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

(11) **EP 1 865 191 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
12.12.2007 Bulletin 2007/50

(51) Int Cl.:
F02M 51/06 *(2006.01)* ***F02M 61/16*** *(2006.01)*
F02M 61/08 *(2006.01)*

(21) Application number: **06011631.6**

(22) Date of filing: **06.06.2006**

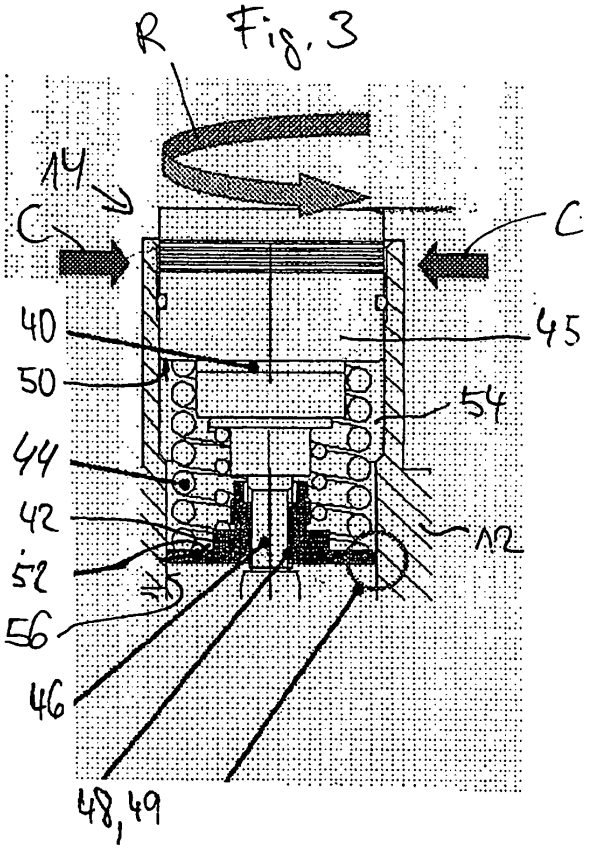
(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI SK TR
Designated Extension States:
AL BA HR MK YU

(71) Applicant: **SIEMENS AKTIENGESELLSCHAFT**
80333 München (DE)

(72) Inventors:
- **Biasci, Enio**
  56010 Campo (Pisa) (IT)
- **Zimmitti, Federico**
  56121 Pisa (IT)

(54) **Adjusting arrangement for an injection valve, injection valve and method for adjusting an injection valve**

(57) Adjusting arrangement (14) for an injection valve (10), the injection valve (10) comprising a housing (12) comprising an actuator unit (16) being coupled to a valve needle (22) and enabling the axial movement of the valve needle (22) relative to the valve body (20) upon actuation of the actuator unit (16). The adjusting arrangement (14) comprises a thermal compensation unit (40) being coupable to the housing (12), a spring retaining element (42) being mechanically coupled to the thermal compensation unit (40), and an adjusting spring (44) arranged between the thermal compensation unit (40) and the spring retaining element (42) and enabled to exert an axial preload force on the actuator unit (16). The thermal compensation unit (40) and the spring retaining element (42) are formed in a manner that under a rotational movement of the thermal compensation unit (40) relative to the housing (12) the spring retaining element (42) is movable in axial direction relative to the thermal compensation unit (40) thereby setting the axial preload force of the adjusting spring (44) on the actuator unit (16).



EP 1 865 191 A1

Description

[0001] Adjusting arrangement for an injection valve, injection valve and method for adjusting an injection valve

[0002] The invention relates to an adjusting arrangement for an injection valve, an injection valve and a method for adjusting an injection valve.

[0003] 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.

[0004] 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.

[0005] 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.

[0006] Injection valves are calibrated dynamically at the end of the manufacturing process. The flow rate provided by such an injection valve during operation is calibrated by exerting a preload force on the actuator unit.

[0007] The object of the invention is to create an adjusting arrangement that is simply to be manufactured and which facilitates a reliable and precise function of the injection valve.

[0008] These objects are achieved by features of the independent claims. Advantageous embodiments of the invention are given in the sub-claims.

[0009] According to a first aspect the invention is distinguished by an adjusting arrangement for an injection valve, the injection valve comprising a housing including a central longitudinal axis, the housing comprising a cavity with a fluid outlet portion, a valve needle axially moveable in the cavity, the valve needle preventing a fluid flow through the fluid outlet portion in a closing position and releasing the fluid flow through the fluid outlet portion in further positions, an actuator unit being coupled to the valve needle and enabling the axial movement of the valve needle relative to the valve body upon actuation of the actuator unit. The adjusting arrangement comprises a thermal compensation unit being coupable to the housing, a spring retaining element being mechanically coupled to the thermal compensation unit, and an adjusting spring arranged between the thermal compensation unit and the spring retaining element and enabled to exert an axial preload force on the actuator unit. The thermal compensation unit and the spring retaining element are formed in a manner that under a rotational movement of the thermal compensation unit relative to the housing the spring retaining element is moveable in axial direction relative to the thermal compensation unit thereby setting the axial preload force of the adjusting spring on the actuator unit.

[0010] This has the advantage that only a small number of components is necessary for the adjusting arrangement. Furthermore, only little installation space is necessary for the adjusting arrangement.

[0011] Preferably the thermal compensation unit comprises a cylindrical piston with a male thread, the spring retaining element comprises a cylindrical cavity with a wall comprising a female thread being an engagement with the male thread of the piston, the spring retaining element is mechanically coupled to the housing in a manner that the spring retaining element is moveable in axial direction and fixed against rotational movement relative to the housing. By this, a simple construction of the adjusting arrangement compressing the adjusting spring on a rotational movement of the thermal compensation unit can be obtained.

[0012] Preferably the thermal compensation unit comprises a thermal compensation unit spring rest and the spring retaining element comprises a spring retaining element spring rest and the adjusting spring is arranged in a recess between the thermal compensation unit spring rest and the spring retaining element spring rest and is coupled with the thermal compensation unit spring rest and the spring retaining elements spring rest. By this, a simple construction of the assembly of the thermal compensation unit, the adjusting spring and the retaining element is available.

[0013] According to a second aspect the invention is distinguished by an injection valve comprising the adjusting arrangement.

[0014] According to a further arrangement the invention is distinguished by a method for adjusting an injection valve comprising the following steps: providing the injection valve and coupling of the injection valve with a fluid supply, actuating of the actuator unit to release the fluid flow through the fluid outlet portion, rotational moving of the thermal compensation unit relative to the housing until a predetermined fluid flow through the fluid outlet portion is obtained, carrying out the fixed coupling of the thermal compensation unit with the housing.

[0015] Preferably the fixed coupling of the thermal compensation unit of the housing is realized by a crimping process.

[0016] 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 adjusting arrangement for the injection valve according to figure 1 in a longitudinal section view, and

Figure 3, an enlarged view of the adjusting arrange-

ment for the injection valve in a longitudinal section view.

[0017] Elements of the same design and function that appear in different illustrations are identified by the same reference characters.

[0018] An injection valve 10 (figure r) that is used as a fuel injection valve for an internal combustion engine, comprises a housing 12, an adjusting arrangement 14 and an actuator unit 16.

[0019] 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.

[0020] 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.

[0021] 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.

[0022] 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.

[0023] Figure 2 shows a sectional view of the adjusting arrangement 14 arranged in the housing 12 and coupled to the actuator unit 16. Figure 3 shows the adjusting arrangement 14 in a longitudinal sectional and in large detailed view. The adjusting arrangement 14 is arranged in the housing 12 of the injection valve 10 and is coupled to the actuator unit 16.

[0024] The adjusting arrangement 14 has a thermal compensation unit 40, a spring retaining element 42 mechanically coupled to the thermal compensation unit 40, and an adjusting spring 44 which is arranged in a recess 54 between the thermal compensation unit 40 and the spring retaining element 42. The thermal compensation unit 40 comprises a thermal compensation unit spring rest 50, the spring retaining element 42 comprises a spring retaining element spring rest 52. The adjusting spring 44 is arranged between the thermal compensation unit spring rest 50 and the spring retaining element spring rest 52. The spring rests 50, 52 are supporting the adjusting spring 44 arranged between the spring retaining element 42 and the thermal compensation unit 40.

[0025] The thermal compensation unit 40 has a main body 45 and a piston 46 which is extending in axial direction from the main body 45 and is coupled to the actuator unit 16.

[0026] The cylindrical piston 46 has a male thread 48. The spring retaining element 42 comprises a cylindrical cavity arranged in axial direction with a wall comprising a female thread 49. The female thread 49 is in engagement with the male thread 48 of the cylindrical piston 46.

[0027] The housing 12 has an inner wall 56 which comprises a groove in which an extension of the spring retaining element 42 is arranged. The groove in the inner wall 56 of the housing 12 is extending in axial direction so that the spring retaining element 42 is moveable in axial direction and is fixed against rotational movement relative to the housing 12.

[0028] In the following, the function of the injection valve 10 will be described in detail:

[0029] 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.

[0030] 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.

[0031] 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 phasing away from the actuator unit 16. The gap forms a valve nozzle 29.

[0032] 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.

[0033] In the following the function of the adjusting arrangement 14 will be described in detail:

[0034] In the manufacturing process of the injection valve 10 a calibration process is carried out to adjust the injection valve 10.

[0035] The injection valve 10 is coupled with a fluid supply to supply fluid to the fluid inlet portion 26. In the following the actuator unit 16 is actuated in the above described manner to release the fluid flow through the fluid outlet portion 28. The fluid flow through the outlet portion 28 is to be determined.

[0036] To adjust the fluid flow through the fluid outlet portion 28 the main body 45 of the thermal compensation unit 40 is moved in a rotational direction R around the longitudinal axis A. The rotational movement of the main body 45 of the thermal compensation unit 40 is transmitted into a rotational movement of the piston 46 of the thermal compensation unit 40 thereby causing an axial movement of the spring retaining element 42 relative to the thermal compensation unit 40 due to the threads 48, 49. If the rotational movement of the piston 46 results in a axial movement of the spring retaining element 42 in direction to the main body 45 of the thermal compensation unit 40 the adjusting spring 44 is compressed thereby setting the axial preload force of the adjusting spring 44 on the actuator unit 16. By this the fluid flow through the fluid outlet portion 44 is adjustable until it reaches its predetermined value. After this the thermal compensation unit 40 is fixedly coupled to the housing 12 by a crimping process in a crimping direction C (figure 3).

Claims

1. Adjusting 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) with a fluid outlet portion (28),
- a valve needle (22) axially movable in the cavity (24), the valve needle (10) preventing a fluid flow through the fluid outlet portion (28) in a closing position and releasing the fluid flow through the fluid outlet portion (28) in further positions, 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 valve body (20) upon actuation of the actuator unit (16),

the adjusting arrangement (14) comprising

- a thermal compensation unit (40) being coupable to the housing (12),
- a spring retaining element (42) being mechanically coupled to the thermal compensation unit (40), and
- an adjusting spring (44) arranged between the thermal compensation unit (40) and the spring retaining element (42) and enabled to exert an axial preload force on the actuator unit (16),

wherein

the thermal compensation unit (40) and the spring retaining element (42) are formed in a manner that under a rotational movement of the thermal compensation unit (40) relative to the housing (12) the spring retaining element (42) is movable in axial direction relative to the thermal compensation unit (40) thereby setting the axial preload force of the adjusting spring (44) on the actuator unit (16).

2. Adjusting arrangement (14) in accordance with claim 1 with the thermal compensation unit (40) comprising a cylindrical piston (46) with a male thread (48),
the spring retaining element (42) comprising a cylindrical cavity with a wall comprising a female thread (49) being in engagement with the male thread (48) of the piston (46), the spring retaining element (42) being mechanically coupled to the housing (12) in a manner that the spring retaining element (42) is movable in axial direction and fixed against rotational movement relative to the housing (12).

3. Adjusting arrangement (14) in accordance with claim 1 or claim 2 with the thermal compensation unit (40) comprising a thermal compensation unit spring rest (50) and the spring retaining element (42) comprising a spring retaining element spring rest (52) and the adjusting spring (44) arranged in a recess (54) between the thermal compensation unit spring rest (50) and the spring retaining element spring rest (52) and being coupled with the thermal compensation unit spring rest (50) and the spring retaining element spring rest (52).

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

5. Method for adjusting an injection valve (10) in accordance with claim 4 comprising the following steps:

- providing the injection valve (10) and coupling of the injection valve (10) with a fluid supply,
- actuating of the actuator unit (16) to release the fluid flow through the fluid outlet portion (44),
- rotational moving of the thermal compensation unit (40) relative to the housing (12) until a predetermined fluid flow through the fluid outlet portion (44) is obtained,
- carrying out a fixed coupling of the thermal compensation unit (40) with the housing (12).

6. Method for adjusting an injection valve (10) in accordance with claim 5 wherein the fixed coupling of the thermal compensation unit (40) with the housing (12) is realized by a crimping process.

FIG 1

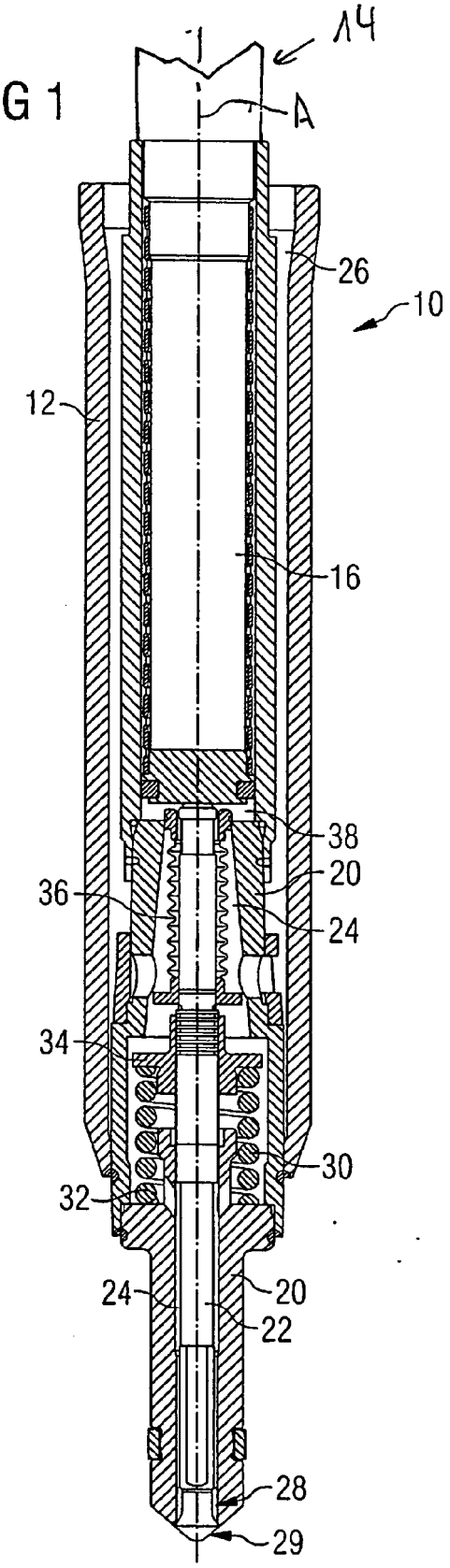


Fig. 2

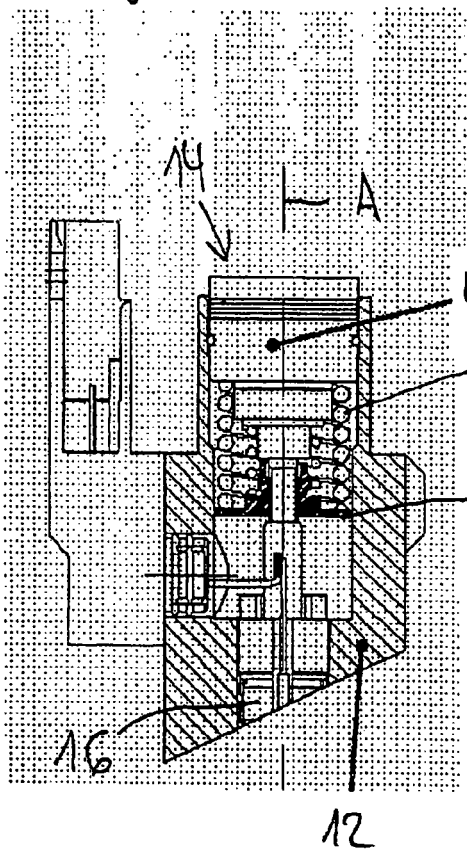
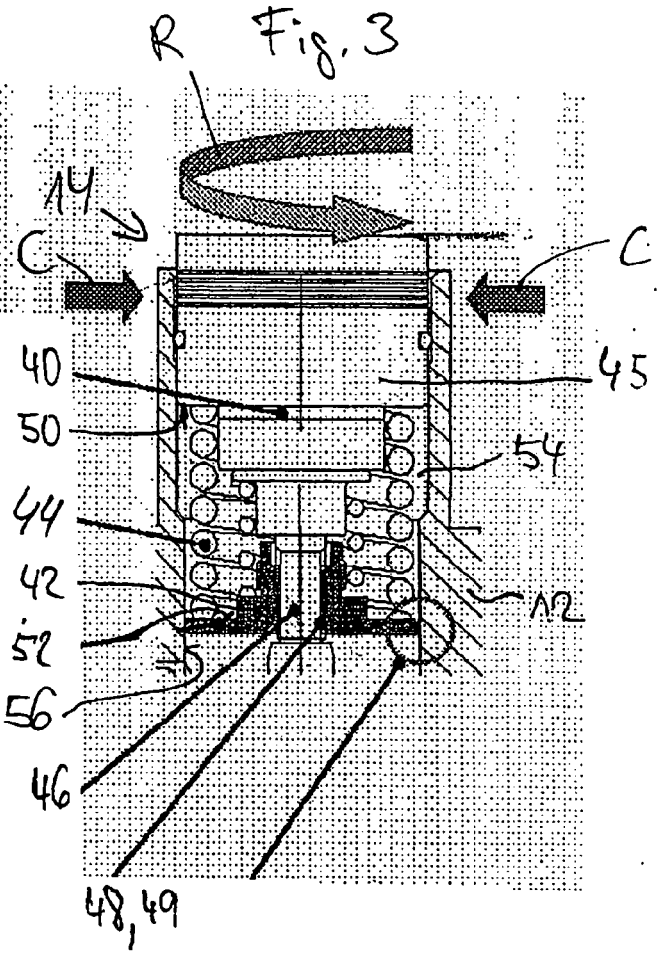


Fig. 3



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 06 01 1631

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	WO 02/31349 A (SIEMENS AUTOMOTIVE CORP LP [US]) 18 April 2002 (2002-04-18) * page 9, line 10 - page 10, line 24; figures 1,2 *	1	INV. F02M51/06 F02M61/16 F02M61/08
A	JP 57 013267 A (NIPPON DENSO CO) 23 January 1982 (1982-01-23) * abstract; figure 1 *	1-6	
A	EP 1 391 606 A1 (SIEMENS VDO AUTOMOTIVE S P A [IT]) 25 February 2004 (2004-02-25) * paragraphs [0002] - [0005], [0014] - [0019]; figures 1,2 *	1	
A	WO 2004/085831 A (SIEMENS AG [DE]; GOTTLIEB BERNHARD [DE]; KAPPEL ANDREAS [DE]; SCHWEBEL) 7 October 2004 (2004-10-07) * page 11, line 18 - page 13, line 35; figure 1 *	1	
A	GB 2 094 940 A (NISSAN MOTOR) 22 September 1982 (1982-09-22) * page 5, line 3 - line 71; figure 4 *	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	1 November 2006	Jucker, Chava

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

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 06 01 1631

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
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

01-11-2006

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 0231349 A	18-04-2002	EP 1325224 A1	09-07-2003
		EP 1325225 A1	09-07-2003
		EP 1325226 A1	09-07-2003
		EP 1325227 A1	09-07-2003
		EP 1325229 A1	09-07-2003
		JP 2004515672 T	27-05-2004
		JP 2004511700 T	15-04-2004
		JP 2004513278 T	30-04-2004
		JP 2004514083 T	13-05-2004
		JP 2004511701 T	15-04-2004
		WO 0231344 A1	18-04-2002
		WO 0231345 A1	18-04-2002
		WO 0231346 A1	18-04-2002
		WO 0231347 A1	18-04-2002
JP 57013267 A	23-01-1982	JP 1430727 C	24-03-1988
		JP 62037225 B	11-08-1987
EP 1391606 A1	25-02-2004	DE 60208189 T2	06-07-2006
WO 2004085831 A	07-10-2004	NONE	
GB 2094940 A	22-09-1982	DE 3205654 A1	07-10-1982
		JP 57136859 U	26-08-1982

EPO FORM P0459

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