



US 20130147257A1

(19) **United States**(12) **Patent Application Publication**
van de Sanden et al.(10) **Pub. No.: US 2013/0147257 A1**(43) **Pub. Date: Jun. 13, 2013**(54) **WHEEL BEARING ASSEMBLY COMPRISING
A JOINT AND CORRESPONDING METHOD
OF MANUFACTURE****Publication Classification**

(51) **Int. Cl.**
B60B 27/00 (2006.01)
B21K 1/00 (2006.01)
B21D 39/06 (2006.01)

(52) **U.S. Cl.**
CPC **B60B 27/0078** (2013.01); **B21D 39/06**
(2013.01); **B21K 1/00** (2013.01)
USPC **301/109**; 29/898.04

(76) Inventors: **John van de Sanden**, Nieuwegein (NL);
Cornelius Petrus Antonius Vissers, Den
Dungen (NL); **Victor Haans**, Rotterdam
(NL); **Andreas Knopf**, Wurzburg (DE);
Paolo A. Re, Nichelino (IT)

(21) Appl. No.: **13/700,390**(22) PCT Filed: **Sep. 14, 2010**(86) PCT No.: **PCT/EP2010/004354**

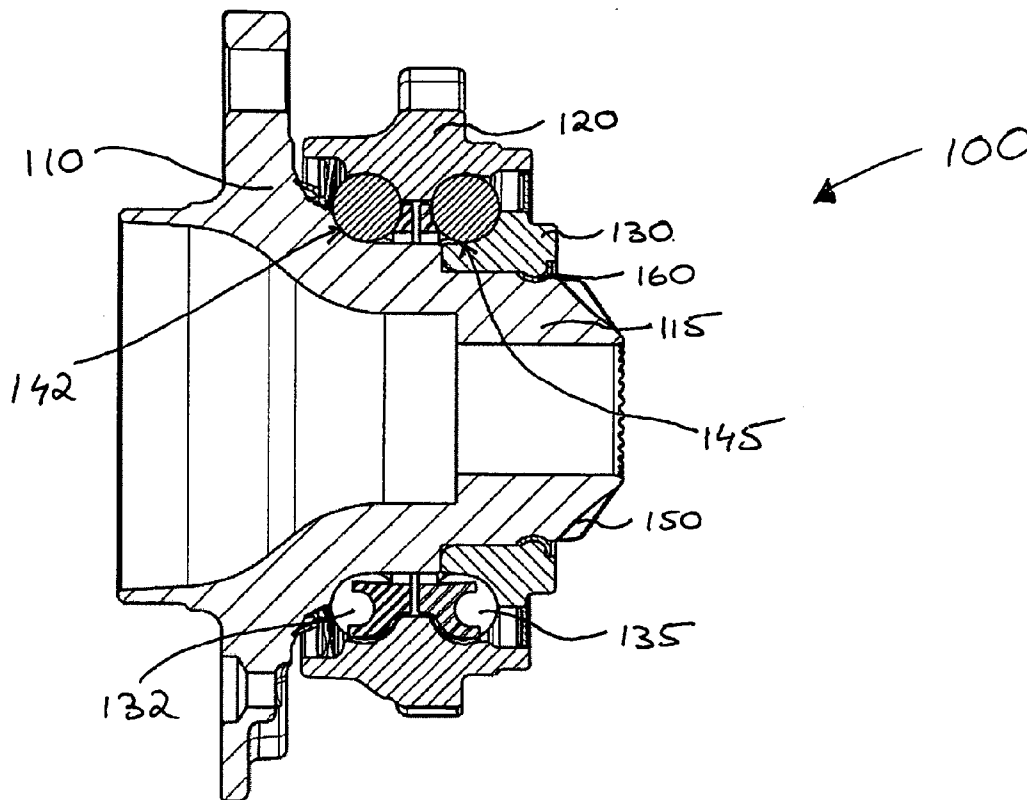
§ 371 (c)(1),
(2), (4) Date: **Feb. 15, 2013**

(30) **Foreign Application Priority Data**

May 28, 2010 (EP) PCT/EP2010/003244

ABSTRACT

The present invention resides in a wheel bearing assembly (100) comprising a flanged hub (110) and at least one second component (130) that is joined to the flanged hub by means of a radially intermediate joint (160). Specifically, the flanged hub has a first joining surface and the second component has a second joining surface, radially opposite from the first joining surface and spaced therefrom, such that a groove is defined between the first and second joining surfaces. According to the invention, the radially intermediate joint (160) is formed by an insert ring made from a high strength material that is pressed into the groove. The invention also relates to a corresponding method of manufacturing a wheel bearing unit.



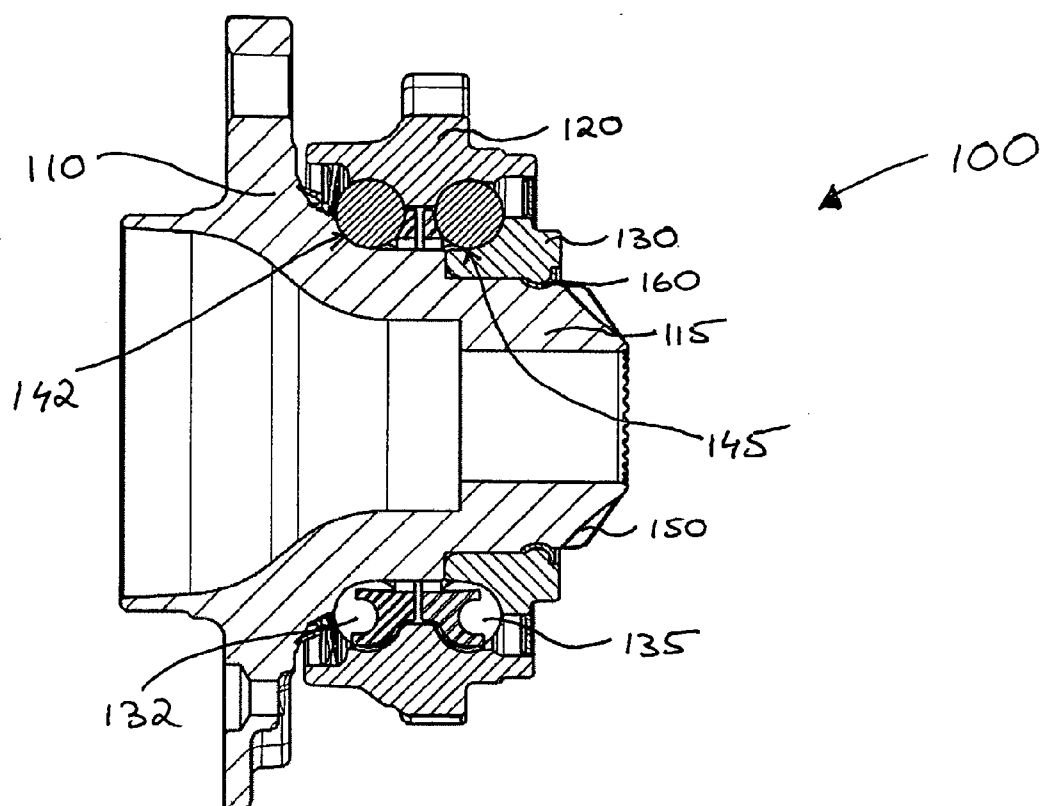


Fig. 1a

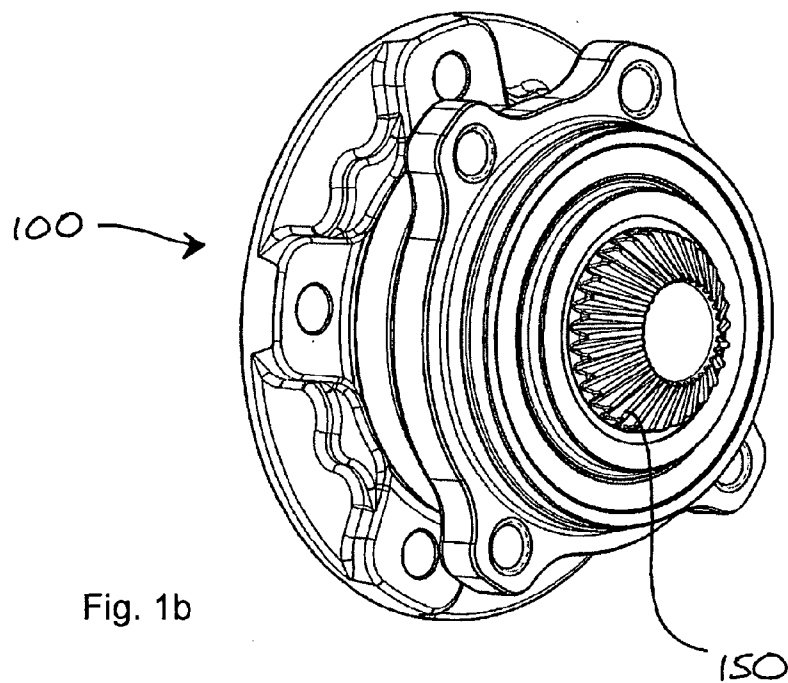
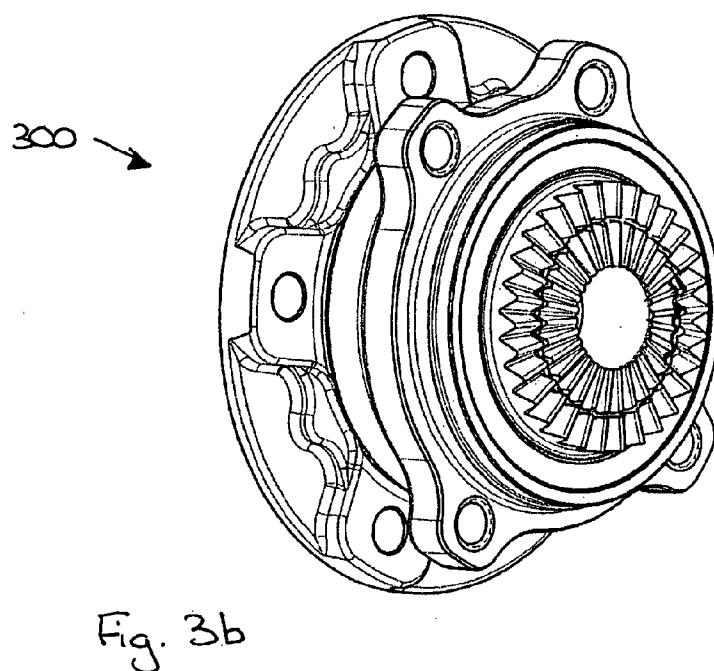
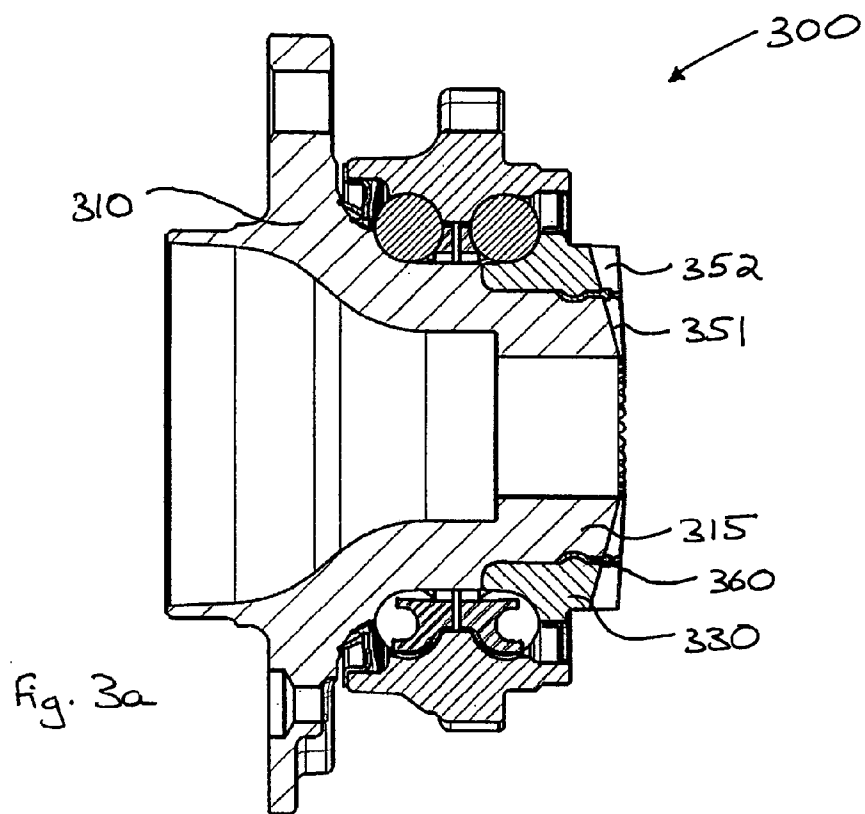


Fig. 1b

Fig.2



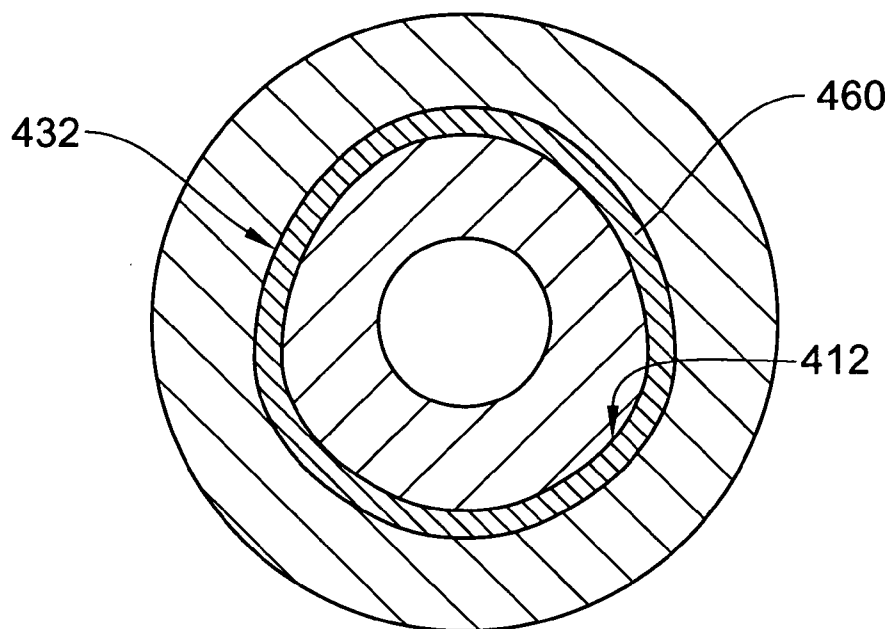


Fig.4a

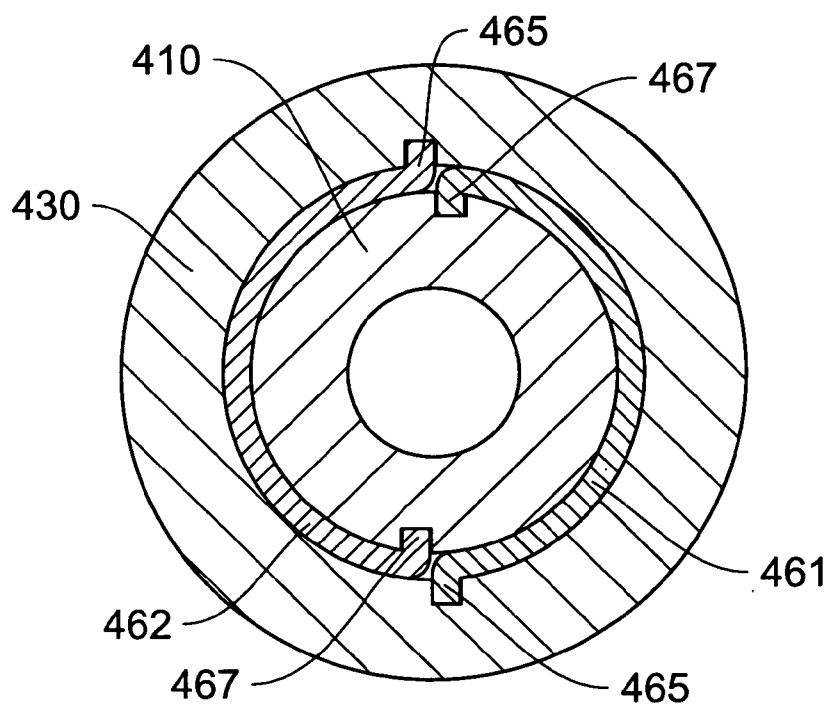


Fig.4b

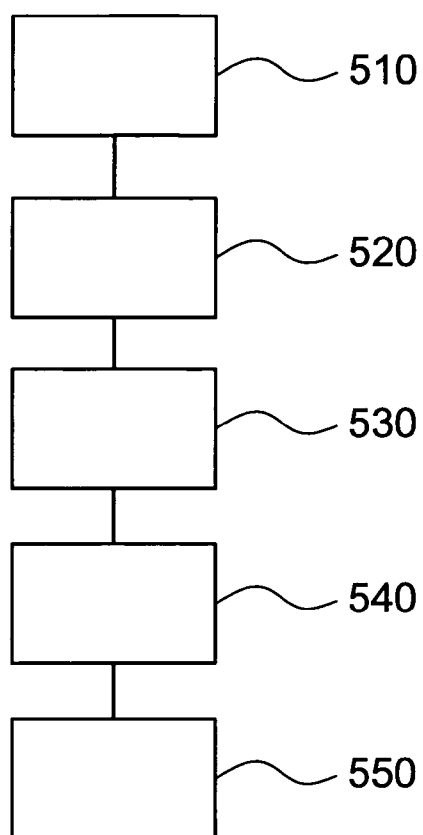


Fig.5

WHEEL BEARING ASSEMBLY COMPRISING A JOINT AND CORRESPONDING METHOD OF MANUFACTURE

FIELD OF THE INVENTION

[0001] The present invention relates to a wheel bearing assembly having a flanged hub that is connected to at least one other component of the assembly by means of a joint. The invention further relates to a method of manufacturing a wheel bearing assembly.

BACKGROUND

[0002] One example of a wheel bearing assembly comprising a joint is known from DE 102006033116. The joint in this example is a weld, which is employed to join a separate inner ring to the flanged hub such that the inner ring presses against an inboard row of rolling elements, to provide bearing preload. In many wheel bearing assemblies, such as disclosed in WO 2007014553, bearing preload is set by orbitally deforming an elongation of the flanged hub to form a collar. This collar then presses the separate inner ring against the inboard row of rolling elements. The welded joint disclosed in DE 102006033116 therefore enables a more compact bearing assembly in comparison with the assembly disclosed in WO 2007014553.

[0003] A disadvantage of welding, however, is that the resulting heat affected zone adversely affects the hardness of bearing steel. If the raceway on the separate inner ring loses hardness, the life of the wheel bearing will be severely diminished. Further, in the example of DE 102006033116, a side face of the separate inner ring is provided with splines for cooperating with mating splines on a constant velocity joint. The heat from the welded joint will also reduce the hardness of the splines on the separate inner ring.

[0004] Consequently, there is room for improvement.

DISCLOSURE OF THE INVENTION

[0005] The present invention resides in a wheel bearing assembly comprising a flanged hub and at least one second component that is joined to the flanged hub by means of a radially intermediate joint. Specifically, the flanged hub has a first joining surface and the second component has a second joining surface, radially opposite from the first joining surface and spaced therefrom, such that a groove is defined between the first and second joining surfaces. According to the invention, the radially intermediate joint is formed by an insert ring made from a high strength material that is pressed into the groove.

[0006] In use, the flanged hub is subject to axial loading in both directions. The joint should therefore possess sufficient shear strength in both axial directions to withstand the application loads. According to a particularly preferred embodiment of the invention, this is achieved in that one of the first and second joining surfaces comprises a concave portion and the other of the first and second joining surfaces comprises a convex portion. The groove between the joining surfaces therefore has an arcuate section. When the insert ring is pressed in, it deforms and adopts the shape of the arcuate section. Thus, material of the deformed insert ring fills the concave portion and surrounds the convex portion, meaning that the flanged hub and the second component are locked with respect to each other in both axial directions. Radial locking is achieved in that the insert ring in undeformed state

has a thickness that is equal to a maximum radial gap between the convex portion and the concave portion.

[0007] Suitably, the insert ring has a volume that is at least equal to a volume of the arcuate section of the groove, to ensure that the arcuate section is completely filled with material of the insert ring. Further, the groove design may be such that the diameter of an apex of the convex portion is essentially equal to a maximum diameter of the joining surface that comprises the concave portion. In other words, the convex portion does not protrude into a cavity defined by the concave portion. This groove design helps ensure that the arcuate section is completely filled with insert ring material at a second side of the arcuate section, opposite from a first side at which the insert ring enters the groove.

[0008] The arcuate geometry of the groove between the first and second components enables the formation of a joint which locks the components relative to each other in both axial directions, while requiring relatively little plastic deformation of the insert ring. As a result, the insert ring may be made from a high-strength material. A high-strength material should be understood as a material with a yield strength of between 250 and 1300 MPa. In a preferred embodiment, the insert ring is made from a quenched and tempered steel with a yield strength of between 800 and 1200 MPa, more preferably between 1000 and 1200 MPa. Examples of suitable steels are defined under "Heat-treatable steels" in Section 2 of "Key to Steel" [22nd edition, Verlag Stahlschlüssel Wegst GmbH].

[0009] When the insert ring is made from a material with a yield strength in the region of 1000-1200 MPa, the arcuate section of the groove should not be too steeply arcuate, or the deformed insert ring will not be able to adopt its shape. Suitably, a surface of the convex portion, at the first side, may have a maximum angle of between 28 and 35 degrees, relative to a reference line parallel to the axial centreline of the assembly. Further, the concave portion at the second side of the groove may have a maximum angle of between 28 and 35 degrees, relative to the reference line. This groove geometry allows the required degree of plastic deformation of the insert ring, and the resulting joint has excellent shear strength in both axial directions.

[0010] In other embodiments, the insert ring is made from a material with a lower yield strength of between 200 and 700 MPa. The first side of the convex portion may then have a maximum angle of between 35 and 42 degrees, and the second side of the concave portion may have a maximum angle of between 35 and 42 degrees. The greater ductility of such lower-strength materials allows the groove geometry to be more steeply arcuate, which in turn allows a relatively greater volume of material at either side of the convex portion. This increases the shear strength of the joint, meaning that groove geometry can be adapted to the material of the insert ring, so as to form a joint with the required strength.

[0011] The convex portion and the concave portion may be formed by surfaces with a radius of curvature. Alternatively, these portions may be formed from oppositely oriented conical surfaces.

[0012] As mentioned, the radial gap between the concave and convex portions has a maximum value equal to the thickness of the insert ring. The radial gap may be essentially constant, or the gap at the second side of the apex may be slightly smaller than at the first side, to take account of a narrowing of the insert ring that may occur as it is deformed around the apex.

[0013] Further, the arcuate section of the groove may be essentially symmetrical at either axial side of the apex. Alternatively, if the joint needs to possess greater axial strength in a particular direction, the arcuate section may be designed such that relatively more deformed insert ring material will surround the convex portion at the corresponding axial side.

[0014] The insert ring may be formed from tube material, or from sheet material that is deformed into a ring shape. Furthermore, the insert ring may consist of a one-piece ring or may be formed from two or more sections.

[0015] In one embodiment of a wheel bearing assembly according to the invention, the at least one second component is a separate inner ring joined to a nose part of the flanged hub. Advantageously, the nose part is hardened, which increases the stiffness of the assembly. Hardening of the nose part is possible in an assembly according to the invention because there is no need to provide a ductile elongation that can be orbitally deformed. Furthermore, the radially intermediate joint is formed in a cold deformation process which has no effect on hardness; unlike a welded joint.

[0016] In a further development of this embodiment, an inboard axial side face of the flanged hub is provided with face splines for driven rotation of the bearing assembly. Again, the advantage of this development is that the splines can be machined into hardened bearing steel, which improves the strength, stiffness and service life of the wheel end assembly.

[0017] In a still further development, an inboard side face of the separate inner ring is provided with face splines that are in alignment with the face splines on the flanged hub. The advantage of this development is increased surface area engagement between the splines on the wheel bearing assembly and the mating splines on a constant velocity joint. As a result, torque transfer capacity is increased.

[0018] To further enhance torque transfer, the intermediate joint may comprise torque transfer means. In one embodiment, the insert ring has an axial length that is somewhat greater than an axial length of the groove. After the insert ring has been pressed in and has filled the arcuate section, a trailing edge of the insert ring protrudes beyond the joining surfaces. Continued pressing of the insert ring causes a radial thickening of the trailing edge, such that a first portion extends between adjacent splines on the separate inner ring and a second portion extends between adjacent splines on the nose part. The joint is thereby mechanically locked to the separate inner ring and the flanged hub in a rotational direction.

[0019] In an alternative example, rotational locking and torque transfer are enabled in that the groove and insert ring have a non-circular cross-section; for example, a triangular shape with rounded corners (lobes).

[0020] In a further alternative, the groove and the insert ring have a circular cross-section and rotational locking and torque transfer are enabled in that the insert ring comprises a radially outward extension and a radially inward extension, each of which is received in a corresponding recess in the first joining surface and a corresponding recess in the second joining surface.

[0021] When the wheel bearing assembly according to the invention comprises face splines, the assembly may be adapted to enable the constant velocity joint to be connected via a bolt connection. In an alternative example, the constant velocity joint is joined to the flanged hub by means of a

radially intermediate joint as described previously. The advantage of this development is that the weight of a vehicle wheel end is further reduced.

[0022] A constant velocity joint may also constitute the at least one second component that is joined to the flanged hub. In one example, a shaft part of the CVJ is joined to a radially inner surface of the flanged hub by means of a radially intermediate joint. Alternatively, a bell part of the CVJ is joined to a radially outer surface of the flanged hub via a radially intermediate joint.

[0023] In a still further embodiment, the second component is a locking ring for retaining one or more bearing inner rings on the flanged hub. Additionally or alternatively, a flange part of the flanged hub can be joined to a ring part of the hub by means of the high-strength joint of the invention. Many other connecting parts may be joined to the flanged hub in accordance with the invention.

[0024] The present invention also defines a method of manufacturing a wheel bearing assembly in which comprising a flanged hub and a separate inner ring. The method comprises the following steps:

[0025] providing a concave joining surface on one of the flanged hub and the separate inner ring;

[0026] providing a convex joining surface on the other of the flanged hub and the separate inner ring;

[0027] arranging the separate inner ring coaxially around the flanged hub, such that the convex and concave joining surfaces are radially opposite each other and a gap exists therebetween;

[0028] pressing an insert ring into the gap, such that the ring is deformed to fill the gap, adopt its shape and form a joint between the flanged hub and the separate inner ring.

[0029] In a particularly preferred embodiment, the step of arranging comprises simultaneously pressing the separate inner ring against an inboard row of rolling elements. As a result, bearing preload can be set by means of the joint formed.

[0030] In a further development, the method of the invention additionally comprises a step of providing face splines on an inboard side face of the wheel bearing assembly, to enable driven rotation of the wheel bearing assembly by a constant velocity joint with meshing face splines. The face splines may be provided on a nose part of the flanged hub and/or on the separate inner ring.

[0031] In one embodiment, the step of providing face splines is performed prior to the step of pressing, which step further comprises radially deforming a trailing edge of the insert ring such that a first portion thereof extends between adjacent splines of the separate inner ring and second portion extends between adjacent splines of the flanged hub. As a result, the joint is rotationally locked with respect to the flanged hub and the separate inner ring, which enhances torque transfer from the CVJ to the wheel bearing assembly.

[0032] Advantageously, the method may additionally comprise a step of hardening the nose part of the flanged hub, prior to the step of pressing and any step of providing face splines. This not only enhances the stiffness of the wheel bearing assembly, but will increase the strength and stiffness of any face splines that are machined on the nose part.

[0033] Thus, the method of the invention allows the manufacture of a wheel bearing assembly that is robust, yet lighter in weight than conventional assemblies. Other advantages of

the present invention will become apparent from the detailed description and accompanying figures.

BRIEF DESCRIPTION OF THE DRAWINGS

[0034] FIG. 1a is a cross-sectional view of an example of a wheel bearing assembly according to the invention, comprising a separate inner ring joined to a flanged hub by means of a radially intermediate joint;

[0035] FIG. 1b is a perspective view of the assembly of FIG. 1a;

[0036] FIG. 2 is a detail of the separate inner ring and the flanged hub of FIG. 1a, prior to formation of the joint;

[0037] FIG. 3a is a cross-sectional view of a further example of an assembly according to the invention.

[0038] FIG. 3b is a perspective view of the assembly of FIG. 3a;

[0039] FIGS. 4a, 4b show an axial cross-section of examples of joined components whereby torque transfer via the joint is enabled.

[0040] FIG. 5 is a flow chart of a method of manufacturing according to the invention.

DETAILED DESCRIPTION

[0041] In the interests of fuel economy, there is an increasing drive towards reducing the weight of automotive components. This also applies to the components of a vehicle wheel end. Further, the vehicle wheel end is part of the unsprung mass, and reducing the unsprung mass is beneficial in terms of reducing wheel vibration. In driven applications, the weight of the wheel end is predominantly governed by the wheel bearing unit and the constant velocity joint (CVJ) which drives a flanged hub of the bearing unit. Generally, a bore of the flanged hub is provided with axially oriented splines, which engage with corresponding splines on a drive-shaft of the CVJ. It has been found that a lighter weight construction is achieved by providing an inboard side face of the flanged hub with radially oriented face splines, for engagement with corresponding face splines on the CVJ. Face splines have the further advantage of being play-free and the corresponding machining process is more economical.

[0042] FIG. 1a shows a cross-section of a wheel bearing unit according to the invention that is provided with such face splines. The unit 100 comprises a flanged inner ring (flanged hub) 110, to which a brake disk and vehicle wheel will be mounted, and further comprises a flanged outer ring 120 adapted for mounting to e.g. a steering knuckle. First and second rows of rolling elements 132, 135 are accommodated between the inner and outer rings. A first inner raceway 142 for the first row of rolling elements 132 is provided on the flanged inner ring 110. A second inner raceway 145 for the second row of rolling elements 135 is provided on a separate inner ring 130. The separate inner ring 130 is mounted on a nose part 115 of the flanged inner ring 110.

[0043] In conventional wheel bearing units, the nose part comprises an axial extension, which is orbitally formed around the separate inner ring 130, to lock up the bearing unit and set the desired amount of preload. The required axial extension adds to the material costs and weight of the bearing unit. Also, because the axial extension needs to be deformable, while other parts of the flanged hub need to be induction hardened, an inadvertent hardening of part of the axial extension can lead to cracking when the extension is orbitally formed. In some examples of bearing units of this kind, face

splines are provided on the orbitally formed extension. The splines are necessarily machined into unhardened material. Generally, it is preferred when meshing parts such as splines and gears are hardened.

[0044] A wheel bearing unit according to the invention overcomes these drawbacks. As shown in FIG. 1a, the separate inner ring 130 has been joined to the nose part 115 of the flanged inner ring 110 by means of a radially intermediate joint 160. The joint is formed by an insert ring that is pressed into a groove formed between respective joining surfaces on the nose part 115 and on the separate inner ring 130. Since there is no need for a ductile axial extension, the nose part 115 can be hardened. Face splines 150 are provided on the nose part, meaning that the splines are also made of hardened material. As best shown in the perspective view of the bearing unit in FIG. 1b, the face splines in this example are radially skewed. The advantage of radially skewed splines over radially straight splines is that spline length is increased. This leads to greater surface area contact with the splines on the CVJ, which in turn increases the strength of the assembly.

[0045] A detail of the groove formed in the example of FIG. 1a is shown in FIG. 2, prior to pressing in the insert ring. The flanged inner ring 210 has a first joining surface 212 and the separate inner ring 230 has a second joining surface 232. A radial gap therebetween constitutes the groove 260, which will be filled with material of the insert ring 270 to form the joint. In use, the bearing unit is subject to axial forces in both directions, and the joint is therefore designed to have excellent shear strength in both axial directions. This is achieved in that the first joining surface 212 in this example has a concave portion 215 and the second joining surface 232 has a convex portion 235. The groove 260 therefore comprises an arcuate section 265. The arcuate section may also be formed by providing a concave portion on the second joining surface 232 and a convex portion on the first joining surface 212. When the insert ring 270 is pressed in, the ring deforms so as to adopt the shape of the arcuate section 265. In other words, material of the insert ring fills the concave portion 215 and surrounds the convex portion 235 at both sides of an apex 237 of the convex portion. Consequently, the separate inner ring 230 and the flanged inner ring 210 become locked with respect to each other in both axial directions. Radial locking is achieved in that the insert ring 270 has a thickness t that is essentially equal to a maximum radial gap between the concave portion and the convex portion.

[0046] The joint will only fail when an axial force, acting to move the separate inner ring 230 and the flanged inner ring 210 relative to each other, is sufficient to shear off material of the insert ring that is axially locked between these two components. To further inhibit relative axial movement of the joint, one or both of the joining surfaces may be roughened, to increase the frictional force that must be overcome. The insert ring 270 in this example has a thickness of approximately 1 mm and is made from a heat-treatable steel with a yield strength of around 1100 MPa. The use of such a high-strength material results in a high-strength joint.

[0047] Because high-strength steel has relatively poor ductility, the arcuate section 265 of the groove 260 is suitably designed to enable the required degree of plastic deformation. When the insert ring 270 is pressed in, a leading edge 272 thereof strikes the convex portion 235 at a first side of the apex 237. Preferably, the first side of the convex portion has a first angle of no more than approximately 35 degrees relative to a reference line 280 that is parallel to an axis of rotation of the

bearing unit. If the first angle were considerably steeper, the first side of the convex portion 235 would simply constitute a barrier.

[0048] In the example of FIG. 2, the first angle is approximately 32 degrees, meaning that continued pressing of the insert ring causes the leading edge 272 to deform around the apex 237. The leading edge then strikes the concave portion 215 at a second side of the apex 237. Correspondingly, the second side of the concave portion has a second angle of no more than around 35 degrees relative to the reference line 280. The second angle in the depicted example is also approximately 30 degrees, which enables material of the insert ring to surround the convex portion at the second side. Furthermore, optimal filling of the arcuate section 265 is facilitated in that the apex 237 has a diameter that is essentially equal to a maximum diameter of the joining surface 212 that has the concave portion 215.

[0049] In the example of FIG. 2, the first and second joining surfaces 212, 232 further comprise cylindrical surfaces, such that the groove 260 additionally comprises a cylindrical section 267 at the entrance side of the groove. Further, the second joining surface 232 in this example has a stepped cylindrical surface, such that an abutment 238 is formed. A trailing edge 275 of the insert ring 270 can be deformed against this abutment, to provide improved axial locking. Moreover, the cylindrical section enhances the stiffness of the flanged inner ring 210 at the inboard side (i.e. the nose part). This is particularly beneficial, given that face splines 250 are machined into the nose part. The cylindrical section 267 at the entrance side of the groove 260 also enables the arcuate section 265 to be located at a region of the separate inner ring that is relatively thicker than at the inboard side. The strength and stiffness of the separate inner ring are thereby optimised.

[0050] Many other groove designs may be employed to form the joint between the separate inner ring and the flanged inner ring.

[0051] In addition to locking the separate inner ring to the flanged inner ring, the joint of the invention also allows bearing preload to be set. With reference to FIG. 1a and FIG. 2, the separate inner ring 130 is pressed against the inboard row of rolling elements 135 with a force that exceeds the desired amount of bearing preload. After the insert ring 270 has been fully pressed into the groove 260 and the separate inner ring is released, a small amount of spring back will take place.

[0052] Suitably, the pressing force exerted on the inboard row of rolling elements minus the spring back force provides the desired amount of preload.

[0053] A further advantage of joining the separate inner ring to the flanged inner ring by means of a radially intermediate joint is that it allows an inboard side face of the separate inner ring to be provided with face splines. An example of a wheel bearing unit 300 comprising this feature is shown in cross-section in FIG. 3a and in a perspective view in FIG. 3b. The nose part 315 of the flanged inner ring 310 is provided with a first set of face splines 351 and the separate inner ring 330 is provided with a second set of face splines 352 which are in alignment with the first set. The combined radial length of the face splines provides a larger surface area for engagement with meshing splines on a CVJ, and therefore allows higher torque transfer.

[0054] In this example, the first set and second set of face splines 351, 352 have been provided before the joint 360 is formed. The insert ring used to create the joint has an axial length which is sufficient for part of the trailing edge of the

insert ring to protrude out of the groove, after the ring has been pressed in to fill the arcuate section. Thus, part of the trailing edge protrudes beyond the 'valleys' formed between the aligned splines on the separate inner ring 310 and on the nose part 315. Advantageously, the insert ring is subjected to a further pressing force that causes a radial thickening of the trailing edge. As a result, a first portion of the trailing edge extends between adjacent splines on the nose part and a second portion of the trailing edge extends between adjacent splines on the separate inner ring. Thus, the joint 360 is rotationally locked with respect to the separate inner ring 330 and the flanged inner ring 310, which further enhances torque transfer capacity.

[0055] Alternatively, the first set and second set of face splines can be formed in a single machining operation, after creation of the joint. A side face of the insert ring trailing edge may then form part of the machined face splines. In this case, rotational locking will be provided by the meshing splines on the CVJ.

[0056] FIG. 4a and FIG. 4b show further examples of how rotational locking and torque transfer from the separate inner ring to the flanged inner ring may be effected. In the example of FIG. 4a, the insert ring 460 and the first and second joining surfaces 412, 432 have a non-circular cross-section. A tri-lobe shaped cross-section is one example of a suitable geometry.

[0057] In the example of FIG. 4b, the insert ring is formed from a first section 461 and a second section 462, where each section has a radially outward extension 465 and a radially inward extension 467. Correspondingly, the joining surface of the flanged inner ring 410 has first and second recesses for receiving the radially inward extension 467 of the first section 461 and of the second section 462; and the joining surface of the separate inner ring 430 has first and second recesses for receiving the radially outward extension 465 of the first section and of the second section. Thus, each of the first and second sections is rotationally locked to both the flanged inner ring and to the separate inner ring.

[0058] The present invention also defines a method of manufacturing a wheel bearing assembly that comprises a flanged hub and at least one other component joined to the flanged hub by means of a radially intermediate joint. An example of the method is depicted in the flowchart of FIG. 5, which relates to a driven wheel bearing whereby the at least one other component is a separate inner ring.

[0059] In a first step 510, a concave joining surface is machined on a radially inner surface of the separate inner ring, on a radially outer surface of the flanged hub.

[0060] In a second step 520, a convex joining surface is machined on a radially outer surface of the flanged hub. Suitably, an apex of the convex joining surface has a diameter that is equal to a maximum diameter of the concave joining surface.

[0061] In a third step 530, the separate inner ring is centred around the flanged hub, such that the concave and convex joining surfaces are radially opposite each other and a radial gap with an arcuate geometry is created between the joining surfaces. In addition to being centred, the separate inner ring is pressed against an inboard row of rolling elements with a force that is somewhat greater than a desired bearing preload.

[0062] In a fourth step 540, an insert ring is pressed into the radial gap, whereby the ring deforms and adopts the arcuate geometry of the radial gap. The insert ring is made of a high strength steel and has a thickness that is equal to a maximum radial thickness of the radial gap. The length of the insert ring

is such that after the ring has been fully pressed into the radial gap, a trailing edge of the ring protrudes beyond the gap.

[0063] In a fifth step 550, radially oriented splines are machined into an inboard side face of: the flanged hub; the trailing edge of the insert ring; and the separate inner ring.

[0064] Preferably, the second step is preceded by a step of hardening the inboard side face of the flanged hub. The resulting wheel bearing assembly is a relatively lightweight assembly, which has excellent strength and stiffness and which is economical to manufacture.

[0065] The method of the invention is not restricted to joining a separate inner ring to the flanged hub. For example, in another embodiment, the first step comprises machining a concave joining surface on a radially inner surface (bore) of the flanged hub; and the second step comprises machining a convex joining surface on a shaft part of a constant velocity joint. The shaft part is then joined to the flanged hub by pressing an insert ring into the radial gap. Other components may be joined to the flanged hub in a similar manner.

[0066] A number of aspects/embodiments of the invention have been described. It is to be understood that each aspect/embodiment may be combined with any other aspect/embodiment. The invention may thus be varied within the scope of the accompanying patent claims.

REFERENCE NUMERALS

[0067]	100	Wheel bearing unit
[0068]	110	Flanged inner ring
[0069]	115	Nose part of flanged inner ring
[0070]	120	Flanged outer ring
[0071]	130	Separate inner ring
[0072]	132, 135	Outboard, inboard row of rolling elements
[0073]	142, 145	Outboard, inboard raceway
[0074]	150	Radially oriented splines
[0075]	160	Intermediate joint
[0076]	210	Flanged inner ring
[0077]	212	First joining surface on flanged inner ring
[0078]	215	Concave portion of first joining surface
[0079]	230	Separate inner ring
[0080]	232	Second joining surface on separate inner ring
[0081]	235	Convex portion of second joining surface
[0082]	237	Apex of convex portion
[0083]	238	Abutment on second joining surface
[0084]	250	Face splines
[0085]	260	Groove
[0086]	265	Arcuate section of groove
[0087]	267	Cylindrical section of groove
[0088]	270	Insert ring
[0089]	272	Leading edge of insert ring
[0090]	275	Trailing edge of insert ring
[0091]	280	Reference line
[0092]	t	Thickness of insert ring
[0093]	300	Wheel bearing unit
[0094]	310	Flanged inner ring
[0095]	315	Nose part
[0096]	330	Separate inner ring
[0097]	351	First set of radial splines
[0098]	352	Second set of radial splines
[0099]	360	Intermediate joint
[0100]	410	Flanged inner ring
[0101]	412	Joining surface of flanged inner ring
[0102]	430	Separate inner ring
[0103]	432	Joining surface of separate inner ring
[0104]	460	Insert ring

[0105] 461 First section of insert ring

[0106] 462 Second section of insert ring

[0107] 465 Radially outward extension

[0108] 467 Radially inward extension

1. A wheel bearing assembly comprising a flanged hub and at least one second component joined to the flanged hub, and the flanged hub having a first joining surface;

the second component having a second joining surface, radially opposite from the first joining surface and spaced therefrom, such that a groove is defined between the first and second joining surfaces; and wherein

the flanged hub and the second component are joined by means of an insert ring that is pressed into the groove.

2. The assembly according to claim 1, wherein one of the first and second joining surfaces comprises a convex portion and the other of the first and second joining surfaces comprises a concave portion, such that the groove comprises an arcuate section.

3. The assembly according to claim 1, wherein the first and second joining surfaces comprise a cylindrical surface at an entrance side of the groove, such that the groove comprises a cylindrical section.

4. The assembly according to claim 2, wherein the insert ring has a volume that is at least equal to a volume of the arcuate section, and has a thickness (t) that is equal to a maximum radial gap between the convex and concave portions.

5. The assembly according to claim 2, wherein the convex portion has an apex with a diameter that is equal to a maximum diameter of the joining surface which comprises the concave portion.

6. The assembly according to claim 1, wherein the at least one second component is a separate inner ring

7. The assembly according to claim 6, wherein a nose part of the flanged hub is provided with face splines.

8. The assembly according to claim 7, wherein the nose part is hardened.

9. The assembly according to claim 6, wherein an inboard side face of the separate inner ring is provided with face splines.

10. The assembly according to claim 9, wherein the splines on the separate inner ring and the splines on the nose part are in alignment.

11. The assembly according to claim 1, wherein the groove and the insert ring have a non-circular cross-section for enabling torque transfer.

12. The assembly according to claim 1, wherein the insert ring is provided with torque transfer means, formed by a trailing edge of the insert ring that is radially deformed such that a first portion extends between adjacent splines on the separate inner ring and a second portion extends between adjacent splines on the nose part.

13. The assembly according to claim 1, wherein the insert ring comprises a radially outward extension and a radially inward extension, and one of the first and second joining surfaces comprises a recess for receiving the radially outward extension and the other of the first and second joining surfaces comprises a recess for receiving the radially inward extension.

14. The assembly according to claim 13, wherein the insert ring is formed from two or more sections, each of which comprises a radially inward extension and a radially outward extension.

15. The assembly according to claim **1**, wherein the at least one second component is a constant velocity joint.

16. The assembly according to claim **1**, wherein the at least one second component is a locking ring for retaining one or more bearing inner rings on the flanged hub.

17. The assembly according to claim **1**, wherein at least a third component is joined to the flanged hub by means of an insert ring pressed into a gap between radially opposite joining surfaces.

18. The assembly according to claim **1**, wherein the insert ring is made of a material with a yield strength of 250-1200 MPa.

19. A method of manufacturing a wheel bearing unit comprising a flanged inner ring and a separate inner ring, the method comprising steps of:

providing a concave joining surface on one of the flanged inner ring and the separate inner ring;

providing a convex joining surface on the other of the flanged inner ring and the separate inner ring;

arranging the separate inner ring coaxially around the flanged inner ring, such that the convex and concave joining surfaces are radially opposite each other and a gap is formed therebetween;

pressing an insert ring into the gap, such that the insert ring is deformed to fill the gap, adopt its shape and form a joint between the flanged inner ring and the separate inner ring.

20. The method according to claim **19**, wherein the step of arranging comprises pressing the separate inner ring against an inboard row of rolling elements, such that bearing preload is set by means of the joint formed.

21. The method according to claim **19**, further comprising a step of hardening a nose part of the flanged hub.

22. The method according to claim **21**, further comprising a step of providing a first set of face splines on the nose part.

23. The method according to claim **22**, further comprising a step of providing a second set of face splines on an inboard side face of the separate inner ring, aligned with the first set of splines.

24. The method according to claim **23**, wherein the step of pressing comprises radially deforming a trailing edge of the insert ring such that a first portion thereof extends between adjacent splines on the separate inner ring and second portion extends between adjacent splines on the flanged hub.

25. The method according to claim **23**, wherein the steps of providing the first and second set of face splines are performed in a single machining operation, wherein the trailing edge of the insert ring is simultaneously machined to form part of the splines.

* * * * *