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(54) **Tappet arrangement and pump**

Stößelanordnung und Pumpe

Agencement de poussoir et pompe

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(56) References cited:
EP-A1- 0 770 762
WO-A1-2006/037676
WO-A1-2008/068116
WO-A1-2010/026463
DE-A1-102005 040 219
JP-A- 2002 332 809

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Description

[0001] The invention relates to a tappet arrangement for a high-pressure pump for the delivery of a fluid and a pump, see for example WO2010026463 with the closest prior art. In today's automotive engine systems, there is an increased demand for low cost, direct injection. In common rail injection systems, the fuel is delivered by means of a high pressure pump from a fuel tank to a fuel rail which serves as a storage reservoir for the fuel. The fuel is under high pressure in the fuel rail (or common rail) and can be injected directly into the cylinders via injection valves connected to the rail.

[0002] Two of the main concerns related to the common rail pumps are cost and durability. On one hand, high durability is required and higher pressure energy output for the pump and on the other hand, the pump has to become smaller to fit to the downsizing strategy of the engine market. These requirements can be in contradiction as downsizing may lead to a reduction of the space available to design a robust pump. In these circumstances, the pump design is pushed towards selecting expensive materials and creating expensive features to ease the internal stresses.

[0003] It is desirable to provide a tappet arrangement for a high-pressure pump and a pump which is cost effective and reliable.

According to an aspect of the invention, a tappet arrangement for a high-pressure pump comprises a tappet body. The tappet arrangement comprises a roller partly arranged in the tappet body. The tappet arrangement further comprises a fixing for holding the roller and the tappet body to prevent a movement of the roller in the direction of the longitudinal axis of the roller. The tappet body comprises two curved side surfaces arranged opposite to each other and aligned in the direction of the longitudinal axis of the roller for a movable coupling of the tappet arrangement with the pump housing of the high-pressure pump. The tappet body is radiused only on two outside vertical sides along the roller. Therefore, the tappet arrangement is able to slightly rotate in its bore in the pump housing. Thus, the tappet arrangement is able to self-align about its longitudinal axis, for example when the bore is not perfectly aligned with the position of a cam of a driveshaft of the pump. Further, a misalignment coming from the position and clearance of the bearings where the camshaft sits is compensated.

[0004] According to further aspects, the tappet body comprises two flat side surfaces arranged opposite to each other aligned in the direction across the longitudinal axis of the roller. The two end faces of the tappet arrangement are straight to limit the rotation of the tappet arrangement.

[0005] According to the invention, the fixing comprises two projecting parts that each are in contact with the roller to prevent a movement of the roller in the direction of the longitudinal axis of the roller. The fixing comprises two contact points with the roller. The fixing is designed to fit in position with the roller center to reduce the breaking torque of the roller. The fixing comprises a tip at each of the two projecting parts that is in contact with the roller.

[0006] According to further aspects, the fixing is made from a metallic material with elastic properties, for example brass.

[0007] According to an aspect of the invention, a high-pressure pump for use in an internal combustion engine comprises a plunger for pressurizing fuel within a pump chamber of a pump housing during a plunger pumping stroke. The pump comprises a driveshaft and the tappet arrangement. The tappet arrangement is coupled with the plunger and the driveshaft for imparting drive from the driveshaft to the plunger to perform the plunger pumping stroke.

[0008] According to further aspects, the pump housing comprises a bore. The shape of a wall surrounding the bore corresponds with the shape of the two curved side surfaces and the two curved side surfaces each are in contact with the wall of the bore. Therefore, the tappet arrangement is able to slightly rotate with respect to the pump housing and to self-align with respect to the pump housing and the driveshaft.

[0009] According to further aspects, the wall surrounds the bore such that the two flat side surfaces are arranged at a distance from the wall. Thus, the rotation of the tappet arrangement with respect to the pump housing is limited to a given angle.

[0010] The tappet arrangement and the bore correspond to each other with a clearance given to provide the required maximum rotation degree of the tappet arrangement with respect to the pump housing. The corners between the two curved side surfaces and the two flat side surfaces serve as rotation stops for the tappet arrangement. The corners are free to travel on a circle circumscribed to the radiused edges for only the amount of space allowed by the clearance between the two flat side surfaces and the corresponding wall of the bore. Thus, the robustness of the pump is increased by the mean of the increase in robustness for the roller alignment to the cam of the driveshaft.

[0011] Reference will now be made in detail to the preferred embodiments, examples of which are illustrated in the accompanying drawings. The same elements, elements of the same type and elements having the same effect may be provided with the same reference symbols in the figures.

FIG. 1 schematically shows a tappet arrangement according to an embodiment, and

FIG. 2 schematically shows a detail of a high-pressure pump according to an embodiment.

[0012] A tappet arrangement 100 comprises a tappet body 101 and a roller 102. The roller is coupled with the tappet body 101 by a fixing 103.

[0013] The roller is coupled with the tappet body 101

such that the roller is able to rotate relative to the tappet body 101 about its longitudinal axis R. The fixing 103 comprises two projecting parts 106. Each of the projecting parts 106 is coupled with a plane of the cylinder-shaped roller 102. For example, each of the projecting parts 106 comprises a point at the end that is in contact with the roller 102. The tip is in contact with the roller 102 in the roller center at the longitudinal axis R. Thus, the friction and the breaking torque between the roller 102 and the fixing 103 is reduced. For example, the fixing 103 is made from a metallic material with elastic properties, for example brass or other metallics. The fixing 103 is a separate part to the tappet body 101 and, for example, is clipped on the tappet body 101.

[0014] The tappet body 101 comprises two curved side surfaces 104. The curved side surfaces 104 are positioned opposite each other. The curved side surfaces are convex. The two curved side surfaces 104 are aligned in the direction of the longitudinal axis R of the roller 102 and in the direction of the longitudinal axis L of the tappet body.

[0015] The tappet body 101 further comprises two flat side surfaces 105 that are aligned in the direction across the longitudinal axis R of the roller 102 and in the direction of the longitudinal axis L of the tappet body 101. The two flat side surfaces 105 each are in alignment with the two planes of the roller 102. The two projecting parts 106 of the fixing 103 are arranged at the respective flat side surfaces 105. The two projecting parts 106 prevent the roller 102 from moving along its longitudinal axis R between the two flat side surfaces 105. The roller 102 is able to rotate about its longitudinal axis R with respect to the tappet body 101 as well as the fixing 103 and is restrained from moving in the direction of the longitudinal axis R of the roller 102 and the longitudinal axis L of the tappet body 101.

[0016] According to aspects, the tappet body 101 comprises a recess 107 on a side 115 opposite the roller 102. The recess is provided for coupling the tappet arrangement 100 with a plunger 110 (FIG. 2) of the high-pressure pump. The fixing 103 comprises a corresponding opening 108 such that the plunger 110 can reach through the fixing 103 into the recess 107.

[0017] FIG. 2 schematically shows a detail of a pump according to an aspect. The pump comprises a housing 114 that surrounds a bore 112. The bore 112 is surrounded by a wall 113. The plunger 110 is mounted within the bore 112. A driveshaft 111 is arranged. The driveshaft 111 comprises an engine-driven cam. As the cam is driven in use, the plunger 110 is caused to reciprocate within the bore 112 and causes pressurization of fuel within a pump chamber defined at one end of the bore. The coupling between the plunger 110 and the driveshaft 111 is realized by the tappet arrangement 100. The tappet arrangement 100 is coupled with the driveshaft 111 or the cam with the roller 102. The tappet arrangement 100 is coupled with the plunger 110 by means of the recess 107.

[0018] The wall 113 surrounds the bore with a shape that corresponds to the two flat side surface 105 and the two curved side surfaces 104. The wall 113 comprises two sections that each have the same or nearly the same radius as the two curved side surfaces 104. Each of the two curved side surfaces 104 is in contact with one section of the curved sections of the wall 113. The tappet arrangement 100 moves inside the bore 112 along the longitudinal axis L of the tappet body 101 guided by the two curved side surfaces 104 that slide along the wall 113. The two flat side surfaces 105 are arranged at a distance from the corresponding sections of the wall 113. Therefore, the tappet arrangement 100 is able to self-align its alignment with respect to the pump housing 114. The tappet arrangement 100 is able to rotate about its longitudinal axis L due to the curved side surfaces and the corresponding curved sections of the wall 113. The two flat side surfaces 105 and the corresponding sections of the wall 113 limit the rotation of the tappet arrangement 100. The distance between the flat side surfaces 105 and the wall 113 defines the given maximum angle of rotation of the tappet arrangement 100.

[0019] According to aspects, the tappet arrangement 100 slides in the bore 112 that is machined directly in the housing 114 and has the corresponding shape in the cross-section as the tappet body 101.

[0020] According to further aspects, the bore 112 comprises a coating on the wall 113 for reducing friction, for example PEEK, PTFE and/or their derivates.

[0021] According to further aspects, the bore 112 comprises a separate sleeve (not shown) inserted in which the tappet arrangement 100 is arranged and movable.

[0022] According to further aspects, the wall 113 is heat treated to a desired given hardness, for example with aluminum anodising.

[0023] According to aspects, the movement of the tappet arrangement 100 in the direction of the longitudinal axis R of the roller 102 is constrained by the coupling of the tappet arrangement 100 with the plunger 110 in the recess 107. The plunger is arranged inside the recess 107 with a small clearance. The plunger 110 itself is constrained by a given clearance in its bore 112 making the plunger 110 to run in a given axial position. The clearance between the plunger 110 and the tappet arrangement 100 is necessary to compensate a misalignment of the roller 102 with respect to the cam or the driveshaft 111 due to the position of the bearings on which the driveshaft 111 sits.

[0024] The radius on the curved side surfaces 104 in combination with the clearance between the flat side surfaces 105 and the wall 113 provide a limited degree of rotation for the tappet arrangement 100. Therefore, a self-alignment of the tappet arrangement 100 with respect to the driveshaft 111 and/or the cam is realized increasing the robustness of the assembly.

[0025] The fixing 103 on top of the tappet body 101 prevents the roller 102 from touching either the tappet or the sleeve with its plane end sides. The fixing 103 comprises small spherical tips on the inside of the projecting

parts 106 that run against the roller center. Therefore, the design of the roller 102 can be very simple and, thus, cost-effective. Further, the breaking torque between the roller 102 and the sleeve is avoided.

[0026] The tappet arrangement 100 and the wall 113 and/or the sleeve inside the bore 112 comprise a calculated clearance on both ends at the flat side surfaces 105 avoiding special machining on the tappet arrangement end face, on the projecting parts 106 and on the bore 112.

[0027] The tappet body 101, the fixing 103 and the roller 102 are prevented to slide along the longitudinal axis R due to the recess 107 provided on the top surface 115 of the tappet body 101 where the plunger sits with a clearance smaller than the clearance between the flat side surfaces 105 and the wall 113. This feature transmits the plunger constraint to the tappet arrangement 100.

[0028] The tappet arrangement 100 comprises the advantage of self-alignment and constraint of the roller position on the cam. According to aspects, there is no need for a sleeve in the bore 112 where the tappet arrangement 100 is guided.

Claims

1. Tappet arrangement for a high pressure pump, comprising:

   - a tappet body (101),
   - a roller (102) arranged partly in the tappet body (101),
   - a fixing (103) for holding the roller (102) in the tappet body (101) to prevent a movement of the roller (102) in direction of the longitudinal axis (R) of the roller (102), wherein the tappet body (101) comprises:
   - two curved side surfaces (104) arranged opposite to each other aligned in direction of the longitudinal axis (R) of the roller (102) for movable coupling the tappet arrangement with a pump housing (114) of the high pressure pump,

   characterized in that the fixing (103) comprises two projecting parts (106) each having a tip that is in contact with the roller (102) center at the longitudinal axis (R) to prevent a movement of the roller (102) in direction of the longitudinal axis (R) of the roller (102).

2. Tappet arrangement according to claim 1, the tappet body (101) comprising:

   - two flat side surfaces (105) arranged opposite to each other aligned in direction across the longitudinal axis (R) of the roller (102).

3. Tappet arrangement according to claim 1 or 2, wherein the curved side surfaces (104) each are convex.

4. Tappet arrangement according to any of claims 1 to 3, the tappet body (101) comprising a recess (107) on the site (115) opposite the roller (102) for coupling the tappet arrangement with a plunger (110) of the high pressure pump.

5. High pressure pump for use in an internal combustion engine, comprising:

   - a plunger (110) for pressurising fuel within a pump chamber of a pump housing during a plunger pumping stroke,
   - a drive shaft (111),
   - a tappet arrangement (100) according to any of claims 1 to 4, the tappet arrangement (100) being coupled with the plunger (110) and the drive shaft (111) for imparting drive from the drive shaft (111) to the plunger (110) to perform the plunger pumping stroke.

6. Pump according to claim 5, the pump housing (114) comprising a bore (112), the shape of a wall (113) surrounding the bore (112) corresponding with the shape of the two curved side surfaces (104) and the two curved side surfaces (104) each being in contact with the wall (113) of the bore (112).

7. Pump according to claim 6, the wall (113) surrounding the bore (112) such that the two flat side surfaces (105) are arranged at a distance from the wall (113).

8. Pump according to claim 6 or 7, wherein the shape of the wall (113) and the shape of the two curved side surfaces (104) as well as the shape of the two flat side surfaces (105) correspond such that the tappet arrangement (100) is free to rotate a given angle relatively to the pump housing.

Patentansprüche

1. Stößelanordnung für eine Hochdruckpumpe, aufweisend:

   - einen Stößelkörper (101),
   - eine teilweise im Stößelkörper (101) angeordnete Rolle (102),
   - eine Befestigung (103) zum Halten der Rolle (102) im Stößelkörper (101), um eine Bewegung der Rolle (102) in Richtung der Längsachse (R) der Rolle (102) zu verhindern, wobei der Stößelkörper (101) aufweist:
   - zwei in Richtung der Längsachse (R) der Rolle (102) ausgerichtete gegenüber angeordnete gekrümmte Seitenflächen (104) zum beweglichen Koppeln der Stößelanordnung mit einem Pumpengehäuse (114) der Hochdruckpumpe,

dadurch gekennzeichnet, dass die Befestigung (103) zwei hervorstehende Teile (106) aufweist, die jeweils eine Spitze aufweisen, die sich in Kontakt mit der Mitte der Rolle (102) bei der Längsachse (R) befindet, um eine Bewegung der Rolle (102) in Richtung der Längsachse (R) der Rolle (102) zu verhindern.

2. Stößelanordnung nach Anspruch 1, wobei der Stößelkörper (101) aufweist:

- zwei in Richtung quer zur Längsachse (R) der Rolle (102) ausgerichtete gegenüber angeordnete flache Seitenflächen (105).

3. Stößelanordnung nach Anspruch 1 oder 2, wobei die gekrümmten Seitenflächen (104) jeweils konvex sind.

4. Stößelanordnung nach einem der Ansprüche 1 bis 3, wobei der Stößelkörper (101) eine Aussparung (107) auf der Seite (115) gegenüber der Rolle (102) zum Koppeln der Stößelanordnung mit einem Kolben (110) der Hochdruckpumpe aufweist.

5. Hochdruckpumpe zur Verwendung bei einem Verbrennungsmotor, aufweisend:

- einen Kolben (110) zur Druckbeaufschlagung von Kraftstoff in einer Pumpenkammer eines Pumpengehäuses während eines Kolbenpumphubs,
- eine Antriebswelle (111),
- eine Stößelanordnung (100) nach einem der Ansprüche 1 bis 4, wobei die Stößelanordnung (100) mit dem Kolben (110) und der Antriebswelle (110) gekoppelt ist, um eine Antriebskraft von der Antriebswelle (111) auf den Kolben (110) zum Durchführen des Kolbenpumphubs zu übertragen.

6. Pumpe nach Anspruch 5, wobei das Pumpengehäuse (114) eine Bohrung (112) aufweist, die Form einer die Bohrung (112) umgebenden Wand (113) der Form der zwei gekrümmten Seitenflächen (104) entspricht und die zwei gekrümmten Seitenflächen (104) jeweils in Kontakt mit der Wand (113) der Bohrung (112) sind.

7. Pumpe nach Anspruch 6, wobei die Wand (113) die Bohrung (112) so umgibt, dass die zwei flachen Seitenflächen (105) in einem Abstand zur Wand (113) angeordnet sind.

8. Pumpe nach Anspruch 6 oder 7, wobei sich die Form der Wand (113) und die Form der zwei gekrümmten Seitenflächen (104) sowie die Form der zwei flachen Seitenflächen (105) entsprechen, so dass sich die Stößelanordnung (100) frei in einem vorgegebenen Winkel relativ zum Pumpengehäuse drehen kann.

Revendications

1. Agencement de poussoir pour une pompe à haute pression, comprenant:

- un corps de poussoir (101),
- un rouleau (102) agencé partiellement dans le corps de poussoir (101),
- une fixation (103) pour maintenir le rouleau (102) dans le corps de poussoir (101) de manière à empêcher un déplacement du rouleau (102) dans la direction de l'axe longitudinal (R) du rouleau (102), dans lequel le corps de poussoir (101) comprend:
- deux surfaces latérales courbes (104) agencées l'une en face de l'autre et alignées dans la direction de l'axe longitudinal (R) du rouleau (102) afin de réaliser un couplage mobile entre l'agencement de poussoir et un boîtier de pompe (114) de la pompe à haute pression,

caractérisé en ce que la fixation (103) comprend deux parties saillantes (106) présentant chacune une pointe qui est en contact avec le centre du rouleau (102) à l'axe longitudinal (R) afin d'empêcher un déplacement du rouleau (102) dans la direction de l'axe longitudinal (R) du rouleau (102).

2. Agencement de poussoir selon la revendication 1, le corps de poussoir (101) comprenant:

- deux surfaces latérales plates (105) agencées l'une en face de l'autre et alignées dans une direction à travers l'axe longitudinal (R) du rouleau (102).

3. Agencement de poussoir selon la revendication 1 ou 2, dans lequel les surfaces latérales courbes (104) sont chacune convexes.

4. Agencement de poussoir selon l'une quelconque des revendications 1 à 3, dans lequel le corps de poussoir (101) comporte un évidement (107) sur le côté (115) opposé au rouleau (102) afin de coupler l'agencement de poussoir à un plongeur (110) de la pompe à haute pression.

5. Pompe à haute pression à utiliser dans un moteur à combustion interne, comprenant:

- un plongeur (110) pour pressuriser un combustible à l'intérieur d'une chambre de pompe d'un boîtier de pompe pendant une course de pompage du plongeur,

- un arbre d'entraînement (111),
- un agencement de poussoir (100) selon l'une quelconque des revendications 1 à 4, l'agencement de poussoir (100) étant couplé au plongeur (110) et à l'arbre d'entraînement (111) pour imprimer un mouvement d'entraînement de l'arbre d'entraînement (111) au plongeur (110) afin d'exécuter la course de pompage du plongeur.

6. Pompe selon la revendication 5, le boîtier de pompe (114) comprenant un alésage (112), la forme d'une paroi (113) qui entoure l'alésage (112) correspondant à la forme des deux surfaces latérales courbes (104) et les deux surfaces latérales courbes (104) étant chacune en contact avec la paroi (113) de l'alésage (112).

7. Pompe selon la revendication 6, la paroi (113) entourant l'alésage (112) de telle sorte que les deux surfaces latérales plates (105) soient agencées à une certaine distance de la paroi (113).

8. Pompe selon la revendication 6 ou 7, dans laquelle la forme de la paroi (113) et la forme des deux surfaces latérales courbes (104) ainsi que la forme des deux surfaces latérales plates (105) se correspondent de telle sorte que l'agencement de poussoir (100) soit libre de tourner à un angle donné par rapport au boîtier de pompe.

Fig 1

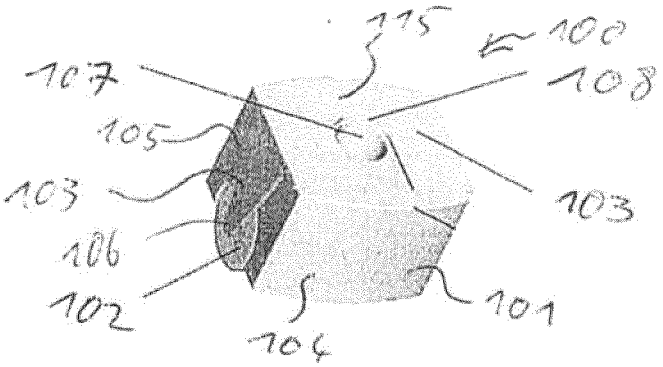
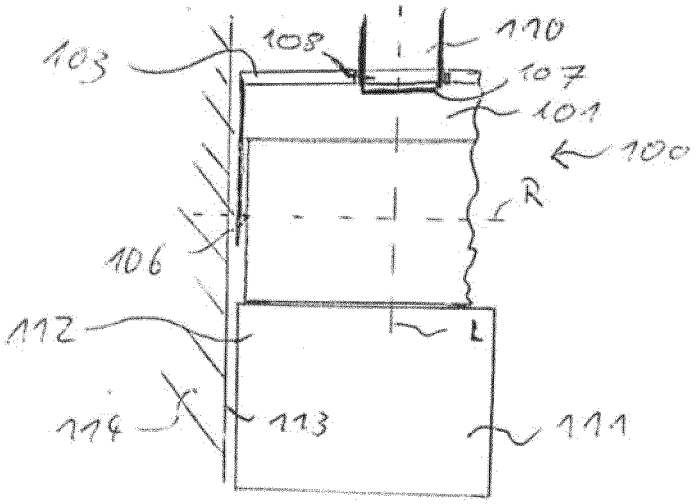

115
100
107
108
105
103
103
106
102
101
104

Fig 2


103
108
110
107
101
100
R
106
112
L
114
113
111

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 2010026463 A **[0001]**