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

(11) EP 2 660 456 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
06.11.2013 Bulletin 2013/45

(21) Application number: **12166297.7**

(22) Date of filing: **01.05.2012**

(51) Int Cl.:
F02M 41/14 *(2006.01)* ***F02D 1/18*** *(2006.01)*

(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

(71) Applicant: **Delphi Technologies Holding S.à.r.l.**
4940 Bascharage (LU)

(72) Inventors:
- **Bootle, Geoffrey**
  Maidstone, Kent ME16 0HJ (GB)
- **Dyason, Rodney**
  Chatham, Kent ME5 7RF (GB)

(74) Representative: **Neill, Andrew Peter et al**
Delphi Diesel Systems
Patent Department
Courteney Road
Gillingham, Kent ME8 0RU (GB)

(54) Fuel pump

(57) The present invention relates to a rotary fuel pump (101). The pump (101) has a rotor (107) and at least one pumping element (115) for supplying high pressure fuel. A cam box (123) containing a cam arrangement (103) is provided for actuating the at least one pumping element (115). A speed dependent fuel pressure line (129) is provided for supplying speed dependent fuel pressure to an advance arrangement (125) for adjusting the timing of fuel delivery by the pump (101). A first vent line (131) is provided for venting air from the speed dependent fuel pressure line (129). The present invention also relates to an advance arrangement (125) for a fuel pump (101) and a rotor (107) for a fuel pump (101).

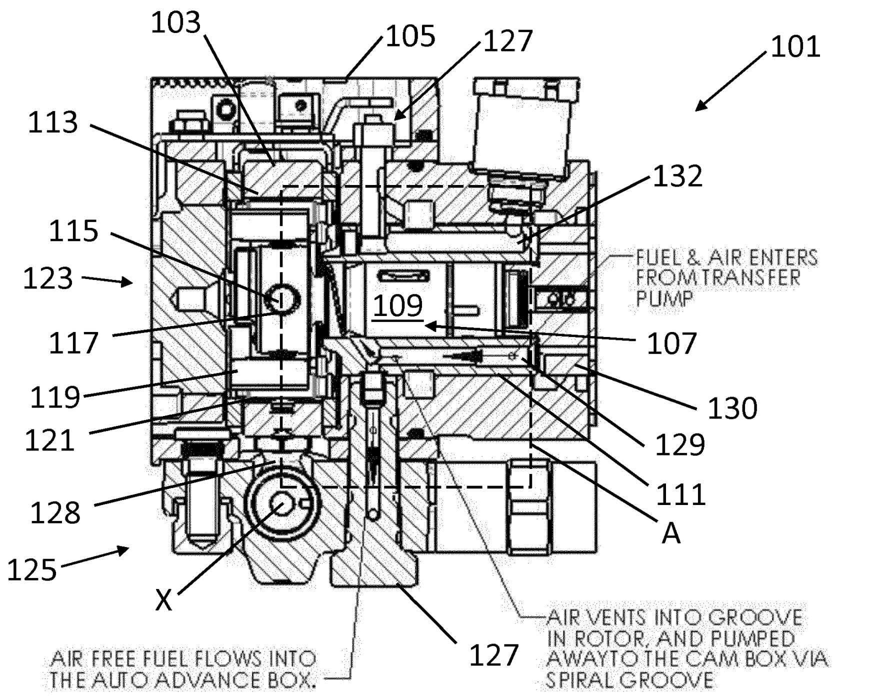

FIG. 2

EP 2 660 456 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to a rotary fuel pump; an advance arrangement for a rotary fuel pump; and a rotor for a rotary fuel pump.

BACKGROUND OF THE INVENTION

[0002] As shown in Figure 1, a conventional rotary fuel pump 1 includes a cam ring 3 which is angularly adjustable with respect to a pump housing 5. A rotor 7 comprising a distributor member 9 is provided for supplying metered volumes of high pressure fuel to fuel injectors (not shown). The cam ring 3 includes a plurality of cam lobes 11 and encircles part of the distributor member 9, including pumping plungers 13 which are slidable within respective bores 15 of the distributor member 9. Each of the pumping plungers 13 has an associated shoe 17 and roller 19 arrangement, the rollers 19 of which are engagable with the cam surface of the cam ring 3. The cam ring 3 is housed in a cam box 21 defined within the pump housing 5.

[0003] In use, fuel is supplied to the bores 15 of the distributor member 9 by a transfer pump 16 and a force due to fuel pressure within the bores 15 serves to urge the plungers 13 in a radially outward direction. The output pressure of the transfer pump 16 (referred to as "transfer pressure") is controlled so as to be related to the speed of operation of the engine with which the pump 1 is being used. Rotation of the distributor member 9 relative to the cam ring 3 causes the rollers 19 to move relative to the cam ring 3, engagement between the rollers 19 and the cam lobes 11 thereby causing the plungers 13 to be forced in a radially inward direction to pressurise fuel within the respective bore 15 and causing fuel to be delivered by the pump 1 at relatively high pressure. By altering the angular position of the cam ring 3 by means of an advance arrangement 23, the timing at which fuel is delivered by the pump 1 can be adjusted.

[0004] The advance arrangement 23 includes a servo piston arrangement which is arranged to influence the degree of timing advance depending on the operating speed of the engine (referred to as "speed advance"), a light load piston arrangement, including a load sensing piston, which is arranged to influence the degree of timing advance depending on the load under which the engine is operating (referred to as "light load advance") and a temperature control valve which is arranged to influence the degree of timing advance depending on the operating temperature of the engine (referred to as "cold advance").

[0005] The cam ring 3 is provided with a cam ball screw 25 which extends into an opening provided in an advance piston in order to permit adjustment of the angular position of the cam ring. The advance piston is slidable within a further bore provided in an advance box housing 27. The ends of the bore are closed by first and second end plates respectively which are secured to the advance box housing 27 by means of bolts 29. Appropriate O-rings may be used to seal the end plates to the advance box housing 27.

[0006] The advance piston is responsive to fuel pressure changes within an advance piston control chamber (the main advance control chamber). If the pressure in the main advance control chamber increases, the advance piston is caused to move in a first direction so as to advance the timing of fuel delivery. If the pressure in the main advance control chamber is reduced, the advance piston is caused to move in an opposite direction to retard the timing of fuel delivery.

[0007] Current rotary pumps are designed to be robust to ingestion of a small amount of air continuously. However, in certain operational circumstances, such as when a fuel filter is changed or the vehicle runs out of fuel, a large volume of air can be introduced into the system. If the volume of air is not removed by priming the system, the lack of fuel in the advance arrangement can result in loss of control over the advance piston and, therefore, the movement of the cam ring. Specifically, if a large volume of air is swept into the pump and is followed by fuel, before the engine can stall, then some of the air can be swept into the advance arrangement. Until the air is ejected from the advance arrangement, the advance piston can reciprocate back and forth rapidly between the end stops. The resulting blows to the advance arrangement can be severe and could potentially cause damage, permanent loss of correct advance functionality and pump leakage.

[0008] The present invention sets out to help ameliorate or overcome at least some of the problems associated with prior art systems.

SUMMARY OF THE INVENTION

[0009] Aspects of the present invention relate to a rotary fuel pump; an advance arrangement for a rotary fuel pump; and a rotor for a rotary fuel pump.

[0010] In a further aspect, the present invention relates to a rotary fuel pump comprising:

a rotor having at least one pumping element for supplying high pressure fuel ;
a cam box containing a cam arrangement for actuating the at least one pumping element; and
a speed dependent fuel pressure line for supplying speed dependent fuel pressure to an advance arrangement for adjusting the timing of fuel delivery by the pump;
wherein a first vent line is provided for venting air from the speed dependent fuel pressure line.

[0011] The first vent line allows air to vent from the fuel supplied to the advance arrangement, thereby reducing the introduction of air to the advance arrangement. The operation of the advance arrangement, including an advance piston, can be controlled even when air is present in the speed dependent fuel pressure line. The first vent line can be provided between a pump for supplying the speed dependent fuel pressure and the advance arrangement.

[0012] The first vent line can be in fluid communication with a collection chamber for collecting air vented from the speed dependent fuel pressure line. The collection chamber can be an annular chamber extending around the rotor. The annular chamber can be maintained in fluid communication with the first vent line. An aperture could be formed in a housing supporting the rotor to form the annular chamber. Alternatively, the annular chamber can comprise an annular groove formed in the rotor.

[0013] A second vent line can be provided for venting air from the collection chamber. The second vent line can be in fluid communication with a drain or a reservoir. Alternatively, the second vent line can be in fluid communication with the cambox.

[0014] The second vent line could be formed in a pump housing. Alternatively, the second vent line can comprise an aperture formed in the rotor. The aperture could be an axial recess or bore formed in the rotor. Alternatively, the aperture can be a spiral or helical groove formed in the rotor. The helical groove can be turned in the same direction as the rotational direction of the rotor; or in the opposite direction to the rotational direction of the rotor.

[0015] The second vent line can have a relatively small cross-sectional area to define a viscous leak path for inhibiting the flow of fuel from the collection chamber to the cam box. The first vent line can have a larger cross-sectional area than the second vent line.

[0016] The first vent line can comprise an inlet and an outlet. The inlet can be positioned at an operative high point of the speed dependent fuel pressure line. This arrangement can promote the venting of air from the speed dependent pressure line.

[0017] The rotary fuel pump can further comprise one or more plungers actuatable by the cam arrangement. The cam arrangement is arranged to cooperate, in use, with an advance piston provided in an advance arrangement.

[0018] The present invention also relates to a rotary fuel pump as described herein in combination with an advance arrangement. The advance arrangement can comprise an advance piston which is slidable within a first bore and which cooperates, in use, with the cam arrangement of the fuel pump to adjust the timing of fuel delivery by the pump.

[0019] In a further aspect, the present invention relates to an advance arrangement for use in controlling timing of fuel delivery by a fuel pump for use in an engine comprising;

an advance piston which is slidable within a first bore and which cooperates, in use, with a cam arrangement of a fuel pump to adjust the timing of fuel delivery by

the pump, the advance piston being slidable within the bore in either an advance or a retard direction to advance or retard, respectively, the timing of the fuel pump delivery;

a speed dependent fuel pressure line being provided for supplying speed dependent fuel pressure to a first control chamber for controlling the position of the advance piston in response to variations in the speed dependent fuel pressure to permit adjustment of the timing in response to engine speed;

wherein a first vent line is provided for venting air from the speed dependent fuel pressure line.

[0020] The first vent line can be in fluid communication with a collection chamber for collecting air vented from the speed dependent fuel pressure line. A second vent line can be provided for venting air from the collection chamber.

[0021] In a still further aspect, the present invention relates to a rotor for a rotary fuel pump, the rotor comprising a head portion and a body portion, wherein at least one aperture is formed in the head portion for providing a fluid communication pathway. The at least one aperture can provide a communication pathway from a first side of the head portion to a second side of the head portion. The at least one aperture can be a helical recess formed in an outer surface of the head portion. An annular groove can be formed in the body portion to form a collection chamber.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] An embodiment of the present invention will now be described, by way of example only, with reference to the accompanying figures, in which:

Figure 1 shows a cross-sectional view of a prior art rotary pump;

Figure 2 shows a cross-sectional view of a rotary pump according to an embodiment of the present invention; and

Figure 3 shows an enlarged view of a region A of the cross-sectional view shown in Figure 2.

DETAILED DESCRIPTION OF AN EMBODIMENT

[0023] A rotary fuel pump 101 in accordance with an embodiment of the present invention will now be described with reference to Figure 2. The rotary fuel pump 101 is a modified version of for storing air vented from the transfer pressure supply line 127 the prior art fuel pump 1 illustrated in Figure 1.

[0024] The rotary fuel pump 101 comprises a cam ring 103 which is angularly adjustable with respect to a pump housing 105. A hydraulic head rotor 107 comprising a distributor member 109 is provided for supplying metered volumes of high pressure fuel to fuel injectors (not shown). The hydraulic head rotor 107 comprises a head portion 107a and a body portion 107b which is supported in a hydraulic head sleeve 111 located in the pump housing 105. The cam ring 103 includes a plurality of cam lobes 113 and encircles part of the distributor member 109, including pumping plungers 115 which are slidable within respective bores 117 of the distributor member 109. Each of the pumping plungers 115 has an associated shoe 119 and roller 121 arrangement, the rollers 121 of which are engageable with the cam surface of the cam ring 103. The cam ring 103 is housed in a cam box 123 defined within the pump housing 105.

[0025] An advance arrangement 125 is provided for controlling speed advance, light load advance and cold advance. The advance arrangement 125 comprises an advance piston (not shown) provided in an advance box housing 127. The advance piston is coupled to the cam ring 103 by a cam ball screw 128. The advance piston is slidable within a bore (extending along an axis X extending perpendicular to the plane of the page in Figure 2) to alter the angular position of the cam ring 103. The advance piston is slidable within the bore in either an advance or a retard direction to advance or retard, respectively, the timing of the fuel pump delivery.

[0026] A transfer pump 130 is provided for supplying fuel to the distributor member 109 and the advance arrangement 125. The output pressure of the transfer pump (referred to as "transfer pressure") is controlled so as to be related to the speed of operation of the engine with which the pump 1 is being used. Thus, the output pressure of the transfer pump is speed dependent. An inlet metering valve 127 supplies a metered volume of fuel to the distributor member 109. The transfer pump 130 is in fluid communication with an annular groove for supplying fuel to the inlet metering valve 127 via a top pressure supply line 132 and an electric shut-off solenoid chamber. A transfer pressure supply line 129 is provided for supplying fuel from the transfer pump 130 to the advance arrangement 125. The transfer pressure supply line 129 is not in communication with the inlet metering valve 127.

[0027] The transfer pump supplies fuel to a main control chamber for controlling the position of the advance piston in response to variations in the speed dependent fuel pressure to permit adjustment of the timing in response to engine speed. A suitable mechanism for controlling operation of the advance piston is known from US patent number US 7,350,508 (Delphi Technologies, Inc.) which is incorporated herein in its entirety by reference. It will be appreciated that the present invention is not limited to this particular control mechanism and can be used with other advance arrangements.

[0028] As shown most clearly in Figure 3, a venting bore 131 having an inlet 133 and an outlet 135 is provided to vent air from the transfer pressure supply line 127. The venting bore 131 extends through the hydraulic head sleeve 111 and forms a first communication pathway extending from the transfer pressure supply line 129 to a collection chamber 137 for storing air vented from the transfer pressure supply line 129. The inlet 133 is provided at a relatively high point of the transfer pressure supply line 129 to promote the flow of air from the transfer pressure supply line 129; and the outlet 135 is open to the collection chamber 137. In the present embodiment, an annular groove 139 is formed in the body portion 107b of the rotor 107 to form the collection chamber 137. In use, rather than a large volume of air being swept into the advance arrangement 125, the air will rise upwards into the collection chamber 137 via the venting bore 131.

[0029] A helical groove 141 is formed in an outer surface of the head portion 107a of the rotor 107 to form a second communication pathway extending from the collection chamber 137 to the cam box 123. The helical groove 141 has a shallow, narrow profile and leads to an 'anti-seizure' groove provided at the front of the rotor 107 just behind the head portion 107a of the rotor 107 within the cam box 123. The annular groove 139 is relatively large in comparison to the helical groove 141. The air collected in the annular groove 139 can be ejected along the helical groove 141 under the influence of the large pressure difference between the transfer pressure in the collection chamber 137 and the pressure in the cam box 123 in front of the rotor 107.

[0030] The helical groove 141 is dimensioned so as to define a viscous leak path suitable for minimizing the flow of fuel from the transfer pressure supply line 129 to the cam box 123. The loss of transfer pressure to the cam box 123 when there is no air in the collection chamber 137 is thereby reduced. Forming the communication pathway from the collection chamber 137 to the cam box 123 in the form of a helical groove 141 serves several purposes, including:

(a) The helical groove 141 provides a long viscous leak path that will allow air to escape relatively easily but creates a strong resistance to the flow of fuel (so air vents preferentially over fuel).

(b) The helical groove 141 can be machined in an outer surface of the rotor 107 using normal manufacturing methods and tolerances without interrupting the cutting, grinding and honing processes.

(c) Forming the helical groove 141 so as to turn in the same direction as the rotational direction of the pump 101 (i.e. clockwise for a clockwise rotation pump; and anticlockwise for an anticlockwise pump) potentially allows the helical groove 141 to act as a weak pump that will tend to assist fuel to pass along the helical towards the cam box 123, but oppose the flow from the cam box 123 towards the collection chamber 137. (In the illustrated arrangement, the rotor 107 rotates in an anticlockwise direction.)

(d) The helical groove 141 allows improved support for a rotor bearing.

[0031] At least one additional communication pathway (not shown) is provided for venting air from the cam box 123. In the present embodiment, a back-leakage connection from the cam box 123 to the fuel tank (not shown) is used to vent the air from the cam box 123 and return it to the fuel tank.

[0032] In use, the pump 101 operates in substantially the same way as the prior art pump 1 illustrated in Figure 1. However, in the event that the transfer pump supplies a volume of air to the advance arrangement 125, at least some of the air can be vented from the transfer pressure supply line 127 via the venting bore 131. The air is collected in the collection chamber 137 and gradually vented to the cam box 123 via the helical groove 141. Thereafter, the air can be vented to atmosphere from the cam box 123. The risk of a relatively large volume of air being introduced into the advance arrangement 125 is reduced, thereby protecting the advance piston from damage.

[0033] It will be appreciated that various changes and modifications can be made to the embodiment described herein without departing from the scope of the present invention.

Claims

1. A rotary fuel pump (101) comprising:

   a rotor (107) having at least one pumping element (115) for supplying high pressure fuel;
   a cam box (123) containing a cam arrangement (103) for actuating the at least one pumping element (115); and
   a speed dependent fuel pressure line (129) for supplying speed dependent fuel pressure to an advance arrangement (125) for adjusting the timing of fuel delivery by the pump (101);
   wherein a first vent line (131) is provided for venting air from the speed dependent fuel pressure line (129).

2. A rotary fuel pump (101) as claimed in claim 1, wherein the first vent line (131) is in fluid communication with a collection chamber (137) for collecting air vented from the speed dependent fuel pressure line (129).

3. A rotary fuel pump (101) as claimed in claim 2, wherein the collection chamber (137) is an annular chamber extending around said rotor (107).

4. A rotary fuel pump (101) as claimed in claim 3, wherein said annular chamber (137) comprises an annular groove (139) formed in said rotor (107).

5. A rotary fuel pump (101) as claimed in any one of the preceding claims, wherein the first vent line (131) is provided between a pump for supplying the speed dependent fuel pressure and the advance arrangement.

6. A rotary fuel pump (101) as claimed in any one of the preceding claims further comprising a second vent line (141) for venting air from the collection chamber (137).

7. A rotary fuel pump (101) as claimed in claim 6, wherein the second vent line (141) is in fluid communication with the cambox (123).

8. A rotary fuel pump (101) as claimed in claim 6 or claim 7, wherein the second vent line (141) comprises an aperture formed in said rotor (107).

9. A rotary fuel pump (101) as claimed in claim 8, wherein said aperture is a helical groove (141) formed in said rotor (107).

10. A rotary fuel pump (101) as claimed in claim 9, wherein said helical groove (141) is turned in the same direction as the rotational direction of the rotor (107).

11. A rotary fuel pump (101) as claimed in any one of the preceding claims, wherein the first vent line (131) comprises an inlet (133) and an outlet (135), the inlet (133) being positioned at an operative high point of the speed dependent fuel pressure line (129).

12. An advance arrangement (125) for use in controlling timing of fuel delivery by a fuel pump (101) for use in an engine comprising;
   an advance piston which is slidable within a first bore and which cooperates, in use, with a cam arrangement (103) of a fuel pump (101) to adjust the timing of fuel delivery by the pump (101), the advance piston being slidable within the bore in either an advance or a retard direction to advance or retard, respectively, the timing of the fuel pump delivery;
   a speed dependent fuel pressure line (129) being provided for supplying speed dependent fuel pressure to a first control chamber for controlling the position of the advance piston in response to variations in the speed dependent fuel pressure to permit adjustment of the timing in response to engine speed;
   wherein a first vent line (131) is provided for venting air from the speed dependent fuel pressure line (129).

13. An advance arrangement as claimed in claim 12, wherein the first vent line (131) is in fluid communication with a collection chamber (137) for collecting air vented from the speed dependent fuel pressure line (129).

14. An advance arrangement as claimed in claim 12 or claim 13 further comprising a second vent line (141) for venting air from the collection chamber (137).

15. A rotor (107) for a rotary fuel pump (101), the rotor comprising a head portion (1 07a) and a body portion (1 07b), wherein at least one aperture (141) is formed in the head portion (107a) to provide a fluid communication pathway.

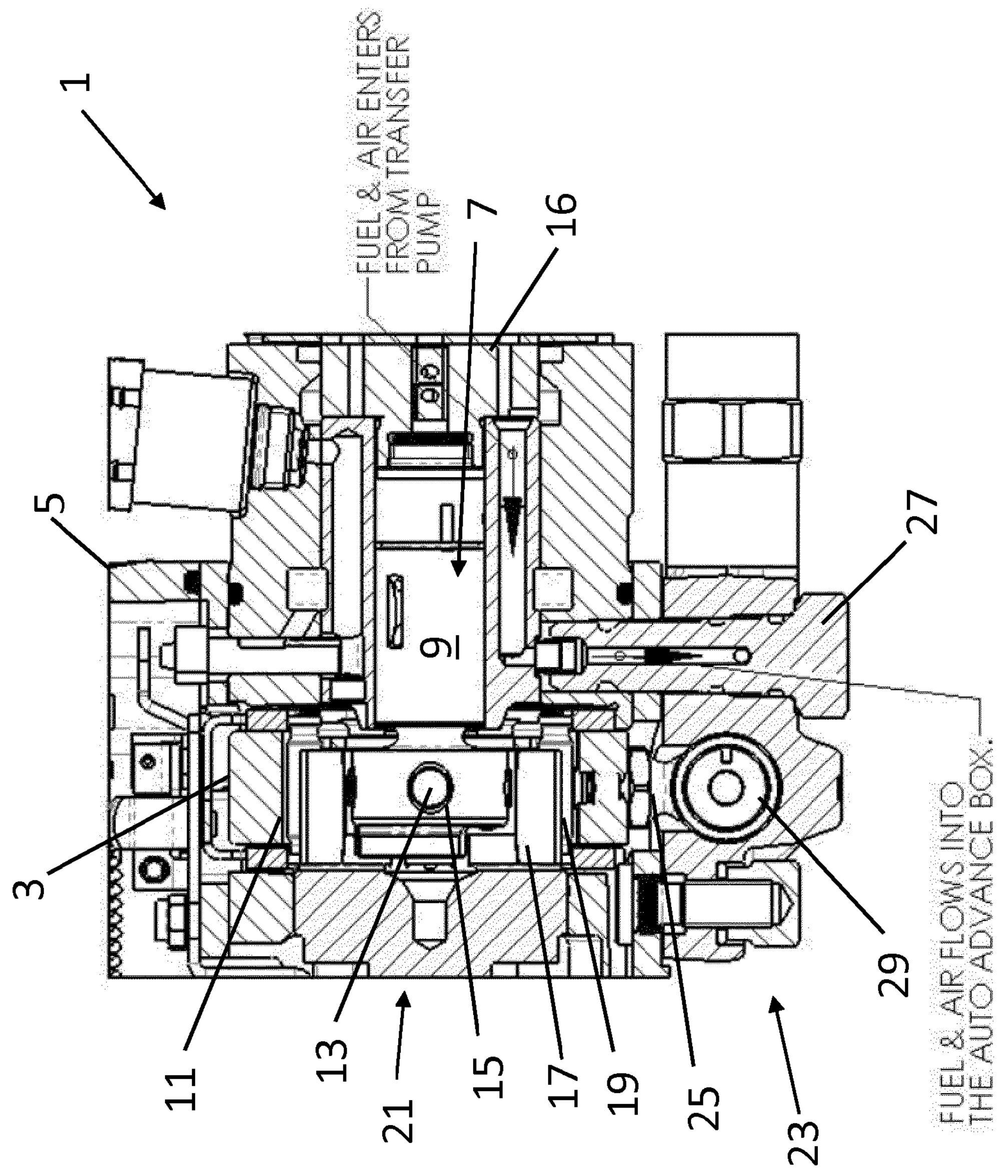
1
FUEL & AIR ENTERS FROM TRANSFER PUMP
7
16
5
27
9
3
11
13
15
17
19
21
25
23
29
FUEL & AIR FLOWS INTO THE AUTO ADVANCE BOX.

FIG. 1

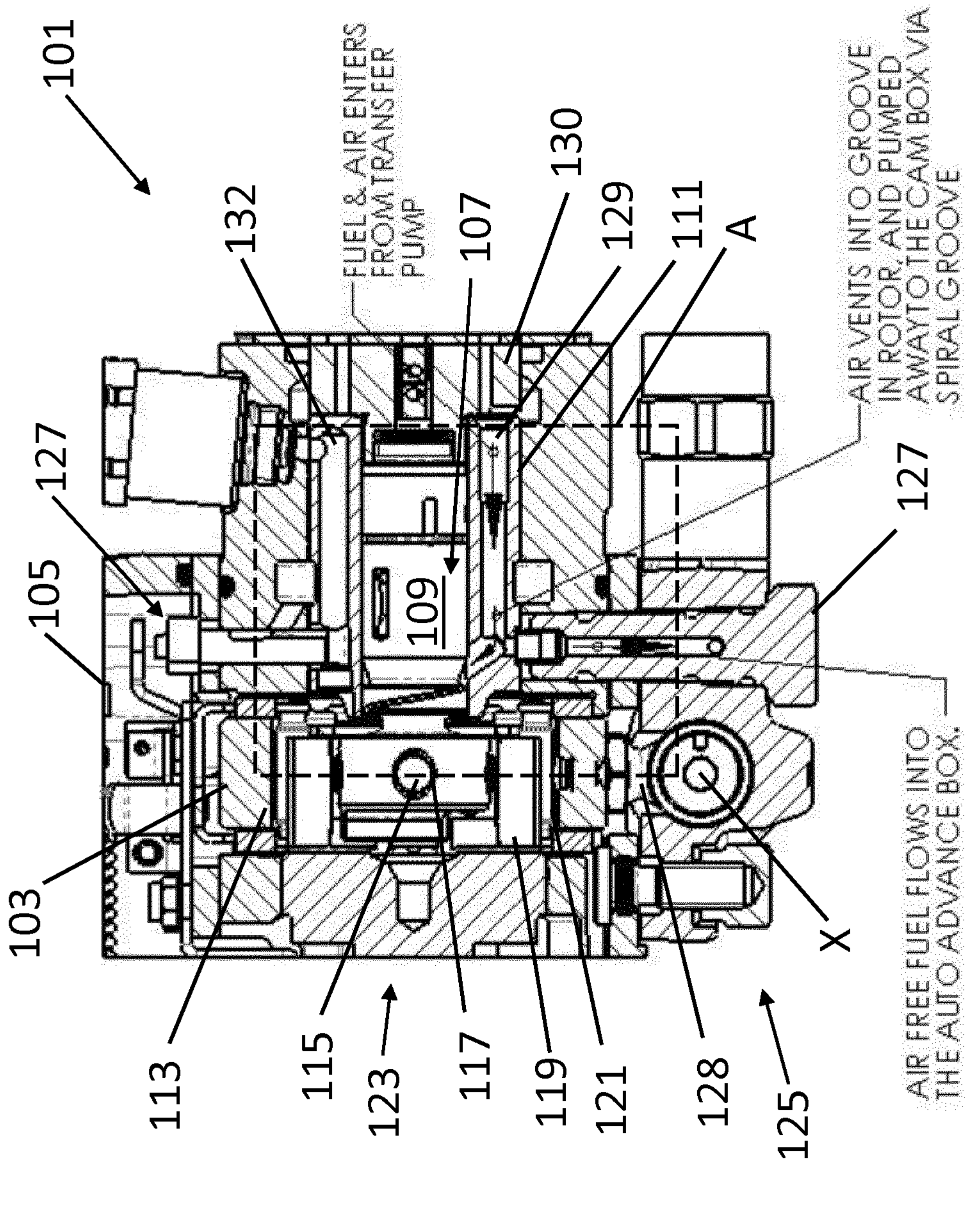
101
132
FUEL & AIR ENTERS FROMTRANSFER PUMP
107
130
129
111
A
127
105
109
AIR VENTS INTO GROOVE IN ROTOR, AND PUMPED AWAYTO THE CAM BOX VIA SPIRAL GROOVE
127
103
113
115
123
117
119
121
128
125
X
AIR FREE FUEL FLOWS INTO THE AUTO ADVANCE BOX.

FIG. 2

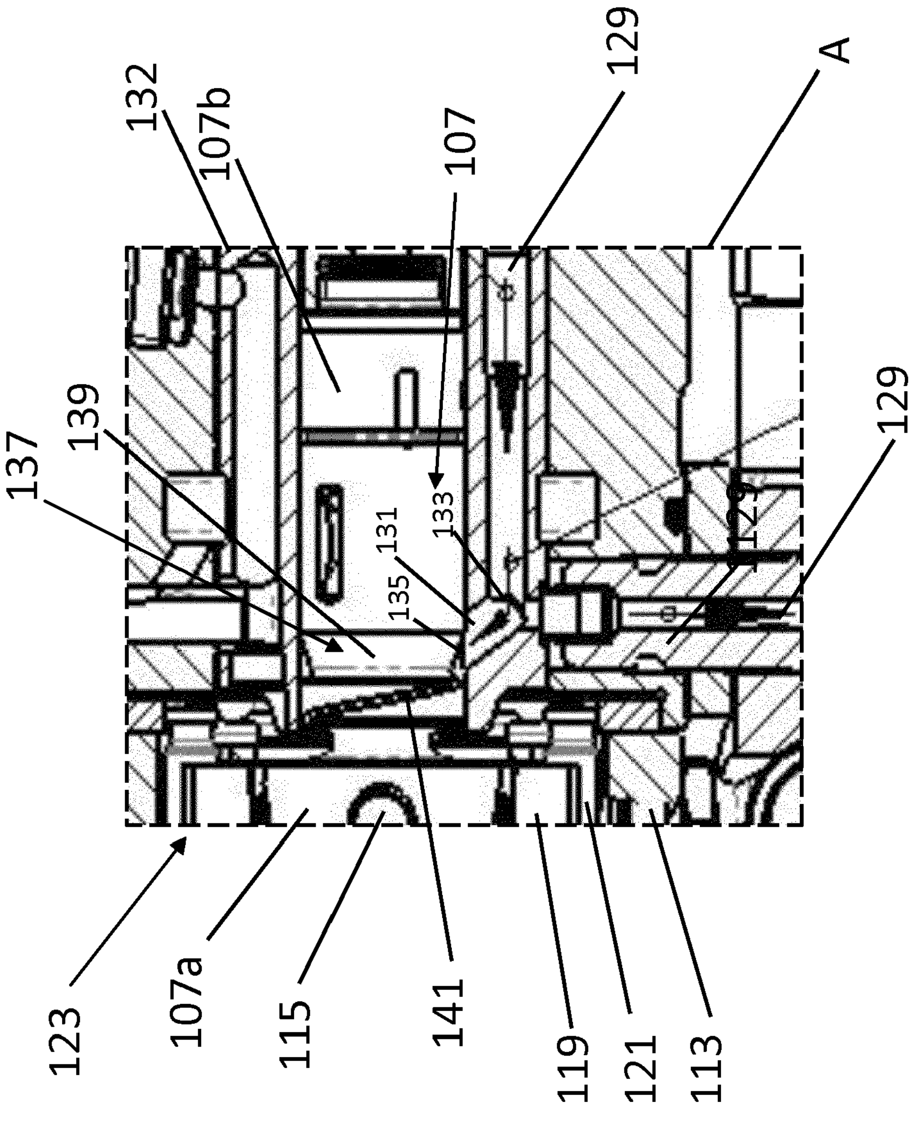
132
107b
107
129
A
139
137
131
133
135
129
123
107a
115
141
119
121
113

FIG. 3

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 12 16 6297

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	GB 1 109 020 A (ROOSA VERNON D) 10 April 1968 (1968-04-10) * page 2, lines 74-110 * * page 3, lines 24-115 * * figures *	1-15	INV. F02M41/14 F02D1/18
X	US 4 381 182 A (BROADWITH BRIAN E [GB]) 26 April 1983 (1983-04-26)	15	
A	* figure 1 *	3,4,7,8	
X	EP 0 303 237 A2 (NIPPON DENSO CO [JP]) 15 February 1989 (1989-02-15)	15	
A	* column 8, line 18 - column 9, line 5; figures 1,2 *	1,12	
X	EP 0 039 304 A1 (STANADYNE INC [US]) 4 November 1981 (1981-11-04)	15	
A	* page 6, lines 8-20; figures 1,2 *	1,12	
X	US 3 486 492 A (LEHNERER GEORGE J) 30 December 1969 (1969-12-30)	15	
A	* column 2, lines 61-69; figures *	1,12	
A	EP 0 859 137 A1 (LUCAS IND PLC [GB] DELPHI TECH INC [US]) 19 August 1998 (1998-08-19) * column 2, lines 40-55; figure *	1,12	

TECHNICAL FIELDS SEARCHED (IPC)

F02M
F02D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	12 October 2012	Landriscina, V

2

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)

Europäisches Patentamt
European Patent Office
Office européen des brevets

Application Number
EP 12 16 6297

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing claims for which payment was due.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☐ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☒ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☐ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

☐ The present supplementary European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims (Rule 164 (1) EPC).

Europäisches Patentamt
European Patent Office
Office européen des brevets

LACK OF UNITY OF INVENTION
SHEET B

Application Number
EP 12 16 6297

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1-11

   Rotary fuel pump according to claim 1
   ---

2. claims: 12-14

   Advance arrangement according to claim 12 for controlling timing of fuel delivery by a fuel pump
   ---

3. claim: 15

   Rotor for a rotary fuel pump according to claim 15

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 12 16 6297

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.

12-10-2012

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
GB 1109020	A	10-04-1968	DE	1526737	B1	04-02-1971
			GB	1109020	A	10-04-1968
			SE	331391	B	21-12-1970
US 4381182	A	26-04-1983	DE	3026896	A1	12-02-1981
			FR	2462570	A1	13-02-1981
			IT	1132265	B	02-07-1986
			JP	1046710	B	11-10-1989
			JP	1572399	C	25-07-1990
			JP	56020756	A	26-02-1981
			US	4381182	A	26-04-1983
EP 0303237	A2	15-02-1989	DE	3877083	D1	11-02-1993
			DE	3877083	T2	06-05-1993
			EP	0303237	A2	15-02-1989
			US	4915592	A	10-04-1990
EP 0039304	A1	04-11-1981	AR	222947	A1	30-06-1981
			AU	540171	B2	08-11-1984
			AU	6836281	A	05-11-1981
			BR	8102153	A	12-01-1982
			CA	1158117	A1	06-12-1983
			DE	3165640	D1	27-09-1984
			EP	0039304	A1	04-11-1981
			ES	8300934	A1	01-02-1983
			IN	152947	A1	05-05-1984
			JP	1622865	C	25-10-1991
			JP	2045012	B	08-10-1990
			JP	57000332	A	05-01-1982
			US	4453522	A	12-06-1984
US 3486492	A	30-12-1969	NONE			
EP 0859137	A1	19-08-1998	DE	69812749	D1	08-05-2003
			DE	69812749	T2	24-12-2003
			EP	0859137	A1	19-08-1998
			ES	2196485	T3	16-12-2003
			US	6183209	B1	06-02-2001

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

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 7350508 B **[0027]**