) so that the bearing (100) overlaps the seal (140) along the internal axis of the housing (95), wherein the bearing (100) has an inner diameter, the seal (140) has an outer diameter, and the inner diameter of the bearing (100) is greater than the outer diameter of the seal (140).

2. A coolant pump (90) as recited in claim 1, wherein the seal is a dynamic seal (150).

3. A coolant (90) pump as recited in claim 1, wherein the seal is a lip seal (140).

4. A coolant pump as recited in one of claims 1-3, wherein the seal (140) prevents leakage of coolant (201) when the impeller (130) is in contact with coolant (201) from a cooling system of an internal combustion engine E.

5. A coolant pump (90) as recited in onr of the claims 1-4, wherein the bearing (100) comprises an inner ring (102) defining said inner diameter and an outer ring (104) disposed to rotate on the inner ring, wherein the inner ring (102) is fixed to the housing (95).

6. A coolant pump (90) as recited in one of the claims 1-5, further comprising a pulley (110) having an inner surface connected to the outer ring (104) of the bearing (100) so that the outer ring (104) is rotatable with the pulley (110), wherein the pulley (110) also has a central portion (117) attached to the shaft (120) so that when the pulley (110) is rotated, the pulley (110), the outer ring (104) of the bearing (100), the shaft (120) and the impeller (130) rotate together.

7. A coolant pump (90) as recited in one of the claims 1-6, wherein the bearing (100) further comprises one or more tracks of rolling elements (106, 108) sandwiched between the inner ring (102) and the outer ring (104) of the bearing (100).

8. A coolant pump (90) as recited in one of the claims 6, wherein the pulley (100) further comprises a belt engaging portion (115) adapted to engage an actuator (210) belt to rotate the pulley (110) and actuate the coolant pump (90).

9. A coolant pump as recited in claim 6, further comprising a support member (190) connected to the outer ring (104) of the bearing (100) so that the support member (190) is rotatable with the outer ring (104), wherein the support member (190) also has a central portion attached to the shaft (120) so that when the ring portion is rotated, the outer ring (104) of the bearing (100), the support member (190), the shaft (120) and the impeller (130) rotate together.

10. A coolant pump as recited in claim 9, wherein the outer ring (180) of the bearing defines a belt engaging portion adapted to engage an actuator belt (211) to rotate the outer ring (180) and actuate the coolant pump.

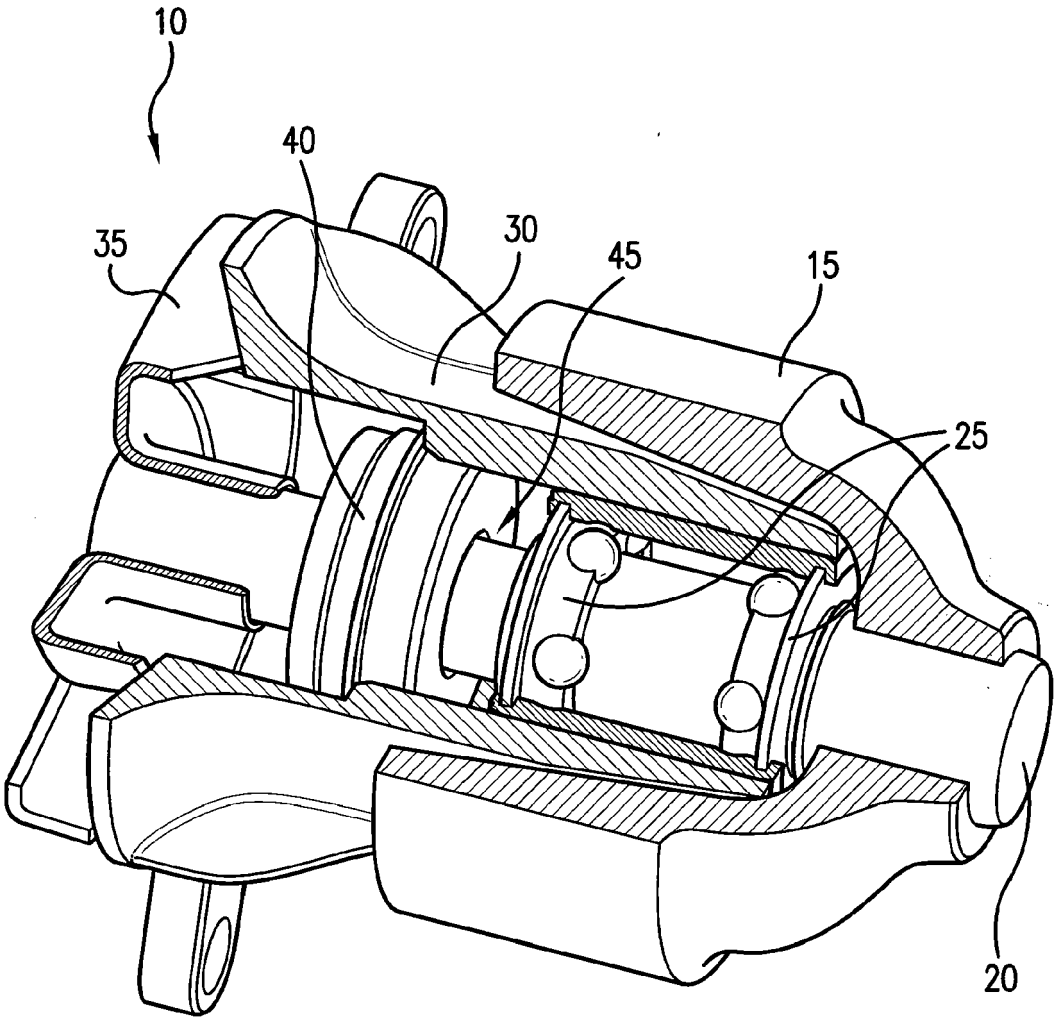


FIG. 1
PRIOR ART

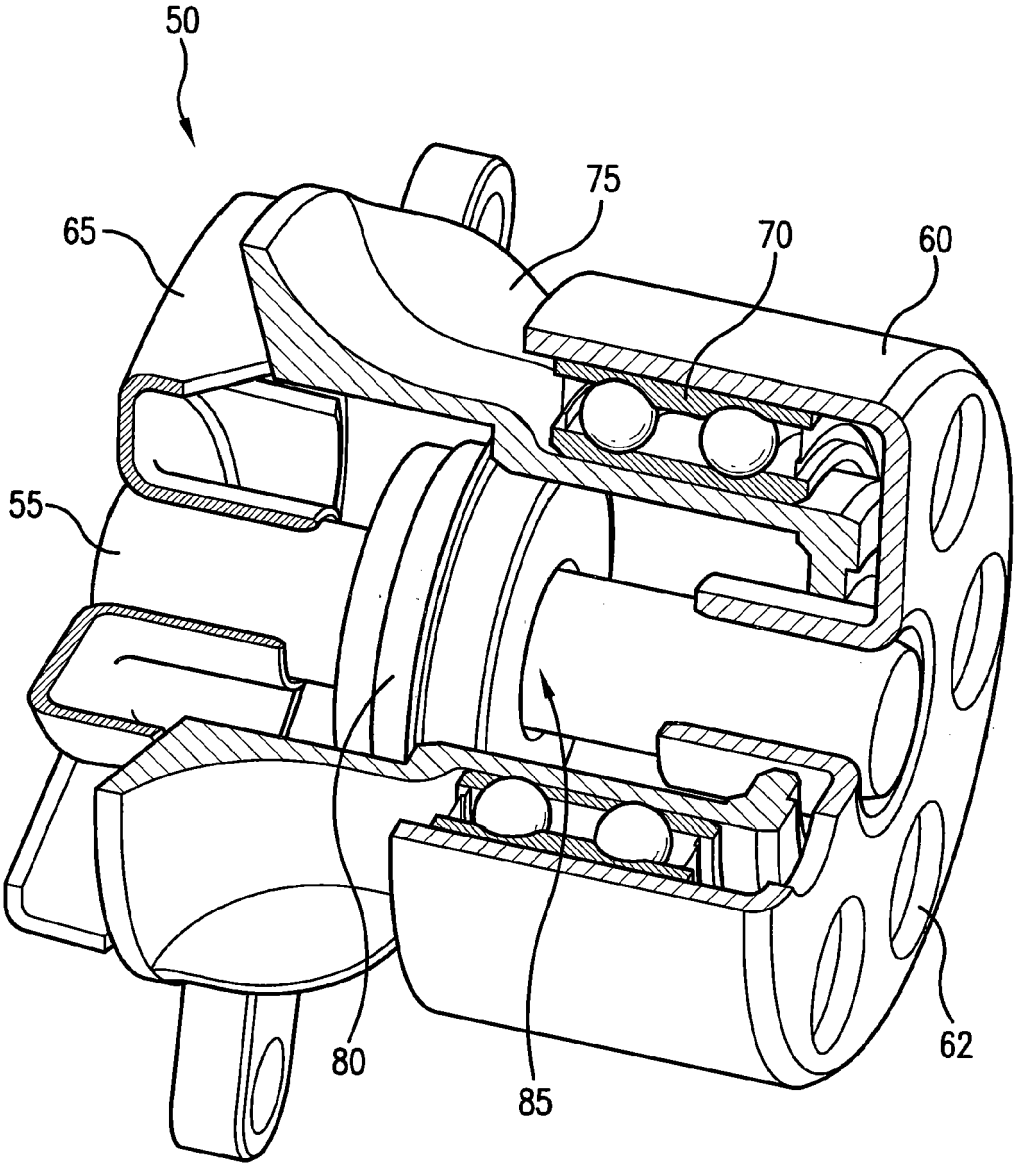


FIG.2

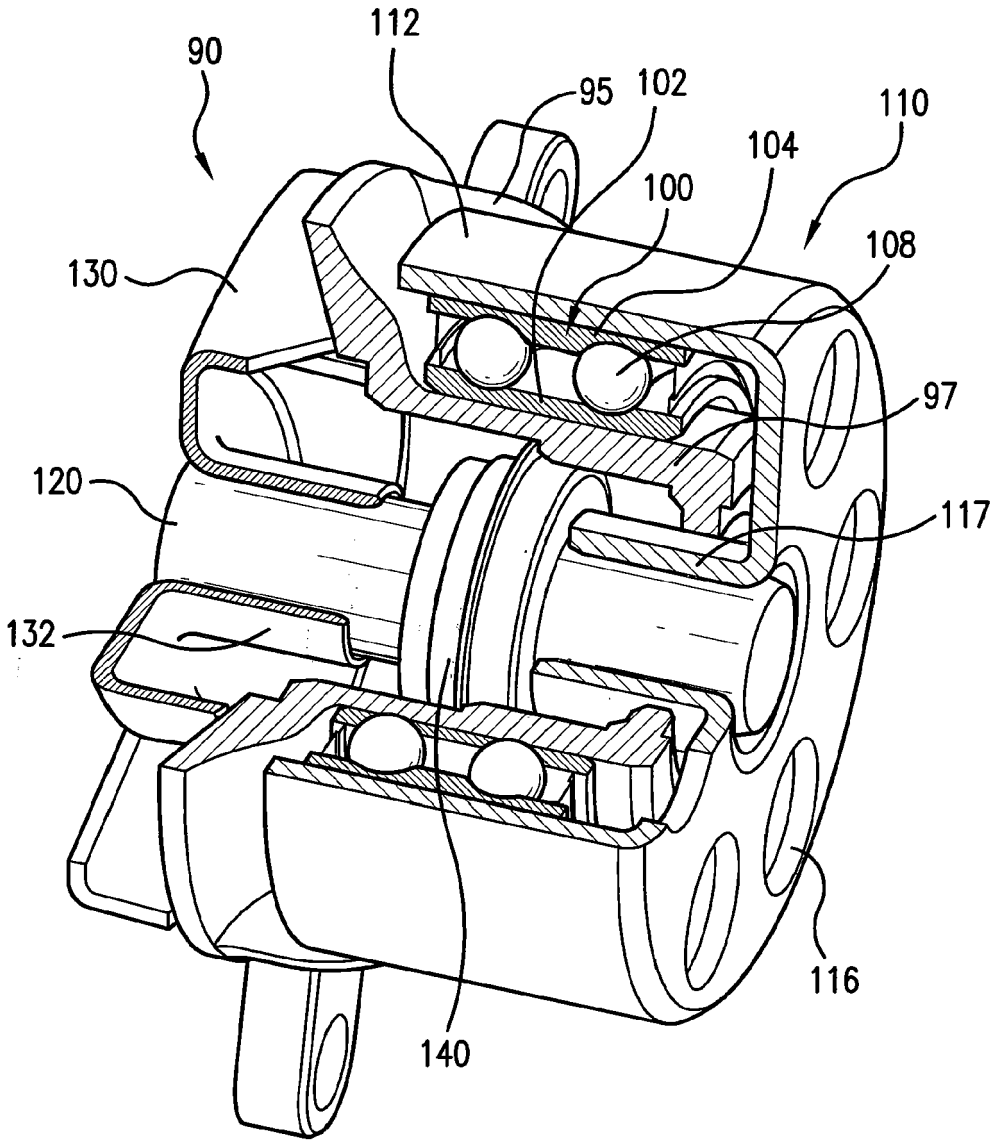


FIG.3

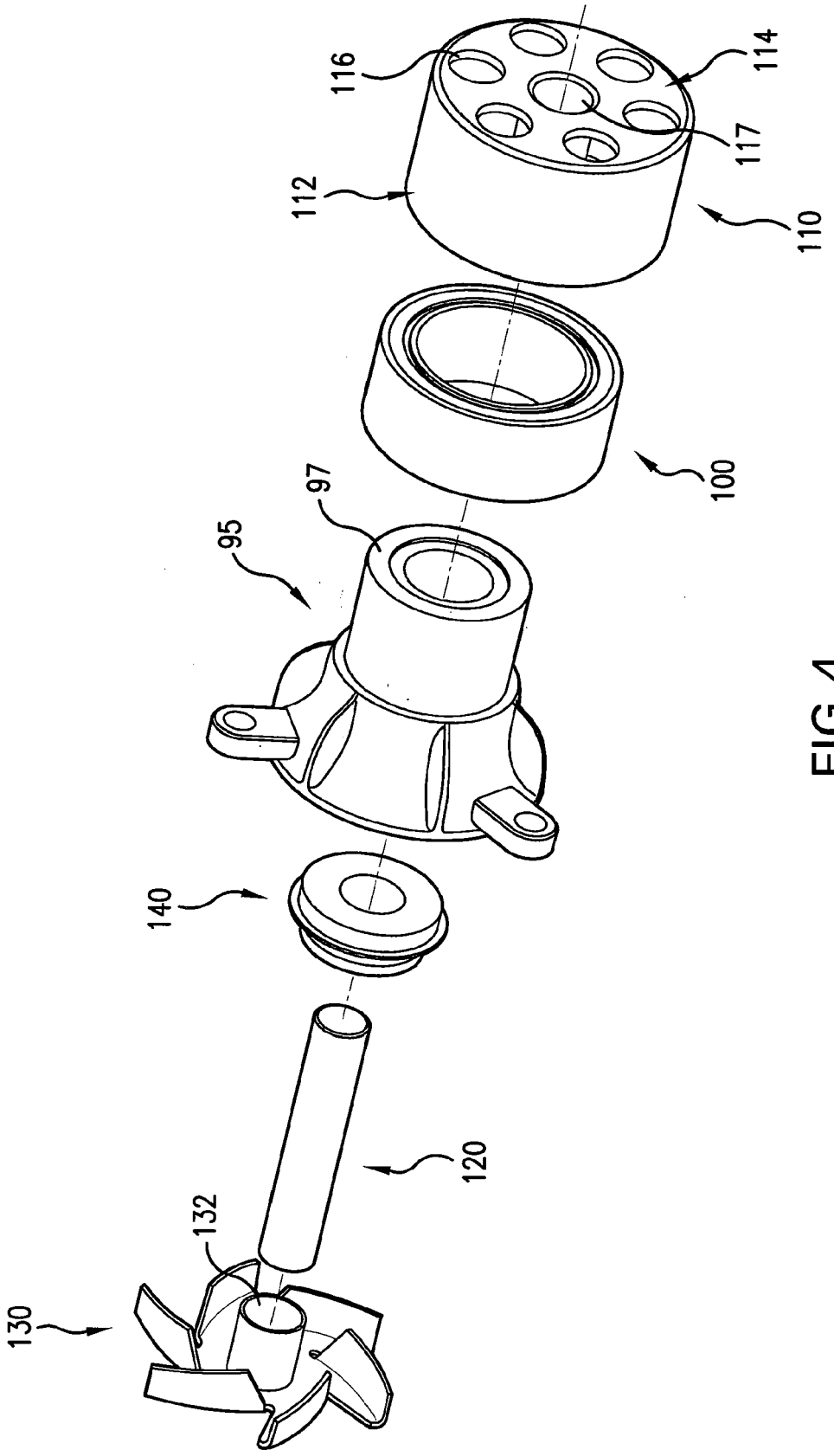
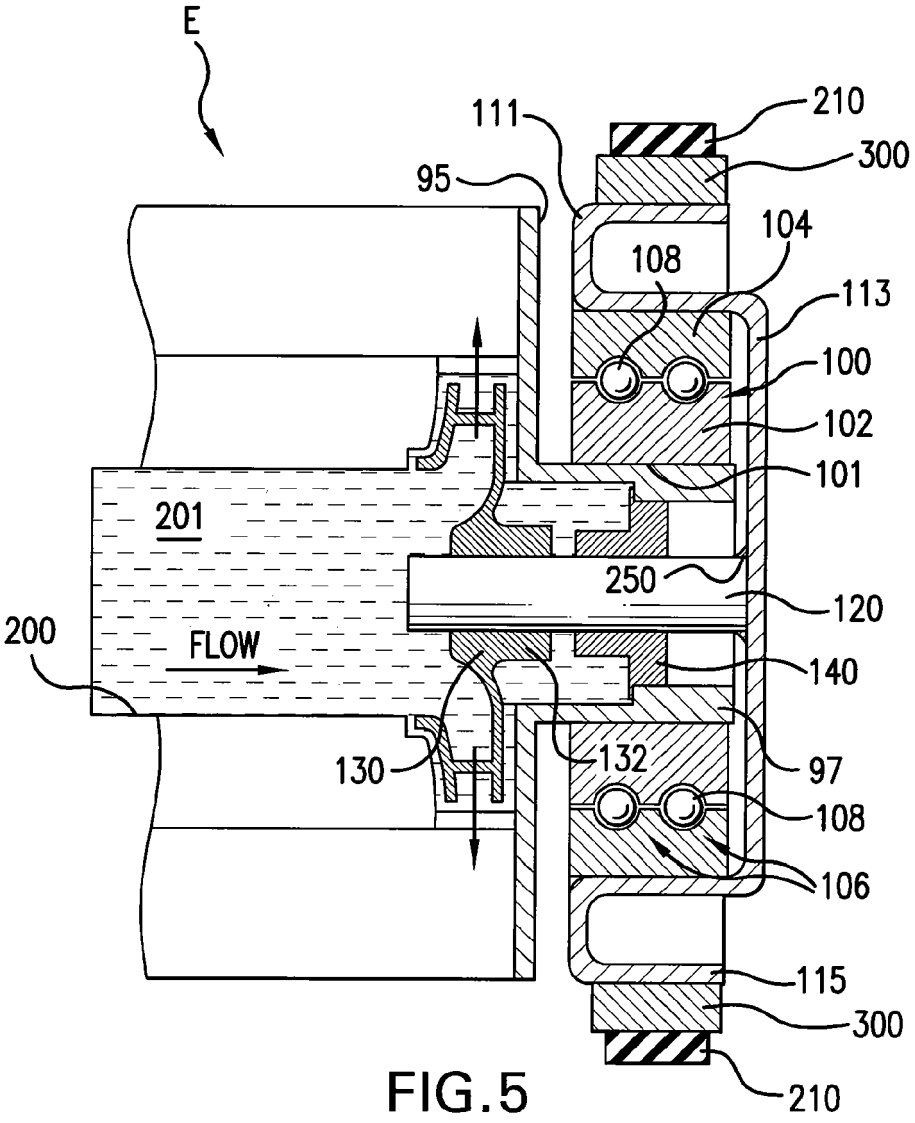


FIG.4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104
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FLOW
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106
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210

FIG.5

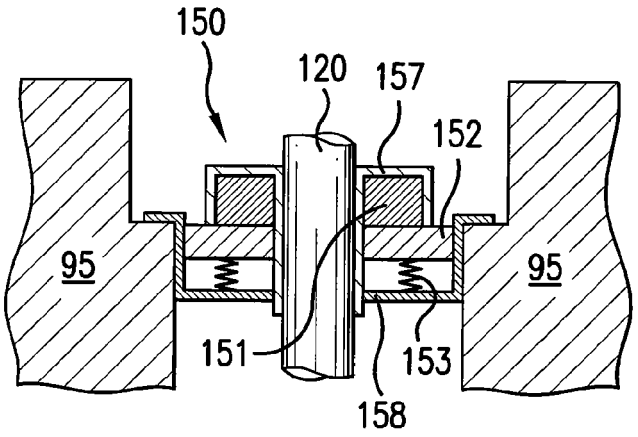
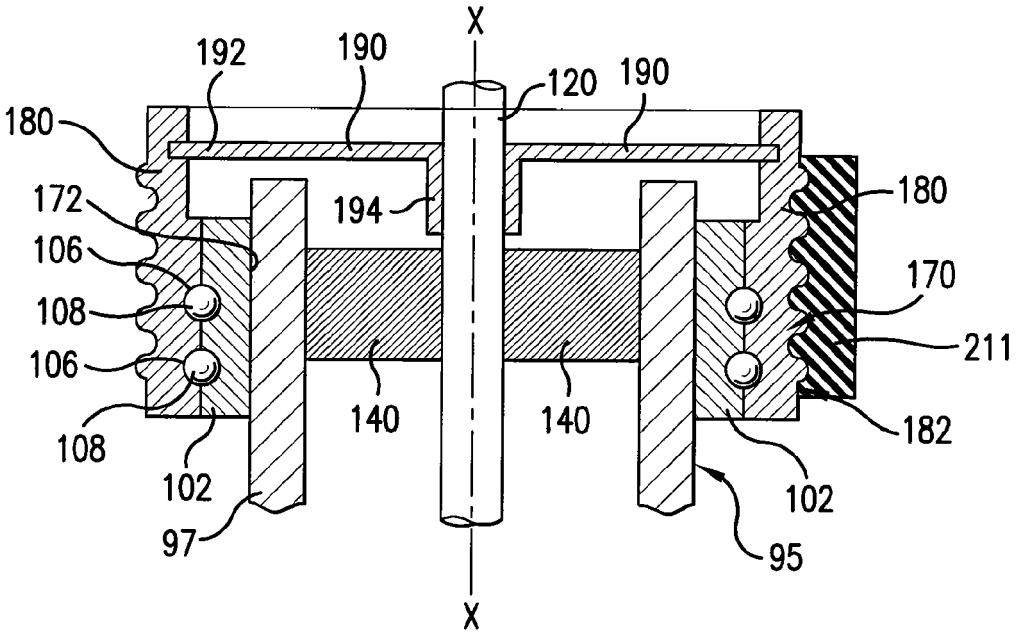

150
120
157
152
95
95
151
153
158

FIG.6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211
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140
140
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108
102
102
97
95
X

FIG.7

REFERENCES CITED IN THE DESCRIPTION

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