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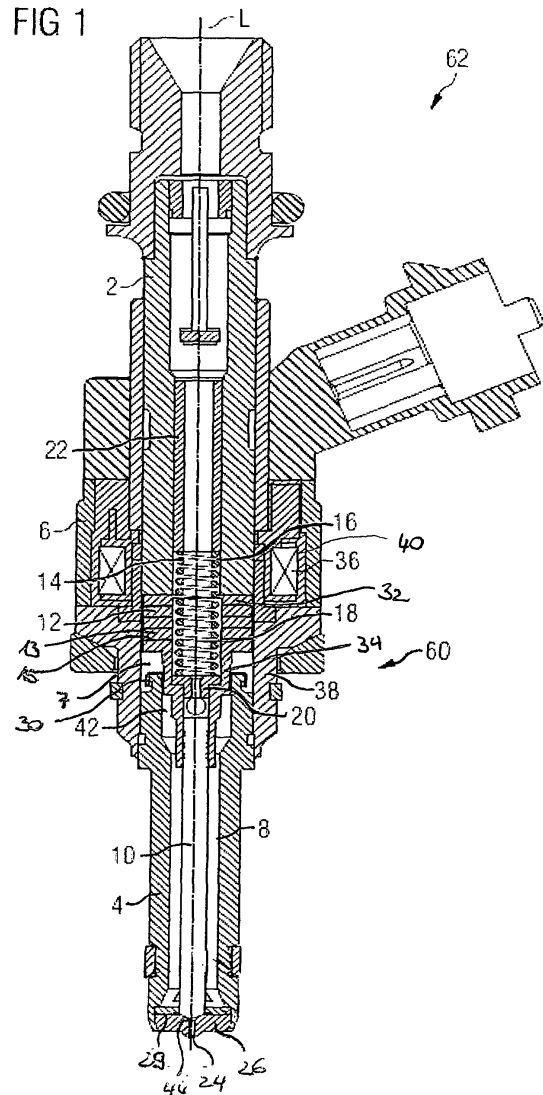
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(54) **Actuator and injection valve**

(57) Actuator that comprises an actuator-element (10) being movable along a predetermined axis (L) of the actuator. The actuator further comprises an armature (12), being axially movable along the predetermined axis (L) and being mechanically coupled to the actuator-element (10) and comprising multiple magnetizable armature discs (13) and one or multiple non-magnetizable separation layers (15). Each separation layer (15) is disposed between two armature discs (13). Furthermore the actuator comprises at least one coil (36), being arranged to magnetically actuate the armature discs (13) to move axially.

FIG 1



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Description

[0001] The invention relates to an actuator and an injection valve with the actuator.

[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 a 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 valves being responsible for the way the fluid is dosed may vary in a wide range. In addition to that, injection valves may accommodate an actuator for actuating a needle of the injection valve, which may, for example, be an electromagnetic actuator.

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

[0006] This object is achieved by the features of the independent claims. Advantageous embodiments of the invention are given in the sub-claims.

[0007] The invention is distinguished concerning a first aspect by an actuator comprising an actuator-element. The actuator-element is movable along a predetermined axis of the actuator. The actuator comprises an armature, which is axially movable along the predetermined axis and which is mechanically coupled to the actuator-element. The armature comprises multiple magnetizable armature discs and one or multiple non-magnetizable separation layers. Each separation layer is disposed between two armature discs. Furthermore, the actuator comprises at least one coil, being operable to magnetically actuate the armature discs to move axially. By using multiple armature discs, a resulting magnetic force acting on the armature, due to the electrical actuation of the at least one coil, is increased compared to armatures made in one piece. The armature discs preferably have ferromagnetic properties and are operable to be magnetically actuated by the coil. Preferably, the separation layers have diamagnetic properties and are operable to reduce magnetic interactions between the particular armature discs.

[0008] In an advantageous embodiment, the multiple armature discs and/or the one or the multiple separation layers are cylindrically shaped. This has the advantage that the armature discs and/or the separation layers can be manufactured very easily. Preferably an outer diam-

eter of the separation layers is basically identical to an outer diameter of the armature discs. This reduces magnetic interactions between the particular armature discs.

[0009] In a further advantageous embodiment, the multiple armature discs are transversally arranged to the axial movement of the armature. This ensures an increased magnetic force acting on the armature of the actuator.

[0010] In a further advantageous embodiment, each separation layer comprises rubber and/or chrome and/or plastics and/or an adhesive. Materials like rubber, chrome, plastics and adhesive are preferably non-magnetizable. Separation layers made of these materials reduce magnetic interactions between the particular armature discs.

[0011] In a further advantageous embodiment, the multiple armature discs are agglutinated by the one or multiple separation layers to form the armature. This has the advantage that the armature can be manufactured very easily. Alternatively, the separation layers may be formed as layers of an adhesive, for example glue, if the adhesive is not non-magnetizable.

[0012] In a further advantageous embodiment, the multiple armature discs are riveted together with the one or multiple separation layers disposed between them to form the armature. By using one or multiple rivets, the armature can be manufactured very easily. Preferably, the one or multiple rivets are made of materials, for example plastics, which have nonmagnetic properties.

[0013] In a further advantageous embodiment, each armature disc has an axial thickness between 0.9 and 2.0 mm. This has the advantage that the magnetic force acting on the armature of the actuator is specifically high.

[0014] In a further advantageous embodiment, each separation layer has an axial thickness between 30 and 100 μm . This significantly reduces magnetic interactions between the particular armature discs.

[0015] In a further advantageous embodiment, the armature comprises at least four armature discs. This amount of armature discs forming the armature ensures the increased magnetic force acting on the armature of the actuator.

[0016] The invention is distinguished concerning a second aspect by an injection valve, comprising an injector body with a central longitudinal axis. The injection valve comprises a valve needle which is axially movable at least partially in the injector body. The valve needle prevents a fluid injection in a closing position and permits a fluid injection in further positions. Furthermore, the injection valve comprises an actuator according to the first aspect, whereas the predetermined axis of the actuator relates to the central longitudinal axis of the injector body. The actuator-element of the actuator relates to the valve needle of the injection valve. The armature discs are axially movable at least partially within the injector body. The injection valve comprises for example a coil assembly with a bobbin that retains a coil. The coil of the actuator preferably relates to the coil of the coil assembly.

[0017] Exemplary embodiments of the invention are explained in the following with the aid of schematic drawings. These are as follows:

FIG. 1 an injection valve in a longitudinal section view,

FIG. 2 section of the injection valve according to FIG. 1 in a longitudinal section view.

[0018] Elements of the same design or function that appear in different illustrations are identified by the same reference sign.

[0019] An injection valve 62 (figure 1), that is in particular suitable for dosing fuel to an internal combustion engine, comprises an inlet tube 2, a housing 6 and a valve assembly 60.

[0020] The valve assembly 60 comprises an injector body 38, which is, for example, part of the housing 6, with a central longitudinal axis L and a first cavity 7. The valve assembly 60 further comprises a valve body 4, which is at least partially disposed within the first cavity 7 of the injector body 38. The valve body 4 takes in a valve needle 10. In the inlet tube 2, a recess 16 is provided which further extends to a recess 18 of an armature 12. The armature 12 comprises a first cylindrical portion 32 with a first outer diameter and a second cylindrical portion 34 with a second outer diameter (figure 2). The first outer diameter is greater than the second outer diameter. The first cylindrical portion 32 is mechanically coupled to the valve needle 10 via the second cylindrical portion 34. The first cylindrical portion 32 comprises multiple armature discs 13 with one or multiple separation layers 15 disposed between the armature discs 13. The recess 16 of the inlet tube 2 and/or the recess 18 of the armature 12 take in a bias spring 14. Preferably, the bias spring 14 rests on a spring seat being formed by a fluid restrictor, for example an anti-bounce disc 20, or being formed by a projection within the recess 18 of the armature 12. By this, the bias spring 14 is mechanically coupled to the valve needle 10. An adjusting tube 22 is provided in the recess 16 of the inlet tube 2. The adjusting tube 22 forms a further seat for the bias spring 14 and may be axially moved during the manufacturing process of the injection valve 62 in order to preload the bias spring 14 in a desired way.

[0021] In a closing position of the valve needle 10, it sealingly rests on a valve needle seat 26, by this preventing a fluid flow through at least one injection nozzle 24. The injection nozzle 24 may be, for example, an injection hole. However, it may also be of some other type suitable for dosing fluid. The valve needle seat 26 may be made in one part with the valve body 4 or a separate part from the valve body 4. In addition to that, a lower guide 29 for guiding the valve needle 10 is provided. The lower guide 29 further comprises an orifice for guiding the fluid flow.

[0022] A fluid inlet portion 42 is provided in the valve body 4 which communicates with a fluid outlet portion 44

which is part of the second cavity 8 near the valve needle seat 28.

[0023] The injection valve 62 is provided with a coil assembly 40 with a bobbin that retains a coil 36, which is preferably overmolded. The injector body 38, the armature 12 with its multiple armature discs 13, and the inlet tube 2 are forming a magnetic circuit when the coil 36 is electrically actuated.

[0024] The armature 12 is guided in the armature guide 30 and is supplied with a magnetic force if the coil assembly 40 is electrically actuated, thus resulting in an axial movement of the armature 12, acting against a spring load of the bias spring 14.

[0025] Figure 2 depicts a section of the injection valve 62 according to figure 1 in a longitudinal section view. The section depicts the armature 12 with its first and second cylindrical portion 32, 34. The armature 12 is axially movable at least partially within the first cavity 7 of the injector body 38. The first cylindrical portion 32 comprises the multiple armature discs 13 and the multiple separation layers 15. Each separation layer 15 is disposed between two armature discs 13. The armature 12 comprises, for example, five armature discs 13, whereas more or less than five armature discs 13 are also possible. Preferably, the first cylindrical portion 32 of the armature 12 comprises at least four armature discs 13. Preferably, each armature disc 13 is cylindrically shaped and comprises a central bore. The armature discs 13 are preferably made of stainless steel with ferromagnetic properties. Each armature disc 13 has preferably an axial thickness between 0.9 and 2.0 mm, whereas also other axial thicknesses are possible. Alternatively, the armature 12 may comprise multiple armature discs 13 with each having a different axial thickness compared to the others.

[0026] The armature 12 comprises four separation layers 15. The multiple separation layers 15 are preferably made of material with diamagnetic properties, for example rubber and/or chrome and/or plastics and/or ceramic, and are applicable to reduce magnetic interactions between the particular armature discs 13. Preferably, each separation layer 15 is cylindrically shaped and comprises a central bore. The bores of the armature discs 13 and the bores of the separation layers 15 form the recess 18 of the armature 12 (figure 1), in which the bias spring 14 is disposed. Each separation layer 15 has preferably an axial thickness of 30 to 100 μm , whereas also other axial thicknesses are possible. Alternatively, the multiple armature discs 13 may be separated by multiple separation layers 15 with each having a different axial thickness compared to the others.

[0027] The multiple armature discs 13 are coupled to each other by preferably using adhesive closure and/or force closure to form the first cylindrical portion 32 of the armature 12. The adhesive closure is preferably realized by agglutinating the armature discs 13 with the separation layers 15. Alternatively, the separation layers 15 can be formed by layers of glue with diamagnetic properties.

[0028] The force closure is preferably realized by using

one or multiple rivets to assemble the multiple armature discs 13 with the multiple separation layers 15 disposed between them. One rivet may, for example, be shaped hollow cylindrically with a central cavity and may be arranged in the central bores of the armature discs 13 and separation layers 15, whereas the central cavity of the rivet form the recess 18 of the armature 12. By upsetting an upper axial end and a lower axial end of the rivet, the multiple armature discs 13 and the multiple separation layers 15 may be assembled as the first cylindrical portion 32 of the armature 12.

[0029] If the coil 36 of the coil assembly 40 is actuated electrically, the coil assembly 40, the multiple armature discs 13 of the first cylindrical portion 32 and the inlet tube 2 form preferably the magnetic circuit moving the armature 12 and the valve needle 10 axially to act against the spring load of the bias spring 14 to open the injection valve 62 for injecting fluid.

[0030] The using of multiple armature discs 13 forming the armature 12 has the advantage that a resulting magnetic force acting on the armature 12 due to the electrical actuation of the coil 36 is increased compared to armatures made in one piece. In particular, the magnetic force increases while a constant current is flowing in the coil 36, resulting in a constant magnetic field acting on the multiple armature discs 13. This results in a decreased actuation response time of the armature 12 and the valve needle 10 after actuating the coil 36. Alternatively, if the response time is predetermined, thus resulting in a desired magnetic force, the armature 12 with multiple armature discs 13 can be manufactured with less material compared to armatures made in one piece.

[0031] The injection needle 10 and the armature 12 with its multiple armature discs 13 and the separation layers 15 and the coil assembly 40 can be identified as an actuator. The injection needle 10 relates to an actuator-element of the actuator, being mechanically coupled to the armature 12. The coil 36 of the coil assembly 40 relates to a coil of the actuator to magnetically actuate the armature with the actuator-element axially along the longitudinal axis L. Such an actuator may also be used in different applications than injection valves.

Claims

1. Actuator, comprising

- an actuator-element (10) being movable along a predetermined axis (L) of the actuator,
- an armature (12), being axially movable along the predetermined axis (L) and being mechanically coupled to the actuator-element (10) and comprising
 - multiple magnetizable armature discs (13),
 - one or multiple non-magnetizable separation layers (15), each being disposed between two armature discs (13),

- at least one coil (36), being arranged to magnetically actuate the armature discs (13) to move axially.

2. Actuator according to claim 1, the multiple armature discs (13) and/or the one or multiple separation layers (15) being cylindrically shaped.
3. Actuator according to claim 1 or 2, the multiple armature discs (13) being transversely arranged to the axially movement of the armature (12).
4. Actuator according to one of the preceding claims, each separation layer (15) comprising rubber and/or chrome and/or plastics and/or an adhesive.
5. Actuator according to one of the preceding claims, the multiple armature discs (13) being agglutinated by the one or multiple separation layers (15) to form the armature (12).
6. Actuator according to one of the preceding claims, the multiple armature discs (13) being riveted together with the one or multiple separation layers (15) disposed between them to form the armature (12).
7. Actuator according to one of the preceding claims, each armature disc (13) having an axial thickness between 0.9 and 2.0 mm.
8. Actuator according to one of the preceding claims, each separation layer (15) having an axial thickness between 30 and 100 μm .
9. Actuator according to one of the preceding claims, the armature (12) comprising at least four armature discs (13).
10. Injection valve (62), comprising

- an injector body (38) with a central longitudinal axis (L),
- a valve needle (10), being axially movable at least partially in the injector body (38) and preventing a fluid injection in a closing position and permitting the fluid injection in further positions,
- an actuator according to one of claims 1 to 9, the predetermined axis being the central longitudinal axis (L) of the injector body (38), with the actuator-element being the valve needle (10), with the armature discs (13) being axially movable at least partially within the injector body (38).

FIG 1

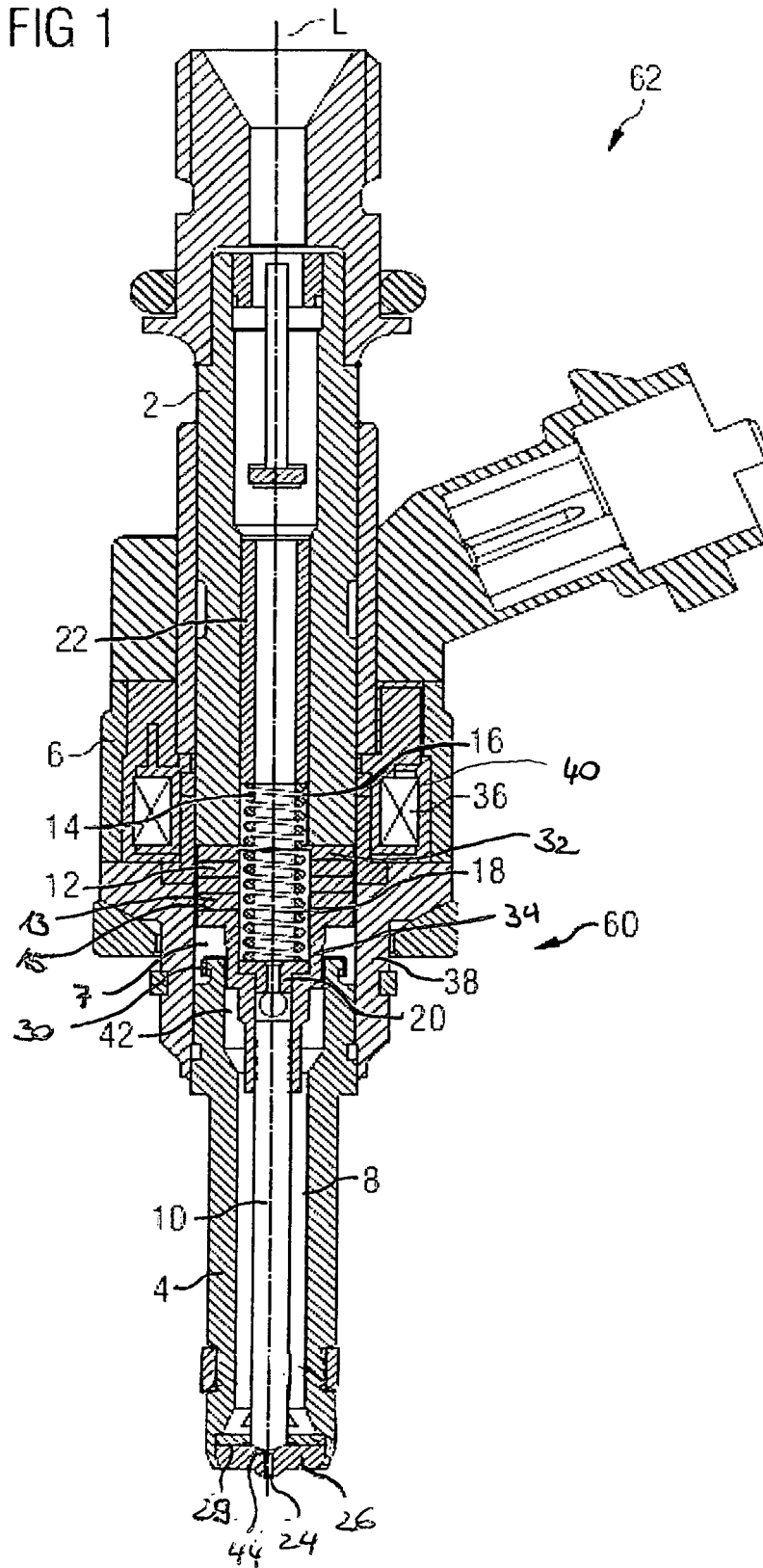
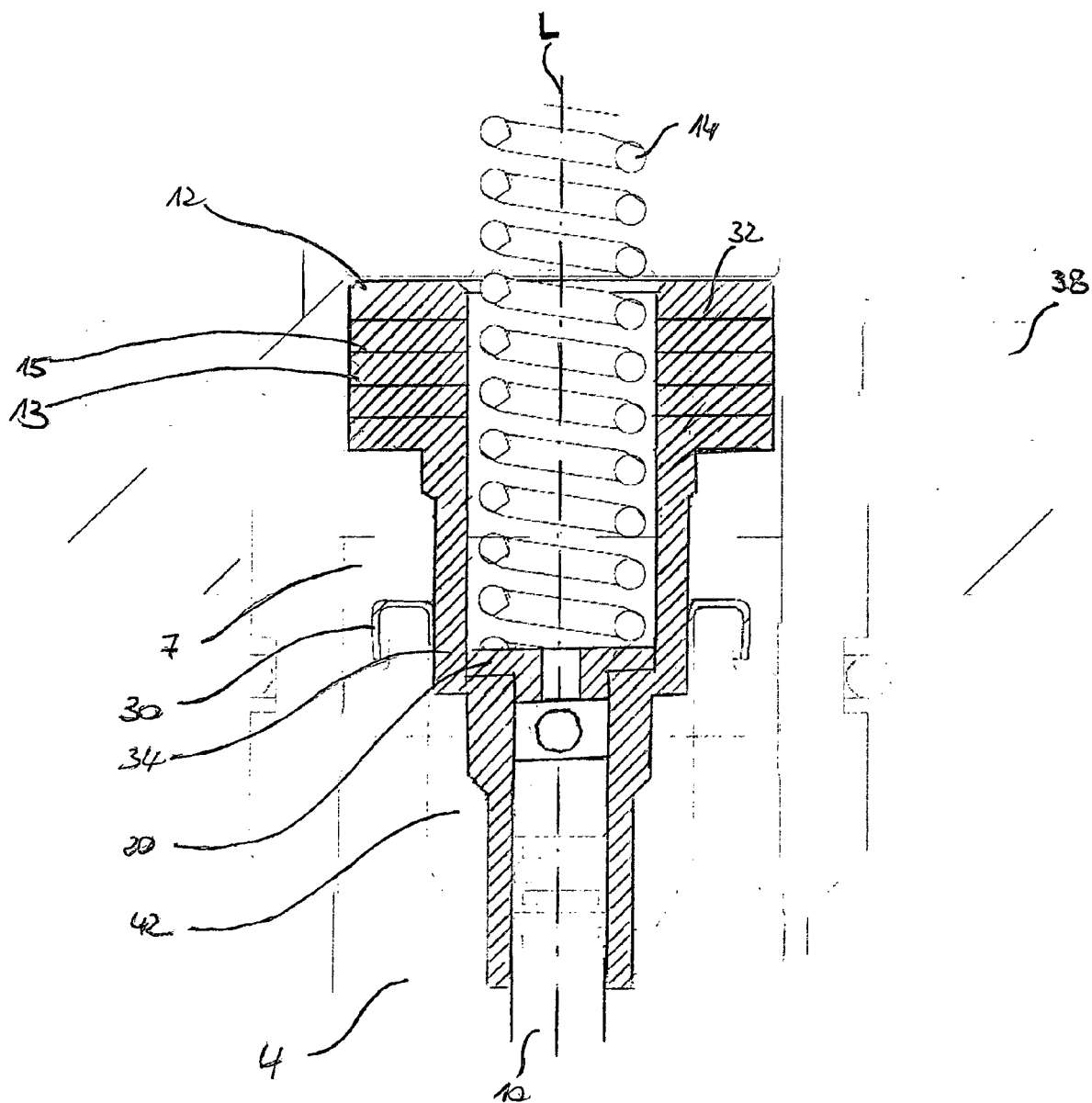


FIG 2





EUROPEAN SEARCH REPORT

Application Number
EP 08 01 7324

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 6 390 393 B1 (BULGATZ DENNIS [US]) 21 May 2002 (2002-05-21) * column 2, line 50 - column 3, line 17; figure 1 * * abstract *	1	INV. F02M51/06 H01F7/08
A	FR 2 810 153 A (PEUGEOT CITROEN AUTOMOBILES SA [FR]) 14 December 2001 (2001-12-14) * page 2, line 22 - page 3, line 21; figures 1,2 * * abstract *	1	
			TECHNICAL FIELDS SEARCHED (IPC)
			F02M H01F H03F
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 28 January 2009	Examiner Hermens, Sjoerd
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EPO FORM 1503 03.82 (P04C01)

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

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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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28-01-2009

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 6390393	B1	21-05-2002	NONE	

FR 2810153	A	14-12-2001	NONE	
