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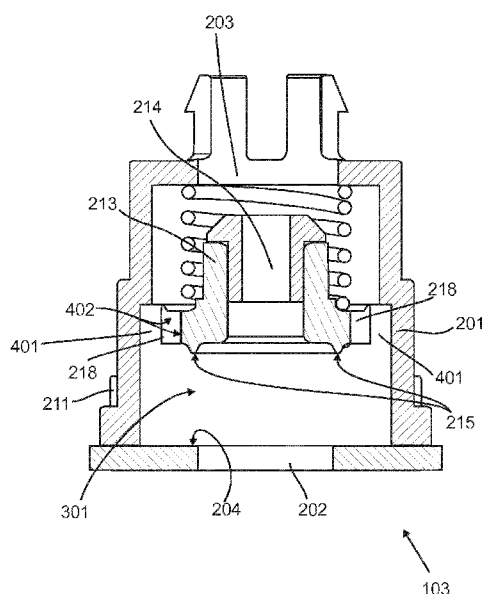


Fig. 5

(57) Abstract: A valve (103, 103A, 103B) for restricting fluid flow, an internal combustion engine 101 comprising a valve (103, 103A, 103B) and a vehicle (150) are disclosed. The valve (103, 103A, 103B) comprises an outer part (201, 201A, 201B) defining a first port (202) for allowing fluid flow through the valve (103, 103A, 103B), a second port (203) for allowing fluid flow through the valve (103, 103A, 103B), and a first sealing surface (204) surrounding the first port (202). The valve (103, 103A, 103B) also includes an inner part (213, 213A, 213B) located inside the outer part (201, 201A, 201B), the inner part (213, 213A, 213B) defining a first passageway (214) to enable fluid to flow between the first port (202) and the second port (203), a plurality of second passageways (401, 401A, 401B) to enable fluid to flow between the first port (202) and the second port (203), and a second sealing surface (215) surrounding an end (216) of the first passageway (214). The inner part (213, 213A, 213B) is moveable between a first position and a second position.



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In the first position, proximity of the second sealing surface (215) to the first sealing surface (204) is arranged to prevent fluid flow via the second passageways (401, 401A, 401B). In the second position, a gap (301) between the first sealing surface (204) and the second sealing surface (215) enables fluid flow between the first port (202) and the second port (203) via the gap (301) and the second passageways (401, 401A, 20 401B).

A VALVE, AN INTERNAL COMBUSTION ENGINE AND A VEHICLE

TECHNICAL FIELD

5 The present disclosure relates to a valve, an internal combustion engine and a vehicle. In particular, but not exclusively it relates to a valve for restricting flow of fluid in an internal combustion engine for a vehicle.

Aspects of the invention relate to a valve, an internal combustion engine and a vehicle.

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BACKGROUND

During operation of an internal combustion engine, some of the gases from the combustion leak past the piston rings to end up inside the crankcase. This leakage of gases is commonly referred to as "blow-by". These gases could cause a buildup of pressure in the crankcase, but it is known to provide a crankcase ventilation system to allow the gases to escape in a controlled manner from the crankcase. To control the escape of the gases, the crankcase ventilation system comprises a PCV (positive crankcase ventilation) valve that allows gases to be vented to the air intake side of the engine.

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The blow-by introduces water vapour and combustion by-products into the crankcase, which tend to reduce engine oil quality. Consequently, it is also known for the crankcase ventilation system to provide a flow of fresh air into the crankcase to purge the crankcase at idle and low speed load conditions. The fresh air is provided from the engine's air filter through a crankcase breather and the purged gases are swept away via the PCV valve into the intake manifold of the engine. Because the fresh air that is introduced in this way bypasses the throttle, it needs to be controlled to ensure that it does not adversely affect engine idle stability. To provide the required control, the fresh air may be provided via a throttle idle flow control (TIFC) valve which restricts the rate of flow of air into the crankcase when the engine is operating under low load and idle conditions.

30

During full load conditions the flow in the breather reverses and gases caused by the blow-by escape via the breather as well as the PCV valve. During such times the TIFC valve is in a more open configuration that provides less restriction to flow. A problem with existing TIFC

valves is that the gases resulting from blow-by cause carbon deposit to build up in the TIFC valve and the carbon deposit can cause the TIFC valve to stick in the more open configuration, which leads to instability of the engine during idle conditions.

- 5 A second problem with existing TIFC valves is that in cold weather water vapour may condense and freeze in the valve and prevent it from operating correctly.

It is an aim of the present invention to address disadvantages of the prior art TIFC valves.

10 SUMMARY OF THE INVENTION

Aspects and embodiments of the invention provide a valve, an internal combustion engine and a vehicle as claimed in the appended claims.

- 15 According to an aspect of the invention there is provided a valve for restricting flow of fluid, the valve comprising: an outer part defining a first port for allowing fluid to flow through the valve, a second port for allowing fluid to flow through the valve, and a first sealing surface surrounding the first port; and an inner part located inside the outer part, the inner part defining a first passageway to enable fluid to flow between the first port and the second port, a plurality
20 of second passageways to enable fluid to flow between the first port and the second port, and a second sealing surface surrounding an end of the first passageway; wherein the inner part is moveable between: a first position in which proximity of the second sealing surface to the first sealing surface is arranged to prevent fluid flowing via the second passageways; and a second position in which a gap between the first sealing surface and the second sealing
25 surface enables fluid to flow between the first port and the second port via the gap and the second passageways.

This provides the advantage that carbon deposits that build up and prevent correct operation of the valve is prevented.

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One or both of the first sealing surface and the second sealing surface may comprise a ridge which can be brought into contact with the other of the first sealing surface and the second sealing surface to form the seal. Where one of the first sealing surface and the second sealing surface comprises a ridge, the other of the first sealing surface and the second sealing surface

may comprise a substantially planar portion against which a peak of the ridge abuts to form the seal.

5 In some embodiment the first port and the second port are collinear. The second port and the first passageway may be collinear.

In some embodiments at least one of the second passageways is defined by an outer surface of the inner part and an inner surface of the outer part.

10 In some embodiments the inner part is urged towards the first position by a spring means. This provides the advantage that a relatively large force may be used to return the inner part to the first position when compared to prior art arrangements, which rely on gravity and the weight of the inner part. Consequently, the action of carbon deposits that build up within the valve may be generally overcome by the action of the spring means.

15 In some embodiments the spring means comprises a spring. The spring may be a helical spring. An advantage of a helical spring is that it may also be used to provide a degree of stability to the orientation of the inner part within the outer part of the valve.

20 In some embodiments a supporting surface of the inner part is arranged to maintain the orientation of the helical spring with respect to the inner part.

In some embodiments the valve is arranged to: enable fluid to flow from the second port to the first port via the first passageway only; and enable fluid to flow from the first port to the second
25 port via the first passageway and the second passageways. This provides the advantage that the valve is able to provide a first resistance to flow in one direction and a smaller resistance to flow in the other direction.

The inner part may be arranged to be moved to the second position by pressure of the fluid.
30 This provides the advantage that the pressure of the fluid is able to switch the valve from one configuration in which the valve is able to provide a first resistance to flow to a second configuration in which it provides a smaller resistance to flow. This may be advantageous when a valve is required to provide a first resistance to flow in one direction and a smaller resistance to flow in the other direction, or when a valve is required to provide a first resistance

to flow in a particular direction when pressure across the valve is small and to provide less resistance to flow when pressure across the valve is increased.

5 In some embodiments the inner part comprises a main body defining the first passageway and a plurality of arms extending from the main body; a second passageway is defined between two of the arms; and a distal surface of the arms is arranged to slide over an inner surface of the outer part. This provides the advantage that the surfaces of the arms which define the second passageways may be generally relatively widely spaced from the inner surface of the outer part. Consequently, when used in a crankcase ventilation system, the surfaces of the arms which define the second passageways are unlikely to become connected to the inner surface of the outer part by a buildup of carbon deposit that would prevent the correct operation of the valve.

15 Each of the second passageways may be defined by two of the plurality of arms and an inner surface of the outer part. This provides the advantage that the surfaces of the arms and the inner surface of the outer part, which define the second passageways, may be generally relatively widely spaced from each other and therefore unlikely to become connected by a buildup of carbon deposit when the valve is used in a crankcase ventilation system.

20 The distal surface of the arms may have a sufficient length along the inner surface of the outer part to maintain the orientation of the inner part within the outer part. This provides the advantage of negating the need for additional means for maintaining the orientation of the inner part.

25 The inner part may comprise at least three arms and the arms in combination with an inner surface of the outer part define at least three second passageways. Having at least three arms provides the advantage of good stability for the orientation of the inner part.

In some embodiments the inner surface may have a cylindrical shape.

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The outer part may define an internal shoulder to limit movement of the inner part away from the first position and the arms may define contact surfaces arranged to contact the inner shoulder when the inner part is in a second position.

The contact surfaces may be defined by ridges formed on the arms. This provides the advantage of a small contact surface area between the arms and the outer part.

5 In some embodiments the outer part defines an internal shoulder to limit movement of the inner part away from the first position.

In some embodiments the inner part comprises: a first component defining the second sealing surface and the second passageways; and a second component which defines the bore of the first passageway. This provides the advantage that the resistance to flow may be changed by
10 changing the second component for one with different dimensions.

In some embodiments the outer part comprises barbed fingers surrounding the second port for connecting the valve to an engine cam cover.

15 According to another aspect of the invention there is provided an internal combustion engine comprising an engine cam cover and valve in accordance with any one the preceding paragraphs arranged to enable fluid to flow from, and to, the inside of the engine cam cover.

In some embodiments of the internal combustion engine, the outer part of the valve comprises a housing containing the inner part and the housing is located within the engine cam cover.
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This provides the advantage that the inner part of the valve within the housing is kept relatively warm by being positioned within the engine cam cover. Consequently, freezing of water within the valve is avoided.

25 The outer part may comprise a connection means at the second port and the connection means may connect the housing to a hole formed in the engine cam cover. The connection means may extend through the hole formed in the engine cam cover. This provides the advantage that the engine cam cover may be formed with a simple hole to which the valve is connectable.

30 The valve may be for controlling fluid flow through a breather hose of an internal combustion engine of a vehicle.

Within the scope of this application it is expressly intended that the various aspects, embodiments, examples and alternatives set out in the preceding paragraphs, in the claims and/or in the following description and drawings, and in particular the individual features thereof, may be taken independently or in any combination. That is, all embodiments and/or features of any embodiment can be combined in any way and/or combination, unless such features are incompatible. The applicant reserves the right to change any originally filed claim or file any new claim accordingly, including the right to amend any originally filed claim to depend from and/or incorporate any feature of any other claim although not originally claimed in that manner.

BRIEF DESCRIPTION OF THE DRAWINGS

One or more embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Fig. 1 shows an internal combustion engine 101 of a vehicle 150;

Fig. 2 shows a cross-sectional side view through the valve 103 through a plane "B" identified in Fig. 4, with the inner part 213 of the valve 103 in a first position;

Fig. 3 shows a cross-sectional side view through the valve 103 through a plane "B" identified in Fig. 4, with the inner part 213 of the valve 103 in a second position;

Fig. 4 shows a cross-sectional bottom view through the valve 103 through a plane "A" identified in Fig. 3;

Fig. 5 shows another cross-sectional view through the valve 103 through a plane "C" identified in Fig. 4, with the inner part 213 of the valve 103 in a second position;

Fig. 6 shows a cross-sectional view of the valve 103 and part of an engine cam cover 102 in which the valve 103 is installed;

Fig. 7 shows an exploded view of the valve 103, which illustrates the method of assembly of the valve;

Fig. 8 shows a cross-sectional side view of an alternative valve 103A, with the inner part 213A of the valve 103A in a second position;

Fig. 9 shows a cross-sectional bottom view of the valve 103A;

Fig. 10 shows a cross-sectional side view of the valve 103A, with the inner part 213A of the valve 103A in a first position;

Fig. 11 shows a cross-sectional side view of another alternative valve 103B, with the inner part 213B of the valve 103B in a second position;

Fig. 12 shows a cross-sectional bottom view of the valve 103B; and

Fig. 13 shows a cross-sectional side view of the valve 103B, with the inner part 213B of the valve 103B in a first position.

5 DETAILED DESCRIPTION

The Figures illustrate a valve 103, 103A, 103B for restricting fluid flow, the valve 103, 103A, 103B comprising: an outer part 201, 201A, 201B defining a first port 202 for allowing fluid flow through the valve 103, 103A, 103B, a second port 203 for allowing fluid flow through the valve 103, 103A, 103B, and a first sealing surface 204 surrounding the first port; and an inner part 10 213, 213A, 213B located inside the outer part 201, 201A, 201B, the inner part 213, 213A, 213B defining a first passageway 214 to enable fluid to flow between the first port 202 and the second port 203, a plurality of second passageways 401, 401A, 401B to enable fluid to flow between the first port 202 and the second port 203, and a second sealing surface 215 surrounding a first end of the first passageway 214; wherein the inner part 213, 213A, 213B is 15 moveable between: a first position in which proximity of the second sealing surface 215 to the first sealing surface 204 is arranged to prevent fluid flow via the second passageways 401, 401A, 401B; and a second position in which a gap 301 between the first sealing surface 204 and the second sealing surface 215 enables fluid flow between the first port 202 and the second port 203 via the gap 301 and the second passageways 401, 401A, 401B.

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An internal combustion engine 101 of a vehicle 150 is shown in Fig. 1. The engine 101 in the present example is a gasoline (i.e. petrol) internal combustion engine. The engine 101 comprises an engine cam cover 102 and a valve 103 arranged to enable fluid to flow from, and to, the inside of the engine cam cover 102. The valve 103 is connected via a breather 25 hose 104 to an outlet duct 105 of an air box 106 containing an air filter. The valve 103 may be referred to as a throttle idle flow control valve.

The outlet duct 105 of the air box 106 is arranged to provide fresh air to the intake manifold 107 of the engine 101 via a throttle valve 108.

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The engine 101 also has a PCV (positive crankcase ventilation) valve 109 arranged to allow relief of pressure in the crankcase caused by gases leaking past the piston rings (i.e. by “blow-by”). The PCV valve 109 enables a flow of gases from the engine cam cover 102 to the intake manifold 107 of the engine 101, possibly via a turbocharger or supercharger (not shown).

When the engine 101 is operating at high load conditions, gases are allowed to escape via the PCV valve 109 to the intake manifold 107 and also via the valve 103 to the duct 105. During these conditions the valve 103 is in a relatively open configuration in which it provides
5 relatively less resistance to flow of fluid. When the engine 101 is operating at low load conditions, gases are allowed to escape via the PCV valve 109 to the intake manifold 107 but the relatively high vacuum at the intake manifold 107 causes fresh air to be drawn into the engine cam cover 102 through the valve 103. In this way, at low load conditions, the fresh air that is drawn through the engine 101 purges the engine crankcase of water vapour and
10 combustion by-products. During this process the valve 103 is in a relatively closed configuration in which it provides relatively greater resistance to fluid flow.

In the example of Fig. 1, the engine 101 is a "V engine" having two banks of cylinders arranged in a V shape. The PCV valve 109 is arranged to enable gases to escape from the engine cam
15 cover 102A of the first bank of cylinders and the valve 103 is arranged to enable gases to escape from, and enable fresh air to be supplied to, the engine cam cover 102B of the second bank of cylinders. However, in other embodiments the engine 101 is a straight or inline engine and the PCV valve 109 and the valve 103 are connected to the same engine cam cover 102.

Cross-sectional views of the valve 103 are shown in Figs. 2, 3, 4 and 5. Fig. 4 shows a bottom
20 cross-sectional view through the valve 103 perpendicular to its centre line 250 and through a plane "A" identified in Fig. 3. Figs. 2 and 3 each show a side cross-sectional view through the valve 103 through a plane "B" identified in Fig. 4 and containing the centre line 250 of the valve 103. Fig. 5 shows a cross-section through the valve 103 through a plane "C" identified in Fig.
25 4 and containing the centre line 250 of the valve 103.

The valve 103 comprises an outer part 201 that defines a first port 202 for allowing fluid to flow through the valve 103, a second port 203 for allowing fluid to flow through the valve 103, and
30 a first sealing surface 204 surrounding the first port 202. The outer part 201 may comprise a housing 205 having the first port 202 at one end and the second port 203 at the opposite end. The first port 202 and the second port 203 may be collinear and each port 202, 203 may be circular.

Connection means 206 may be provided at the second port 203 to enable connection of the valve 103 to an engine cam cover (102 in Figs. 1 and 6) as will be described in further detail below. The connection means 206 may comprise circularly arranged barbed fingers 206A that surround the second port 203 and allow connection to an engine cam cover by clipping the
5 fingers 206A into a circular hole (603 in Fig. 6) in the engine cam cover. In alternative embodiments, alternative connection means may be provided. For example, the barbed fingers 206A may be replaced by a cylindrical tube that defines a thread for receiving a threaded nut, or the connection may be achieved by welding, such as vibration welding or gas welding.

10 The outer part 201 may be formed of two components. A first component 207 of the outer part 201 may have an inner surface 208 defining at least a part of a chamber 209 within the outer part 201. This first component 207 may also define the second port 203. A second component 210 of the outer part 201 may provide an end wall of the chamber 209 and define the first port
15 202. The second component 210 of the outer part 201 may be attached to the first component 207 of the outer part 201 by attachment means such as sprung barbed fingers 211 which are arranged to clip over a flange 212 provided at the end of the first component 207. Alternatively the second component 210 may be attached to the first component 207 by a screw threaded connection, or fasteners such as screws or rivets, or adhesive, or other suitable means of
20 attachment.

The valve 103 also includes an inner part 213 located inside the outer part 201. The inner part 213 defines a first passageway 214 to enable fluid to flow between the first port 202 and the second port 203 of the outer part 201. The first passageway 214 may have a circular cross-
25 section, as shown in Fig. 4 and the first passageway 214 and the second port 203 may be collinear.

The inner part 213 also defines a plurality of second passageways 401 (shown in Figs. 4 and 5) to enable fluid to flow between the first port 202 and the second port 203 of the outer part
30 201, and a second sealing surface 215 surrounding a first end 216 of the first passageway 214.

The inner part 213 is moveable between a first position illustrated in Fig. 2 and a second position illustrated in Figs. 3, 4 and 5. In the first position, the second sealing surface 215 is

arranged to reside in close proximity to the first sealing surface 204 so that the close proximity of the second sealing surface 215 to the first sealing surface 204 resists flow of fluid via the second passageways 401 (shown in Figs. 4 and 5). In the first position, the second sealing surface may butt against the first sealing surface 204 to prevent flow of fluid via the second passageways 401. The second sealing surface 215 may comprise an annular surface, defined by a peak of a circular ridge formed on the inner part 213 around the first end 216 of the first passageway 214, which abuts the first sealing surface 204 surrounding the first port 202. By providing the second sealing surface 215 at the peak of a ridge enables the area of contact between the sealing surfaces 204 and 215 to be kept relatively small, so that the possibility of the inner part 213 sticking in the first position is minimised.

It will be appreciated that a circular ridge may be provided on the outer part 201 instead of the inner part 213. Thus, in an alternative embodiment, the outer part 201 is provided with a first sealing surface 204 comprising an annular surface defined by a peak of a circular ridge that butts against a relatively flat second sealing surface 215 on the inner part 213.

When the inner part 213 is in the second position, shown in Fig. 3, 4 and 5, a gap 301 is formed between the first sealing surface 204 and the second sealing surface 215 that enables fluid flow between the first port 202 and the second port 203 via the gap 301 and the second passageways 401.

At least one of the second passageways 401 may be defined by an outer surface 402 of the inner part 213 and the inner surface 208 of the outer part 201. As shown in Figs. 4 and 5, all of the second passageways 401 may be defined by an outer surface 402 of the inner part 213 and the inner surface 208 of the outer part 201. The inner part 213 may comprise a main body 217, which defines the first passageway 214, and a plurality of arms 218 that extend from the main body 217. A second passageway 401 may be defined between two of the arms 218. That is, a space between an arm 218 and a neighbouring arm 218 provides one of the second passageways. The inner part 213 may have four arms 218 and a corresponding four second passageways 401 as shown in Fig. 4, but in alternative embodiments the inner part 213 has just three arms 218 and three second passageways 401 or more than four arms 218 and a corresponding number of second passageways 401.

The arms 218 may each have a distal surface 219 that is shaped to provide a sliding fit of the inner part 213 within the inner surface 208 of the outer part 201. For example, the inner surface 208 of the outer part 201 may be cylindrical and the distal surfaces 219 of the arms 218 may follow a cylindrical surface of slightly smaller diameter than the inner surface 208. The distal surface 219 of the arms 218 may have a sufficiently long length along the inner surface 208 of the outer part 201 to maintain the orientation of the inner part 213 within the outer part 201. That is, the inner part 213 may be oriented to have a central axis that is parallel to its direction of movement within the outer part 201, and the distal surfaces 219 of the arms 218 may be sufficiently long so as to prevent the central axis of the inner part 213 from forming an angle with the direction of movement.

As shown in Fig. 4, the arms 218 in combination with an inner surface 208 of the outer part 201 define the second passageways 401. However, alternative embodiments may be envisaged in which the inner part 213 includes an outer ring connecting the distal ends of the arms 218. (Such an example is described below with regard to Figs. 11 to 13.) In such a case the inner surface 208 of the outer part 201 may not be considered to define the second passageways.

The outer part 201 may define an internal shoulder 220 to provide a stop that limits movement of the inner part 213 away from the first position. The arms 218 may be arranged to abut the internal shoulder 220 when the inner part 213 is in the second position shown in Fig. 3, 4 and 5, and the arms 218 may define contact surfaces 221 arranged to contact the inner shoulder 220. The contact surface 221 on an arm 218 may be provided by a peak of a ridge formed on the arm 218 or the peaks of several bumps formed on the arm 218. In this way, the area of contact between the arms 218 and the shoulder 220 may be kept relatively small to reduce the chance of the arms 218 becoming stuck to the shoulder 220.

The inner part 213 may comprise two components. A first component 222 of the inner part 213 may define the second sealing surface 215 and the second passageways 401 and a second component 223 of the inner part 213 may define the size of the bore of the first passageway 214. The first component 222 may define an orifice and the second component 223 may have an outer surface configured to be a good fit within the orifice. The second component 223 may define a hole 224 that provides at least a part of the first passageway 214. The hole 224 within the second component 223 may be arranged to provide the greatest

resistance to flow through the first passageway 214 and therefore the resistance to flow through the first passageway 214 may be adjusted by replacing the second component 213 with a different second component 223 having a differently sized hole 224.

- 5 The valve 103 may also comprise a spring means 226 configured to urge the inner part 213 towards the first position shown in Fig. 2. The spring means 226 may comprise a spring, such as a helical spring. The spring 226 may be dimensioned such that it is compressed when the inner part 213 is in its first position, shown in Fig. 2, and therefore the spring 226 may cause the second sealing surface 215 on the inner part 213 to be pushed against the first sealing
10 surface 204 on the outer part 201. The spring 226 is further compressed when the inner part 213 is moved to the second position shown in Figs. 3, 4 and 5.

The spring means 226 may be arranged to apply forces all around the main body 217 of the inner part 213 and in this way it assists the arms 218 to provide stability to the orientation of
15 the inner part 213, as well as performing the function of urging the inner part 213 towards the first position.

The inner part 213 may have a supporting surface 225 that is dimensioned to be a good fit within the helical spring 226 and therefore maintain the orientation of the helical spring 226
20 relative to the inner part 213 and outer part 201. The helical spring 226 may have a diameter that is larger than the diameter of the second port 203 and it may be positioned so that it surrounds the second port 203. The helical spring 226 may also have sufficiently large coil spacing so that when the spring 226 is at its most compressed (when the inner part 213 is in the second position) the spacing between adjacent coils enables fluid to flow through the valve
25 103 via the second passageways 401.

In an alternative embodiment, the valve 103 is not provided with a spring means 226 and the inner part 213 is urged into its first position by the weight of the inner part 213. However, in
30 embodiments that include a spring means 226, the valve 103 may be oriented at angles to vertical without affecting the correct operation of the valve 103. Also, the force provided by the spring means 226 may be made relatively strong compared to the weight of the inner part 213, and therefore the inner part 213 is less likely to become stuck in the second position when a spring means 226 is included.

During operation of the engine 101 at low load conditions, the valve 103 allows fresh air to flow through the second port 203 to the first port 202 and through the first port 202 into the engine cam cover 102 to purge the engine 101 of combustion by-products. During this process, the inner part 213 is held in its first position by the spring means 226, as shown in Fig. 2. Consequently, fresh air may be allowed to flow through the second port 203 to the first port 202 via the first passageway 214 only, because the second sealing surface 215 may provide a seal with the first sealing surface 204 to prevent a flow from the second passageways 401 to the first port 201.

During operation of the engine 101 at high load conditions the valve 103 enables fluid to flow through the first port 202 to the second port 203 to relieve pressure in the crankcase of the engine 101. This flow, through the first port 202 to the second port 203 is via the first passageway 214 of the inner part 213 and additionally via the second passageways 401. This is possible because the pressure built up in the engine cam cover 102 (and at the first port 202) is sufficient to force the inner part 213 to the second position (shown in Figs. 3 to 5) against the force of the spring means 226 (and/or the weight of the inner part 213) and open up the gap 301 between the first sealing surface 204 and the second sealing surface 215.

The valve 103 is shown installed within an engine cam cover 102 in a cross-sectional view in Fig. 6. The engine cam cover 102 includes a connector tube 601 for connection to the breather hose 104 (shown in Fig. 1). The engine cam cover 102 also includes a bottom wall 602, at the end of the connector tube 601, that defines a hole 603. The connection means 206 of the valve 103, which may comprise barbed fingers 206A, is dimensioned to be a good fit within the hole 603 and provides attachment of the valve 103 to the bottom wall 602.

As shown in Fig. 6, the housing 205 of the valve 103, which contains the inner part 213, is located within the engine cam cover 102. Consequently, the valve 103 is generally kept warmer in cold weather than it would be if it were mounted outside of the engine cam cover 102. This may be particularly advantageous in very cold weather when condensation might otherwise freeze in the valve 103 and prevent movement of the inner part 213.

An exploded view of the valve 103 is shown in Fig. 7, which illustrates the method of assembly of the valve 103. The above-described features of the valve 103 have been provided with reference symbols previously used.

The first and second components 207 and 210 of the outer part 201 and the first and second components 222 and 223 of the inner part 213 may be formed of a plastics material by a moulding process.

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To assemble the valve 103 the inner part 213 may firstly be assembled by locating the second component 223 of the inner part 213 within the hole formed in the first component 222 of the inner part 213. To maintain the second component 223 of the inner part 213 in place, the second component 223 may be dimensioned to be a press-fit in the first component of the inner part 213. Alternatively, the second component 223 may be a snap-fit in the first component of the inner part 213 or may be fixed in place with glue or adhesive. A helical spring 226 may be located over the inner part 213 so that it extends around the inner part 213 and is supported on a supporting surface 225 of the inner part 213. The inner part 213 is slid into the open end 701 of the first component 207 of the outer part 201, so that the distal surfaces 219 of the arms 218 of the inner part 213 slide along the inner surface 208 (shown in Fig. 2) of the outer part 201. The second component 210 of the outer part 201 is then located over the open end 701 of the first component 207 of the outer part 201 and fixed in place, for example by clipping the sprung barbed fingers 211 over the flange 212 on the first component 207. This completes the assembly of the valve 103.

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The valve 103 may then be fixed within an engine cam cover 102 (as shown in Fig. 6) by locating the connection means 206 within the hole 603 formed in the bottom wall 602 of the connecting tube 601 (shown in Fig. 6).

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An example of an alternative valve 103A is shown in the cross-sectional side views of Figs. 8 and 10 and the cross-sectional bottom view of Fig. 9. The valve 103A of Figs. 8 to 10 has many features that are similar to those of valve 103 of Figs. 2 to 5 and many of these features have been provided with similar reference numbers. Therefore, the valve 103A comprises an outer part 201A defining a first port 202 for allowing fluid to flow through the valve 103A, a second port 203 for allowing fluid to flow through the valve 103A, and a first sealing surface 204 surrounding the first port 202. The valve 103A also comprises an inner part 213A located inside the outer part 201A. The inner part 213A defines: a first passageway 214 to enable fluid to flow between the first port 202 and the second port 203; a plurality of second passageways

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401A to enable fluid to flow between the first port 202 and the second port 203; and a second sealing surface 215 surrounding a first end of the first passageway 214.

The inner part 213A is moveable between a first position, which is shown in Fig. 10, and a second position, which is shown in Fig. 8. In the first position, shown in Fig. 10, the close proximity of the second sealing surface 215 to the first sealing surface 204 is arranged to prevent fluid flow via the second passageways 401A. In the second position, shown in Fig. 8, a gap 301 between the first sealing surface 215 and the second sealing surface 204 enables fluid flow between the first port 202 and the second port 203 via the gap 301 and the second passageways 401A.

However, the valve 103A of Figs. 8 to 10 differs from valve 103 in that it does not comprise a spring means 226. Instead, to provide the inner part 213A with increased stability of its orientation, the inner part 213A has a second set of arms 1018A in addition to the first set of arms 218A, the second arms 1018A being spaced from the first arms 218A along the axis 250 of the valve 103A. In the present example, the first set of arms 218A comprises three arms 218A and the second set of arms 1018A comprises three arms 1018A, but it will be appreciated that more than three arms 218A, 1018A may be provided in each set and/or the number of arms 1018A in the second set may differ from the number of arms 218A in the first set. Each of the arms 218A and 1018A extends from the main body 217A of the inner part 213A and each one has a distal surface 219 adjacent to the inner surface 208 of the outer part 201A.

Another alternative valve 103B is shown in the cross-sectional side views of Figs. 11 and 13 and the cross-sectional bottom view of Fig. 12. The valve 103B of Figs. 11 to 13 has many features that are similar to those of valve 103 of Figs. 2 to 5 and many of these features have been provided with similar reference numbers. Therefore, the valve 103B comprises an outer part 201B defining a first port 202 for allowing fluid to flow through the valve 103B, a second port 203 for allowing fluid to flow through the valve 103B, and a first sealing surface 204 surrounding the first port 202. The valve 103B also comprises an inner part 213B located inside the outer part 201B. The inner part 213B defines a first passageway 214 to enable fluid to flow between the first port 202 and the second port 203, a plurality of second passageways 401B to enable fluid to flow between the first port 202 and the second port 203, and a second sealing surface 215 surrounding a first end of the first passageway 214.

The inner part 213B is moveable between a first position, which is shown in Fig. 13, and a second position, which is shown in Fig. 11. In the first position, shown in Fig. 13, the close proximity of the second sealing surface 215 to the first sealing surface 204 is arranged to prevent fluid flowing via the second passageways 401B. In the second position, shown in Fig. 11, a gap 301 between the first sealing surface 215 and the second sealing surface 204 enables fluid to flow between the first port 202 and the second port 203 via the gap 301 and the second passageways 401B.

However, the valve 103B of Figs. 11 to 13 differs in that the inner part 213B is formed of a single component. The inner part 213B has a main body 217B from which extend only two arms 218B that are connected at their distal ends by a cylindrical portion 1101. The cylindrical portion 1101 has an outer surface 1102 that is a sliding fit within the inner surface 1103 of the outer part 201B. Thus, the present valve 103 has two second passageways 401B that are entirely defined by the inner part 213B.

It may also be noted that a lower portion of the outer part 201B has a larger internal diameter. Consequently, during high load conditions, when the inner part 213B is in the second position as shown in Fig. 11, the inner surface 1103, along which the outer surface 1102 of the inner part 213B slides, is not exposed to the flow of gases from the engine 101.

Unlike the valve 103 of Figs. 2 to 5, the valve 103B of Figs. 11 to 13 does not have an internal shoulder to act as a stop and limit the movement of the inner part 213B away from the first position. Instead, the cylindrical portion 1101 has a sufficiently long length so that its upper edge 1104 butts against an upper wall 1105 of the outer part 201B and acts as a stop when the inner part 213B is in its second position. However, in an alternative arrangement an internal shoulder stop may be provided on the outer part 201B and the length of the cylindrical portion 1101 may be reduced.

Although embodiments of the present invention have been described in the preceding paragraphs with reference to various examples, it should be appreciated that modifications to the examples given can be made without departing from the scope of the invention as claimed.

Features described in the preceding description may be used in combinations other than the combinations explicitly described.

5 Although functions have been described with reference to certain features, those functions may be performable by other features whether described or not.

Although features have been described with reference to certain embodiments, those features may also be present in other embodiments whether described or not.

10 Whilst endeavoring in the foregoing specification to draw attention to those features of the invention believed to be of particular importance it should be understood that the Applicant claims protection in respect of any patentable feature or combination of features hereinbefore referred to and/or shown in the drawings whether or not particular emphasis has been placed thereon.

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CLAIMS

1. A valve for restricting flow of fluid, the valve comprising:
an outer part defining a first port for allowing fluid to flow through the valve, a second
5 port for allowing fluid to flow through the valve, and a first sealing surface surrounding the first
port; and
an inner part located inside the outer part, the inner part defining a first passageway to
enable fluid to flow between the first port and the second port, a plurality of second
passageways to enable fluid to flow between the first port and the second port, and a second
10 sealing surface surrounding an end of the first passageway;
wherein the inner part is moveable between:
a first position in which proximity of the second sealing surface to the first sealing
surface is arranged to prevent fluid flowing via the second passageways; and
a second position in which a gap between the first sealing surface and the second
15 sealing surface enables fluid to flow between the first port and the second port via the gap
and the second passageways.
2. A valve according to claim 1, wherein the first port and the second port are collinear.
- 20 3. A valve according to claim 1 or claim 2, wherein the second port and the first
passageway are collinear.
4. A valve according to any one of claims 1 to 3, wherein at least one of the second
passageways is defined by an outer surface of the inner part and an inner surface of the outer
25 part.
5. A valve according to any one of claims 1 to 4, wherein the inner part is urged towards
the first position by a spring means.
- 30 6. A valve according to claim 5, wherein the spring means comprises a spring.
7. A valve according to claim 6, wherein the spring comprises a helical spring.

8. A valve according to claim 7, wherein a supporting surface of the inner part is arranged to maintain the orientation of the helical spring with respect to the inner part.

9. A valve according to any one of claims 1 to 8, wherein the valve is arranged to: enable
5 fluid to flow from the second port to the first port via the first passageway only; and enable fluid to flow from the first port to the second port via the first passageway and the second passageways.

10. A valve according to claim 9, wherein the inner part is arranged to be moved to the
10 second position by pressure of the fluid.

11. A valve according to any one of claims 1 to 10, wherein: the inner part comprises a main body defining the first passageway and a plurality of arms extending from the main body; a second passageway is defined between two of the arms; and a distal surface of the arms is
15 arranged to slide over an inner surface of the outer part.

12. A valve according to claim 11, wherein each of the second passageways is defined by two of the plurality of arms and an inner surface of the outer part.

20 13. A valve according to claim 12, wherein the distal surface of the arms has a sufficient length along the inner surface of the outer part to maintain the orientation of the inner part within the outer part.

14. A valve according to any one of claims 11 to 13, wherein the inner part comprises at
25 least three arms and the arms in combination with an inner surface of the outer part define at least three second passageways.

15. A valve according to claim 14, wherein the inner surface has a cylindrical shape.

30 16. A valve according to any one of claims 11 to 15, wherein the outer part defines an internal shoulder to limit movement of the inner part away from the first position and the arms define contact surfaces arranged to contact the shoulder when the inner part is in a second position.

17. A valve according to claim 16, wherein the contact surfaces are defined by ridges formed on the arms.

18. A valve according to any one of claims 1 to 17, wherein the outer part defines an internal shoulder to limit movement of the inner part away from the first position.

19. A valve according to any one of claims 1 to 18, wherein the inner part comprises: a first component defining the second sealing surface and the second passageways; and a second component which defines the bore of the first passageway.

20. A valve according to any one of claims 1 to 19, wherein the outer part comprises barbed fingers surrounding the second port for connecting the valve to an engine cam cover.

21. A valve according to any preceding claim, wherein one or both of the first sealing surface and the second sealing surface comprises a ridge, the peak of which may be brought into contact with the other of the first sealing surface and the second sealing surface to form a seal.

22. An internal combustion engine comprising an engine cam cover and valve in accordance with any one of claims 1 to 21 arranged to enable fluid to flow from, and to, the inside of the engine cam cover.

23. An internal combustion engine according to claim 22, wherein the outer part of the valve comprises a housing containing the inner part and the housing is located within the engine cam cover.

24. An internal combustion engine according to claim 23, wherein the outer part comprises a connection means at the second port and the connection means connects the housing to a hole formed in the engine cam cover.

25. An internal combustion engine according to claim 24, wherein the connection means extends through the hole formed in the engine cam cover.

26. A vehicle comprising an internal combustion engine according to any one of claims 22 to 25.

27. A valve substantially as herein disclosed with reference to the accompanying Figures.

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28. An internal combustion engine as herein disclosed with reference to the accompanying Figures.

29. A vehicle as herein disclosed with reference to the accompanying Figures.

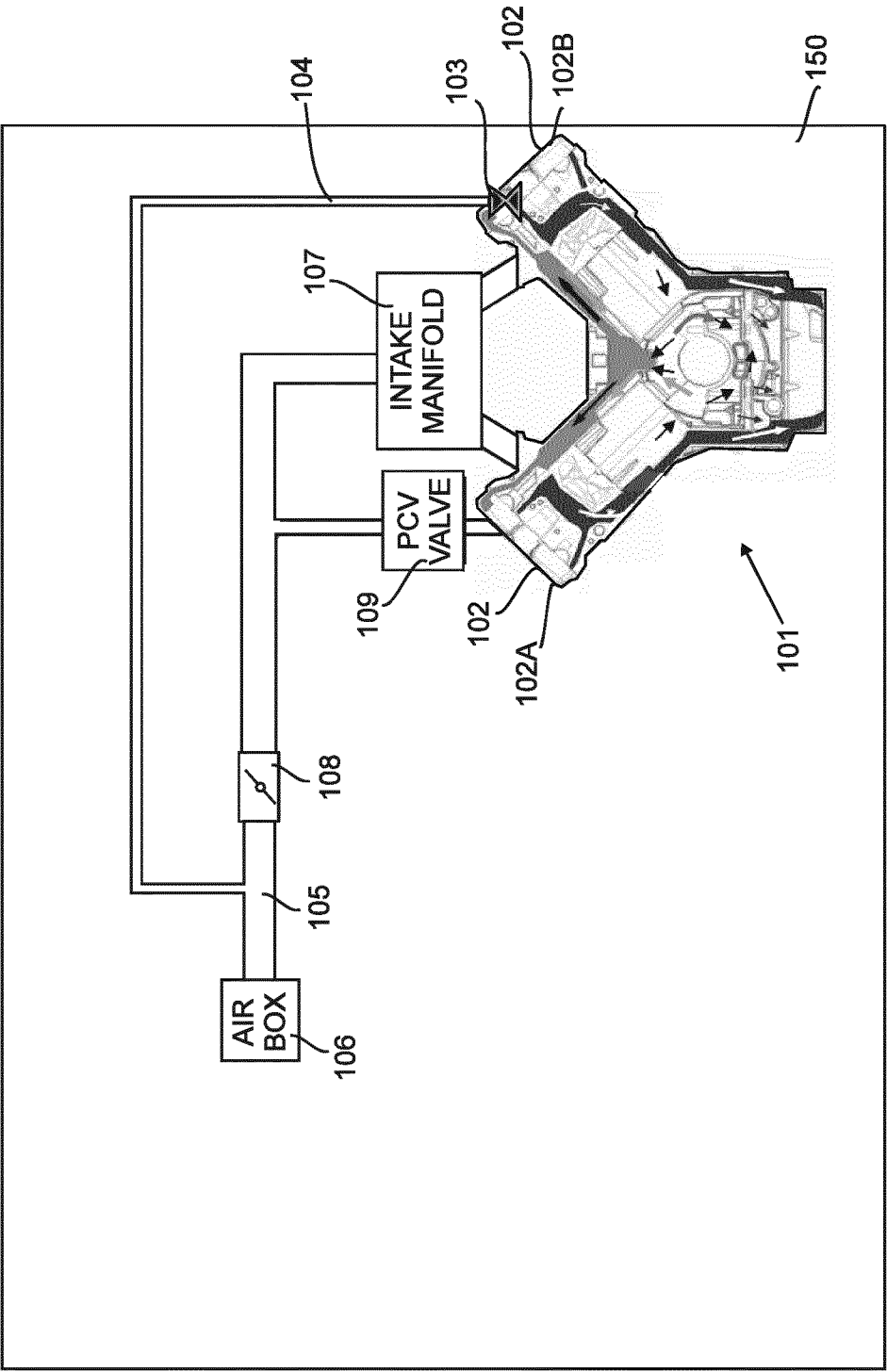


Fig. 1

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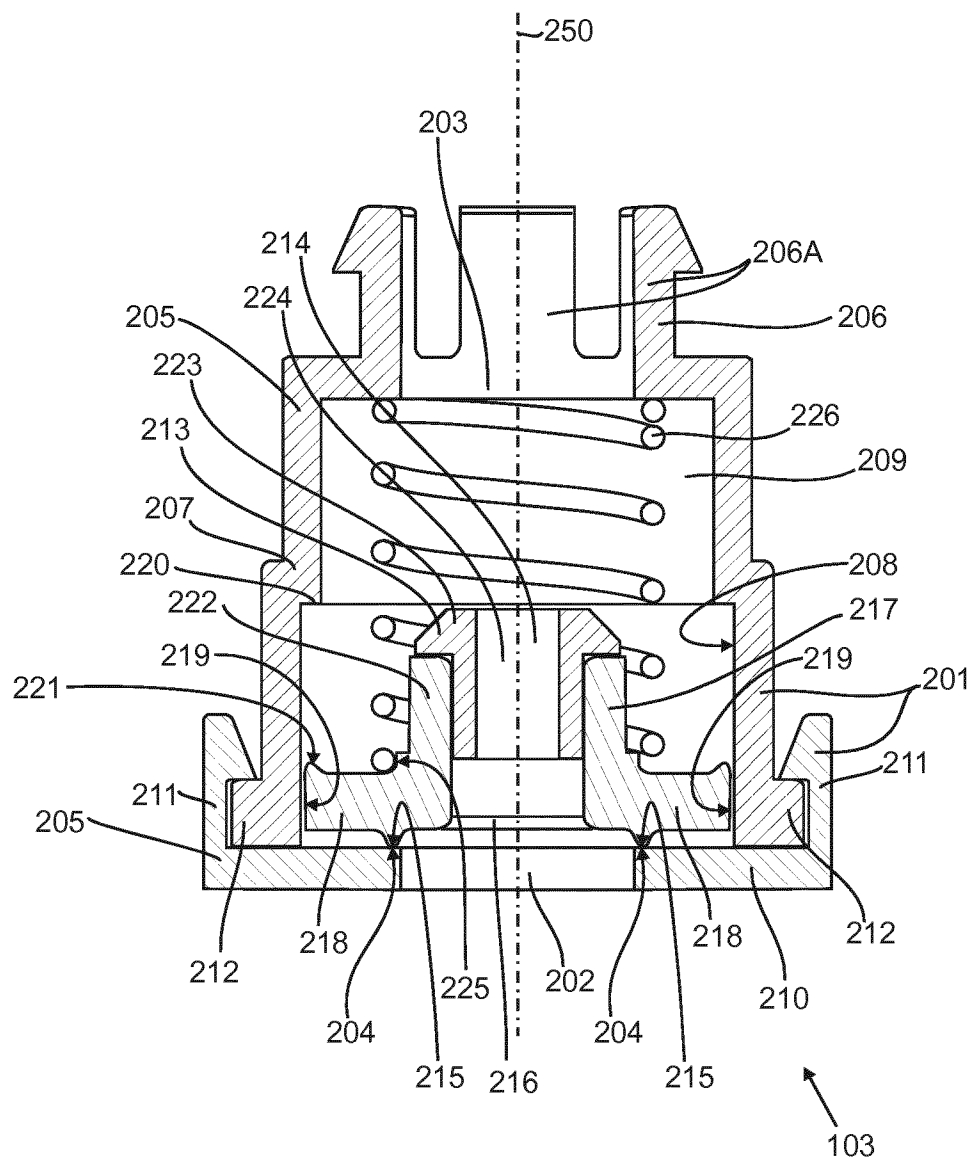


Fig. 2

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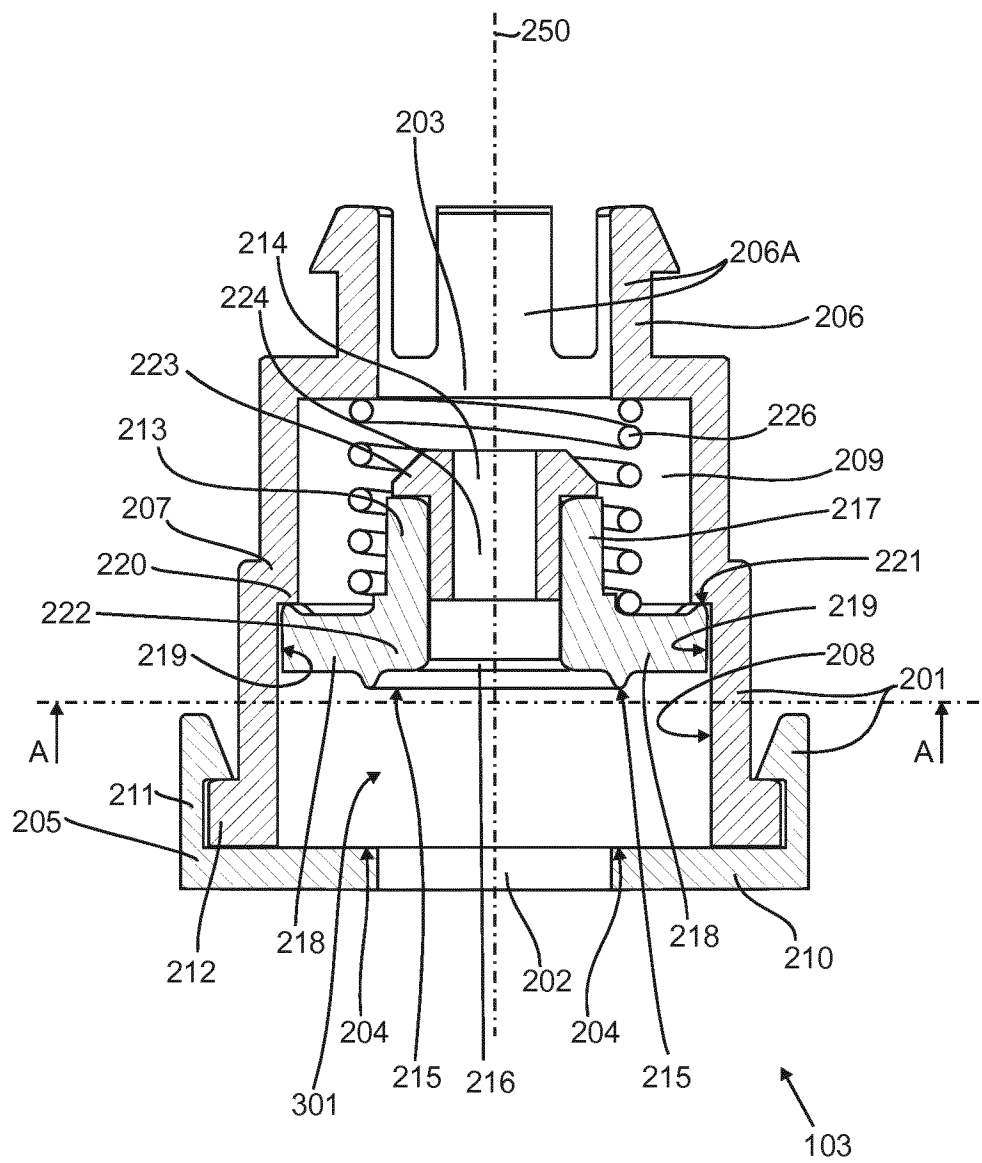


Fig. 3

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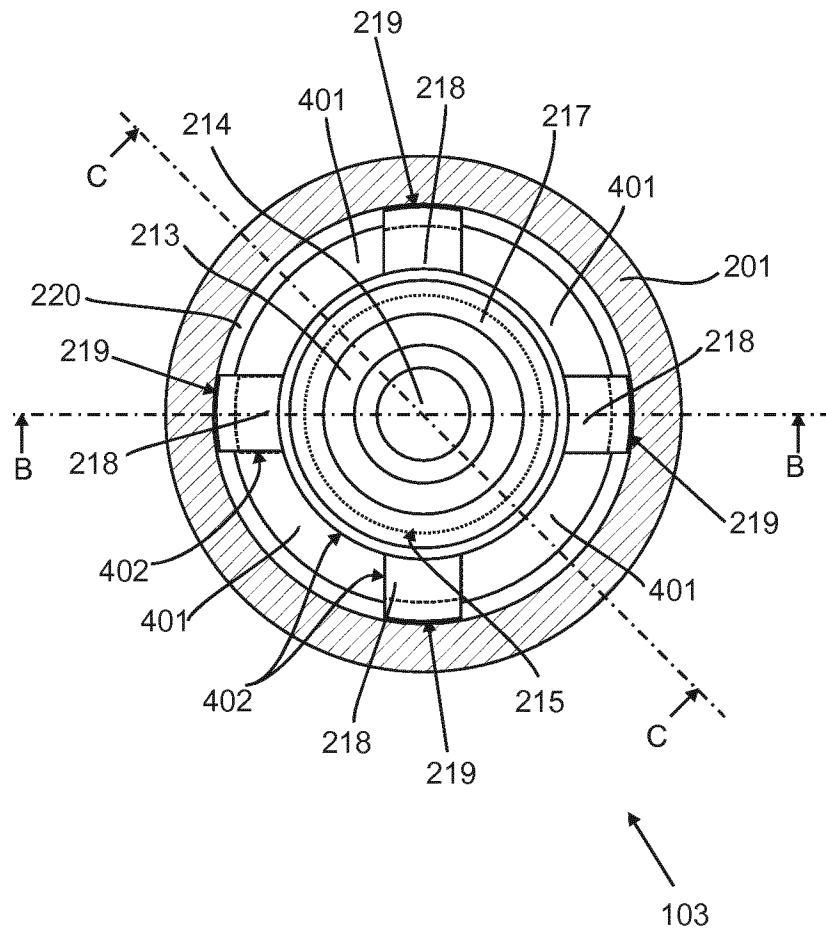


Fig. 4

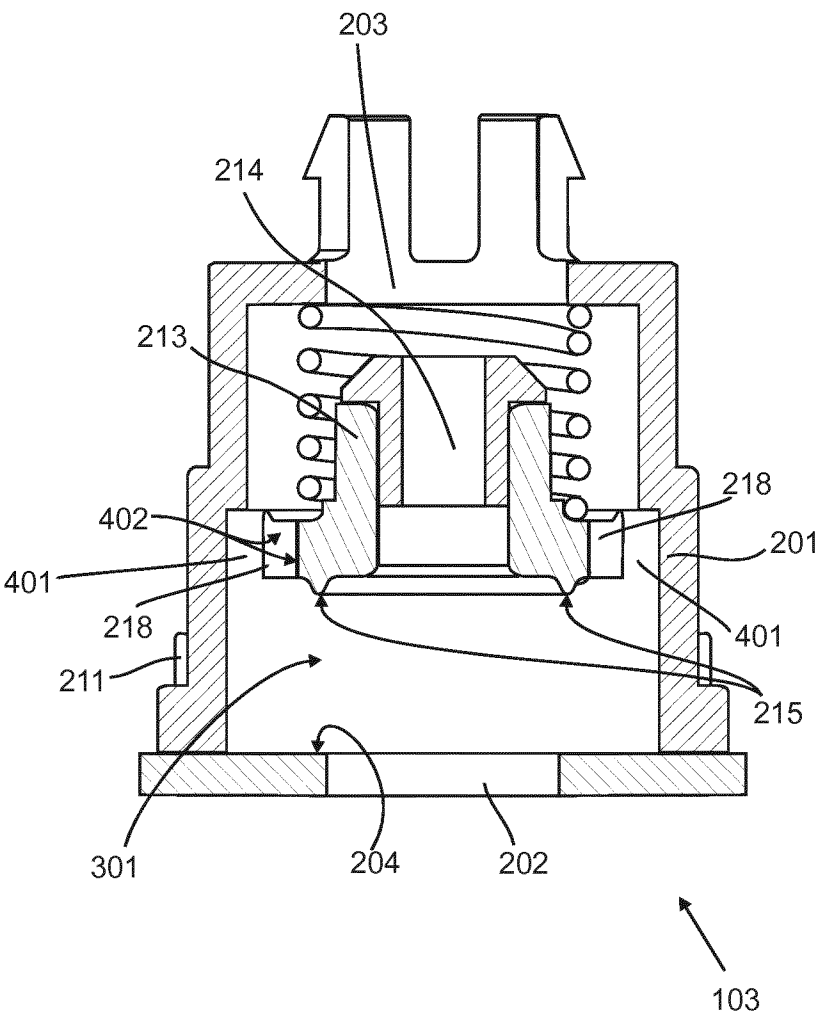


Fig. 5

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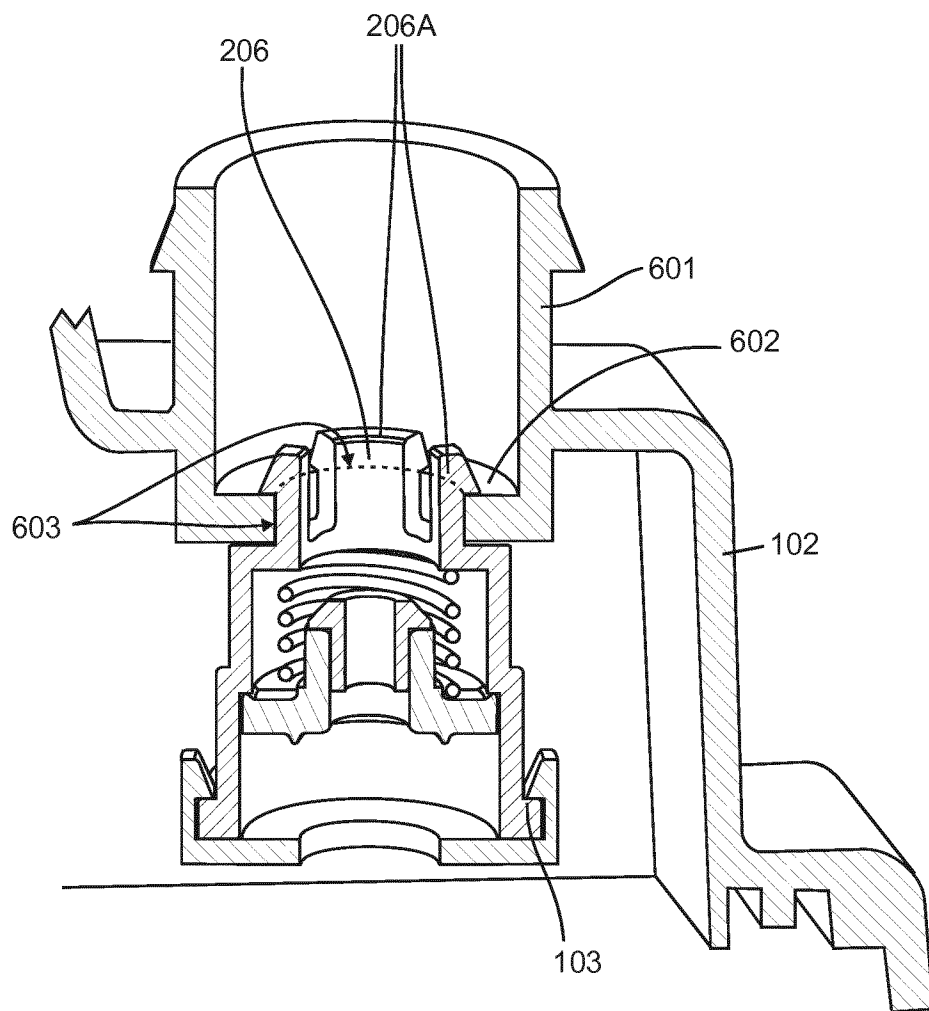


Fig. 6

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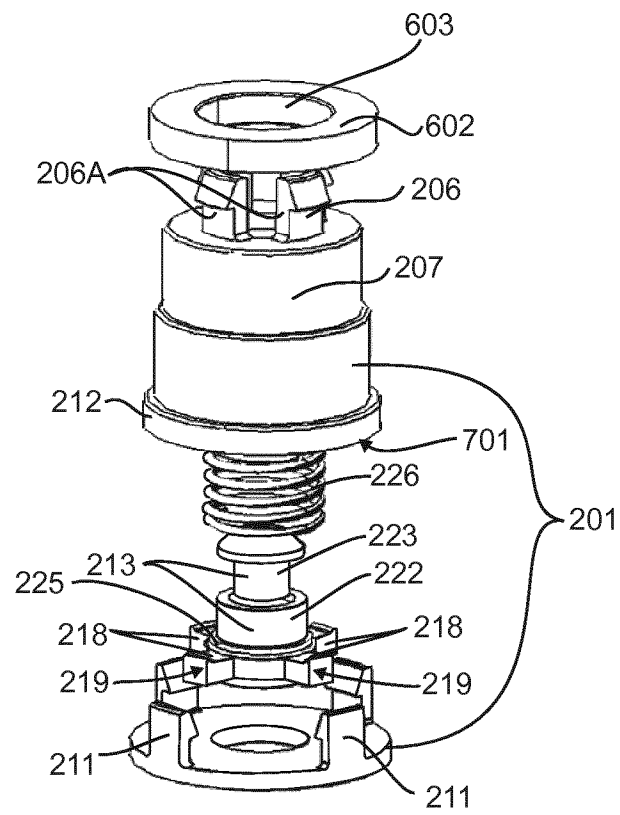


Fig. 7

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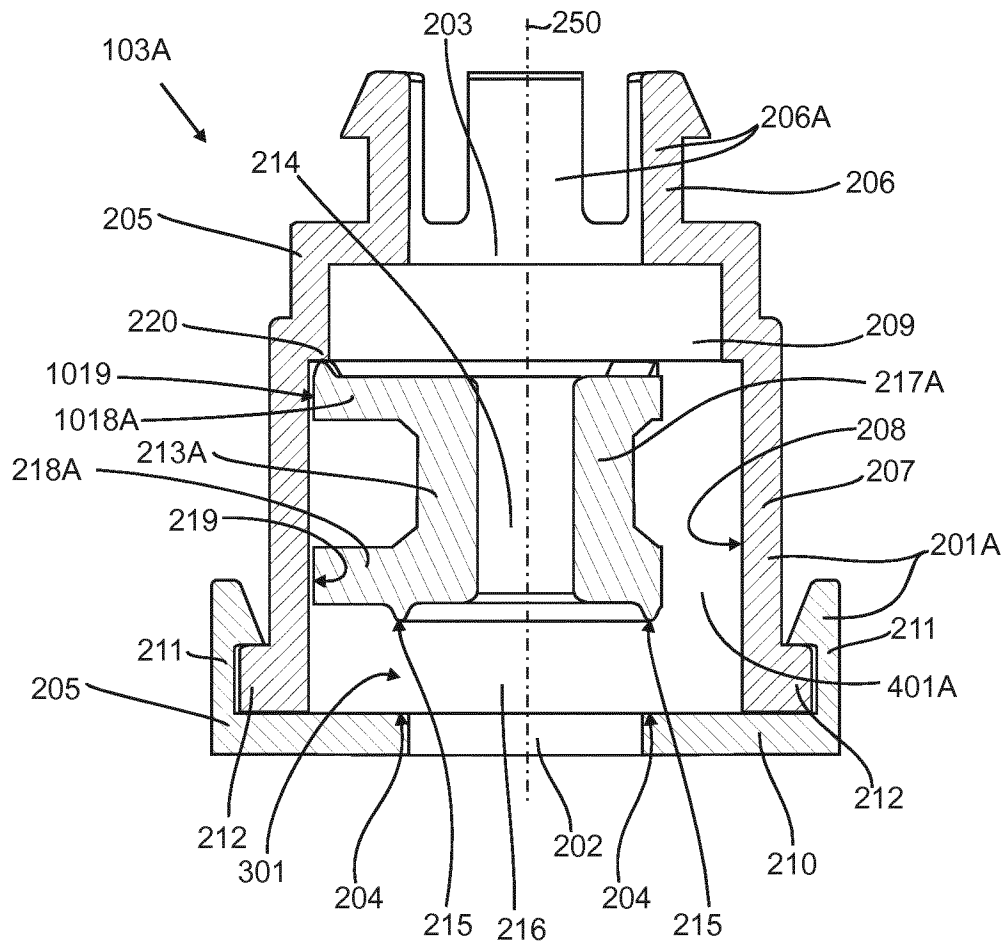


Fig. 8

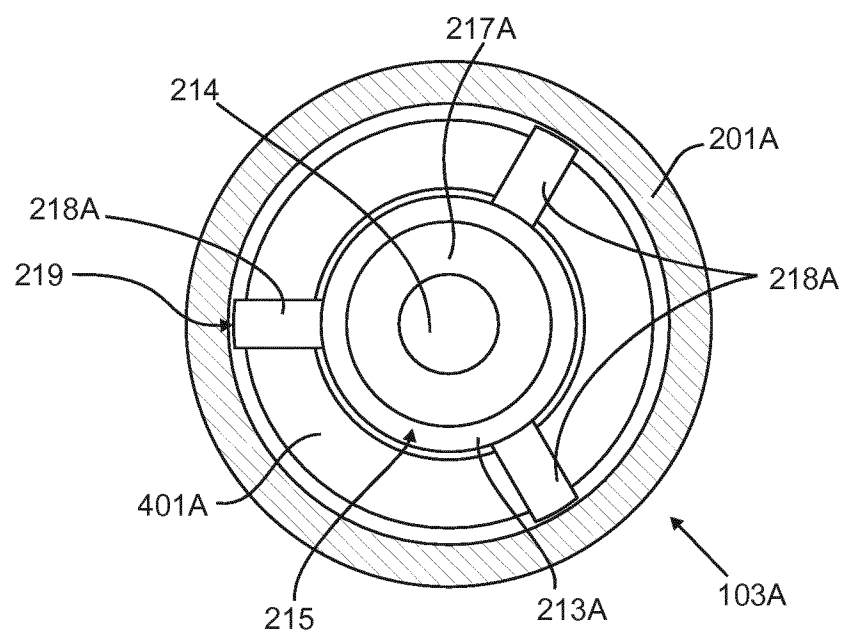


Fig. 9

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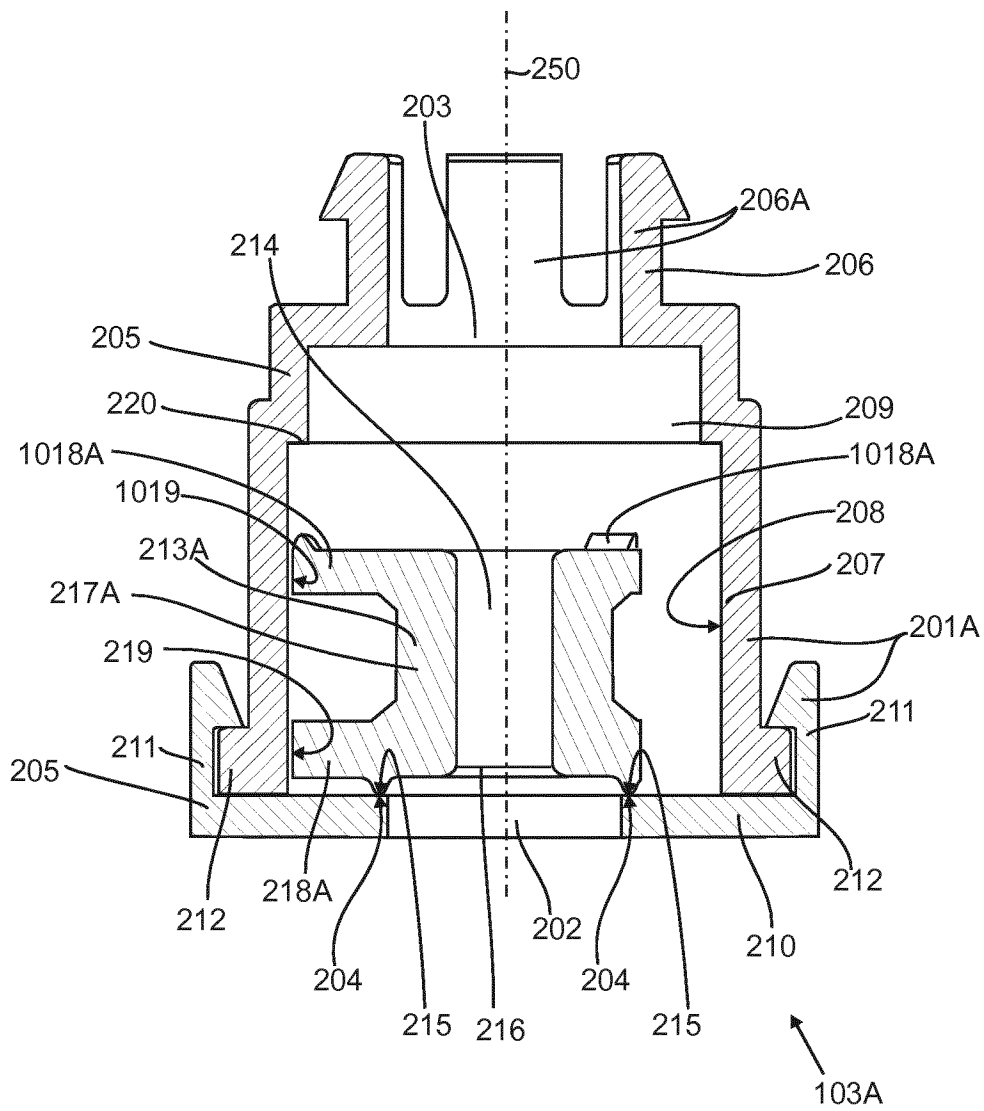


Fig. 10

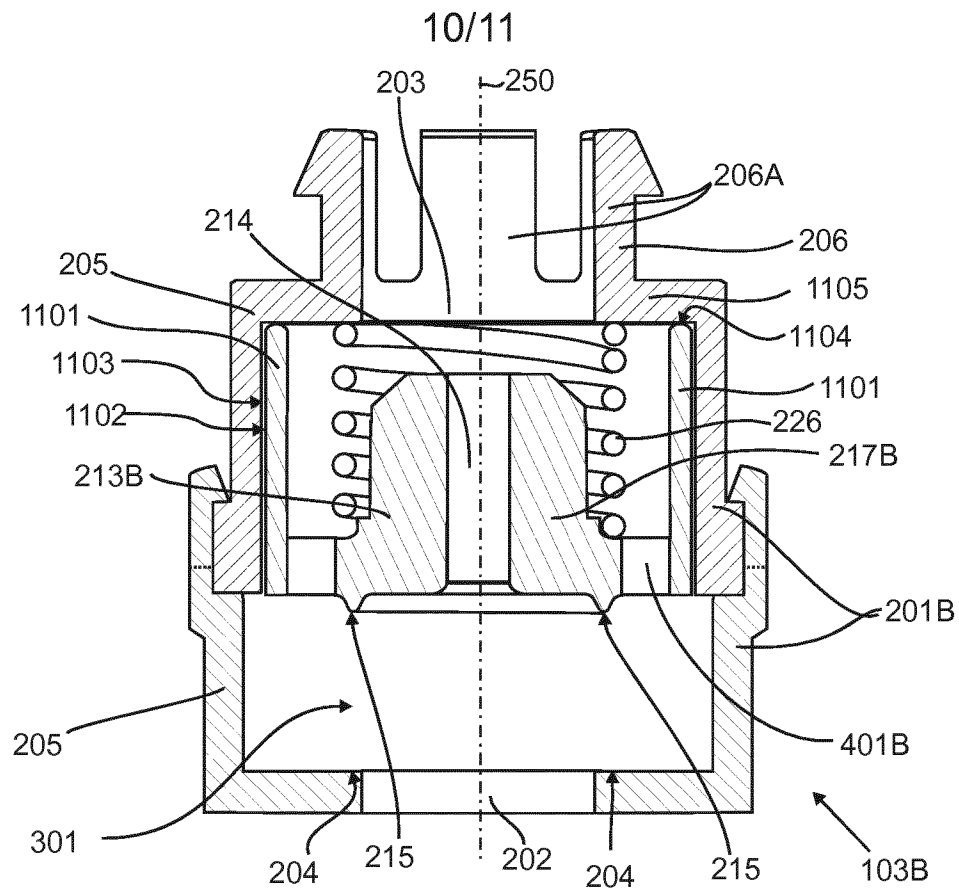


Fig. 11

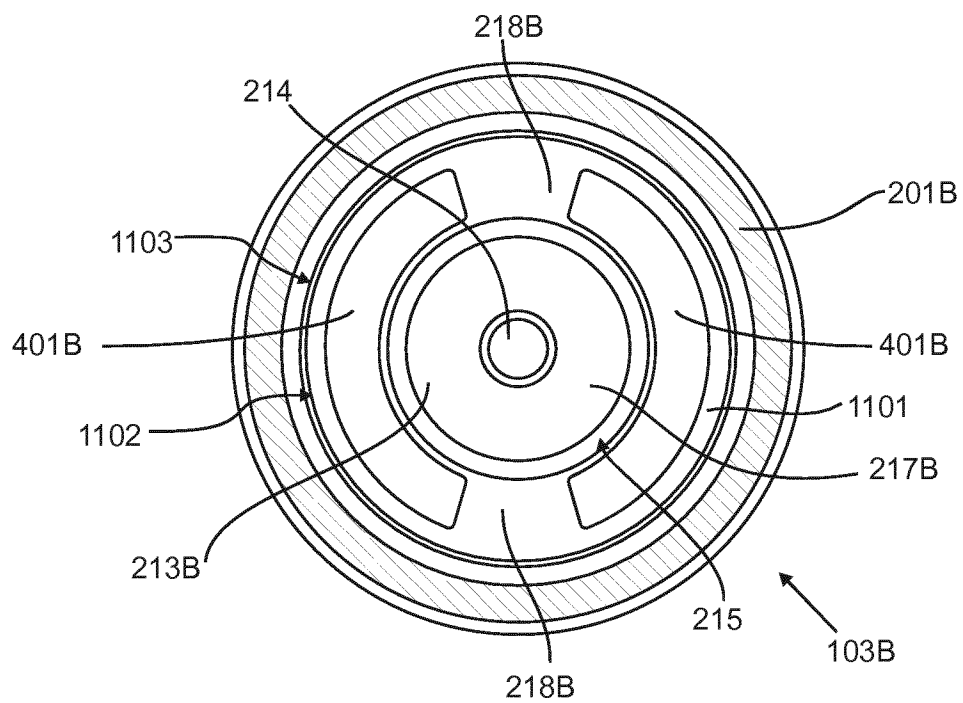


Fig. 12

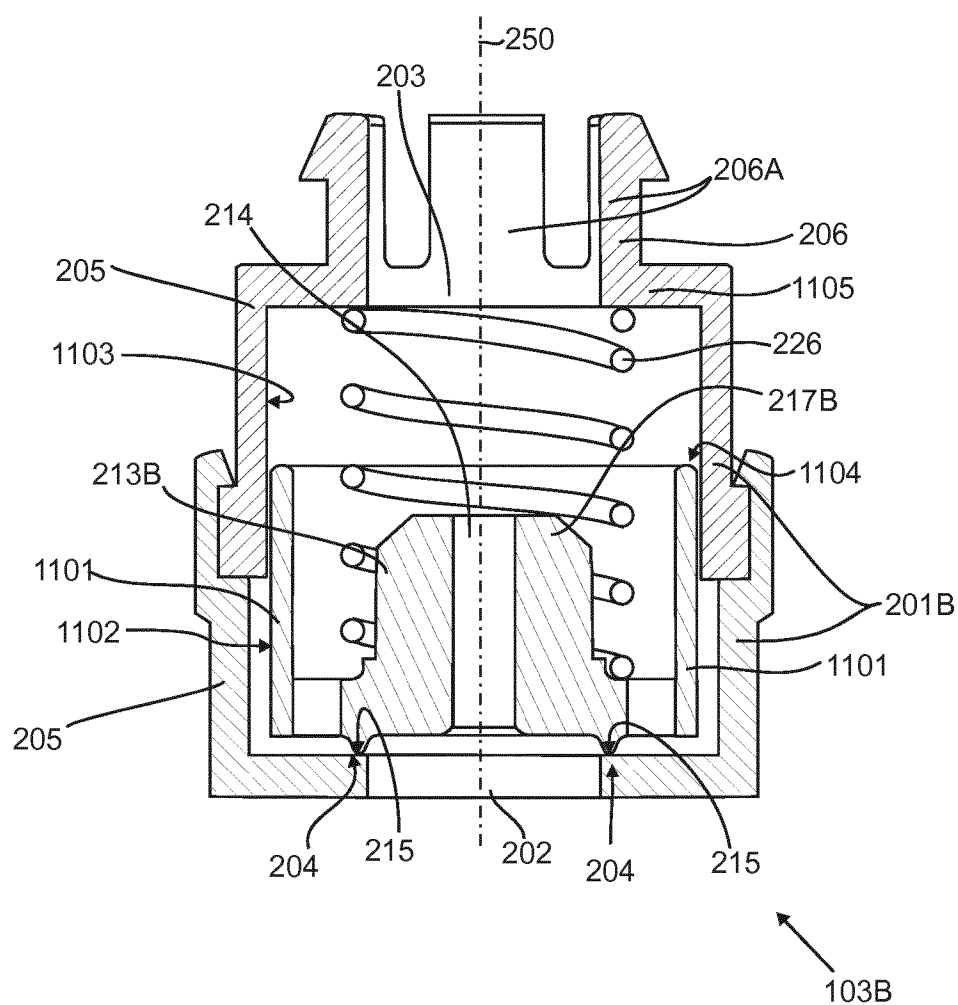


Fig. 13

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/078656

A. CLASSIFICATION OF SUBJECT MATTER
INV. F01M13/00
ADD. F01M13/02

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)
F01M

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.
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X	----- JP S58 44412 U (-) 25 March 1983 (1983-03-25) figures 1-5	1-7, 9-16, 19-22, 26-29
X	----- JP 2002 195017 A (AISIN SEIKI) 10 July 2002 (2002-07-10) abstract; figures 1-4 ----- -/--	1-7,9-29



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

19 January 2018

Date of mailing of the international search report

02/02/2018

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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/078656

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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Information on patent family members

International application No

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