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(54) **High pressure fuel pump and combustion engine**

(57) The invention relates to a high pressure fuel pump (10) which comprises a tappet (38) guided in a tappet guide (40) along a longitudinal extension axis (46) and a spring zone (52) comprising a spring (50) to bias the tappet (38) onto a surface (48) of a drive shaft (16) to drive the tappet (38). At least one venting opening (56) is provided in the tappet guide (40) to connect the spring zone (52) and a surrounding (60) of the high pressure fuel pump (10). The venting opening (56) is extending parallel to the longitudinal extension axis (46) of the tappet guide (40). Further, the invention relates to a combustion engine comprising the high pressure fuel pump (10).

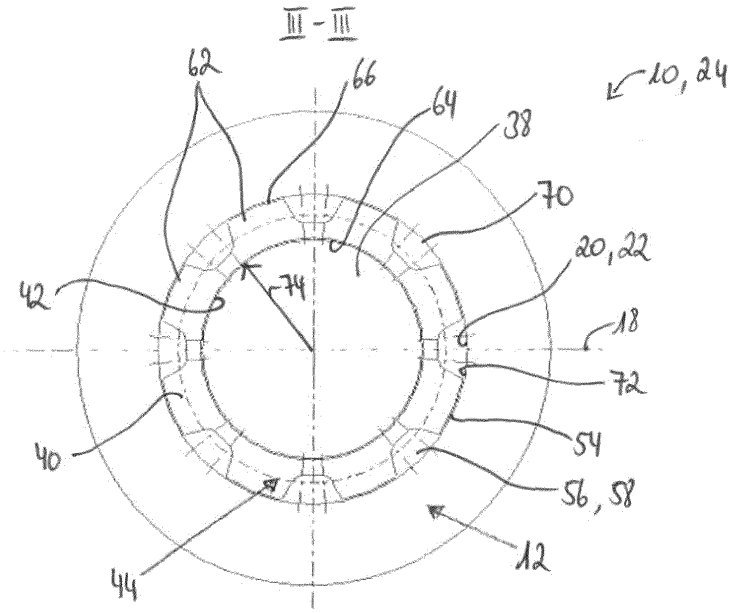

Fig. 3

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Description

[0001] The invention relates to a high pressure fuel pump and a combustion engine comprising the high pressure fuel pump.

[0002] High pressure fuel pumps which pressurize a fuel to be supplied to a combustion room of a combustion chamber are mostly provided as piston pumps, wherein a piston compresses the fuel being located in a pressurizing chamber by a translational movement in order to provide the high pressurized fuel. For example high pressure fuel pumps in gasoline combustion engines pressurize the fuel with a pressure of between 200 bar and 250 bar, whereas high pressure fuel pumps for diesel combustion engines pressurize the fuel with a pressure of between 2000 bar and 2500 bar.

[0003] The piston in these piston pumps is often driven by the drive shaft of the combustion engine, the drive shaft comprising an eccentric which operates the piston via a tappet. In operation the tappet and the piston are continuously in a translational movement. The tappet and the piston are in permanent contact with a surface of the drive shaft as a spring biases the tappet and the piston onto this surface, the spring being arranged in a spring zone of the high pressure fuel pump.

[0004] Due to the continuously moving tappet a lubricant being located in the area of the drive shaft is transferred into the spring zone as lubricant leakage. The lubricant mixes with air being present in the spring zone. Due to the translational movement of the tappet the air-lubricant-mixture in the spring area is pressurized, wherein a clearance connecting the spring zone and the area of the drive shaft is not large enough to relieve this pressure built-up. Therefore, a back pressure acts onto the tappet and is further transmitted onto the drive shaft.

[0005] This can lead to a wear and a reduced life time of the involved components.

[0006] Until now it is known to provide a venting bore in a housing in which the tappet and the spring zone are arranged in order to relieve the spring zone. This venting bore is provided perpendicular to the moving direction of the tappet and is mostly located in an engine block of the combustion engine which is highly elaborate in the manufacturing process.

[0007] Therefore, it is an object of the invention to provide an in this respect improved high pressure fuel pump.

[0008] This object is attained by a high pressure fuel pump comprising the features of the independent claim 1.

[0009] A combustion engine comprising this high pressure fuel pump is the subject-matter of the further independent claim.

[0010] Preferred embodiments of the invention are subject-matter of the dependent claims.

[0011] A high pressure fuel pump comprises a high pressure generating zone in which a translational movement can be carried out to generate a high pressure in a fuel, a tappet to transfer and transform a rotational movement of the drive shaft into the translational movement of the pressure generating zone, a tappet guide to guide the tappet on a tappet guide wall, the tappet guide having a longitudinal extension axis being arranged parallel to direction of the translational movement, and a spring zone comprising a spring to bias the tappet onto a surface of the drive shaft. At least one venting opening is provided in the tappet guide to connect the spring zone and a surrounding of the high pressure fuel pump, in particular an engine compartment, in which the drive shaft is arranged. The venting opening is extending parallel to the longitudinal extension axis of the tappet guide.

[0012] Therefore it is proposed to provide a venting opening which does not pass through the entire engine block, but which is instead located in the tappet guide and which extends along the longitudinal extension axis of the tappet guide instead of perpendicular to the longitudinal extension axis. Therefore, the venting opening can be easily manufactured, which results in a less expensive manufacturing of the overall high pressure fuel pump.

[0013] The venting opening is preferably not provided in the tappet itself, but in the tappet guide, as due to the general assembly of the high pressure fuel pump venting openings which are located in the tappet itself can be locked. For example often a spring plate on the tappet provided to support the spring covers a venting opening provided in the tappet such that this venting opening becomes inoperative.

[0014] In a preferred embodiment the at least one venting opening is arranged in the tappet guide such that it is during operation of the tappet in constant fluidic communication with the spring zone. Therefore, the venting opening can provide a pressure relieve of the spring zone in any position of the tappet during its operation.

[0015] In a preferred embodiment a guide bushing is provided to form the tappet guide. With a guide bushing the venting opening can preferably be provided in a separate component part of the high pressure fuel pump which is easy to manufacture.

[0016] In a preferred embodiment the guide bushing comprises an inner wall forming the tappet guide wall and an outer wall opposite to the tappet guide wall, wherein the at least one venting opening is provided in the outer wall. Providing the venting opening in the outer wall of the guide bushing provides a more stable guide for the tappet compared to an arrangement where the venting opening is provided in the inner wall which forms the tappet guide wall and is in contact with the tappet.

[0017] In a preferred embodiment the guide bushing is formed from aluminum or from iron casting. Both aluminum as well as iron casting comprises a good thermal conductivity which is advantageous to discharge heat from the guide bushing to the surrounding. Aluminum has a higher conductivity than iron casting and is therefore the preferred material in due of heat discharge. However, iron casting has the advantage that in most cases the engine block material is built from iron casting and therefore the same thermal expansion of the guide bush-

ing and the surrounding material can be attained due to the use of the same material. This leads to less stress in the components.

[0018] In a preferred embodiment a plurality of venting openings are provided in the tappet guide. This arrangement can provide an improved pressure relief of the spring zone compared to an arrangement comprising of only one venting opening.

[0019] Providing a plurality of venting openings has the further advantage that cooling fins are formed in the tappet guide which can discharge heat generated by the operation of the tappet. For example, 2, 4 or 8 venting openings can be provided. It is preferred if the distance between the cooling fins and therefore the distance between the venting openings is provided such that on the one hand a sufficient pressure relief of the spring zone and a sufficient cooling effect can be realized, but on the other hand the stability of the overall system is not impacted too much.

[0020] In a preferred embodiment the tappet guide is divided into a first area and a second area by a plane being perpendicular to a rotational axis of the drive shaft, wherein the at least one venting opening is provided only in the first area.

[0021] The venting opening is preferably provided in that first area of the tappet guide which is opposite to a rotation direction of the drive shaft. Due to this arrangement the abuting area of the tappet at the tappet guide can be formed as large as possible and therefore a better and in particular symmetric transmittal of force from the drive shaft to the piston can be realized.

[0022] In a preferred embodiment the spring zone is completely closed in a radial direction of the tappet by a spring zone housing wall, wherein a clearance is provided between the tappet and the tappet guide. This means that in the spring zone there are no further venting openings provided in a radial direction. The clearance between the tappet and the tappet guide has the advantage that the lubricant present in the area of the drive shaft can be used to also lubricate the tappet.

[0023] In a preferred embodiment as sealing is provided to seal the spring zone against entrance of a fuel leakage from the pressure generating zone.

[0024] In operation of the high pressure fuel pump the piston pressurizes the pressure chamber comprising the fuel, wherein this fuel flows through an unavoidable clearance in which the piston is guided in the direction of the tappet, and further flows into the spring zone and therefore contaminates the lubricant. A contaminated lubricant can have the result that components of the high pressure fuel pump as for example the tappet or the drive shaft can wear. Therefore the sealing is provided to avoid the mixture of lubricant and fuel in the spring zone.

[0025] In a preferred embodiment the high pressure fuel pump is provided as a plug-in pump which is to be plugged in into a recess of an engine block of a combustion engine. Such a plug-in pump has the advantage that it has a low weight and is easy to assemble.

[0026] A combustion engine comprises an engine block which comprises an engine compartment with a drive shaft extending along a drive shaft rotational axis and a recess extending perpendicular to the drive shaft rotational axis, the recess having a recess wall. Further, the combustion engine comprises a high pressure fuel pump as described above, wherein the high pressure fuel pump is housed in the recess and wherein the venting opening is provided in a recess wall.

[0027] The venting opening can easily be formed by milling or drilling or pocketing into the recess wall in a longitudinal direction of the recess. Therefore, a venting opening passing through the whole engine block can be preferably avoided.

[0028] Additionally or alternatively the guide bushing as described above can easily be press-fitted, glued or welded into the recess.

[0029] In the following preferred embodiments of the invention are described with regard to the accompanying drawings, in which:

Fig. 1 shows a sectional view of a high pressure fuel pump comprising the tappet;

Fig. 2 shows a detailed sectional view of Fig. 1 in the area of the tappet in a first embodiment;

Fig. 3 shows a cross section along the line III-III in Fig. 2;

Fig. 4 shows a detailed sectional view of Fig. 1 in the area of the tappet in a second embodiment;

Fig. 5 shows a cross section along the line V-V in Fig. 4; and

Fig. 6 shows a detailed sectional view of the area above the tappet comprising a sealing.

[0030] Fig. 1 shows a sectional view of a high pressure fuel pump 10 arranged in an engine block 12 of a combustion engine. The engine block 12 comprises an engine compartment 14, where a drive shaft 16 is arranged, the engine compartment 14 and the drive shaft 16 both extending along a drive shaft rotational axis 18. Further, the engine block 12 comprises a recess 20 which extends perpendicular to the drive shaft rotational axis 18 and which comprises a recess wall 22. In the recess 20 the high pressure fuel pump 10 is inserted. The high pressure fuel pump 10 does not comprise an own housing, but uses the engine block 12 as housing, i.e. the high pressure fuel pump 10 is formed as a plug-in pump 24. The plug-in pump is only an example for a high pressure fuel pump 10. All features of the following description are also applicable to a high pressure fuel pump having an own housing.

[0031] The high pressure fuel pump 10 comprises a high pressure generating zone 26 by which a high pres-

sure is generated in a fuel. In the high pressure generating zone 26 a piston 28 is provided which generates the high pressure in the fuel during a translational movement along a translational movement direction 30 which is perpendicular to the drive shaft rotational axis 18. Due to the movement of the piston 28 the volume of the pressure chamber 32 is shortened and fuel being present in the pressure chamber 32 is pressurized.

[0032] The piston 28 is driven by the drive shaft 16 via an exzenter 34, for example a cam 36, wherein a tappet 38 is provided to transfer a rotational movement of the drive shaft 16 into a translational movement of the piston 28 being the main element of the high pressure generating zone 26.

[0033] Tappet 38 during its movement is guided by a tappet guide 40 on a tappet guide wall 42. The tappet guide 40 can be provided by the recess wall 22 of the recess 20 in the engine block 12 or by an additional element, for example a guide bushing 44, which is inserted in the recess 20 as will be described later. The tappet guide 40 has a longitudinal extension axis 46 which is arranged parallel to the translational movement direction 30 of the piston 28 and which is perpendicular to the drive shaft rotational axis 18.

[0034] In order to maintain the tappet 38 in permanent contact with a surface 48 of the drive shaft 16 in the area of the cam 36, a spring 50 is provided in a spring zone 52 of the high pressure fuel pump 10. The spring 50 biases the tappet 38 and also the piston 28 onto the surface 48 of the drive shaft 16.

[0035] The drive shaft 16 in the engine compartment 14 is lubricated by a lubricant, for example oil. In order to be able to also lubricate the tappet 38 during its movement, a clearance 54 is provided between the tappet 38 and the tappet guide 40 such that the lubricant in the engine compartment 14 can enter this clearance 54 and therefore can lubricate also the tappet 38.

[0036] Via this clearance 54 the lubricant can enter also the spring zone 52 where it mixes with air being already present in the spring zone 52. This mixture leads to a pressure built-up during the operation of the tappet 38 when the spring zone 52 is compressed. This built-up pressure cannot be reduced via the clearance 54 as the clearance 54 is not large enough.

[0037] Therefore, as described with regard to figs. 2 to 5, at least one venting opening 56 is provided in the tappet guide 40.

[0038] Usually such venting openings 56 are provided in the spring zone 52 and act as escape vent for the mixture of air and the lubricant, for example oil, which is trapped between the high pressure generating zone 26 and the tappet guide 40. Usually this venting opening 56 is an opening in the engine compartment 14 of the engine block 12. Unfortunately additional bores and openings in the engine compartment 14 are not preferred as they raise the cost of manufacturing due to complex orientation of this venting opening 56.

[0039] Therefore, at least one venting opening 56 according to the invention is provided in the tappet guide instead of in the engine compartment 14. Therefore, a simple venting opening 56 can be provided which acts as a vent for the trapped mixture in the spring zone 52.

[0040] There are two possibilities to provide the venting opening 56, the first possibility is to provide a pocket 58 in a recess wall 22, the pocket 56 extending along the longitudinal extension axis 46 between the spring zone 52 and the engine compartment 14. In a second possible embodiment the venting opening 56 is provided in an additional component, namely a guide bushing 44 which is inserted into the recess 20.

[0041] The two embodiments are described in the following.

[0042] Fig. 2 shows an enlarged detail of the sectional view of the high pressure fuel pump 10 of fig. 1. The detail shows the area of the tappet 38. In the first embodiment the tappet guide 40 is provided by a guide bushing 44 inserted into the recess 20. As can be seen in fig. 2 there are several venting openings 56 provided in the guide bushing 44 which extend between the spring zone 52 and a surrounding 60 of the high pressure fuel pump 10, which is according to fig. 1 formed for example by the engine compartment 14.

[0043] Fig. 3 shows a cross section of fig. 2 along the line III-III. Here it can be seen that the guide bushing 44 comprises a plurality of venting openings 56 such that automatically cooling fins 62 are formed and heat generated during the operation of the tappet 38 can be discharged.

[0044] As can be seen in fig. 2 und fig. 3 the guide bushing 44 comprises an inner wall 64 forming the tappet guide wall 42 at which the tappet 38 is guided, and an outer wall 66 opposite to the tappet guide wall 42 and directed to the recess wall 22 of the recess 20. The venting openings 56 are provided in the outer wall 66 of the guide bushing 44 which provides a better stability for the tappet guide wall 42 during the operation of the tappet 38.

[0045] The venting openings 56 are provided as pockets 58 with a pocket opening 70 directed to the recess wall 22.

[0046] Due to the provision of the venting openings 56 a further venting opening 56 in the recess wall 22 which forms a housing wall 72 for the spring zone 52 can be avoided. Therefore, in a radial direction 74 of the tappet 38 the spring zone 52 is completely closed by this housing wall 72.

[0047] Fig. 4 and fig. 5 show an alternative embodiment of the invention, where the venting openings 56 are not provided in an extra guide bushing 44, but in the recess wall 22 of the engine block 12. Also these venting openings 56 extend between the spring zone 52 and the surrounding 60, namely the engine compartment 14, and are preferably formed as pockets 58, wherein the pocket opening 70 is directed to the tappet 38.

[0048] As can be seen in fig. 5 the tappet guide 40 provided by the recess wall 22 is divided into a first area 76 and a second area 78 by the drive shaft rotational axis

18. The venting openings 56 are only provided in the first area 76, wherein the drive shaft 18 is arranged to rotate in the opposite direction, i.e. in the direction towards the second area 78. This arrangement increases the stability of the tappet guide 40. The forces acting on the tappet guide 40 due to the rotational forces of the drive shaft 16 which are transmitted onto the tappet 38 are acting only on the second area 78 and not on the first area 76 which is less rigid due to the insertion of the venting opening 56.

[0049] In fig. 6 a detailed view of the high pressure fuel pump 10 in the area of the high pressure generating zone 26 is shown. Here the piston 28 is surrounded by a sealing 80 which avoids that fuel can migrate from the pressure chamber 32 which is located above the piston 28 into the spring zone 52 which is located around the piston 28. Therefore, a mixing of the fuel and the lubricant can be avoided and the danger of wear of the high pressure fuel pump components is reduced.

[0050] The venting openings 56 are different to the kwon prior art solutions and are not arranged anymore in the engine block 12 itself, but in the tappet guide 40. Further, they are provided in a position such that they are in a constant fluidic communication with the spring zone 52. In arrangements where the venting openings 56 are located for example in the tappet 38 itself, there is the possibility that they are covered by for example a spring plate constituted to support the spring 50. This danger is not given if the venting openings 56 are arranged in the tappet guide 40 instead of in the tappet 38.

[0051] Therefore, the venting openings 56 in the tappet guide 40 act as venting holes and therefore no additional venting is required in the spring zone 52. The venting opening 56 in the tappet guide 40 reduce the contact forces of the tappet body and of the tappet guide 40 which ensures a lower friction and improves the thermal behavior. As is shown for example in fig. 5 this venting openings 56 are strategically placed such that the load from the cam 36 of the drive shaft 16 is not in the direction of the venting openings 56. Depending on the volume which has to be vented it is possible to provide more or less venting openings 56. In the embodiment shown in figs. 2 and 3 the special tapped guide 40 formed by the guide bushing 44 eliminates a precise machining of the tappet guide 40 on the engine block 12 and is therefore a less expensive solution. The guide bushing 44 can be of improved materials as for example aluminum or iron casting which have better thermal extension behavior, thus eliminating a disalignment in use of the tappet 38 due to tilting at high operation temperatures. The special rib feature around the guide bushing 44 which constitutes cooling fins 62 also dissipates heat generated by the tappet friction effectively. The gap between the fins 62 and the number of the fins 62 are specifically designed to ensure optimum venting and cooling conditions thereby not compromising on the stability of the system.

Reference list

[0052]

10	high pressure fuel pump
12	engine block
14	engine compartment
16	drive shaft
18	drive shaft rotational axis
20	recess
22	recess wall
24	plug-in pump
26	high pressure generating zone
28	piston
30	translational movement direction
32	pressure chamber
34	excenter
36	cam
38	tappet
40	tappet guide
42	tappet guide wall
44	guide bushing
46	longitudinal extension axis
48	surface
50	spring
52	spring zone
54	clearance
56	venting opening
58	pocket
60	surrounding
62	cooling fin
64	inner wall
66	outer wall
70	pocket opening
72	housing wall
74	radial direction
76	first area
78	second area
80	sealing

Claims

1. High pressure fuel pump (10), comprising

- a high pressure generating zone (26) in which a translational movement can be carried out to generate a high pressure in a fuel,
- a tappet (38) to transfer and transform a rotational movement of a drive shaft (16) into the translational movement of the pressure generating zone (26),
- a tappet guide (40) to guide the tappet (38) on a tappet guide wall (42), the tappet guide (40) having a longitudinal extension axis (46) being arranged parallel to a direction (30) of the translational movement,
- a spring zone (52) comprising a spring (50) to

bias the tappet (38) onto a surface (48) of the drive shaft (16),

wherein at least one venting opening (56) is provided in the tappet guide (40) to connect the spring zone (52) and a surrounding (60) of the high pressure fuel pump (10), in particular an engine compartment (14), in which the drive shaft (16) is arranged,
wherein the venting opening (56) is extending parallel to the longitudinal extension axis (46) of the tappet guide (40).

2. High pressure fuel pump (10) according to claim 1, wherein the at least one venting opening (56) is arranged in the tappet guide (40) such that it is during operation of the tappet (38) in constant fluidic communication with the spring zone (52) .

3. High pressure fuel pump (10) according to any of the claims 1 or 2,
wherein a guide bushing (44) is provided to form the tappet guide (40) and/or wherein the at least one venting opening (56) is formed as a venting pocket (58) in a wall of the tappet guide (40).

4. High pressure fuel pump (10) according to any of the claims 1 to 3,
wherein the guide bushing (44) comprises an inner wall (64) forming the tappet guide wall (42) and an outer wall (66) opposite to the tappet guide wall (42),
wherein the at least one venting opening (56) is provided in the outer wall (66).

5. High pressure fuel pump (10) according to any of the claims 1 to 4,
wherein a plurality of venting openings (56) are provided in the tappet guide (40), the plurality of venting openings (56) in the guide bushing (44) forming cooling fins (62) to discharge a heat generated during the operation of the tappet (38).

6. High pressure fuel pump (10) according to any of the claims 1 to 5,
wherein the tappet guide (40) is divided into a first area (76) and a second area (78) by a plane being perpendicular to a rotational axis (18) of the drive shaft (16), wherein the at least one venting opening (56) is provided only in the first area (76) .

7. High pressure fuel pump (10) according to any of the claims 1 to 6,
wherein the spring zone (52) is in a radial direction (74) of the tappet (38) completely closed by a spring zone (52) housing wall (72), wherein a clearance (54) is provided between the tappet (38) and the tappet guide (40).

8. High pressure fuel pump (10) according to any of the claims 1 to 7,
wherein a sealing (80) is provided to seal the spring zone (52) against entrance of a fuel leakage from the high pressure generating zone (26).

9. High pressure fuel pump (10) according to any of the claims 1 to 8, being provided as a plug-in pump (24) to be plugged in into a recess (20) of an engine block (12) of a combustion engine.

10. Combustion engine having an engine block (12) which comprises

- an engine compartment (14) with a drive shaft (16) extending along a drive shaft rotational axis (18),
- a recess (20) extending perpendicular to the drive shaft rotational axis (18) and having a recess wall (22),
- a high pressure fuel pump (10) according to any of the claims 1 to 9,
wherein the high pressure fuel pump (10) is housed in the recess (20) and wherein the venting opening (56) is provided in the recess wall (22).

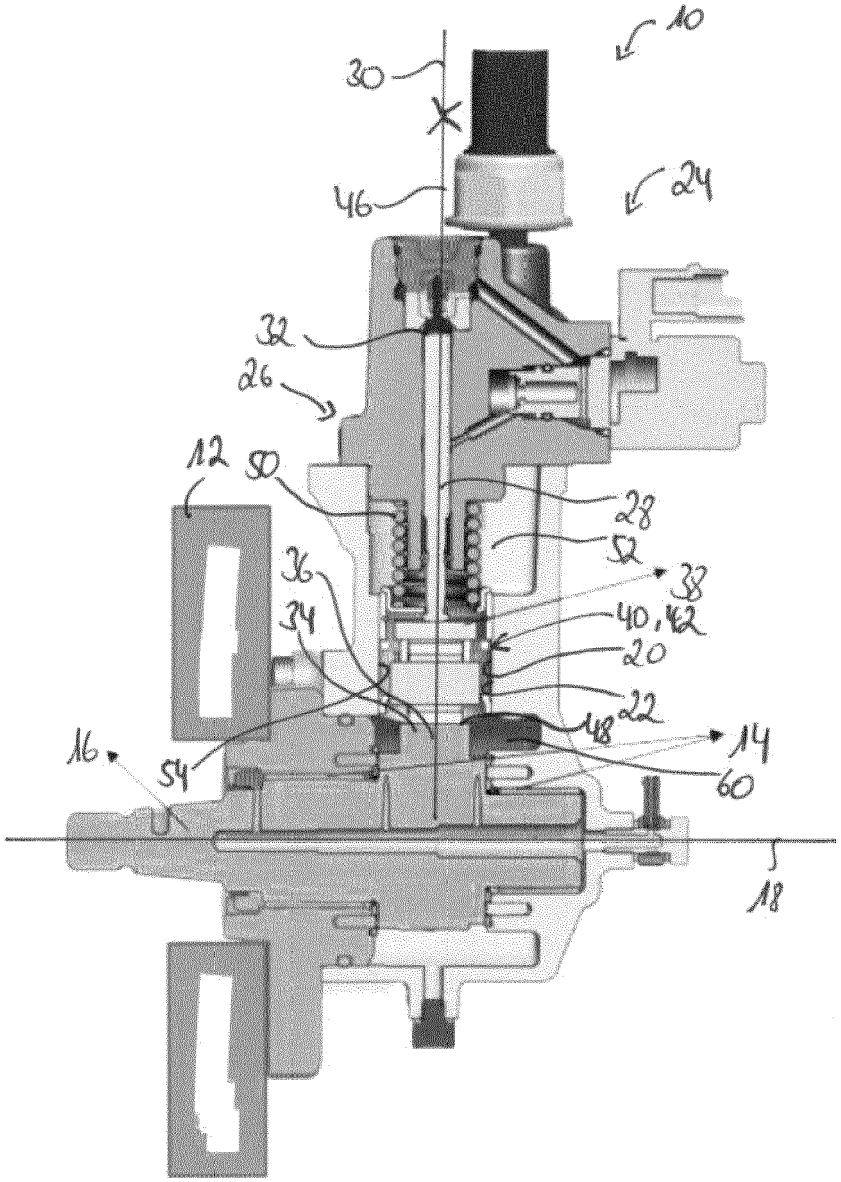

Fig. 1

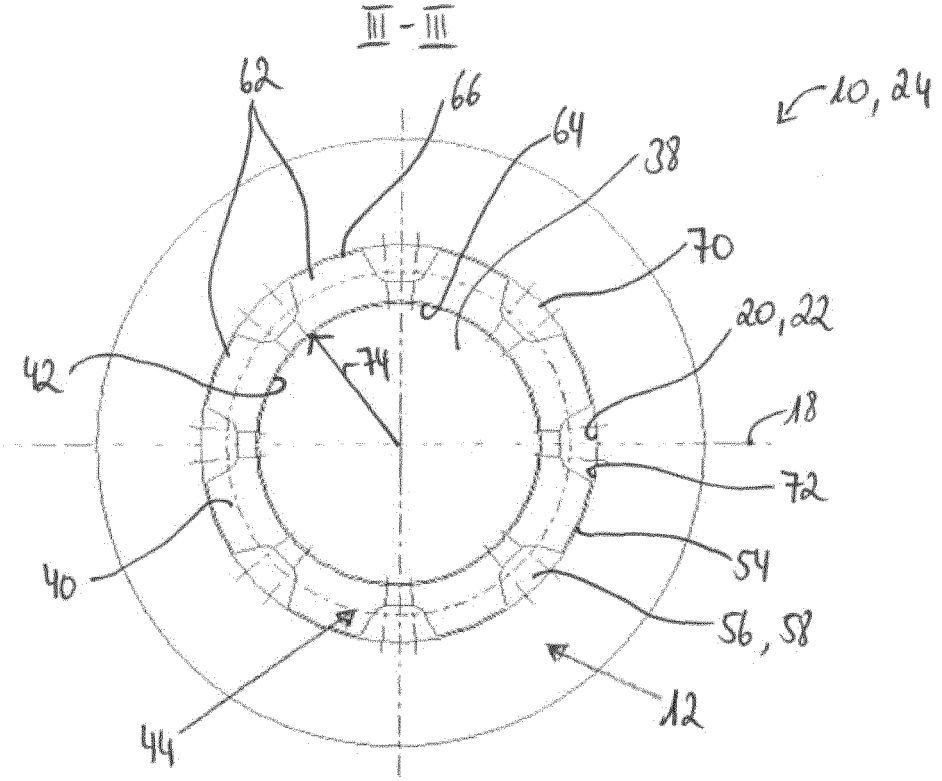
III - III
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Fig. 3

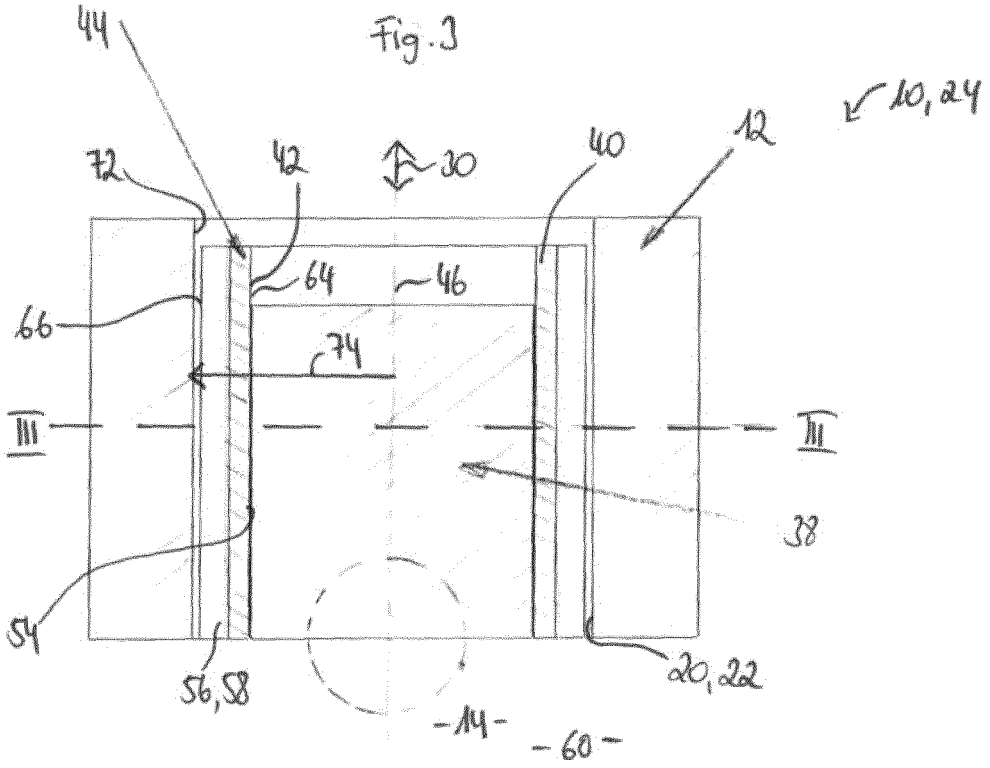
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Fig. 2

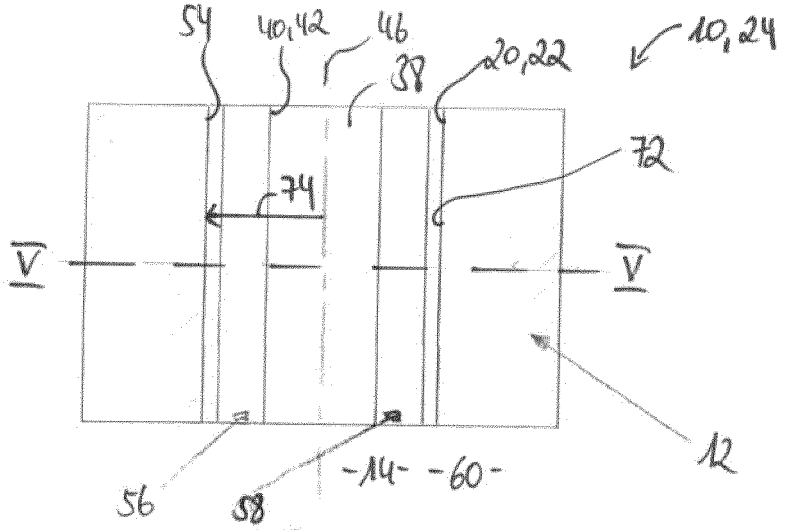
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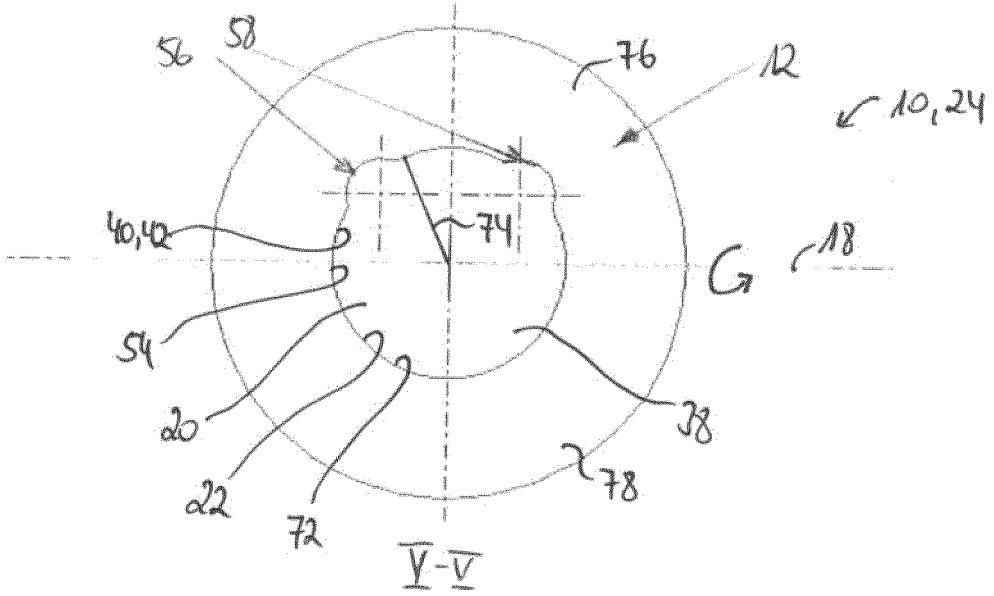
Fig. 4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V-V

Fig. 5

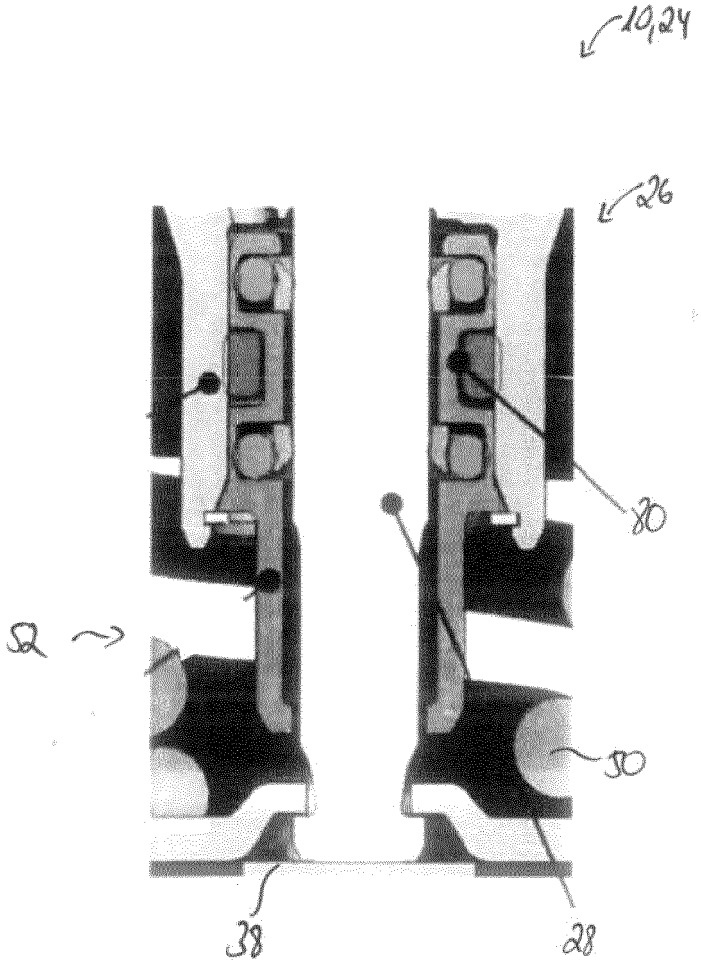

Fig. 6

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EUROPEAN SEARCH REPORT

Application Number
EP 14 18 8681

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	DE 10 2011 084486 A1 (BOSCH GMBH ROBERT [DE]) 18 April 2013 (2013-04-18) * abstract; figures 1,4,5,6 * * claims 1,2, * * paragraph [0021] - paragraph [0024] * * paragraph [0002] * * paragraph [0005] * * paragraph [0018] * * paragraph [0020] *	1,2,5,7	INV. F02M59/10 F02M63/00
X	JP H10 30526 A (DENSO CORP) 3 February 1998 (1998-02-03) * abstract; figures 1,6,8 * * claims 1,4,5,6,7 * * paragraph [0005] * * paragraph [0015] * * paragraph [0023] * * paragraph [0022] * * paragraph [0025] - paragraph [0026] * * paragraph [0010] *	1,4,9,10	
X	US 2003/175137 A1 (INOUE HIROSHI [JP]) 18 September 2003 (2003-09-18) * abstract; figure 1 * * claims 1,4,6 * * paragraph [0073] - paragraph [0075] * * paragraph [0043] * * paragraph [0046] * * paragraph [0005] *	1-4,8,9	TECHNICAL FIELDS SEARCHED (IPC) F02M F01M

-/--

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	17 March 2015	Barunovic, Robert

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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Application Number
EP 14 18 8681

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	JP 2012 102701 A (DENSO CORP) 31 May 2012 (2012-05-31) * abstract; figures 1,2,7,8,9,14 * * claims 1,4 * * paragraph [0049] - paragraph [0052] * * paragraph [0006] - paragraph [0007] * * paragraph [0062] * * paragraph [0042] * * paragraph [0053] * * paragraph [0060] * -----	1-3,6	
X	GB 2 269 210 A (BOSCH GMBH ROBERT [DE]) 2 February 1994 (1994-02-02) * abstract; figures 1,2,3 * * claim 1 * * page 6, line 23 - page 8, line 18 * -----	1-3,6	
X	DE 42 27 853 A1 (BOSCH GMBH ROBERT [DE]) 24 February 1994 (1994-02-24) * abstract; figures 1,6,7 * * claims 1,2,8 * * column 5, line 33 - line 48 * * column 3, line 33 - line 64 * -----	1,3,4,9, 10	
			TECHNICAL FIELDS SEARCHED (IPC)

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	17 March 2015	Barunovic, Robert

CATEGORY OF CITED DOCUMENTS

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 14 18 8681

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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17-03-2015

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 102011084486 A1	18-04-2013	NONE	
JP H1030526 A	03-02-1998	JP 3750203 B2	01-03-2006
		JP H1030526 A	03-02-1998
US 2003175137 A1	18-09-2003	JP 3897096 B2	22-03-2007
		JP 2003269295 A	25-09-2003
		US 2003175137 A1	18-09-2003
JP 2012102701 A	31-05-2012	JP 5516347 B2	11-06-2014
		JP 2012102701 A	31-05-2012
GB 2269210 A	02-02-1994	DE 4225363 A1	03-02-1994
		GB 2269210 A	02-02-1994
		JP H06159191 A	07-06-1994
DE 4227853 A1	24-02-1994	DE 4227853 A1	24-02-1994
		GB 2270350 A	09-03-1994
		JP 3474226 B2	08-12-2003
		JP H06159192 A	07-06-1994
		US 5415533 A	16-05-1995

EPO FORM P0459

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