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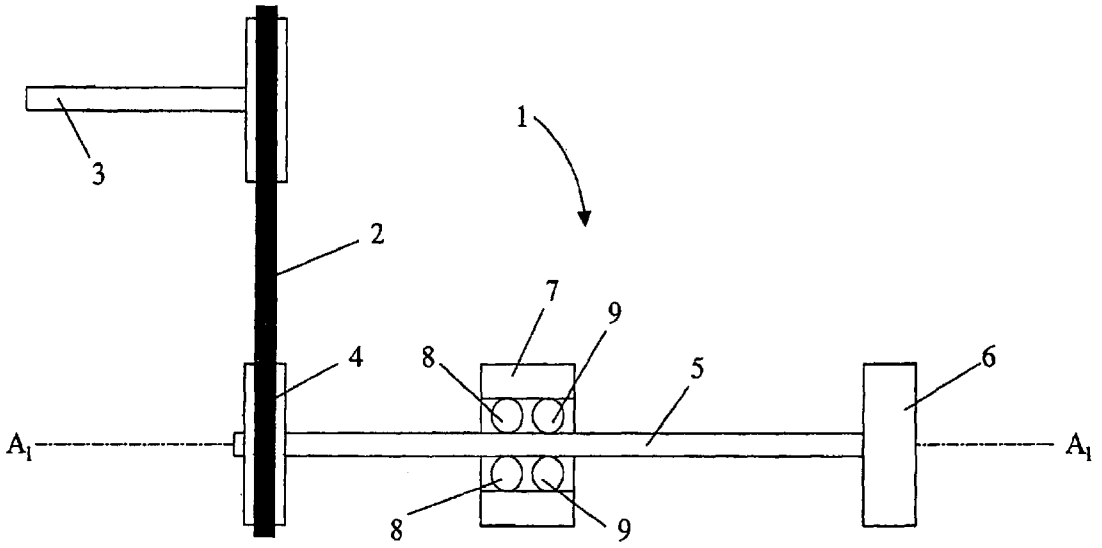

(57) Abstract: A compact water pump assembly has a shaft extending from a first end to a second end. An annular groove is located on the shaft. A housing member is located about the shaft and intermediate the first and second ends. An impeller is coupled to the second end of the shaft. A plurality of bearing members are arranged in a single- row within the groove. The bearing members rotatably support the shaft in the housing. In addition, each bearing member includes a radial centerline. A pulley is coupled to the first end of the shaft. The pulley is capable of engaging a drive belt such that the centerline of the belt driving surface is in substantial alignment with the bearing centerlines.

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TITLE

COMPACT PUMP ARRANGEMENT

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This non-provisional patent application claims the benefit of United States Provisional Patent Application No. 60/809,763, entitled "COMPACT PUMP ARRANGEMENT," filed May 31, 2006, which is hereby incorporated in its entirety.

FIELD OF THE INVENTION

[0002] The present invention relates generally to compact pump arrangements, and more particularly, to compact water pumps for automobile engines.

BACKGROUND

[0003] Pumps are utilized in a wide variety of systems and assemblies to displace liquids, gases, slurries, and the like. One such system that utilizes a pump is a cooling system of an automobile engine. Automobile engine cooling systems typically include a pump, commonly referred to as a "water pump," to pump antifreeze, or other similar coolants, around and through the automobile engine to cool the engine during operation.

[0004] A common water pump 1 is schematically illustrated in Figure 1. A water pump 1 is typically a centrifugal pump driven by a drive belt 2 connected to the

crankshaft 3 of the engine. The water pump 1 includes a pulley 4, a center shaft 5, an impeller 6, and a bearing assembly 7. The pulley 4 and impeller 6 are coupled to opposite ends of the center shaft 5. The drive belt 2 is connected to the pulley 4 such that the pulley 4 rotates as the crankshaft 3 of the engine rotates. The coupling of the pulley 4 and the impeller 6 to the center shaft 5 causes the shaft 5 and impeller 6 to rotate as the pulley 4 rotates. The center shaft 5 is supported by the bearing assembly 7, which generally secures the shaft 5 while allowing the shaft 5 to rotate about its longitudinal axis A_1. The bearing assembly 7 is positioned to contact the center shaft 5 at a location between the pulley 4 and the impeller 6. The illustrated bearing assembly 7 is a double-row bearing assembly. In other words, the bearing assembly 7 includes first and second sets or rows of bearing elements 8 and 9, respectively, to secure the center shaft 5. The bearing assembly 7 is typically secured in a housing (not shown in Figure 1), which may be used to secure the water pump 1 within the engine.

[0005] Prior art arrangements for water pumps, such as that shown in Figure 1, may be difficult to incorporate into automobile engines due to the overall size of the water pump. As some automobiles are designed to be more compact and increasingly include features such as front wheel drive, available space in and around the engine becomes increasingly scarce. Therefore, there is a need in the art for arrangements of water pumps that reduce the overall size of the pump. Such reductions in size may increase the flexibility in which a water pump may be packaged into an automobile engine. Similarly, a reduction in the size of any pump may lead to greater flexibility in positioning the pump within its operational environment.

SUMMARY OF THE INVENTION

[0006] An embodiment of the present invention provides a compact water pump assembly. The assembly includes a shaft having a first end and a second end. An annular groove is located on the shaft. A housing member is located about the shaft and intermediate the first and second ends. An impeller is coupled to the second end of the shaft. A plurality of bearing members are arranged in a single-row within the groove. The bearing members rotatably support the shaft in the housing. In addition, each bearing member includes a radial centerline. A pulley is coupled to the first end of the shaft. The pulley is capable of engaging a drive belt such that the centerline of the belt driving surface is in substantial alignment with the bearing centerlines.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

[0007] Objects and advantages together with the operation of the invention may be better understood by reference to the following detailed description taken in connection with the following illustration, wherein:

[0008] Figure 1 is a schematic illustration of a prior art water pump including a double-row bearing assembly;

[0009] Figure 2 is a cross-sectional view of an embodiment of a water pump in accordance with the present invention; and

[0010] Figure 3 is a cross-sectional view of the bearing assembly and integral shaft of the water pump of Figure 2.

DETAILED DESCRIPTION OF THE INVENTION

[0011] The above-identified disadvantages of the prior art are overcome through the use of the invention disclosed herein. By reducing the overall size of a pump, the pump may be more readily packaged into an appropriate environment. In one embodiment, the reduction of the overall size of a water pump may allow the water pump to be more readily packaged into an automobile engine compartment.

[0012] Referring to Figure 2, an exemplary embodiment of a pump in accordance with the present invention is illustrated. The pump may be a water pump **10** for use in an automobile engine. The water pump **10** may include a housing **12**, a bearing assembly **14**, a shaft **16**, a hub **18**, a pulley **20**, and an impeller **22**. The bearing assembly **14** may be press-fit into the housing **12** to secure and position the bearing assembly **14** with respect to the housing **12**. The bearing assembly **14** may be in contact with the shaft **16** to fix the position of or otherwise secure the shaft **16** with respect to the bearing assembly **14**. The shaft **16** may include a generally circular cross-section and may be positioned to rotate about its longitudinal axis A_{is}. In an embodiment, the shaft **16** may be integrally formed with the hub **18**.

[0013] Figure 3 illustrates the bearing assembly **14** in relation to the shaft **16** in one embodiment of the invention. As shown, the bearing assembly **14** may be a single-row bearing assembly. The bearing assembly **14** may be generally circular in cross-section to position the circular shaft **16** therein. The bearing assembly **12** may include an outer race **24**, which contains a plurality of bearing members **26**. The outer race **24** may be a groove corresponding in size and shape to the bearing members **26**. While the exemplary embodiment is described as including a single-row bearing assembly

with the bearing members **26**, it will be readily understood that a wide variety of load bearing assemblies and elements may be utilized in the practice of this invention. For example, the bearings may be ball elements, such as, ball bearings, cylindrical roller bearings, needle roller bearings, tapered roller bearings, and the like. The bearing members **26** may all serve as load bearing assemblies and elements in the practice of this invention.

[0014] The shaft **16** may have an annular groove **28** along its outer surface that may correspond in shape and size to the bearing members **26**. In one embodiment, the shaft **16** may be positioned such that the annular groove **28** serves as the inner race of the bearing assembly **14** and/or the bearing members **26**. The plurality of bearing members **26** may fit into the groove **28** to maintain the position of the shaft **16** and/or the bearing members **26** relative to the housing **12**. The annular groove **28** may have a arcuate cross-section, as shown in Figure 3, a substantially V-shaped cross-section, a substantially U-shaped cross-section, a substantially square cross-section (i.e. having two spaced apart, substantially parallel walls joined together by an intermediate, substantially perpendicular wall), or any other cross-section corresponding in shape and size to the bearing members **26**. Of course, other cross-sections suitable for engagement with the bearing members **26** are contemplated will be appreciated by one of ordinary skill in the art.

[0015] In an embodiment, the bearing members **26** may maintain the lateral and the longitudinal position of the shaft **16** while permitting the shaft **16** to rotate about a longitudinal axis A_{ls} extending therethrough. To facilitate the rotation of the shaft **16**, the bearing assembly **14** may be packed and/or coated with lubricant, which may be

contained within the bearing assembly **14** by, for example, seals **30** located at the outer ends of the bearing assembly **14**. Additionally, spacers (not shown) may be employed between each bearing member **26** to prevent the bearing members **26** from concentrating in one specific area within the groove **28**.

[0016] Referring again to Figure 2, in one embodiment, the hub **18** may be press-fit at a first end **32** of the shaft **16**, and the impeller **22** may be press-fit at a second end **34** of the shaft **16**. A mechanical seal **50** may be disposed between the shaft **16** and the portion of the housing **12** adjacent to the impeller **22** to prevent entry of coolant from the pump chamber of the engine block into the bearing assembly **14**. The pulley **20** may be coupled to the hub **18** by a plurality of bolts **36** or other such fasteners. A drive belt (not shown) may connect the pulley **20** with the crankshaft of the engine such that when the crankshaft rotates, the pulley **20** rotates. In a preferred embodiment, the pulley **20** is arranged such that the centerline of the drive surface of the drive belt is in substantial alignment with the centerline **38** of the bearing assembly **14**, and specifically, the radially extending centerlines **38** of each ball element **26**.

[0017] By utilizing a single-row bearing **14** rather than the double-row bearing used in the prior art, the overall length, from the first end **32** of the shaft **16** to the second end **34** of the shaft **16**, may be reduced. This reduction in length may reduce the forces translated or transferred to the water pump from to the drive belt and the pulley. The drive belt is typically drawn tightly around the pulley and driveshaft to resist and prevent slippage as the belt rotates about the pulley and crankshaft. The drive belt and pulley arrangement of the present invention may result in a force vector

in line with and/or substantially parallel to the drive belt. The force of the drive belt, along with any additional forces due to the rotation of the pulley by the drive belt, may create normal and torque forces on the water pump. Advantageously, the shorter shaft length may reduce torque forces experiences by the water pump due to the drive belt. In addition, the positioning of the drive belt in line with or substantially parallel to the centerline of the bearing elements places the drive belt force vector in line with the bearing elements. This arrangement may further reduce the effects of forces on the water pump due to the arrangement and orientation of the drive belt.

[0018] As an example of the reduction of overall length of a water pump **10**, a 27 millimeter wide double-row bearing assembly may be replaced by a 14 millimeter wide single-row bearing assembly. The inclusion of this single-row bearing assembly in place of the double-row bearing assembly may, for example, reduce the overall length of a shaft by 13 millimeters, from 66 millimeters to 53 millimeters. The reduction of length by 13 millimeters may increase the flexibility of packaging the water pump into an automobile engine. In addition, although the exemplary embodiment is described as a water pump **10**, it will be readily understood by those skilled in the art that the practice of this invention can include a wide variety of pumps and other assemblies that rely on transfer of rotation force though pulley-to-belt or other similar arrangements.

[0019] While the invention has been described with reference to the preferred embodiment, other embodiments, modifications, and alternations may occur to one skilled in the art upon reading and understanding of this specification and are to be covered to the extent that they fall within the scope of the appended claims. Indeed,

the invention as described by the claims is broader than and unlimited by the preferred embodiment, and the terms in the claims have their full and ordinary meaning.

CLAIMS

Having thus described the invention, I claim:

1. A compact water pump assembly comprising:

a shaft having a first end and a second end;

an annular groove in said shaft;

a housing member located about said shaft and intermediate said first end and said second end;

an impeller coupled to said second end;

a plurality of bearing members arranged in a single-row within said annular groove and rotatably supporting said shaft in said housing, each of said bearing members having a radial centerline; and

a pulley coupled to said first end and capable of engaging a drive belt such that the centerline of the drive belt is in substantial alignment with at least one of said centerlines of said bearing members.

2. The compact water pump assembly of claim 1 wherein said annular groove has a radial centerline in substantial alignment with said bearing centerlines.

3. The compact water pump assembly of claim 2 wherein said annular groove has an arcuate cross-section.

4. The compact water pump assembly of claim 2 wherein said annular groove corresponds in size and shape to the bearing members.

5. The compact water pump assembly of claim 1 wherein said bearing members are ball bearings.

6. The compact water pump assembly of claim 1 wherein said bearing members are roller bearings.

7. The compact water pump assembly of claim 1 further comprising:

a hub positioned between said shaft and said pulley wherein said hub is integrally formed with said shaft.

8. The compact water pump assembly of claim 1 further comprising:

a mechanical seal positioned between said housing and said bearing members capable of preventing fluid communication into said bearing members.

9. The compact water pump assembly of claim 1 further comprising:

an annular outer race in said housing member, said annular outer race sized and shaped to receive said bearing members.

10. The compact water pump assembly of claim 9 wherein said outer race has a radial centerline in substantial alignment with at least one of said bearing centerlines.

11. A compact water pump assembly comprising:

a shaft having a first end and a second end;

an annular groove in said shaft;

a housing member located about said shaft and intermediate said first end and said second end;

an impeller coupled to said second end;

a plurality of bearing members arranged in a single-row within said annular groove and rotatably supporting said shaft in said housing, each of said bearing members having a radial centerline;

a pulley coupled to said first end; and

a belt in driving engagement with said pulley, said belt having a centerline in substantial alignment with said bearing centerlines.

12. The compact water pump assembly of claim 11 wherein said annular groove has a radial centerline in substantial alignment with at least one of said bearing centerlines.

13. The compact water pump assembly of claim 11 wherein said annular groove has an arcuate cross-section.

14. The compact water pump assembly of claim 11 wherein said bearing members are ball bearings.

15. The compact water pump assembly of claim 11 further comprising:

a mechanical seal positioned between said housing and said bearing members capable of preventing fluid communication into said bearing members.

16. The compact water pump assembly of claim 11 wherein said annular groove corresponds in shape and size to said bearing members.

17. The compact water pump assembly of claim 11 further comprising:

a hub positioned between said shaft and said pulley wherein said hub is integrally formed with said shaft.

18. The compact water pump assembly of claim 17 further comprising:

an outer race formed in said hub, said outer race shaped and sized to receive said bearing members.

19. The compact water pump assembly of claim 11 further comprising:

an annular outer race in said housing member, said annular outer race sized and shaped to receive said bearing members.

20. The compact water pump assembly of claim 19 wherein said outer race has a radial centerline in substantial alignment with at least one of said bearing centerlines.

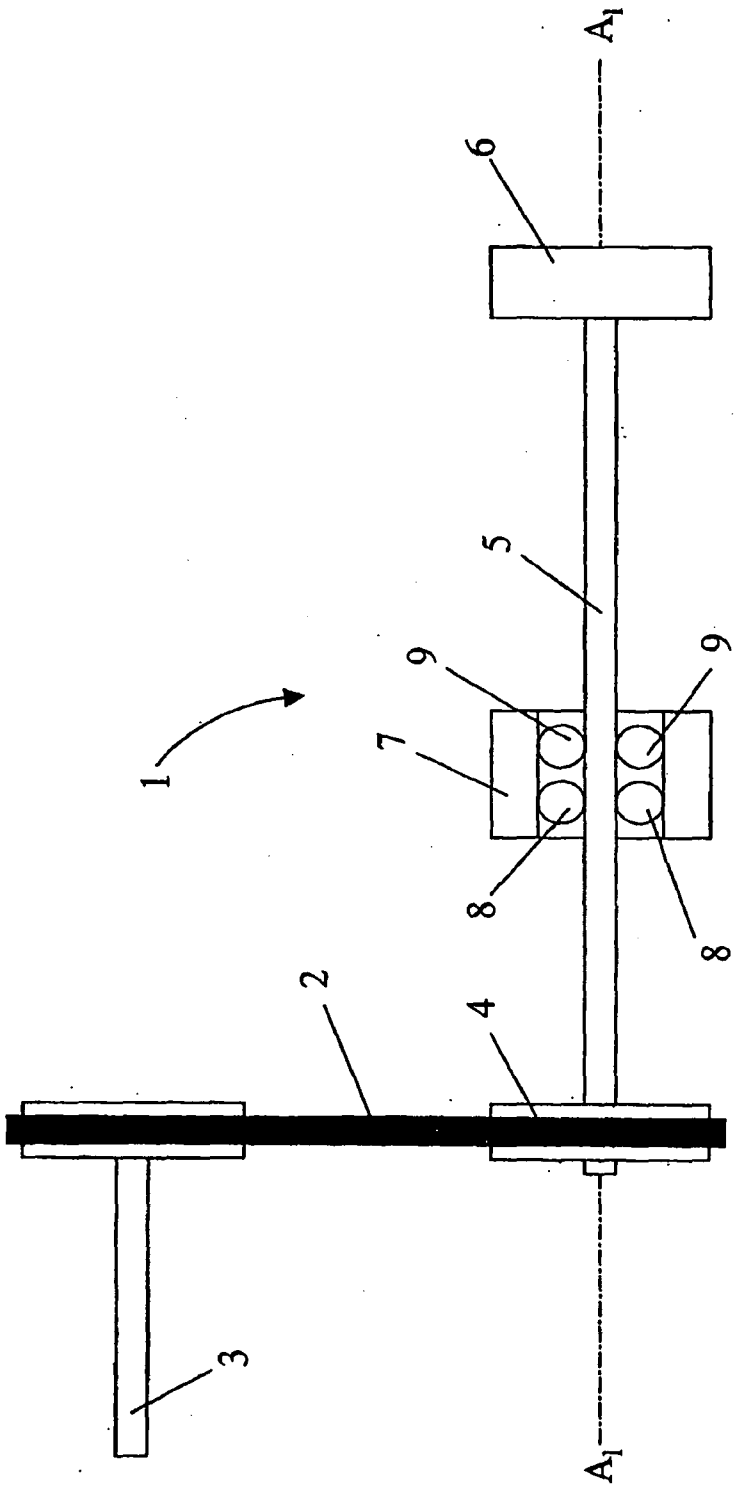
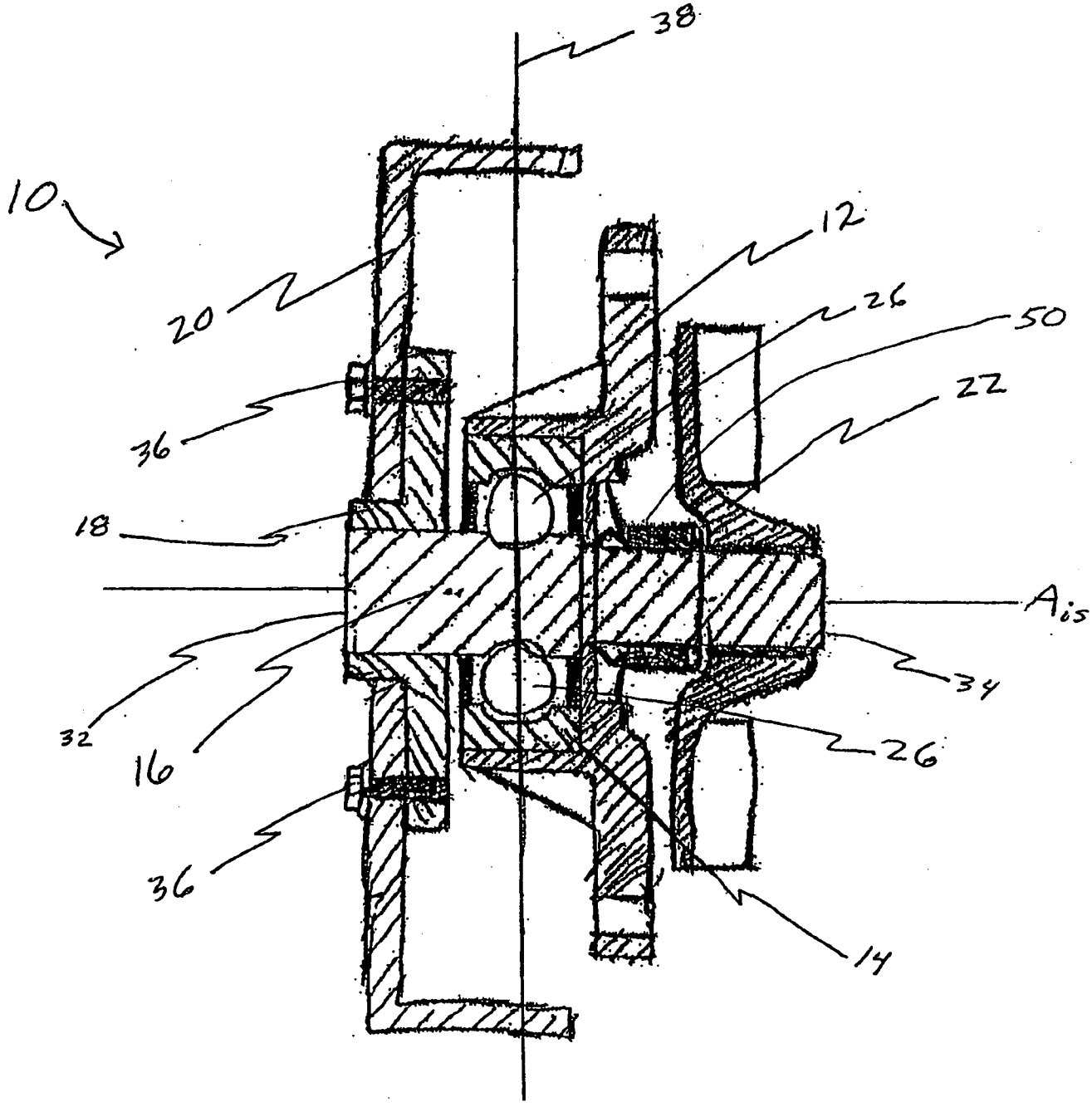


Figure 1
Prior Art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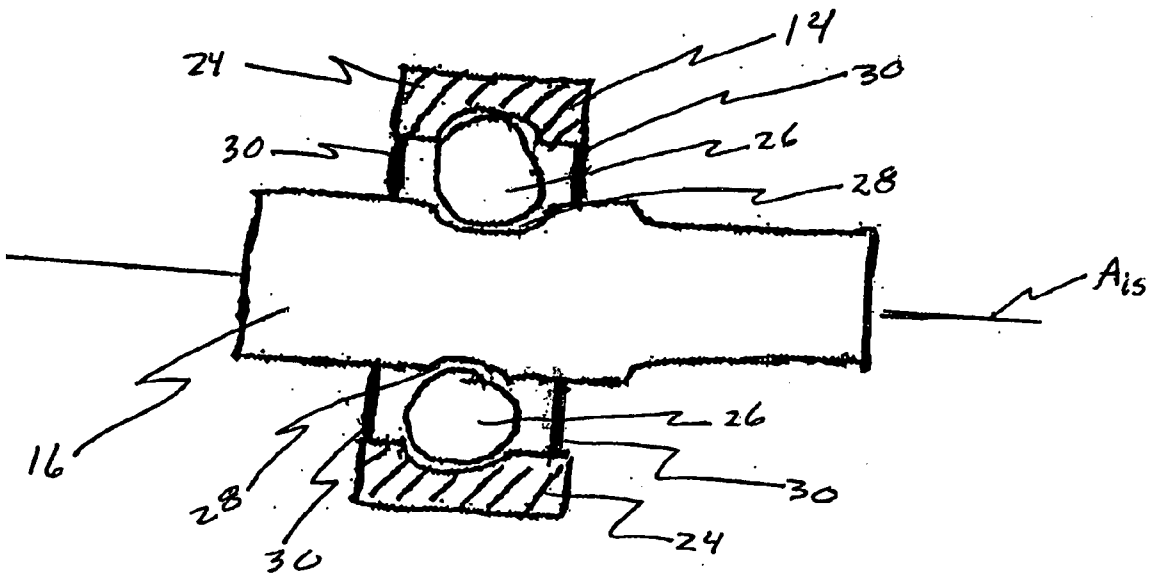

FIGURE 3