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

(11) EP 1 887 216 B1

(12) EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent:
06.01.2010 Bulletin 2010/01

(51) Int Cl.:
F02M 63/00 *(2006.01)* ***F02M 61/16*** *(2006.01)*

(21) Application number: **06016135.3**

(22) Date of filing: **02.08.2006**

(54) Thermal compensation arrangement in an injection valve

Anordnung zum thermischen Ausgleich in einem Einspritzventil

Arrangement thermique de compensation dans une valve d'injection

(84) Designated Contracting States:
DE FR IT

(43) Date of publication of application:
13.02.2008 Bulletin 2008/07

(73) Proprietor: **Continental Automotive GmbH**
30165 Hannover (DE)

(72) Inventor: **Cipriani, Emiliano, Dr.**
57100 Livorno (IT)

(56) References cited:
EP-A- 1 519 035 **EP-A1- 1 391 608**
EP-A2- 1 591 656 **WO-A-02/31349**

Note: Within nine months of the publication of the mention of the grant of the European patent in the European Patent Bulletin, any person may give notice to the European Patent Office of opposition to that patent, in accordance with the Implementing Regulations. Notice of opposition shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

EP 1 887 216 B1

Description

[0001] The invention relates to a thermal compensation arrangement for an injection valve and an injection valve, as shown in WO 02/31340 A.

[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 for an internal combustion engine comprise actuator units. In order to inject fuel, the actuator unit is energized so that a fluid flow through the fluid outlet portion of the injection valve is enabled.

[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 the range of up to 200 bar or in the case of diesel engines in the range of up to 2,000 bar. The injection of fluids under such high pressures has to be carried out very precisely.

[0005] The object of the invention is to create a thermal compensation arrangement which facilitates a reliable and precise function of the injection valve.

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

[0007] According to a first aspect the invention is distinguished by a thermal compensation arrangement for an injection valve, the injection valve comprising a housing including a central longitudinal axis, the housing comprising a cavity, a valve needle axially movable in the cavity, and an actuator unit being coupled to the valve needle and enabling the axial movement of the valve needle relative to the housing upon actuation of the actuator unit. The thermal compensation arrangement comprises a casing being coupable to the housing and comprising a recess, a piston axially movable in the recess and being coupable to the actuator unit. The piston has a lateral surface, a first front surface pointing in axial direction and a second front surface pointing in axial direction and away from the first front surface. Furthermore, the thermal compensation arrangement comprises a gap being formed in the recess and extending in radial direction between the lateral surface of the piston and the casing, a first piston channel being arranged in the piston and extending from the first front surface to the second front surface of the piston, and a second piston channel extending from the lateral surface to the first piston channel thereby enabling a fluid flow through the second piston channel between the gap and a recess section extending in axial direction between the first front surface of the piston and the casing.

[0008] This has the advantage that in the case of an axial movement of the piston in direction to the actuator unit a high fluid flow rate from the gap to the recess section between the front surface and the casing via the piston channels is possible. In this case a high circulation flow rate of the fluid flowing from the recess section between the front surface and the casing through the gap and the piston channels back to the recess section between the front surface and the casing is possible. By this deposits of components of the fluid in the recess and in particular in the gap can be prevented.

[0009] In an advantageous embodiment the thermal compensation arrangement has a groove being arranged on the lateral surface of the piston and being hydraulically coupled to the second piston channel. This allows a good performance of the fluid flow from the gap into the piston channel.

[0010] In a further advantageous embodiment the groove is extending circumferentially over the lateral surface of the piston. The advantage of this is that a good fluid flow performance from the whole gap over the whole circumference of the piston into the piston channel is possible.

[0011] According to a second aspect the invention is distinguished by an injection valve comprising a thermal compensation arrangement.

[0012] Exemplary embodiments of the invention are explained in the following with the help of schematic drawings. These are as follows:

Figure 1, an injection valve in a longitudinal section view,

Figure 2, an enlarged view of a part of the injection valve according to figure 1 with a thermal compensation arrangement,

Figure 3, an enlarged view of the thermal compensation arrangement for the injection valve in a first operating condition, and

Figure 4, an enlarged view of the thermal compensation arrangement for the injection valve in a second operating condition.

[0013] Elements of the same design and function that appear in different illustrations are identified by the same reference characters.

[0014] An injection valve 10 (figure 1) that is used as a fuel injection valve for an internal combustion engine, comprises a housing 12, a thermal compensation arrangement 14 and an actuator unit 16.

[0015] The housing 12 has a tubular shape. The actuator unit 16 is inserted into the housing 12 and comprises a piezo actuator, which changes its axial length depending on a control signal applied to it. The actuator unit 16 may, however, also comprise another type of actuator, which is known to person skilled in the art for that purpose. Such an actuator may be, for example, a solenoid.

[0016] The injection valve 10 comprises a valve body 20 with a central longitudinal axis A and a cavity 24 which is axially led through the valve body 20. On one of the free ends of the cavity 24, a fluid outlet portion 28 is formed which is closed or open depending on the axial position of a valve needle 22. The injection valve 10 further has a fluid inlet portion 26 which is arranged in the housing 12 and which is hydraulically coupled to the cavity 24 and a not shown fuel connector. The fuel connector is designed to be connected to a high pressure fuel chamber of an internal combustion engine, the fuel is stored under high pressure, for example, under the pressure above 200 bar.

[0017] The valve body 20 has a valve body spring rest 32 and the valve needle 22 comprises a valve needle spring rest 34, both spring rests 32, 34 supporting a main spring 30 arranged between the valve body 20 and the valve needle 22.

[0018] The injection valve 10 is of an outward opening type. In an alternative embodiment of the injection valve 10 may be of an inward opening type. Between the valve needle 22 and the valve body 20 a bellow 36 is arranged which is sealingly coupling the valve body 20 with the valve needle 22. By this a fluid flow between the cavity 24 and a chamber 38 is prevented. Furthermore, the bellow 36 is formed and arranged in a way that the valve needle 22 is actuable by the actuator unit 16.

[0019] Figure 2 shows a longitudinal sectional view of the thermal compensation arrangement 14 arranged in the housing 12 and coupled to the actuator unit 16.

[0020] The thermal compensation unit 14 has a casing 45 of a cylindrical shape which has a recess 54, in which a piston 46 is arranged which is of a cylindrical shape and extends in the axial direction of the casing 45 and is coupled to the actuator unit 16 by a connecting bar 48.

[0021] The thermal compensation unit 14 comprises a sealing element 50 arranged in a piston rest 51 being part of the casing 45 and supporting the piston 46 in an initial state of the thermal compensation unit 14 as described below.

[0022] A spring retaining element 42 is mechanically coupled to the thermal compensation unit 14 by the connecting bar 48. A compensation spring 44 is arranged between the sealing element 50 of the thermal compensation unit 14 and a spring retaining element spring rest 52 of the spring retaining element 42 to support the compensation spring 44.

[0023] The thermal compensation arrangement 14 is rigidly coupled to the housing 12 of the injection valve 10 by a welding seam 56 extending circumferentially over a side surface 57 of the casing 45 of the thermal compensation arrangement 14.

[0024] Figure 3 and 4 show the thermal compensation arrangement 14 in a longitudinal sectional and in large detailed view. The piston 46 of the thermal compensation arrangement 14 has a first front surface 58 pointing in axial direction away from the actuator unit 16 and a second front surface 59 pointing in axial direction and facing the actuator unit 16 thereby pointing away from the first front surface 58. The cylindrical shaped piston 46 furthermore has a lateral surface 60 extending between the first front surface 58 and the second front surface 59.

[0025] Between the lateral surface 60 of the piston 46 and the casing 45 of the thermal compensation arrangement 14, a gap 65 is formed being a part of the recess 54 of the casing 45. Between the first front surface 58 of the piston 46 and the casing 45 a recess section 66 is extending in axial direction. Between the second front surface 59 of the piston 46 and the sealing element 50 a bottom recess section 67 is arranged. The recess section 66 and the bottom recess section 67 are part of the recess 54 of the casing 45.

[0026] It will be described in the following that the recess section 66 and the bottom recess section 67 are changing their volumes in the case of an axial movement of the piston 46 in the casing 45.

[0027] A first piston channel 61a is arranged in the piston 46 and extends from the first front surface 58 of the piston 46 to the second front surface 59 of the piston 46. The first piston channel 61a allows a hydraulic coupling of the recess section 66 between the first front surface 58 of the piston 46 and the casing 45 and the bottom recess section 67 extending between the sealing element 50 and the second front surface 59 of the piston 46.

[0028] A second piston channel 61b is extending from the lateral surface 60 of the piston 46 to the first piston channel 61a. The second piston channel 61b enables a hydraulic coupling between the gap 65 and the first piston channel 61a.

[0029] On the lateral surface 60 of the piston 46 a groove 62 is arranged in the piston 46 which extends circumferentially over the lateral surface 60 of the piston 46 and is hydraulically coupled to the second piston channel 61b. By this a good hydraulic coupling of the gap 65 to the second piston channel 61b can be obtained. The width of the groove 62 in axial direction is larger than the width of the second piston channel 61b. By that the groove 62 and the second piston channel 61b are forming a funnel with good values for the fluid dynamic properties of the hydraulic coupling between the gap 65 and the second piston channel 61b.

[0030] At one end of the first piston channel 61a on the first front surface 58 of the piston 46 a flap 64 is arranged.

[0031] In the following, the function of the injection valve 10 will be described:

[0032] The fuel is led from the fluid inlet portion 26 in the housing 12 towards the valve body 20 and then towards the fluid outlet portion 28.

[0033] The valve needle 22 prevents a fluid flow through the fluid outlet portion 28 in the valve body in a closing position of the valve needle 22. Outside of the closing position of the valve needle 22, the valve needle 22 enables the fluid flow through the fluid outlet portion 28.

[0034] In the case that the actuator unit 16 has a piezo electric actuator, the piezo electric actuator may change its axial length if it gets energized. By changing its length the actuator unit 16 may effect a force on the valve needle 22. Due to the elasticity of the bellow 36 the valve needle 22 is able to move in axial direction out of the closing position. Outside the closing position of the valve needle 22 there is a gap between the valve body 20 and the valve needle 22 at an axial end of the injection valve 10 facing away from the actuator unit 16. The gap is forming a valve nozzle 29.

[0035] The main spring 30 can force the valve needle 22 via the valve needle spring rest 34 towards the actuator unit 16. In the case the actuator unit 16 is de-energized the actuator unit 16 shortens its length. Due to the elasticity of the bellow 36 the main spring 30 can force the valve needle 22 to move in axial direction its closing position. It is depending on the force balance between the force on the valve needle 22 caused by the actuator unit 16 and the force on the valve needle 22 caused by the main spring 30 whether the valve needle 22 is in its closing position or not. If the valve needle 22 is not in its closing position a fuel flow is enabled through the valve nozzle 29.

[0036] The thermal compensation arrangement 14 serves two purposes: first the compensation of changes of the length of the actuator unit 16 due to thermal variations which are comparable slow changes and second the compensation of impulsive forces of the actuator unit 16 due to an energizing and a de-energizing of the actuator unit 16 which result in relative fast movements of the piston 46 in the casing 45 of the thermal compensation arrangement 14. In the following the function of the thermal compensation arrangement 14 concerning the fast movements of the piston 46 due to energizing and de-energizing of the actuator unit 16 will be described in detail:

[0037] In figure 3 the thermal compensation arrangement 14 is shown in its initial state. This means that the actuator unit 16 is de-energized and the piston 46 is in contact with the piston rest 51 due to the spring forces of the compensation spring 44.

[0038] If the actuator unit 16 is energized and therefore changes its length to move the valve needle 22 out of the closing position simultaneously the piston 46 in the recess 54 of the casing 45 is moved in axial direction in a first piston movement direction P1 (Fig. 3) away from the sealing element 50. This movement causes a pressure wave in the recess section 66 between the first front surface 58 of the piston 46 and the casing 45 of the thermal compensation arrangement 14. The pressure wave in the fluid forces the fluid in the recess 54 to flow in a fluid flow direction F from the recess section 66 to the gap 65. When the piston 46 starts to move in the first piston direction P1 the piston 46 looses contact with the piston rest 51 allowing the fluid flowing from the gap 65 to the bottom recess section 67 adjacent to the sealing element 50. During this the volume of the bottom recess section 67 is increasing while the volume of the recess section 66 is decreasing. As the pressure wave in the recess section 66 caused by the movement of the piston 46 forces the flap 64 to be closed a fluid flow through the first piston channel 61a is prevented.

[0039] If the actuator unit 16 is de-energized and consequently, the actuator unit 16 shortens its length to force the valve needle 22 to move in axial direction into its closing position, the piston 46 of the thermal compensation arrangement 14 is forced to move in a second piston movement direction P2 (Fig. 4) towards the sealing element 50. During this the volume of the recess section 66 is increasing and the volume of the bottom recess section 67 is decreasing. The movement of the piston 46 creates a pressure wave in the fluid being in the first piston channel 61a which opens the flap 64. By this fluid flows through the first piston channel 61a into the recess section 66 between the first front surface 58 of the piston 46 and the casing 54.

[0040] Due to the pressure wave of the fluid in the first piston channel 61a, low pressure is generated in the second piston channel 61b which allows to suck fluid from the gap 65 into the second piston channel 61b and further into the first piston channel 61a. By this a good circulation of fluid in the gap 65 is achieved. Additionally, the groove 62 allows sucking the fluid in the gap 65 into the second piston channel 61b over the whole circumference of the piston 46. Due to the second piston channel 61b a good circulation of fluid from the piston channel 61a to the recess section 66 and further to the gap 65 and the second piston channel 61b in fluid flow direction F is possible. By this a deposition of components of the fluid in the recess 54 and in particular in the gap 65 may be prevented.

Claims

1. Thermal compensation arrangement (14) for an injection valve (10), the injection valve (10) comprising

    - a housing (12) including a central longitudinal axis (A), the housing (12) comprising a cavity (24),
    - a valve needle (22) axially movable in the cavity (24), and
    - an actuator unit (16) being coupled to the valve needle (22) and enabling the axial movement of the valve needle (22) relative to the housing (12) upon actuation of the actuator unit (16),

    the thermal compensation arrangement (14) comprising

    - a casing (45) being coupable to the housing (12) and comprising a recess (54),
    - a piston (46) axially movable in the recess (54) and being coupable to the actuator unit (16), the piston (46) having a lateral surface (60), a first front surface (58) pointing in axial direction and a second front surface (59) pointing in axial di-

rection and away from the first front surface (58),
- a gap (65) being formed in the recess (54) and extending in radial direction between the lateral surface (60) of the piston and the casing (45),
- a first piston channel (61a) being arranged in the piston (46) and extending from the first front surface (58) to the second front surface (59) of the piston (46), **characterised in that** the injection valve (10) comprises
- a second piston channel (61b) extending from the lateral surface (60) to the first piston channel (61a) thereby enabling a fluid flow through the second piston channel (61b) between the gap (65) and a recess section (66) extending in axial direction between the first front surface (58) of the piston (46) and the casing (45).

2. Thermal compensation arrangement (14) in accordance with claim 1 with a groove (62) being arranged on the lateral surface (60) of the piston (46) and being hydraulically coupled to the second piston channel (61b).

3. Thermal compensation arrangement (14) in accordance with claim 2 with the groove (62) extending circumferentially over the lateral surface (60) of the piston (46).

4. Injection valve (10) comprising the thermal compensation arrangement (14) in accordance with one of the preceding claims.

Patentansprüche

1. Thermische Ausgleichsanordnung (14) für ein Einspritzventil (10), während das Einspritzventil (10) umfasst:

- ein Gehäuse (12) mit einer zentralen Längsachse (A), während das Gehäuse (12) einen Hohlraum (24) aufweist,
- eine Ventilnadel (22), die axial in dem Hohlraum (24) bewegbar ist, und
- eine Betätigungseinheit (16), die an die Ventilnadel (22) gekoppelt ist und die die axiale Bewegung der Ventilnadel (22) im Bezug auf das Gehäuse (12) aufgrund der Betätigung der Betätigungseinheit (16) gestattet, während die thermische Ausgleichsanordnung (14) umfasst
- eine Ummantelung (45), die an das Gehäuse (12) koppelbar ist und eine Aussparung (54) aufweist,
- einen Kolben (46), der axial in der Aussparung (54) bewegbar ist und der an die Betätigungseinheit (16) koppelbar ist, während der Kolben (46) eine laterale Oberfläche (60) aufweist, wobei eine erste Stirnfläche (58) in axiale Richtung und eine zweite Stirnfläche (59) in axiale Richtung und weg von der ersten Stirnfläche (58) zeigt,
- einen Spalt (65), der in der Aussparung (54) ausgebildet ist und sich in radialer Richtung zwischen der lateralen Oberfläche (60) des Kolbens und der Ummantelung (45) erstreckt,
- einen ersten Kolbenkanal (61a), der in dem Kolben (46) angeordnet ist und sich von der ersten Stirnfläche (58) zu der zweiten Stirnfläche (59) des Kolbens (46) erstreckt,

dadurch gekennzeichnet, dass das Einspritzventil (10) umfasst:

- einen zweiten Kolbenkanal (61b), der sich von der lateralen Oberfläche (60) zu dem ersten Kolbenkanal (61a) erstreckt, wodurch ein Flüssigkeitsfluss durch den zweiten Kolbenkanal (61b) zwischen dem Spalt (65) und einem Aussparungsabschnitt (66) ermöglicht wird, der sich in axialer Richtung zwischen der ersten Stirnfläche (58) des Kolbens (46) und der Ummantelung (45) erstreckt.

2. Thermische Ausgleichsanordnung (14) gemäß Anspruch 1 mit einer Rille (62), die an der lateralen Oberfläche des Kolbens (46) angeordnet ist und hydraulisch an den zweiten Kolbenkanal (61b) gekoppelt ist.

3. Thermische Ausgleichsanordnung (14) gemäß Anspruch 2, während die Rille (62) sich umfänglich über die laterale Oberfläche (60) des Kolbens (46) erstreckt.

4. Einspritzventil (10), umfassend die thermische Ausgleichsanordnung (14) gemäß einem der vorhergehenden Ansprüche.

Revendications

1. Dispositif de compensation thermique (14) pour une soupape d'injection (10), la soupape d'injection (10) comprenant

- un boîtier (12) définissant un axe longitudinal central (A), ce boîtier (12) comportant une cavité (24),
- une aiguille de soupape (22) déplaçable axialement dans la cavité (24), et
- une unité d'actionnement (16) couplée à l'aiguille de soupape (22) et permettant d'en assurer le mouvement axial par rapport au boîtier (12) après une activation de l'unité d'actionnement (16),

le dispositif de compensation thermique (14) comprenant

- un fourreau (45) qui peut être couplé au boîtier (12) et qui définit une cavité (54),
- un piston (46) qui peut se déplacer axialement dans la cavité (54) et être couplé à l'unité d'actionnement (16), ce piston (46) présentant une surface latérale (60), une première face frontale (58) faisant face à la direction axiale et une seconde face frontale (59) faisant face à la direction axiale mais en sens opposé par rapport à la première face frontale (58),
- une fente (65) formée dans la cavité (54) et s'étendant en direction radiale entre la surface latérale (60) du piston et le fourreau (45),
- un premier passage de piston (61a) ménagé dans le piston (46) en s'étendant à partir de la première face frontale (58) vers la seconde face frontale (59) du piston (46),

caractérisé en ce que la soupape d'injection (10) comprend

- un second passage de piston (61b) s'étendant à partir de la surface latérale (60) vers le premier passage de piston (61a) pour permettre un écoulement de fluide à travers le second passage de piston (61b) entre la fente (65) et la partie de cavité (66) s'étendant axialement entre la première face frontale (58) du piston (46) et le fourreau (45).

2. Dispositif de compensation thermique (14) selon la revendication 1, comprenant une rainure (62) agencée dans la surface latérale (60) du piston (46) et couplée hydrauliquement au second passage de piston (61b).

3. Dispositif de compensation thermique (14) selon la revendication 2, dans lequel la rainure (62) s'étend autour de la surface latérale (60) du piston (46).

4. Soupape d'injection (10) comprenant un dispositif de compensation thermique (14) selon l'une des revendications précédentes.

FIG 1

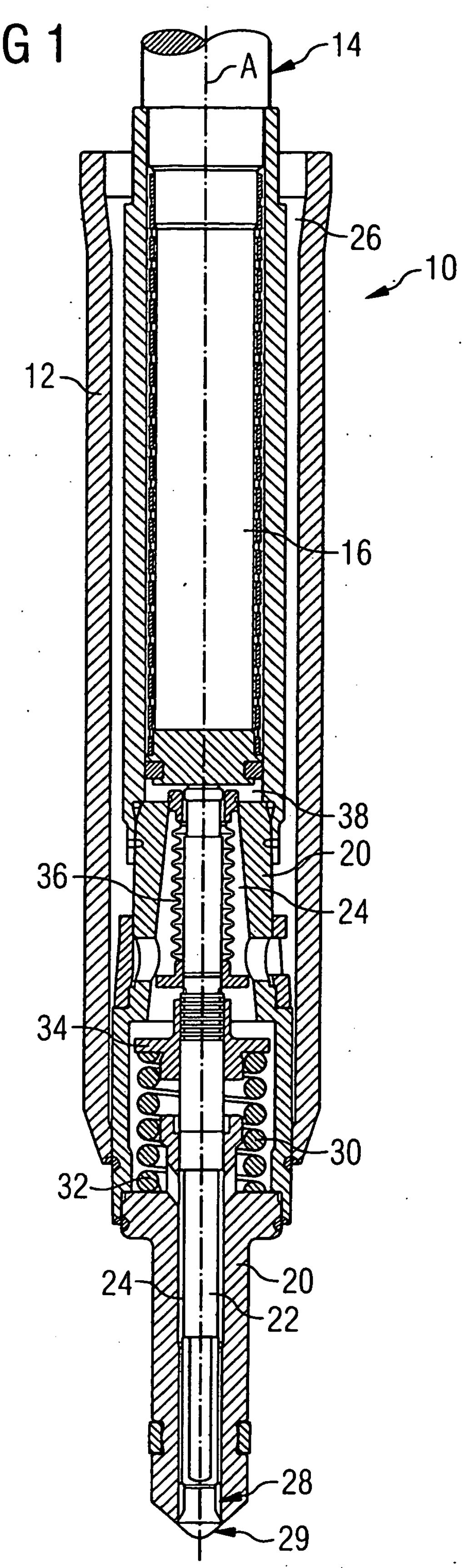


FIG 2

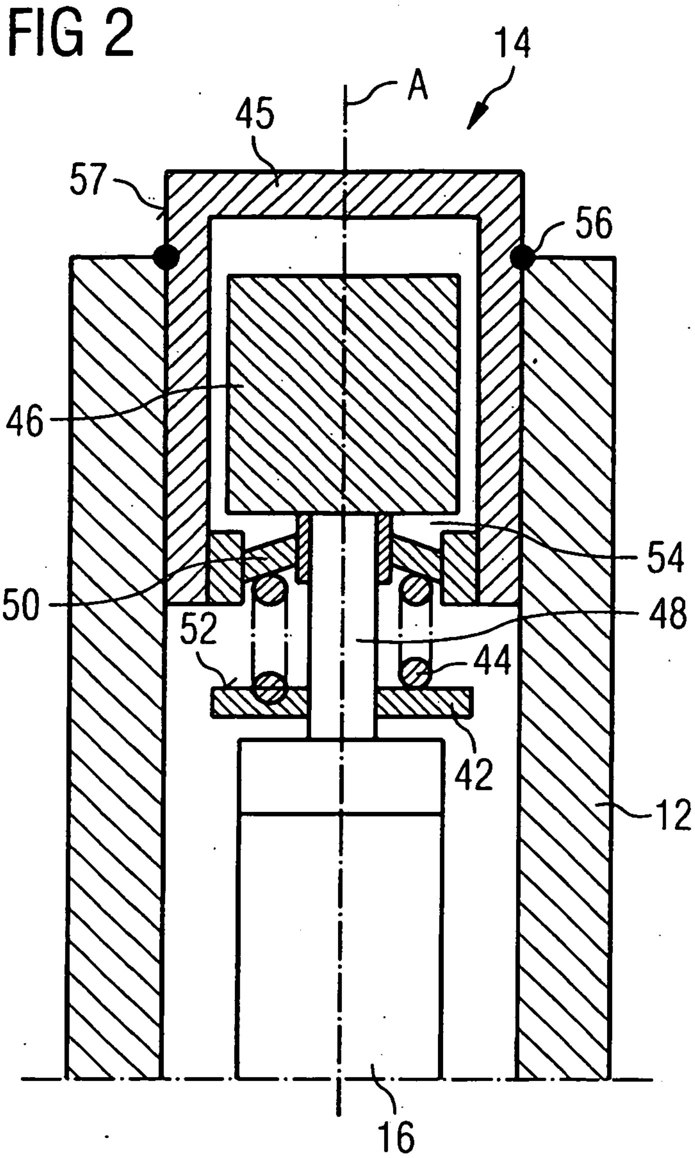


FIG 3

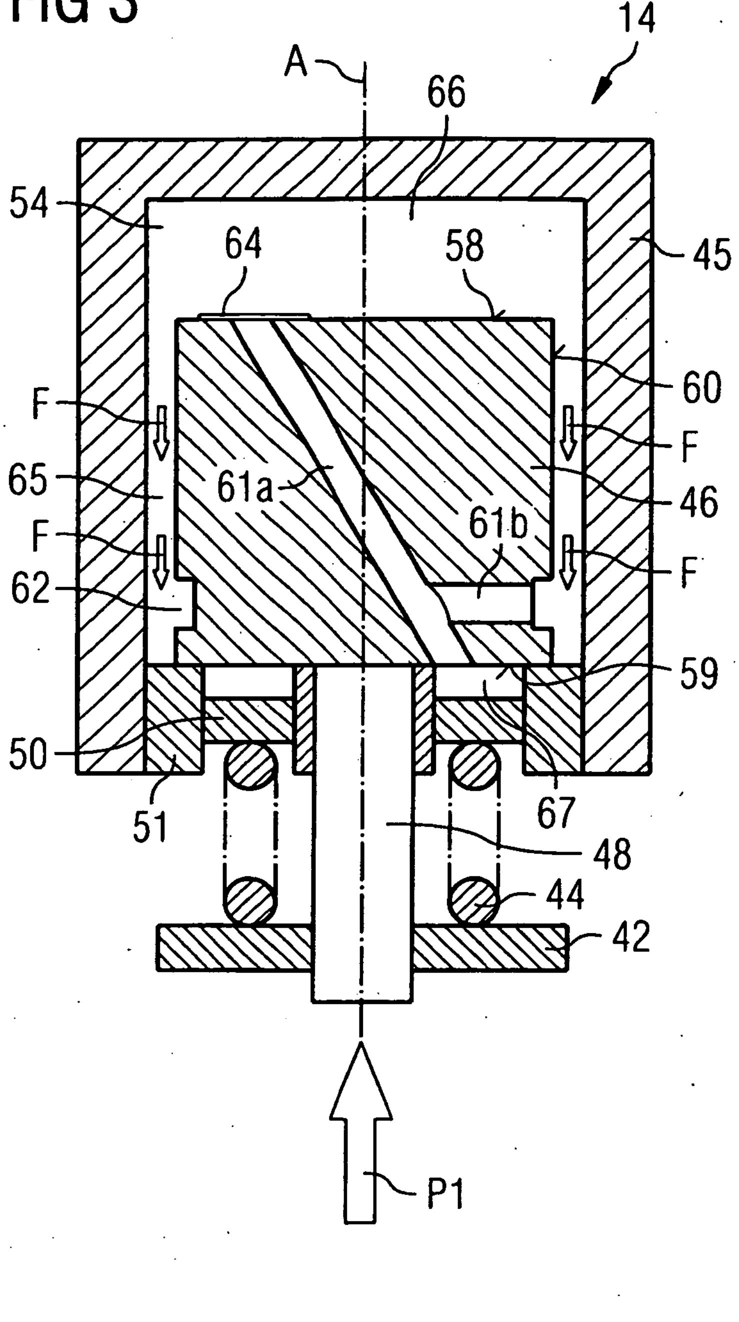
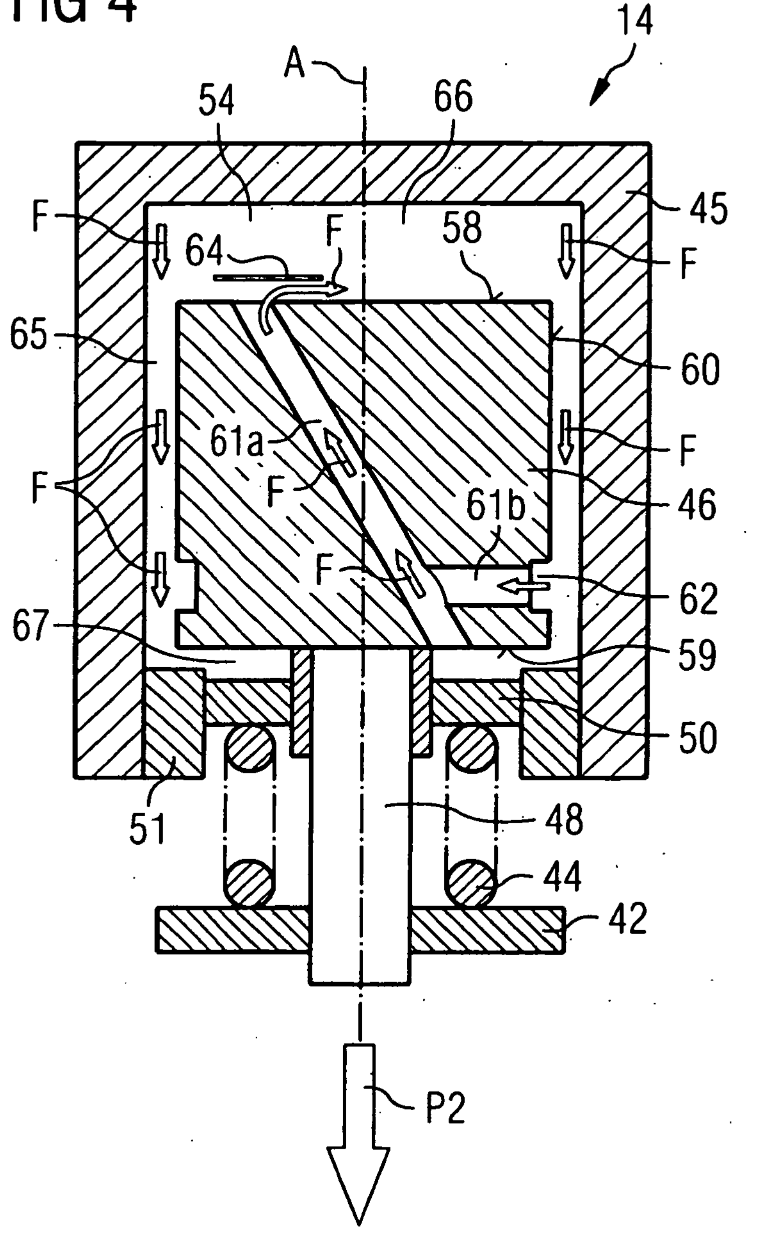


FIG 4


14
A
54
66
45
F
64
F
58
F
65
60
61a
F
F
F
46
61b
F
62
67
59
50
51
48
44
42
P2

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- WO 0231340 A **[0001]**