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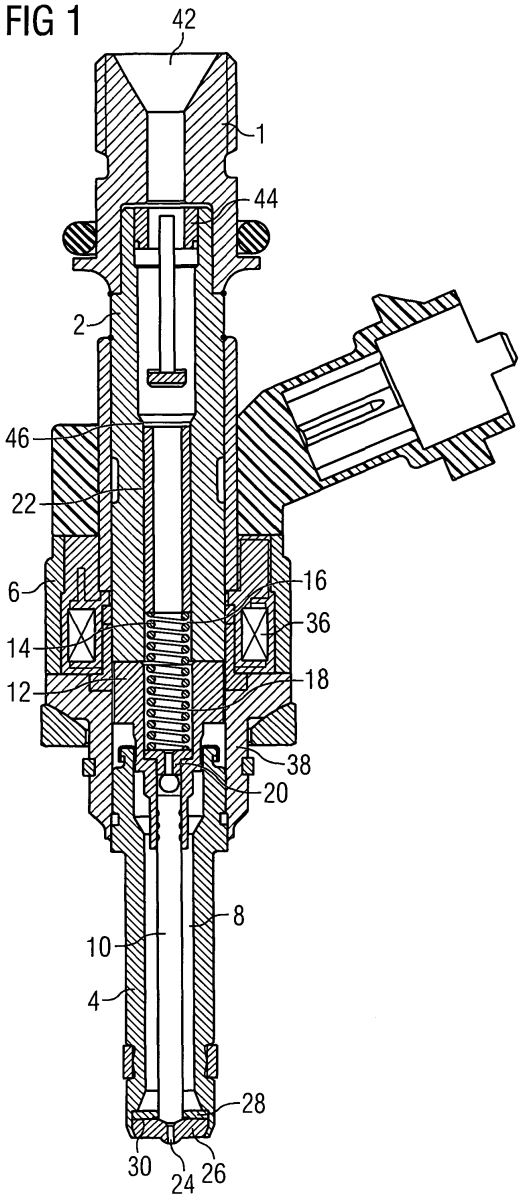
(54) Fluid injection valve

(57) A fluid injection valve is provided with a body, which comprises a recess. It further is provided with a needle (10) being arranged in the recess of the body and preventing a fluid flow through at least one injection nozzle (24) in a closing position and outside of the closing position enabling the fluid flow. A spring (14) is provided for preloading the needle (10) towards the closing position. An adjusting tube (22) is provided for setting the preloading force of the spring (14). The adjusting tube (22) is designed for the fluid flowing through it towards the injection nozzle (24) and is provided with a damper (46) designed for dampening the fluid flow.

FIG 1



EP 1 741 925 A1

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FIG 3

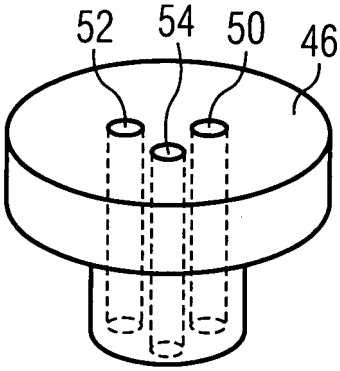
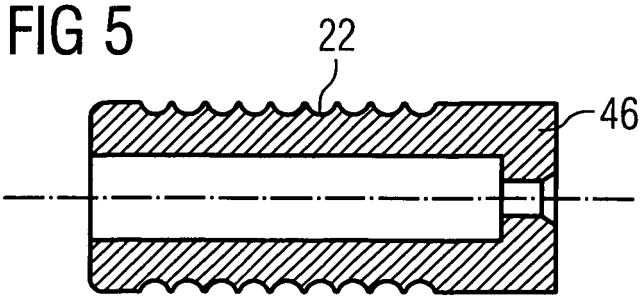


FIG 5



Description

[0001] The invention relates to a fluid injection valve.

[0002] Increasingly stringent rules concerning the admissibility of noxious emissions from internal combustion engines, which are arranged in vehicles, render it necessary to take various measures, which reduce these emissions.

[0003] One way to reduce these emissions is to improve the combustion process in the internal combustion engine. This may be achieved by precisely dosing the fluid. This is a challenge in particular for small quantities of fluid to be dosed into a combustion chamber of an internal combustion engine.

[0004] US 5,967,419 discloses a fuel injector with a valve, with a valve seat, with a valve closing element that is dedicated to the valve seat. The valve closing element is connected to an armature. The armature is preloaded by a spring to the valve seat. The spring is arranged in a tube and adjacent to a spring pin, that is arranged in the tube as well. The spring is pressed to fit within the tube, the spring normally biases the armature in a closing direction of the valve.

[0005] US 5,937,887 discloses a method of assembling an electromagnetically actuated disk-type valve with a calibration slide, a filter holder and a spring. The filter holder is moveably located in the fuel passage of the valve between the calibration slide and the spring. The tension of the spring is set by the calibration slide that is moved to the appropriate location with a tool. The calibration slide is formed from an elongated role of spring steel that fixes itself in the fuel passage of the valve.

[0006] The object of the invention is to provide a fluid injection valve, which enables precise dosing of fluid. The object is obtained by the features of the independent claim. Advantageous embodiments are disclosed in the subclaims.

[0007] The invention is distinguished by a fluid injection valve with a body comprising a recess, with a needle being arranged in the recess of the body and preventing a fluid flow through at least one injection nozzle in a closing position and outside of the closing position enabling the fluid flow. A spring is provided, which preloads the needle towards the closing position. The fluid injection valve further comprises a driver for controlling the position of the needle. An adjusting tube is provided for setting the preloading force of the spring. The adjusting tube is designed for the fluid flowing through it towards the injection nozzle and is provided with a damper. The damper is designed for dampening the fluid flow.

[0008] The invention is based on the finding oscillations of the fluid pressure occurred in the area of the injection nozzle following a movement of the needle away from the closing position, which have a significant influence on the amount of fluid actually dosed especially with very small quantities of fluid to be dosed. By providing the damper these oscillations may be effectively dampened and in that way, even with small quantities of fluid to be dosed, these quantities may be precisely dosed due to an improved linear control behavior of the fuel injection valve. The damper enables to stabilize pressure and an instantaneous fluid flow.

[0009] In a preferred embodiment of the invention the damper is arranged in an area of a fluid inlet of the adjusting tube. By this especially good dampening properties may be obtained.

[0010] According to a further preferred embodiment of the invention the damper comprises multiple orifices. In that way a reduced pressure drop has been observed with, at the same time, very good dampening properties. This further improves precise dosing, especially very small quantities of fluid.

[0011] According to a further preferred embodiment of the invention the damper is made in one piece with the adjusting tube. This enables to include the damper in the fluid injection valve with few production steps and therefore especially in mass production at only little extra cost for manufacturing the damper.

[0012] Exemplary embodiments of the invention are shown in the following with the aid of the schematic drawings. The figures are illustrating:

Figure 1, a cross-section of a fluid injector,

Figure 2, a first embodiment of a damper,

Figure 3, a second embodiment of a damper,

Figure 4, a first embodiment of an adjusting tube with the damper,

Figure 5, a second embodiment of the adjusting tube with the damper and

Figure 6, a fluid pressure plotted over time.

[0013] Elements of the same design or function are referred to by the same numerals.

[0014] A fluid injection valve (Figure 1), that is in particular suited for dosing fuel into an internal combustion engine, comprises a fitting adapter 1 being designed for fitting the injection valve to a fluid reservoir, such as a fuel rail. The fluid injection valve further comprises an inlet tube 2 and a valve body 4 and a housing 6. A body of the valve may therefore comprise one or more of the fitting adapter 1, the inlet tube 2, the valve body 4 and the housing 6.

[0015] A recess 8 in the valve body 4 is provided, which takes in a needle 10 and preferably part of an armature 12. A recess 16 of the inlet tube 2 is provided which further extends to a recess 18 of the armature 12. A spring 14 is arranged in the recess 16 of the inlet tube 2 and/or the recess 18 of the armature 12. Preferably it rests on a spring seat being formed by an anti-bounce disk 20. The spring 14 is in this way mechanically coupled to the needle 10. An adjusting tube 22 is provided in the recess 16

of the inlet tube 2. The adjusting tube 22 forms a further seat for the spring 14 and may during the manufacturing process of the fluid injection valve be axially moved in order to preload the spring 14 in a desired way. This process is further described below.

[0016] In a closing position of the needle 10 it sealingly rests on a seat 26 an prevents in this way a fluid flow through at least one injection nozzle 24. The injection nozzle 24 may, for example, be an injection hole it may however also be of some other type suitable for dosing fluid. The seat 26 may be made in one part with the valve body or may also be a separate part from the valve body 4. In addition to that preferably a lower guide 28 for guiding the needle 10 is provided. In addition preferably a swirl disk 30 may be provided.

[0017] The fluid injection valve is provided with a drive, that is preferably an electromagnetic drive, comprising a coil 36, which is preferably overmolded, a valve body shell 38, the armature 12 and the inlet tube 2 all forming an electromagnetic circuit.

[0018] During the manufacturing process of the fluid injection valve the adjusting tube 22 is pushed into the recess 16 to an initial position. Then the fluid injection valve may be calibrated by succeedingly energizing the coil 36 which then results in an electromagnetic force acting on the needle and acting against the mechanical force obtained from the spring 14 and after a given time deenergizing the coil 36 again. By appropriately energizing the coil 36, the needle 10 may in that way be moved away from its closing position resulting in fluid flowing through the injection nozzle 24. The fluid flow or the amount of fluid dosed may then be measured and a desired correlation between a control signal for energizing and deenergizing the coil and an actual amount of fluid dosed may be calibrated by axially moving the adjusting tube. In this way the preloading force of the spring 14 may be adjusted.

[0019] When the desired control characteristic of the fluid injection valve is obtained, the inlet tube may be plastically deformed in a way that the adjusting tube 22 is axially fixed in respect to the inlet tube 2. Preferably after this an overmolded portion of the housing is then created by a molding process and in that way also a connector for electrically connecting the fluid injection valve externally may be created.

[0020] A fluid inlet 42 is provided in the fitting adapter 1 which then communicates with a filter 44. The adjusting tube 22 is designed for the fluid flowing through it towards the injection nozzle 24. For this purpose the anti-bounce disk 20 is provided with an appropriate recess and also the armature 12 is provided with an appropriate recess.

[0021] The adjusting tube 22 is provided with a damper 46 (Figure 2). The damper is designed for dampening a fluid flow. The damper 46 comprises at least one orifice, through which the fluid must flow when flowing from the fluid inlet 42 of the injector to the at least one injection nozzle 24. In the embodiment of Figure 2 the damper 46 comprises a single orifice 48, whereas in the embodiment according to Figure 3 the damper 46 comprises multiple orifices 50, 52, 54, which may be a present in an amount of two, three, four, five or also a suitable other amount of orifices.

[0022] The orifices 48, 50, 52, 54 are designed in order to provide desired dampening properties of the damper 46. The design is made taking into consideration that a pressure drop due to the dampening should be minimized and the other hand pressure oscillations after moving the needle 10 out of its closing position should also be minimized. In this way by making simulations or just simply trying different properties of the orifices an optimum or nearly optimum solution may be found. Figure 6 shows two traces of the fluid pressure p in the recess 8 plotted over the time t where 60 denotes the trace of the pressure without having the damper installed in the adjusting tube 22 and 62 denotes the trace of respective pressure p with the damper 46 arranged in the adjusting tube 22. It can be derived from Figure 6, that at the price of a small pressure drop the oscillations are extinguished and therefore especially opening times with respective short energization time of the coil 36 ranging in the area with the oscillations of the trace 60 lead to a more precise dosing of the fluid by the use of the damper 46. TPW denotes a control pulse width, t1 denotes the point of time of the needle 10 beginning to leave its closing position, t2 denotes the point of time, when the pressure p reaches its stablized level with the damper 46 being installed and t3 denotes the beginning of the movement of the needle 10 back towards its closing position.

[0023] Preferably the damper is arranged in an area of the fluid inlet of the adjusting tube 22 as shown by way of example in Figures 4 and 5. It may, however, also be arranged in another location of the adjusting tube 22. The damper 46 may be formed as a separate part from the adjusting tube 22 and may be connected to the adjusting tube 22, for example by way of welding or any other suitable process of connecting the two parts. Especially for mass production it is however preferred to manufacture the adjusting tube 22 and the damper 46 from one part and in this case it is preferred to drill the single orifice 48 or the multiple orifices 50 to 54 directly into the adjusting tube 22.

[0024] The orifices may however also have another geometrical form apart from a cylindrical form, which also serves the purpose of properly dampening the pressure oscillations.

[0025] The adjusting tube 22 may also be axially moveable in respect to the inlet tube 2 during the calibration process by a suitable geometry of the adjusting tube 22 and the inlet tube 2, which e.g. allows for an axial movement in only one direction and assures a fixation in the opposite direction. Then the step of plastically deforming a part of the fluid injection valve for fixing the adjusting tube 22 relative to the inlet tube 2 may be omitted.

Claims

1. Fluid injection valve with a body comprising a recess, with a needle (10) being arranged in the recess of the body and preventing a fluid flow through at least one injection nozzle (24) in a closing position and outside of the closing position enabling the fluid flow, with a spring (14) preloading the needle (10) towards the closing position, with a drive for controlling the position of the needle and with an adjusting tube (22) being provided for setting the preloading force of the spring (14), the adjusting tube (22) being designed for the fluid flowing through it towards the injection nozzle (24) and being provided with a damper (46) designed for dampening the fluid flow.

2. Fluid injection valve according to claim 1, with the damper (46) being arranged in an area of a fluid inlet of the adjusting tube (22).

3. Fluid injection valve according to one of the previous claims, with the damper (46) comprising multiple orifices (50, 52, 54).

4. Fluid injection valve according to one of the previous claims, with the damper (46) being made in one piece with the adjusting tube (22).

FIG 1

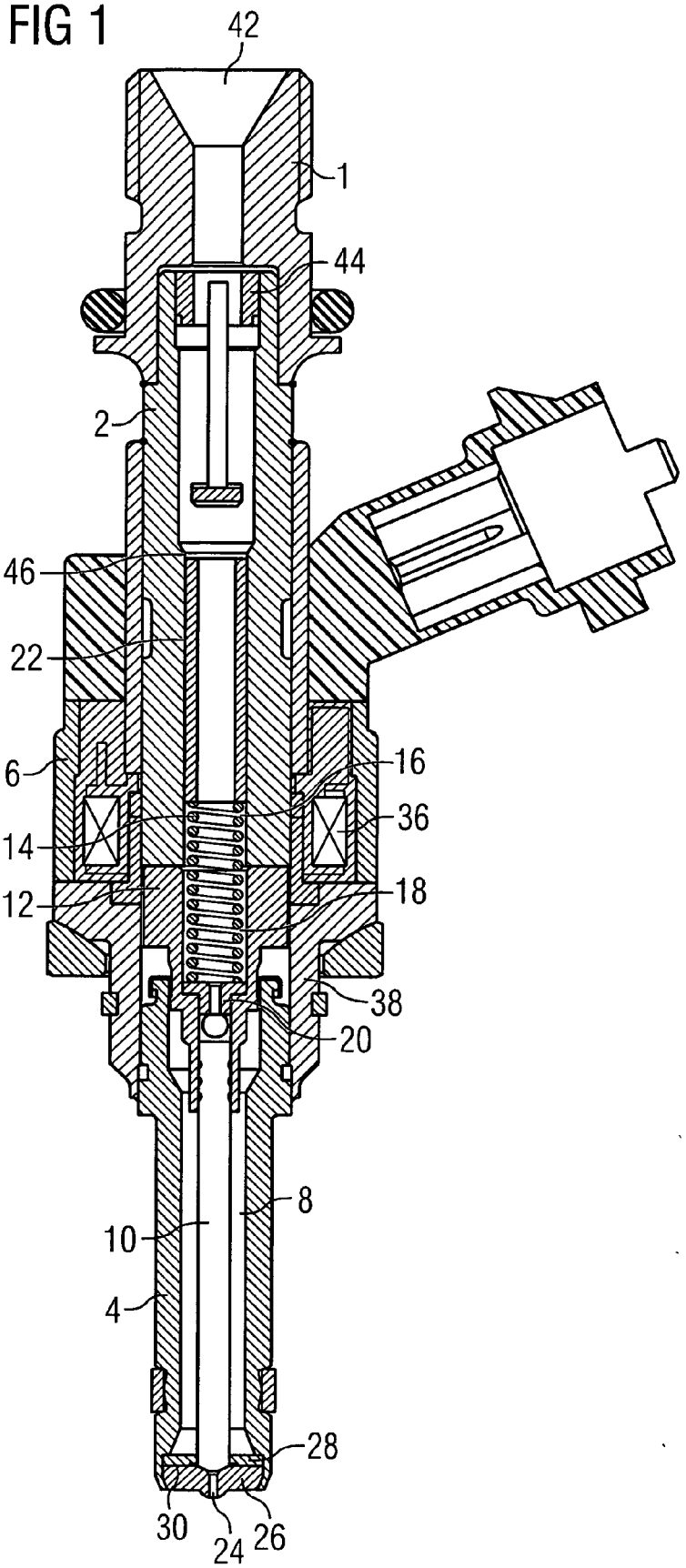


FIG 2

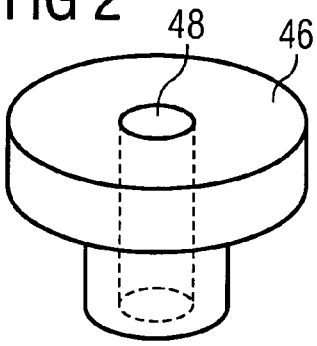


FIG 3

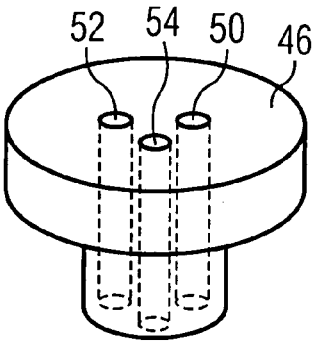


FIG 4

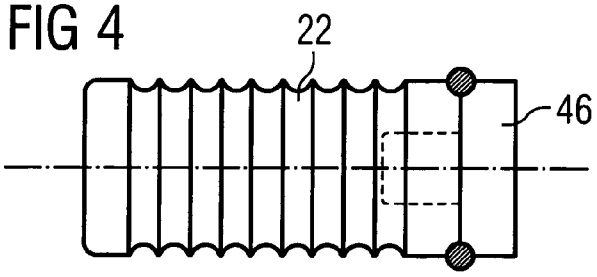


FIG 5

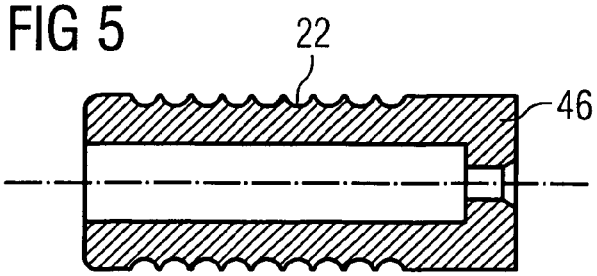
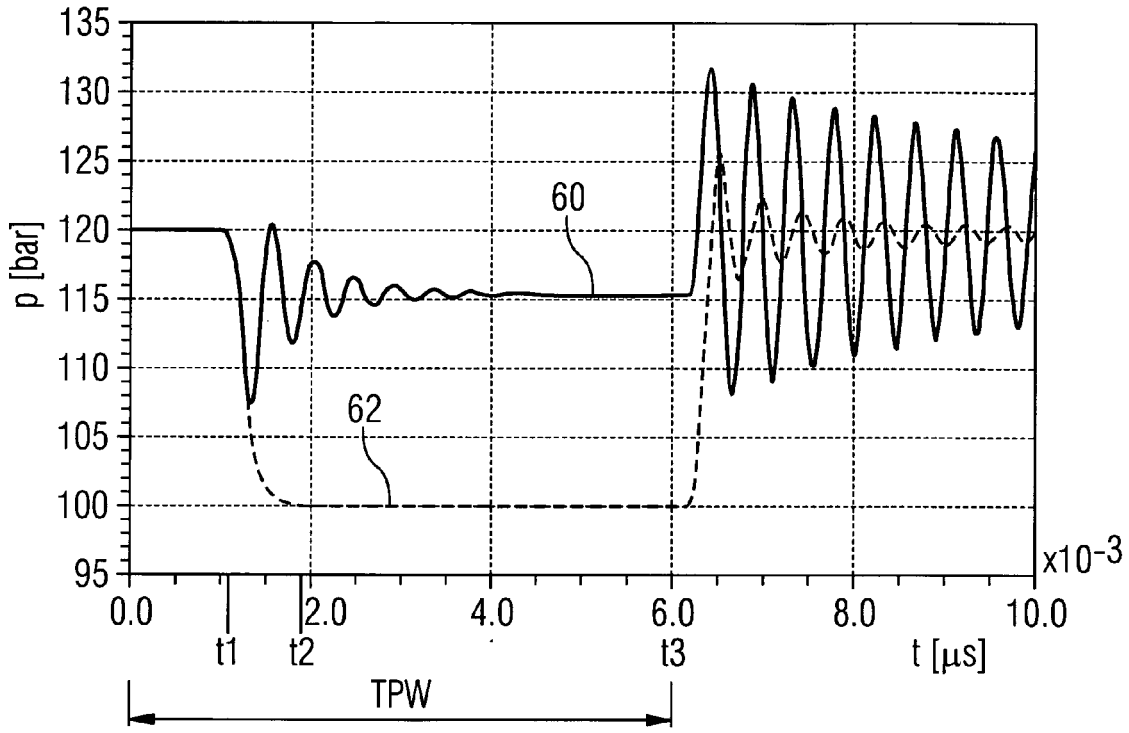


FIG 6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Application Number
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	23 November 2005	Boye, M

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