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(54) **FUEL SUPPLY SYSTEM**

KRAFTSTOFFZUFUHRSYSTEM

SYSTEME D'ALIMENTATION EN CARBURANT

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## Description

**[0001]** The present invention relates to a fuel supply system in accordance with the preamble of claim 1 comprising at least a fuel source and a high-pressure pump in flow communication therewith for raising the fuel pressure up to an increased pressure, at least two fuel injectors arranged in conjunction with engine cylinders, each of which injectors is in flow communication with the high-pressure pump, and where an individual pressure accumulator unit is connected to each fuel injector, respectively.

**[0002]** For improving the operation of piston engines a so-called common rail fuel supply system is commonly used, where the pressure supply and the injection control are separated from each other. Thus, a more precise fuel injection has been achieved as to its timing and volume for instance. In large engines, which have e.g. more than six cylinders in a row, an elongated pressure accumulator unit causes, among other things, vibration problems in the fuel pressure.

**[0003]** EP 968367 B1 discloses a fuel injection arrangement, where a large uniform space is divided into high-pressure lines leading to their respective injectors, where a pressure accumulator is provided. Even if this kind of an arrangement as such would decrease the pressure vibration in the fuel, it is not applicable in large engines using high-viscous fuel. When the engine is not running, fuel is stored in each separate accumulator and when chilled, the fuel becomes stiff and does not flow freely enough for providing a troublefree running of the engine, when it is restarted.

**[0004]** Document EP 0 959 245 A2 shows a fuel supply system according to the preamble of claim 1. The intermediate document EP 1 314 883 A2 shows a fuel supply system with an intermediate pressure accumulator to which several high pressure pumps are connected.

**[0005]** An object of the present invention is therefore to provide a fuel supply system, where the problems related to the prior art are minimized.

**[0006]** The aims of the invention are achieved as is described in claim 1.

**[0007]** The fuel supply system in accordance with the invention comprises at least a fuel source and a high-pressure pump in flow communication therewith for raising the fuel pressure up to an increased pressure and at least two fuel injectors arranged in conjunction with engine cylinders, each of which injectors is in flow communication with the high-pressure pump via a pressure accumulator unit. At least one pressure accumulator unit is in connection with both the fuel injector and at least one other pressure accumulator unit for fuel.

**[0008]** Each of the latter pressure accumulator units for fuel in the flow direction of the fuel is in flow communication with the pressure-increasing pump only via the former pressure accumulator unit in the flow direction of the fuel. In the flow direction of the fuel the last pressure accumulator unit for fuel is in controllable flow commu-

nication with the fuel source via a separate return channel or the like, and provided with a valve. Preferably, the fuel supply system comprises a plurality of pressure accumulator units, each of which is connected to its respective fuel injector and to the next pressure accumulator unit in the flow direction of the fuel, except for the last one.

**[0009]** The pressure-increasing pump is substantially in direct flow communication with only one pressure accumulator unit and each of the other pressure accumulator units is connected to the pressure accumulator unit preceding it in the flow direction of the fuel. Thus, an interconnection enabling efficient fuel circulation and simultaneously preventing efficiently the development of pressure vibrations is provided.

**[0010]** The fuel supply system comprises at least a third pressure accumulator unit after the pressure-increasing pump, through which accumulator unit all the fuel to be supplied is arranged to pass.

**[0011]** By the invention it is possible to arrange the fuel circulation so that in the flow circuit only very short ducts connecting the pressure accumulator units and the injectors will remain outside the circuit. Thus, most of the fuel may be circulated by the fuel supply system e.g. for preheating the fuel before the engine start. By using the arrangement an efficient and quick-operated injection is provided by the adjacent location of the pressure accumulator units and injectors, and further, this may be combined with the efficient fuel circulation brought about by the interconnection. Thus, a highly applicable and advantageous arrangement is provided by this solution, especially for fuels with high viscosity. In addition, an equal injection rate to each cylinder is achieved, as the size of the pressure accumulator unit for each individual injection valve may be dimensioned optimally. When this kind of an arrangement is used, also the pressure vibrations are very small.

**[0012]** In the following the invention is described by way of example with reference to the attached drawings, in which

Fig. 1 shows schematically an embodiment of the invention, and

Fig. 2 shows schematically another embodiment of the invention.

**[0013]** Fig. 1 is a highly schematic illustration and it only shows the necessary elements for describing the basic idea of the present invention. The reference number 1 refers to the cylinders of the application of the invention, i.e. of a piston engine. Here, the number of cylinders is four, but it is evident that the number of cylinders may vary, and it is also evident that for instance in so-called V-engines there are two cylinder rows next to each other. A fuel injector 2 is arranged in conjunction with each cylinder 1. The supply system comprises a fuel source 3, such as a fuel tank, from which fuel is pumped through a fuel pipe 4 with the aid of a high-pressure pump 5 further on in the system to a pressure, which is higher

than the pressure of the fuel source. The high-pressure pump 5 is via a fuel pipe 8 connected to a pressure accumulator unit 6, through which all the fuel to be supplied passes. The pressure accumulator unit 6 is provided with a connection to the pressure accumulator unit 7.1 of the first injector 2.1 in the flow direction of the fuel. The fuel passes to all injectors 2.1 - 2.N also through this pressure accumulator unit 7.1. Each injector 2.1 - 2.N is provided with its respective pressure accumulator unit 7.1 - 7.N connected by a relatively short duct 9.1 - 9.N. Thus the number of injectors and pressure accumulator units varies depending on the engine, but in any case the pressure accumulator unit connected to the injector is in connection with both the fuel injector and another pressure accumulator unit for fuel in the flow direction of the fuel, except for the last pressure accumulator unit, whereby the pressure accumulator units 7.1 - 7.N are located in the branch point of a section of the fuel supply duct 8 and a section of the fuel duct 8 taking fuel to the next pressure accumulator unit, except for the last pressure accumulator unit 7.N, and the fuel duct 9.1 - 9.N taking fuel to the injector 2.1 - 2.N. A duct 9 from the last pressure accumulator unit 7.N leading back to the fuel source 3 is provided. The duct 9 is provided with a valve 10, by which the quantity of fuel circulating through the system may be adjusted. In V-engine application two rows would be connected to the pressure accumulator 6.

**[0014]** When the engine is started after a longer shutdown period the high-pressure pump 5 is started and valve 10 is opened and the fuel starts flowing. Alternatively the fuel may be circulated by a fuel transfer pump, not shown here. While circulating through each accumulator unit 6, 7.1, 7.N and duct 9 back to the tank 3 fuel heats up and it will run fluently enough for trouble-free operation of the engine.

**[0015]** In Figure 2 there is shown an embodiment which is otherwise corresponding to embodiment of Figure 1 but where several fuel injectors 2.1, 2.2, 2.3; 2.4, 2.5, 2.N are connected to one pressure accumulator 7.1; 7.N. This may be advantageous e.g. in smaller engines where the fuel ducts 9.1 - 9.N taking fuel to the injectors 2.1 - 2.N may still be substantially short.

**[0016]** The invention is not limited to the above-described applications, but several other modifications are conceivable in the scope of the appended claim.

### Claims

1. A fuel supply system comprising at least a fuel source (3) and a high-pressure pump (5) in flow communication therewith for raising the fuel pressure up to an increased pressure, at least two fuel injectors (2.1-2.N) arranged in conjunction with engine cylinders (1), each of which injectors (2.1- 2.N) is in flow communication with the high-pressure pump (5), via a plurality of pressure accumulator units (7.1-7.1) whereby

each of the plurality of pressure accumulator units (7.1- 7.N) is connected to its respective fuel injector, the pressure-increasing pump (5) is substantially in direct flow communication with only one pressure accumulator unit (7.1.),

each of the latter pressure accumulator units (7.2) in the flow direction of the fuel is in flow communication with the pressure-increasing pump (5) only via the former pressure accumulator unit (7.1) in the flow direction of the fuel, and

the last pressure accumulator unit (7.N) for fuel in the flow direction of the fuel is in controllable flow communication (9, 10) with the fuel source (3), **characterized in that**

it comprises at least a further pressure accumulator unit (6) after the pressure-increasing pump (5), through which unit all the fuel to be supplied is arranged to pass, whereby all the fuel is fed to the further pressure accumulator unit (6) via one duct (8).

### Patentansprüche

1. Kraftstoffzufuhrsystem, das mindestens eine Kraftstoffquelle (3) und eine sich in Fließverbindung damit befindliche Hochdruckpumpe (5) für das Anheben des Kraftstoffdrucks auf einen erhöhten Druck, und mindestens zwei Kraftstoffeinspritzvorrichtungen (2.1 - 2.N), die in Verbindung mit Maschinenzylindern (1) angeordnet sind, umfasst, wobei sich jede der Einspritzvorrichtungen (2.1 - 2.N) über eine Vielzahl von Drucksammeleinheiten (7.1 - 7.N) in Fließverbindung mit der Hochdruckpumpe (5) befindet, wobei jede aus der Vielzahl der Drucksammeleinheiten (7.1 - 7.N) mit ihrer jeweiligen Kraftstoffeinspritzvorrichtung oder ihren jeweiligen Kraftstoffeinspritzvorrichtungen (2.1 - 2.N) verbunden ist, sich die Druckerhöhungspumpe (5) im wesentlichen in direkter Fließverbindung mit nur einer Drucksammeleinheit (7.1) befindet, sich jede der letzteren Drucksammeleinheiten (7.2) in der Fließrichtung des Kraftstoffs in Fließverbindung mit der Druckerhöhungspumpe (5) nur über die vorherige Drucksammeleinheit (7.1) in der Fließrichtung des Kraftstoffs befindet, und sich die letzte Drucksammeleinheit (7.N) für den Kraftstoff in der Fließrichtung des Kraftstoffs in steuerbarer Fließverbindung (9, 10) mit der Kraftstoffquelle (3) befindet,

**dadurch gekennzeichnet, dass** es mindestens eine weitere Drucksammeleinheit (6) nach der Druckerhöhungspumpe (5) umfasst, durch welche Einheit der ganze zu liefernde Kraftstoff hindurch strömt, wobei der gesamte Kraftstoff zur weiteren Drucksammeleinheit (6) über einen einzelnen Kanal (8) geführt wird.

**Revendications**

1. Système d'alimentation en carburant comprenant au moins une source de carburant (3) et une pompe à haute pression (5) en communication fluide avec celle-ci pour augmenter la pression du carburant jusqu'à une pression accrue, au moins deux injecteurs de carburant (2.1 - 2.N) agencés en conjugaison avec les cylindres (1) du moteur, chacun des injecteurs (2.1 - 2.N) étant en communication fluide avec la pompe à haute pression (5), via une pluralité d'unités d'accumulation de pression (7.1 - 7.N), chacune de la pluralité d'unités d'accumulation de pression (7.1 - 7.N) étant reliée à son injecteur de carburant respectif, la pompe d'augmentation de pression (5) étant sensiblement en communication fluide directe avec une seule unité d'accumulation de pression (7.1), chacune des dernières unités d'accumulation de pression (7.2) dans le sens d'écoulement du carburant étant en communication fluide avec la pompe d'augmentation de pression (5) uniquement via l'unité d'accumulation de pression (7.1) précédente dans le sens d'écoulement du carburant, et la dernière unité d'accumulation de pression (7.N) pour le carburant dans le sens d'écoulement du carburant étant en communication fluide contrôlable (9, 10) avec la source de carburant (3),
- caractérisé par le fait qu'il** comprend au moins une autre unité d'accumulation de pression (6) en aval de la pompe d'augmentation de pression (5), à travers laquelle doit passer l'ensemble du carburant d'alimentation, l'ensemble du carburant d'alimentation étant introduit à l'autre unité d'accumulation de pression (6) par l'intermédiaire d'un conduit (8).

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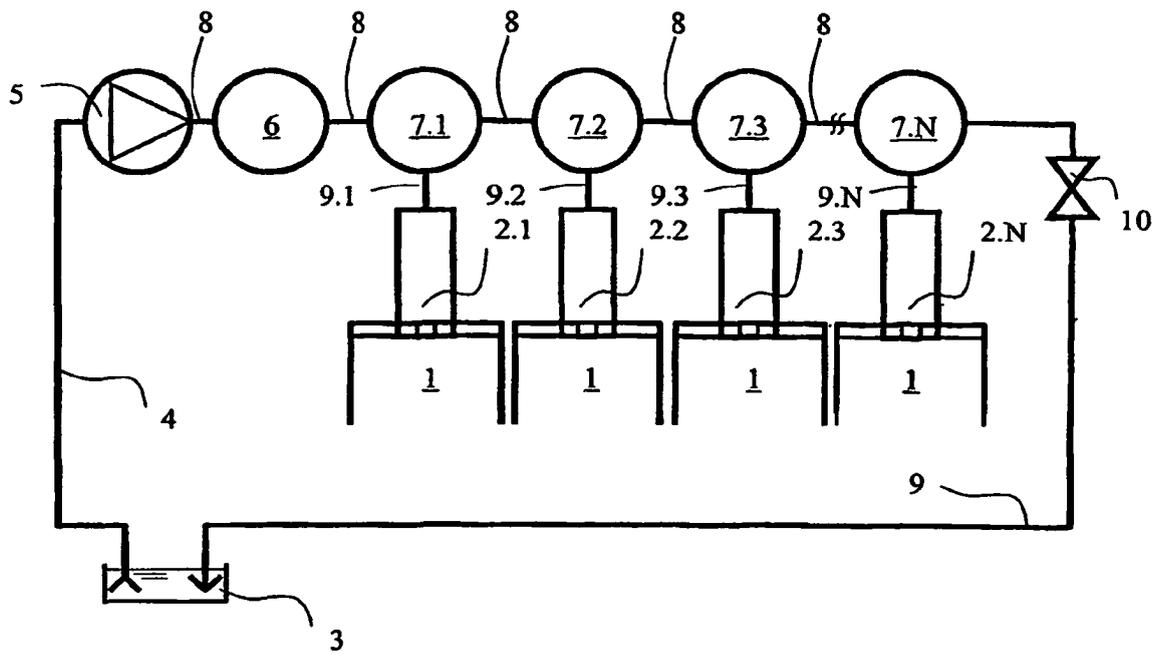


Fig. 1

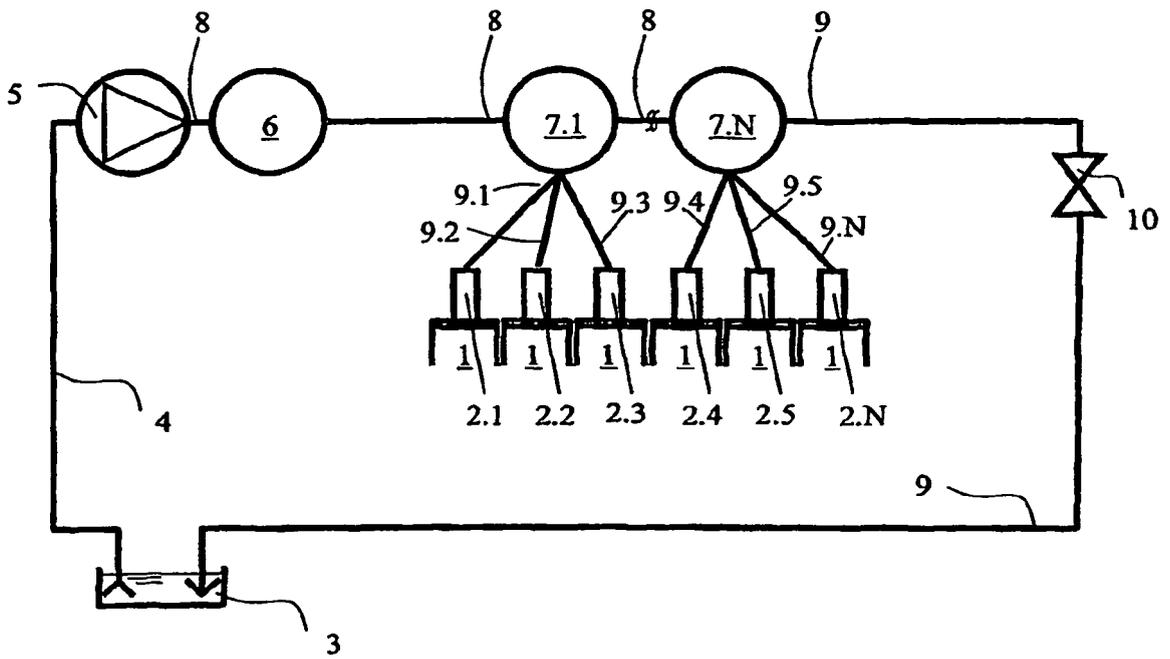


Fig. 2

**REFERENCES CITED IN THE DESCRIPTION**

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- EP 1314883 A2 [0004]