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(71) Applicant: **Continental Automotive GmbH**
30165 Hannover (DE)

(72) Inventor: **Gestri, Luca**
56023 Cascina (PI) (IT)

(54) **VALVE ASSEMBLY FOR AN INJECTION VALVE AND INJECTION VALVE FOR A COMBUSTION ENGINE**

(57) A valve assembly (1) is disclosed comprising a valve body (3) which has a central longitudinal axis (L) and comprises a cavity (5) with a lower cavity portion (7) and a fluid outlet portion (9) with a seal seat (11). It further comprises two or more flow passages (13) being arranged radially asymmetrical with respect to the longitudinal axis (L). The flow passages (13) are either arranged axially between the lower cavity portion (7) and the seal seat (11) and penetrate the valve body (3) from the lower cavity portion (7) towards the fluid outlet portion (9) upstream of the seal seat (11) or the valve assembly comprises a throttling element (15) which is arranged in the lower cavity portion (7) of the cavity (5) and axially spaced apart from the seal seat (11) and the flow passages (13) penetrate the throttling element (15).

FIG 1A

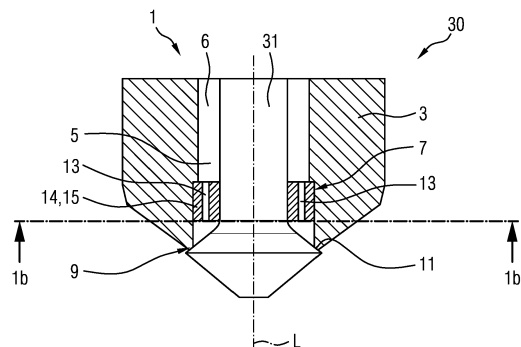
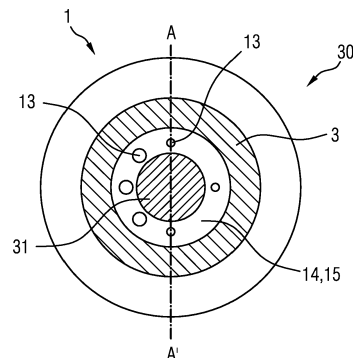


FIG 1B



Description

[0001] The invention relates to a valve assembly for an injection valve and to an injection valve for a combustion engine.

[0002] Injection valves are in widespread use, in particular for combustion engines where they may be arranged in order to dose a fluid into an intake manifold of the combustion engine or directly into a combustion chamber of a cylinder of the combustion engine.

[0003] In general, an injection valve provides a fluid spray during an operation. The shape of the fluid spray is influenced by a flow field of fluid upstream of a sealing area in the injection valve. A distribution of the fluid spray further depends on the geometry of the injector nozzle that is formed, for example, by a valve needle and a cartridge of the injection valve in the case of an outward opening injection valve. For example, outward opening injection valves may provide a hollow cone fluid spray structure during an operation.

[0004] Injection valves are manufactured in various forms in order to satisfy the various needs for the various combustion engines. Therefore, for example, their positioning, their diameter and all the various elements of the injection valve being responsible for the way the fluid is dosed into a combustion chamber may vary in a wide range. Some combustion engines require side mounted injection valves and multi stream configurations that better fit the geometrical constraint of the combustion chamber. Therefore, it is beneficial to enable an asymmetrical fluid spray out of the injection valve for reasons of an enhanced combustion process.

[0005] One object of the invention is to specify a valve assembly for an injection valve which enables a reliable and secure functioning of an injection valve to realize in a simple manner an asymmetrical fluid spray during operation.

[0006] The object is achieved by a valve assembly having the features of the claim 1. Advantageous embodiments of the invention are given in the dependent claims.

[0007] According to a first aspect of the invention, a valve assembly for an injection valve is specified. According to a second aspect, of the invention, an injection valve for a combustion engine is specified which comprises the valve assembly.

[0008] The valve assembly comprises a valve body. The valve body includes a central longitudinal axis and has a cavity. The cavity may expediently extend through the valve body in axial direction.

[0009] The cavity comprises a lower cavity portion and, adjacent to the lower cavity portion, a fluid outlet portion with a seal seat. In one embodiment, the lower cavity portion has a circular cylindrical basic shape and the fluid outlet portion expands conically from the lower cavity portion in downstream direction. In one embodiment, the lower cavity portion and the fluid outlet portion merge at a common interface.

[0010] In one embodiment, the valve assembly further

comprises a valve needle which is arranged axially moveable in the cavity and which is configured to prevent a fluid flow through the fluid outlet portion in a closing position in coaction with the seal seat and to release the fluid flow in further positions. The injection valve is in particular an outward opening injection valve, i.e. the valve needle is displaceable in axial direction from the lower cavity portion towards the seal seat for releasing the fluid flow, i.e. for unsealing the valve.

[0011] The valve assembly has two or more flow passages which are arranged radially asymmetrical with respect to the longitudinal axis. For example, the flow passages are unevenly distributed around the longitudinal axis and/or at least two circumferentially subsequent flow passages have different cross-sectional areas.

[0012] In one embodiment, the flow passages are arranged axially between the lower cavity portion and the seal seat of the fluid outlet portion with respect to the longitudinal axis and penetrate the valve body from the lower cavity portion towards the fluid outlet portion upstream of the seal seat. For example, the valve body has a radially inward protruding guide portion for axially guiding the valve needle. The guide portion may represent a throttling element for fluid flowing through the cavity towards the seal seat during operation of the valve assembly. An upstream surface of the guide portion may represent a bottom surface of an upper cavity portion of the cavity, delimiting the upper cavity portion in downstream direction where it in particular merges with the lower cavity portion. The lower cavity portion may be shaped by the guide portion, in particular by an inner lateral surface of the guide portion. The fluid outlet portion is in one development shaped by a downstream surface of the guide portion which is in particular a conical surface. In one embodiment, the flow passages extend through the guide portion in axial direction.

[0013] In another embodiment, the valve assembly comprises a separate throttling element which is arranged in the lower cavity portion of the cavity - in particular axially spaced apart from the seal seat - and the flow passages penetrate the throttling element.

[0014] Such configurations provide a simple and reliable possibility to realize an asymmetrical fluid spray during operation of the valve assembly or the corresponding injection valve. In this context, the asymmetrical fluid spray is realized by the asymmetrical arrangement of the flow passages above the seal seat of the fluid outlet portion. "Above the seal seat" or "upstream of the seal seat" describes a position in axial direction of the cavity from the seal seat towards the lower cavity portion. The asymmetrical arrangement of the flow passages enables an asymmetrical fluid spray and hence locally influences the fluid mass and velocity and thus the distribution of the fluid can be controlled. This further effects a penetration of the fluid spray out of the valve assembly or the corresponding injection valve into a combustion chamber.

[0015] The described valve assembly influences the fluid flow of a streaming fluid and hence a mass distribu-

tion of the fluid at the fluid outlet portion. Because of the asymmetrical arrangement of the two or more flow passages the fluid can be locally accelerated and modulated. The fluid distribution is further influenced by a nozzle cross-section which provides a final angle to the fluid spray as well as its own thickness. Such an arrangement of the valve assembly enables side mounting of injection valves, for example, without having a high risk for wetting the cylinder surfaces of the combustion chamber with the fuel spray dispensed from the injection valve. In this context, the valve assembly enables an asymmetrical distribution of the thin fluid spray of gasoline mass which helps mixture spray formation reducing the momentum and therefore the penetration as well as the film thickness. Furthermore, outward opening injection valves are robust against flow drift phenomena produced by coking for example. Hence, the described valve assembly enables multi-stream configurations using outward opening injection valves to better fit the geometrical constraint of the combustion chamber geometry amongst others. It further makes a contribution to prevent a spray collapse in case of small spray angles.

[0016] When a separate throttling element comprises the flow passages, the other elements of the valve assembly do not have to be modified, for example concerning their geometry or design for changing the shape of the fluid spray. This allows for a particular cost-efficient valve design, in particular by using the same valve body for valve assemblies having different spray distributions.

[0017] The flow passages can be drilled into the valve body or the separate throttling element using a laser beam like femtosecond laser drilling or drilling by electrical discharge machining. Other manufacturing processes are also possible.

[0018] With advantage, the valve assembly makes it possible to precisely modulate or inhibit the fluid flow above the seal seat. Hence, it enables to adjust a tangential distribution of the fluid spray out of the fluid outlet portion consequently. The geometry of the flow passages that feed the area above the seal seat can easily be customized for different central and side applications, for example by drilling as mentioned above. Therefore, by forming the flow passages into the valve body or the throttling element a desirable flow throttling of the fluid can be reached and hence a consequent reduction of fluid penetration and fluid distribution to meet the requirements for a respective application.

[0019] The described asymmetrical arrangement of the flow passages can also be used to minimize flow sensitivity to lift tolerances of a valve needle of a solenoid outward opening injection valve, for example.

[0020] Such valve assemblies and corresponding injection valves are beneficial to provide an increased flexibility in fluid spray customization with respect to central and side mounted applications. Another benefit is an improved robustness towards fluid spray architecture collapse for compact fluid sprays under flash boiling conditions. The described configurations of the flow passages

further provide an elimination of fluid flow drift due to coking and reduced wetting potential by thin fluid spray applications. And it makes a contribution to eliminate issues due to emptying of a sac volume of the valve assembly or the injection valve during closure.

[0021] According to one embodiment, the throttling element comprises a ring shape and an opening to enable an arrangement of a valve needle with respect to the longitudinal axis. In other words, the ring shape comprises the opening. The opening extends through the throttling element in axial direction for receiving the valve needle. In particular, the valve needle extends through the opening of the ring-shaped throttling element in axial direction. In one development, the throttling element is operable to guide the valve needle axially with respect to the valve body.

[0022] This embodiment describes one simple geometry of the throttling element which realizes a symmetrical arrangement of the valve assembly or a corresponding injection valve. For example, the throttling element surrounds the valve needle of the injection valve which is axially movable with respect to the longitudinal axis. The throttling element may be fixedly connected to the valve needle and hence being axially movable as well or it may be fixedly connected to the valve body - or in one piece with the valve body - and hence retains in its axial position relatively to the valve body.

[0023] The asymmetrical arrangement of the two or more flow passages through the throttling element enables an asymmetrical fluid spray during operation of the valve assembly and therefore advantageous fluid spray conditions for a side-mounted outward opening injection valves, for example.

[0024] According to a further embodiment of the second aspect, the flow passages are designed as grooves in a lateral surface on the throttling element. This may allow for a particularly good lubrication when surfaces of the valve needle or the valve body and the throttling element are in sliding contact for axially guiding the valve needle. In another embodiment, the flow passages are spaced apart from the opening of the throttling element in radial outward direction. In this way, a particularly effective modification of the spray distribution may be achievable.

[0025] According to an embodiment of the first or second aspect, the flow passages are arranged in a circle with respect to the longitudinal axis. For example, the geometrical centers of gravity of cross-sections of the flow passages in a plane - in particular in each plane - perpendicular to the longitudinal axis are positioned on a single circle which extends around the longitudinal axis, in particular in said plane and which preferably has its center on the longitudinal axis. For example, in a top view of the valve assembly along the longitudinal axis, the circle may consist of a first and a second semicircle. There may be four flow passages arranged on the first semicircle which penetrate the valve body or the throttling element. The second semicircle may only comprise one

flow passage penetrating the valve body or the throttling element. Further embodiments may comprise other numbers of flow passages regarding the respective semicircles.

[0026] According to another embodiment, the flow passages have a circular cross-sectional shape. Such a configuration of the flow passages describes a simple way to realize flow passages penetrating the valve body or the throttling element especially by drilling. This enables, in a simple manner, an arrangement of the two or more flow passages to the valve body or to the throttling element and hence to reach the desired flow throttling of the fluid and the given asymmetric fluid spray out of the valve assembly. In one development, each flow passage comprises a diameter and at least one diameter differs from the others. In other words, at least two of the flow passages have different diameters. The "diameter" is in the present context the outer diameter which defines the cross-sectional contour of the respective flow channel. In this way, an asymmetrical fluid spray is achievable in particularly simple fashion by drilling.

[0027] For example, with respect to a plane comprising the longitudinal axis and dividing the throttling element and the valve body in a first half and a second half, there are three flow passages penetrating the first half of the throttling element or the valve body and another three flow passages penetrating the second half. In one exemplary development, the three flow passages penetrating the first half may have a diameter which is twice as large as that of the three flow passages on the second half. Hence, there is an asymmetrical fluid flow realized during operation of the valve assembly which enables an asymmetrical fluid spray into a combustion chamber of a combustion engine which, for example, is beneficial for multi-stream and/or side-mounted configurations of injection valves.

[0028] According to another embodiment, the flow passages are tilted with respect to the longitudinal axis. A tilt of the flow passages also influences the fluid flow and the generation of an asymmetrical fluid spray out of the valve assembly. In this context, one or more flow passages comprise a hole axis which includes a given - in particular acute - angle with respect to the longitudinal axis. It is further possible that the flow passages include different angles with the longitudinal axis.

[0029] According to an embodiment, the throttling element is one part of the valve needle. The throttling element and the valve needle may be manufactured from one blank, for example in this case. Alternatively, the throttling element can be a separate piece which is fixedly connected to the valve needle, for example by a welded connection and/or by a friction fit connection and/or by a form fit connection. As a further alternative, the throttling element can be a separate piece which is fixedly connected to the valve body, for example by a friction fit connection and/or by a form fit connection and/or by a welded connection. In each case, the throttling element can function as a guide element for axially guiding the

valve needle relative to the valve body.

[0030] Exemplary embodiments of the invention are explained in the following with the aid of schematic drawings and reference symbols.

[0031] In the figures:

Figure 1a shows a valve assembly for an injection valve according to a first exemplary embodiment in a longitudinal section view;

Figure 1b shows the valve assembly according to the first embodiment in a cross-sectional view;

Figure 2a shows a valve assembly for an injection valve according to a second exemplary embodiment in a longitudinal section view;

Figure 2b shows the valve assembly according to the second embodiment in a cross-sectional view;

Figure 3a shows a valve assembly according to a third exemplary embodiment in a longitudinal section view;

Figure 3b shows the valve assembly according to the third embodiment in a cross-sectional view;

Figure 4a shows a valve assembly according to a fourth exemplary embodiment in a longitudinal section view; and

Figure 4b shows the valve assembly according to the fourth embodiment in a cross-sectional view.

[0032] In the exemplary embodiments and figures, identical, similar or similarly acting constituent parts are provided with the same reference symbols. In some figures, individual reference symbols may be omitted to improve the clarity of the figures. The elements illustrated in the figures and their size relationships among one another should not be regarded as true to scale. Rather, individual elements may be represented with an exaggerated size for the sake of better representability and/or for the sake of better understanding.

[0033] Figure 1a shows a cross section of a valve assembly 1 for an injection valve 30 according to a first exemplary embodiment in a longitudinal section view with respect to a longitudinal axis L.

[0034] The valve assembly 1 comprises a valve body 3 including the longitudinal axis L and having a cavity 5. The cavity 5 comprises an upper cavity portion 6, a lower cavity portion 7 downstream of the upper cavity portion 6 and, adjacent to and downstream of the lower cavity portion 7, a fluid outlet portion 9. During operation of the valve assembly 1, fluid may flow through the cavity 5 in downstream longitudinal direction from the upper

cavity portion 6 through the lower cavity portion 7 to the fluid outlet portion 9 to be dispensed from the valve assembly 1 at the fluid outlet portion 9.

[0035] The valve assembly 1 further comprises a valve needle 31. The valve needle 31 and the seal seat 11 are configured and arranged to act together to prevent a fluid flow out of the fluid outlet portion 9 in a closed position of the valve needle 31. In the closed position, a sealing element of the valve needle 31 is in sealing mechanical contact with the seal seat 11. In the present embodiment, the sealing element has a conical surface which is operable to establish the sealing mechanical contact with the valve seat 11. At the upstream axial end of said conical surface, the sealing element merges with a shaft of the valve needle 31. The shaft may have the general shape of a cylindrical rod.

[0036] The valve needle 31 is axially displaceable in downstream axial direction along the longitudinal axis L to establish a gap between the seal seat 11 and the sealing element for enabling fuel flow out of the cavity 5 through the fluid outlet portion 9. The valve assembly 1 is in particular a valve assembly 1 of an outward opening injection valve 30.

[0037] The valve assembly 1 further comprises a throttling element 15. The throttling element 15 is a separate piece which is arranged in the lower cavity portion 7 of the cavity 5 upstream of the seal seat 11.

[0038] The throttling element 15 is ring-shaped, having a penetrating opening which extends longitudinally through the throttling element 15. The throttling element 15 contacts a wall of the valve body 3. More specifically it is in press-fit and form-fit connection with the circular cylindrical side surface of the lower cavity portion 7 of the cavity 5 of the valve body 3 so that it has a fixed position relative to the valve body 3.

[0039] An upstream surface of the throttling element 15 represents a bottom surface of the upper cavity portion 6. The fluid outlet portion 9 is positioned downstream of the throttling element 15. In the present embodiment, the fluid outlet portion 9 has a conical circumferential surface which comprises the seal seat 11, for example adjacent to a downstream edge of the conical circumferential surface.

[0040] The valve needle 31 extends through the opening of the throttling element 15 so that it is in sliding mechanical contact with the throttling element 15. In this way, the throttling element 15 represents a guide element 14 for axially guiding the valve needle 31 relative to the valve body 3.

[0041] The throttling element 15 comprises two or more flow passages 13 which penetrate the throttling element 15 and which are arranged radially asymmetrical with respect to the longitudinal axis L. The flow passages 13 of the throttling element 15 end upstream of the seal seat 11 and preferably also upstream of the sealing element of the valve needle. For instance, the flow passages 13 have circular cross-sectional shapes but with different diameters and are asymmetricaly positioned on a circle

around the longitudinal axis L.

[0042] Figure 1b shows a cross section of the valve assembly 1 according to the first embodiment in a cross-sectional view on the plane 1b-1b (see Fig. 1a).

[0043] In the present exemplary embodiment, the throttling element 15 comprises six flow passages 13 which have a circular cross-sectional shape and which are substantially arranged in a circle. With respect to a reference line A-A' which imaginarily subdivides the throttling element 15 into a first half (the left half in Fig. 1b) and a second half (the right half in Fig. 1b), there are three flow passages 13 arranged on the left half and only one flow passage 13 on the right half. Two further flow passages 13 are positioned symmetrically with respect to the reference line AA'.

[0044] The three flow passages 13 in the left half have a larger diameter which is larger than the diameter of the flow channel 13 in the right half and also than the diameters of the two flow passages 13 which are positioned symmetrically with respect to the reference line AA'. Hence, with respect to the reference line AA' the flow passages 13 are asymmetricaly arranged around the valve needle 31 or around the longitudinal axis L.

[0045] In the present embodiment, the all flow passages 13 have a central axis which is parallel to the longitudinal axis L. However, it is also possible that one or more flow passages 13 are tilted with respect to the longitudinal axis L to further influence throttling of the fluid flow and the generation of an asymmetrical fluid spray.

[0046] With the valve assembly 1 according to the present embodiment, an asymmetrical fluid spray is simply and reliably achievable during operation. The asymmetrical fluid spray is realized by the asymmetrical arrangement of the flow passages 13 above the seal seat 11 of the fluid outlet portion 9.

[0047] The described valve assembly 1 influences the fluid flow of a streaming fluid and hence a mass distribution of the fluid at the fluid outlet portion 9. Because of the asymmetrical arrangement of the two or more flow passages 13 the fluid can be locally accelerated and modulated. The asymmetrical arrangement of the flow passages 13 enables an asymmetrical fluid spray and hence locally influences the fluid mass and velocity, thus the distribution of the fluid can be controlled. This may influence a penetration of the fluid spray out of the valve assembly 1 or the injection valve 30 into a combustion chamber, for example.

[0048] Such an arrangement of the valve assembly 1 enables side mounting of the outward opening injection valve 30, for example. Outward opening injection valves may be beneficial for side mounting applications because of their robustness against flow drift phenomena produced by coking, for example. Hence, the described valve assembly 1 and injection valve 30 enables multi-stream configurations using outward opening injection valves to better fit a geometrical constraint of a combustion chamber geometry amongst others. Furthermore, it makes a contribution to less sensitiveness to carbon de-

posits over time that lead to tip sooting, for example, and to undesirable change of fluid spray properties.

[0049] Figure 2a shows a longitudinal section view of a valve assembly 1 according to a second exemplary embodiment. Figure 2b shows a cross-sectional view on the plane 2b-2b (see Fig. 2a) of the valve assembly 1 according to the second embodiment. The valve assembly 1 according to the second embodiment corresponds in general to that of the first embodiment.

[0050] In difference to the exemplary embodiment of figures 1a and 1b no separate throttling element 15 is present. Rather the throttling element 15 which also represents the guide element 14 is formed by an integral portion of the valve body 3. In other words, a radially inward protruding portion of the circumferential sidewall of the valve body 3 represents a guide portion 14 for axially guiding the valve needle 31 in the present embodiment. The guide portion 14 also represents a throttling element 15 for restricting and shaping fluid flow through the cavity 5 towards the seal seat 11 during operation of the valve assembly 1.

[0051] An upstream surface of the guide portion 14 represents a bottom surface of the upper cavity portion 6 of the cavity 5 and delimits the upper cavity portion 6 in downstream direction. At the bottom surface, the upper cavity portion 6 merges with the lower cavity portion 7. The lower cavity portion 7 is shaped by an inner lateral surface of the guide portion 14 in the present embodiment. The fluid outlet portion 9 is shaped by a downstream, conical surface of the guide portion 14. The conical surface tapers in upstream direction, i.e. in longitudinal direction towards the lower cavity portion 7.

[0052] The flow passages 13 extend through the guide portion 14 in axial direction so that they penetrate the valve body 3 from the lower cavity portion 7 to the fluid outlet portion 9. They may or may not reach the seal seat 11 and the nozzle tip when the valve needle 31 is in the closed position.

[0053] For example, the flow passages 13 are drilled into the radially inward protruding portion of the sidewall of the valve body 3 which represents the guide element 14 and the throttling element 15. They enable fluid to pass from the lower cavity portion 7 to the fluid outlet portion 9 along the valve needle 31. Drilling may be done by the use of a laser beam or by electrical discharge machining, for example.

[0054] Analogously to the first embodiment, there are six flow passages 13 asymmetrically arranged in a circle around the valve needle 31 and the longitudinal axis L. There are three flow passages 13 on the left half which comprise circular shapes with larger diameter than the one flow passage 13 on the right half with respect to the marked reference line AA'. Further embodiments may comprise other numbers of flow passages 13 which may comprise other shapes than circular ones. The arrangement of the two or more flow passages 13 can also vary from the illustrated one in a circle.

[0055] Such a configuration of the assembly 1 or the

injection valve 30 describes another possibility to realize an asymmetrical fluid spray during operation of the valve assembly 1 or the injection valve 30.

[0056] Figure 3a shows a longitudinal section view of a valve assembly 1 for an injection valve 30 according to a third exemplary embodiment. For simplicity, only the portion on the left side of the longitudinal axis L is shown in Fig. 3a. Fig. 3b shows a cross-sectional view of the valve assembly 1 according to the third embodiment on the plane 3b-3b.

[0057] The valve assembly 1 of the present embodiment corresponds in general to those of the first and second embodiments. Contrary thereto, the throttling element 15 is not positionally fix relative to the valve body 3.

[0058] Rather, the throttling element 15 is in one piece with the valve needle 31. Alternatively, it is conceivable that it is fixedly connected to the valve needle 31. The throttling element 15 may be connected to the valve needle 31 by welding, for example. Alternatively, the throttling element 15 and the valve needle 31 are manufactured from one blank, for example.

[0059] The throttling element 15 is positioned upstream of the seal seat 11. It is also positioned spaced apart from and upstream of the sealing element of the valve needle 31. It protrudes radially outward from a shaft of the valve needle 31. The outline of the shaft of the valve needle 31 is roughly indicated by the dashed circle in Fig. 3b. The shaft protrudes axially from the throttling element 15 on both axial sides. The shaft is in particular in the shape of a cylindrical rod.

[0060] In the present embodiment, the throttling element 15 and the guide element 14 are different from one another, in contrast to the first and second embodiments. The guide element 14 is fixed to or in one piece with the valve needle 31 in the present embodiment. It is positioned upstream and spaced apart from the throttling element 15. Preferably, the valve needle 31 comprises a second guide element (not shown) in an axial end region of the valve needle remote from the sealing element, the guide element 14 and the throttling element 15. By means of the guide element 14 and the second guide element, tilting of the valve needle with respect to the valve body 3 may be prevented.

[0061] The throttling element 15 has a radially outward tapering disc shape in the present embodiment and comprises flow passages 13 which are tilted with respect to the longitudinal axis L (cf. the inclined central axis of the flow channel 13 shown in Fig. 3a).

[0062] The lateral arrangement of the flow passages can be seen in Figure 3b. Similar to the preceding embodiments, there are six flow passages 13 asymmetrically arranged in a circle and penetrate the throttling element 15. But in contrast to the preceding embodiment, each fluid passage 13 has an elliptical cross-sectional shape wherein the three flow passages 13 in the first (left) half as well as the two flow passages on the reference line AA' have a larger cross-section than the one in the second (right) half.

[0063] Figure 4a shows a longitudinal section view corresponding to that of Fig. 3a of a valve assembly 1 and an injection valve 30 according to a fourth exemplary embodiment. Figure 4b shows a cross-sectional view of the valve assembly 1 of the fourth embodiment on the plane 4b-4b which is indicated in Fig. 4a.

[0064] The valve assembly 1 of the fourth embodiment corresponds in general to that of the third embodiment. In difference to that embodiment, there is no separate guide element 14. Instead, the throttling element 15 which is an integral part of the valve needle 31 also represents the guide element 14 which is operable to guide the downstream end portion of the valve needle 31 in axial direction.

[0065] Further, in contrast to the previous embodiment, the flow passages 13 are not spaced apart from the circumferential edges of the throttling element 15. Rather, they are in the shape of grooves in an outer lateral surface of the throttling element 15 which is in sliding mechanical contact with the valve body 3 for axially guiding the valve needle 31. Also, the central axes of the flow channels 13 are not inclined relative to the longitudinal axis L but parallel thereto.

[0066] Figure 4b shows that there are six flow passages 13 in the present embodiment which are asymmetrically arranged in a circle corresponding to the outer circumferential edge of the throttling element 15. As in the previous embodiments, there are three grooves positioned on the left half and one on the right half with respect to the reference line AA' as an exemplary configuration for the asymmetrical arrangement of the flow channels 13. Two more grooves are in line with the reference line AA'.

[0067] The invention is not limited to specific embodiments by the description on basis of these exemplary embodiments. Rather, it comprises any combination of elements of different embodiments. Moreover, the invention comprises any combination of claims and any combination of features disclosed by the claims. In particular, the number of flow passages 13 can vary for different embodiments as well as their geometry. Moreover, combinations of the described embodiments are also possible to realize a desirable throttling of the fluid flow and to enable an asymmetrical fluid spray.

Claims

1. Valve assembly (1) for an injection valve (30), the valve assembly (1) comprising a valve body (3) which has a central longitudinal axis (L) and comprises a cavity (5), the cavity (5) comprising a lower cavity portion (7) and, adjacent to the lower cavity portion (7), a fluid outlet portion (9) with a seal seat (11), wherein the valve assembly (1) comprises two or more flow passages (13) which are arranged radially asymmetrical with respect to the longitudinal axis (L),

- the flow passages (13) are either arranged axially between the lower cavity portion (7) and the seal seat (11) of the fluid outlet portion (9) with respect to the longitudinal axis (L), and penetrate the valve body (3) from the lower cavity portion (7) towards the fluid outlet portion (9) upstream of the seal seat (11)

- or the valve assembly comprises a throttling element (15) which is arranged in the lower cavity portion (7) of the cavity (5) and axially spaced apart from the seal seat (11) and the flow passages (13) penetrate the throttling element (15).

2. Valve assembly (1) in accordance with claim 1, wherein the flow passages (13) penetrate the throttling element (15) and the throttling element (15) comprises a ring shape having an opening for receiving a valve needle (31).

3. Valve assembly (1) in accordance with claim 2, wherein the flow passages (13) are spaced apart from the opening in radial outward direction.

4. Valve assembly (1) in accordance with claim 1 or 2, wherein the flow passages (13) are designed as grooves in a lateral surface of the throttling element (15).

5. Valve assembly (1) in accordance with one of the preceding claims, wherein the flow passages (13) are arranged on a circle which surrounds the longitudinal axis (L).

6. Valve assembly (1) in accordance with one of the preceding claims, wherein the flow passages (13) comprise a circular cross-sectional shape.

7. Valve assembly (1) in accordance with the preceding claim, wherein at least two of the flow passages (13) have different diameters.

8. Valve assembly (1) in accordance with one of the preceding claims, wherein the flow passages (13) are tilted with respect to the longitudinal axis (L).

9. Valve assembly (1) in accordance with one of the preceding claims, further comprising a valve needle (31) which is arranged axially movable in the cavity (5) and which is configured to prevent a fluid flow through the fluid outlet portion (9) in a closing position in coaction with the seal seat (11) and releasing the fluid flow through the fluid outlet portion (9) in further positions.

10. Valve assembly (1) in accordance with the preceding claim, wherein the throttling element (15) is one part of the valve needle (31) or fixedly connected to the valve needle (31).

11. Valve assembly (1) in accordance with claim 9 or 10, wherein the throttling element (15) is configured for guiding the valve needle (31) in axial direction.

12. Injection valve (30) for a combustion engine, comprising a valve assembly (1) in accordance with one of the preceding claims. 5

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FIG 1A

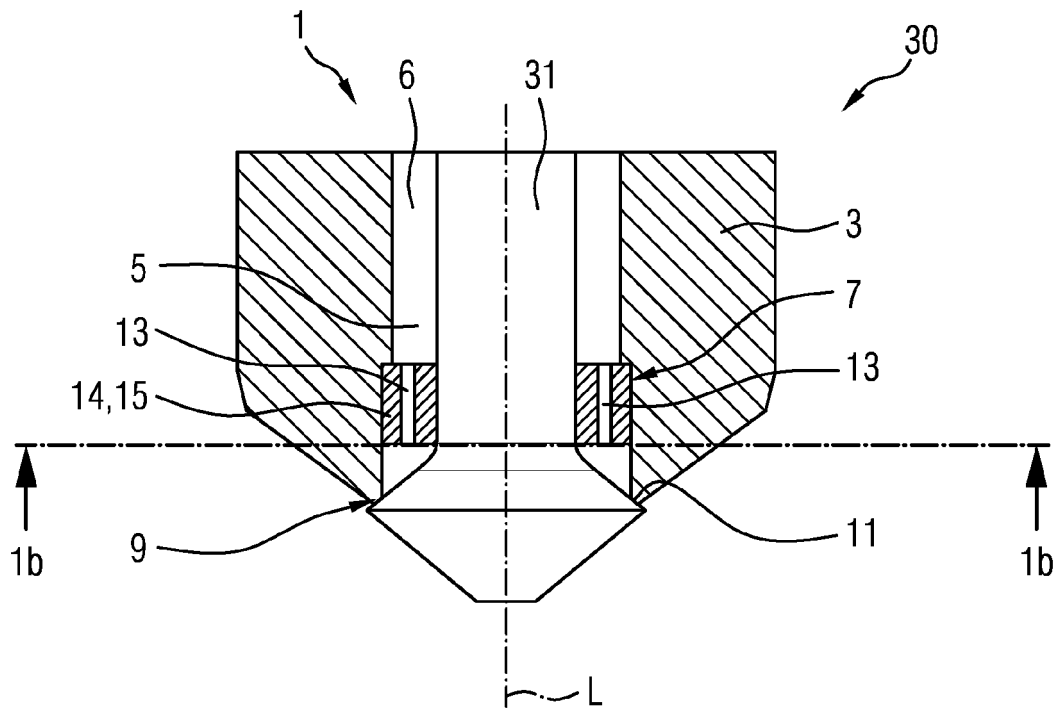


FIG 1B

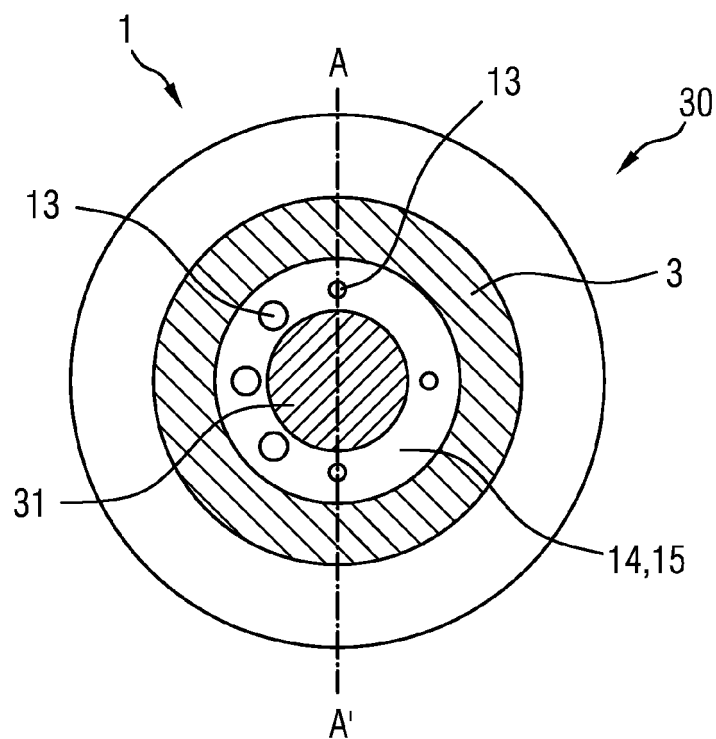


FIG 2A

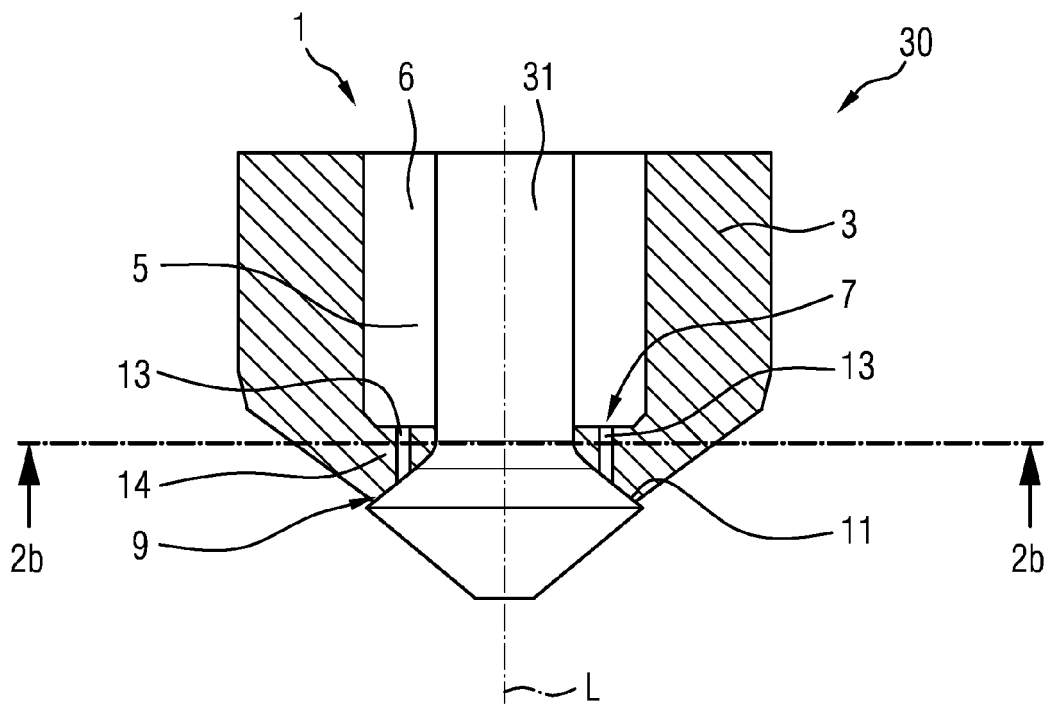


FIG 2B

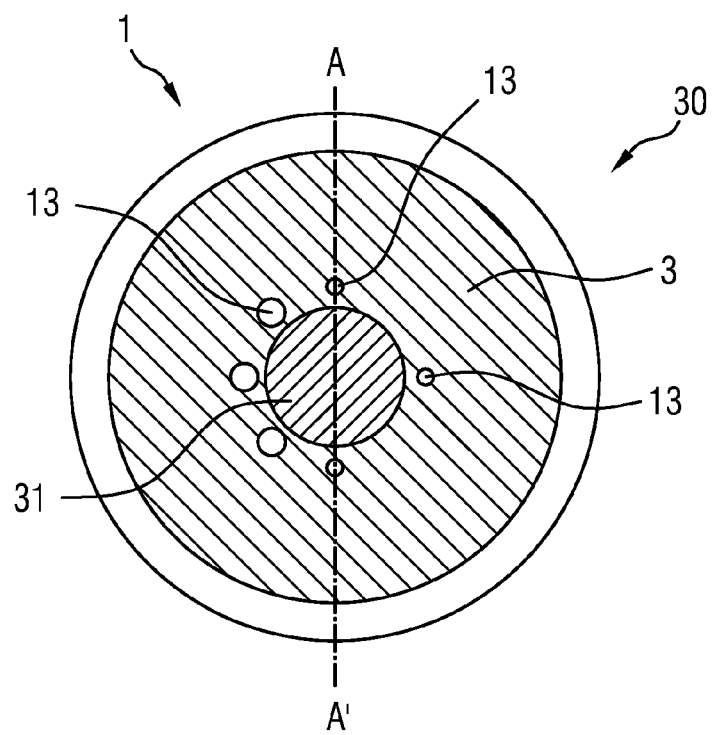


FIG 3A

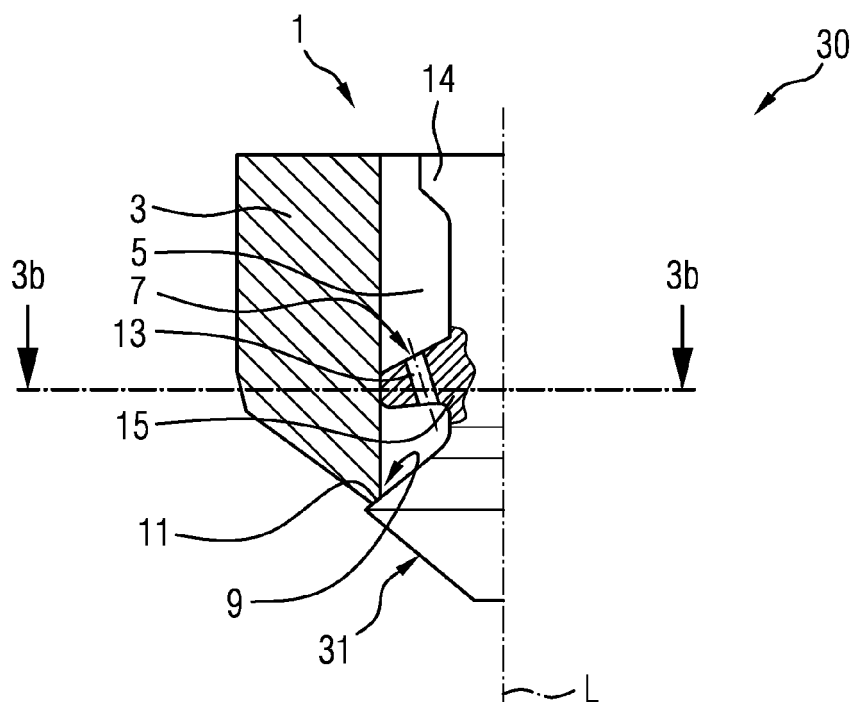


FIG 3B

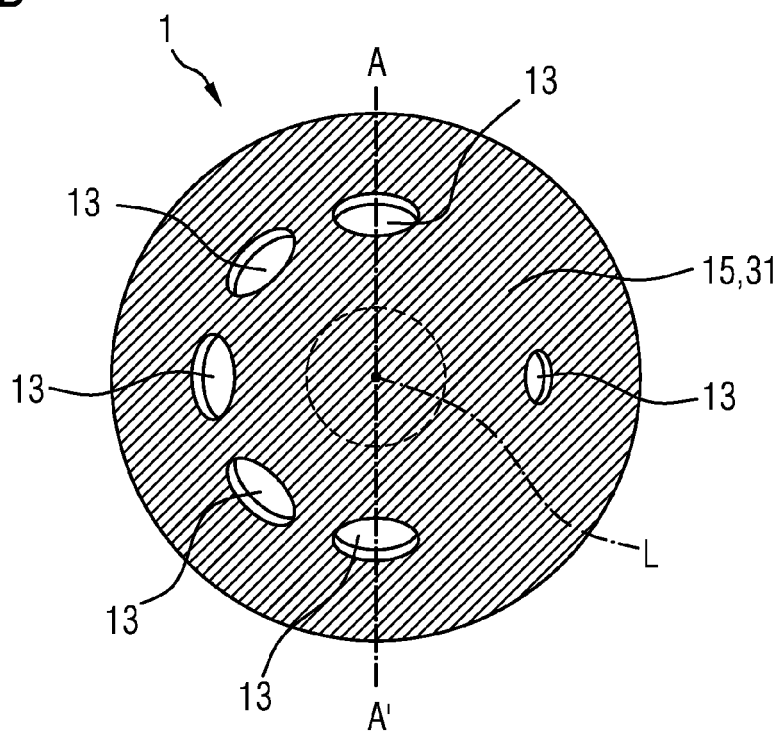


FIG 4A

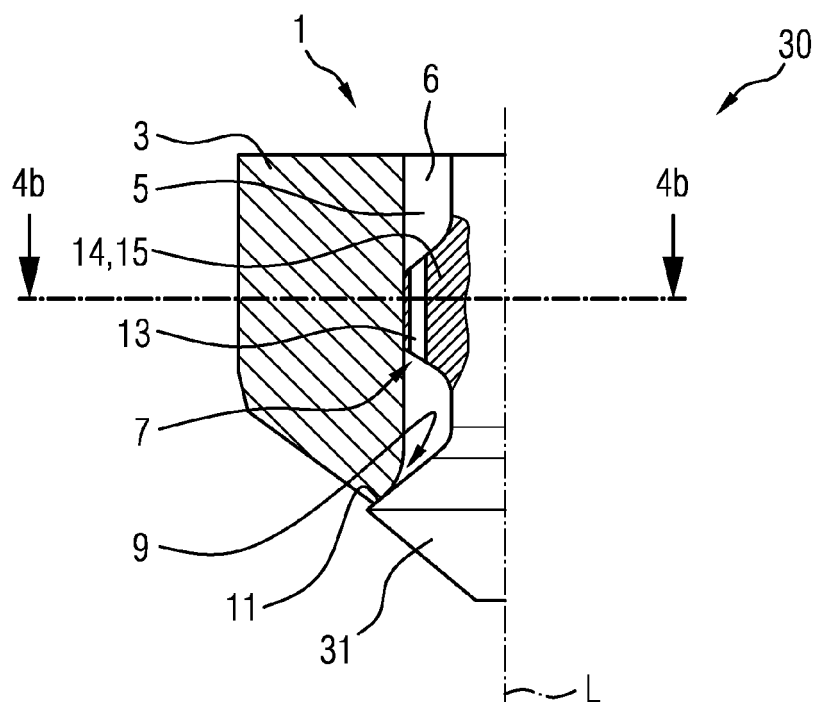
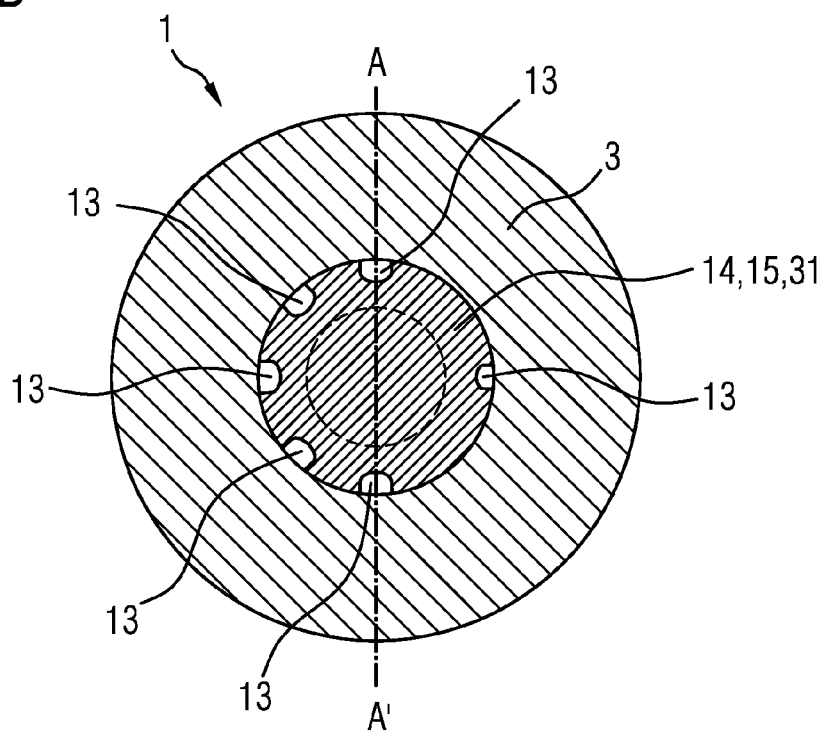


FIG 4B





EUROPEAN SEARCH REPORT

Application Number
EP 15 17 1767

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	US 6 155 499 A (REMBOLD HELMUT [DE] ET AL) 5 December 2000 (2000-12-05) * column 4, line 9 - column 8, line 39 * * abstract; figures 3,16,18,19 *	1-12	INV. F02M61/08 F02M61/12 F02M61/18
Y	DE 101 08 541 A1 (HITACHI LTD [JP]; HITACHI CAR ENG CO LTD [JP]) 6 September 2001 (2001-09-06) * column 14, line 47 - line 60; figures 12a,12b * * abstract *	1-12	
A	EP 1 531 259 A1 (BOSCH GMBH ROBERT [DE]) 18 May 2005 (2005-05-18) * paragraph [0024] - paragraph [0027]; figure 4 * * abstract *	1-12	
A	EP 2 698 527 A1 (CONTINENTAL AUTOMOTIVE GMBH [DE]) 19 February 2014 (2014-02-19) * paragraphs [0007], [0008], [0009], [0026], [0031], [0032]; figures 2-4 *	1-12	TECHNICAL FIELDS SEARCHED (IPC)
A	US 2011/215176 A1 (MEYER ANDREW E [US]) 8 September 2011 (2011-09-08) * paragraph [0040] - paragraph [0044]; figure 4 * * abstract *	1-12	F02M
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 2 October 2015	Examiner Hermens, Sjoerd
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 15 17 1767

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

02-10-2015

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 6155499 A	05-12-2000	CN 1226950 A	25-08-1999
		DE 19633260 A1	19-02-1998
		EP 0918927 A1	02-06-1999
		ES 2174264 T3	01-11-2002
		JP 3737131 B2	18-01-2006
		JP 2000516319 A	05-12-2000
		US 6155499 A	05-12-2000
		WO 9807980 A1	26-02-1998
DE 10108541 A1	06-09-2001	DE 10108541 A1	06-09-2001
		US 2001022170 A1	20-09-2001
EP 1531259 A1	18-05-2005	DE 10353639 A1	16-06-2005
		EP 1531259 A1	18-05-2005
EP 2698527 A1	19-02-2014	EP 2698527 A1	19-02-2014
		WO 2014026872 A1	20-02-2014
US 2011215176 A1	08-09-2011	US 7942349 B1	17-05-2011
		US 2011215176 A1	08-09-2011
		US 2015152821 A1	04-06-2015