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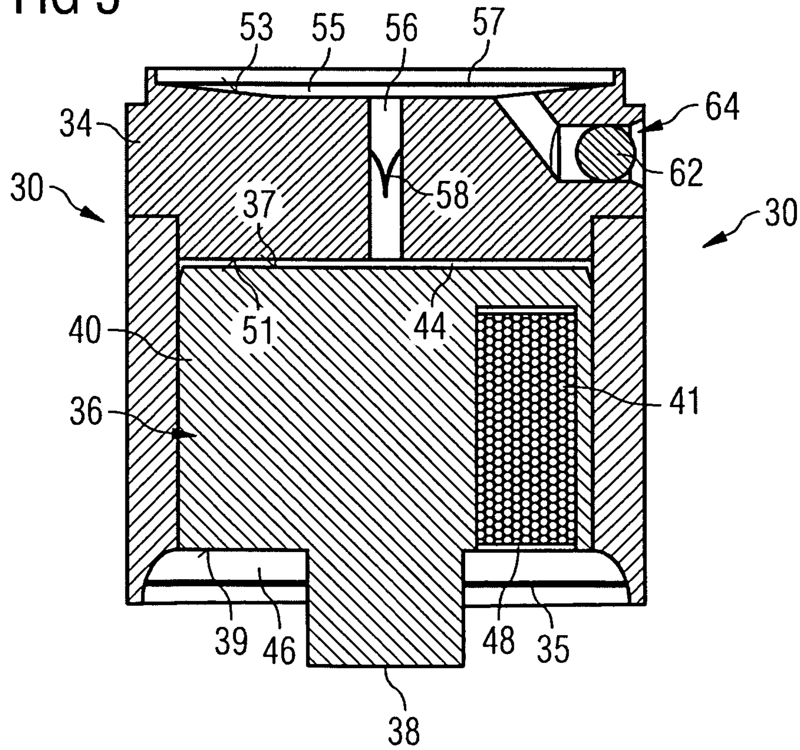
(54) Compensation assembly for an injector

(57) A Compensation assembly (30) for an injector comprises a cup shaped compensation assembly body (32) having a bottom portion (34) and a recess (33). A piston (36) is arranged in the recess (33) of the cup shaped compensation assembly body (32) movable in axial direction. A first fluid chamber (44) is bordered in axial direction by a first side (37) of the piston (36) and by the bottom portion (34) of the cup shaped compensation assembly body (32). A second fluid chamber (46) is bordered in axial direction by a first membrane (35) and by a second side (39) of the piston (36) facing away from the first side (37) of the piston (36). A fluid path extends from the first to the second fluid chamber (44, 46). An elastic compensation device is checklessly hydraulically coupled to the second fluid chamber (46).

FIG 5



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Description

[0001] The invention relates to a compensation assembly for an injector. The compensation assembly comprises a cup shaped compensation assembly body having a bottom portion and a recess. A piston is arranged in the recess of the cup shaped compensation assembly body movable in axial direction.

[0002] DE 197 08 304 A1 discloses a device for transferring a movement in an injector. A transferring device is arranged intermediate a piezoelectric actuator and a piston. The transferring device comprises at least one pressure chamber. The pressure chamber is sealed by a first membrane. The pressure chamber is connected with a compensation chamber by a throttle. The throttle as well is arranged in the transferring device.

[0003] DE 102 45 109 A1 discloses an injector, especially for injecting fuel comprising a piezoelectric actuator. A shell of a body of the piezoelectric actuator is surrounded by a wall of a recess of an injector housing comprising a clearance fit to the wall of the recess of the injector housing. Further, the shell is cooled by a direct contact to an inert, electrically non-conductible thermally coupling fluid. Further, the injector housing comprises a fluid chamber which is nearly completely filled with a fluid. The rest volume of the fluid chamber which is not filled with the fluid has at least such a size that the rest volume is able to compensate a thermal expansion of the thermally coupling fluid at the highest working temperature of the actuator body.

[0004] The object of the invention is to create a compensation assembly for an injector which enables a precise compensation of an axial expansion of the injector in a simple way.

[0005] The object of the invention is achieved by the features of the independent claims 1 and 8. Advantageous embodiments of the invention are given in the subclaims.

[0006] The invention is distinguished concerning a first aspect of the invention by a compensation assembly for an injector. The compensation assembly comprises a cup shaped compensation assembly body having a bottom portion and a recess. A piston is arranged in the recess of the cup shaped compensation assembly body movable in axial direction. A first fluid chamber is bordered in axial direction by a first side of the piston and by the bottom portion of the cup shaped compensation assembly body. A second fluid chamber is bordered in axial direction by a first membrane and by a second side of the piston facing away from the first side of the piston. A fluid path extends from the first to the second fluid chamber. An elastic compensation device is checklessly hydraulically coupled to the second fluid chamber.

[0007] If the compensation assembly is arranged in an injector coupling an actor of the injector with a wall of the injector or with a needle of the injector, the compensation assembly enables a compensation of a thermal expansion of the injector housing relative to the actor. If a fluid in the compensation assembly expands with increasing temperature, the elastic compensation device is deformed elastically. The elastic deformation of the elastic compensation device in that way compensates the increasing need for volume of the fluid in the compensation assembly. This contributes to a precise compensation of a thermal expansion of the injector, especially of the injector housing and so contributes to a precise dosing of fluid by the injector.

[0008] In an advantageous embodiment of the invention, the elastic compensation device comprises a first elastic compensation element which is arranged in a compensation element recess of the piston. This enables in a simple way a checkless hydraulic coupling to the second fluid chamber without modification of the cup shaped compensation assembly body.

[0009] In a further advantageous embodiment of the invention, the elastic compensation device comprises a second elastic compensation element being arranged in the second fluid chamber. This enables in a simple way a checkless hydraulic coupling to the second fluid chamber without modification of the compensation assembly.

[0010] In a further advantageous embodiment of the first aspect of the invention, the elastic compensation device comprises a third elastic compensation element which is arranged in a compensation element recess of the cup shaped compensation assembly body. This enables in a simple way a checkless hydraulic coupling to the second fluid chamber without modification of the piston.

[0011] In a further advantageous embodiment of the first aspect of the invention, the fluid path comprises a clearance fit between the piston and the wall of the recess of the cup shaped compensation assembly body. This enables in a simple way a hydraulic connection between the first and the second fluid chamber without forming a recess in the piston. If the piston in the recess of the cup shaped compensation assembly body comprises the clearance fit, this may be used for throttling the fluid while passing the space between the piston and the recess.

[0012] In a further advantageous embodiment of the first aspect of the invention, the fluid path comprises a fluid recess of the piston. The compensation assembly comprises a first throttle and/or a first control valve and/or a first check valve being arranged in such a way that the fluid which passes the fluid recess of the piston has to pass the first throttle and/or, respectively, the first control valve and/or, respectively, the first check valve. This enables in a simple way a hydraulic connection between the first and the second fluid chamber while having a given throttling of the fluid which passes the fluid recess of the piston.

[0013] In a further advantageous embodiment of the first aspect of the invention, the elastic compensation device and/or the first and/or the second and/or the third elastic compensation element comprise rubber and/or polychloroprene and/or silicon. This contributes to a proper elastic deformation-ability of the elastic compensation device and/or of the elastic compensation elements.

[0014] The invention is distinguished concerning a second aspect of the invention by the compensation assembly for the injector. The compensation assembly comprises the cup shaped compensation assembly body having the bottom portion and the recess. The piston is arranged in the recess of the cup shaped compensation assembly body movable in axial direction. The first fluid chamber is bordered in axial direction by the first side of the piston and the first side of the bottom portion of the cup shaped compensation assembly body. A third fluid chamber is bordered in axial direction by a second membrane and by a second side of the bottom portion facing away from the first side of the bottom portion. A fluid recess of the bottom portion extends from the first to the third fluid chamber. A second throttle and/or a second control valve and/or a second check valve is arranged in such a way that the fluid which passes the fluid recess of the bottom portion has to pass the second throttle and/or the second control valve and/or the second check valve. The elastic compensation device is checklessly hydraulically coupled to the third fluid chamber. If a fluid in the compensation assembly expands with increasing temperature, the elastic compensation device is deformed elastically. The elastic deformation of the elastic compensation device in that way compensates the increasing need for volume of the fluid in the compensation assembly. This contributes to a precise compensation of a thermal expansion of the injector, especially of the injector housing and so contributes to a precise dosing of fluid by the injector.

[0015] In an advantageous embodiment of the second aspect of the invention, the compensation assembly comprises the second fluid chamber which is bordered in axial direction by the first membrane and by the second side of the piston facing away from the first side of the piston. The fluid path extends from the first to the second fluid chamber. The elastic compensation device is checklessly hydraulically coupled to the second fluid chamber. The combination of the second and the third fluid chamber may contribute to a proper compensation of the thermal expansion of the injector.

[0016] In a further advantageous embodiment of the second aspect of the invention, the elastic compensation device comprises a fourth compensation element which is arranged in the third fluid chamber. This enables in a simple way a checkless hydraulic coupling to the third fluid chamber without modification of the compensation assembly. In a further advantageous embodiment of the second aspect of the invention, the elastic compensation device comprises a fifth compensation element which is arranged in a compensation element recess of the bottom portion and which is checklessly hydraulically coupled to the third fluid chamber. This enables in a simple way a checkless hydraulic coupling of the elastic compensation device and the third fluid chamber.

[0017] In a further advantageous embodiment of the second aspect of the invention, the elastic compensation device and/or the first and/or the second and/or the third and/or the fourth and/or the fifth elastic compensation element comprises rubber and/or polychloroprene and/or silicon. This contributes to a proper elastic deformation-ability of the elastic compensation device and/or of the elastic compensation elements.

[0018] Advantageous embodiments of the invention are explained in the following with the aid of schematic drawings.

[0019] These are as follows:

Figure 1 an injector,

Figure 2 a first embodiment of a compensation assembly,

Figure 3 a second embodiment of the compensation assembly,

Figure 4 a third embodiment of the compensation assembly,

Figure 5 a fourth embodiment of the compensation assembly,

Figure 6 a fifth embodiment of the compensation assembly,

Figure 7 a sixth embodiment of the compensation assembly.

[0020] Elements with the same design and function that appear in the different illustrations are identified by the same reference character.

[0021] An injector (figure 1) comprises an injector housing 1 and a valve group 2. The valve group 2 comprises a nozzle body 4 having a nozzle body recess 6, a needle 8, a spring 10, and a spring washer 12. The needle 8 is arranged movable in axial direction in the nozzle body recess 6. The spring 10 is arranged circumferential the needle 8 and in axial direction intermediate the nozzle body 4 and the spring washer 12. The spring 10 acts on the needle 8 via the spring washer 12 in direction away from the nozzle body 4. The injector is preferably suited for injecting fluid into a combustion chamber of an internal combustion engine. In an alternative embodiment, the nozzle body 4 may be made of two or more pieces.

[0022] The actor 14 is arranged in an inner tube 15 of the injector housing 1. The actor 14 comprises a ground plate 16 and a top plate 18. The injector is arranged intermediate the spring washer 12 and a compensation device 13. The actor 14 acts on the needle 8 and on the spring washer 12 via the ground plate 16. The actor 14 acts on the compensation assembly 30 via the top plate 18. In an alternative embodiment, the compensation assembly 30 may be arranged intermediate the actor 14 and the spring washer 12 and the needle 8. A fluid, which is in this embodiment preferably fuel, may flow from a connection 20 to the nozzle body 4 through a free volume between the inner tube 15 and the injector housing 1.

[0023] In a closing position of the needle 8, the needle 8 and the nozzle body 4 prevent a fluid flow into the combustion chamber of the internal combustion engine. Outside of the closing position of the needle 8, there is a nozzle formed between a tip of the needle 8 and a tip of the nozzle body 4 facing away from the actor 14. Whether the needle 8 is in its closing position or not depends on a force balance between a first force acting on the needle 8 because of the spring 10 and a second force acting on the needle 8 because of the actor 14. The actor 14 preferably is a piezoelectric actuator. If the actor 14 gets energized, the actor 14 expands its axial length. If the actor 14 gets de-energized, the axial length decreases.

[0024] If the temperature of the injector increases while the operation of the injector, the injector, especially the injector housing 1, expands its axial length. In general, the injector housing 1, which is preferably made of stainless steel, expands more with the temperature than the actor 14. The compensation device 30 is arranged in order to compensate that thermal expansion of the injector housing 1.

[0025] The compensation assembly 30 comprises a cup shaped compensation assembly body 32 having a recess 33 and a bottom portion 34 (figure 2). The cup shaped compensation assembly body 32 is sealed by a first membrane 35. A piston 36 is arranged movable in axial direction in the recess 33 of the cup shaped compensation assembly body 32. The piston 36 comprises a piston head 40 and, preferably, a piston rod 38. In case, the piston rod 38 protrudes through a recess of the first membrane 35. The piston head 40 separates the recess 33 of the cup shaped compensation assembly body 32 in a first fluid chamber 44 and a second fluid chamber 46. The piston head 40 comprises a clearance fit to the wall of the recess 33. The clearance fit preferably is formed in such a way that a fluid in the first or the second fluid chamber 44, 46 may flow to the second or, respectively, the first fluid chamber 46, 44. The fluid flow from the first to the second fluid chamber 44, 46 or vice versa in that way may be throttled by the clearance fit.

[0026] During the operation of the compensation assembly 30, the first and the second fluid chamber 44, 46 are filled with fluid, preferably oil. The fluid in the first and the second fluid chamber 44, 46 is pressurized. The fluid may be pressurized by a compensation assembly spring which is arranged in such a way that the compensation assembly spring acts on the first membrane 35. Normally, there is the same pressure of the fluid in the first fluid chamber 44 and the second fluid chamber 46 because of the clearance fit. The first side 37 of the piston 36 has a larger surface than the second side 39 of the piston 39 because of the piston rod 38. The pressure acting on the larger surface of the first side 37 of the piston 36 causes a bigger force on the piston 36 then the pressure acting on the second side 39 of the piston 36. So, if there is no force acting on the compensation device 30 from the outside of the compensation assembly 30, the piston 36 is pressed away from the bottom portion 34. In that way the piston rod 38 never loses contact to the actor 14 and the bottom portion 34 never loses contact to a wall of the connection 20.

[0027] If the compensation assembly 30 is arranged in the injector, it is arranged in such a way that the compensation assembly 30 is preloaded. So, the actor 14 never loses contact to the piston rod 38. If the injector housing 1 expands with the changing temperature, the force on the piston 36 is decreasing. The fluid presses the piston 36 away from the bottom portion 34. So the thermal expansion of the injector housing 1 is compensated.

[0028] If the actor 14 gets energized, it may expands in a few microseconds. This duration is too short for the fluid to pass the clearance fit between the piston 36 and the recess 33 of the cup shaped compensation assembly body 32. So in that duration the piston 36 stays nearly in its position and the actor 14 has a nearly solid base to act on so that the ground plate 16 of the actor 14 acts on the needle 8 and on the spring washer 12 in order to move the needle 8 out of its closing position.

[0029] If the fluid in the first and/or the second fluid chamber 44, 46 expands itself by the temperature, a first compensation element 41 which may be arranged in a compensation element recess 48 of the piston 36 gets deformed elastically. By its elastic deformation, the first compensation element 41 compensates the thermal expansion of the fluid in the second fluid chamber 46 and because of the clearance fit between the piston 36 and the recess 33, it compensates the thermal expansion of the fluid in the first fluid chamber 44.

[0030] In order to increase the fluid exchange between the first fluid chamber 44 and the second fluid chamber 46, there may be a fluid recess 50 (figure 3) in the piston 36. The fluid recess 50 extends from the first fluid chamber 44 to the second fluid chamber 46. The fluid recess 50 of the piston 36 may be formed in such a way that the fluid which passes the fluid recess 50 gets throttled. Preferably, there is a throttle 52 formed and arranged in the fluid recess 50 of the piston 36. Additionally or alternatively to the first compensation element 41, there may be a second compensation element 42 arranged in the second fluid chamber 46. The second compensation element 42 compensates the thermal expansion of the fluid of the compensation assembly 30 in the same manner as the first compensation element 41. The fluid recess 50 and the clearance fit between the piston 36 and the fluid recess 33 of the cup shaped compensation assembly body 32 enable a hydraulic coupling of the first and the second fluid chamber 44, 46.

[0031] Alternatively or additionally to the first throttle 52, there may be arranged a first check valve 54 in such a way that the fluid which passes the fluid recess 50 of the piston 36 has to pass the first check valve 54. The first check valve 54 may be of a sheet-like check valve type. The sheet-like check valve may be made of a thin metal sheet covering the fluid recess 50 of the piston 36 and being fixed only at one side of the fluid recess 50 of the piston 36 comprising a given flexibility. If the piston 36 moves very slowly, for example because of the thermal expansion of the injector housing 1, there is nearly the same pressure on both sides of the sheet-like check valve. So, the fluid may pass the sheet-like check valve. If the piston 36 moves fast towards the bottom portion 34 of the cup shaped compensation assembly body 32, the sheet-like check valve gets pressed against the piston 36 next to the fluid recess 50 of the piston 36 because of the fluid pressure in the first fluid chamber 44. In that way, the fluid recess 50 gets sealed by the sheet-like check valve. So the piston 36 is not able to move further towards the bottom portion 34. The compensation assembly 30 reacts like a stiff body. So, the actor 14 is able to act on the needle 8 via its ground plate 16.

[0032] Alternatively or additionally to the first and/or the second compensation element 41, 42, there may be arranged a third compensation element 43 (figure 4) in a compensation element recess 49 of the cup shaped compensation assembly body 32. The compensation element recess 49 is formed like a groove circumferential the wall of the recess 33 of the cup shaped compensation assembly body 32. The third compensation element 43 compensates the thermal expansion of the fluid in the first and the second fluid chamber 44, 46 in the same manner as the first and/or the second compensation element 41, 42.

[0033] The bottom portion 34 may comprise a fluid recess 56 (figure 5) of the bottom portion 34 which extends from the first side of the bottom portion 51 to the second side of the bottom portion 53. Then, the second side of the bottom portion 53 preferably is covered by the second membrane 57 forming a third fluid chamber 55 between the second membrane 57 and the second side of the bottom portion 53. The compensation device spring may be arranged in this embodiment in such a way that the compensation device spring acts on the second membrane 57. The fluid recess 56 of the bottom portion 34 may be formed in such a way that the fluid which passes the fluid recess 56 of the bottom portion 34 is throttled by passing the fluid recess 56 of the bottom portion 34. Preferably, there is a second throttle arranged in the fluid recess 56 of the bottom portion 34 and/or a control valve and/or a second check valve 58. The second check valve 58 for example comprises two sheet-like pieces of metal which are fixed on one side of the wall of the fluid recess 56 of the bottom portion 34 and which are pressed together on the other side of the sheet-like check valve. The second check valve alternatively comprises only one sheet-like piece of metal. The control valve in this context is a valve which enables a direct controlling of the valve, for example an electric valve which could be controlled via a controlling device.

[0034] If a force acts on the piston 36, especially on the piston rod 38 towards the bottom portion 34, the fluid of the first fluid chamber 44 is pressed into the fluid recess 56 of the bottom portion 34. If the force on the piston 36 changes very slowly, there is nearly the same pressure on both sides of the second check valve 58. So the fluid can flow through the second check valve 58 in little amounts. So the piston is able to move slowly and is able to compensate the thermal expansion of the injector housing 1. Additionally, there may be a fluid flow through the clearance fit of the piston 36 to the wall of the recess 33 of the cup shaped compensation assembly body 32.

[0035] If the force on the piston 36 changes fast, the fluid presses against the second check valve 58 towards the second membrane 57, the two sheet-like metals are pressed together and so the check valve 58 gets closed and the pressure in the first fluid chamber 44 is increasing. The piston 36 is not able to move towards the bottom portion 34 because of the pressure of the fluid in the first fluid chamber 44. In this case the compensation assembly 30 reacts like a stiff body and the force caused by the expansion of the actor 14 is transferred to the needle 8. The needle 8 is forced outside of its closing position and enables the fluid flow into the combustion chamber of the internal combustion engine.

[0036] Because of the clearance fit between the piston 36 and the recess 33, it is possible to arrange the first compensation element 41 in the compensation element recess 48 of the piston 36. For filling the fluid into the compensation assembly 30, there is a fluid supply 64, for example, arranged in the bottom portion 34 of the cup shaped compensation assembly body 32. The fluid supply 64 preferably gets sealed by a sealing ball 62. Preferably, in the injector a spring acts on the first and/or the second membrane 35, 57.

[0037] Additionally or alternatively there may be arranged a fourth compensation element 61 (figure 6) in a compensation element recess 59 of the bottom portion 34 of the cup shaped compensation assembly body 32. Additionally or alternatively to the second throttle or the second check valve 58, there may be arranged the control valve 66. If the control valve is normally open, the fluid can flow from the first to the third fluid chamber 44, 55 in order to compensate, for example, the thermal expansion of the injector housing 1. If the actor 14 gets energized, the control valve 66 has to be closed simultaneously. Then, the piston 36 is not able to move towards the bottom portion 34 and the actor 14 is able to open the needle 8.

[0038] In a further alternative embodiment, the compensation assembly 30 does not comprise the second fluid chamber 46 (figure 7). The recess 33 of the cup shaped compensation assembly body 32 then preferably is sealed by a sealing 68 at the piston 36. Alternatively or additionally, the piston 36 may not comprise the piston rod 33 and acts directly on the top plate of the actor 40. Further, the check valve 58 may be of a sheet-like type covering the fluid recess 56 of the bottom portion 34. Further, a fifth compensation element may be arranged directly in the third fluid chamber 55.

[0039] The invention is not restricted by the explained embodiments. For example, the second compensation element 42 may comprise a ring shaped circumferential piston rod 38. Further, the alternative embodiments may be combined. For example, there may be more compensation elements 41, 42, 43, 60, 61 in one embodiment.

Claims

1. Compensation assembly (30) for an injector, the compensation assembly (30) comprising

   - a cup shaped compensation assembly body (32) having a bottom portion (34) and a recess (33),
   - a piston (36) being arranged in the recess (33) of the cup shaped compensation assembly body (32) movable in axial direction,
   - a first fluid chamber (44) being bordered in axial direction by a first side (37) of the piston (36) and by the bottom portion (34) of the cup shaped compensation assembly body (32),
   - a second fluid chamber (46) being bordered in axial direction by a first membrane (35) and by a second side (39) of the piston (36) facing away from the first side (37) of the piston (36),
   - a fluid path extending from the first to the second fluid chamber (44, 46),
   - an elastic compensation device being checklessly hydraulically coupled to the second fluid chamber (46).

2. Compensation assembly (30) in accordance with claim 1 with the elastic compensation device comprising a first elastic compensation element (41) which is arranged in an compensation element recess (48) of the piston (36).

3. Compensation assembly (30) in accordance with one of the preceding claims with the elastic compensation device comprising a second elastic compensation element (42) being arranged in the second fluid chamber (46).

4. Compensation assembly (30) in accordance with one of the preceding claims with the elastic compensation device comprising a third elastic compensation element (43) which is arranged in a compensation element recess (49) of the cup shaped compensation assembly body (32).

5. Compensation assembly (30) in accordance with one of the preceding claims with the fluid path (56) comprising a clearance fit between the piston (36) and a wall of the recess (33) of the cup shaped compensation assembly body (32).

6. Compensation assembly (30) in accordance with one of the preceding claims with the fluid path comprising a fluid recess (50) of the piston (36) and with the compensation assembly (30) comprising a first throttle (52) and/or a first control valve and/or a first check valve (54) being arranged in such a way that a fluid which passes the fluid recess (50) of the piston (36) has to pass the first throttle (52) and/or, respectively, the first control valve and/or, respectively, the first check valve (54).

7. Compensation assembly (30) in accordance with one of the preceding claims with the elastic compensation device and/or the first and/or the second and/or the third elastic compensation element (41, 42, 43) comprising rubber and/or polychloroprene and/or silicon.

8. Compensation assembly (30) for an injector, the compensation assembly (30) comprising

   - a cup shaped compensation assembly body (32) having a bottom portion (34) and a recess (33),
   - a piston (36) which is arranged in the recess (33) of the cup shaped compensation assembly body (32) movable in axial direction,
   - a first fluid chamber (44) being bordered in axial direction by a first side (37) of the piston (36) and a first side (51) of the bottom portion (34) of the cup shaped compensation assembly body (32),
   - a third fluid chamber (55) being bordered in axial direction by a second membrane (57) and by a second side (53) of the bottom portion (34) facing away from the first side (51) of the bottom portion (34),
   - a fluid recess (56) of the bottom portion (34) extending from the first to the third fluid chamber (44, 55),
   - a second throttle and/or a second control valve (66) and/or a second check valve (58) being arranged in such a way that a fluid which passes the fluid recess (56) of the bottom portion (34) has to pass the second throttle and/or the second control valve (66) and/or the second check valve (58).
   - an elastic compensation device being checklessly hydraulically coupled to the third fluid chamber (55).

9. Compensation assembly (30) in accordance with claim 8 comprising

   - a second fluid chamber (46) being bordered in axial direction by a first membrane (35) and by a second side (39) of the piston (36) facing away from the first side (37) of the piston (36),

- a fluid path extending from the first to the second fluid chamber (44, 46),

and with the elastic compensation device being checklessly hydraulically coupled to the second fluid chamber (46).

10. Compensation assembly (30) in accordance with claim 9 with the elastic compensation device comprising a first elastic compensation element (41) which is arranged in an compensation element recess (48) of the piston (36) and which is checklessly hydraulically coupled to the second fluid chamber (46).

11. Compensation assembly (30) in accordance with one of the claims 9 or 10 with the elastic compensation device comprising a second elastic compensation element (42) being arranged in the second fluid chamber (46).

12. Compensation assembly (30) in accordance with one of the claims 9 to 11 with the elastic compensation device comprising a third elastic compensation element (43) which is arranged in a compensation element recess (49) of the cup shaped compensation assembly body (32) and which is checklessly hydraulically coupled to the second fluid chamber (46).

13. Compensation assembly (30) in accordance with one of the claims 8 to 12 with the elastic compensation device comprising a fourth compensation element (60) which is arranged in the third fluid chamber (55).

14. Compensation assembly (30) in accordance with one of the claims 8 to 13 with the elastic compensation device comprising a fifth compensation element (61) which is arranged in a compensation element recess (59) of the bottom portion (34) and which is checklessly hydraulically coupled to the third fluid chamber (55).

15. Compensation assembly (30) in accordance with one of the claims 8 to 14 with the elastic compensation device and/or the first and/or the second and/or the third and/or the fourth and/or the fifth elastic compensation element (41, 42, 43, 60, 61) comprising rubber and/or polychloroprene and/or silicon.

16. Compensation assembly (30) in accordance with one of the claims 9 to 15 with the fluid path comprising a clearance fit between the piston (36) and a wall of the recess (33) of the cup shaped compensation assembly body (32).

17. Compensation assembly (30) in accordance with one of the claims 9 to 16 with the fluid path comprising a fluid recess (50) of the piston (36) and with the compensation assembly (30) comprising a first throttle (52) and/or a first control valve and/or a first check valve (54) being arranged in such a way that a fluid which passes the fluid recess (50) of the piston (36) has to pass the first throttle (52) and/or, respectively, the first control valve and/or, respectively, the first check valve (54).

FIG 1

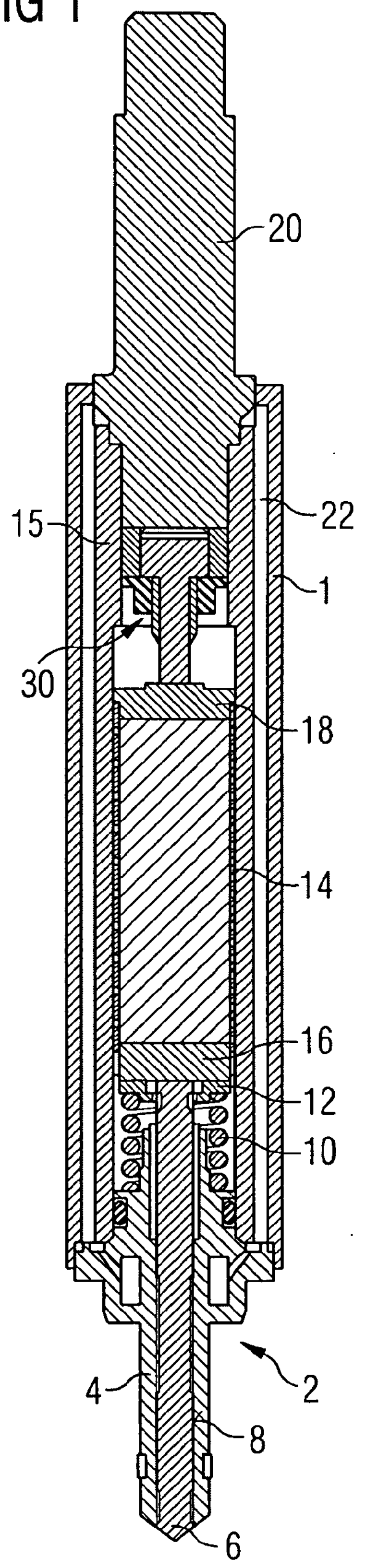

FIG 2

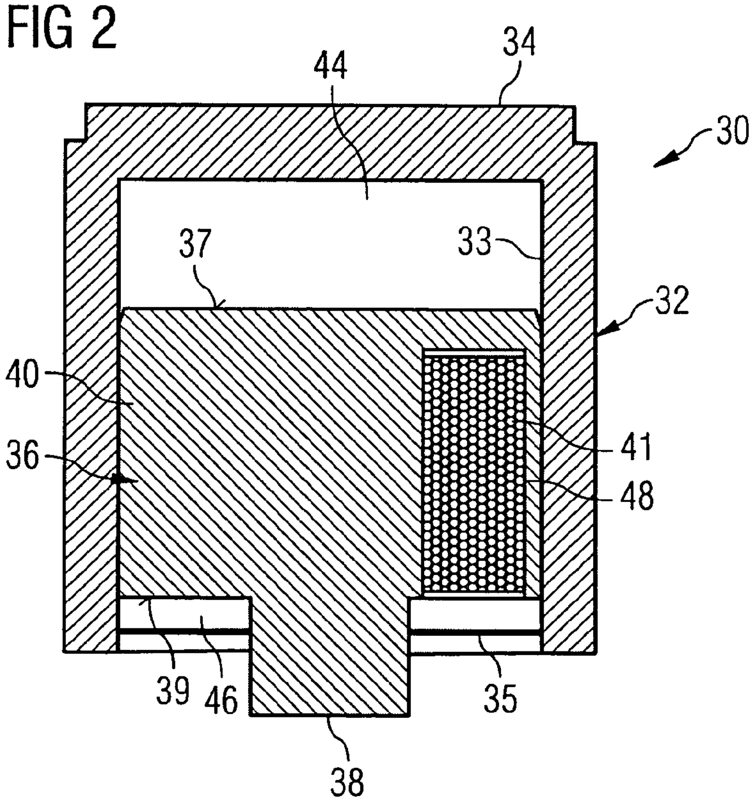
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FIG 3

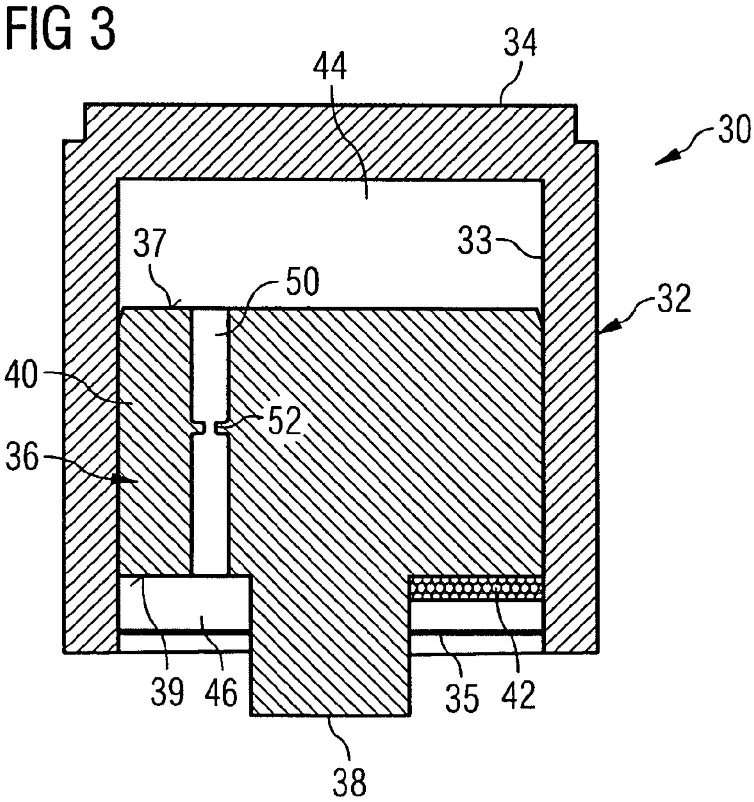
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FIG 4

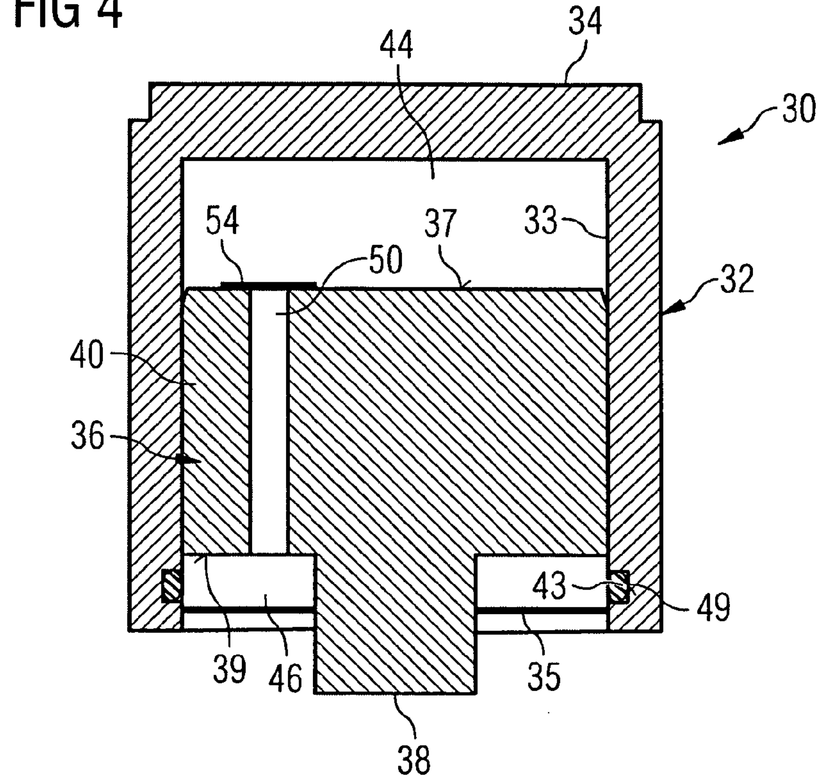
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FIG 5

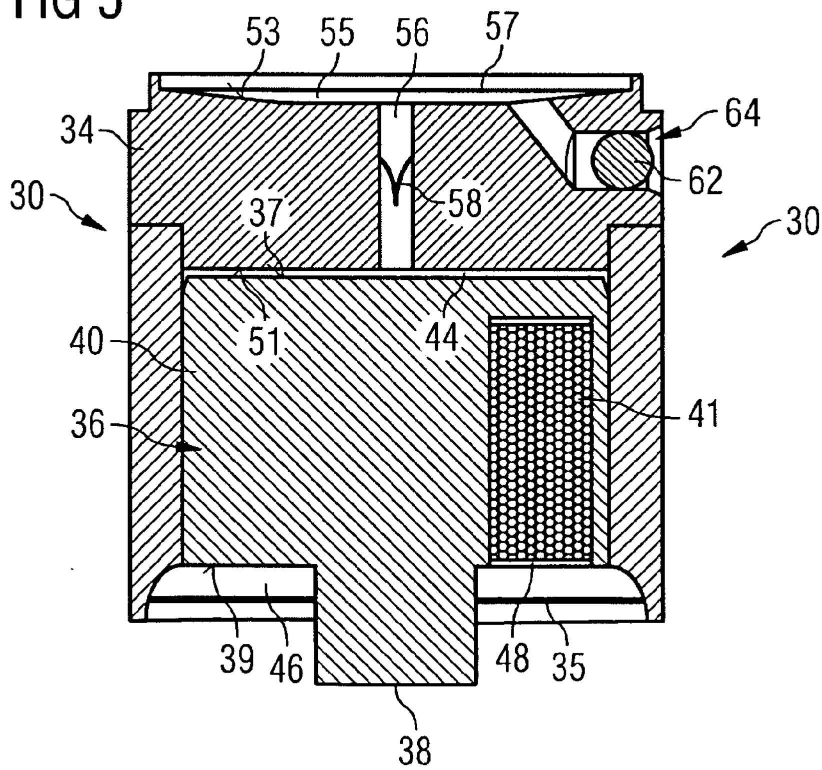
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FIG 6

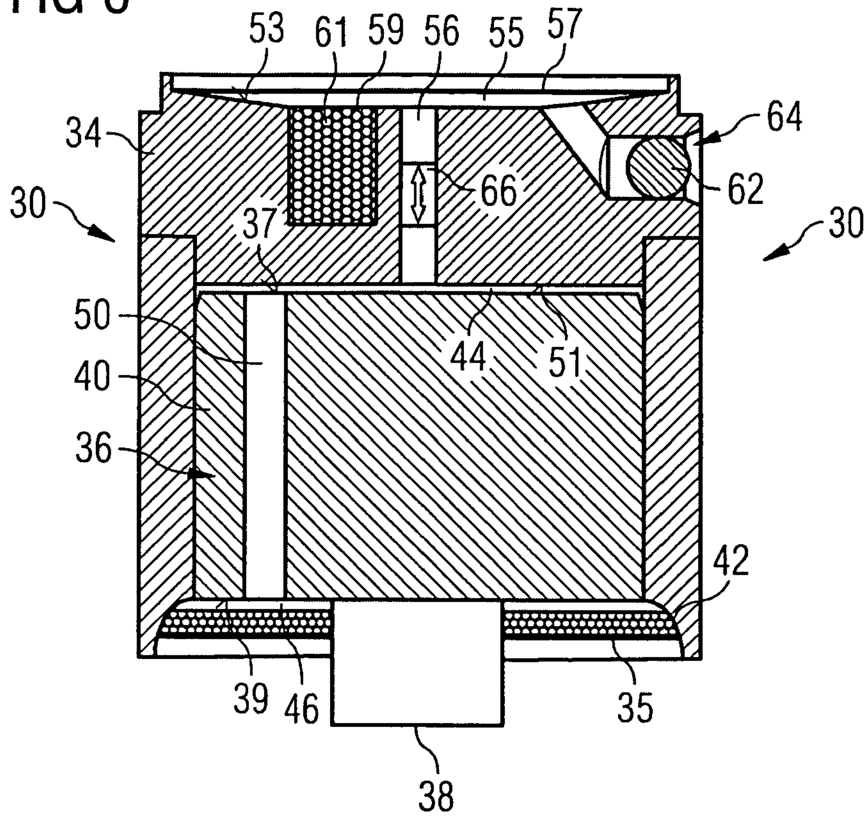
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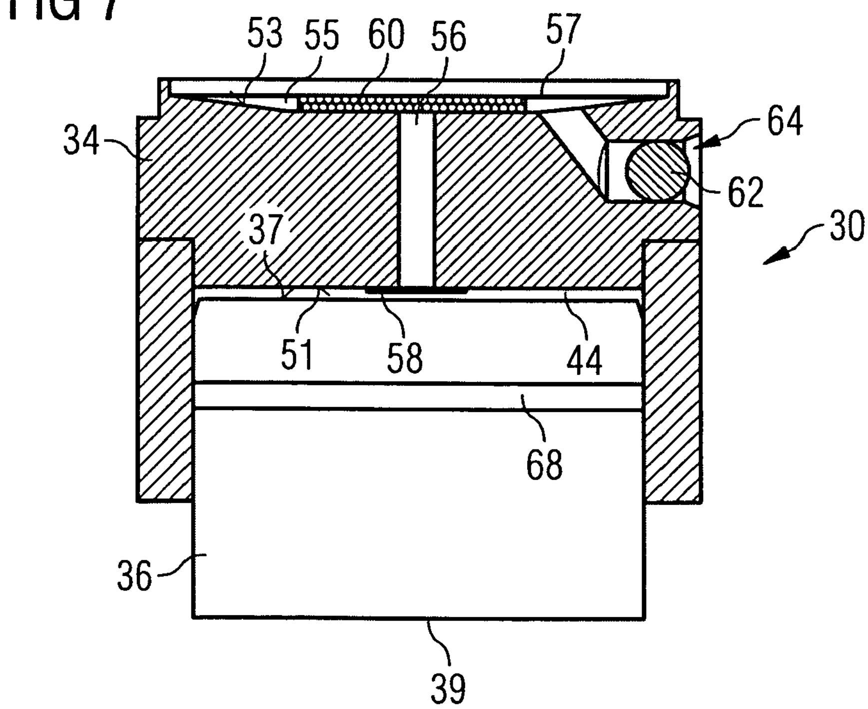
FIG 7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European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 06 00 1744

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	EP 1 538 331 A (ROBERT BOSCH GMBH) 8 June 2005 (2005-06-08) * paragraph [0033] - paragraph [0034]; figure 4 *	1,5-7	INV. F02M61/16 F02M51/06
X	DE 10 2004 002081 A1 (ROBERT BOSCH GMBH) 4 August 2005 (2005-08-04) * paragraph [0046]; figures 2,3 *	1,5,6	
A	WO 2005/026528 A (SIEMENS AKTIENGESELLSCHAFT; BACHMAIER, GEORG; FISCHER, BERNHARD; GOTTL) 24 March 2005 (2005-03-24) * page 27, paragraph 1 - page 29, last paragraph; figures 12,13 *	1,5,6,8, 16,17	
A	EP 1 519 037 A (ROBERT BOSCH GMBH) 30 March 2005 (2005-03-30) * paragraph [0026] *	1,7,8	
A	EP 1 519 035 A (ROBERT BOSCH GMBH) 30 March 2005 (2005-03-30) * abstract *	1,6	TECHNICAL FIELDS SEARCHED (IPC)
A	EP 1 445 479 A (SIEMENS VDO AUTOMOTIVE S.P.A) 11 August 2004 (2004-08-11) * paragraph [0027] *	8	F02M

The present search report has been drawn up for all claims

2

Place of search	Date of completion of the search	Examiner
Munich	29 May 2006	Torle, E

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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L : document cited for other reasons

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 06 00 1744

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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29-05-2006

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 1538331 A	08-06-2005	DE 10357454 A1	07-07-2005
DE 102004002081 A1	04-08-2005	NONE	
WO 2005026528 A	24-03-2005	NONE	
EP 1519037 A	30-03-2005	DE 10345203 A1	04-05-2005
EP 1519035 A	30-03-2005	DE 10343017 A1	14-04-2005
EP 1445479 A	11-08-2004	DE 60302329 D1	22-12-2005
		EP 1464828 A1	06-10-2004

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- DE 19708304 A1 **[0002]**
- DE 10245109 A1 **[0003]**