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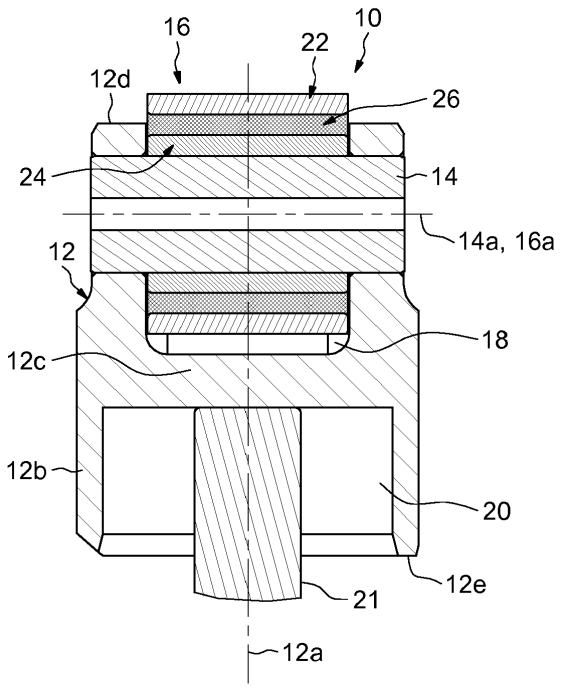
(54) CAM FOLLOWER ROLLER DEVICE WITH ROLLER

(57) The cam follower roller device comprises a tappet body (12), a pin (14) mounted into said tappet body, and a roller 16 mounted on said pin and comprising an inner bore (24b) and an outer surface (22a).

The roller (16) comprises an inner axial portion (24) provided with said inner bore, an outer axial portion (22) provided with said outer surface, and a body (26) radially interposed between the inner and outer axial portions, the density of the material of said body being smaller than that of the material(s) of the inner and outer axial portions

FIG.1



EP 3 179 061 A1

Description

[0001] The present invention relates to the field of cam follower roller devices used in automotive or industrial applications.

[0002] One advantageous application of the invention is the use of the cam follower roller device in a fuel injection pump intended for an internal combustion engine, in particular of a motor vehicle. Another advantageous application of the invention is the use of the device in a rocker system intended for controlling valves of an internal combustion piston engine.

[0003] Such a cam follower roller device generally comprises an outer tappet body, a pin mounted on the tappet body and a roller movable in rotation relative to the pin around its axis. When the cam follower roller device is in service in a fuel injection pump, the roller collaborates with a cam synchronized with the internal combustion engine camshaft or crankshaft. The rotation of the camshaft, or crankshaft, leads to a periodic displacement of a piston of the pump that rests against the tappet body, to allow fuel to be delivered.

[0004] Generally, such cam follower roller device comprises a forged tappet body and a roller of the massive or solid type. A "massive roller" is to be understood as a roller obtained by machining with removal of material (by turning, grinding) from steel tube stock, bar stock, rough forgings and/or rolled blanks.

[0005] This leads to increase the inertia of the device and also the increase of rotational inertia of the roller itself.

[0006] One aim of the present invention is to overcome these drawbacks.

[0007] It is a particular object of the present invention to provide a cam follower roller device with lightweight construction.

[0008] In one embodiment, the cam follower roller device comprises a tappet body, a pin mounted into said tappet body, and a roller mounted on said pin and comprising an inner bore and an outer surface.

[0009] The roller comprises an inner axial portion provided with said inner bore, an outer axial portion provided with said outer surface, and a body radially interposed between the inner and outer axial portions. The density of the material of said body is smaller than that of the material(s) of the inner and outer axial portions.

[0010] Accordingly, the weight of the roller as well as the device is limited. A low density material may be used for the body since only the inner and outer axial portions are in contact with the pin and with the associated cam of the internal combustion engine. The roller is a multi-material roller. With a reduced inertia of the roller, there is a lower risk of sliding between said roller and the cam. Besides, the pressure contact between the roller and the cam is also reduced with a lighter device.

[0011] Preferably, the body of the roller is mounted into radial contact with the inner and outer axial portions. The body may be axially delimited by two opposite frontal surfaces which are flush with adjacent frontal surfaces of the inner and outer axial portions, or which are axially offset inwards, or outwards, with respect to said opposite frontal surfaces.

[0012] In one embodiment, the body of the roller is made from a flexible material. With such embodiment, an angular tilting of the outer axial portion of the roller with respect to the inner axial portion may be obtained. This has the effect of reducing the edge stresses that may occur at the ends of the roller with the contact against the cam. Accordingly, in operation, the pressure contact between the roller and the cam may be reduced.

[0013] In one embodiment, the roller further comprises a radial intermediate portion connecting the inner and outer axial portions, the body extending axially on both side of said radial intermediate portion. The radial intermediate portion of the roller may be disposed into a radial median plane of said roller. The body may comprise at least two parts being located axially on either side of said radial intermediate portion.

[0014] In one embodiment, the body of the roller is overmoulded onto the outer and inner axial portions. To further increase the cohesion between the overmoulded body and the inner and/or outer axial portions, said portion(s) may comprise recesses into which protrude complementary ribs of the body.

[0015] In one embodiment, the body of the roller is made from synthetic material. Alternatively, the body may be made from metal, such as aluminium or titanium, or from wood.

[0016] In one embodiment, the ends of the pin are mounted into through-holes formed on the tappet body. In another embodiment, the device may further comprise an insert mounted in the tappet body, the ends of the pin being mounted at least on said insert. Preferably, the insert comprises a central core and at least two side tabs each comprising a receiving housing for an end of the pin. The tappet body may comprise axial blocking means for maintaining the pin into the receiving housings.

[0017] The present invention and its advantages will be better understood by studying the detailed description of specific embodiments given by way of non-limiting examples and illustrated by the appended drawings on which:

- Figure 1 is a cross-section of a cam follower roller device according to a first example of the invention,
- Figure 2 is a cross-section of a roller of the device of Figure 1, and
- Figure 3 is a cross-section of a roller of a cam follower roller device according to a second example of the invention.

[0018] As shown on Figure 1, a cam follower roller device 10 comprises a tappet housing or body 12 extending along an axis 12a, a shaft or pin 14 extending along an axis 14a perpendicular to the axis 12a, and a roller 16, with an axis 16a coaxial with the axis 14, mounted on the

pin and movable in rotation relative to said pin. In the disclosed embodiment, the roller 16 is directly mounted on the pin 14. Alternatively, a rolling bearing or a plain bearing may be radially interposed.

[0019] The pin 14 is mounted on the tappet body 12. The tappet body 12 supports the pin 14. The ends of the pin 14 are mounted in through-holes (not referenced) provided on the tappet body 12 and facing one another. In the disclosed example, the ends of the pin 14 are fixed into said through-holes for example by push-fitting. Alternatively, it could be possible to fix each end of the pin on the tappet body 12 by any other appropriate means, for example with a washer inserted into the associated through-hole.

[0020] In the disclosed example, the tappet body 12 is made in one part. The tappet body 12 comprises an outer axial sleeve portion 12b and an inner radial portion 12c extending radially an inner bore of said sleeve portion. The sleeve portion 12b has a tubular form. The tappet body 12 delimits a first open cavity 18 inside which is located the roller 16. The cavity 18 is delimited axially by the radial portion 12c. The cavity 18 is delimited radially by the bore of the sleeve portion 12b. The roller 16 is mounted inside the cavity 18. The roller 16 axially protrudes outwards with respect to an upper face 12d of the tappet body. The tappet body 12 also comprises a lower face 12e which delimits axially together with the upper face 12d said body.

[0021] The tappet body 12 also delimits a second open cavity 20 oriented axially on the side opposite to the cavity 18. A movable element 21, such as a piston of a fuel injection pump, extends into the cavity 20. Said element 21 axially bears against a rear abutment surface of the radial portion 12c of the tappet body. Similarly to the cavity 18, the cavity 20 is delimited axially by the radial portion 12c and radially by the bore of the sleeve portion 12b of the tappet body. The cavities 18, 20 are disposed on either side of the radial portion 12c.

[0022] The roller 16 is designed to reduce the inertia of the device 10 and also its own rotational inertia as it rotates around the pin 14. As shown more clearly on Figure 2, the roller 16 comprises an annular outer axial portion 22, an annular inner axial portion 24 and an annular body 26 radially interposed between said inner and outer axial portions. The roller 16 is formed by the assembling of parts which are separate and distinct one from another. These parts are mounted bearing radially against one another. The roller 16 is subdivided in the radial direction by the outer and inner axial portions 22, 24 and the body 26. The body 26 forms an intermediate middle ring and the outer and inner axial portions 22, 24 form end rings which are respectively adapted to bear against the associated cam of the internal combustion engine (not shown) and the pin 14. The outer and inner axial portions 22, 24 and the body 26 are concentric.

[0023] The outer and inner axial portions 22, 24 of the roller are spaced apart in the radial direction. The outer axial portion 22 radially surrounds the inner axial portion 24. The outer axial portion 22 comprises an axial cylindrical outer surface 22a which forms a contact surface intended to bear against the cam. The outer surface 22a forms the outer surface of the roller 16. The outer axial portion 22 also comprises a cylindrical bore 22b radially opposed to the outer surface 22a, and two opposite radial lateral surfaces 22c, 22d which axially delimit said bore and outer surface.

[0024] The inner axial portion 24 comprises an axial cylindrical outer surface 24a and a cylindrical bore 24b radially opposed to said outer surface. The cylindrical bore 24b forms the bore of the roller which is mounted on the pin 14 (Figure 1). The inner axial portion 24 also comprises two opposite radial lateral surfaces 24c, 24d which axially delimit the bore 24b and the outer surface 24a. In the illustrated example, the lateral surfaces 24c, 24d are respectively coplanar with the lateral frontal surfaces 22c, 22d of the outer axial portion. Alternatively, each lateral surface 24c, 24d may axially protrude with respect to the associate lateral surface 22c, 22d.

[0025] The body 26 is radially located between the outer and inner axial portions 22, 24. The body 26 is in radial contact with the outer axial portion 22 on one side and in radial contact with the inner axial portion 24 on the other side. The body 26 comes radially into contact with the bore 22b of the outer axial portion. The body 26 comes radially into contact with the outer surface 24a of the inner axial portion.

[0026] The body 26 comprises an axial cylindrical outer surface 26a in radial contact with the bore 22b of the outer axial portion, and a cylindrical bore 26b radially opposed to said outer surface and in radial contact with the outer surface 24a of the inner axial portion. The body 26 also comprises two opposite radial lateral surfaces 26c, 26d which axially delimit the bore 26b and the outer surface 26a.

[0027] In the illustrated example, the lateral surfaces 26c, 26d of the body are respectively coplanar with the lateral frontal surfaces of the outer and inner axial portions 22, 24. Alternatively, each lateral surface 26c, 26d may axially be offset inwards with respect to the associated lateral frontal surfaces of the inner and outer axial portions 22, 24.

[0028] The outer and inner axial portions 22, 24 of the roller 16 may be made of steel, for example through-hardening carbon chromium steel such as 100Cr6. The density of the material of the body 26 is smaller than that of the material of the outer and inner axial portions 22, 24. This leads to a weight reduction of the roller 16 as well as the device 10. A low density material may be used since the body 26 is not in contact with the pin 14 nor in contact with the associated cam of the internal combustion engine. The body 26 may be made from synthetic material, such as PA for example, or be made of low density metal such as aluminium or titanium. In another embodiment, the outer and inner axial portions 22, 24 of the roller may be made of two different materials.

[0029] In the illustrated example, the body 26 of the

roller is overmoulded onto the outer and inner axial portions 22, 24. This results in excellent cohesion between these axial portions and the body 26. Alternatively, the body 26 may be secured to the outer and inner axial portions 22, 24 by any other appropriate means, for example by gluing.

[0030] In the example illustrated on Figure 3, in which identical parts are given identical references, the roller 16 further comprises an annular radial intermediate portion 28 extending between the outer and inner axial portions 22, 24 and connected to said portions. The intermediate portion 28 extends radially from the outer surface 24a of the inner axial portion and is connected to the bore 22b of the outer axial portion. The intermediate portion 28 is disposed into a radial median plane of the roller. In this example, the outer and inner axial portions 22, 24 and the radial intermediate portion 28 are made in one part. With the radial intermediate portion 28 extending between the outer and inner axial portions 22, 24, the mechanical strength of the roller 16 is increased.

[0031] In this example, the roller 16 comprises a body 30 which differs from the body disclosed in the first example in that it comprises two distinct parts 32, 34. Similarly to the first example, the body 30 is radially located between the outer and inner axial portions 22, 24. The body 30 is in radial contact with the outer axial portion 22 on one side and in radial contact with the inner axial portion 24 on the other side. The body 30 comes radially into contact with the bore 22b of the outer axial portion. The body 30 comes radially into contact with the outer surface 24a of the inner axial portion. The body 30 extends axially on both side of the intermediate portion 28 of the roller.

[0032] The part 32 of the body is axially disposed on one side of the intermediate portion 28 while the part 34 is axially disposed on the other side of said portion. The parts 32, 34 are symmetrical with respect to the radial median plane of the roller. In the illustrated example, the parts 32, 34 have in cross-section a rectangular shape. Alternatively, the parts may have any other different profile in cross-section, for example a trapezoidal, a triangular or a square one.

[0033] Each part 32, 34 comprises an axial cylindrical outer surface 32a, 34a in radial contact with the bore 22b of the outer axial portion, and a cylindrical bore 32b, 34b radially opposed to said outer surface and in radial contact with the outer surface 24a of the inner axial portion. Each part 32, 34 of the body also comprises two opposite outer and inner radial lateral surfaces 32c and 32d, 34c and 34d which axially delimit the bore 32b, 34b and the outer surface 32a, 34a. The inner lateral surface 32d, 34d of each part 32, 34 axially bears against the intermediate portion 28. In the illustrated example, the outer lateral surface 32c, 34c of each part 32, 34 is axially offset inwards with respect to the associated lateral frontal surfaces of the outer and inner axial portions 22, 24. Alternatively, each lateral surface 32d, 34d may be coplanar with the lateral frontal surfaces of the outer and inner axial portions 22, 24.

[0034] Similarly to the first example, the density of the material of the body 30 of the roller is smaller than that of the material of the outer and inner axial portions 22, 24. In the illustrated example, the body 30 is overmoulded onto the outer and inner axial portions 22, 24. Annular grooves 36, 38 are formed on the outer surface of the inner axial portion 24. Here, the grooves 36, 38 are located near to the radial intermediate portion 28. Each part 32, 34 of the body comprises an annular rib (not referenced) protruding radially inwards from the inner bore 32a, 34a and into one of the grooves 36, 38. The cohesion between each part 32, 34 of the body and the inner axial portion 24 is enhanced with the material of said body entering into the grooves 36, 38 to form the ribs.

[0035] In another embodiment, a plurality of through-holes extending into the thickness of the radial intermediate portion 28 may be provided. Accordingly, the body 30 may comprise a plurality of studs each extending into one of said through-holes. In this case, the two parts 32, 34 of the body will be connected by the studs. Alternatively or in combination, through-holes may also be provided into the axial thickness of the outer axial portion 22 or into the axial thickness of the inner axial portion 24.

[0036] In the second illustrated example, the roller 16 is formed of three distinct parts. Alternatively, the roller may comprise two distinct parts, for example with a specific design where the two parts of the body are connected as previously mentioned, i.e. with studs. In another embodiment, the roller may comprise four or more distinct parts assembled together.

[0037] In another variant, the body of the roller could have various profiles formed on its end lateral surfaces to reduce even further the mass of the roller, for example hollow sections or holes of any shape that create rib sections extending substantially radially.

[0038] The invention has been illustrated on the basis of a cam follower roller device comprising a pin mounted directly on the tappet body. Alternatively, the device may comprise an insert supporting the pin while the tappet body supports said insert.

Claims

1. Cam follower roller device comprising a tappet body (12), a pin (14) mounted into said tappet body, and a roller (16) mounted on said pin and comprising an inner bore (24b) and an outer surface (22a), **characterized in that** the roller (16) comprises an inner axial portion (24) provided with said inner bore, an outer axial portion (22) provided with said outer surface, and a body (26; 30) radially interposed between the inner and outer axial portions, the density of the material of said body being smaller than that of the material(s) of the inner and outer axial portions.

2. Device according to claim 1, wherein the body (26;

30) of the roller is mounted into radial contact with the inner and outer axial portions.

3. Device according to claim 1 or 2, wherein the body (26; 30) of the roller is axially delimited by two opposite frontal surfaces (26c, 26d; 32c, 34c) which are flush with adjacent frontal surfaces of the inner and outer axial portions (24, 22), or which are axially offset inwards, or outwards, with respect to said opposite frontal surfaces.

4. Device according to any of the preceding claims, wherein the body (26; 30) of the roller is made from a flexible material.

5. Device according to any of the preceding claims, wherein the roller (16) further comprises a radial intermediate portion (28) connecting the inner and outer axial portions (24, 22), the body (26; 30) extending axially on both side of said radial intermediate portion.

6. Device according to claim 5, wherein the radial intermediate portion (28) of the roller is disposed into a radial median plane of said roller.

7. Device according to claim 5 or 6, wherein the body (30) comprises at least two distinct parts (32, 34) being located axially on either side of said radial intermediate portion (28).

8. Device according to any of the preceding claims, wherein the body (26; 30) of the roller is overmoulded onto the outer and inner axial portions (22, 24).

9. Device according to claim 8, wherein the inner axial portion (24) and/or the outer axial portion (22) of the roller comprise recesses (36, 38) into which protrude complementary ribs of the body (26; 30).

10. Device according to any of the preceding claims, wherein the body (26; 30) of the roller is made from synthetic material.

11. Device according to any of the preceding claims 1 to 9, wherein the body (26; 30) of the roller is made from metal such as aluminium or titanium.

12. Device according to any of the preceding claims, wherein the ends of the pin (14) are mounted into through-holes formed on the tappet body.

13. Device according to any of the preceding claims 1 to 11, further comprising an insert mounted in the tappet body, the ends of the pin (14) being mounted at least on said insert.

FIG.1

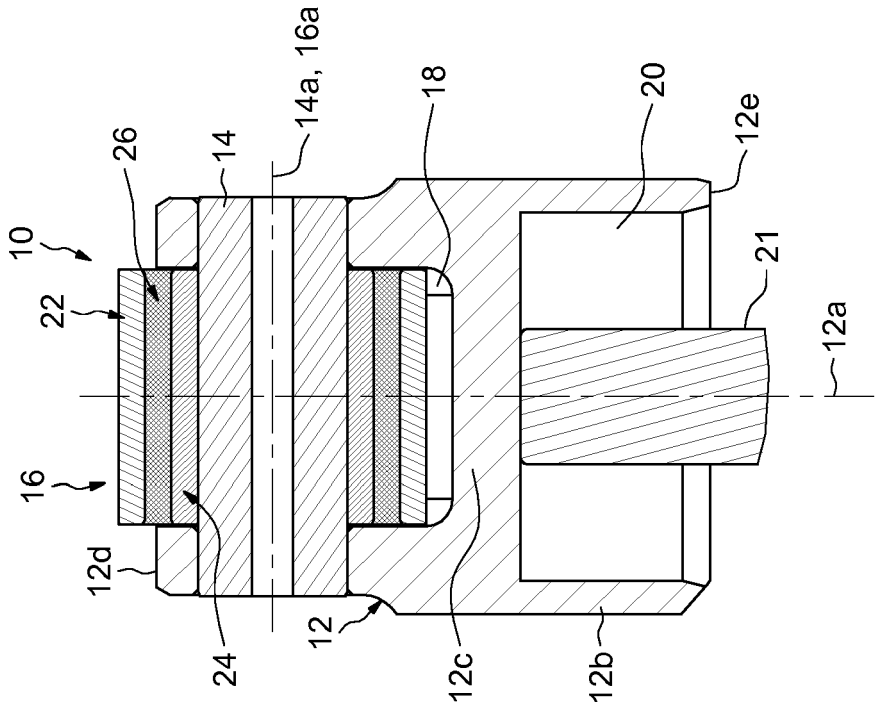


FIG.3

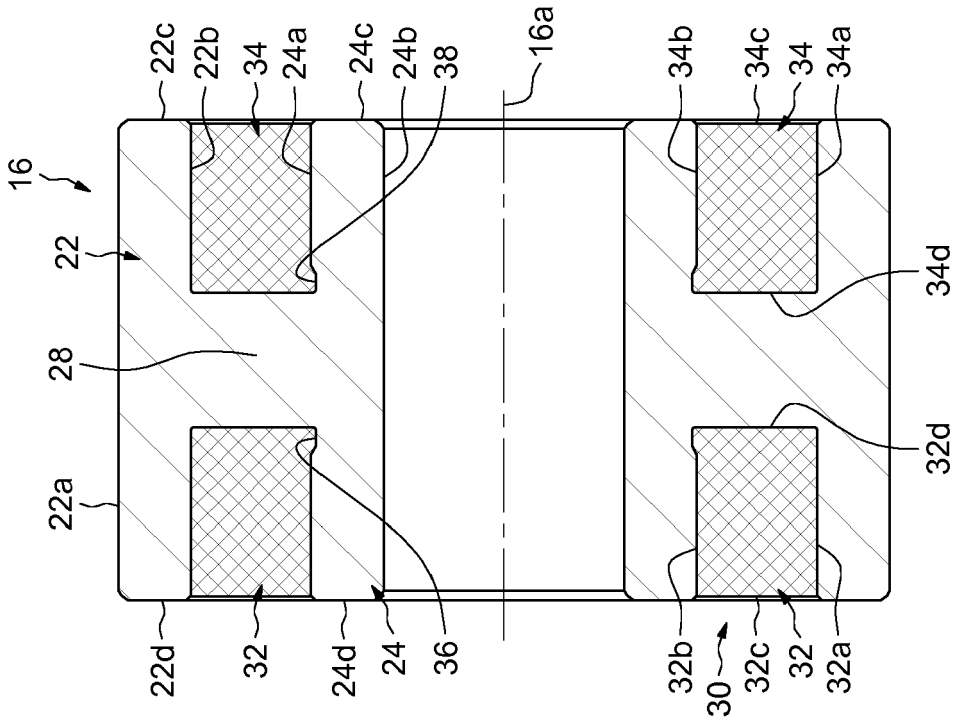

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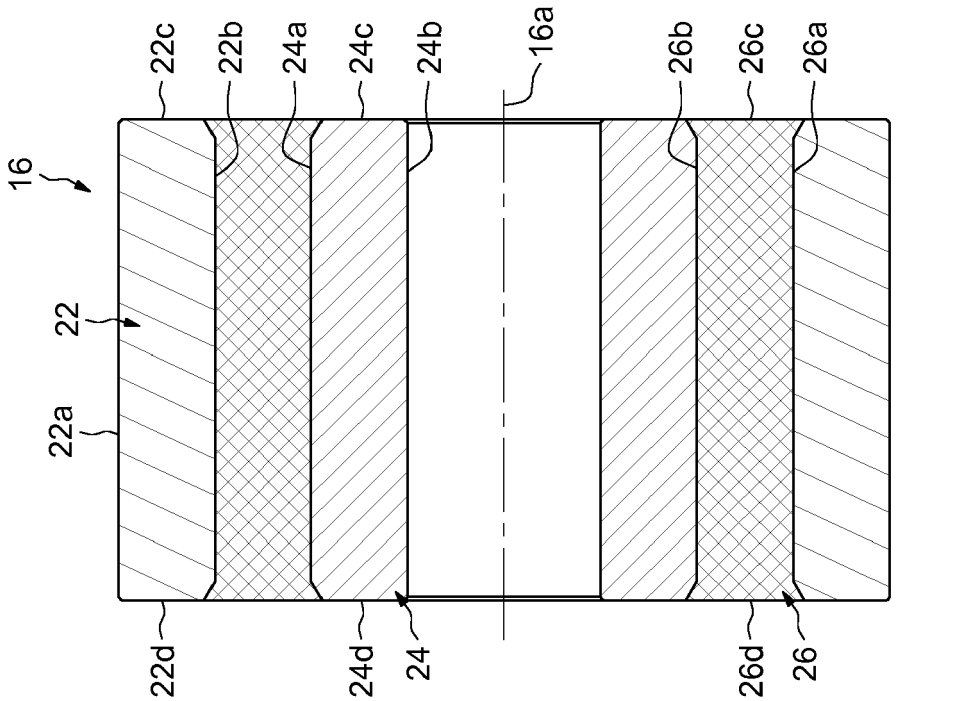
FIG.2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EUROPEAN SEARCH REPORT

Application Number
EP 15 30 6967

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	EP 2 937 566 A1 (SKF AB [SE]) 28 October 2015 (2015-10-28) * paragraph [0001] * * paragraph [0024] - paragraph [0025] * * figures *	1-4,12	INV. F01L1/18 F01L1/14 F02M59/10 F16C17/02
A	DE 10 2014 206660 A1 (SCHAEFFLER TECHNOLOGIES AG [DE]) 8 October 2015 (2015-10-08) * paragraph [0001] * * paragraph [0017] * * paragraph [0018] * * figures *	1-4,12	
A	DE 10 2012 207520 A1 (SCHAEFFLER TECHNOLOGIES AG [DE]) 7 November 2013 (2013-11-07) * paragraph [0001] * * paragraph [0014] *	1-4,12	
A	JP 2000 034907 A (NIPPON SEIKO KK) 2 February 2000 (2000-02-02) * abstract; figures * * paragraph [0016] *	1-4,12	TECHNICAL FIELDS SEARCHED (IPC) F01L F16C F02M F04B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	4 March 2016	Paquay, Jeannot

CATEGORY OF CITED DOCUMENTS

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04-03-2016

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 2937566 A1	28-10-2015	CN 105179129 A	23-12-2015
		EP 2937566 A1	28-10-2015
		US 2015300476 A1	22-10-2015
DE 102014206660 A1	08-10-2015	DE 102014206660 A1	08-10-2015
		WO 2015154757 A1	15-10-2015
DE 102012207520 A1	07-11-2013	NONE	
JP 2000034907 A	02-02-2000	JP 3640140 B2	20-04-2005
		JP 2000034907 A	02-02-2000

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