



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
12.03.2014 Bulletin 2014/11

(51) Int Cl.:
F02M 63/00 (2006.01) F04B 53/10 (2006.01)

(21) Application number: **12183506.0**

(22) Date of filing: **07.09.2012**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
 Designated Extension States:
BA ME

(72) Inventors:
 • **Grandi, Mauro**
57128 Livorno (IT)
 • **Lenzi, Francesco**
57128 Livorno (IT)
 • **Polidori, Valerio**
57128 Livorno (IT)

(71) Applicant: **Continental Automotive GmbH**
30165 Hannover (DE)

(54) **Relief valve, high pressure pump and fuel injection system**

(57) A relief valve arrangement is specified. It comprises a first valve seat (103) and a first sealing member (105). The first sealing member (105) is designed to seal the first valve seat (103) hydraulically in case of a mechanical connection between the first sealing member (105) and the first valve seat (103). It further comprises a second valve seat (106) and a second sealing member (107). The second sealing member (107) is designed to seal the second valve seat (106) hydraulically in case of a mechanical connection between the second sealing member (107) and the second valve seat (106). The relief

valve arrangement also comprises a first spring (109) comprising a spring rate and being coupled to the first sealing member (105) such that the first sealing member (105) is pressed against the first valve seat (103), and a second spring (112) comprising a spring rate and being coupled to the second sealing member (107) such that the second sealing member (107) is pressed against the second valve seat (106). The value of the spring rate of the first spring (109) is greater than the value of the spring rate of the second spring (112). Further, a high pressure pump and a fuel injection system are specified.

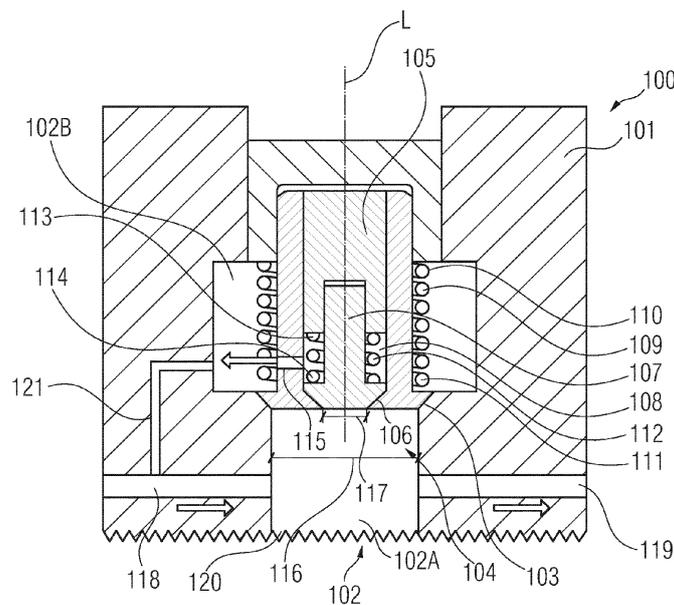


FIG 1

Description

[0001] The invention relates to a relief valve arrangement. Further, the invention relates to a high pressure pump for use in an internal combustion engine comprising such a valve arrangement. Further, the invention relates to a fuel injection system for an internal combustion engine comprising such a valve arrangement.

[0002] In today's automotive engine systems, there is an increased demand for low cost, direct injection. In common rail injection systems, the fuel is delivered by means of a high pressure pump from a fuel tank to a fuel rail which serves as a storage reservoir for the fuel. The fuel is under high pressure in the fuel rail (or common rail) and can be injected directly into the cylinders via injection valves connected to the rail. Common rail injections systems comprise relief valves for the high pressure pump and/or the fuel rail.

[0003] It is desirable to provide a valve arrangement, a high pressure pump and a fuel injection system for an internal combustion engine that is reliable, in particular under different operating conditions.

[0004] According to one aspect of the invention, a valve arrangement, in particular a relief valve arrangement, is specified. According to another aspect of the invention, a high pressure pump for use in an internal combustion engine is specified, the high pressure pump comprising the valve arrangement. According to yet another aspect of the invention, a fuel injection system - or fuel injection assembly - for an internal combustion engine is specified. The fuel injection assembly comprises a valve arrangement. In particular it comprises the high pressure pump with the valve assembly.

[0005] For example, the fuel injection assembly has a low-pressure fuel supply side and a high-pressure fuel rail side. The high pressure pump may be operable to move fuel from the fuel supply side to the fuel rail side of the fuel injection assembly, in particular in order to build up and/or maintain the desired high pressure on the fuel rail side. The valve arrangement may be comprised by the high-pressure side of the fuel injection assembly and operable to control fuel flow through a fluid connection from the high-pressure side to the low pressure side of the fuel injection assembly. In this way, the pressure may be stabilized on the high-pressure side and/or undesirably high pressure may be relieved by the valve arrangement which may be called a relief valve arrangement for example in this case.

[0006] In one embodiment, the high pressure pump or the fuel injection assembly with the high pressure pump may be configured for operating at a first pressure, at a second pressure, exceeding the first pressure, and at a third pressure, exceeding the second pressure, on the fuel rail side. For example, the second pressure has a value of at least 150 % of the first pressure and the third pressure has a value of at least 200 %, in particular at least 250%, of the first pressure. Both the second and third pressures may have a value of 10 times the first

pressure or less, for example of 5 times the first pressure or less. The first pressure may, for example, correspond to a "normal" operating mode. The second pressure may correspond to a cranking mode. The third pressure may correspond to a so called "limp home" mode which is in particular configured to provide the motor with a particularly rich mixture.

[0007] The relief valve arrangement comprises a housing having a cavity. The cavity may have a longitudinal axis. A first section of the cavity may be hydraulically coupleable or coupled with the high-pressure fuel rail side of the high pressure pump or fuel injection assembly, respectively. A second section of the cavity may be hydraulically coupleable or coupled with the low-pressure fuel supply side.

[0008] The relief valve arrangement comprises a first valve seat. The relief valve arrangement further comprises a first sealing member. The first sealing member is arranged in the cavity in one embodiment, in particular in the second section. It is designed to seal the first valve seat hydraulically in case of a mechanical connection between the first sealing member and the first valve seat.

[0009] The valve arrangement comprises a second valve seat and a second sealing member. The second sealing member is designed to seal the second valve seat hydraulically in case of a mechanical connection between the second sealing member and the second valve seat.

[0010] In particular, the first and second valve seats are arranged in an interface region between the first and second sections of the cavity. Preferably, the first section is hydraulically separated from the second section - i.e. fluid flow from the first to the second section is prevented - when the first sealing member seals the first valve seat and the second sealing member seals the second valve seat.

[0011] The valve arrangement comprises a first spring that comprises a spring rate. The first spring is configured for pressing the first sealing member against the first valve seat. The first sealing member, the first valve seat and the first spring represent a first sealing assembly. In one embodiment, the first spring is arranged in the cavity with a first axial end being coupled to the housing and a second axial end being coupled to the first sealing member such that the first sealing member is pressed against the first valve seat.

[0012] The valve arrangement comprises a second spring that comprises a spring rate. The second spring is configured for pressing the second sealing member against the second valve seat. The second sealing member, the second valve seat and the second spring represent a second sealing assembly. The value of the spring rate of the first spring is greater than the value of the spring rate of the second spring.

[0013] The second sealing member is pushed towards the second valve seat by the second spring that comprises a lower stiffness than the first spring. The second sealing member remains in mechanical connection with the

second valve seat until the pressure of a fluid that is in hydraulic communication with the relief valve arrangement is higher than a given value for the operating pressure - in particular higher than the second pressure. For example, the second sealing member opens when the pressure is higher than 150% of the normal operating pressure.

[0014] When the second sealing member opens, a fluid flow between the second sealing member and the second valve seat is possible. When the second sealing member opens, a rise in pressure may be stopped or reduced to stabilize the pressure value at the above-mentioned second pressure, for example 150% of normal operating pressure. For example, such over-pressure occurs during cranking conditions when the pressure has to be high enough to have a very efficient ignition and large bursts of power are needed.

[0015] The first sealing member opens at a higher pressure than the second sealing member. For example, the second sealing member opens when the fluid pressure exceeds the third pressure - e.g. doubles the normal operating pressure. This may correspond to a limp home condition, for example.

[0016] In other words, the valve arrangement may expediently hydraulically separate the first section of the cavity of the housing from the second section at the first pressure so that in particular fuel flow from the high-pressure side to the low-pressure side of the fuel injection assembly through the fluid connection is prevented. By means of the first and second sealing assemblies, the valve arrangement may be operable to allow fluid flow from the first to the second section of the cavity of the housing - and in particular through the fluid connection from the high-pressure side to the low-pressure side of the fuel injection assembly - at a first flow rate when the pressure exceeds the third pressure. The valve arrangement, by means of the second sealing assembly alone, may further be operable to allow fluid flow from the first to the second section of the cavity of the housing - and in particular through the fluid connection from the high-pressure side to the low-pressure side of the fuel injection assembly - at a second flow rate when the pressure has a value between the second pressure and the third pressure. The second flow rate is smaller than the first flow rate. For example, it is 70 % or less, in particular 50 % or less, and preferably 10 % or more of the first flow rate.

[0017] In one embodiment, the movement of the second sealing member away from the second valve seat is limited to avoid instability during opening. For example, the first sealing member is displaceable from the first valve seat by a larger distance than the distance of which the second sealing member is displaceable from the second valve seat.

[0018] In one embodiment, the second valve seat is comprised by the first sealing member and the second sealing member is arranged in a cavity of the first sealing member. In one development, the second spring is arranged in the cavity of the first sealing member with a

first axial end that is coupled to the first sealing member and a second axial end that is coupled to the second sealing member such that the second sealing member is pressed against the second valve seat.

[0019] According to a further embodiment, the first sealing member comprises an opening for a fluid communication from the inside of the first sealing member - i.e. from the cavity of the first sealing member - to the outside of the first sealing member, in particular to the second section of the cavity of the housing. A fluid flow from the cavity of the first sealing member to the cavity of the housing, in particular to the low pressure side, is possible through the opening when the second sealing member is arranged in the cavity of the first sealing member and allows a fluid flow between the second sealing member and the second valve seat.

[0020] In an expedient embodiment, the hydraulic diameter of the first valve seat is greater than the hydraulic diameter of the second valve seat. For example, the first and the second valve seat each comprise a cross-section, in particular across a longitudinal axis of the valve arrangement, and the value of the cross-section of the first valve seat is greater than the value of the cross-section of the second valve seat. Due to the larger cross-section of the first valve seat a higher through-flow volume at the first valve seat is possible in comparison with the second valve seat. Therefore, the lift of the first valve seat can be small in order to guarantee the system's pressure stability.

[0021] Reference will now be made in detail to the preferred embodiments, examples of which are illustrated in the accompanying drawing.

[0022] Figure 1 -the only figure - shows a section (indicated by the jagged line at the bottom of Figure 1) of a relief valve arrangement according to one embodiment in a schematic cross section. The figure is not to be regarded as being true to scale. Rather, individual elements may be exaggerated in size for better visibility and/or better understanding.

[0023] The relief valve arrangement is in particular provided for use in a high pressure pump of a fuel injection assembly for an internal combustion engine. The fuel injection assembly may be provided for operating at a first pressure - of up to 200 bar in the case of a gasoline engine, for example - in a normal operating mode, at second pressure in a cranking mode and at a third pressure in a "limp home" mode.

[0024] The relief valve arrangement 100 comprises a housing 101. The housing 101 surrounds a cavity 102. The cavity 102 may be hydraulically arranged between a fluid inlet 118 and a fluid outlet 119. The fluid inlet 118 may make part of a low-pressure fuel supply side of the fuel injection assembly. The cavity 102 and the fluid outlet 119 may make part of a high-pressure side. For example, the fluid outlet 119 is hydraulically coupled to the high pressure fuel rail. A one-way sealing assembly (not shown) may be arranged between the fluid inlet 118 and the cavity 102 to prevent fluid which is under high pres-

sure in the cavity 102 flow from flowing back to the low-pressure fluid inlet 118.

[0025] The relief valve arrangement 100 further comprises a fluid connection 121. The fluid connection 102 in particular hydraulically couples the cavity 102 to the fluid inlet 118, bypassing the one-way sealing assembly in one embodiment. The fluid connection 121 may be provided for enabling a reflux of fluid from the high pressure side to the low pressure side of the fuel injection assembly in this way.

[0026] A first sealing member 105 is arranged in the cavity 102. The first sealing member 105 seals a first valve seat 103 hydraulically in case of a mechanical connection between the first sealing member 104 and the first valve seat 103. The valve seat 103 is arranged at a wall 104 of the housing 101 surrounding the cavity 102.

[0027] In this way, the sealing assembly represented by the first sealing member 105 and the first valve seat 103 divides the cavity 102 into a first section 102A and a second section 102B. The first section 102A may be hydraulically coupleable or coupled with the high-pressure fuel rail side of the high pressure pump or fuel injection assembly, respectively (lower portion of the cavity 102 in Fig. 1). The second section 102B of the cavity 102 may be hydraulically coupleable or coupled with the low-pressure fuel supply side, here by means of the fluid connection 121 (upper portion of the cavity 102 containing the first sealing member 105 in Fig. 1).

[0028] A first spring 109 is coupled with a first axial end 110 with the housing 101 and with a second axial end 111 with the first sealing member 105. The first spring 109 is biased to push the first sealing member 105 in a direction to the first valve seat 103. The first spring 109 has a spring rate. The value of the spring rate is given such that the first sealing member 105 lifts off from the first valve seat 103 when the pressure in the first section 102A of the cavity 102 is higher than a given pressure, in particular the third pressure. For example, the given pressure is 250% of the normal operating pressure.

[0029] When the first sealing member is moved away along a longitudinal axis L of the relief valve arrangement 100 from the first valve seat 103, fluid can flow between the first valve seat 103 and the first sealing member 105 from the first section 102A to the second section 102B of the cavity 102 and further through the fluid connection 121 to the low pressure side of the relief valve arrangement 100. For example, the low pressure side is a fluid inlet 118 of the high pressure pump for use in an internal combustion engine.

[0030] The first sealing member 105 comprises a cavity 108 having an opening 115 and a second valve seat 106. The opening 115 may be provided to hydraulically connect the cavity 108 of the first sealing member 105 to the second section 102B of the cavity 102 of the relief valve arrangement 100 and, thus, via the fluid connection 121 to the fluid inlet 118.

[0031] The relief valve arrangement 100 further comprises a second sealing member 107. The second seal-

ing member 107 is arranged inside the first sealing member 105, specifically in the cavity 108. The second sealing member 107 is pushed against the second valve seat 106 by a second spring 112. The second spring 112 is also arranged in the cavity 108. The second spring 112 is coupled to the first sealing member 105 with the first axial end 113 and coupled to the second sealing member 107 with a second axial end 114.

[0032] The second spring 112 comprises a spring rate. The spring rate of the second spring 112 is less than the spring rate of the first spring 109. The second sealing member 107 moves away from the second valve seat 106 along the longitudinal axis L when the pressure in the first section 102A of the cavity 102 is higher than a given pressure, in particular the second pressure. The given pressure for the second sealing member 107 is less than the given pressure for the first sealing member 105. For example the given pressure for the second sealing member 107 is 150% of the normal operating pressure. For pressures higher than the second pressure, e.g. 150% of normal operating pressure, the second sealing member 107 is moved away from the second valve seat 106 against a spring force of the second spring 112 and allows a fluid flow from the first section 102A of the cavity 102 of the housing 101 via the cavity 108 of the first sealing member 105, the opening 115 of the first sealing member 105 and the second section 102B of the cavity 102 of the relief valve arrangement 102 to the fluid connection 121 and further to the fluid inlet 118.

[0033] The first sealing member 105 and the first valve seat 103 have a cross-section 116 at the contact area. The second valve seat 106 and the second sealing member 107 have another cross-section 117 at their respective contact area. The value of the cross-section 116 of the first valve seat 103 is greater than the value of the cross-section 117 of the second valve seat 106.

[0034] When the pressure in the first section 102A of the cavity 102 is less than the given pressure for the first sealing member 105 and becomes higher than the given pressure for the second sealing member 107 - i.e. when the pressure has a value less than the third pressure and reaches a value larger than the second pressure and - the second sealing member 107 moves with respect to the first sealing member 105. Specifically, the first sealing member 105 remains in sealing contact with the first valve seat 103 and the second sealing member 107 moves away from the second valve seat 106.

[0035] When the pressure exceeds the third pressure and the first sealing member 105 moves away from the first valve seat 103, the second sealing member 107 and the second spring 112 move together with the first sealing member 105 relatively to the housing 101. The second sealing member 107 is spaced from the second valve seat 106 in this case and in particular does not move relative to the first sealing member 105.

[0036] According to further embodiments, the first and the second valve seats 103, 106 are coaxially arranged in the cavity 102. According to further embodiments, the

first and the second sealing members 105, 107 are coaxially arranged.

[0037] Due to the graduated cross-section of the opening for the fluid to flow from the first section 102A of the cavity 102 to the fluid inlet 118 dependent on the pressure in the first section 102A of the cavity 102, a stable operation of the system of the relief valve arrangement is possible. Dependent on the pressure in the first section 102A of the cavity 102, the relief valve arrangement 100 opens the smaller cross-section 117 or the larger cross-section 116 for the fluid flow. Thus, the movement of the first sealing member 105 and the second sealing member 107 along the longitudinal axis L can be limited to a small lift. This increases the stability of the system.

[0038] For example, the second sealing member 107 is pushed down against the second valve seat 106 by the low stiffness spring 112 and remains closed until the pressure is higher than 150% of the normal operating value. For higher pressure, the second sealing member 107 opens and thus stops the pressure raising and stabilizes the pressure value at 150% of normal operating value. Such slight over-pressure is desirable during cranking conditions, when the pressure has to be high enough to have a very efficient ignition and large bursts of power are needed. To avoid instability during opening, the second sealing member 107 has a very small lift.

[0039] For example in case of a pump failure mode, such a small lift cannot guarantee a through-flow volume that is sufficient to maintain the pressure inside a safe range. For example, over-pressure can reach 250% of normal operating pressure. The first sealing member 105 is maintained in close contact with the first valve seat 103 by the stiffer spring 109. The first sealing member 105 opens only when the fuel pressure, for example, is double the normal operating pressure. The first sealing member 105 comprises the cross-section 116 that is bigger than the cross-section 117 of the second sealing member 107. Therefore, a higher through-flow volume is possible when the first valve seat 103 is open, even if the lift of the first sealing member 105 is small in order to guarantee systems pressure stability.

[0040] According to aspects the relief valve arrangement 100 is part of a high pressure pump for use in a internal combustion engine. The housing 101, for example, is the housing of the high pressure pump. The cavity 102, for example, is part of a fluid chamber 120. The fluid chamber 120 is hydraulically arranged between the fluid inlet 118 and a fluid outlet 119. For example, the fluid outlet 119 is hydraulically coupled to the high pressure fuel rail. For example a plunger is arranged in the fluid chamber 120 to pressurize fuel from the fluid inlet 118. The high pressure pump may be configured to generate a maximum pressure which is higher than the third pressure - for example a maximum pressure of at least about twice the third pressure, i.e. 500 bar in the present embodiment - absent the pressure reduction by means of the relief valve arrangement.

[0041] According to further aspects, the valve arrange-

ment 100 is part of the fuel injection system for the internal combustion engine. For example, the valve arrangement 100 is arranged at the fuel rail or the high pressure pipes.

[0042] With the relief valve arrangement 100 with different pressure release sealing members 105, 107, the pressure release by the relief valve arrangement 100 is adapted to different operating conditions. Therefore, all system components will not be exposed to uncontrolled high pressure values which the high pressure pump may be operable to generate. It is not necessary to strengthen the rail injector connection to avoid injector ejection during pump failure mode. This leads to cost reduction.

[0043] Absent the relief valve arrangement, a pump failure mode could rapidly lead to an over-pressure equal or bigger than 250% of the normal operating pressure. Such a high fluid pressure needs to use a metal-to-metal rail injector connection, because the o-ring injector interface would not be sufficient to avoid external leakage. With the relief valve arrangement 100 it is assured that the fuel pressure remains below 250% of normal operating pressure. In this pressure condition, the o-ring interface is sufficient to prevent external leakage. With the relief valve arrangement 100 the electronic motor control unit can be simplified because the injected fuel quantity is limited by the limitation of the over-pressure itself.

[0044] The invention is not limited to specific embodiments by the description on the basis of said exemplary embodiments but comprises any combination of elements of different embodiments. Moreover, the invention comprises any combination of claims and any combination of features disclosed by the claims.

35 Claims

1. Relief valve arrangement, comprising:

- a first valve seat (103),
- a first sealing member (105), the first sealing member (105) being designed to seal the first valve seat (103) hydraulically in case of a mechanical connection between the first sealing member (105) and the first valve seat (103),
- a second valve seat (106),
- a second sealing member (107), the second sealing member (107) being designed to seal the second valve seat (106) hydraulically in case of a mechanical connection between the second sealing member (107) and the second valve seat (106),
- a first spring (109) comprising a spring rate and being coupled to the first sealing member (105) such that the first sealing member (105) is pressed against the first valve seat (103),
- a second spring (112) comprising a spring rate and being coupled to the second sealing member (107) such that the second sealing member

- (107) is pressed against the second valve seat (106),
 - the value of the spring rate of the first spring (109) being greater than the value of the spring rate of the second spring (112).
2. Relief valve arrangement according to claim 1, further comprising a housing (101) having a cavity (102) with a longitudinal axis (L), wherein
- the first sealing member (105) is arranged in the cavity (102) and comprises the second valve seat (106),
 - the second sealing member (107) is arranged in a cavity (108) of the first sealing member (105),
 - the first spring (109) is arranged in the cavity (102) with a first axial end (110) being coupled to the housing (101) and a second axial end (114) being coupled to the first sealing member (105) such that the first sealing member (105) is pressed against the first valve seat (103),
 - the second spring (112) is arranged in the cavity (108) of the first sealing member (105) with a first axial end (113) being coupled to the first sealing member (105) and the second axial end (114) being coupled to the second sealing member (107) such that the second sealing member (107) is pressed against the second valve seat (106).
3. Valve arrangement according to claim 2, the first sealing member (105) comprising an opening (115) for a fluid communication from the cavity (108) of the inside of the first sealing member (105) to the outside of the first sealing member (105).
4. Valve arrangement according to one of the preceding claims, the first (103) and the second (106) valve seat each comprising a cross section (116, 117), the value of the cross section (116) of the first valve seat (103) being greater than the value of the cross section (117) of the second valve seat (106).
5. Valve arrangement according to any of the preceding claims, the first (103) and the second (106) valve seat being coaxially arranged.
6. Valve arrangement according to any of the preceding claims, the first (105) and the second (107) sealing member being coaxially arranged.
7. High pressure pump for use in an internal combustion engine, comprising a relief valve arrangement according to any of the preceding claims.
8. Fuel injection system for an internal combustion engine, comprising a relief valve arrangement according to any of claims 1 to 6.
9. Fuel injection system according to claim 8 having a high-pressure side and a low-pressure side, wherein the valve arrangement is comprised by the high-pressure side and operable to control fuel flow through a fluid connection (121) from the high-pressure side to the low pressure side.
10. Fuel injection assembly according to claim 9, the fuel injection system being configured for operating at a first pressure, at a second pressure, exceeding the first pressure, and at a third pressure, exceeding the second pressure, on its high-pressure side and the valve arrangement is operable
- to prevent fuel flow through the fluid connection at the first pressure,
 - to allow fluid flow through the fluid connection at a first flow rate when the pressure exceeds the third pressure, and
 - to allow fluid flow through the fluid connection at a second flow rate when the pressure has a value between the second pressure and the third pressure,
- wherein the second flow rate is smaller than the first flow rate.



EUROPEAN SEARCH REPORT

Application Number
EP 12 18 3506

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	JP 2010 156256 A (DENSO CORP) 15 July 2010 (2010-07-15) * abstract; figures 1-3 * -----	1-10	INV. F02M63/00 F04B53/10
X	US 2011/139126 A1 (INOUE HIROSHI [JP]) 16 June 2011 (2011-06-16) * abstract; figures * -----	1-10	
X	US 2011/125387 A1 (SUZUKI TAKASHI [JP] ET AL) 26 May 2011 (2011-05-26) * abstract; figures 1-14 * -----	1-10	
X	JP 2009 108847 A (NIPPON SOKEN; DENSO CORP) 21 May 2009 (2009-05-21) * abstract; figures * -----	1-10	
X	US 2011/126804 A1 (LUCAS ROBERT G [US] ET AL) 2 June 2011 (2011-06-02) * abstract; figures * -----	1,4-8	
			TECHNICAL FIELDS SEARCHED (IPC)
			F02M F04B
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 29 January 2013	Examiner Godrie, Pierre
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 (F04C01)

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

EP 12 18 3506

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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29-01-2013

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 2010156256 A	15-07-2010	NONE	
US 2011139126 A1	16-06-2011	JP 4998837 B2 JP 2011122521 A US 2011139126 A1	15-08-2012 23-06-2011 16-06-2011
US 2011125387 A1	26-05-2011	CN 102080616 A DE 102010043869 A1 JP 2011132941 A US 2011125387 A1	01-06-2011 09-06-2011 07-07-2011 26-05-2011
JP 2009108847 A	21-05-2009	JP 4413260 B2 JP 4842361 B2 JP 2009108847 A JP 2010019263 A	10-02-2010 21-12-2011 21-05-2009 28-01-2010
US 2011126804 A1	02-06-2011	CN 102639862 A EP 2507505 A1 US 2011126804 A1 WO 2011068524 A1	15-08-2012 10-10-2012 02-06-2011 09-06-2011