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(54) **FUEL INJECTOR AND CONTROL VALVE THEREOF**

(57) A fuel injector and a control valve used in it are disclosed. The control valve comprises: a valve seat defining a valve seating surface and a valve hole extending through a center portion of the valve seating surface in a longitudinal direction, the valve hole and the valve seating surface defining a longitudinal central axis, and the valve hole being in fluid communication with an injection valve of the fuel injector; a valve element configured to be moved between a closed position and an opened position along the longitudinal central axis, the valve element contacting and cooperating with the valve seat in the closed position to close the valve hole, and the valve

element being moved away from the valve seat in the opened position to open the valve hole; and a holding block having an accommodating recess for holding the valve element; wherein the valve element is in the form of a solid of revolution, with the longitudinal central axis being the revolution axis of the solid of revolution, and the solid of revolution having a non-circular section in a longitudinal plane in which the longitudinal central axis lies so that the valve element is able to rotate around the longitudinal central axis but cannot rotate around any transverse central axis that is perpendicular to the longitudinal central axis.

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Description

Technical Field

[0001] The disclosure relates to a control valve used in a fuel injector as well as a fuel injector, in particular a common rail type fuel injector, comprising such a control valve.

Background Art

[0002] A fuel injector generally comprises a control valve and an injection valve, the fuel injection action of the injection valve being controlled by switching the control valve between its opened and closed states. Figure 1 schematically shows a partial structure of such a control valve, the control valve comprising a valve seat 1 which is formed with a valve hole 2 and a valve seating surface 3, a spherical valve element 4 which cooperates with the valve seating surface 3 to achieve the opening and closing of the valve hole 2, and a holding block 5 which accommodates a portion of the valve element 4 and acts to push the valve element 4 towards a position where it closes the valve hole 2. The valve hole 2, the valve element 4 and the holding block 5 are disposed along a central axis Z that extends in a longitudinal direction of the control valve. When the valve element 4 is pushed by the holding block 5 to be biased against the valve seating surface 3, pressure accumulation of the fuel in the injection valve is effected. Once the pushing force from the holding block 5 disappears, the valve element 4 leaves the valve seating surface 3, and a portion of the fuel in the injection valve flows into the control valve via the valve hole 2 so that pressure difference is established in the injection valve and thus a fuel injection action of the injection valve is performed.

[0003] When the valve hole 2 is opened, the valve element 4 is impacted by the fuel introduced from the injection valve via the valve hole 2. As a result, after a long term service, a corrosion portion 6 may be formed at a location of the valve element 4 that faces towards the valve hole 2 due to corrosive impaction of the fuel, as shown in Figure 2. For the reason that the valve element 4 is spherical, the valve element 4 may rotate slowly and randomly around the longitudinal central axis Z and transverse axes that are perpendicular to the longitudinal central axis Z with respect to the holding block 5, as indicated by arrows in this figure. When the corrosion portion 6 is turned to a location facing towards the valve seating surface 3, as shown in Figure 3, the valve element 4 cannot close the valve hole 2 effectively, which impedes the pressure accumulation in the fuel in the injection valve and thus causes malfunction of the fuel injector.

Summary of the Invention

[0004] An object of the disclosure is to make improvements to the fuel injector to alleviate or prevent the above

problems caused by the impact corrosion of the valve element in the prior art.

[0005] According to one aspect of the disclosure, there provides a control valve that can be used in a fuel injector, the control valve comprising: a valve seat defining a valve seating surface and a valve hole extending through a center portion of the valve seating surface in a longitudinal direction, the valve hole and the valve seating surface defining a longitudinal central axis, and the valve hole being in fluid communication with an injection valve of the fuel injector; a valve element configured to be moved between a closed position and an opened position along the longitudinal central axis, the valve element contacting and cooperating with the valve seat in the closed position to close the valve hole, and the valve element being moved away from the valve seat in the opened position to open the valve hole; and a holding block having an accommodating recess for holding the valve element; wherein the valve element is in the form of a solid of revolution, with the longitudinal central axis being the revolution axis of the solid of revolution, and the solid of revolution having a non-circular section in a longitudinal plane in which the longitudinal central axis lies so that the valve element is able to rotate around the longitudinal central axis but cannot rotate around any transverse central axis that is perpendicular to the longitudinal central axis.

[0006] According to a possible embodiment of the disclosure, the valve element comprises a first portion received in the accommodating recess and a second portion exposed from the holding block, and the valve element is able to rotate around the longitudinal central axis by means of form fitting between the first portion and the accommodating recess.

[0007] According to a possible embodiment of the disclosure, also by means of the form fitting between the first portion and the accommodating recess, the valve element is unable to rotate around any transverse central axis that is perpendicular to the longitudinal central axis.

[0008] According to a possible embodiment of the disclosure, by means of form fitting between the second portion and the valve seating surface, the valve element is unable to rotate around any transverse central axis that is perpendicular to the longitudinal central axis.

[0009] According to a possible embodiment of the disclosure, the valve element is an oblate spheroid having a shorter semi-axis length in the longitudinal central axis and a longer semi-axis length in both transverse central axes that are perpendicular to the longitudinal central axis.

[0010] According to a possible embodiment of the disclosure, the control valve further comprises a biasing mechanism configured for selectively applying a pushing force to the holding block so that the valve element is moved towards the closed position under the action of the holding block.

[0011] According to a possible embodiment of the disclosure, the control valve further comprises a returning

mechanism configured for forcing the biasing mechanism to move towards its home location in a direction opposite to the applying direction of the pushing force.

[0012] According to a possible embodiment of the disclosure, the valve element is pushed to the opened position from the closed position under the action of high pressure fuel introduced from an injection valve cavity via the valve hole.

[0013] According to another aspect of the disclosure, there provides a fuel injector, in particular a common rail type fuel injector, comprising a control valve described above and an injection valve assembled to be in combination with the control valve; wherein the injection valve performs fuel injection in responsive to the opened/closed state of the control valve.

[0014] According to a possible embodiment of the disclosure, the injection valve comprises an injection valve cavity and a valve needle disposed in the injection valve cavity; wherein when the valve element of the control valve is in the opened position, a portion of high pressure fuel contained in the injection valve cavity flows into the control valve via the valve hole of the control valve so that a pressure difference is created between front and back sides of the valve needle, and the valve needle moves backwards under the pressure difference to open the injection valve so that a fuel injection action is performed.

[0015] According to the disclosure, by using a non-spherical valve element in the form of a solid of revolution with the revolution axis of it being along the longitudinal central axis, the valve element is able to rotate around the longitudinal central axis, and by means of the fitting between the valve element and the holding block and/or the fitting between the valve element and the valve seating surface, the valve element is unable to rotate around any transverse central axis, so that the valve hole of the control valve, which is in a closed state, can always be effectively closed tightly even if there is any corrosion in the valve element, and the function of the control valve can be reliably maintained in a long term.

Brief Description of the Drawings

[0016]

Figure 1 is a partial schematic sectional view of a control valve used in a fuel injector according to prior art.

Figure 2 is a schematic view for explaining the corrosion and turning of the valve element of the control valve shown in Figure 1.

Figure 3 is a schematic view for explaining a problem caused from the corrosion of the valve element of the control valve shown in Figure 1

Figure 4 is a schematic sectional view of a fuel in-

jector according to a possible embodiment of the disclosure.

Figures 5 to 7 are views of a valve element of a control valve in the fuel injector shown in

Figure 4 taken in different directions.

Figure 8 is a schematic view for explaining the rotation ability of the valve element of the disclosure.

Figure 9 is a schematic view for explaining the corrosion of the valve element of the disclosure.

Figures 10 to 15 are schematic views for explaining some alternative structures of the valve element of the disclosure.

Detailed Description of Preferred Embodiments

[0017] Some possible embodiments of the disclosure will be described with reference to the drawings.

[0018] Figure 4 shows in a partial view a fuel injector for injecting fuel into an engine according to a possible embodiment of the disclosure, in particular a fuel injector used in a common rail type diesel injection system. The fuel injector comprises a control valve and an injection valve, which are assembled together, for example, assembled in a common fuel injector casing 8 (not illustrated in detail). The improvements made in the disclosure relate to the control valve, and so Figure 4 only shows corresponding portions relevant to the control valve. The injection valve is assembled to a front side (lower side in Figure 1) of the control valve, directed to the engine. The control valve is switchable between an opened state and a closed state. The fuel injection actions of the injection valve are controlled by means of the opened and closed states of the control valve.

[0019] The control valve has a central axis Z extending in a longitudinal direction, and comprises a valve seat 1 which is formed with a valve hole 2 extending in the longitudinal direction and a valve seat cavity defined by a valve seating surface 3 and an inner peripheral surface 7. The central axis of the valve hole 2 coincides with the longitudinal central axis Z, and the valve hole 2 has a front end (lower end in Figure 1) opened into an injection valve cavity of the injection valve and a back end (upper end in Figure 1) opened into the valve seat cavity. High pressure fuel that is supplied into the injection valve cavity can flow into the valve seat cavity via the valve hole 2 to create partial pressure relief in the injection valve cavity. The valve seating surface 3 is formed between the valve hole 2 and the inner peripheral surface 7. Both the valve seating surface 3 and the inner peripheral surface 7 are conical surfaces, with the valve seating surface 3 having a bigger cone angle than the inner peripheral surface 7.

[0020] The control valve further comprises a valve element 4 in the form of an oblate spheroid which is formed

by rotating an ellipse around the central axis Z, the valve element 4 being located in the valve seat cavity, facing the valve seating surface 3, and cooperating with the valve seating surface 3 to achieve the opening and closing of the valve hole 2. The cone angle of the valve seating surface 3 facilitates self-centering of the valve element 4. The oblate spheroid forming the valve element 4 has a shorter semi-axis length along the longitudinal central axis Z and two longer semi-axis lengths (the two longer semi-axis lengths being equal to each other) along transverse central axes X, Y that are perpendicular to the longitudinal central axis Z so that the valve element 4 has an elliptical section in a front view (Figure 5) and a side view (Figure 6), both taken perpendicular to the longitudinal central axis Z, and a circular section in a top view (Figure 7) taken along the longitudinal central axis Z.

[0021] The control valve further comprises a holding block 5, which is located axially behind the valve element 4 and is formed with an accommodating recess, the accommodating recess having a shape corresponding to the outer shape of a first portion (substantially the back half portion) of the valve element 4 for accommodating the first portion of the valve element 4, and a second portion (substantially the front half portion) of the valve element 4 being exposed and facing the valve seating surface 3 and the valve hole 2. The two portions of the valve element 4 may be formed to be integral with each other, or be formed separately and then assembled to each other.

[0022] The control valve further comprises an intermediate ring 9 disposed behind the valve seat 1 and a guiding tube 10 disposed behind the intermediate ring 9. The guiding tube 10 comprises a tubular portion 10a extending in the axial direction and a flange portion 10b extended radially outwards from a front end of the tubular portion 10a, the flange portion 10b being formed with a plurality of through holes 10c extending therethrough axially.

[0023] The control valve further comprises an assembling sleeve 11 disposed behind the flange portion 10b, the assembling sleeve 11 being fixed in the fuel injector casing 8 by screw threads or other means. A circular space is formed between the assembling sleeve 11 and the tubular portion 10a. In addition, a front end of the valve seat 1 is biased against a corresponding step in the fuel injector casing 8. In this way, the valve seat 1, the intermediate ring 9 and the guiding tube 10 are clamped together in the axial direction by means of the assembling sleeve 11.

[0024] The control valve further comprises an armature core 12 having a main body in the form of a cylinder extending in the axial direction and a circular flange 12a formed adjacent to a front end of the main body or assembled thereto and extending radially. The main body of the armature core 12 is inserted through an inner hole in the tubular portion 10a in an axially slidable manner, with the circular flange 12a being in front of the flange portion 10b and mainly within an internal space of the intermediate ring 9. The internal space of the intermedi-

ate ring 9 is in fluid communication with the circular space between the assembling sleeve 11 and the tubular portion 10a via the through holes 10c, and the internal space of the intermediate ring 9 is also in fluid communication with the valve seat cavity.

[0025] The front end of the main body of the armature core 12 abuts against a back end of the holding block 5. A back end (not shown) of the main body of the armature core 12 extends out of a back end of the tubular portion 10a. A compressive spring 13 is disposed in the circular space between the assembling sleeve 11 and the tubular portion 10a, the compressive spring 13 having a front end biased against a back end surface of the flange portion 10b and a back end applying an axially backward pushing force to the back end of the main body of the armature core 12 via an element or structure not shown.

[0026] The control valve further comprises a magnetic coil which generates an axially forward pushing force in the armature core 12 by electric-magnetic induction in an energized state. The forward pushing force generated in the magnetic coil overcomes a backward pushing force provided by the compressive spring 13 and the fuel pressure in the valve hole 2 so that the armature core 12 is in an advanced position as shown in Figure 4 and thus pushes the valve element 4 against the valve seating surface 3 via the holding block 5 to close the valve hole 2 and achieve the closed state. In this position, the back end surface of the circular flange 12a is separated from a front end surface of the flange portion 10b by a small axial distance. For the sake of clarity, this axial distance is shown in a larger scale in Figure 4, but it is very small in actual. Once the magnetic coil is de-energized, the forward pushing force generated by the magnetic coil disappears, and the armature core 12 is moved axially backwards under the backward pushing force of the compressive spring 13 and the fuel pressure in the valve hole 2 until the back end surface of the circular flange 12a comes into contact with the front end surface of the flange portion 10b. Meanwhile, the valve element 4 moves axially backwards together with the armature core 12 under the action of the fuel pressure in the valve hole 2 to leave the valve seating surface 3 and open the valve hole 2, so the control valve is switched to the opened state.

[0027] The above components of the control valve have their central axes generally along the longitudinal central axis Z.

[0028] The injection valve comprises a valve needle (not shown) disposed in its injection valve cavity, and the opening and closing of the injection valve is controlled by the axial movement of the valve needle to perform fuel injection. When the magnetic coil in the control valve is energized so that the control valve comes into the closed state shown in Figure 4, the fuel (for example, comes from a common rail) supplied into the injection valve cavity is under a pressure accumulation state, so that ultimately every portion of the injection valve cavity becomes under high pressure, and then the valve needle in the injection valve closes the injection valve. After that,

the magnetic coil in the control valve is de-energized so that the control valve comes into the opened state, so a portion of the fuel in the injection valve cavity flows into the control valve via the valve hole 2. This results in lowering down of the fuel pressure behind the valve needle, so that a pressure difference is created between front and back sides of the valve needle. Under this pressure difference, the valve needle moves backwards to open the injection valve, so a fuel injection action is performed. The fuel that flows into the control valve via the valve hole 2 will then flow through the valve seat cavity, the internal space of the intermediate ring 9, the through holes 10c, and the circular space between the assembling sleeve 11 and the tubular portion 10a in sequence, and finally flows back to a fuel tank. Then, the magnetic coil in the control valve is energized again so that the control valve comes to the closed state again, and thus the injection valve is switched to the pressure accumulation state until the fuel pressures at the front and back sides of the valve needle become the same level. Now the valve needle closes the injection valve under the action of a returning element for the valve needle. Then, the next fuel injection action will be performed.

[0029] In the embodiment described above, the forward pushing force applied to the holding block 5 is generated by the magnetic coil and the armature core 12. It is appreciated that, however, other forms of biasing mechanisms may alternatively be used for applying a forward pushing force to the holding block 5 so that the valve element 4 is biased against the valve seating surface 2 to close the valve hole 2.

[0030] In addition, in the embodiment described above, the armature core 12 returns to its home position by means of the compressive spring 13 to release the forward pushing force applied to the holding block 5. It is appreciated that other forms of returning mechanisms may alternatively be used for forcing the biasing mechanism to move back to its home position so that the valve element 4 can leave the valve seating surface 3 to open the valve hole 2.

[0031] In addition, it is noted that, since there is a fuel film between the armature core 12 and the holding block 5, and the holding block 5 is always subjected to a fuel pressure from the valve hole 2 (directly, or transmitted from the valve element 4 to the holding block 5), the holding block 5 always keeps to be adhered to the armature core 12 when the armature core 12 moves. In order to guarantee proper alignment between the holding block 5 and the armature core 12, a locating structure of the type of form fitting may be provided at the interface between them.

[0032] As shown in Figure 8, for the reason that the valve element 4 of the disclosure is in the form of an oblate spheroid with the longitudinal central axis Z as its revolution axis, and that the holding block 5 is formed with the accommodating recess for accommodating and forming form fitting with the first portion of the valve element 4, the valve element 4 has the ability of rotating

slowly around the longitudinal central axis Z with respect to the holding block 5 and the valve seat 1, as indicated by the arrow in this figure, but the valve element 4 is unable to rotate around the two transverse central axes X, Y.

[0033] When the control valve is being switched from closed state to the opened state, as the valve element 4 leaves the valve seating surface 3 axially backwards, the high pressure fuel comes from the injection valve via the valve hole 2 will impact the valve element 4 in the form of jet flow. During long term operation, the jet flow, which is mainly fuel in gas state, a portion of the valve element 4 that faces towards the valve hole 2 is subjected to corrosive impaction and thus a corrosion portion 6 will be formed, as shown in Figure 9. However, since the valve element 4 is not able to rotate around its transverse central axes X, Y, the corrosion portion 6 always faces towards the valve hole 2 and cannot come to a position facing the valve seating surface 3 even if the valve element 4 rotates around the longitudinal central axis Z. In this way, even if the corrosion portion 6 is formed on the valve element 4, it will not result in closing deficiency of the valve hole 2. In addition, thanks for the ability of being only able to rotate around the longitudinal central axis Z of the valve element 4, which is in the form of an oblate spheroid around the longitudinal central axis Z, the contact portion of the valve element 4 and the valve seating surface 3 is always a complete circle, which effectively guarantees that the control valve is closed tightly in the closed state, so the function of the control valve will not be lowered down.

[0034] In the embodiments of the valve element 4 as described above, by means of the fitting between the oblate spheroidal valve element 4 and the holding block 5, the valve element 4 is restricted from rotating around any transverse central axis. It is appreciated that the valve element 4 may alternatively be in the form of other solids of revolution to achieve the same function.

[0035] For example, in the embodiment shown in Figure 10, the valve element 4 is formed by combination of a first portion in the form of a half oblate spheroid fitted in the holding block 5 and a second portion in the form of a semi sphere exposed from the holding block 5, the two portions each having the longitudinal central axis Z as its revolution axis. By means of the fitting between the first portion which is in the form of a half oblate spheroid and the accommodating recess of the holding block 5, the valve element 4 has the ability of rotating around the longitudinal central axis Z but does not have the ability of rotating around any transverse central axis.

[0036] In the embodiment shown in Figure 11, the valve element 4 is formed by combination of a first portion in the form of a truncated cone fitted in the holding block 5 and a second portion in the form of a semi sphere exposed from the holding block 5, the two portions each having the longitudinal central axis Z as its revolution axis. By means of the fitting between first portion in the form of a truncated cone and the accommodating recess

in the holding block 5, the valve element 4 has the ability of rotating around the longitudinal central axis Z but does not have the ability of rotating around any transverse central axis.

[0037] In the embodiment shown in Figure 12, the valve element 4 is formed by combination of a first portion in the form of a cylinder fitted in the holding block 5 and a second portion in the form of a semi sphere exposed from the holding block 5, the two portions each having the longitudinal central axis Z as its revolution axis. By means of the fitting between first portion in the form of a cylinder and the accommodating recess in the holding block 5, the valve element 4 has the ability of rotating around the longitudinal central axis Z but does not have the ability of rotating around any transverse central axis.

[0038] Other shapes (including combined shapes) of the first portion for obtaining the above function can also be contemplated.

[0039] As an alternative to the solutions described above in which the ability of the valve element 4 rotating around the transverse central axes is eliminated by means of the fitting between the valve element 4 and the holding block 5 (which can be referred to as static fitting since the fitting state between the valve element 4 and the holding block 5 is always maintained), the ability of the valve element 4 rotating around the transverse central axes may be eliminated by means of the fitting between the valve element 4 and the valve seating surface 3 (which can be referred to as dynamic fitting since the fitting between the valve element 4 and the valve seating surface 3 only exists when the control valve is closed). For example, in the embodiment shown in Figure 13, a first portion of the valve element 4 fitted in the holding block 5 is in the form of a semi sphere, and a second portion exposed from the holding block 5 has a main body in the form of substantial cylinder, with a front peripheral portion (the transition portion between the cylindrical surface and a flat front end surface) of the second portion forming a conical portion 4a. The conical portion 4a has a cone angle equal to the cone angle of the valve seating surface 3, and thus forms sealing contact with the valve seating surface 3. When the control valve is closed, the holding block 5 transmits the axially forward pushing force induced by the magnetic coil on the armature core 12 to the valve element 4 to forcefully pushing the valve element 4 against the valve seating surface 3, so the valve element 4 is automatically centered by means of the fitting between the conical portion 4a and the valve seating surface 3. In this way, any possible micro rotation of the valve element 4 around any transverse central axis can be eliminated, and thus the portion of the valve element 4 that faces towards the valve hole 2 cannot be misplaced transversely.

[0040] In the embodiment shown in Figure 14, a first portion of the valve element 4 fitted in the holding block 5 is in the form of a semi sphere, and a second portion exposed from the holding block 5 is in the form of a substantial cone. In addition, a portion of the valve seating

surface 3 that is corresponding to the second portion of the valve element 4 is reformed to have the same cone angle with the second portion of the valve element 4. In this way, the valve element 4 is automatically centered by means of the dynamic fitting between the second portion of the valve element 4 and corresponding portion of the valve seating surface 3, so any possible micro rotation of the valve element 4 around any transverse central axis can be eliminated.

[0041] Other shapes (including combined shapes) of the second portion for obtaining the above function can also be contemplated, so that solutions in which the ability of the valve element 4 rotating around the transverse central axes is prevented by means of various dynamic fitting manners can be designed out. In these cases, the ability of the valve element 4 rotating around the longitudinal central axis Z is also provided by means of the fitting between the first portion of the valve element 4 and the accommodating recess in the holding block 5.

[0042] In addition, it is contemplated that the solution comprising the static fitting between the valve element 4 and the holding block 5 can be combined with the solution comprising the dynamic fitting between the valve element 4 and the valve seating surface 3 to prevent the rotation of the valve element 4 around the transverse central axes. For example, in the embodiment shown in Figure 15, a first portion of the valve element 4 fitted in the holding block 5 is in the form of a truncated cone (similar to that shown in Figure 11), and a second portion exposed from the holding block 5 has a main body in the form of substantial cylinder with a front peripheral portion formed as a conical portion 4a (similar to that shown in Figure 13). In this way, the ability of the valve element 4 rotating around any transverse central axis is eliminated by means of the static fitting between the first portion of the valve element 4 and the holding block 5, and the valve element 4 is given the automatic centering ability thanks for the fitting between the second portion of the valve element 4 and the valve seating surface 3, so the valve element 4 is additionally prevented from rotating around any transverse central axis. Other combined fitting solution can also be contemplated.

[0043] It can be seen that the valve element 4 possesses the ability of rotating around the longitudinal central axis (which provides flexibility in the assemble and operation of the control valve) by forming the valve element 4 as a solid of revolution with the longitudinal central axis Z as its revolution axis, but the valve element 4 has a non-circular section in any longitudinal plane that passes through the longitudinal central axis Z. In addition, by means of the fitting (static fitting) between the valve element 4 and the holding block 5 and/or the fitting (dynamic fitting) between the valve element 4 and the valve seating surface 3, the rotation of the valve element 4 around any transverse central axis is prevented. As a result, the portion of the valve element 4 that faces towards the valve hole 2 is maintained to be not misplaced in any transverse direction and thus cannot moves to a position facing the

valve seating surface 3. Even if corrosion is formed on the portion of the valve element 4 that faces towards the valve hole 2 by fuel impaction, the valve element 4 always effectively guarantee that the valve hole of the control valve is tightly closed when the control valve is in the closed state, so the function of the control valve can be maintained in a long time. As a result, the service time of the control valve, or even of the whole fuel injector, can be prolonged.

[0044] Although the disclosure has been described above with reference to some preferred embodiments, the disclosure is not limited to the described details. Various modifications to the details can be made without departing from the spirit of the disclosure.

Claims

1. A control valve used in a fuel injector, comprising:

a valve seat (1) defining a valve seating surface (3) and a valve hole (2) extending through a center portion of the valve seating surface (3) in a longitudinal direction, the valve hole (2) and the valve seating surface (3) defining a longitudinal central axis (Z), and the valve hole (2) being in fluid communication with an injection valve of the fuel injector;

a valve element (4) configured to be moved between a closed position and an opened position along the longitudinal central axis (Z), the valve element (4) contacting and cooperating with the valve seat (1) in the closed position to close the valve hole (2), and the valve element (4) being moved away from the valve seat (1) in the opened position to open the valve hole (2); and a holding block (5) having an accommodating recess for holding the valve element (4);

wherein the valve element (4) is in the form of a solid of revolution, with the longitudinal central axis (Z) being the revolution axis of the solid of revolution, and the solid of revolution having a non-circular section in a longitudinal plane in which the longitudinal central axis (Z) lies so that the valve element (4) is able to rotate around the longitudinal central axis (Z) but cannot rotate around any transverse central axis that is perpendicular to the longitudinal central axis (Z).

2. The control valve of claim 1, wherein the valve element (4) comprises a first portion received in the accommodating recess and a second portion exposed from the holding block (5), and the valve element (4) is able to rotate around the longitudinal central axis (Z) by means of form fitting between the first portion and the accommodating recess.

3. The control valve of claim 2, wherein, also by means of the form fitting between the first portion and the accommodating recess, the valve element (4) is unable to rotate around any transverse central axis (X, Y) that is perpendicular to the longitudinal central axis (Z).

4. The control valve of claim 2 or 3, wherein, by means of form fitting between the second portion and the valve seating surface (3), the valve element (4) is unable to rotate around any transverse central axis (X, Y) that is perpendicular to the longitudinal central axis (Z).

5. The control valve of any one of claims 1 to 4, wherein the valve element (4) is an oblate spheroid having a shorter semi-axis length in the longitudinal central axis (Z) and a longer semi-axis length in both transverse central axes (X, Y) that are perpendicular to the longitudinal central axis (Z).

6. The control valve of any one of claims 1 to 5, further comprising a biasing mechanism configured for selectively applying a pushing force to the holding block (5) so that the valve element (4) is moved towards the closed position under the action of the holding block (5).

7. The control valve of claim 6, further comprising a returning mechanism configured for forcing the biasing mechanism to move towards its home location in a direction opposite to the applying direction of the pushing force.

8. The control valve of claim 6 or 7, wherein the valve element (4) is pushed to the opened position from the closed position under the action of high pressure fuel introduced from an injection valve cavity via the valve hole (2).

9. A fuel injector, in particular a common rail type fuel injector, comprising:

a control valve of any one of claims 1-8; and an injection valve assembled to be in combination with the control valve;

wherein the injection valve performs fuel injection in responsive to the opened/closed state of the control valve.

10. The fuel injector of claim 9, wherein the injection valve comprises an injection valve cavity and a valve needle disposed in the injection valve cavity; and wherein when the valve element (4) of the control valve is in the opened position, a portion of high pressure fuel contained in the injection valve cavity flows into the control valve via the valve hole (2) of the

control valve so that a pressure difference is created between front and back sides of the valve needle, and the valve needle moves backwards under the pressure difference to open the injection valve so that a fuel injection action is performed.

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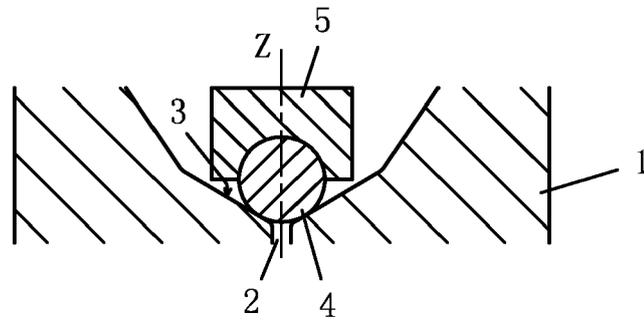


Figure 1

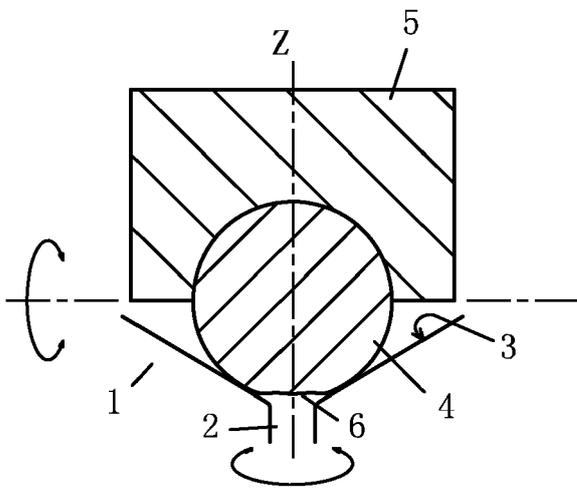


Figure 2

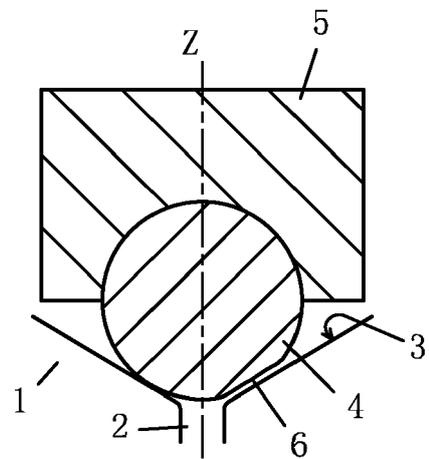


Figure 3

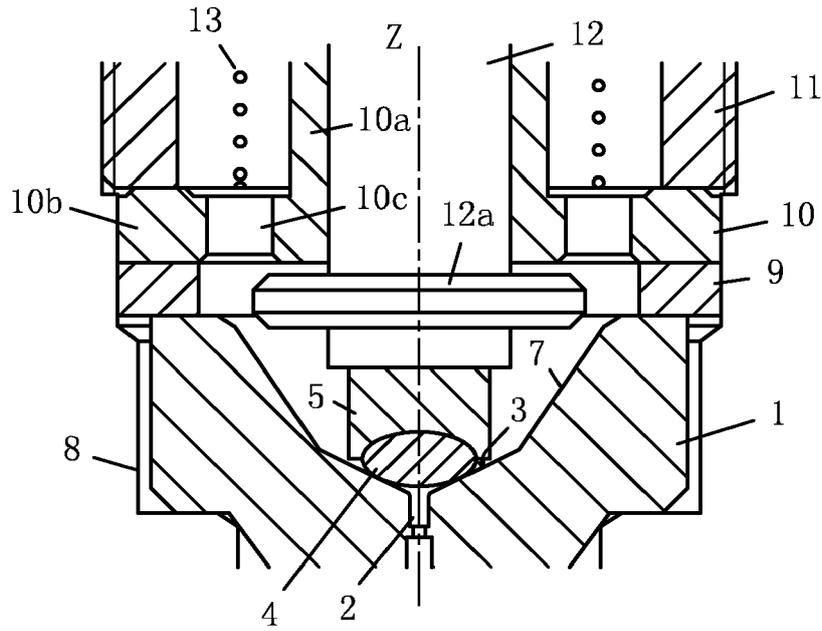


Figure 4

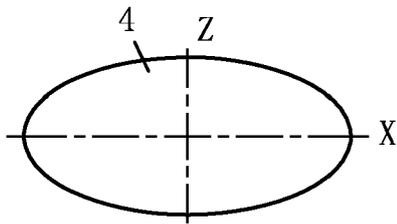


Figure 5

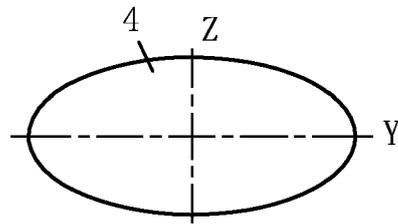


Figure 6

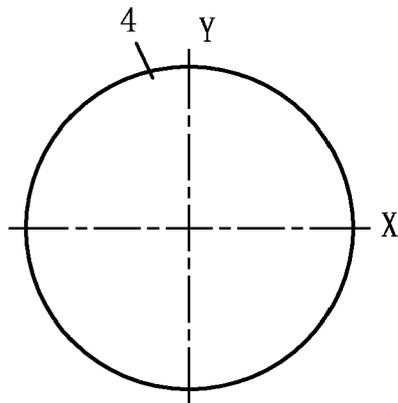


Figure 7

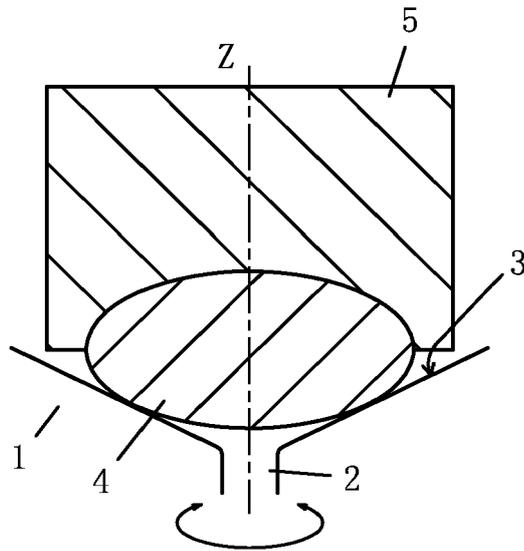


Figure 8

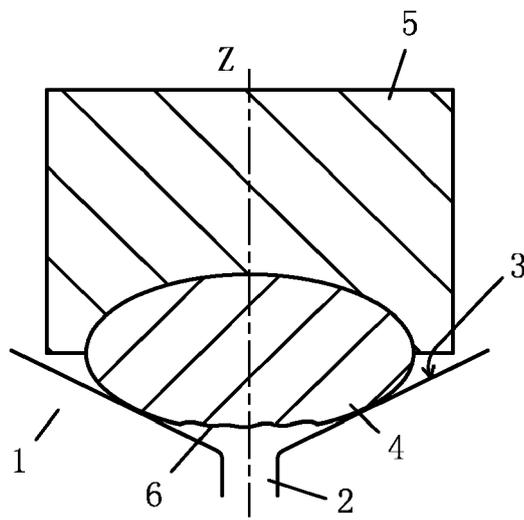


Figure 9

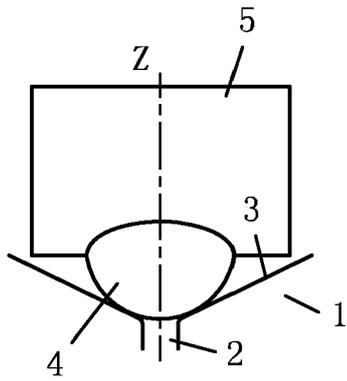


Figure 10

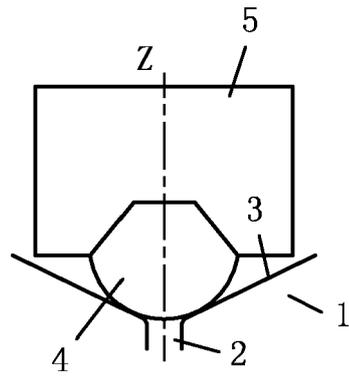


Figure 11

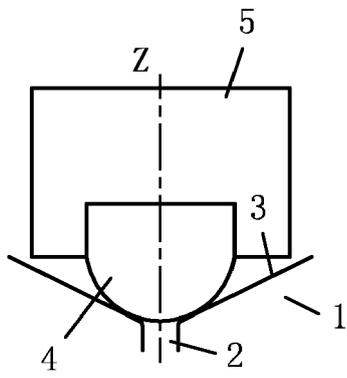


Figure 12

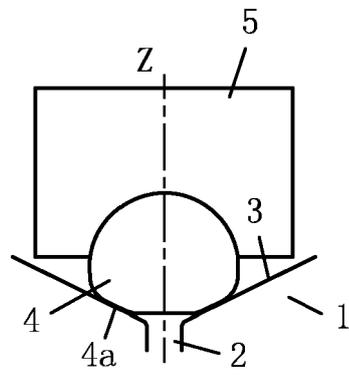


Figure 13

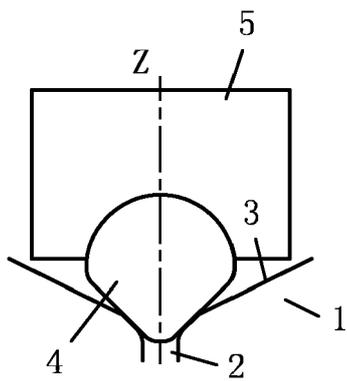


Figure 14

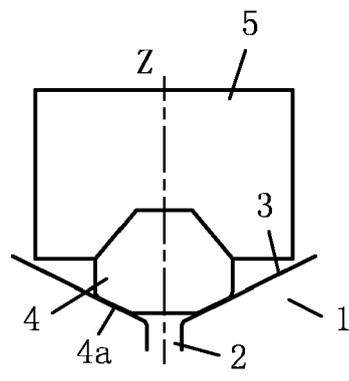


Figure 15



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Application Number
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			F02M
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 15 July 2016	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	

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