(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 236 812 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
06.10.2010 Bulletin 2010/40

(51) Int Cl.:
F02M 61/20 *(2006.01)*

(21) Application number: **09004292.0**

(22) Date of filing: **25.03.2009**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK TR
Designated Extension States:
AL BA RS

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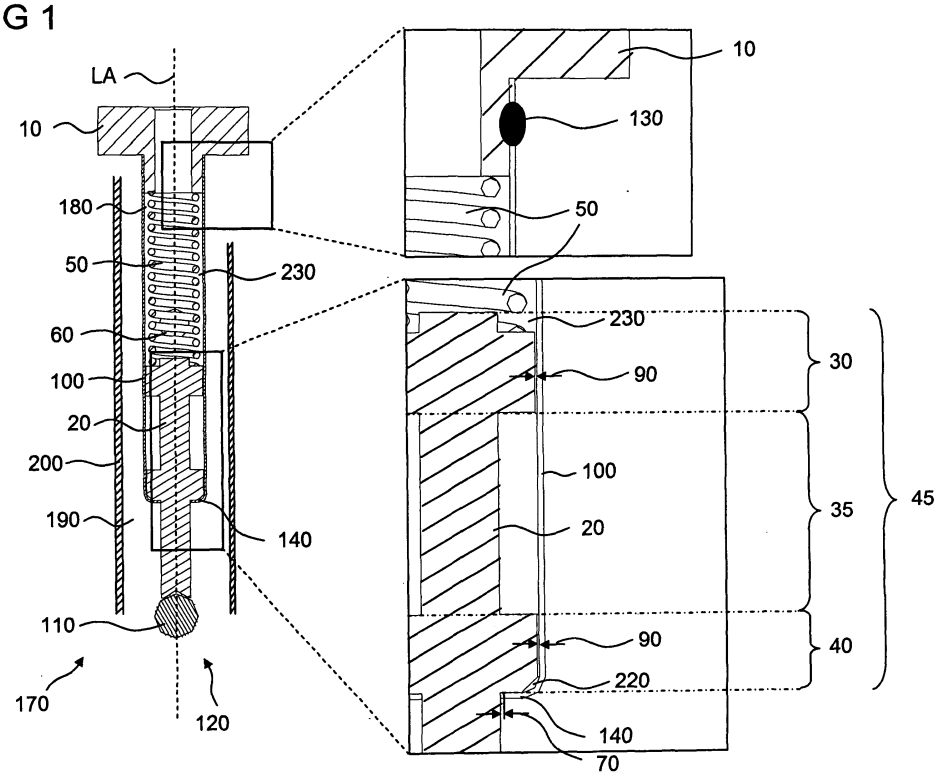
(54) Injection valve

(57) Injection valve (170) comprising an injection valve housing (200) with an injection valve cavity (190) and a valve needle (120) being axially moveable within the injection valve cavity (190). The valve needle (120) comprises a valve needle housing (100) with a valve needle cavity (180) and a sealing element (110) preventing a fluid injection in a closing position and permitting the fluid injection in further positions. A valve needle body (20) being fixedly coupled to the sealing element (110), whereas the valve needle body (20) is disposed at least partially within the valve needle cavity (180) to divide the valve needle cavity (180) into a first and second fluid volume (220, 230). At least one first fluid passage (70) hydraulically connects the first fluid volume (220) with the injection valve cavity (190). At least one spring element (50) is preloaded and acts on the valve needle body (20) towards a maximum axial expansion of the valve needle (120).

FIG 1



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Description

[0001] The invention relates to an injection valve for injecting fluid.

[0002] Injection valves are in widespread 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 valve needle of the injection valve, which may, for example, be an electromagnetic 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 up to 2000 bar.

[0005] US 6,523,759 B1 discloses that during operation of the injection valve, a close action of the valve needle to prevent dosing of fluid into the intake manifold or into the combustion chamber is followed by an unwanted reopen and close phase of the valve needle, called needle bounce. During the unwanted reopen and close phase, unwanted fluid is dispensed from the injection valve, resulting in a degraded performance of the injection valve. Therefore, a flow restrictor is disposed in an armature of the valve needle to restrict fluid flow towards an upstream end of the armature, resulting in a reduced bouncing of the valve needle.

[0006] The object of the invention is to create an injection valve which facilitates a reliable and precise function.

[0007] These objects are achieved by the features of the independent claims. Advantageous embodiments of the invention are given in the sub-claims.

[0008] The invention is distinguished according to a first aspect by an injection valve for injecting fluid. The injection valve comprises a central longitudinal axis and an injection valve housing with an injection valve cavity. The injection valve further comprises a valve needle being axially moveable within the injection valve cavity. The valve needle comprises a valve needle housing with a valve needle cavity and a sealing element preventing a fluid injection in a closing position and permitting the fluid injection in further positions. The valve needle further comprises a valve needle body being axially moveable relative to the valve needle housing and being fixedly coupled to the sealing element. The valve needle body is disposed at least partially within the valve needle cavity to divide the valve needle cavity into a first and second fluid volume. The first fluid volume expands if an axial expansion of the valve needle decreases. Furthermore, the valve needle comprises at least one first fluid passage with a predetermined opening to hydraulically connect the first fluid volume with the injection valve cavity. The valve needle comprises at least one spring element being preloaded and acting on the valve needle body towards a maximum axial expansion of the valve needle. This contributes to minimizing a bouncing of the valve needle and by this contributes to ensuring a reliable and precise fluid injection. Preferably the valve needle comprises an additional valve needle body being axially moveable relative to the valve needle body and preferably forming a first seat of the at least one spring element, whereas the valve needle body forms a second seat of the at least one spring element. The additional valve needle body may be a component of the valve needle housing or may be a separate component to the valve needle housing, whereas the additional valve body is fixedly coupled to the valve needle housing. The additional valve needle body is for example coupled to an armature which is operable to be actuated by a solenoid in case of an electromagnetic actuated injection valve. In case of a piezoelectric injection valve, the additional valve needle body is preferably coupled to a piezoelectric actuator. The valve needle body and the sealing element are axially moveable relative to each other.

[0009] The valve needle cavity and the injection valve cavity are designed to be filled with fluid. The first fluid volume increases while the axial expansion of the valve needle decreases. The axial expansion of the valve needle decreases, if the sealing element is for example in its closing position. The axial expansion is increased if the sealing element is in further positions. While the first fluid volume increases due to the movement of the valve needle body, the second fluid volume typically decreases.

[0010] While the first fluid volume increases the fluid within the injection valve cavity is forced, due to a resulting depression within the first fluid volume, to pass the at least one first fluid passage towards the first fluid volume. Due to the predetermined opening of the at least one first fluid passage, the axial movement of the valve needle body and/or of the valve needle housing is dampened. By varying the diameter of the opening of the at least one first fluid passage the dampening can be varied. This reduces the bouncing of the sealing element and by this contributes to ensuring a reliable and precise function of the injection valve.

[0011] In an advantageous embodiment of the invention according to the first aspect, the valve needle comprises a resting element with a cavity, wherein the valve needle body is at least partially disposed. The resting element is fixedly coupled to the valve needle housing. The at least one first fluid passage is a radial clearance between the valve needle body and an inner wall of the cavity of the resting element. The resting element is a separate component to the valve needle housing and preferably comprises one or more resting element pro-

jections which facilitate an axial adjustment relative to the valve needle housing. In addition, the resting element facilitates a precise coaxial arrangement of the valve needle body and the sealing element. This contributes to ensuring a reliable and a precise function of the injection valve.

[0012] In a further advantageous embodiment of the invention according to the first aspect, the at least one spring element is a helical spring, being arranged within the valve needle cavity. This contributes to ensuring a robust injection valve.

[0013] The invention is distinguished according to a second aspect by an injection valve for injecting fluid comprising a central longitudinal axis and an injection valve housing with an injection valve cavity. The injection valve further comprises a valve needle being axially moveable within the injection valve cavity. The valve needle comprises a valve needle housing with a valve needle cavity and a valve needle body. The valve needle body is at least partially arranged within the valve needle cavity to divide the valve needle cavity into a first and second fluid volume. The first fluid volume expands if an axial expansion of the valve needle decreases. The valve needle body and the valve needle housing are axially moveable relative to each other. The valve needle comprises a sealing element being fixedly coupled to the valve needle housing and preventing a fluid injection in a closing position and permitting the fluid injection in further positions. Furthermore, the valve needle comprises at least one first fluid passage with a predetermined opening to hydraulically connect the first fluid volume with the injection valve cavity. In addition, the valve needle comprises at least one spring element being preloaded and acting on the valve needle housing towards a maximum axial expansion of the valve needle. This contributes to minimizing a bouncing of the valve needle and by this contributes to ensuring a reliable and precise fluid injection. Preferably the valve needle is for example coupled to an armature which is operable to be actuated by a solenoid in case of an electromagnetic actuated injection valve. In case of a piezoelectric injection valve, the valve needle body is preferably coupled to a piezoelectric actuator.

[0014] The valve needle cavity and the injection valve cavity are designed to be filled with fluid. The first fluid volume increases while the axial expansion of the valve needle decreases. The axial expansion of the valve needle is decreased, if the sealing element is for example in its closing position. The axial expansion is increased if the sealing element is in further positions. While the first fluid volume increases due to the axial movement of the valve needle housing, the second fluid volume typically decreases.

[0015] While the first fluid volume increases, the fluid within the injection valve cavity is forced, due to a resulting depression within the first fluid volume, to pass the at least one first fluid passage towards the first fluid volume. Due to the predetermined opening of the at least one first fluid passage, the axial movement of the valve needle housing and/or the valve needle body is dampened. By varying the diameter of the opening of the at least one first fluid passage the dampening can be varied. This reduces the bouncing of the sealing element and by this contributes to ensuring a reliable and precise function of the injection valve.

[0016] In an advantageous embodiment of the invention according to the second aspect, the at least one spring element is a helical spring being coupled to the valve needle housing and enveloping at least partially the valve needle body. This contributes to ensuring a robust injection valve.

[0017] In an advantageous embodiment of the invention according to the first and second aspect, the valve needle housing comprises at least one projection limiting the axial expansion of the valve needle. The projection is preferably formed by plastical deformation of the particular valve needle housing. This simplifies the manufacturing of the injection valve.

[0018] In an advantageous embodiment of the invention according to the first and second aspect, the at least one first fluid passage is a first radial clearance between the at least one projection and the valve needle body. The first radial clearance has a predetermined opening representing the predetermined opening of the at least one first fluid passage. This contributes to ensuring a reliable and precise function of the injection valve.

[0019] In an advantageous embodiment of the invention according to the first and second aspect, the valve needle comprises a second radial clearance between the valve needle body and an inner wall of the valve needle cavity. The second radial clearance facilitates a fluid accumulation between the valve needle body and the inner wall of the valve needle cavity. This reduces a friction between the valve needle body and the inner wall of the valve needle cavity. In addition, the second radial clearance may facilitate a predetermined leakage characteristic having effects on the dampening for reducing the bouncing of the sealing element.

[0020] In an advantageous embodiment of the invention according to the first and second aspect, the valve needle body comprises a first, second and third portion, each portion being disposed within the valve needle cavity. The second portion is arranged between the first and third portion and has a less diameter than the first and third portion. The diameter of the first and third portion are basically identical. This has the advantage that the friction between the valve needle body and the inner wall of the valve needle cavity is reduced.

[0021] In an advantageous embodiment of the invention according to the first and second aspect, the second radial clearance is formed by a radial clearance between the first portion respectively the third portion of the valve needle body and the wall of the valve needle cavity. This contributes to ensuring a robust injection valve and facilitates a reduced friction between the inner wall of the valve needle cavity and the valve needle body.

[0022] In an advantageous embodiment of the inven-

tion according to the first and second aspect, the valve needle comprises at least one O-ring enveloping the second portion of the valve needle body and is adopted to basically prevent a fluid flowing between the first and second fluid volume. By this, a hydraulical connection between the first and second fluid volume is basically prevented, whereas the second clearance still facilitates an accumulation of fluid between the inner wall of the valve needle cavity and the valve needle body. This reduces the friction between both components.

[0023] Exemplary embodiments of the invention are explained in the following with the aid of schematic drawings. These are as follows:

Figure 1 first embodiment of the injection valve,

Figure 2 second embodiment of the injection valve,

Figure 3 third embodiment of the injection valve,

Figure 4 diagram.

[0024] Elements of the same design and function that appear in different illustrations are identified by the same reference character.

[0025] An injection valve 170 (figure 1) that is in particular suitable for dosing fluid into an internal combustion engine, comprises an injection valve housing 200 with a central longitudinal axis LA, an injection valve cavity 190 and a valve needle 120. The valve needle 120 comprises a valve needle housing 100, a first and second valve needle body 10, 20, a sealing element 110 and a spring element 50.

[0026] The first valve needle body 10 is operable to be actuated by an actuator of the injection valve 170, e.g. an electromagnetic actuator or a piezoelectric actuator. While being actuated, the first valve needle body 10 moves axially within the injection valve cavity 190.

[0027] The valve needle housing 100 is fixedly coupled to the first valve needle body 10, e.g. by one or more welding spots 130. Alternatively, the valve needle housing 100 is a one piece component together with the first valve needle body 10. The valve needle housing 100 comprises a valve needle cavity 180, wherein the second valve needle body 20 is at least partially disposed. The injection valve cavity 190 and the valve needle cavity 180 are designed to be filled with fluid.

[0028] The first and second valve needle body 10, 20 are relatively moveable to each other in axial direction.

[0029] A part 45 of the second valve needle body 20 is arranged within the valve needle housing 100 and divides the valve needle cavity 180 into a first and second fluid volume 220, 230. A fluid passage 60 is provided to hydraulically connect the second fluid volume 230 with the injection valve cavity 190. The second valve needle body 20 is fixedly coupled to the sealing element 110, e.g. welded or being made of one piece. The part 45 of the second valve needle body 20 comprises a first, second and third portion 30, 35, 40. The second portion 35 is arranged between the first 30 and third portion 40 and has a less diameter than the first and third portion 30, 40. The diameter of the first and third portion 30 are basically identical. By this, a surface of the part 45 contacting the inner wall of the valve needle cavity 180 is reduced, thus reducing the friction between the valve needle cavity 180 and the second valve needle body 20. The first and third portion 30, 40 and/or the valve needle housing 100 are shaped in such a way, that a predetermined radial clearance 90, in the following named as second radial clearance 90, between the first respectively third portion 30, 40 and an inner wall of the valve needle housing 100 is provided. The second radial clearance 90 facilitates an accumulation of fluid between the first respectively third portion 30, 40 and the inner wall of the valve needle cavity 180. This reduces a friction between the second valve needle body 20 and the valve needle cavity 180. Alternatively the second radial clearance 90 facilitates a second fluid passage hydraulically connecting the first and second fluid volume 220, 230 and representing a predetermined leakage characteristic.

[0030] The first and third portion 30, 40 of the part 45 form a guiding element to keep the sealing element 110 coaxial to the injection valve housing 200, while the injection valve 170 is actuated.

[0031] The sealing element 110 has a spherical shape. Alternatively, the sealing element 110 has a conical shape. In a closing position, the sealing element 110 sealingly rests on a valve needle seat of the injection valve 170, by this preventing a fluid flow through at least one injection nozzle of the injection valve 170. The injection nozzle may be, for example, an injection hole. However, it may also be of some other type suitable for dosing fluid. The sealing element 110 permits the fluid injection into the combustion chamber in further positions, i.e. when it does not rest on the valve needle seat. The further positions represent non-closing positions.

[0032] The valve needle housing 100 comprises a projection 140, forming a seat where the second valve needle body 20, preferably with its third portion 40, rests on, if the sealing element 110 is in a non-closing position. E.g. the projection 140 may be formed by means of plastical deformation.

[0033] A first radial clearance with a predetermined opening is formed between the projection 140 and the second valve needle body 20. The first radial clearance represents a first fluid passage 70 with a predetermined opening. The first fluid passage 70 hydraulically connects the first fluid volume 220 with the injection valve cavity 190.

[0034] The spring element 50 is a helical spring and preferably made of stainless steel. The spring element 50 is disposed within the valve needle cavity 180. The first valve needle body 10 forms a first seat of the spring element 50 and the second valve needle body 20 forms a second seat of the spring element 50. The spring element 50 is preloaded and acts on the second valve nee-

dle body 20 towards a maximum expansion of the valve needle 120 in axial direction. If the second valve needle body 20 rests on the projection 140 an axial expansion of the valve needle 120 is maximized.

[0035] If the sealing element 110 impacts the valve needle seat of the injection valve 170 in a closing phase, the spring element 50 basically decouples the second valve needle body 20 and the sealing element 110 from the axial movements of the first valve needle body 10 and the valve needle housing 100. After the sealing element 110 impacts the valve needle seat, the first valve needle body 10 and the valve needle housing 100 typically oscillate in axial directions with decreasing oscillation amplitudes. The axial movements of the first valve needle body 10 and the valve needle housing 100 basically do not affect the current position of the sealing element 110 which rests on the valve needle seat, while the kinetic energy of the first valve needle body 10 and the valve needle housing 100 is at least partially absorbed by the spring element 50.

[0036] While the axial expansion of the valve needle 120 decreases, e.g. after the sealing element 110 impacts the valve needle seat, the first fluid volume 220 increases. Due to the increasing first fluid volume 220 a resulting depression within the first fluid volume 220 forces the fluid within the injection valve cavity 190 to pass the first fluid passage 70 towards the first fluid volume 220. Additionally the fluid accumulated in the second fluid volume 230 may be forced to pass the second radial clearance 90. If the sealing element 110 axially moves towards non-closing positions, the fluid accumulated in the first fluid volume 220 is forced to pass the first fluid passage 70 towards the injection valve cavity 190. If the second valve needle body 20 rests on the projection 140 the first fluid volume 220 is minimized, e.g. zero unit of volume.

[0037] A damping constant of the decreasing oscillation of the first valve needle body 10 and the valve needle housing 100 and/or the second valve needle body 20 and the sealing element 110 is, among other effects, dependent on the spring rate of the spring element 50 and on the predetermined diameter of the opening of the first fluid passage 70 and the second radial clearance 90, if it hydraulically connects the first and second fluid volume 220, 230. Due to the decoupling of the axial oscillation of the first and second valve needle body 10, 20 the sealing element 110 basically rests on the valve needle seat. This reduces a bouncing of the sealing element 110 after impacting the valve needle seat in the closing phase and reduces an uncontrolled fluid injection during the closing phase of the injection valve 170.

[0038] In another embodiment (figure 2), the injection valve 170 comprises a resting element 160 representing the projection 140. The resting element 160 is a separate part and is preferably made of stainless steel. Alternatively, the resting element 160 is a one piece component together with the valve needle housing 100. The resting element 160 is at least partially disposed within the valve needle cavity 180 and fixedly coupled to the valve needle housing 100, e.g. by welding or press-fitting. Preferably the resting element 160 comprises at least one resting element projection 210 to adjust the axial arrangement of the resting element 160 relative to the valve needle housing 100. The resting element 160 comprises a cavity, wherein the second valve needle body 20 is at least partially disposed. A radial clearance between the second valve needle body 20 and an inner wall of the cavity of the resting element 160 represents the first fluid passage 70.

[0039] Due to an addition guiding effect of the second valve needle body 20 via the resting element 160, an axial expansion of the part 45 of the second valve needle body 20 may be reduced, e.g. by reducing the particular axial expansion of the first, second and/or third portion of the part 45. This contributes to ensuring the coaxial arrangement of the sealing element 110 to the injection valve housing 200 and to the valve needle seat.

[0040] According to figure 2 the second portion 35 of the part 45 is enveloped by at least one o-ring 150, which is preferably made of elastic material, e.g. rubber. The o-ring 150 is in contact with the inner wall of the valve needle cavity 180. The o-ring 150 basically prevents a fluid flowing between the first and second fluid volume 220, 230.

[0041] In another embodiment (figure 3), the injection valve 170 comprises the injection valve housing 200 with a central longitudinal axis LA, the injection valve cavity 190 and a valve needle 120. The valve needle 120 comprises the valve needle housing 100, a valve needle body 25, the sealing element 110 and the spring element 50.

[0042] The valve needle body 25 is operable to be actuated by an actuator of the injection valve 170, e.g. an electromagnetic actuator or a piezoelectric actuator. While being actuated, the valve needle body 25 moves axially within the injection valve cavity 190.

[0043] The valve needle housing 100 is fixedly coupled to the sealing element 110, e.g. welded or being made of one piece. The valve needle housing 100 comprises the valve needle cavity 180, wherein the valve needle body 25 is at least partially disposed. The injection valve cavity 190 and the valve needle cavity 180 are designed to be filled with fluid.

[0044] The valve needle housing 100 is axially moveable relative to the valve needle body 25.

[0045] The injection valve 170 according to figure 3 comprises a part 45 of the valve needle body 25. The part 45 is arranged within the valve needle housing 100 and divides the valve needle cavity 180 into the first and second fluid volume 220, 230. A fluid passage is provided to hydraulically connect the second fluid volume 230 with the injection valve cavity 190. The part 45 comprises the first, second and third portion 30, 35, 40. The second portion 35 is arranged between the first 30 and third portion 40 and has a less diameter than the first and third portion 30, 40. The diameter of the first and third portion 30 are basically identical. By this, a surface of the part

45 contacting the inner wall of the valve needle cavity 180 is reduced, thus reducing the friction between the valve needle cavity 180 and the valve needle body 25. The first and third portion 30, 40 and/or the valve needle housing 100 are shaped in such a way, that the predetermined second radial clearance 90 between the first respectively third portion 30, 40 and the inner wall of the valve needle cavity 180 is provided. The second radial clearance 90 facilitates an accumulation of fluid between the first respectively third portion 30, 40 and the inner wall of the valve needle cavity 180 and by this reduces the friction between the valve needle body 25 and the valve needle cavity 180. Alternatively the second radial clearance 90 facilitates the second fluid passage hydraulically connecting the first and second fluid volume 220, 230 and representing a predetermined leakage characteristic.

[0046] The first and third portion 30, 40 of the part 45 form a guiding element to keep the valve needle housing 100 and the sealing element 110 coaxial to the injection valve housing 200, while the injection valve 170 is actuated.

[0047] The sealing element 110 corresponds to the sealing element 110 according to figure 1 and 2.

[0048] The valve needle housing 100 comprises the projection 140, whereas the valve needle body 25 forms a seat, preferably with its third portion 40, where the valve needle housing 100 rests on. E.g. the projection 140 may be formed by means of plastical deformation.

[0049] The first radial clearance with a predetermined opening is formed between the projection 140 and the valve needle body 25 and represents the first fluid passage 70 with a predetermined opening. The first fluid passage 70 hydraulically connects the first fluid volume 220 with the injection valve cavity 190.

[0050] The spring element 50 is a helical spring and preferably made of stainless steel. The spring element 50 envelops at least partially the valve needle body 25, whereas the first seat of the spring element 50 is formed by the valve needle body 25 or another part of the valve needle 120, which is fixedly coupled to the valve body 25. The second seat of the spring element 50 is formed by the valve needle housing 100, preferably by its projection 140. The spring element 50 is preloaded and acts on the valve needle housing 100 towards a maximum expansion of the valve needle 120 in axial direction. If the projection 140 of the valve needle housing 100 rests on the valve needle body 25 the axial expansion of the valve needle 120 is maximized.

[0051] If the sealing element 110 impacts the valve needle seat of the injection valve 170 in the closing phase, the spring element 50 basically decouples the valve needle housing 100 and the sealing element 110 from the axial movements of the valve needle body 25. After the sealing element 110 impacts the valve needle seat, the valve needle body 25 typically oscillates in axial directions with decreasing oscillation amplitudes. The axial movements of the valve needle body 25 basically do not affect the current position of the sealing element 110 which still rests on the valve needle seat, while the kinetic energy of the valve needle body 25 is at least partially absorbed by the spring element 50.

[0052] While the axial expansion of the valve needle 120 decreases, e.g. after the sealing element 110 impacts the valve needle seat, the first fluid volume 220 increases. Due to the increasing first fluid volume 220 the resulting depression within the first fluid volume 220 forces the fluid within the injection valve cavity 190 to pass the first fluid passage 70 towards the first fluid volume 220. Additionally the fluid accumulated in the second fluid volume 230 may be forced to pass the second radial clearance 90. If the sealing element 110 axially moves towards non-closing positions, the fluid accumulated in the first fluid volume 220 is forced to pass the first fluid passage 70 towards the injection valve cavity 190. If the projection 140 of the valve needle housing 100 rests on the valve needle body 25 the first fluid volume 220 is minimized, e.g. zero unit of volume.

[0053] The damping constant of the decreasing oscillation of the valve needle body 25 and/or the valve needle housing 100 and the sealing element 110 is dependent on the spring rate of the spring element 50 and on the predetermined diameter of the opening of the first fluid passage 70 and the second radial clearance 90, if it hydraulically connects the first and second fluid volume 220, 230. Due to the decoupling of the axial oscillation of the valve needle body 25 and the valve needle housing 100, the sealing element 110 basically rests on the valve needle seat. This reduces a bouncing of the sealing element 110 after impacting the valve needle seat in the closing phase and reduces an uncontrolled fluid injection during the closing phase of the injection valve 170.

[0054] In a further embodiment, the injection valve 170 according to figure 3 comprises the o-ring as shown in figure 2 to basically prevent a fluid flowing between the first and second fluid volume 220, 230.

[0055] Figure 4 depicts a time diagram illustrating a bounce of particular sealing elements. A first characteristic 300 represents a lift L of the sealing element in an injection valve without reduced bouncing. A second characteristic 310 represents the lift L of the sealing element 110 in the injection valve 170 according to figure 1, 2 or 3, i.e. with reduced bouncing. A first lift L1 represents a non-closing position of the particular sealing element. A second lift L2 represents the closing position of the particular sealing element. In a first point in time t1 the particular injection valve enters its closing phase. The particular sealing element impacts the valve needle seat in a second point in time t2 to stop the fluid injection.

[0056] As shown in figure 4, the injection valve without reduced bouncing of the sealing element has multiple unwanted reopen phases in which fluid is dispensed from the injection valve. The fluid injection finally stops at a fourth point in time t4 in which the kinetic energy of the valve needle is dissipated.

[0057] As depicted in figure 4, the injection valve 170

according to figure 1, 2 or 3 has also multiple unwanted reopen phases, represented by the second characteristic 310. Compared to the first characteristic 300 the amount of reopen phases is significantly reduced. Furthermore, the particular amplitudes representing the particular lifts of the particular sealing element 110 of the second characteristic 310 are significantly reduced compared to the particular amplitudes of the first characteristic 200. The fluid injection finally stops at a third point in time t3, which is before the forth point in time t4.

Claims

1. Injection valve (170) for injecting fluid, comprising:

- a central longitudinal axis (LA),
- an injection valve housing (200) with an injection valve cavity (190),
- a valve needle (120) being axially moveable within the injection valve cavity (190) and comprising:

-- a valve needle housing (100) with a valve needle cavity (180),
-- a sealing element (110) preventing a fluid injection in a closing position and permitting the fluid injection in further positions,
-- a valve needle body (20), being axially moveable relative to the valve needle housing (100) and being fixedly coupled to the sealing element (110), whereas the valve needle body (20) is disposed at least partially within the valve needle cavity (180) to divide the valve needle cavity (180) into a first and second fluid volume (220, 230), whereas the first fluid volume (220) expands if an axial expansion of the valve needle (120) decreases,
-- at least one first fluid passage (70) with a predetermined opening to hydraulically connect the first fluid volume (220) with the injection valve cavity (190),
-- at least one spring element (50), being preloaded and acting on the valve needle body (20) towards a maximum axial expansion of the valve needle (120).

2. Injection valve (170) according to claim 1, wherein the valve needle (120) comprises a resting element (160) with a cavity, wherein the valve needle body (20) is at least partially disposed, whereas the resting element (160) is fixedly coupled to the valve needle housing (100), whereas the at least one first fluid passage (70) is a radial clearance between the valve needle body (20) and an inner wall of the cavity of the resting element (160).

3. Injection valve (170) according to claim 1 or 2, the at least one spring element (50) is a helical spring being arranged within the valve needle cavity (180).

4. Injection valve (170) for injecting fluid, comprising:

- a central longitudinal axis (LA),
- an injection valve housing (200) with an injection valve cavity (190),
- a valve needle (120) being axially moveable within the injection valve cavity (190) and comprising:

-- a valve needle housing (100) with a valve needle cavity (180),
-- a valve needle body (25), being at least partially arranged within the valve needle cavity (180) to divide the valve needle cavity (180) into a first and second fluid volume (220, 230), whereas the first fluid volume (220) expands if an axial expansion of the valve needle (120) decreases, whereas the valve needle body (25) and the valve needle housing (100) are axially moveable relative to each other,
-- a sealing element (110) being fixedly coupled to the valve needle housing (100) and preventing a fluid injection in a closing position and permitting the fluid injection in further positions,
-- at least one first fluid passage (70) with a predetermined opening to hydraulically connect the first fluid volume (220) with the injection valve cavity (190),
-- at least one spring element (50), being preloaded and acting on the valve needle housing (100) towards a maximum axial expansion of the valve needle (120).

5. Injection valve (170) according to claim 4, the at least one spring element (50) is a helical spring, being coupled to the valve needle housing (100) and enveloping at least partially the valve needle body (25).

6. Injection valve (170) according to one of the preceding claims, wherein the valve needle housing (100) comprises at least one projection (140) limiting the axial expansion of the valve needle (120).

7. Injection valve (170) according to claim 6, wherein the at least one first fluid passage (70) is a first radial clearance between the at least one projection (140) and the valve needle body (20, 25).

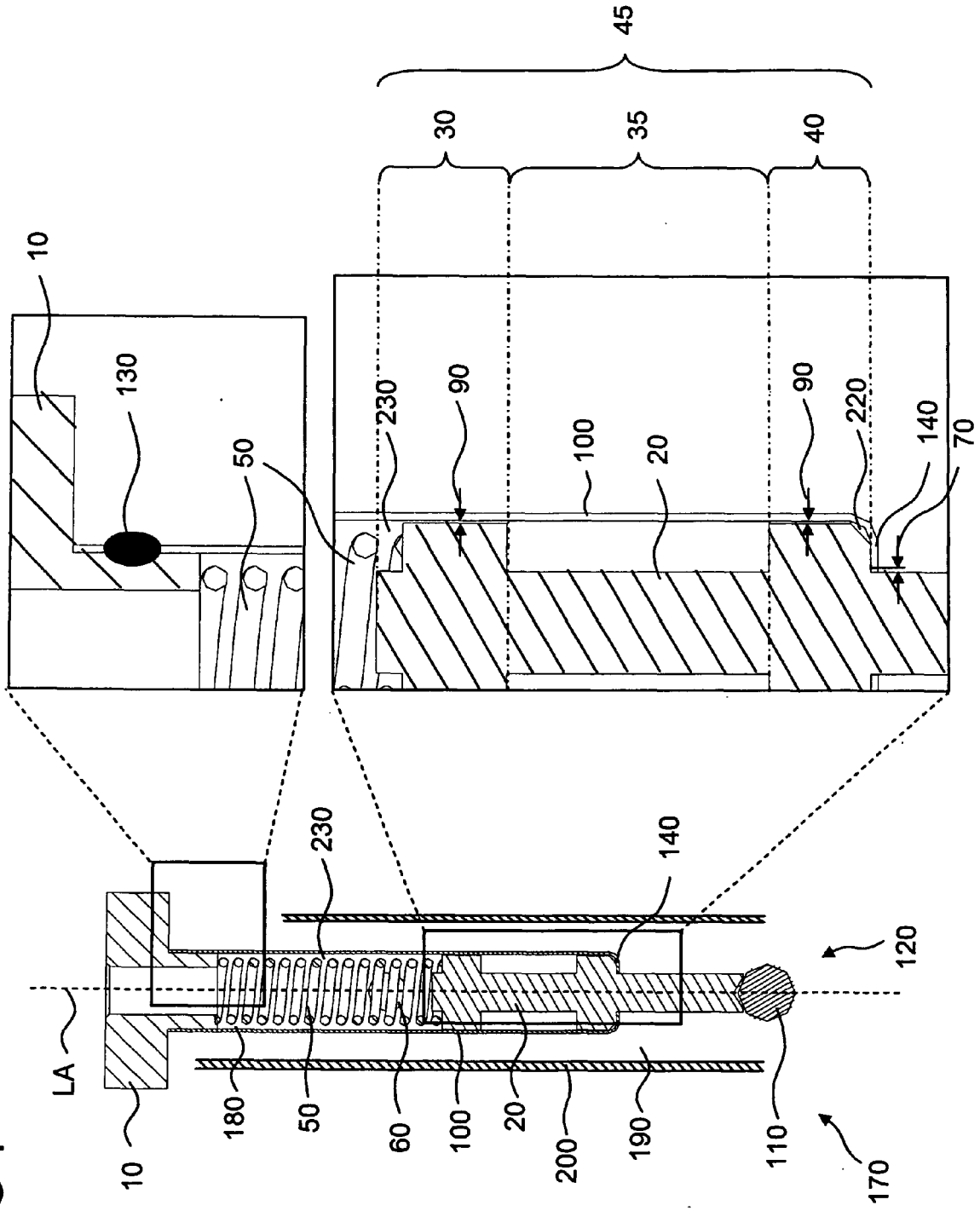
8. Injection valve (170) according to one of the preceding claims, wherein the valve needle (120) comprises a second radial clearance between the valve needle body (20, 25) and an inner wall of the valve needle

cavity (180).

9. Injection valve (170) according to one of the preceding claims, wherein the valve needle body (20, 25) comprises a first (30), second (35) and third portion (40), each portion being disposed within the valve needle cavity (180), whereas the second portion (35) being arranged between the first (30) and third portion (40) and having a less diameter than the first (30) and third portion (40), whereas the diameter of the first (30) and third portion (40) are basically identical.

10. Injection valve (170) according to claim 9, the second radial clearance being formed by a radial clearance between the first portion (30) respectively the third portion (40) of the valve needle body (20, 25) and the wall of the valve needle cavity (180).

11. Injection valve (170) according to claim 9 or 10, wherein the valve needle (120) comprises at least one O-ring enveloping the second portion (35) of the valve needle body (20, 25) and being adopted to basically prevent a fluid flowing between the first and second fluid volume (220, 230).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200
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FIG 1

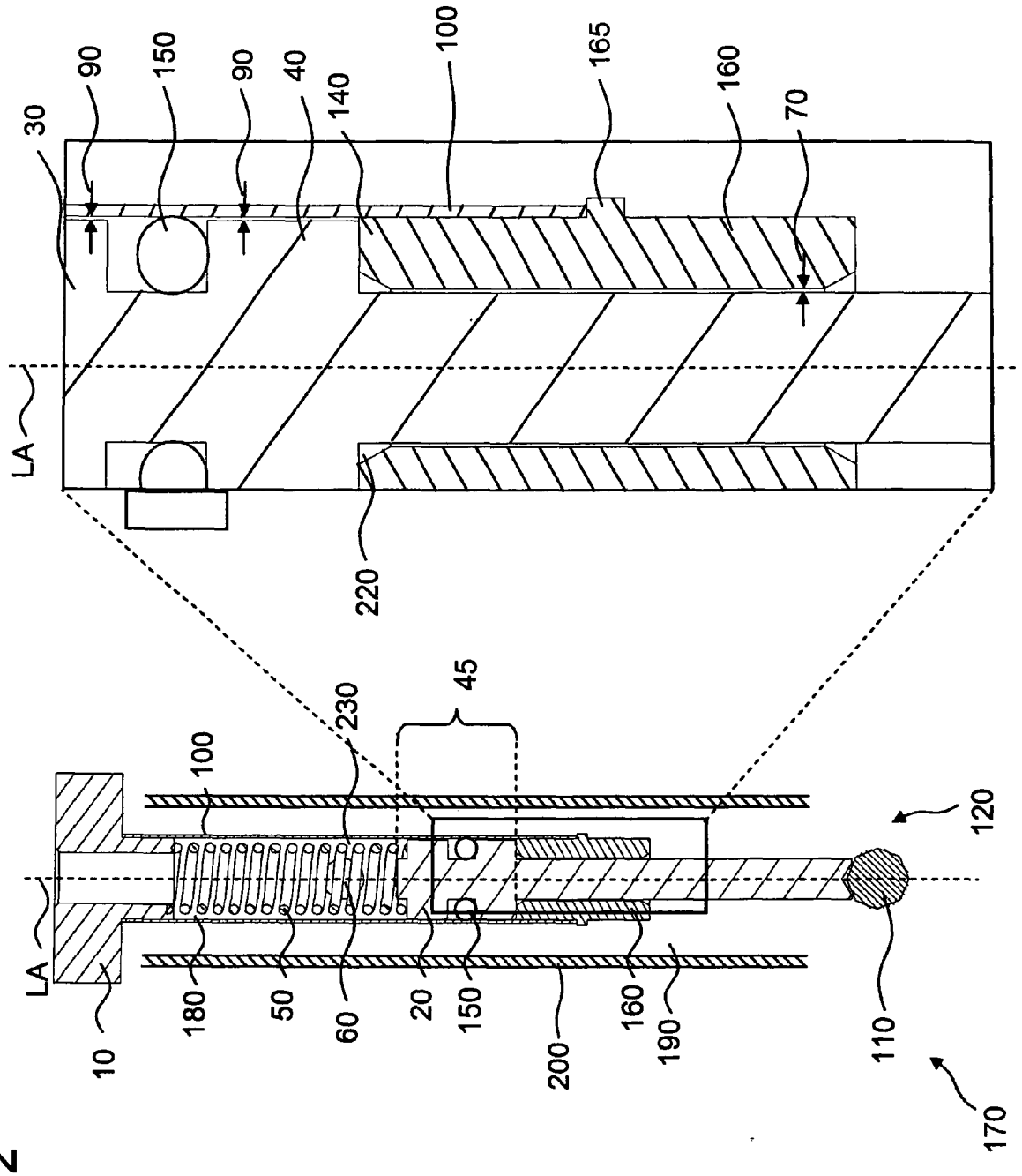
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FIG 2

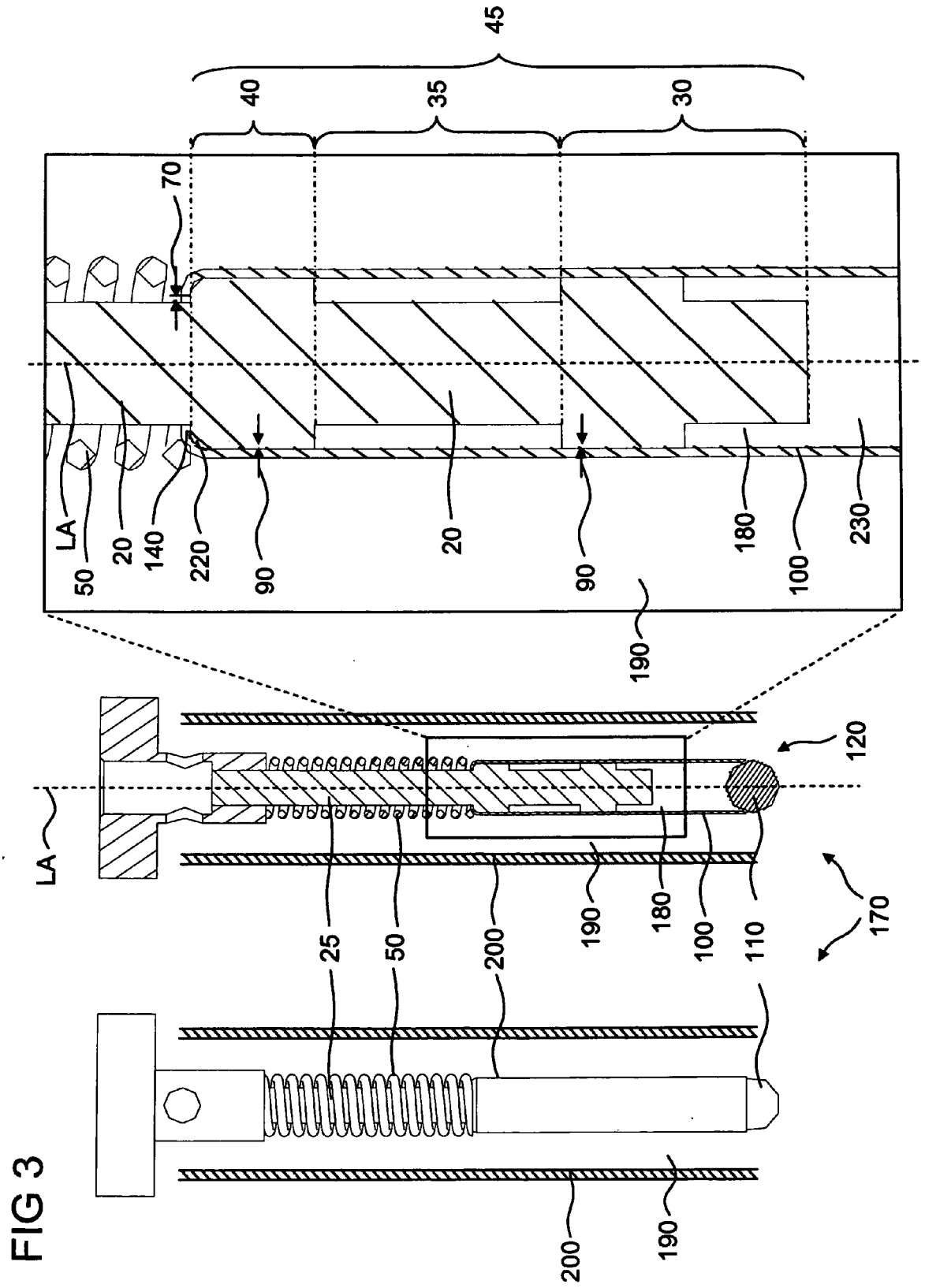
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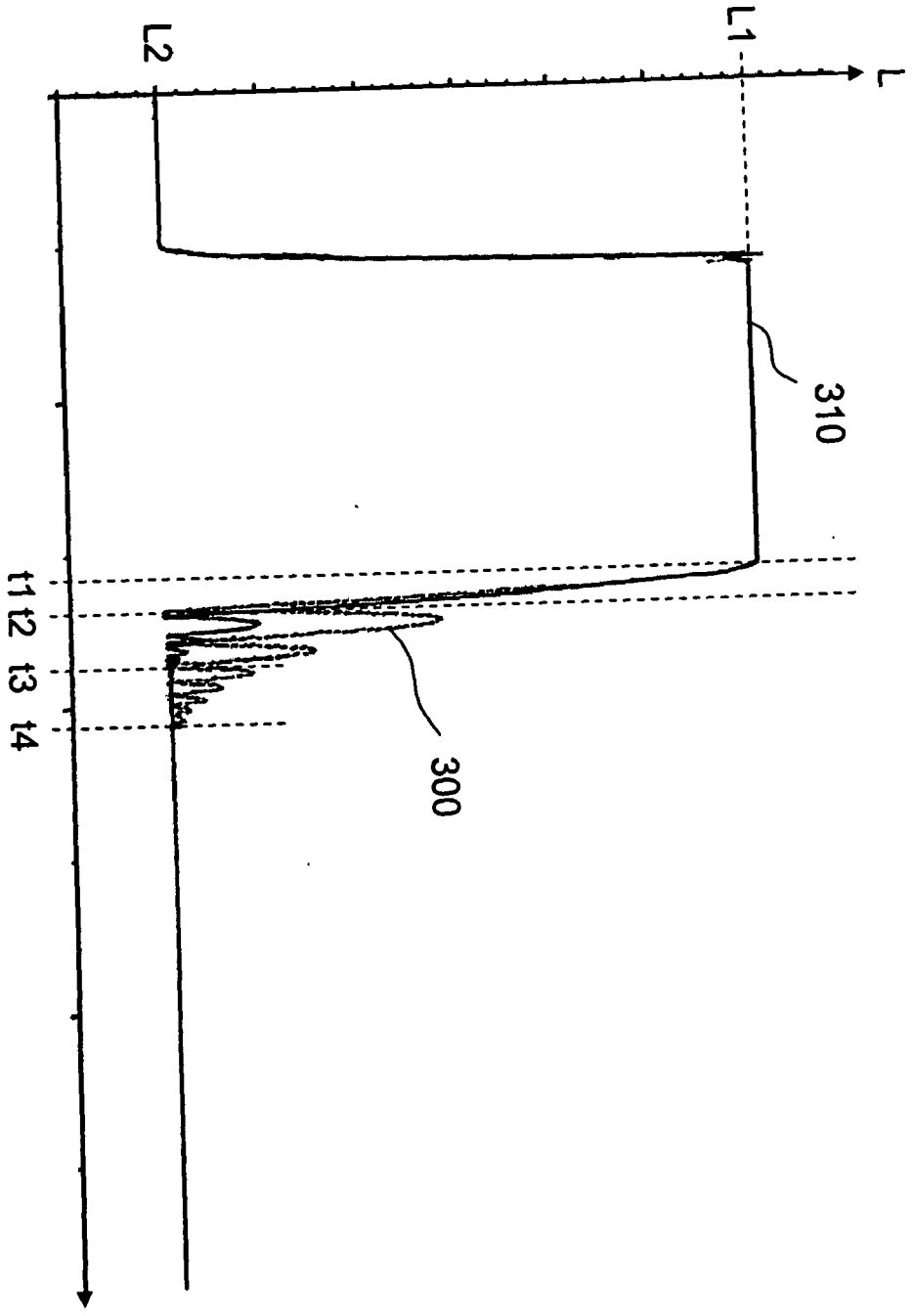
FIG 3

FIG 4



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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
Munich	21 September 2009	Etschmann, Georg

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