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

(11) **EP 3 032 091 A1**

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
15.06.2016 Bulletin 2016/24

(21) Application number: **14196725.7**

(22) Date of filing: **08.12.2014**

(51) Int Cl.:
F02M 69/54 *(2006.01)* ***F02M 55/00*** *(2006.01)*
F02M 55/04 *(2006.01)* ***F02M 57/02*** *(2006.01)*
F02M 59/02 *(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

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(54) Fuel injection arrangement

(57) The fuel injection arrangement for a piston engine comprises a number of fuel injection pumps (1), each fuel injection pump (1) being configured to inject liquid fuel into a cylinder of the engine, at least one feed pump (2) for supplying fuel to the fuel injection pumps (1), fuel supply line (3) connecting the fuel injection pumps (1) to the feed pump (2), a return line (4) for receiving excess fuel from the fuel injection pumps (1), and pressure regulating means (8) arranged in the return line (4). The arrangement is provided with a bypass line (5) allowing outflow from the fuel supply line (3) and/or the return line (4) for reducing pressure pulsations.

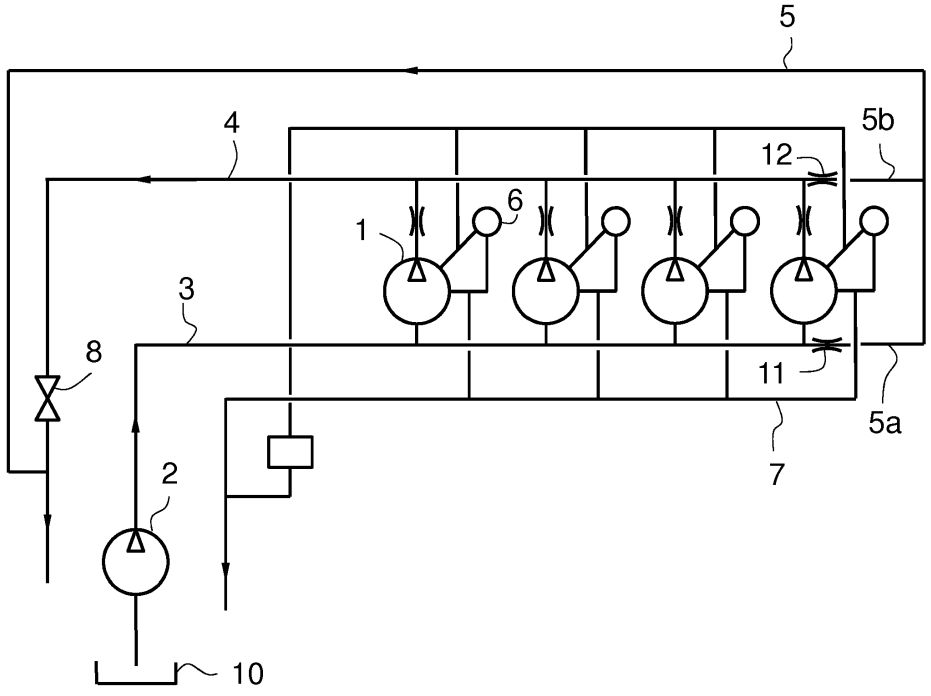

FIG. 1

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Description

Fuel injection arrangement

[0001] The present invention relates to a fuel injection arrangement for a piston engine in accordance with the preamble of claim 1.

Background of the invention

[0002] The fuel injection systems of compression ignition piston engines can be divided into common rail systems and systems that comprise a separate fuel injection pump for each cylinder of the engine. In common rail systems, fuel pressurized by a high-pressure pump is supplied into a storage, from which it can be fed to several cylinders of the engine. The amount of the injected fuel and the fuel injection timing is controlled by the fuel injectors, which are usually electrically controlled. In fuel injection systems with individual fuel injection pumps, each cylinder of the engine is provided with an own fuel injection pump, which also controls the amount of the fuel to be injected and the fuel injection timing. The fuel injectors are opened by the pressure of the fuel. A feed pump supplies fuel to the fuel injection pumps. In the systems with individual fuel injection pumps, which are commonly called as jerk pumps, pressure peaks occur in the low pressure part of the fuel injection system, i.e. in the fuel supply line and in the return line that collects clean excess fuel from the fuel injection pumps.

[0003] Pressure peaks can be lowered by using large diameter pipes, but this is not always sufficient and often leads to a need to provide the pipes with pulsation dampers. Often several different pulsation dampers need to be used. This increases the costs and the need for service.

Summary of the invention

[0004] The object of the present invention is to provide an improved fuel injection arrangement for a piston engine. The fuel injection arrangement comprises a number of fuel injection pumps, each fuel injection pump being configured to inject liquid fuel into a cylinder of the engine, at least one feed pump for supplying fuel to the fuel injection pumps, a fuel supply line connecting the fuel injection pumps to the feed pump, a return line for receiving excess fuel from the fuel injection pumps and pressure regulating means arranged in the return line. The characterizing features of the fuel injection arrangement according to the invention are given in the characterizing part of claim 1.

[0005] According to the invention, the fuel injection arrangement is provided with a by-pass line allowing outflow from the fuel supply line and/or the return line for reducing pressure pulsations.

[0006] The arrangement according to the invention effectively reduces pulsations in the fuel injection system. The reliability of the engine and the lifetime of the components can thus be increased. The need for expensive pulsation dampers can be avoided and manufacturing costs can thus be reduced.

[0007] According to an embodiment of the invention, the arrangement comprises means for restricting flow into the by-pass line. The means for restricting flow into the by-pass line can comprise an orifice having a smaller diameter than the by-pass line. According to an embodiment of the invention, the diameter of the orifice is 5 to 30 percent of the inner diameter of the by-pass line.

[0008] According to an embodiment of the invention, a first end of the by-pass line is connected to the fuel supply line. According to another embodiment of the invention, a first end of the by-pass line is connected to the return line on the upstream side of the pressure regulating means. A second end of the by-pass line can be connected to the return line on the downstream side of the pressure regulating means or to a pressureless tank.

[0009] According to an embodiment of the invention, the inner diameter of the by-pass line is 20 to 60 percent of the inner diameter of the return line.

[0010] The pressure regulating means can be a pressure regulating valve.

Brief description of the drawings

[0011] Embodiments of the invention are described below in more detail with reference to the accompanying drawing, which shows a fuel injection arrangement according to an embodiment of the invention.

Description of embodiments of the invention

[0012] In figure 1 is shown schematically a fuel injection system of a piston engine. The engine is a large internal combustion engine, such as a main or an auxiliary engine of a ship or an engine that is used at a power plant for producing electricity. In the embodiment of figure 1, the fuel injection system is configured for a four-cylinder engine, but the invention is applicable to engines with any number of cylinders. In the embodiment of the figure, the cylinders are arranged in line, but the invention is also suitable for V-engines and other cylinder configurations. The fuel injection system of figure 1 is configured to inject liquid fuel directly into the cylinders of the engine. The fuel can be, for instance, light fuel oil (LFO), heavy fuel oil (HFO), marine gas oil (MGO), crude oil or marine diesel oil (MDO). The engine can be provided with additional fuel injection systems, such as a gas injection system for introducing gaseous fuel into the engine and a pilot fuel injection system for introducing liquid pilot fuel into the cylinders when the engine is operated using a gaseous main fuel.

[0013] The fuel injection system of figure 1 comprises a number of fuel injection pumps 1. One fuel injection pump 1 is provided for each cylinder of the engine. The fuel injection pumps 1 are conventional fuel injection

pumps, which are preferably cam-operated. The fuel injection pumps 1 can also be called as jerk pumps. Each fuel injection pump 1 is connected to a fuel injector 6, which is arranged to inject fuel directly into a cylinder of the engine. Each fuel injector 6 is provided with an injector needle, which is opened by the pressure produced by the fuel injection pump 1. As opposed to a common rail system, the fuel injectors 6 are thus not electrically controlled, but the fuel injection timing and the amount of the injected fuel is determined by the fuel injection pumps 1. The injection pressure is typically 1000 to 1800 bar.

[0014] The fuel injection system is provided with a feed pump 2 for supplying fuel from a tank 10 to the fuel injection pumps 1. The feed pump 2 is a low-pressure pump that raises the pressure of the fuel to the range of 5 to 15 bar. A fuel supply line 3 connects the feed pump 2 to the inlets of the fuel injection pumps 1. During each cycle of a fuel injection pump 1, the fuel injection pump 1 takes in substantially the same amount of fuel. However, the amount of the fuel that is supplied to the fuel injector 6 depends on the load of the engine. The fuel injection system is provided with a return line 4 for receiving the excess fuel that is not supplied to the fuel injector 6. In the embodiment of figure 1, all the cylinders are connected to the same return line 4. However, more than one return lines 4 could be provided, for instance in a V-engine a separate return line 4 could be arranged for each bank of the engine. Via the return line 4, the excess fuel can be returned to the tank 10. The return line 4 comprises pressure regulating means 8. In the embodiment of the figure, the pressure regulating means is a pressure regulating valve 8. The pressure regulating valve 8 is a normally closed valve, which is arranged to open when a certain threshold pressure is exceeded. The opening pressure of the pressure regulating valve 8 can be adjusted. Typically, the nominal pressure in the return line 4 is kept in the range of 6 to 12 bar. With that nominal pressure, the actual pressure in the return line 4 typically varies in the range of 2 to 20 bar. Instead of the pressure regulating valve 8, a throttling device could be arranged in the return line 4 to regulate the pressure.

[0015] The fuel injection system is further provided with a leakage line 7. The leakage line 7 collects clean fuel leakage from the fuel injectors 6 and the fuel injection pumps 1. The clean leakage is caused by the clearances of the fuel injection pumps 1 and the fuel injectors 6 during normal operation of the engine. The clean fuel leakage can be returned to the tank 10. The engine is also provided with a separate leakage line for dirty fuel (not shown). Via the leakage line for dirty fuel, the fuel that is mixed with other substances can be collected to a separate tank.

[0016] For reducing pulsations in the low-pressure part of the fuel injection system, i.e. in the return line 4 and the fuel supply line 3, the fuel injection system is provided with a by-pass line 5. The by-pass line 5 is arranged to allow outflow from the fuel supply line 3 and/or from the return line 4. In the embodiment of the figure, the by-pass line 5 is configured to allow outflow from both the fuel supply line 3 and the return line 4. However, instead of connecting the by-pass line 5 to both lines 3, 4, the by-pass line 5 could be connected only to the fuel supply line 3 or to the return line 4. It is also possible to provide each of the fuel supply line 3 and the return line 4 with an own by-pass line 5. The fuel injection system would thus comprise two by-pass lines 5. By connecting both the fuel supply line 3 and the return line 4 to a by-pass line 5, pulsations in the low-pressure lines 3, 4 of the fuel injection system can be more effectively reduced. On the other hand, if only the return line 4 is connected to a by-pass line 5, sufficient cooling and filling of the fuel injection pumps 1 is better guaranteed.

[0017] The by-pass line 5 is a pipe having a smaller diameter than the fuel supply line 3 and the return line 4. Suitable inner diameter for the by-pass line 5 is 20 to 60 percent of the inner diameter of the return line 4.

[0018] The by-pass line 5 has a first end and a second end. The first end of the by-pass line 5 is divided into a first branch 5a and a second branch 5b. The first branch 5a of the by-pass line 5 is connected to the fuel supply line 3 and the second branch 5b is connected to the return line 4. The point where the second branch 5b of the by-pass line 5 is connected to the return line 4 is located upstream from the pressure regulating valve 8. The second end of the by-pass line 5 is connected to the return line 4 on the downstream side of the pressure regulating valve 8. Instead of connecting the second end of the by-pass line 5 to the return line 4, the second end of the by-pass line 5 could be connected to a mixing tank.

[0019] The fuel injection system comprises means for restricting flow into the by-pass line 5. In the embodiment of the figure, the flow restricting means comprise orifices 11, 12 that are arranged between the fuel supply line 3 and the by-pass line 5 and between the return line 4 and the by-pass line 5. The orifices 11, 12 are openings between the fuel supply line 3 and the by-pass line 5 and between the return line 4 and the by-pass line 5 having a substantially smaller diameter than the by-pass line 5. A suitable diameter for the orifices is 5 to 30 percent of the inner diameter of the by-pass line 5. The orifices 11, 12 restrict the outflow from the fuel supply line 3 and/or the return line 4 to the by-pass line 5.

[0020] It will be appreciated by a person skilled in the art that the invention is not limited to the embodiments described above, but may vary within the scope of the appended claims.

Claims

1. A fuel injection arrangement for a piston engine, the arrangement comprising

   - a number of fuel injection pumps (1), each fuel injection pump (1) being configured to inject liquid fuel into a cylinder of the engine,

- at least one feed pump (2) for supplying fuel to the fuel injection pumps (1),
- a fuel supply line (3) connecting the fuel injection pumps (1) to the feed pump (2),
- a return line (4) for receiving excess fuel from the fuel injection pumps (1), and
- pressure regulating means (8) arranged in the return line (4),

characterized in that the fuel injection arrangement is provided with a by-pass line (5) allowing outflow from the fuel supply line (3) and/or the return line (4) for reducing pressure pulsations.

2. An arrangement according to claim 1, wherein the arrangement comprises means (11, 12) for restricting flow into the by-pass line (5).

3. An arrangement according to claim 2, wherein the means (11, 12) for restricting flow into the by-pass line (5) comprise an orifice having a smaller diameter than the by-pass line (5).

4. An arrangement according to claim 3, wherein the diameter of the orifice is 5 to 30 percent of the inner diameter of the by-pass line (5).

5. An arrangement according to any of the preceding claims, wherein a first end of the by-pass line (5) is connected to the fuel supply line (3).

6. An arrangement according to any of the preceding claims, wherein a first end of the by-pass line (5) is connected to the return line (4) on the upstream side of the pressure regulating means (8).

7. An arrangement according to any of the preceding claims, wherein a second end of the by-pass line (5) is connected to the return line (4) on the downstream side of the pressure regulating means (8).

8. An arrangement according to any of claims 1 to 6, wherein a second end of the by-pass line (5) is connected to a pressureless tank.

9. An arrangement according to any of the preceding claims, wherein the inner diameter of the by-pass line (5) is 20 to 60 percent of the inner diameter of the return line (4).

10. An arrangement according to any of the preceding claims, wherein the pressure regulating means (8) is a pressure regulating valve.

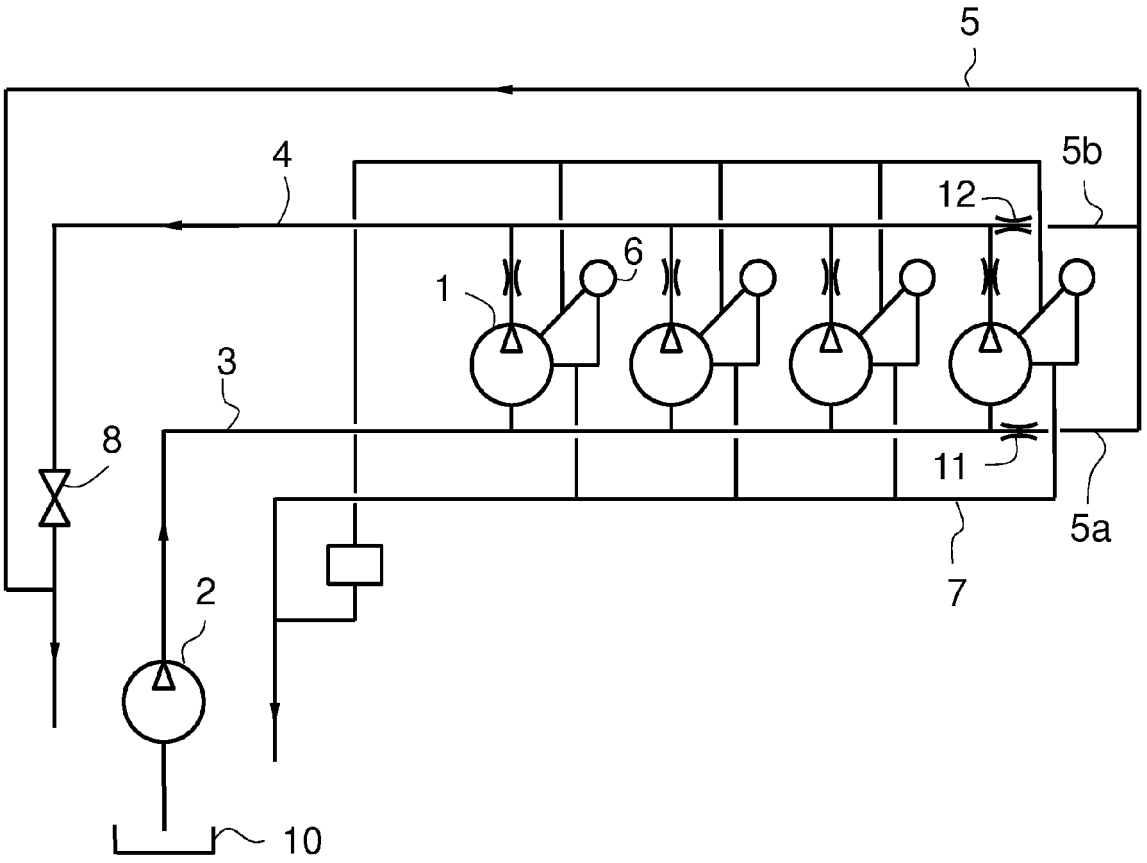

FIG. 1

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EUROPEAN SEARCH REPORT

Application Number
EP 14 19 6725

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	WO 2012/175800 A2 (WAERTSILAE FINLAND OY [FI]; CAPUTO GENNARO [IT]; SCROCCO PIETRO [IT]) 27 December 2012 (2012-12-27) * abstract; figure * -----	1-5,7,8, 10	INV. F02M69/54 F02M55/00 F02M55/04 F02M57/02
A	WO 03/093668 A1 (DELPHI TECH INC [US]; HARCOMBE ANTHONY T [GB]; PANESAR LUKHBIR S [GB];) 13 November 2003 (2003-11-13) * abstract; figures * -----	1	F02M59/02

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
Munich	15 May 2015	Godrie, Pierre

CATEGORY OF CITED DOCUMENTS

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EPO FORM 1503 03.82 (P04C01)

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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