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(54) **Electromagnetic valve**

(57) An electromagnetic valve (10) includes a valve member (14) located within a valve body (16), and adapted to move in slidable manner within a bore defined in the valve body (16). The movement of the valve member (14) is selectively allowing fluid/fuel flow within the electromagnetic valve (10). The valve body (16) includes a central longitudinal axis (L). The valve member (14) is operatively connected to a valve armature (12), such that

activation/deactivation of the valve armature (12) provides the slidable movement of the valve member (14). The valve armature (12) is generally of cylindrical form having an upper face and a lower face wherein the valve body (16) includes an armature chamber (28) within which the valve armature (12) is located. A substantial portion of said upper face (18) of the valve armature (12) is sloped outwardly from said central axis (L).

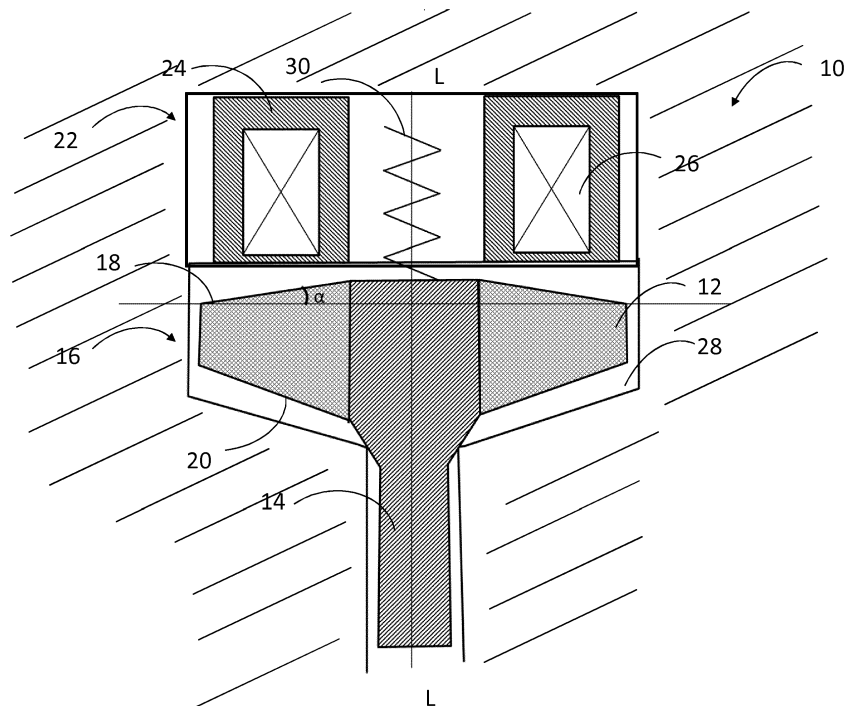


Figure 2

Description

TECHNICAL FIELD OF THE INVENTION

[0001] This disclosure relates to electromagnetic valves and has particular, but not exclusive application, to electromagnetic valves for a fuel injector, such as for, but not limited to, automotive applications.

BACKGROUND OF THE INVENTION

[0002] Known fuel injectors generally comprise member such as a valve needle slidable within a bore to control flow of fuel. In common arrangements the valve needle is arranged to lift away from a valve seat to allow fuel under pressure from a supply passage to be dispensed in a combustion space/chamber. Conversely to close the valve the needle is forced onto the valve seat. In other examples, a valve member may be generally slidably located to control flow of fuel. Typically movement of the valve needle/member movement is provided by electromagnetic (solenoid) actuation means. The movable valve member will include an armature portion, and in typical designs this armature is attached to a valve needle or valve stem (portion). Movement of the valve member is provided by electromagnetic attraction of the armature towards the actuator, typically against an actuator spring acting in the opposite direction. The attraction force applied at the peripheral edge of a valve armature is in the order of 30N, whilst the valve stem is urged toward down by the actuator spring with a force in the order of 20 N. Through time, it has been observed for valve armatures comprising flat upper faces, as a result of such high magnetic forces applied from the actuator, a deformation on the valve armature occurs in the form of a slightly concave shape of the upper face of the valve armature.

[0003] As a result of such deformation, the fuel within the area between the valve armature face and the actuator does not drain efficiently. The remaining fuel between the valve armature and the electromagnetic actuator results in having a slower motion of the valve, resulting in difficulty to control opening and closing sequences of short duration for pilot injections (such as e. g. in the order of 100 μ s) where small quantities of fuel are to be injected into the combustion chamber before a main injection.

[0004] It is an object of the invention to provide an improved electromagnetic valve that overcomes such problems.

SUMMARY OF THE INVENTION

[0005] In one aspect of the invention is provided an electromagnetic valve including a valve member located within a valve body, and adapted to move in slidable manner within a bore defined in the valve body, movement of the valve member selectively allowing fluid/fuel flow within said electromagnetic valve.

The valve body may include a central longitudinal axis. The valve member may operatively be connected to a valve armature, such that activation/deactivation of the valve armature provides the slidable movement of said valve member. The valve armature may be generally of cylindrical form having an upper face and a lower face wherein the valve body includes an armature chamber within which the valve armature is located. A substantial portion of said upper face of the valve armature may be sloped outwardly from the central axis and/or wherein the side wall of the armature chamber and/or the valve armature is sloped.

[0006] The upper face of the valve armature may be convex. The upper face of the valve armature may be of conically form. The upper face of the valve armature may be curved.

[0007] The electromagnetic valve may include an angle (α) between the upper face of the valve armature and a horizontal plane being between 1° - 9°. The angle (α) may be between 3° - 7°. The angle (α) may be between 4° - 6°. The side wall of the armature chamber and/or the valve armature may be sloped. A fuel injector includes an electromagnetic valve.

[0008] Further features, uses and advantages of the invention will appear more clearly on a reading of the following detailed description of the embodiments of the invention, which is given by way of non-limiting example only and with reference to the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] This invention will be further described by way of example and with reference to the accompanying drawings in which:

Figure 1 is a cross-sectional view showing prior art of an electromagnetic valve.

Figure 2 is a cross-sectional view showing an embodiment of an electromagnetic valve, in accordance with an example of the invention.

Figure 3 is a cross-sectional view showing an embodiment of an electromagnetic valve, in accordance with another example of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0010] Figure 1 shows a conventional portion of an electromagnetic valve 10. The electromagnetic valve 10 includes a valve member 14 located within a valve body 16, and adapted to move in a slidable manner within a bore defined in the valve body 16. The valve body 16 includes a central longitudinal axis L. The movement of the valve member 14 selectively allows fluid/fuel flow within the electromagnetic valve 10. The valve member 14 is operatively connected to a valve armature 12, such that

an activation/deactivation of such valve armature 12 provides the movement of the valve member 14. The valve armature 12 is generally of cylindrical form having an upper face 18 and a lower face 20. The valve body 16 includes an armature chamber 28 within which the valve armature 12 is located. The valve armature 12 is located below an electromagnetic actuator 22 which includes a fixed core 24, an excitation coil 26 and a return spring 30. Such an electromagnetic actuator 22 provides an electromagnetic attraction (force) on the valve armature 12 to provide an upwards force and movement of the valve member 14 against the force of the spring 30.

[0011] Figure 2 shows a portion of an electromagnetic valve 10 according to one embodiment of the invention. Again the electromagnetic valve 10 includes a valve member 14 located within a valve body 16, and adapted to move in a slidable manner within a bore define in the valve body 16. The valve body 16 includes a central longitudinal axis L. The movement of the valve member 14 is selectively allowing fluid/fuel flow within the electromagnetic valve 10. The valve member 14 is operatively connected to a valve armature 12, such that an activation/deactivation of the valve armature 12 provides the movement of the valve member 14. Although in the figure 2 the valve armature 12 and the valve member 14 are shown as one piece, they may alternatively embodied in two pieces. The valve armature 12 is generally of cylindrical form having an upper face 18 and a lower face 20. The valve body 16 includes an armature chamber 28 within valve armature 12 is located. The valve armature 12 is located below an electromagnetic actuator 22 which includes a fixed core 24, an excitation coil 26 and a return spring 30. Such electromagnetic actuator 22 allows the movement of the valve member 14 by electromagnetic attraction of the valve armature 12. The lower face 20 of the valve armature is generally conical in form. The upper face 18 of the valve armature 12 is sloped outwardly from the central axis L. As example, upper face 18 of the valve armature 12 can be convex in shape, curved in shape or having a conically form sloping upwards. Such shape of the upper face 18 of the valve armature 12 allows an efficient draining of the fuel/liquid between the upper face 18 of the valve armature 12 and the electromagnetic actuator 22. The magnetic force coming from the electromagnetic actuator 22 is now applying mostly on the center area of the armature. Such shape of the upper face 18 of the valve armature 12 gives also benefits to have a higher level of stiffness, thus less deformable, deformation being due to magnetic force. The global benefit of such electromagnetic valve 10 is that the valve motion is better, thus valve is quicker (closing and opening phases). As example for fuel injector, the fuel delivery in a combustion chamber is better controlled, especially on small quantities like pilot injections.

[0012] The outward slope from the central axis L of the upper face 18 of the valve armature 12 may be defined by an angle α between the upper face 18 of the valve armature 12 and a horizontal plane. The larger the angle

α , the smaller is the deformation induced by the electromagnetic force on the upper face 18 of the valve armature 12. But, on the other hand, the bigger the angle α , the greater is the needed electromagnetic force to attract the valve armature 12. Therefore there will be tradeoff with respect to the angle α . Preferably, the value of the angle α is within the interval $1^\circ - 9^\circ$. A tradeoff could be applied on the angle α and so a reduced interval of the angle α within $3^\circ - 7^\circ$ can be applied. In case of having the possibility to manufacture valve armature 12 with high accuracy of geometries properties, the angle α can vary within the interval $4^\circ - 6^\circ$.

[0013] Figure 3 shows an embodiment similar to that of figure 2, where a substantial portion of the side wall of the armature chamber 28 and/or the side wall of the valve armature 12 is sloped, at least along a substantial portion thereof. The slope is such that the diameter of the chamber armature 28 narrows towards the lower/distal portion(s) thereof. The side wall of the armature chamber 28 and the side wall of the valve armature may be substantially parallel. This gives the benefit of better flow of the fuel by avoiding sharp corners.

Claims

1. An electromagnetic valve (10) including:

a valve member (14) located within a valve body (16), and adapted to move in slidable manner within a bore defined in said valve body (16), movement of said valve member (14) selectively allowing fluid/fuel flow within said electromagnetic valve (10),
said valve body (16) includes a central longitudinal axis (L)
said valve member operatively connected to a valve armature (12), such that activation/deactivation of said valve armature (12) provides said slidable movement of said valve member (14), said valve armature (12) being generally of cylindrical form having an upper face and a lower face,
wherein said valve body (16) includes an armature chamber (28) within which said valve armature (12) is located,

characterized in that a substantial portion of said upper face (18) of the valve armature (12) is sloped outwardly from said central axis (L) and/or wherein the side wall of the armature chamber (28) and/or the valve armature (12) is sloped.

2. An electromagnetic valve (10) as in claim 1 wherein the upper face (18) of the valve armature (12) is convex.

3. An electromagnetic valve (10) as claimed in any pre-

vious claims wherein the upper face (18) of the valve armature (12) is of conically form.

4. An electromagnetic valve (10) as claimed in any previous claims wherein the upper face (18) of the valve armature (12) is curved. 5
5. An electromagnetic valve (10) as in any previous claims wherein the angle (α) between the upper face (18) of the valve armature (12) and a horizontal plane is between 1° - 9° . 10
6. An electromagnetic valve (10) as in claim 5 wherein the angle (α) is between 3° - 7° . 15
7. An electromagnetic valve (10) as in claim 6 wherein the angle (α) is between 4° - 6° .
8. An electromagnetic valve (10) as claimed in any previous claims wherein the side wall of the armature chamber (28) and/or the valve armature (12) is sloped. 20
9. A fuel injector including an electromagnetic valve (10) as claimed in any preceding claim. 25

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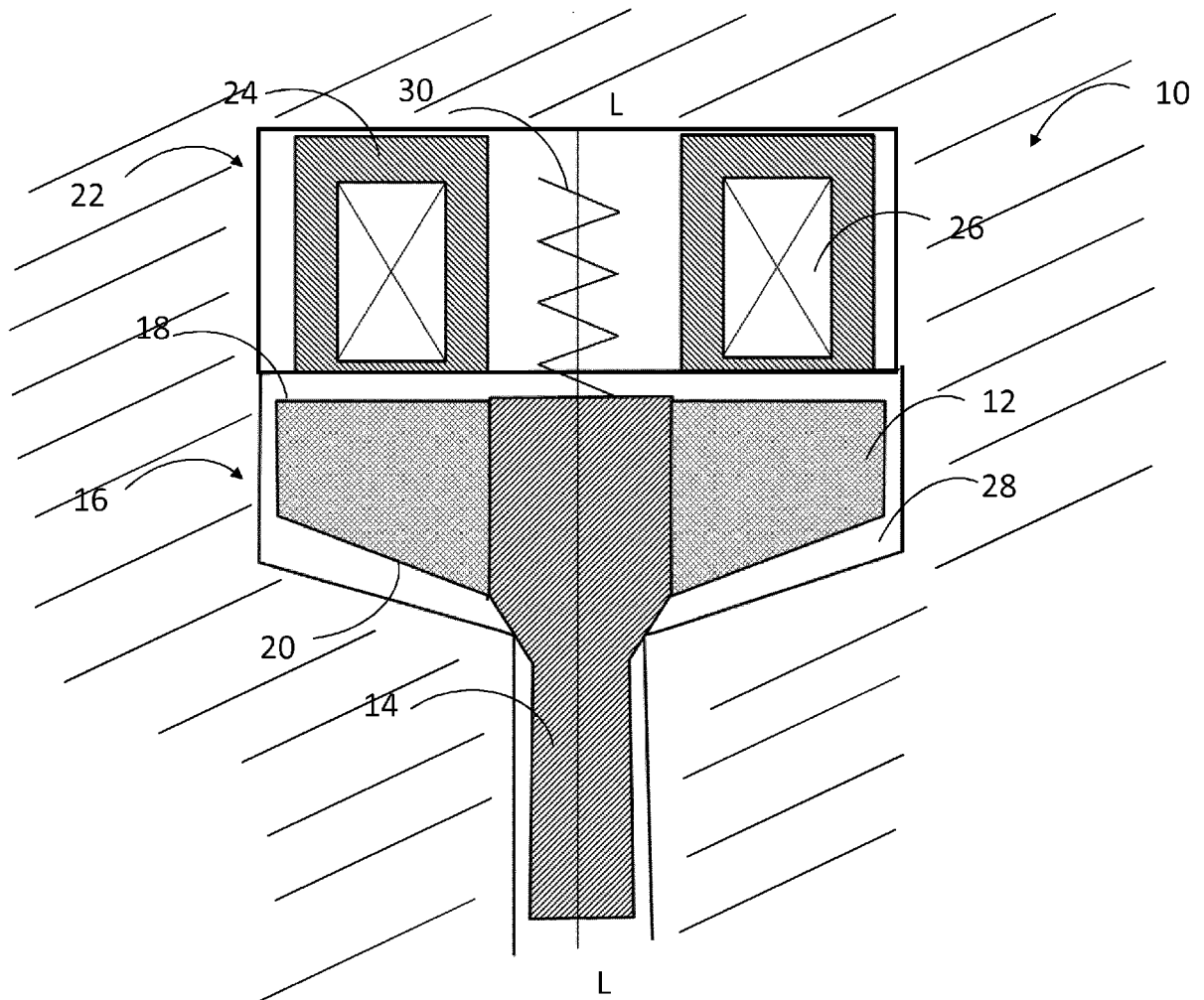


Figure 1

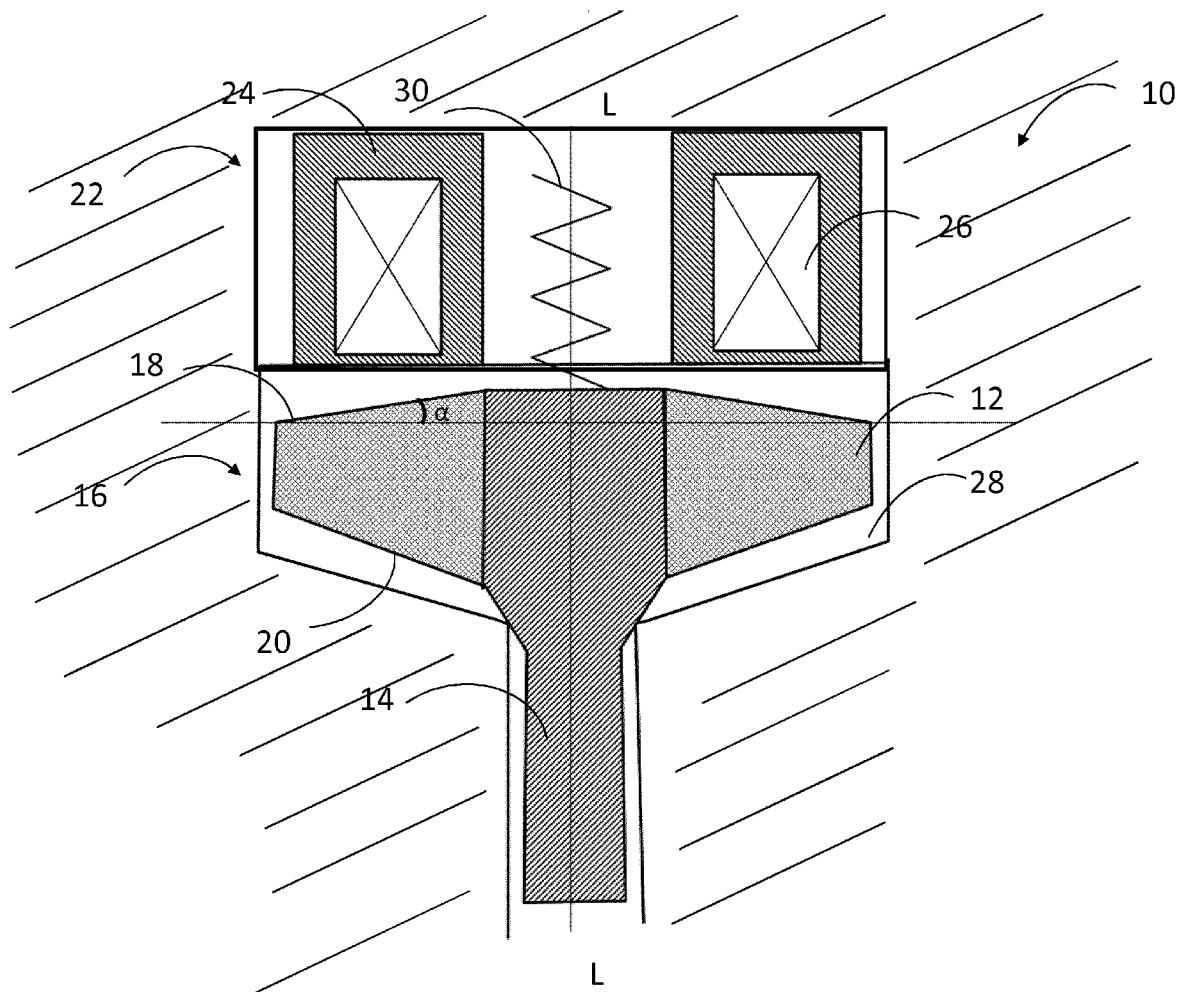


Figure 2

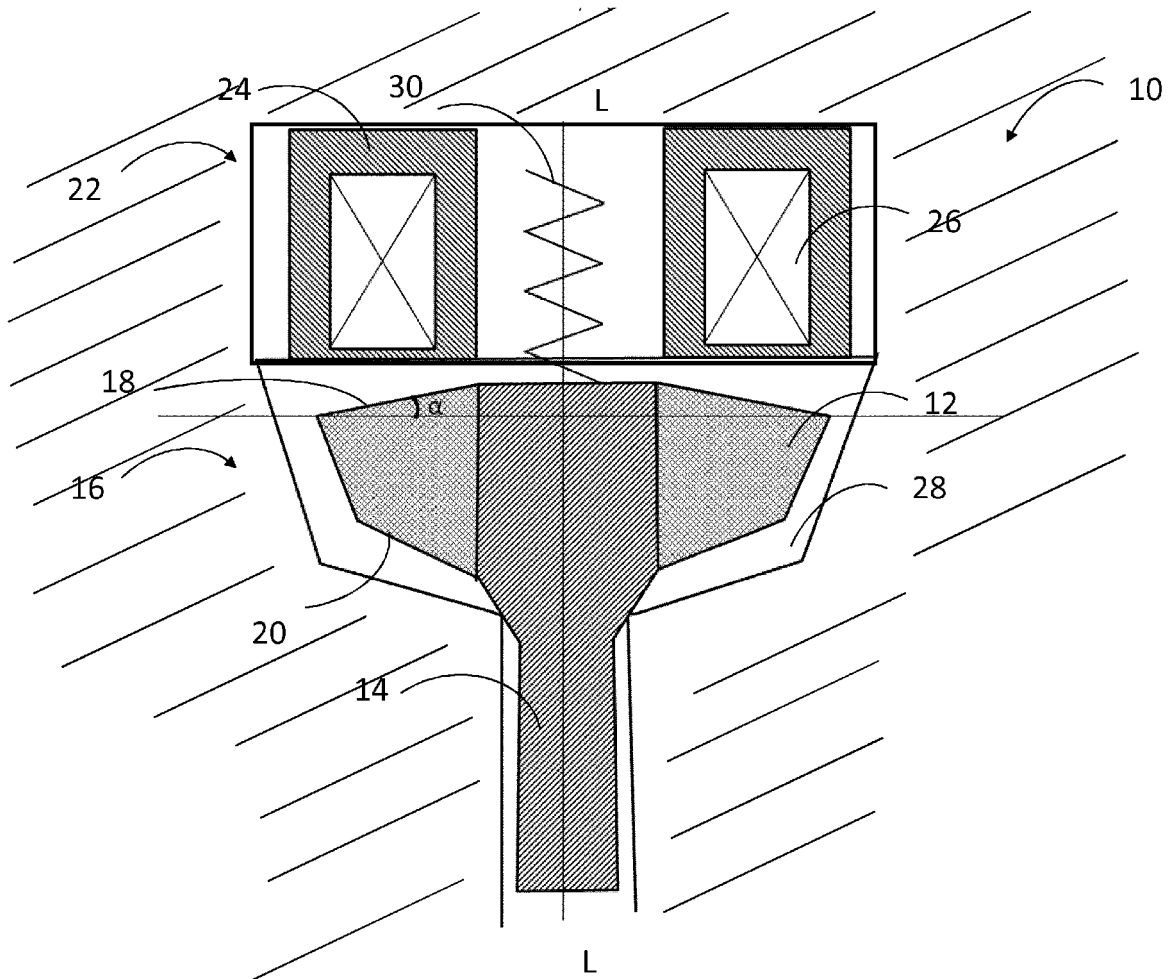


Figure 3



EUROPEAN SEARCH REPORT

Application Number
EP 13 17 7653

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Place of search Munich		Date of completion of the search 28 October 2013	Examiner Etschmann, Georg
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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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
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82