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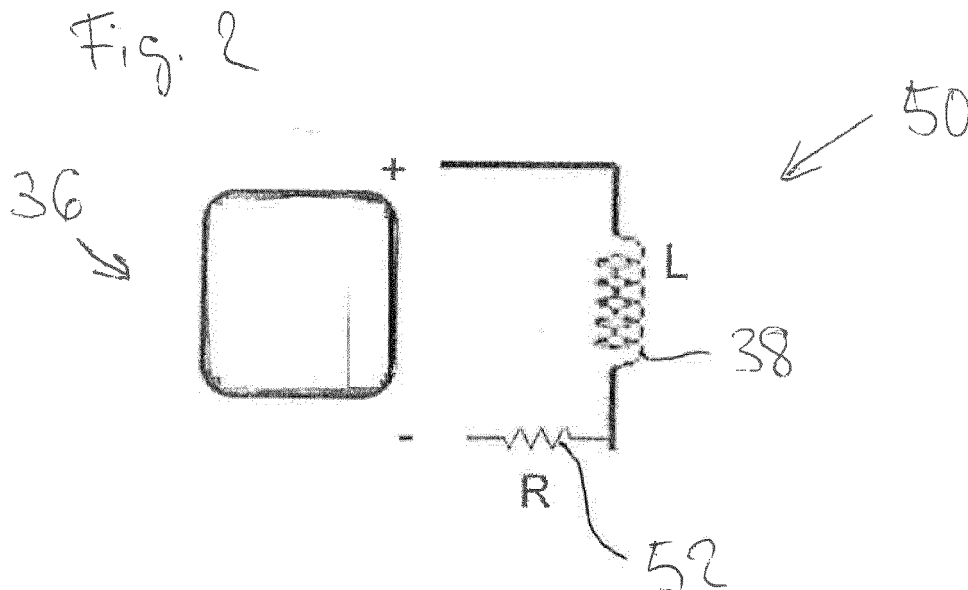
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(54) **Method for manufacturing an injection valve**

(57) Method for manufacturing an injection valve (10), the injection valve (10) comprising a valve body (14) including a central longitudinal axis (L), the valve body (14) comprising a cavity (18) with a fluid inlet portion (42) and a fluid outlet portion (40), a valve needle (20) axially movable in the cavity (18), the valve needle (20) preventing a fluid flow through the fluid outlet portion (40) in a closing position and releasing the fluid flow through the fluid outlet portion (40) in further positions, and an electromagnetic actuator unit (36) comprising a coil (38) and an armature (22). The coil (38) is designed to effect an electro-magnetic force on the armature (22). The armature

(22) is axially movable in the cavity (18) and is designed to actuate the valve needle (20). The method comprises the steps: providing the injection valve (10) and coupling the injection valve (10) with a fluid supply, actuating the actuator unit (16) by means of a predetermined voltage curve to actuate the valve needle (20) to move between the closing position and a further position to release a fluid flow through the fluid outlet portion (40), determining an opening time of the valve needle (20) from the closing position to the further position, and adjusting an electric resistance (52) in a series circuit (50) with the coil (38) depending on the determined opening time of the valve needle (20).



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Description

[0001] The invention relates to a method for manufacturing an injection valve.

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

[0003] Injection valves are manufactured in various forms in order to satisfy the various needs for the various combustion engines. Therefore, for example, their length, their diameter and also various elements of the injection valve being responsible for the way the fluid is dosed may vary in a wide range. In addition to that, injection valves may accommodate an actuator for actuating a needle of the injection valve, which may, for example, be an electromagnetic actuator or piezo electric actuator.

[0004] In order to enhance the combustion process in view of the creation of unwanted emissions, the respective injection valve may be suited to dose fluids under very high pressures. The pressures may be in case of a gasoline engine, for example, in the range of up to 200 bar and in the case of diesel engines in the range of more than 2000 bar.

[0005] The object of the invention is to provide a method for manufacturing an injection valve which is to be carried out in a simple manner.

[0006] These objects are achieved by the features of the independent claim. Advantageous embodiments of the invention are given in the sub-claims.

[0007] The invention is distinguished by a method for manufacturing an injection valve. The injection valve comprises a valve body including a central longitudinal axis, the valve body comprises a cavity with a fluid inlet portion and a fluid outlet portion, a valve needle axially movable in the cavity, the valve needle preventing a fluid flow through the fluid outlet portion in a closing position and releasing the fluid flow through the fluid outlet portion in further positions, and an electro-magnetic actuator unit comprising a coil and an armature. The coil is designed to effect an electro-magnetic force on the armature. The armature is axially movable in the cavity and is designed to actuate the valve needle. The method comprises the following steps: providing the injection valve and coupling the injection valve with a fluid supply, actuating the actuator unit by means of a predetermined voltage curve to actuate the valve needle to move between the closing position and a further position to release a fluid flow through the fluid outlet portion, determining an opening time of the valve needle from the closing position to the further position, and adjusting an electric resistance in a series circuit with the coil depending on the determined opening time of the valve needle.

[0008] This has the advantage that the injection valve may be calibrated by selecting an appropriate electric

resistance. Consequently, the dynamics of the injection valve may be dependent of the electric resistance.

[0009] In an advantageous embodiment of the invention the adjustment of the electric resistance is carried out by selecting the electric resistance from a plurality of fixed resistances. This has the advantage that the adjustment of the electric resistance may be carried out in a very simpler manner. Furthermore, a long term stability of the electric resistance may be achieved.

[0010] In a further advantageous embodiment of the invention, before the electric resistance is adjusted, a closing time of the valve needle from the further position to the closing position is determined, and the calibration spring is adjusted depending on the determined closing time of the valve needle.

[0011] Exemplary embodiments of the invention are explained in the following with the aid of schematic drawings. These are as follows:

Figure 1 an injection valve with a valve assembly in a longitudinal section view, and

Figure 2 a schematic view of an actuator unit of the valve assembly.

[0012] Elements of the same design and function that appear in different illustrations are identified by the same reference character.

[0013] Figure 1 shows an injection valve 10 that is in particular suitable for dosing fuel to an internal combustion engine comprises in particular a valve assembly 11 and an inlet tube 12.

[0014] The valve assembly 11 comprises a valve body 14 with a central longitudinal axis L. The valve assembly 11 has a housing 16 which is partially arranged around the valve body 14. A cavity 18 is arranged in the valve body 14.

[0015] The cavity 18 takes in a valve needle 20 and an armature 22. The valve needle 20 is axially movable in the cavity 18. At an axial end of the valve needle 20 a ring element 28 is fixedly coupled to the valve needle. The ring element 28 is formed as a collar around the valve needle 14. The armature 22 is axially movable in the cavity 18.

[0016] A calibration spring 24 is arranged in a recess 26 which is provided in the inlet tube 12. The calibration spring 24 is mechanically coupled to the valve needle 20. The valve needle 20 forms a first seat for the calibration spring 24.

[0017] A filter element 30 is arranged inside the inlet tube 12 and forms a further seat for the calibration spring 24. During the manufacturing process of the injection valve 10 the filter element 30 can be axially moved into the inlet tube 12 in order to preload the calibration spring 24 in a desired manner. By this the calibration spring 24 exerts a force on the valve needle 20 towards an injection nozzle 34 of the injection valve 10.

[0018] In a closing position of the valve needle 20 it

sealingly rests on a seat plate 32 by this preventing a fluid flow through the at least one injection nozzle 34. The injection nozzle 34 may be, for example, an injection hole.

[0019] The valve assembly 11 is provided with an actuator unit 36 that is preferably an electro-magnetic actuator. The electro-magnetic actuator unit 36 comprises a coil 38, which is preferably arranged inside the housing 16. Furthermore, the electro-magnetic actuator unit 36 comprises the armature 22. The valve body 14, the housing 16, the inlet tube 12 and the armature 22 are forming an electromagnetic circuit.

[0020] A fluid outlet portion 40 is a part of the cavity 18 near the seat plate 32. The fluid outlet portion 40 communicates with a fluid inlet portion 42 which is provided in the valve body 14.

[0021] Inside the valve body 14 a step 44 is arranged in the valve body 14. Preferably, an armature support spring 48 is arranged in the cavity 18 axially between the step 44 of the valve body 14 and the armature 22. Preferably, the armature support spring 48 is a coil spring. The armature support spring 48 is supported by the step 44 in the valve body 14. The armature support spring 48 forms a support element for the armature 22.

[0022] The actuator unit 36 comprises an electric resistance 52. The electric resistance 52 and the coil 38 are arranged in a series circuit 50.

[0023] In the following the function of the injection valve 10 will be described in detail:

[0024] Initially the fluid is led through the filter element 30 in the recess 26 of the inlet tube 12 to the fluid inlet portion 42. Subsequently, the fluid is led towards the fluid outlet portion 40. The valve needle 20 prevents a fluid flow through the fluid outlet portion 40 in a closing position of the valve needle 20. Outside of the closing position of the valve needle 20, the valve needle 20 enables the fluid flow through the fluid outlet portion 40.

[0025] In the case when the electro-magnetic actuator unit 36 with the coil 38 gets energized the actuator unit 36 may affect an electro-magnetic force on the armature 22. The armature 22 is attracted by the electro-magnetic actuator unit 36 with the coil 38 and moves in axial direction away from the fluid outlet portion 40. Due to the mechanical coupling between the armature 22 and the valve needle 20 via the ring element 28 the armature 22 takes the valve needle 20 with it. Consequently, the valve needle 20 moves in axial direction out of the closing position. Outside of the closing position of the valve needle 20 a gap between the seat plate 32 and the valve needle 20 forms a fluid path and fluid can pass through the injection nozzle 34. The increase of the current through the coil 38 during the coil 38 gets energized depends on the resistance value of the electric resistance 52.

[0026] In the case when the actuator unit 36 is de-energized the calibration spring 24 can force the ring element 28 and the valve needle 20 to move in axial direction towards the injection nozzle 34. Consequently, the valve needle 20 may be forced to move in its closing position.

It is depending on the force balance between the force on the valve needle 20 caused by the actuator unit 36 with the coil 38 and the force on the valve needle 20 caused by the calibration spring 24 whether the valve needle 20 is in its closing position or not.

[0027] In the following a method for manufacturing the injection valve 10 will be described in detail:

[0028] During the manufacturing process of the injection valve 10 a calibration process is carried out to adjust the injection valve 10.

[0029] The injection valve 10 is coupled with a fluid supply to supply fluid to the fluid inlet portion 26.

[0030] In the following the actuator unit 36 is actuated by means of a predetermined voltage curve. The actuation of the actuator unit 16 actuates the valve needle 20 to move between the closing position and a further position to release a fluid flow through the fluid outlet portion 40. The opening time of the valve needle 20 between the closing position and the further position is determined. Furthermore, the closing time of the valve needle 20 between the further position and the closing position is determined.

[0031] Depending on the determined closing time of the valve needle 20 the calibration spring 24 is compressed thereby setting the axial preload force of the calibration spring 24 on the valve needle 20. Consequently, by compressing the calibration spring 24 the closing time of the valve needle 20 may be adjusted until it reaches its predetermined value.

[0032] Depending on the determined opening time of the valve needle 20 the electric resistance 52 is adjusted. This may be achieved by selecting the electric resistance 52 from a plurality of fixed resistances. In particular, the adjustment of the electric resistance 52 may be carried out by replacing the electric resistance 52 with one resistance value by an electric resistance 52 with another resistance value.

[0033] The adjustment of the electric resistance 52 allows to achieve a predetermined opening time of the valve needle 20. Consequently, by adjusting the electric resistance 52 a calibration of the opening time of the valve needle 20 of the injection valve 10 is possible.

[0034] This has the advantage that the injection valve 10 may be calibrated not only by adjusting the load of the calibration spring 24 on the valve needle 20. Rather, adjusting the electric resistance 52 being arranged in the series circuit 50 with the coil 38 allows to calibrate the opening time of the valve needle 20 separately from the closing time of the valve needle 20. This makes it possible to achieve the required dynamic flow of the injection valve 10.

Claims

1. Method for manufacturing an injection valve (10), the injection valve (10) comprising

- a valve body (14) including a central longitudinal axis (L), the valve body (14) comprising a cavity (18) with a fluid inlet portion (42) and a fluid outlet portion (40),
- a valve needle (20) axially movable in the cavity (18), the valve needle (20) preventing a fluid flow through the fluid outlet portion (40) in a closing position and releasing the fluid flow through the fluid outlet portion (40) in further positions, and
- an electro-magnetic actuator unit (36) comprising a coil (38) and an armature (22), the coil (38) being designed to effect an electro-magnetic force on the armature (22), the armature (22) being axially movable in the cavity (18) and being designed to actuate the valve needle (20),

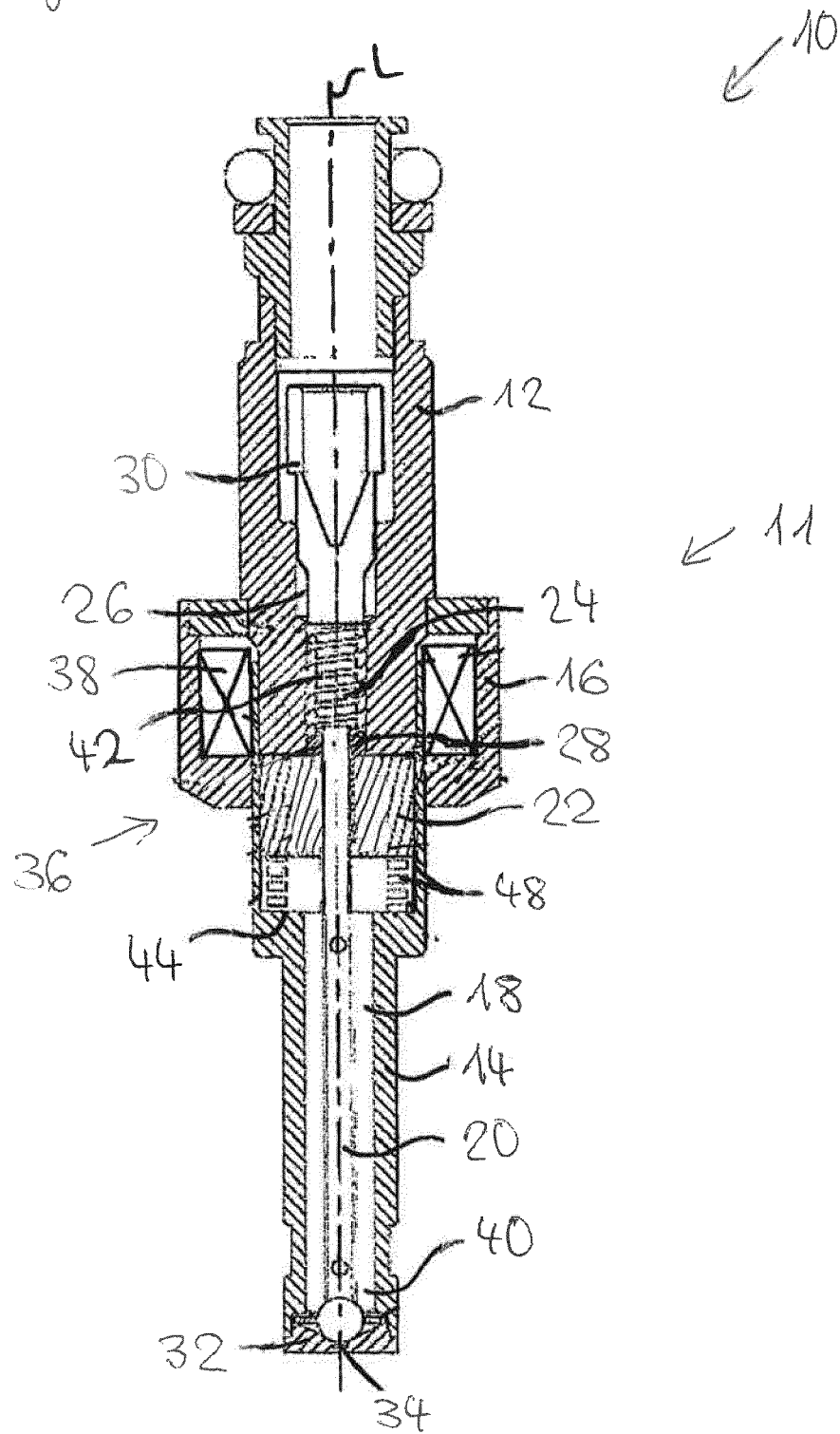
the method comprising the following steps:

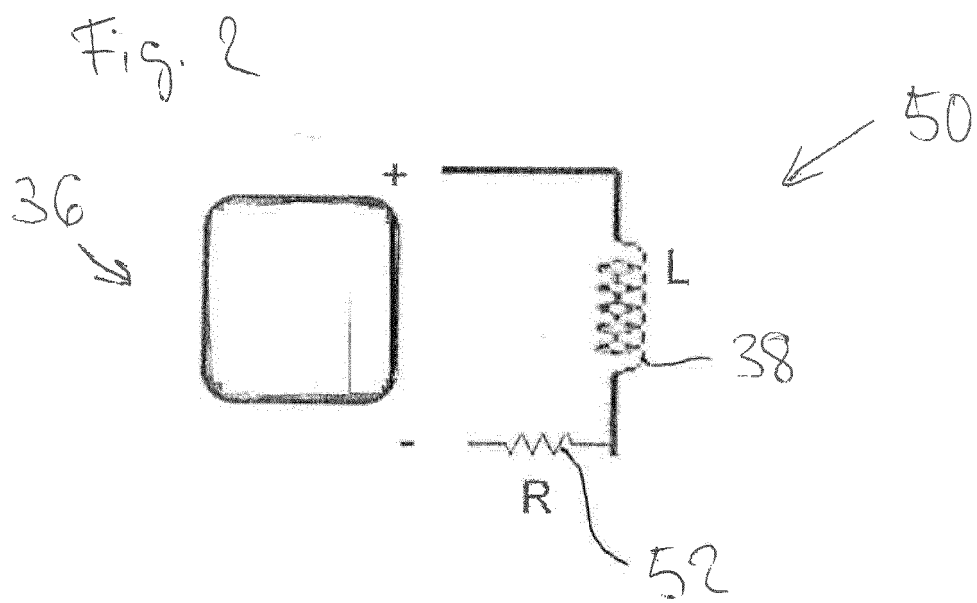
- providing the injection valve (10) and coupling the injection valve (10) with a fluid supply,
 - actuating the actuator unit (16) by means of a predetermined voltage curve to actuate the valve needle (20) to move between the closing position and a further position to release a fluid flow through the fluid outlet portion (40),
 - determining an opening time of the valve needle (20) from the closing position to the further position, and
 - adjusting an electric resistance (52) in a series circuit (50) with the coil (38) depending on the determined opening time of the valve needle (20).
2. Method according to claim 1, wherein the adjustment of the electric resistance (52) is carried out by selecting the electric resistance (52) from a plurality of fixed resistances.
 3. Method according to claim 1 or 2, wherein, before the electric resistance (52) is adjusted,
 - a closing time of the valve needle (20) from the further position to the closing position is determined, and
 - the calibration spring (24) is adjusted depending on the determined closing time of the valve needle (20).

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Fig. 1







EUROPEAN SEARCH REPORT

Application Number
EP 11 19 4600

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 5 291 170 A (WAHBA BRENT J [US] ET AL) 1 March 1994 (1994-03-01)	1,2	INV. F02M61/16 F02M61/20 F02M65/00
Y	* column 3 - column 4; figures 1,2 * * abstract *	3	
Y	----- EP 1 467 086 A1 (SIEMENS AG [DE]) 13 October 2004 (2004-10-13)	3	
A	* paragraph [0024] - paragraph [0028]; figure 2 * * abstract *	1,2	
A	----- US 7 407 120 B1 (FRENCH JACK [US]) 5 August 2008 (2008-08-05) * column 7; figure 1 * * abstract *	1-3	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (IPC)
			F02M
Place of search		Date of completion of the search	Examiner
The Hague		22 May 2012	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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EPO FORM 1503 03.82 (P04C01)

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

EP 11 19 4600

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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22-05-2012

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US 5291170	A	01-03-1994	NONE
EP 1467086	A1	13-10-2004	DE 60306333 T2 31-05-2007 EP 1467086 A1 13-10-2004
US 7407120	B1	05-08-2008	NONE