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(54) A fuel injector with axial sealing element

(57) The invention relates to the field of fuel injectors and specifically to the field of common rail fuel injectors. The common rail fuel injectors typically have a nozzle (12), a nozzle needle (14), a fuel inlet (16), a return fuel path (30), a valve (24), a pressure control chamber (22), a high pressure volume (18) and a low pressure volume (20). The high pressure volume (18) and low pressure volume (20) are separated by a throttle plate (36) with a bore (40) in it to allow flow of fuel from high pressure volume (18) to low pressure volume (20) and vice versa. The invention proposes a modification in the throttle plate (36) and also proposes an additional sealing element called axial sealing element (38). The modified throttle plate (36) is loosely coupled to the needle (14) and provides a large gap with the needle (14) to compensate any radial offset caused during the motion of the needle (14). The axial sealing element (38) prevents the leakage of the fuel from low pressure volume to (20) high pressure volume (18).

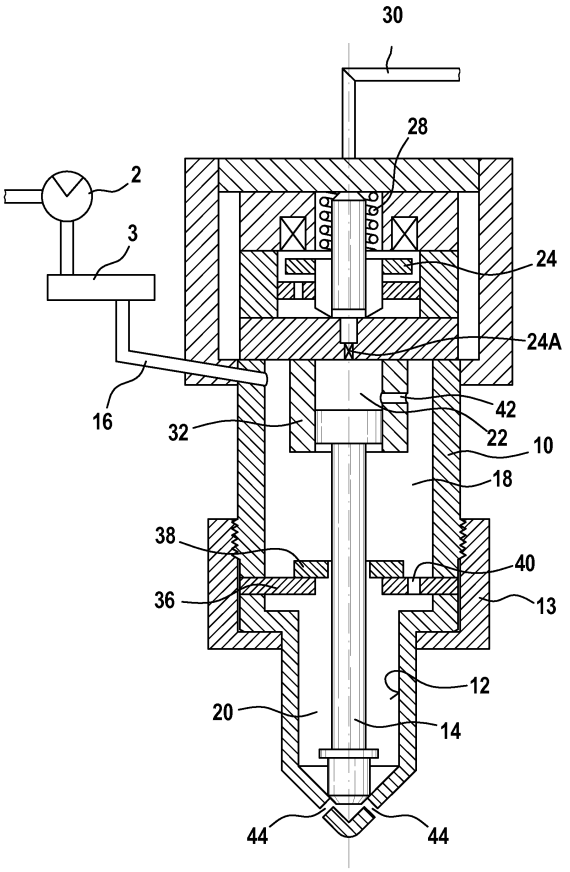

Fig. 1

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Description

State of the Art

[0001] The invention relates to the field of fuel injectors and specifically to the field of common rail fuel injectors.

[0002] The common rail fuel injectors known in the state of the art, typically comprise a nozzle, a needle moving inside the nozzle, a fuel inlet supplying fuel to the injector, a return fuel path, a valve to regulate the pressure inside the injector, a pressure control chamber, a high pressure volume having a pressure of about 2000 bars and a relatively low pressure volume having a pressure of about 1900 bars. The high pressure and low pressure volumes are separated by a throttle plate with a bore in it to allow flow of fuel from high pressure volume to low pressure volume. The throttle plate is tightly coupled to the needle and does two functions, one: providing a bearing for the needle and second: preventing the leakage of fuel through the gap between throttle plate and the needle. But this dual functionality results in an unwanted guiding function and an uncertain bearing function because, the rotation and positioning tolerances of the needle can lead to a large radial offset of the throttle plate to the upper and lower part of the injector.

[0003] The consequences of this uncertain bearing and the radial offset of the nozzle needle could be: high wear out of all the supporting points of the nozzle needle due to the large radial bearing forces, a high one-sided nozzle seat wear out due to the large radial bearing forces, an asymmetrical spray formation due to the needle offset.

Advantages of the invention

[0004] The device according to the independent patent claim has the below mentioned advantages:

[0005] The sufficient gap between the throttle plate and the needle will provide a radial offset to the needle, reducing the wear out of the needle because of the radial forces acting upon the needle. The small gap of about 2 to 10 micrometers between the axial sealing element and the needle will prevent the leakage of fuel from high pressure volume to the low pressure volume providing better regulation of the pressure in the high and low pressure areas.

[0006] Further improvements and/or advantages are realised by the features of the dependent patent claims.

[0007] The axial sealing element does not need any special type of material. It is made up of steel.

[0008] The axial sealing element does not need any special kind of design. It is a simple disk.

[0009] For additional stability, if required, the axial sealing element is fixed with a simple compression spring.

[0010] The axial sealing element and the throttle plate have a self sealing effect with each other because of the difference in pressure in high pressure volume and a low pressure volume, providing easy prevention of leakage of fuel.

Brief descriptions of the drawings

[0011]

Figure 1 shows the schematic of the invention according to a first embodiment

Figure 2 shows the detailed view of the invention

Figure 3 shows the schematic of the invention according to a second embodiment

Description of the embodiments

[0012] Shown in Fig. 1 is the first embodiment of the invention. The fuel injector comprises of a nozzle 12, a needle 14 reciprocatively movable in the nozzle 12, a high pressure fuel inlet 16 supplying fuel to the injector, a high pressure volume 18 where the fuel is stored under high pressure up to 2000 bars, a low pressure volume 20 containing fuel at a relatively lower pressure, of about 1900 bars, a pressure control chamber 22 to regulate the force ating on the needle 14, a throttle member 24 controlled by the valve actuator 26 to regulate the pressure in the pressure control chamber 22, a biasing spring 28 to keep the valve member 24 closed when the valve actuator 26 is de-activated, a return fuel path 30 to return the fuel from the pressure control chamber 22 to the low pressure source which is not shown in the figure, a guide 32 holding the needle 14 a throttle plate 36 and an axial sealing element 38. The throttle plate 36 contains a throttle bore 40 to allow the flow of fuel from high pressure volume 18 to low pressure volume 20.

[0013] The fuel injector is connected to the common rail 3 through the fuel inlet 16. The common rail 3 is supplied with fuel by a pump 2.

[0014] A typical common rail fuel injection system which is not shown in the figure, comprises of a fuel tank storing the fuel, a high pressure fuel pump supplying fuel to a plurality of injectors connected to a common rail, the injectors injecting fuel into a combustion chamber where the air and fuel mixture is burnt to produce power to move the vehicle. An electronic control unit controls the combustion engine based on different operating conditions of the combustion engine.

[0015] In fig. 1, the fuel from the high pressure fuel flows through the fuel inlet 16, enters the high pressure volume 18. The fuel from high pressure volume 18 passes through the throttle bore 40 and enters the low pressure volume 20 and also passes through the fuel inlet 42 and enters the pressure control chamber 22. The valve member 24 is closed at this point of time as the valve actuator 26 is de-activated and the biasing spring 28 keeps the valve member 24 closed. When sufficient pressure is built up in the low pressure volume 20, the valve

actuator 26 is activated causing the valve member 24 to open. As the valve member 24 opens, the fuel from the pressure control chamber 22 will flow through the return fuel path 24A to a low pressure source, causing the pressure in the pressure control chamber 22 to drop rapidly, resulting forces on the needle to move towards the throttle member 24. The movement of the needle 14 towards the throttle member 24 will open the injector holes 44 and the fuel is injected into the combustion chamber which is not shown in the figure.

[0016] The injection of fuel into the combustion chamber will reduce the pressure in the low pressure volume 20. The valve actuator 26 is de-activated causing the throttle member 24 to close. The fuel starts flowing into the pressure control chamber 22. The pressure in the pressure control chamber 22 increases rapidly causing the needle 12 to move towards the injector holes 44 closing the injector holes 44 and stopping the fuel injection into the combustion chamber. The pressure difference between the high pressure volume 18 and low pressure volume 20 is necessary to close the needle rapidly.

[0017] In the state of the art fuel injectors, the throttle plate is tightly coupled to the needle with a very small gap in between to prevent the leakage of fuel from high pressure volume to low pressure volume. As the throttle plate is tightly coupled to the needle to prevent the leakage of fuel from low pressure volume to high pressure volume, the result is, the needle does not have any offset in the radial direction. Because of the rotation of the needle or because of the movement of the needle in radial direction, there will be high wear out of the needle and also asymmetric spray formation.

[0018] The invention shown in detail in Fig. 2 eliminates the above disadvantages from the existing injectors.

[0019] Shown in Fig. 2 is only a part of an injector. Shown in fig. 2 is a needle 14, a throttle plate 36 and an axial sealing element 38. The throttle plate has a throttle bore 40 to allow flow of fuel from high pressure volume 18 to low pressure volume 20 and vice versa.

[0020] The throttle plate 36 has a sufficient gap with the needle, the gap being about 50 micorometers to 500 micrometers based on the length of the needle and the offset it would undergo under different conditions during its motion. Because of the sufficient gap between the throttle plate 36 and the needle 14, the disadvantage like, high wear out of all the supporting points of the nozzle needle due to the large radial bearing forces, a high one-sided nozzle seat wear out due to the large radial bearing forces, an asymmetrical spray formation due to the needle offset etc. are eliminated.

[0021] The axial sealing element 38 has a very narrow gap of about 2 to 10 micrometers with the needle 14. This narrow gap will prevent the leakage of the fuel from low pressure volume 20 to high pressure volume 18. The axial sealing element 38 is in contact with the throttle plate 36 and the axial sealing element 38 is movable with respect to the throttle plate 36 in radial direction. The movement of the axial sealing element 38 in radial direction will provide flexibility for the radial movement of the needle if any such movement occurs. The axial sealing element 38 and the throttle plate 36 have a self sealing effect with each other because of the difference in the pressure in high pressure volume 18 and the low pressure volume 20.

[0022] Shown in Fig. 3 is the invention according to a second embodiment. Here all the elements remain same, the difference being that the axial sealing element is fixed to a spring 42. The functionality of the axial sealing element 38 and the throttle plate 36 remains as explained with Fig. 2.

Claims

1. A fuel injector capable of injecting fuel into a combustion chamber of an internal combustion engine, comprising a nozzle (12) in which the needle moves, a needle (14) reciprocatively moving in the nozzle (12), a high pressure volume (18) supplying fuel to the pressure control chamber (22) and to the low pressure volume (20), the pressure control chamber (22) regulating the pressure for the movement of the needle (14), a throttle member (24) allowing the fuel from pressure control chamber to return to the low pressure source, a throttle plate (36) with a bore (40), the said fuel injector **characterised by**

   - an axial sealing element (38) in contact with the throttle plate (36) and movable in radial direction with respect to the throttle plate (36), the said axial sealing element (38) having a small gap with the needle 14, the said throttle plate (36) having a sufficient gap with the needle (14)

2. A fuel injector according to claim 1 where in the gap between the sealing element (38) and the needle (14) is of the order of 2 to 10 micrometers.

3. A fuel injector according to claim 1 where in the gap between the throttle plate (36) and the needle (14) is of the order of 50 to 500 micrometers.

4. A fuel injector according to claim 1 where in the axial sealing element (38) is made of steel.

5. A fuel injector according to claim 1 where in the axial sealing element (38) is a disk plate.

6. A fuel injector according to claim 1 where in the axial sealing element (38) is fixed in a stable-state by a compression spring.

7. A fuel injector according to claim 1 where in the axial sealing element (38) and the throttle plate have a self sealing effect with each other because of the

difference in high pressure volume and a low pressure volume.

8. A fuel injector according to claim 1 where in the gap between the axial sealing element (38) and the needle is in such away that it minimises the fuel leakage.

9. A fuel injector according to claim 1 where in the gap between the axial sealing element (38) and the needle (14) is in such away that any inclination of the needle (14) is compensated.

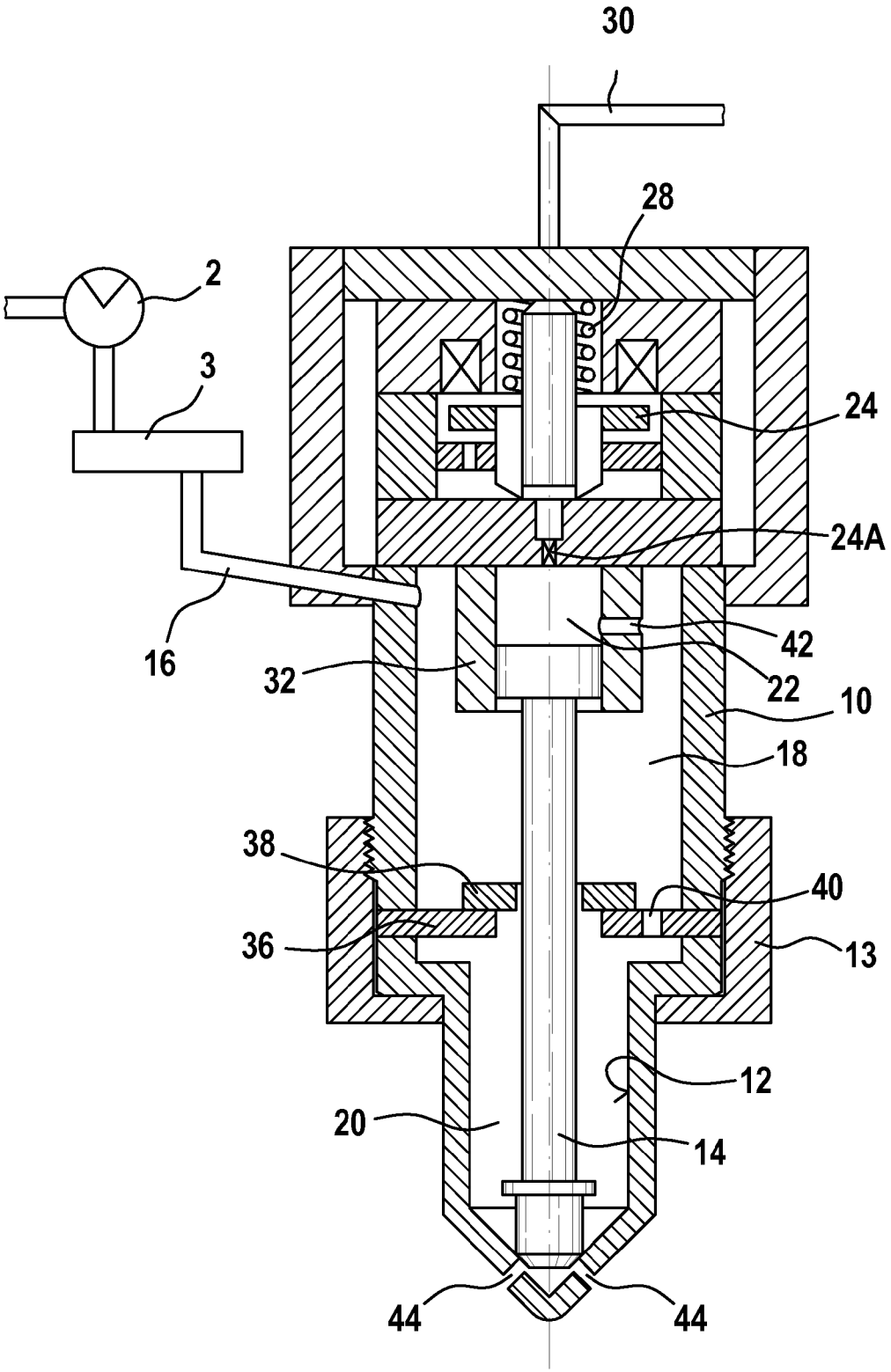

Fig. 1

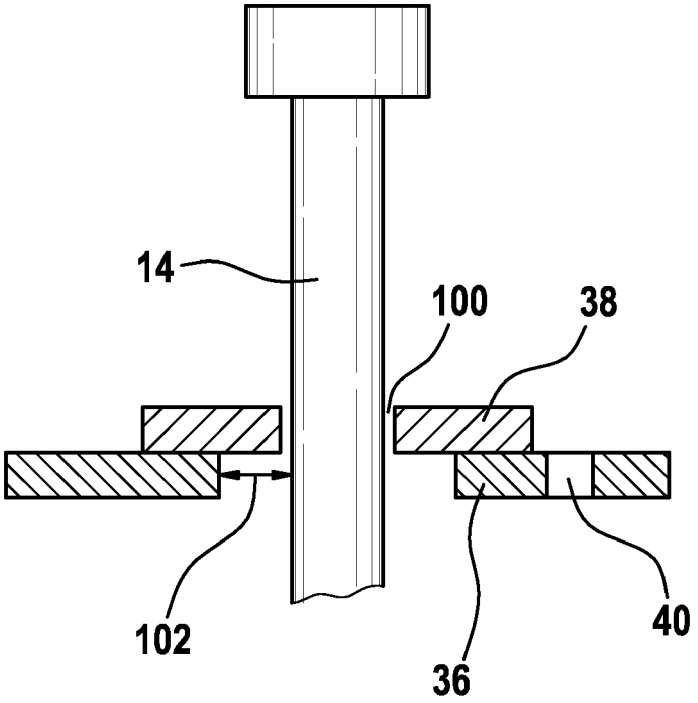

Fig. 2

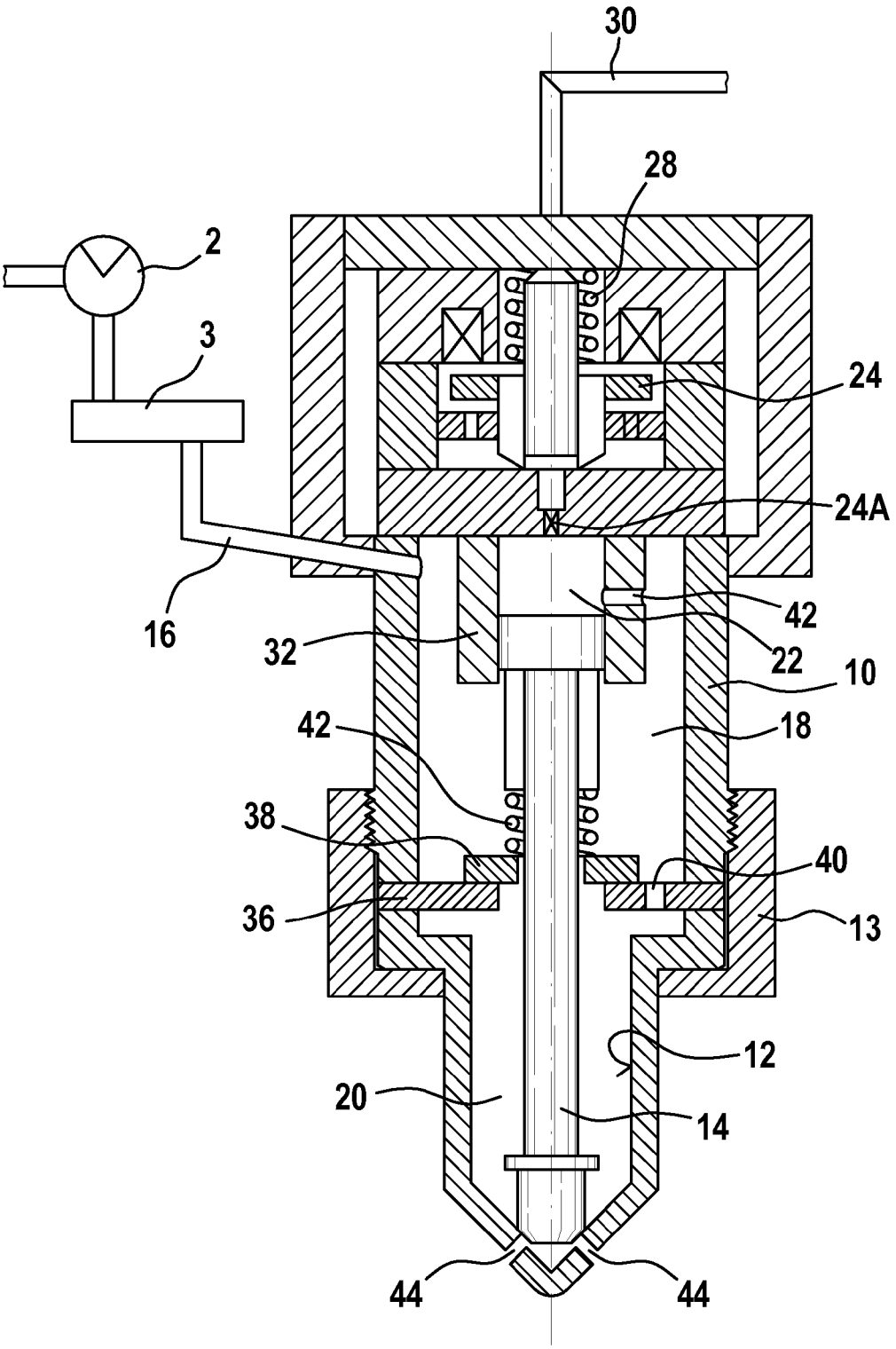

Fig. 3

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EUROPEAN SEARCH REPORT

Application Number
EP 08 10 5799

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	EP 1 990 532 A (BOSCH GMBH ROBERT [DE]) 12 November 2008 (2008-11-12) * paragraphs [0024] - [0026]; figure 1 * * abstract *	1	INV. F02M47/02
A	DE 10 2006 036447 A1 (BOSCH GMBH ROBERT [DE]) 7 February 2008 (2008-02-07) * paragraphs [0022] - [0030], [0036], [0043], [0044]; figure 2 * * abstract *	1	
A	EP 1 936 180 A (BOSCH GMBH ROBERT [DE]) 25 June 2008 (2008-06-25) * the whole document *	1	

TECHNICAL FIELDS SEARCHED (IPC)
F02M

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	26 February 2009	Hermens, Sjoerd

CATEGORY OF CITED DOCUMENTS

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 08 10 5799

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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26-02-2009

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