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(71) Applicant: **EAGLE SIMRAX B.V.** [NL/NL]; Hopelerweg 250, 6468 XX Kerkrade Parkstad 4005 (NL).

(72) Inventor: **VAN HOOIJDON, Rob**; Hopelerweg 250, 6468 XX Kerkrade Parkstad 4005 (NL).

(74) Agents: **SIEBERT, Karsten** et al.; c/o WSL Patentanwälte Partnerschaft mbB, Kaiser-Friedrich-Ring 98, 65185 Wiesbaden (DE).

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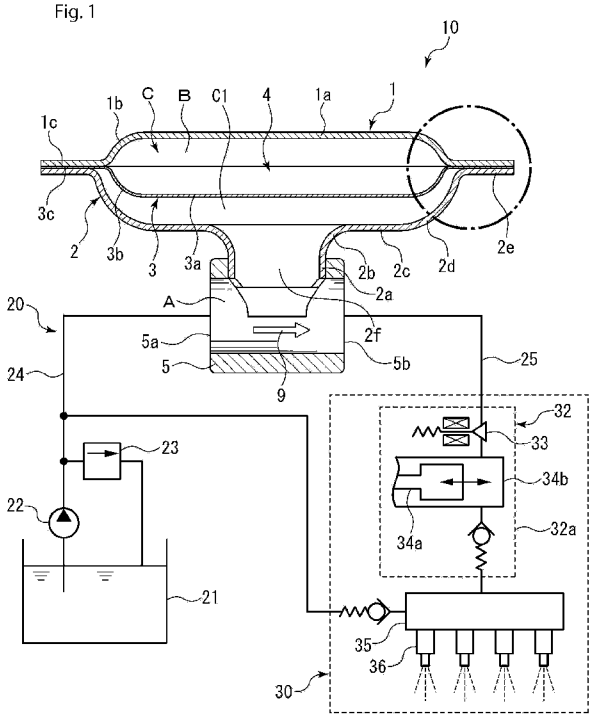
(54) Title: FUEL INJECTION SYSTEM AND DAMPER USED IN THE FUEL INJECTION SYSTEM

Fig. 1



(57) Abstract: To provide a fuel injection system and a damper used in the fuel injection system, the diesel fuel injection system being simply configured to eliminate an effect of a high pressure peak which is generated at a low pressure circuit at low pressure side and preventing a high pressure pump from being complicated and growing in size. [Problem solution] A damper (10) is further arranged in and fixed to a fuel line (24, 25), the damper (10) including a fuel line portion (5, 6) which has both ends provided with a pair of fuel line connecting portions (5a, 5b, 6a, 6b, 7a, 7b) connected to the fuel line (24, 25) and which has an inner portion allowing passage of the diesel fuel; a cover portion (1, 2, 40, 42) forming an enclosed room (C) arranged to extend from the fuel line portion (5, 6, 7); and a pressure absorption body (3) arranged in the enclosed room (C).

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[Description]

[Title of Invention]

Fuel injection system and damper used in the fuel injection system

[Technical Field]

[0001]

The invention relates to a fuel injection system supplying fuel to an internal combustion engine by using a fuel line connecting a high pressure pump and a low pressure pump and to a damper used in the fuel injection system.

[0002]

[Background Art]

A current diesel fuel injection system is equipped with a low pressure pump (feed pump) and a high pressure pump (supply pump). This low pressure pump feeds diesel fuel at about 0.5 MPa (about 5 bar) from a fuel tank through a fuel line to the high pressure pump, and the high pressure pump supplies the diesel fuel at 200 MPa (at a pressure over 200 MPa in the future) to a common rail and injectors. The generally-used high pressure pump is a plunger pump having plural plungers, and it generates a pressure peak with every stroke. Therefore, such diesel fuel injection system is configured that a magnetic valve (spill valve) between a high pressure circuit in which the plunger pump is located and a low pressure circuit is controlled in accordance with a target pressure at the fuel injection timing to allow the high pressure circuit and the low pressure circuit to be momentarily communicated to each other and that the pressure peak generated by the high pressure pump acts on the low pressure circuit (for example, the fuel

line connecting the high pressure pump and the low pressure pump); therefore, a pulsation pressure involving the pressure peak is generated here.

[0003]

[Citation List]

[Patent Literature]

[0004]

[Patent Literature 1] JP2005-042554A (paragraph 0008 to 0037, Fig. 1)

[Summary of Invention]

[Technical Problem]

[0005]

The pulsation pressure in the low pressure circuit of such diesel fuel injection system generates structural issues, noise issues, or the like. In order to damp the pulsation pressure, a damper or the like needs to be installed.

In a gasoline fuel injection system, as illustrated in Fig. 7, a damper 110 is integrally installed in a housing of a high pressure pump 132 to reduce a pulsation pressure in the housing of the high pressure pump 132, thereby preventing the pulsation pressure from affecting a low pressure circuit 120 (for example, refer to Patent Literature 1).

In particular, gasoline (fuel) is discharged from a fuel tank 121 by a low pressure pump 122 and a pressure of the gasoline is regulated by a pressure regulator 123. Then, the gasoline is fed through a fuel line 124 to the high pressure pump 132 of an internal combustion engine 130, thereafter being pressurized by the high pressure pump 132 to be supplied to a common

rail 135 and injectors 136. A pressure peak of the gasoline flowing through a magnetic valve 133 to the low pressure side when a plunger 134a moves in a reciprocating manner within a cylinder 134b is reduced by deformation of metal diaphragms 102, 102 sealed up gas therebetween arranged in a damper chamber 101 adjacent to an inlet of the high pressure pump 132.

[0006]

It is expected that a damper is installed in the high pressure pump in the diesel fuel injection system. However, an average pressure of the low pressure circuit is low at about 0.5 MPa but a pressure peak is very high at 1.5 MPa or higher; therefore, it is difficult to effectively reduce the pulsation pressure generated in the low pressure circuit at the low pressure side. In addition, in the event of installation of the damper in a housing of the high pressure pump, the structure of the high pressure pump cannot help being complicated.

[0007]

As described above, the pressure peak in the diesel fuel injection system is high compared to that in the gasoline fuel injection system. In order to inhibit a pulsation pressure involving such high pressure peak, the diesel fuel injection system requires a damper having a large surface area and a high functionality and a damper chamber having a large capacity capable of accommodating the damper. Therefore, the high pressure pump and an internal combustion engine as well as a damper mechanism may grow in size. As a result, the layout flexibility of the internal combustion engine in an engine room may decrease.

[0008]

Further, in the diesel fuel injection system, the average pressure of the low pressure circuit is about 0.5 MPa but the pressure peak is very high at 1.5 MPa or higher compared to that in the gasoline fuel injection system; therefore, it is difficult for the pulsation pressure to be reduced only in the housing of the high pressure pump 132 and an effect of the high pressure peak generated in the low pressure circuit cannot be eliminated at present.

[0009]

The present invention is made in view of such drawbacks. The object of the present invention is to provide a fuel injection system which is simply configured so as to eliminate an effect of a high pressure peak generated in a low pressure circuit at a low pressure side and which inhibits a high pressure pump from being complicated and growing in size, and to provide a damper used in the fuel injection system.

[0010]

In order to solve the above drawbacks, the fuel injection system of the present invention is characterized to include: a low pressure pump (22) feeding a fuel from a fuel tank (21); a high pressure pump (32) feeding the fuel to injectors (36) of an internal combustion engine (30); and a fuel line (24, 25) connecting the low pressure pump (22) and the high pressure pump (32), wherein a damper (10) is further arranged in and fixed to the fuel line (24, 25), the damper (10) including a fuel line portion (5, 6, 7) which has both ends provided with a pair of fuel line connecting portions (5a, 5b, 6a, 6b, 7a, 7b) connected to the fuel line portion (24, 25) and which has an inner portion allowing passage of the fuel; a cover portion (1, 2, 40, 42) forming an enclosed room (C) arranged to extend from the fuel line portion (5, 6, 7); and a

pressure absorption body (4) arranged in the enclosed room (C).

According to this feature, the fuel line connecting portions at the both ends of the fuel line portion can be arranged by a plug-in connection (so-called in-line layout) in the fuel line making a connection between the fuel tank and the internal combustion engine; thereby, the layout flexibility, for example, in the direction in which the enclosed room (C) extends can be increased. In addition, the cover portion which accommodates the pressure absorption body can be formed at the outside of the high pressure pump; thereby, a high pressure pump housing can be downsized.

Further, the damper is arranged in the fuel line connecting the low pressure pump and the high pressure pump, therefore reducing an effect of a high pressure peak at a side closer to a low pressure circuit, i.e., in a wide area between the low pressure pump and the high pressure pump.

[0011]

The fuel injection system of the present invention is characterized in that the cover portion (1, 2) includes a flattened shape short in a direction intersecting with the passing direction (9) of the fuel.

According to this feature, the cover portion is short in the direction intersecting with the passing direction of the fuel; therefore, a length occupied by the cover portion in the direction intersecting with the passing direction of the fuel can be reduced. As a result, the cover portion hardly interferes with other components in an engine room and a structure less likely to be restricted in the layout of the fuel line arranged between the internal combustion engine and the fuel tank can be offered.

[0012]

A damper of the present invention is characterized to include: a fuel line portion (5, 6, 7) provided with fuel line connecting portion (5a, 5b, 6a, 6b, 7a, 7b) at both ends and including an inner portion allowing passage of a fuel; a cover portion (1, 2, 40, 42) forming an enclosed room (C) arranged to extend from the fuel line portion (5, 6, 7) ; and a pressure absorption body (4) arranged in the enclosed room (C), wherein the cover portion (1, 2, 40, 42) and the pressure absorption body (4) are arranged to extend along a passing direction (9) of the fuel.

According to this feature, a length of the cover portion in a direction intersecting with the passing direction of the fuel can be reduced and an equipment configuration can be downsized.

[0013]

The damper of the present invention is characterized in that the cover portion (1, 2) is configured by a lower cover (2) connected to the fuel line portion (5, 6) and a top cover (1) connected to the lower cover (2) and that the pressure absorption body (4) arranged in the enclosed room (C) is configured by a gas-filling chamber (B) formed by a metal diaphragm member (3) and the top cover (1), and a gas filled in the gas-filling chamber and being at a predetermined pressure.

According to this feature, when a pressure of the fuel has reached a pressure equal to or greater than the predetermined pressure, the pressure absorption body is configured that the filled gas is compressed and the metal diaphragm member is elastically deformed; therefore, a damper function utilizing a gas pressure and the metal diaphragm member can restrain various pressure peaks at respective portions of the metal diaphragm

member. Moreover, the gas is filled between the metal diaphragm member and the top cover; therefore, the number of components is small and a simple configuration can be attained.

[0014]

The damper of the present invention is characterized in that the pressure absorption body (4) is configured by a gas-filling chamber (4A) formed by a pair of metal diaphragm members (3A, 3B) and a gas filled in the gas-filling chamber (4A) being at a predetermined pressure, and that one end of the pressure absorption body (4) is positioned via a holder (46) to the cover portion (40, 42) and the other end of the pressure absorption body (4) is positioned via a fixation spring (44) to the cover portion (40, 42) and is fixed thereto.

According to this feature, the pressure absorption body is positioned via the holder and the fixation spring to the cover portion and is fixed thereto, therefore being attached to the cover portion without loosening and rattling.

[0015]

The damper of the present invention is characterized in that the fuel line connecting portion (5a, 5b) is shaped to be connected to a metal fuel line by welding or brazing.

According to this feature, the damper can be applied to the metal fuel line and the fuel does not leak from a connected portion with the fuel line.

[0016]

The damper of the present invention is characterized in that the fuel line connecting portion (6a, 6b, 7a, 7b) includes a connecting plug to be inserted in a rubber fuel line.

According to this feature, the damper can be applied to the rubber fuel line and the damper can be easily attached to the fuel line.

[Brief Description of Drawings]

[0017]

Fig. 1 is a cross sectional view of a diesel fuel injection system and a damper used in the diesel fuel injection system according to Example 1.

Fig. 2 (a) is an enlarged view of a flange portion of Fig. 1 and Fig. 2 (b) is an enlarged view of a flange portion of a modified example of Fig. 1.

Fig. 3 (a) and Fig. 3 (b) are front and side views of the damper of Fig. 1.

Fig. 4 (a) and Fig. 4 (b) are front and side views of the damper according to Example 2.

Fig. 5 (a) is a top view of the damper according to Example 3 and Fig. 5 (b) is a cross-sectional view taken along the line V-V.

Fig. 6 is a top view of a holder of Fig. 5.

Fig. 7 is a view illustrating a conventional gasoline fuel injection system.

[Description of Embodiments]

[0018]

Embodiments of a fuel injection system and a damper used in the fuel injection system according to the present invention will be described on the basis of Examples.

[Example 1]

[0019]

The diesel fuel injection system and the damper used in the diesel

fuel injection system according to Example 1 will be described with reference to Figs. 1 to 3. Hereinafter, upper, lower, left, and right sides presented on papers of Fig. 2 are explained as upper, lower, left, and right sides.

[0020]

A plug-in pulsation damper (damper) 10 is arranged between fuel lines 24, 25 of a common rail diesel fuel injection system. A low pressure circuit 20 is mainly configured by a fuel tank 21, a low pressure pump 22, a pressure regulator 23, the fuel line 24 at upstream side, the plug-in pulsation damper 10, and the fuel line 25 at downstream side. An internal combustion engine 30 is connected to the fuel line 25 at downstream side and is mainly configured by a high pressure pump (supply pump) 32, a common rail 35, injectors 36, and a combustion chamber and an output shaft which are not shown.

[0021]

The high pressure pump 32 is a plunger pump in which a plunger 34a moves in a reciprocating manner within a cylinder 34b. A magnetic valve (spill valve) 33 is arranged at a low pressure side (suction side) of the high pressure pump 32. A discharge pressure of the high pressure pump 32 is 200 MPa and an opening of the magnetic valve 33 is controlled in accordance with a pressure requested by the common rail 35. The low pressure pump 22 feeds diesel fuel at an average fuel pressure of 0.5 MPa from the fuel tank 21 to the high pressure pump 32. In addition, the high pressure pump 32 operates to generate a pressure peak up to 1.5 MPa or higher at the low pressure side.

[0022]

The plug-in pulsation damper 10 is mainly configured by a top cover 1 (cover portion), a lower cover 2 (cover portion), a metal diaphragm member 3, a pressure absorption body 4, and a fuel line portion 5. The top cover 1 is formed by pressing a stainless steel plate with a thickness of about 2.0 mm. The top cover 1 includes a flat portion 1a at an intermediate portion, a curved portion 1b continuously formed with the flat portion 1a, and a flange 1c continuously formed with the curved portion 1b, thereby forming a substantially annular plate shape. The lower cover 2 is formed by pressing a stainless steel plate with a thickness of about 2 mm. The lower cover 2 includes a tubular portion 2a extending downward from an intermediate portion, a curved portion 2b continuously formed with the tubular portion 2a, a flat portion 2c continuously formed with the curved portion 2b, a curved portion 2d continuously formed with the flat portion 2c, and a flange 2e continuously formed with the curved portion 2d, thereby forming a substantially a funnel shape. A communication hole 2f at an inner side of the tubular portion 2a is communicated to an inner portion of the fuel line portion 5.

[0023]

The respective flanges 1c, 2e of the top cover 1 and the lower cover 2 are fixed liquid-tightly by welding; thereby, a substantially annular plate-shaped enclosed room C inside the top cover 1 and the lower cover 2. In addition, fixation of the top cover 1 and the lower cover 2 by welding will be described in detail below. Moreover, the top cover 1 and the lower cover 2 extend in a direction perpendicular to a passing direction 9 (direction indicated by an arrow in Fig. 1) of the diesel fuel so as to form flattened

shapes short in the direction perpendicular to the passing direction 9 of the diesel fuel.

[0024]

The fuel line portion 5 is made of stainless steel with a thickness of about 3 mm and is formed into a pipe shape including a fuel passage A at the inner portion. Fuel line connecting portions 5a, 5b to which the fuel lines 24, 25 of metal are connected by welding or brazing are arranged at both ends of the fuel line portion 5. Further, the fuel line portion 5 is fixed to the tubular portion 2a of the lower cover 2 by welding or brazing.

[0025]

A metal diaphragm member 3 is provided so as to divide the enclosed room C into an upper gas-filling chamber B and a lower chamber C1. The chamber C1 is communicated via the communication hole 2f to the inner portion of the fuel line portion 5. The metal diaphragm member 3 extends along the passing direction 9 of the diesel fuel. A gas such as an argon gas or a helium gas is filled between the top cover 1 and the metal diaphragm member 3. The pressure absorption body 4 is configured by the metal diaphragm member 3 and the gas.

[0026]

A stainless steel plate with a thickness of about 0.15 mm to 0.25 mm is pressed to form the metal diaphragm member 3. The metal diaphragm member 3 includes a flat portion 3a at an intermediate portion, a curved portion 3b continuously formed with the flat portion 3a, and a flange 3c continuously formed with the curved portion 3b, thereby forming a substantially annular plate shape. The metal diaphragm member 3 and the

top cover 1 having substantially the same shape are arranged symmetrically with respect to a plane.

[0027]

Fixation of the top cover 1, the lower cover 2, and the metal diaphragm member 3 will be described. As shown in Fig. 2 (a), a welding portion 13 on a lower surface of the flange 1c and an upper surface of the flange 3c are welded; thereby, the top cover 1 and the metal diaphragm member 3 are integrally fixed to each other. A welding portion 23 on a lower surface of the flange 3c and an upper surface of the flange 2e are welded; thereby, the metal diaphragm member 3 and the lower cover 2 are integrally fixed to each other. Thus, the top cover 1, the lower cover 2, and the metal diaphragm member 3 are integrated with one another. In this case, the top cover 1 and the lower cover 2 are indirectly integrated with each other via the metal diaphragm member 3. In addition, the flange 1c, the flange 2e, and the flange 3c may be simultaneously welded to be fixed to one another. In addition, resistance welding or ultrasonic welding is appropriate but types of welding are no object.

[0028]

A modified example of fixation of the top cover 1, the lower cover 2, and the metal diaphragm member 3 will be described. As shown in Fig. 2 (b), a welding portion 13' on the lower surface of the flange 1c and the upper surface of the flange 3c are welded; thereby the top cover 1 and the metal diaphragm member 3 are integrally fixed to each other. A welding portion 12' on the lower surface of the flange 1c and the upper surface of the flange 2e are welded; thereby, the top cover 1 and the lower cover 2 are integrally

fixed to each other. In this case, the top cover 1 and the lower cover 2 are directly integrated with each other.

[0029]

When a fuel pressure equal to or greater than a predetermined pressure (for example, 0.7 MPa) acts on the pressure absorption body 4, the gas is compressed to elastically deform the metal diaphragm member 3. This elastic deformation reduces the volume of the gas-filling chamber B; therefore, a large volume of the diesel fuel is accommodated in the chamber C1. Thus, a pulsation involving a pressure peak can be reduced. The diaphragm thicknesses of the metal diaphragm member 3 and a gas filling pressure can be determined so as not to plastically deform the metal diaphragm member 3 when a maximum pressure peak generated from the high pressure pump 32 at downstream side acts on the pressure absorption body 4. In addition, the gas filling pressure is approximately equal to the predetermined pressure (for example, 0.7 MPa).

[0030]

The fuel line connecting portions 5a, 5b at the both ends of the fuel line portion 5 can be arranged by a plug-in connection (so-called in-line layout) in the fuel lines 24, 25 making a connection between the fuel tank 21 and the internal combustion engine 30; thereby, the layout flexibility, for example, in the direction in which the enclosed room C extends can be increased. Additionally, the top cover 1 and the lower cover 2 which accommodate the metal diaphragm member 3 can be formed at the outside of a high pressure pump housing 32a; therefore, the high pressure pump housing 32a can be downsized.

[0031]

In addition, the plug-in pulsation damper 10 is arranged in the fuel lines 24, 25 connecting the low pressure pump 22 and the high pressure pump housing 32a, therefore reducing an effect of a high pressure peak at a side closer to the low pressure circuit 20, i.e., in a wide area between the low pressure pump 22 and the high pressure pump housing 32a.

[0032]

Moreover, the plug-in pulsation damper 10 is an in-line type damper; therefore, the plug-in pulsation damper 10 can be utilized in various vehicle models and various models of internal combustion engines. For example, the plug-in pulsation damper 10 can be used in an internal combustion engine applied in two vehicle models and can be used in two different models of internal combustion engines applied in the same vehicle model.

[0033]

Further, when a pressure of the diesel fuel has reached a pressure equal to or greater than the predetermined pressure, the filled gas is compressed to elastically deform the metal diaphragm member 3. Accordingly, the metal diaphragm member 3 is simply configured and its maintenance is reduced. Further, the gas is filled between the metal diaphragm member and the top cover; therefore, the number of components is small and a simple configuration can be obtained.

[0034]

Furthermore, resistance to a high pressure peak can be obtained by the use of the metal diaphragm member 3. In addition, the top cover 1 and the lower cover 2 which accommodate the metal diaphragm member 3 can be

formed at the outside of the high pressure pump 32; thereby, the high pressure pump housing 32a does not grow in size.

[0035]

Moreover, the metal diaphragm member 3 is accommodated in the top cover 1 and the lower cover 2. Therefore, the diesel fuel leaks outside can be inhibited even in a case where the metal diaphragm member 3 bursts. In this case, the top cover 1 and the lower cover 2 have rigidities higher than that of the metal diaphragm member 3; thereby, the diesel fuel leaks outside can be surely inhibited.

[0036]

Further, the top cover 1 and the lower cover 2 have the flattened shapes short in a direction intersecting with the passing direction 9 of the diesel fuel; therefore, a length occupied by the top cover 1 and the lower cover 2 in a direction away from the fuel lines 24, 25 can be reduced. As a result, the cover portion hardly interferes with other components in an engine room and a structure less likely to be restricted in the layout of the fuel lines 24, 25 arranged between the internal combustion engine 30 and the fuel tank 21 can be offered.

[0037]

Furthermore, the gas is filled in the metal diaphragm member 3 and the top cover 1; therefore, the number of components is small and a simple configuration can be obtained.

[0038]

In addition, the metal diaphragm member 3 is fixed to the top cover 1 at a radially inner side from a portion at which the lower cover 2 is fixed

(directly or indirectly) to the top cover 1. Accordingly, the metal diaphragm member 3 does not interfere with the lower cover 2; therefore, a wide range of movement for the elastic deformation of the metal diaphragm member 3 can be secured. Moreover, as shown in Fig. 2 (b), the lower cover 2 and the metal diaphragm member 3 are directly connected to the top cover 1; thereby, the welding portions do not overlap with one another in the upward-downward direction; therefore, easy manufacturing can be attained.

[0039]

Moreover, the meal diaphragm member 3 includes a shape bulging to the fuel line portion 5, and the top cover 1 has a shape identical to the shape of the metal diaphragm member 3 and bulging in the opposite direction from the metal diaphragm member 3. Therefore, the top cover 1 and the metal diaphragm member 3 can be simply configured and easily manufactured. In addition, when shock wave acts on the metal diaphragm member 3, a pressure acts relatively evenly on the gas-filling chamber B of the top cover 1 and the metal diaphragm member 3. Due to this action, an unnecessarily deformation of the metal diaphragm member 3 does not easily occur when shock wave involving a low pressure peak acts on the metal diaphragm member 3.

[0040]

Further, the top cover 1 and the lower cover 2 are arranged at the upper side of a circumferential side of the fuel line portion 6, and an area in which protruding portions of the top cover 1 and the lower cover 2 do not exist is provided at the lower side of the top cover 1 and the lower cover 2. As a result, restriction in the layout of the fuel lines 24, 25 is reduced.

[0041]

Furthermore, the top cover 1, the lower cover 2, and the metal diaphragm member 3 are hermetically fixed to one other with the flanges 1c, 2e, 3c welded at the outer circumferential side. Therefore, pressure receiving portions (3a, 3b) can be secured to be large. In addition, components to be used can be reduced.

[0042]

Moreover, the top cover 1 and the metal diaphragm member 3 are hermetically fixed to each other with the flanges 1c, 3c welded at the outer circumferential side. Therefore, the pressure receiving portions 3a, 3b can secured to be large.

[0043]

Further, the top cover 1, the lower cover 2, and the metal diaphragm member 3 are formed by the same material of a stainless material, therefore being superior in corrosion resistance. In addition, an electrical potential difference is not generated between metals and electric corrosion is not easily generated.

Furthermore, if pressure is low, the top cover 1, the lower cover 2, and the metal diaphragm members 4, 5 can be formed by a material such as resin.

[Example 2]

[0044]

Next, the plug-in pulsation damper according to Example 2 will be described with reference to Fig. 4. Plug connecting portions 6a, 6b are arranged at both ends of a fuel line portion 6. A rubber fuel line (not shown)

is press-fitted and fixed to these plug connecting portions 6a, 6b. In addition, other configurations of Example 2 are the same as those of Example 1 and therefore will not be explained.

[Example 3]

[0045]

Next, the plug-in pulsation damper according to Example 3 will be described with reference to Fig. 5 and Fig. 6. In Example 3, the pressure absorption body 4, a fuel line portion 7, and a cover portion are mainly different from those of Example 1. Further, the same configurations as in Example 1 will not be explained.

[0046]

The plug-in pulsation damper 10 is mainly configured by a case 40 (cover portion), an adapter 42 (cover portion), the pressure absorption body 4, and the fuel line portion 7. The pressure absorption body 4 is configured by a gas-filling chamber 4A which is formed by a pair of metal diaphragm members 3A, 3B and a gas filled in the gas-filling chamber being at a predetermined pressure. Flanges at the outer circumferential side of the metal diaphragm members 3A, 3B are air-tightly connected to each other by welding. In Fig. 5, the flanges welded to each other are indicated by reference symbol 4B.

[0047]

The case 40 is formed by pressing a stainless steel plate with a thickness of about 2 mm into a substantially cup shape. The adapter 42 is made of a stainless material and is formed into a substantially circular plate shape. A circumferential end portion 40a of the case 40 is inserted in a

recessed portion 42a at the outer circumferential side of the adapter 42 and liquid-tightly fixed by welding 48 or the like to the adapter 42; thereby, the enclosed room C having a substantially column-shape is formed inside the case 40.

[0048]

The pressure absorption body 4 is positioned by a wave spring 44 for fixation (fixation spring) and a holder 46 in the enclosed room C so as to be fixed therein. The holder 46 is configured by a retaining portion 46 having a ring shape and eight leg portions 46b. A tongue-shaped section 46b' (only one tongue-shaped section shown in Fig. 6) extending radially inward from the retaining portion 46a is bent, thereby configuring the leg portion 46b. It is preferable that the wave spring 44 and the holder 46 are respectively fixed by spot welding to the flange 4B of the pressure absorbing body 4. One end of the wave spring 44 is inserted in a recessed portion 42c formed inside of a ring-shaped convex portion 42b of the adapter 42 so as to be positioned thereat. The leg portions 46b of the holder 46 are arranged along an inner circumferential corner portion of the case 40 so as to be positioned thereat. Thus, the pressure absorption body 4 is attached between the case 40 and the adapter 42 without loosening and rattling to be generated therebetween.

[0049]

A through hole 7c penetrating through the adapter 42 in a radial direction is formed in the adapter 42. Plug connecting portions 7a, 7b are attached by welding 48 to both ends of the through hole 7c; thereby, the fuel line portion 7 is formed. A through hole 42d perpendicular to the through hole 7c to be communicated from the case 40 to the through hole 7c is formed

in the adapter 42. This through hole 42d allows the fuel passage A and the enclosed room C to be communicated with each other. That is, the enclosed room C is formed so as to extend from the fuel line portion 7. When a fuel pressure greater than a predetermined pressure acts on the pressure absorption body 4, the gas is compressed and therefore the metal diaphragm members 3A, 3B are elastically deformed. Further, the wave spring may be arranged so as to be in contact with the case and the leg portions of the holder may be arranged so as to be in contact with the adapter.

[0050]

A through hole 42e penetrating through the adapter 42 in the thickness direction is formed in the adapter 42 and is positioned so as not interfere with the through hole 7c. A sensor 49 for measuring a fuel pressure in the enclosed room C is liquid-tightly arranged at this through hole 42e.

[0051]

As describe above, Examples of the present invention are described with reference to the drawings but the specific configuration is not limited to these Examples, and even modifications and alternations of the invention may be made without departing from the scope the invention.

[0052]

With regard to examples 1 and 2, the metal diaphragm member 3 fixed to the rigid top cover 1 is explained as an example of the pressure absorption body 4. Alternatively, a pressure absorption body configured in a manner that a gas is filled between metal diaphragm members may be applied. In this case, the pressure absorption body may be arranged in the

room C defined by the top cover 1 and the lower cover 2.

[0053]

Further, with regard to examples 1, 2 and 3, in addition to the plug-in pulsation damper 10, an additional damper may be arranged in the high pressure pump housing 32a.

[0054]

Furthermore, with regard to examples 1, 2 and 3, the pressure absorption body 4 utilizing the metal diaphragm member 3 and the gas is explained as an example but another member which can absorb a pressure of the diesel fuel may be applied.

[0055]

Further, with regard to example 3, an example where the through hole 42e is formed in the adapter 42 and the pressure sensor 49 is attached to the through hole 42e is explained above. Alternatively, the pressure sensor 49 may be attached to the top cover 1, the lower cover 2, or the case 40.

[0056]

Furthermore, with regard to examples 1, 2 and 3, the diesel fuel injection system and the damper used in the diesel fuel injection system are explained as an example in the foregoing Examples. Alternatively, the present invention can be applied to, for example, a gasoline injection system other than a diesel fuel injection system.

[Reference Signs List]

[0057]

1 top cover (cover portion)

2	lower cover (cover portion)
3	metal diaphragm member
4	pressure absorption body
5	fuel line portion
5a, 5b	fuel line connecting portion
6	fuel line portion
6a, 6b	fuel line connecting portion
7	fuel line portion
7a, 7b	fuel line connecting portion
9	passing direction of fuel
10	plug-in pulsation damper (damper)
20	low pressure circuit
21	fuel tank
22	low pressure pump
24, 25	fuel line
30	internal combustion engine
32	high pressure pump
32a	high pressure pump housing
36	injectors
40	case (cover portion)
42	adapter (cover portion)
44	wave spring (fixation spring)
46	holder
A	fuel passage
B	gas-filling chamber

C enclosed room

C1 chamber

c1, c2 communication hole

[Claims]

[Claim 1]

A fuel injection system, comprising:

a low pressure pump (22) feeding a fuel from a fuel tank (21);

a high pressure pump (32) feeding the fuel to injectors (36) of an internal combustion engine (30); and

a fuel line (24, 25) connecting the low pressure pump (22) and the high pressure pump (32),

wherein a damper (10) is further arranged in and fixed to the fuel line (24, 25), the damper (10) including a fuel line portion (5, 6) which has both ends provided with a pair of fuel line connecting portions (5a, 5b, 6a, 6b, 7a, 7b) connected to the fuel line (24, 25) and which has an inner portion allowing passage of the fuel; a cover portion (1, 2, 40. 42) forming an enclosed room (C) arranged to extend from the fuel line portion (5, 6, 7); and a pressure absorption body (4) arranged in the enclosed room (C).

[Claim 2]

The fuel injection system according to claim 1, wherein the cover portion (1, 2) includes a flattened shape short in a direction intersecting with a passing direction (9) of the fuel.

[Claim 3]

A damper comprising:

a fuel line portion (5, 6, 7) provided with fuel line connecting portion (5a, 5b, 6a, 6b, 7a, 7b) at both ends and including an inner portion allowing passage of a fuel;

a cover portion (1, 2, 40, 42) forming an enclosed room (C) arranged

to extend from the fuel line portion (5, 6, 7); and

a pressure absorption body (4) arranged in the enclosed room (C),

wherein the cover portion (1, 2, 40, 42) and the pressure absorption body (4) are arranged to extend along a passing direction (9) of the fuel.

[Claim 4]

The damper according to claim 3, wherein the cover portion (1, 2) is configured by a lower cover (2) connected to the fuel line portion (5, 6) and a top cover (1) connected to the lower cover (2), and

wherein the pressure absorption body (4) arranged in the enclosed room (C) is configured by a gas-filling chamber (B) formed by a metal diaphragm member (3) and the top cover (1), and a gas filled in the gas-filling chamber and being at a predetermined pressure.

[Claim5]

The damper according to claim 3 or 4, wherein the pressure absorption body (4) is configured by a gas-filling chamber (4A) formed by a pair of metal diaphragm members (3A, 3B) and a gas filled in the gas-filling chamber (4A) and being at a predetermined pressure, and

wherein one end of the pressure absorption body (4) is positioned via a holder (46) to the cover portion (40, 42) and the other end of the pressure absorption body (4) is positioned via a fixation spring (44) to the cover portion (40, 42) and is fixed thereto.

[Claim 6]

The damper according to one of claims 3 to 5, wherein the fuel line connecting portion (5a, 5b) is shaped to be connected to a metal fuel line by

welding or brazing.

[Claim 7]

The damper according to one of claims 3 to 5, wherein the fuel line connecting portion (6a, 6b, 7a, 7b) includes a connecting plug to be inserted in a rubber fuel line.

Fig. 1

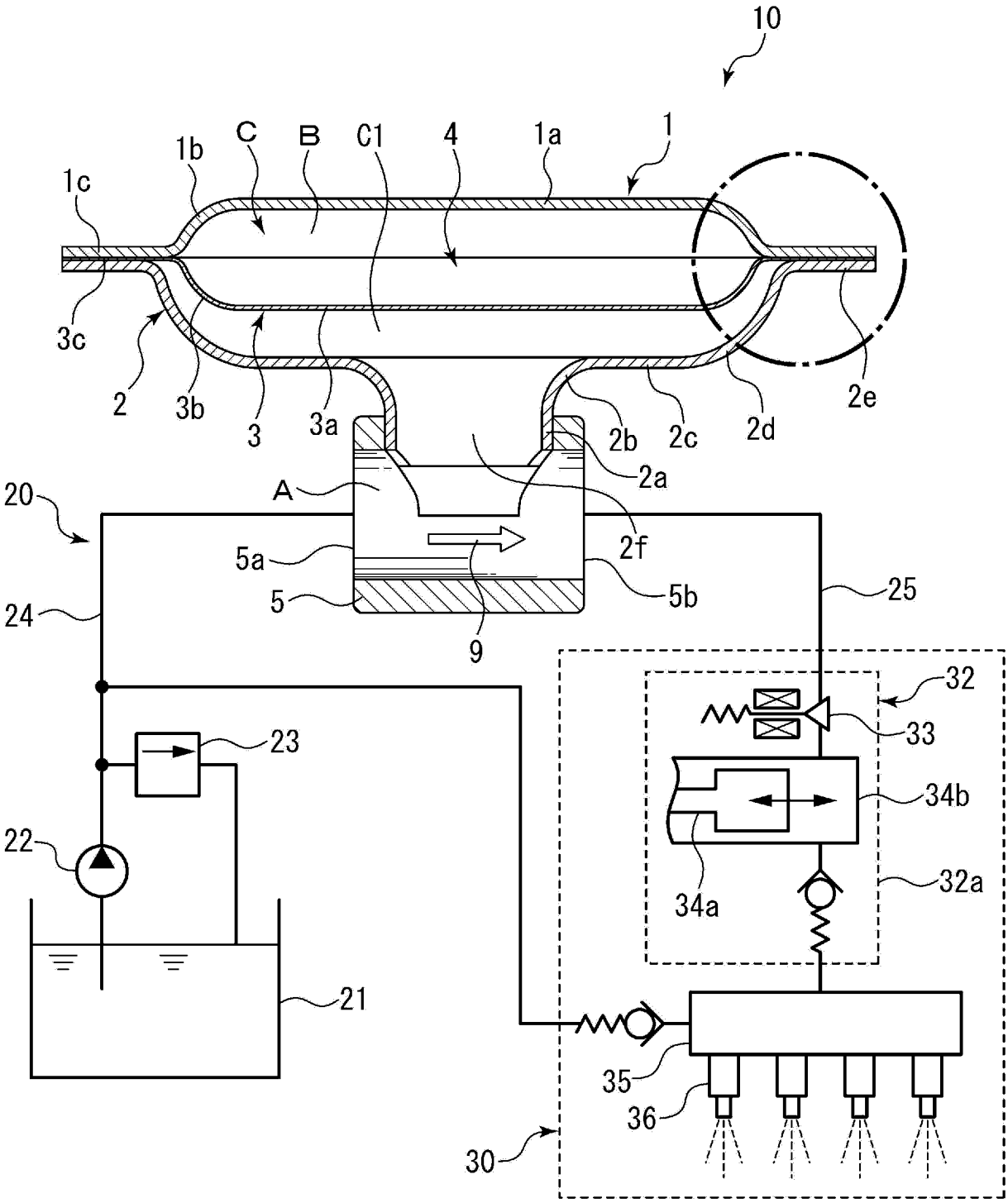

10
1
1a
1b
1c
C
B
C1
4
3c
2
3b
3
3a
2b
2c
2d
2e
2a
A
20
2f
5a
5
5b
24
25
9
32
33
34b
34a
32a
23
22
21
35
36
30

Fig. 2

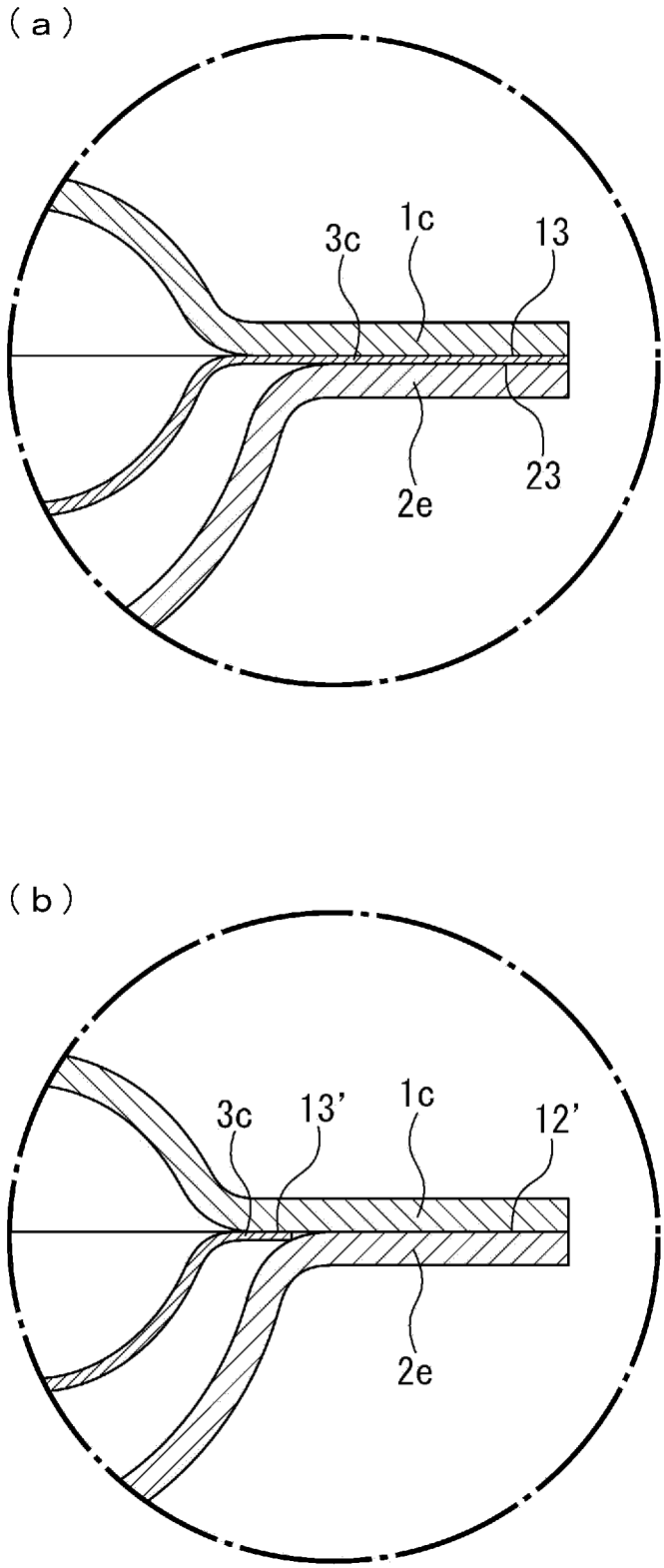


Fig. 3

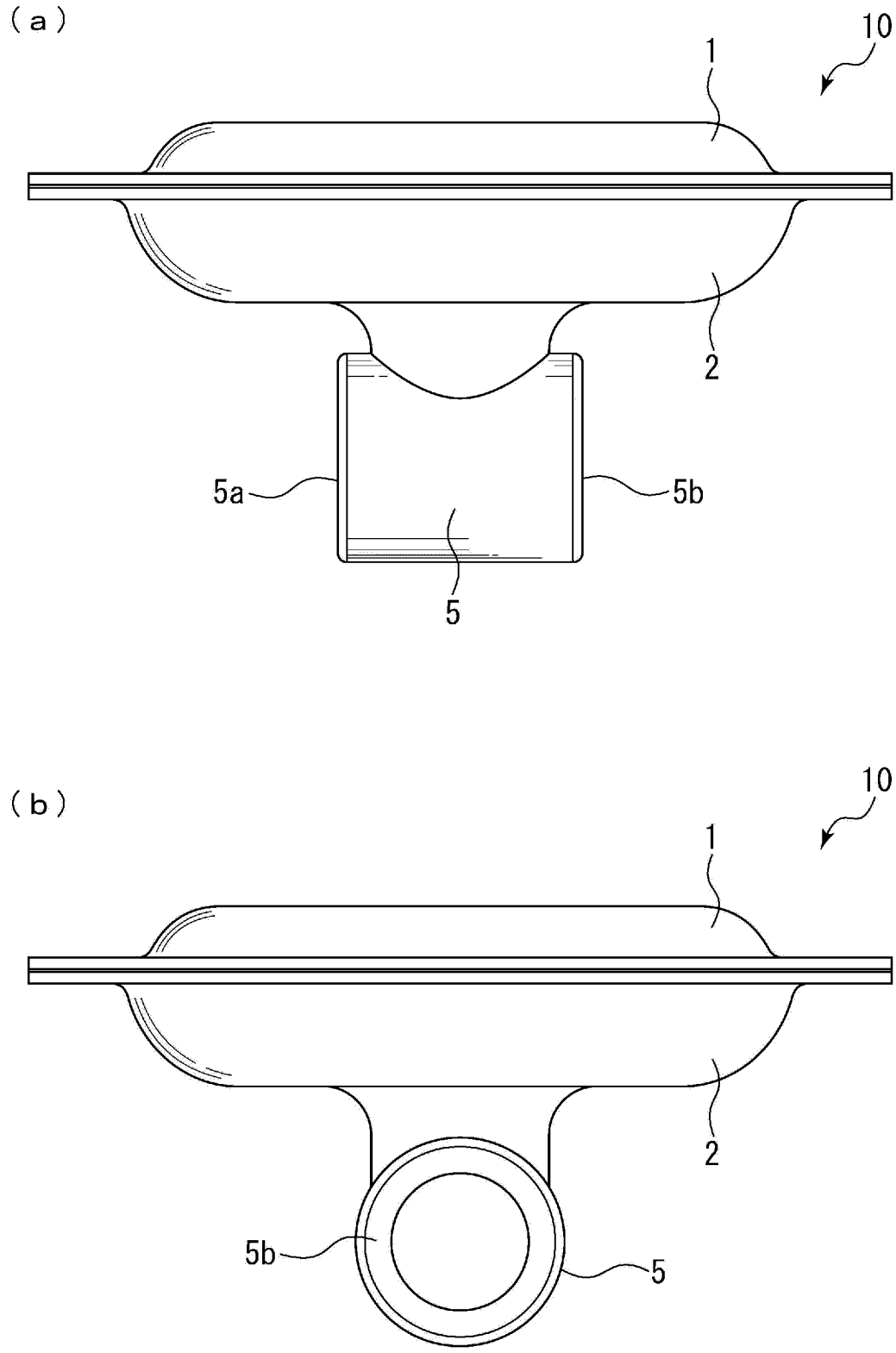


Fig. 4

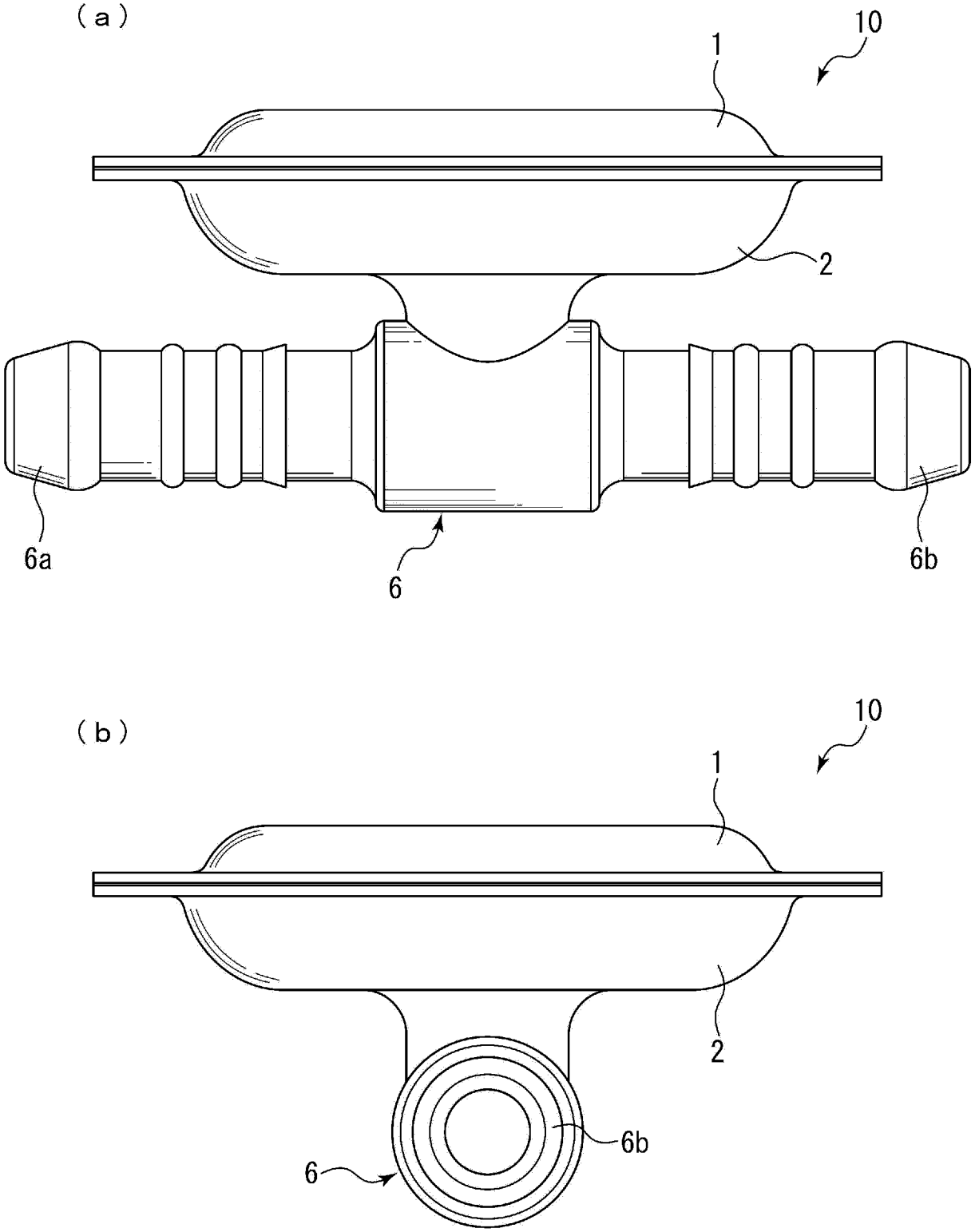
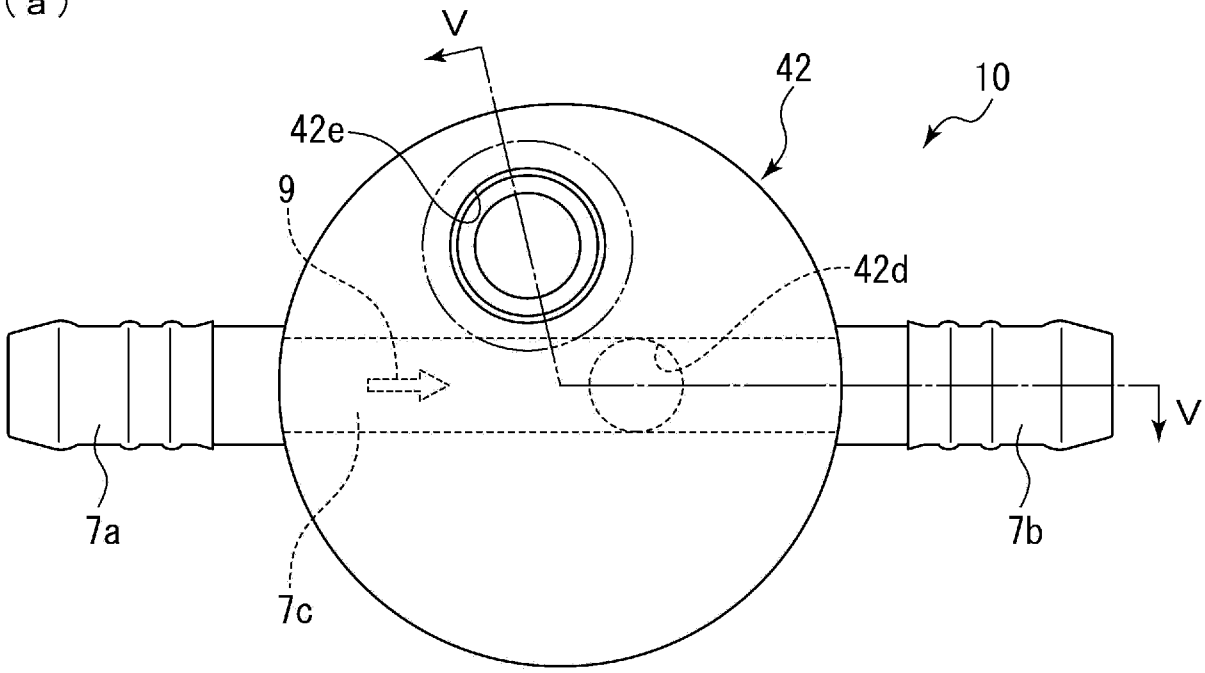


Fig. 5

(a)


V
42
10
42e
9
42d
V
7a
7b
7c

(b)

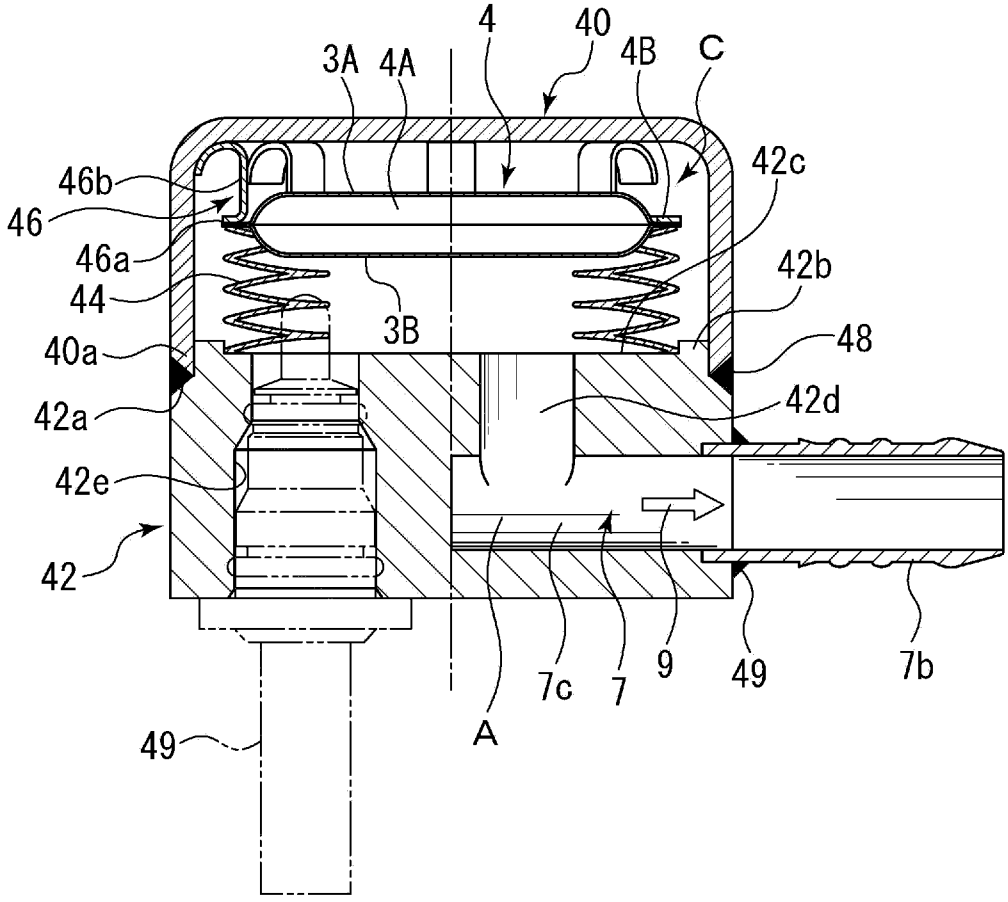

4
40
3A
4A
4B
C
42c
46b
46
46a
42b
44
3B
48
40a
42d
42a
42e
42
49
7b
7c
7
9
49
A

Fig. 6

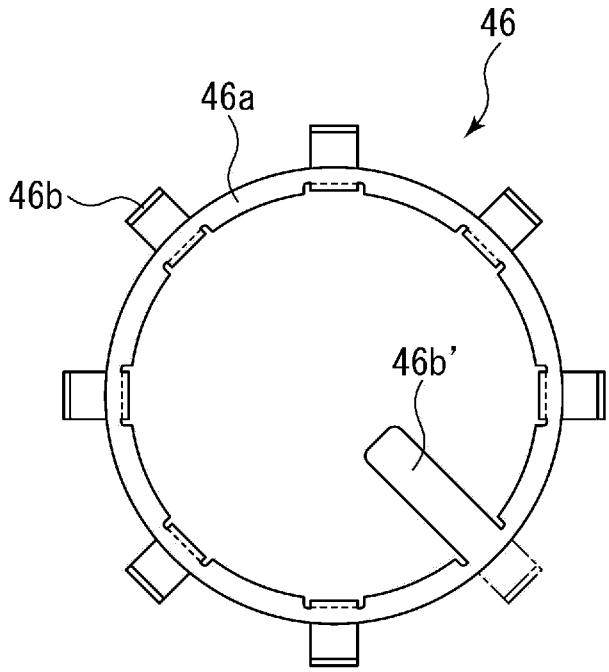
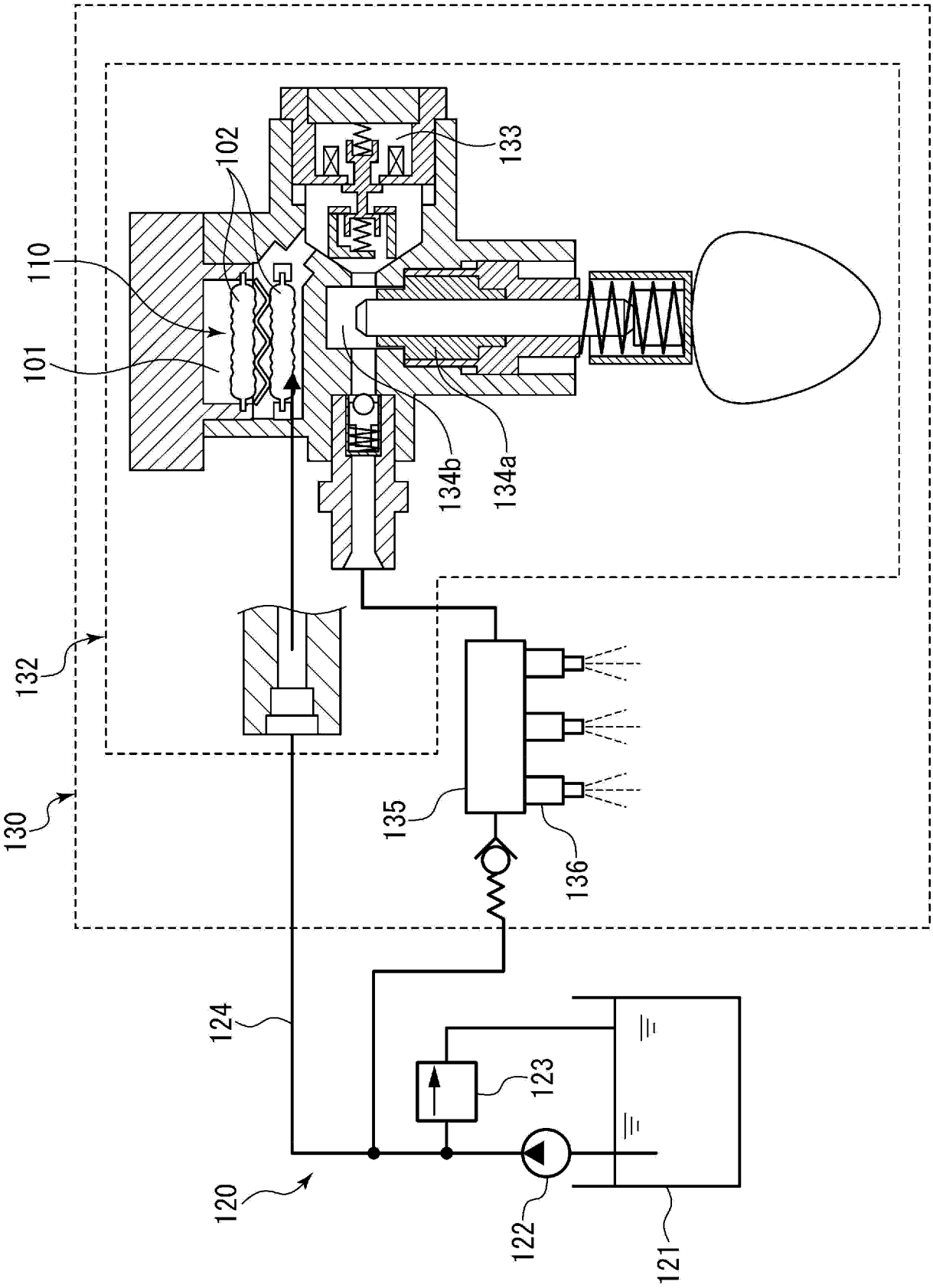


Fig. 7



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/058894

A. CLASSIFICATION OF SUBJECT MATTER
INV. F02M55/04 F02M37/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F02M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1 411 236 A2 (BOSCH GMBH ROBERT [DE]) 21 April 2004 (2004-04-21) figures 1-12	1-7
X	US 5 505 181 A (MCRAE KENNETH J [US] ET AL) 9 April 1996 (1996-04-09) figures 1,2	1-7
X	DE 33 26 995 A1 (BOSCH GMBH ROBERT [DE]) 7 February 1985 (1985-02-07) figure 1	1-7
X	DE 10 2004 002489 A1 (BOSCH GMBH ROBERT [DE]) 11 August 2005 (2005-08-11) figures 1-5	1-7

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23 May 2016	31/05/2016

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Morales Gonzalez, M

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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PCT/EP2016/058894

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