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(54) **Pulsation damper**

(57) Pulsation damper, in particular pulsation damper for a high-pressure fuel pump of a motor vehicle, comprising a damper housing, at least one first flexible bended damping element being formed as a hollow capsule having an internal volume. This pulsation damper allows handling a bigger throughput by a compact size and furthermore has a wide application range.

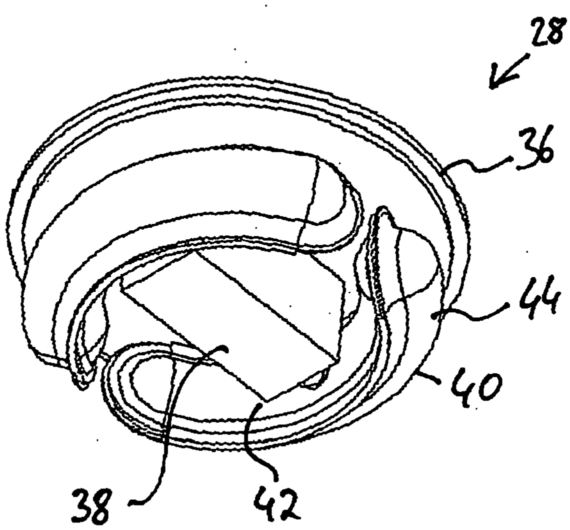

Fig. 3

EP 2 385 241 A1

Description

[0001] The invention relates to a pulsation damper. In particular, the invention relates to a pulsation damper for a high-pressure pump like a fuel pump for conveying fuel in a fuel system of a motor vehicle.

[0002] It is widely known to apply high-pressure pumps for a high-pressure fuel supply in internal combustion engines of motor vehicles. These kind of high-pressure pumps are particularly applicable for supplying gasoline fuel at Common Rail Systems. With this regard, the fuel supplied is compressed up to a pressure of 150 to 200 bar.

[0003] High-pressure pumps usually comprise a housing in which a compressing unit with a cylinder for high-pressure compression is arranged. Within the housing, channels are provided serving as a feed line for the fuel being conveyed from the fuel tank via the compressing unit to the cylinder of the internal combustion engine. Often, due to the working principle of conventional displacement pumps, these compressors cause pressure or stream pulsations. Additionally, the fuel generally reaches the high-pressure pump with pulsations, e.g. caused by a backing pump. In order to reduce such pulsations, fuel systems, or high-pressure pumps, respectively, may comprise pulsation dampers.

[0004] Conventional pulsation dampers use a spring-biased or flexible damping element which damps pulsation by an axial movement, or displacement, respectively. The major drawback of such kinds of pulsation dampers is the requirement of forming them big-sized to allow an adequate flowrate. Furthermore, no adjustment is possible for an adaption to vary performance conditions.

[0005] It is therefore the object of the present invention to provide a pulsation damper which reduces at least one of the limitations as set forth above.

[0006] This object is solved by a pulsation damper according to claim 1. Preferred embodiments of the present invention are set forth in the dependent claims.

[0007] The pulsation damper, in particular pulsation damper for a high-pressure fuel pump of a motor vehicle, according to the invention comprises a damper housing, and at least one first flexible bended damping element being formed as a hollow capsule having an internal volume.

[0008] The pulsation damper according to the invention takes advantage of the special geometry of a bended damping element. Due to its bended form, there are different surface areas at the internal side and at the external side of the bended element on which the pressure may act. In other words, the damping properties are caused by the difference of wetted length between the internal surface and the external surface. Due to its flexibility, the damping element may be deformed by the pressure of the conveyed fluid, in particular by the conveyed fuel. It thus transforms the pressure pulsation in a bent. The damping element may therefore act as an elastic receptacle for the volume stream pulsation, or pressure pulsations. A consumer may therefore be supplied with a continuous stream the pressure level of which has negligible fluctuations or no fluctuations at all.

[0009] Additionally, the pulsation damper according to the invention may handle a bigger volume stream compared to conventional pulsation dampers. This may be realized even by forming it in a compact size. Therefore, it is especially suitable for inserting it into systems with small-sizes requirements.

[0010] In a preferred embodiment of the present invention, the damping element is filled with gas. The volumetric stiffness of the damping element is thereby given by the gas pressure inside said damping element. This enables to take influence on the damping properties by providing a defined gas pressure inside the damping element, or the inner volume, respectively. Here, it is especially preferred that the gas is air. This is the most simple way of forming the damping element.

[0011] In a further preferred embodiment of the present invention, the at least one damping element is connected to the damper housing by a connector, wherein the connector has an internal volume being in fluid communication with the internal volume of the damping element and with a gas connection. This allows filling the damping element not only with air, bit with every fluid which is suitable for the desired application. Furthermore, due to the gas connection provided at the connector, it is possible to apply various gas pressures inside the connector and inside the damping element. Due to the fact that the volumetric stiffness is given by the pressure inside the damping element, the damping properties may thus be changed in a very easy manner, making the pulsation damper according to the invention usable in a wide range of applications. Furthermore, this adjustment may be carried out by the consumer or a garage but has not to be arranged at the production of said damper. This allows an adjustment at any time when required.

[0012] With this regard, it is especially preferred that the damping element is connected to the connector at one connection point. This allows suitable deformation properties, or bending properties, respectively, of the damping element.

[0013] In a further preferred embodiment of the present invention, the damping element is formed of a metal, in particular of stainless steel. This is a very beneficial material for providing the desired damping properties.

[0014] In a further preferred embodiment of the present invention, the damping element comprises an external partial ring and an internal partial ring. Due to the fact that the damping properties are caused by bending said damping element which in turn is strongly dependent of the properties of the internal surface and the external surface of the damping element, this is a further beneficial way to adjust the damping properties.

[0015] With this regard, it is preferred that the external partial ring and the internal partial ring are formed of dissimilar materials. In detail, it is possible to form them of different metals. This provides different stiffness properties of the internal surface and the external surface and thus allows to adjust the bending properties of the damping element and thus of the damping properties, or the damping capacity, respectively.

[0016] This effect may furthermore be reached if the external partial ring and the internal partial ring are formed in different thicknesses. This may be advantageous if the external partial ring and the internal partial ring are formed of the same material, in particular stainless steel, or are formed of dissimilar materials.

[0017] In a further preferred embodiment of the present invention, a second separate bended damping element is provided being arranged on the damper housing, together with the first damping element, in a substantially circular shape and being connected to the damper housing by the connector, wherein the second damping element is formed as a hollow capsule having an internal volume, the latter being in fluid communication with the internal volume of the connector. This embodiment allows providing an improved damping capacity. The term "substantially circular shape" as used herein shall refer to an arrangement having the shape or nearly the shape of a circle, e.g. in the form of an ellipse, oval, etc. However, a substantially circular shape according the invention implies that the latter is interrupted in that the damping elements are separated from each other to allow an adequate deformation, or bending, respectively.

[0018] The invention further relates to a pump, in particular high-pressure fuel pump for a motor vehicle, comprising a pulsation damper according to the invention.

[0019] These and other aspects of the invention will be apparent from and elucidated with reference to the embodiments described hereinafter. However, the invention is not limited to these embodiments.

[0020] In the drawings:

Fig. 1 shows a schematical sectional side view of a pump comprising a pulsation damper according to the invention.

Fig. 2 shows a schematical top view of the pump according to figure 1.

Fig. 3 shows a schematical view of a pulsation damper according to the invention.

Fig. 4 shows a schematical partial view of one embodiment of the pulsation damper according to the invention.

Fig. 5 shows a schematical sectional view of a further embodiment of the pulsation damper according to the invention.

[0021] In figure 1, a pump 10 is shown. This pump 10 preferably is a high-pressure pump of a fuel system of a motor vehicle. Consequently, this pump 10 may mainly be used for conveying fuel, in particular diesel fuel in common rail systems, at high pressures. In detail, pressures up to 2 500 bar may be reached. However, the pump 10 is not strictly limited to this application.

[0022] The pump 10 comprises a housing 12, which comprises or is connected to a cylinder 14. The cylinder 14 serves for high-pressure compression of fluids, in particular for high-pressure compression of diesel fuel. The cylinder 14 has an inner surface 16 which abuts the housing 12. The cylinder 14 comprises a cylinder bore 18 and a compression chamber 20, in which fed fuel is compressed to be conveyed, after the compression, at least partly to a common rail system for fuel injection. In the cylinder bore 18, a moveable piston 22 is arranged. For an actuation of a movement of the piston 22 in the cylinder bore 18, the piston 22 may be connected to an excenter. By means of the movement of the piston 22, the volume of the compression chamber 20 may be changed. For example, by decreasing the volume of the compression chamber 20, fuel being located in the latter may be compressed.

[0023] Fuel is guided through a conduct 24 into the compression chamber 20 and leaves the pump 10 through an outlet 26. Upstream and/or downstream the compression chamber 20, a pulsation damper 28 is provided. The pulsation damper 28 has as object to damp pulsations and thus to generate a continuous flow of fuel. The subsequent description is directed towards a pulsation damper 28 being located upstream the compression chamber 20. However, the pulsation damper 28 as well as the pump 10 according to the invention is not limited to this embodiment.

[0024] In detail, the pump 10 may comprise an enclosure 30 in which the pulsation damper 28 is arranged. The enclosure 30 comprises a joint 32 for guiding the fuel from the enclosure 30 through the conduct 24 into the compression chamber 20. The pump 10 furthermore comprises an inlet 34 for guiding the fuel into the enclosure 30 and thus to the pulsation damper 28. The inlet 34 is shown in figure 2. Preferably, the inlet 34 is arranged on top of the enclosure 30. The enclosure 30 thus forms a closed cavity for an arrangement of the pulsation damper 28.

[0025] The pulsation damper 28 is shown in detail in figure 3. The pulsation damper 28 comprises a damper housing 36. The damper housing 36 may have a circular form and may be formed of metal. An especially preferable metal for forming the damper housing 36 is stainless steel. The damper housing 36 may be fixed in the enclosure 36 to hold the pulsation damper 28 in place. Consequently, it is advantageous that the damper housing 36 has the same shape as the enclosure 30.

[0026] A connector 38 is preferably connected to the damper housing 36. The connector 38 may be formed hollow as it is described in detail with respect to figure 5. The connector 38 has as one objective to serve as an interface between the damper housing 36 and a bended damper element 40.

[0027] It has to be noted, that according to the invention, one bended damping element 40 may be sufficient. In this case, the single damping element 40 may have a semicircular or nearly circular form. However, in the following, the present invention will be described in an embodiment comprising two damping elements 40. Consequently, it is possible to provide at least one damping element 40, preferably two damping elements 40 and in some embodiments more than two damping elements 40 without leaving the invention as such. This implies that all features of the damping elements 40 described with regard to an embodiment comprising two damping elements 40 are as well applicable for an embodiment comprising one damping element 40.

[0028] According to figure 3, the damping elements 40 are shaped in a bended form. By providing two damping elements 40, each of the damping elements 40 substantially has a semicircular shape. Consequently, the damping elements 40 together substantially form a circle. It is, however, essential, that the damping elements 40 are separated from each other to provide a sufficient movability like described down below.

[0029] In case two damping elements 40 are provided, the connector 38 may be located between the damping elements 40. Like described above, the connector 38 may form a connection between the damping elements 40 and the damper housing 36 for holding the damping elements 40 in place. It is, however, preferred, that the damping elements 40 are connected to the connector 38 at one connection point. This enables the damping elements 40 to be suspended freely and allows a free movability of the damping elements 40 and thus good bending properties.

[0030] The pulsation damper 28 according to the invention will then work as follows. In case the pulsation damper 28 is arranged in the fuel system of a motor vehicle, in particular in the high-pressure fuel pump, fuel is guided into the enclosure 30. Consequently, fuel will contact the pulsation damper 28 and particularly the damping elements 40 with an increased pressure. Furthermore, the fuel will enter the enclosure 30 with pulsations. That means that the fuel flows in a discontinuous manner, i.e. the fuel forms a flow with pressure and/or volume pulsations.

[0031] The damping elements 40 have an internal surface 42 and an external surface 44. The fuel flow will then exert pressure to both the internal surface 42 and the external surface 44 of the damping elements 40. Due to the bended shape, the pressure interacting on the damping elements 40 will cause a deformation of the latter, thereby transforming the pressure in a bent. The stiffness of the damping elements 40, however, will force them back into their initial shape when the pressure has a lower value caused by the pressure pulsations. This mechanism allows to damp pulsations and thus to generate a nearly or completely continuous flow of fuel.

[0032] The damping elements 40 are formed as hollow capsules. It is advantageous that the damping elements are formed of a metal, in particular of stainless steel. In one embodiment, the damping elements 40 may be formed as bent pipes. This is shown in figure 4. The damping elements 40 have an inner volume 46 which may be filled with any kind of gas. However, air is most preferred, as this is the simplest way to fill the damping elements 40 or the inner volume 46, respectively. Even though the damping elements 40 are formed as capsules, i.e. an air exchange is not possible directly between the inner volume 46 of the damping elements 40 and the surrounding atmosphere, the inner volume 46 of the damping elements 40 is connected to an inner volume 48 of the connector 38.

[0033] In figure 5, the fluid communication of the inner volume 46 of the damping elements 40 and the inner volume 48 of the connector 38 is shown. The inner volume 46 and the inner volume 48 form a gas chamber which may be filled with gas to create a desired pressure inside that gas chamber. In order to change the gas which is present inside that gas chamber and/or to vary the gas pressure, the connector 38 comprises a gas connection 50, which connects the inner volume 48 of the connector 38 and thus the inner volume 46 of the damping elements 40 to the outer atmosphere. In order to close the gas chamber, a plug 52 may be provided to close the gas connection 50. It has to be noted that apart from a plug, there are several closing elements known in the art which may be applicable to close the gas connection 50.

[0034] The stiffness, or the flexibility, respectively of the damping elements 40 and thus the ability to damp pressure pulsations is thereby dependent from the gas and the gas pressure pressure inside the damping elements 40. Therefore, by varying the gas and/or the gas pressure inside the damping elements 40, the damping properties may be varied according to the current requirements.

[0035] This arrangement may be realized in combination with a damping element like described above. However, according to figure 5, the damping elements 40 comprise an inner or internal partial ring 54 and an outer or external partial ring 56. In order to create defined damping properties of the damping elements 40, the internal partial ring 54 and the external partial ring 56 may be formed of different materials. With this regard, the materials may be chosen to create the desired damping properties. Furthermore, the damping properties may be adjusted by forming the internal partial ring 54 and the external partial ring 56 with different thicknesses.

[0036] In some applications, it may be advantageous that the damping properties are adjusted to a required amount by using a combination of the above described measures. In detail, it may be advantageous to fine-tune the damping properties of the pulsation damper by choosing suitable materials and/or thicknesses for the internal partial ring 54 and the external partial ring 56 and by adjusting the pressure inside the damping elements 40.

[0037] For some special applications, it may be advantageous if the two damping elements 40 differ from each other in their damping properties. Therefore, the damping elements 40 may be formed of different materials. Furthermore, the inner volume 48 of the connector 38 may be divided into two parts, each of the parts having one gas connection and being connected to one of the damping elements 40. This allows providing different gas pressures in each of the damping elements 40 and thus adjusting the damping properties independent from each other.

Reference Signs

[0038]

10	pump
12	housing
14	cylinder
16	inner surface
18	cylinder bore
20	compression chamber
22	piston
24	conduct
26	outlet
28	pulsation damper
30	enclosure
32	joint
34	inlet
36	damper housing
38	connector
40	damping element
42	internal surface
44	external surface
46	inner volume (damping element)
48	inner volume (connector)
50	gas connection
52	plug
54	internal ring
56	external ring

Claims

1. Pulsation damper, in particular pulsation damper for a high-pressure fuel pump of a motor vehicle, comprising
a damper housing (36), and
at least one first flexible bended damping element (40) being formed as a hollow capsule having an internal volume (46).

2. Pulsation damper according to claim 1, **characterized in that** the damping element (40) is filled with gas.

3. Pulsation damper according to claim 1 or 2, **characterized in that** the at least one damping element (40) is connected to the damper housing (36) by a connector (38), wherein the connector (38) has an internal volume (48) being in fluid communication with the internal volume (46) of the damping element (40) and with a gas connection (50).

4. Pulsation damper according to claim 3, **characterized in that** the damping element (40) is connected to the connector (38) at one connection point.

5. Pulsation damper according to any of the preceding claims, **characterized in that** the damping element (40) is formed of a metal, in particular of stainless steel.

6. Pulsation damper according to any of the preceding claims, **characterized in that** the damping element (40) comprises an external partial ring (56) and an internal partial ring (54).

7. Pulsation damper according to claim 5, **characterized in that** the external partial ring (56) and the internal partial ring (54) are formed of dissimilar materials.

8. Pulsation damper according to claim 5 or 6, **characterized in that** the external partial ring (56) and the internal partial ring (54) are formed in different thicknesses.

9. Pulsation damper according to any claims 3 to 8, **characterized in that** a second separate bended damping element (40) is provided being arranged on the damper housing (36), together with the first damping element (40), in a substantially circular shape and being connected to the damper housing (36) by the connector (38), wherein the second

damping element (40) is formed as a hollow capsule having an internal volume (46), the latter being in fluid communication with the internal volume (48) of the connector (38).

10. Pump, in particular high-pressure fuel pump for a motor vehicle, comprising a pulsation damper (28) according to any of the preceding claims.

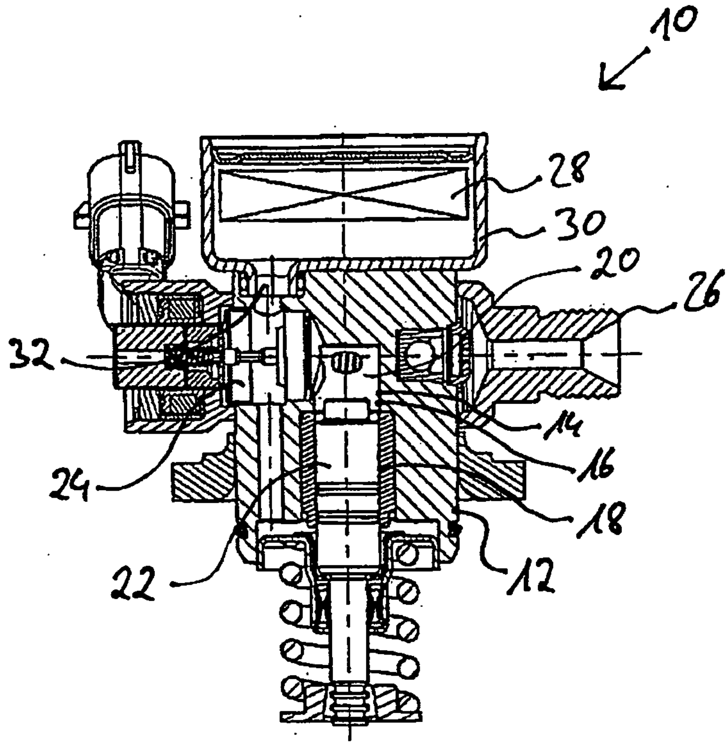

Fig. 1

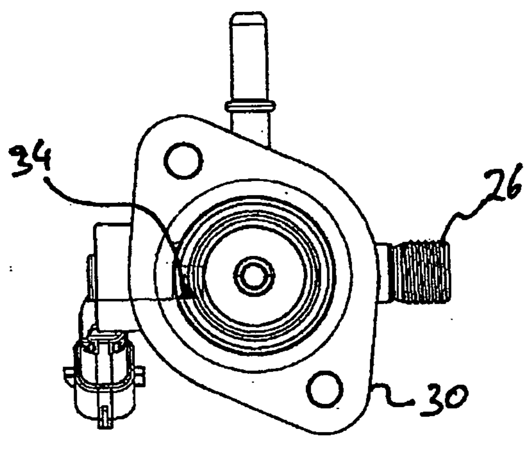

Fig. 2

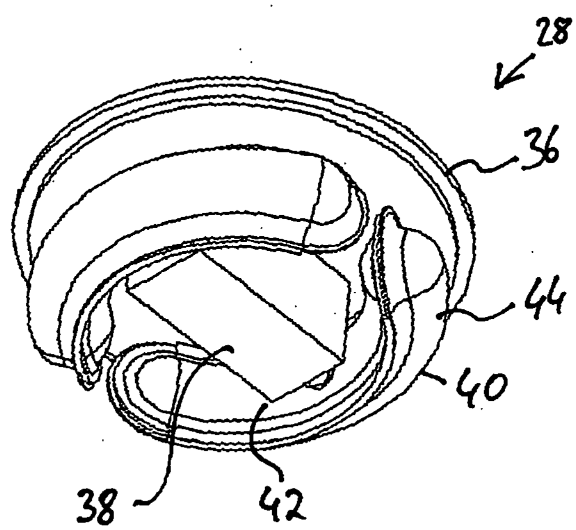

Fig. 3

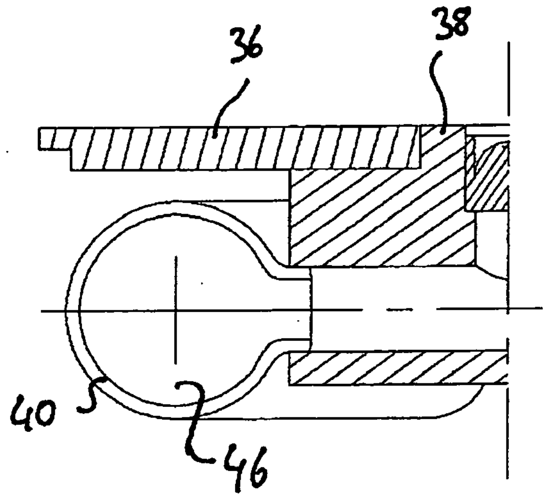

Fig. 4

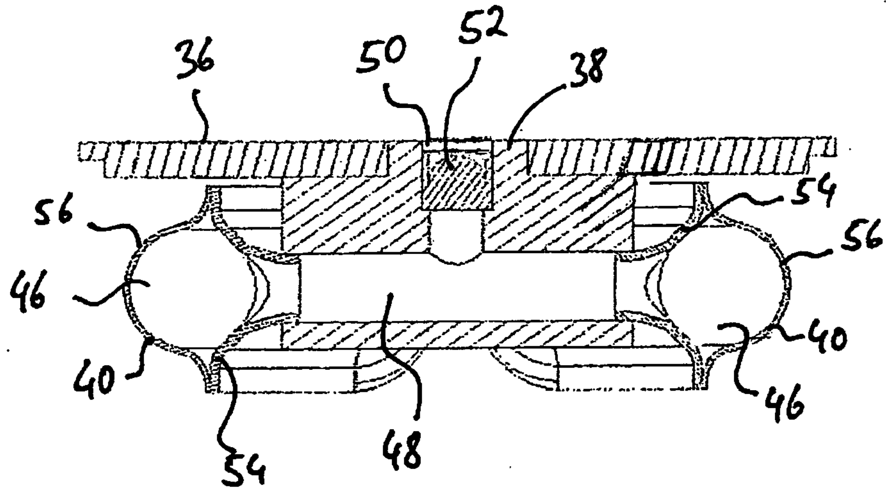

Fig. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 10 00 4708

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The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	20 September 2010	Etschmann, Georg

CATEGORY OF CITED DOCUMENTS

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