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(11) **EP 1 377 746 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention
of the grant of the patent:
20.12.2006 Bulletin 2006/51

(21) Application number: **02712990.7**

(22) Date of filing: **04.04.2002**

(51) Int Cl.:
F02M 61/10 ^(2006.01) **F02M 61/16** ^(2006.01)

(86) International application number:
PCT/FI2002/000289

(87) International publication number:
WO 2002/084108 (24.10.2002 Gazette 2002/43)

(54) **FUEL INJECTOR AND METHOD OF INJECTING FUEL**

KRAFTSTOFFEINSPRITZVENTIL UND VERFAHREN ZUM EINSPRITZEN VON KRAFTSTOFF
INJECTEUR DE CARBURANT ET PROCEDE D'INJECTION DE CARBURANT

(84) Designated Contracting States:
**AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU
MC NL PT SE TR**

(30) Priority: **10.04.2001 FI 20010742**

(43) Date of publication of application:
07.01.2004 Bulletin 2004/02

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Description

[0001] The present invention relates to a fuel injection valve in accordance with the preamble of claim 1 and a method for fuel injection in accordance with the preamble of claim 8.

[0002] In fuel injection so-called needle valves are commonly utilized referring to valves generally used in the art having an elongated and relatively thin valve body. Fuel feed systems especially based on the use of a common pressure supply have become more popular and for instance heavy oil can also be used as a fuel. Particularly in said fuel feed systems based on a common pressure supply it is very important to have a well-controlled injection process. In order to secure operational safety it is also essential to be able to control the start of the injection and the combustion process efficiently.

[0003] A common pressure supply system is disclosed in EP 959 245, in conjunction of which system the present invention can be applied with success and thereby the system disclosed herein improved. In this kind of a system there is always a high pressure prevailing in the common pressure supply, whereby a possible malfunction of the injection valve can cause fuel leakage into the cylinder.

[0004] The aim of the present invention is to provide a new fuel injection valve and a method for fuel injection. The aim of the present invention is especially to provide a new injection valve arrangement applied particularly in fuel feed systems based on the use of a common pressure supply of a piston engine, which arrangement is reliable and enables enhanced control and monitoring of the combustion process.

[0005] The aims of the invention are achieved principally as is described in more detail in claims 1 and 8 as well as in the other independent claims.

[0006] A fuel injection valve according to the invention comprises a needle valve assembly arranged in a valve body and having a valve needle arranged to control the fuel injection into the cylinder of an engine from a fuel chamber located in the valve body. The fuel injection valve comprises a pressure sensing chamber arranged in communication with the fuel chamber of the needle valve assembly. In addition, pressure measuring means are arranged in communication with the pressure sensing chamber.

[0007] The pressure sensing chamber is in conjunction with the fuel return conduit for conducting the discharged fuel away from the injection valve, whereby fuel is allowed to flow away from the pressure sensing chamber, according to need.

[0008] The pressure sensing chamber is arranged to interact with the fuel chamber via first pressure reducing means, whereby the pressure in the pressure sensing chamber can be reduced to a level optimum for measuring the pressure. Preferably the pressure measuring means are within the pressure sensing chamber so that only substantial pressure loss is caused by the first pres-

sure reducing means. Thus the pressure measuring means may be selected substantially based on circumstances provided by the first pressure reducing means in the pressure sensing chamber. Further, a check valve or similar is mounted between the pressure sensing chamber and the first pressure reducing means. Similarly, second pressure reducing means are mounted between the pressure sensing chamber and the fuel return conduit. The pressure reducing means generally comprise a bore, a nozzle, a flange or similar, of appropriate size. Especially the first pressure reducing means include a replaceable nozzle element or similar, where an orifice of appropriate size is arranged for providing a desired pressure loss.

[0009] By the arrangement according to the invention the starting and ending moment of the injection can be monitored. The arrangement according to the invention is especially applicable to an injection arrangement utilizing a so called common rail pressure supply, whereby possible fuel leaks from the common rail pressure supply into the injection valve can be monitored by means of the invention. With the present invention it is possible to avoid dimensioning the pressure measuring means for excessively high pressures due to the utilization of the pressure reducing means between the fuel chamber and the pressure sensing chamber. This way the sensitivity of the arrangement remains high enough.

[0010] In the following the invention is described by way of example with reference to the accompanying drawings, in which

Fig. 1 shows schematically a needle valve assembly according to the invention; and

Fig. 2 shows schematically a detail of the needle valve assembly according to the invention.

[0011] In the figure the reference number 1 indicates a valve body containing a needle valve assembly 2. The valve body consists of two parts, and the lower part abutting a cylinder 11 of an engine comprises a fuel chamber 5, from where the fuel is injected into the cylinder 11. The valve needle 2' of the needle valve assembly is arranged in connection with the fuel chamber 5. The fuel chamber 5 is via a duct 3 connected to a fuel supply 4 preferably being a common rail pressure supply. Based on its position the valve needle guides the fuel injection from the fuel chamber 5 into the engine cylinder 11. The valve needle assembly can include a solution known per se, operating in a known manner, and thereby the structure, operation or the control thereof is not disclosed herein.

[0012] According to the invention a pressure sensing chamber 6 is arranged in the valve body 1 and a pressure measuring device 7 is mounted in conjunction therewith. The pressure measuring device measures the pressure in the pressure sensing chamber 6 and sends the measuring data to further processing in the engine control system (not shown).

[0013] The pressure sensing chamber 6 is in connection with the fuel chamber 5 through an annular groove 5" and a duct 5'. The annular groove 5" can be uniform, i.e. open along its whole length around the longitudinal axis of the valve body, whereby the pressure sensing chamber 6 is in connection with the fuel chamber 5 through the duct 5', and with the duct 3 through the groove 5". The annular groove 5" can also be arranged to extend only partly around the longitudinal axis of the valve body, whereby the pressure sensing chamber 6 is in connection with the duct 3 through the fuel chamber 5. The annular groove is arranged between the upper and lower part of the valve body. In addition, the pressure sensing chamber 6 is connected to a fuel return conduit 8, through which the fuel discharged from the valve can flow out, e.g. back to the fuel tank (not shown). In the valve body 1, between the fuel chamber 5 and the pressure sensing chamber 6, are arranged first pressure reducing means 9, by means of which the pressure in the pressure sensing chamber 6 can be reduced to a substantially lower level than the pressure prevailing in the fuel chamber 5. This way the sensitivity of the pressure measurement may be maintained adequately high. In this case, the pressure reducing means 9 may be accurately dimensioned and its effect on the pressure drop may be accurately predicted. Also by using the pressure reducing means 9, it is possible to select the operation range of the pressure measuring device 7

[0014] Similarly, after the pressure sensing chamber 6 second pressure reducing means 9' are provided. By choosing the first 9 and the second pressure reducing means 9' correctly, i.e. by dimensioning their flow resistances adequately, the pressure level in the pressure sensing chamber 6 can be adjusted to a level creating optimum conditions for pressure measuring.

[0015] The pressure reducing means 9, 9" can include for instance a bore, a nozzle, a flange or similar of appropriate size, by which some pressure loss is brought about in the fuel flow. Appropriate throttling can be determined experimentally for each nozzle and/or engine type, i.e. in each case individually. The first pressure reducing means 9 preferably comprise a nozzle/flange element, which can be replaced according to the application. The second pressure reducing means 9' preferably comprise an orifice of appropriate size in a flow channel. The interaction between these provides an advantageous overall solution.

[0016] The valve body is preferably also provided with check valves 10, 10'. The first check valve 10 is mounted between the first pressure reducing means 9 and the pressure sensing chamber 6. The first check valve 10 prevents the fuel from flowing back to the fuel chamber 5. The second check valve 10' is mounted after the pressure sensing chamber 6, preferably after the second pressure reducing means 9'. The second check valve 10' also enables the monitoring of fuel leaks, since no fuel can flow from the return conduit 8 to the pressure sensing chamber 6.

[0017] In some cases the operation of the system according to the invention can be improved by means of a piston member 21 shown in fig. 2. This piston member comprises a first section 22 arranged to fit inside the first pressure reducing means 9, and a second section 23 whose cross section in the direction of its longitudinal axis is larger than the first section 22. Accordingly, the diameter of the piston member is different in various points along its longitudinal axis. The piston member 21 is arranged to move by the action of the fuel flow and the pressure variations between the positions, in which the first section 22 is located inside the pressure reducing means 9 or the first section 22 is situated outside the pressure reducing means 9, respectively. Thus the piston member 21 is arranged to operate like a check valve. The piston member can operate as an element replacing the check valve 10 and it can also contribute to the reduction of fuel pressure.

[0018] The method according to the invention operates in such a way that as the needle valve assembly is by the duct 3 connected to the fuel supply 4, preferably to a common rail pressure supply, the pressure in the fuel chamber 5 rises up to injection pressure. Hence, the fuel flows along the duct 5' to the annular groove 5" and further to the pressure sensing chamber 6 via the first pressure reducing means 9 and the check valve 10. From the pressure sensing chamber a small amount of fuel is allowed to flow through the second pressure reducing means 9' and the check valve 10' to the fuel return conduit 8. Due to this arrangement the pressure in the pressure sensing chamber 6 behaves in such a way that pressure monitoring can be performed with sufficient accuracy. By monitoring the pressure being on a lower level than the injection pressure it is possible to get information on the state of the valve assembly and its operation, on the basis of which information the combustion process of the engine can be controlled better than before and even the operation and performance thereof will thus improve.

[0019] The present arrangement enables accurate measuring of the pressure variations in the pressure sensing chamber 6, where a pressure substantially lower than that in the fuel chamber 5 prevails. The fuel injection valve according to the invention is preferably dimensioned so that the pressure in the pressure sensing chamber 6 rises when the valve is in operation typically to less than 50 bars, the maximum being though only some hundreds of bars, whereas the injection pressure in the fuel chamber 5 can be typically in the range of 1000 to 1500 bars.

[0020] The pressure measuring means 7 can also in some cases be a separate device being only operationally connected to the valve body. The invention can be applied to such arrangements, where the fuel pressure in the injection valve prevails between the injections, or to arrangements where the pressure is not maintained between the injections.

[0021] It is thus evident that the above-described technical solutions are only exemplary, whereby the invention

is not limited to the above application, but several other modifications are conceivable in the scope of the appended claims.

Claims

1. A fuel injection valve comprising a needle valve assembly (2) arranged in a valve body (1), where a valve needle (2') is arranged to control the fuel injection into a cylinder (11) of an engine from a fuel chamber (5) arranged in the valve body (1), **characterised in that** the injection valve comprises a pressure sensing chamber (6) arranged in communication with the fuel chamber (5), and that pressure measuring means (7) are arranged in communication with the pressure sensing chamber (6).
2. A fuel injection valve according to claim 1, **characterised in that** the pressure sensing chamber (6) is connected to a fuel return conduit (8) for conducting the discharged fuel away from the injection valve.
3. A fuel injection valve according to claim 1 or 2, **characterised in that** the pressure sensing chamber (6) is arranged in communication with the fuel chamber (5) via first pressure reducing means (9).
4. A fuel injection valve according to claim 3, **characterised in that** a check valve (10) is mounted between the pressure sensing chamber (6) and the first pressure reducing means (9).
5. A fuel injection valve according to claim 2, **characterised in that** second pressure reducing means (9') are mounted between the pressure sensing chamber (6) and the return conduit (8).
6. A fuel injection valve according to claim 5, **characterised in that** a second check valve (10') is mounted between the second pressure reducing means (9') and the fuel return conduit.
7. A fuel injection valve according to claim 3 or 5, **characterised in that** the pressure reducing means (9, 9') comprise a bore, a nozzle or a flange of suitable size.
8. A method for fuel injection, wherein fuel is conducted at raised pressure, controlled by a valve needle (2') arranged in a valve body (1) from a fuel chamber (5) to a cylinder (11) of an engine, **characterised in that** fuel is conducted from the fuel chamber (5) at raised pressure via pressure reducing means (9) arranged in the valve body to a pressure sensing chamber (6), where pressure measuring means (7) are arranged to monitor the operation of the injection valve.

9. A method according to claim 8, **characterised in that** the fuel pressure is reduced to at least a tenth part of the pressure prevailing in the fuel chamber (5) when the fuel is conducted via the pressure reducing means (9) to the pressure sensing chamber (6).
10. A method according to claim 8, **characterised in that** fuel is conducted from the pressure sensing chamber (6) to a fuel return conduit (8).

Patentansprüche

1. Kraftstoffeinspritzventil, das eine Nadelventilbaugruppe (2) aufweist, die in einem Ventilkörper (1) angeordnet ist, wobei ein Nadelventil (2') zur Steuerung der Kraftstoffeinspritzung in einen Zylinder (11) eines Motors aus einer Kraftstoffkammer (5) dient, die im Ventilkörper (1) angeordnet ist, **dadurch gekennzeichnet, dass** das Einspritzventil eine Druckerfassungskammer (6) aufweist, die mit der Kraftstoffkammer (5) in Verbindung stehend angeordnet ist, und dass ein druckmessendes Mittel (7) mit der Druckerfassungskammer (6) in Verbindung stehend angeordnet ist.
2. Kraftstoffeinspritzventil nach Anspruch 1, **dadurch gekennzeichnet, dass** die Druckerfassungskammer (6) mit einer Kraftstoffrückführungsleitung (8) verbunden ist, um abgegebenen Kraftstoff vom Einspritzventil wegzuführen.
3. Kraftstoffeinspritzventil nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** die Druckerfassungskammer (6) mit der Kraftstoffkammer (5) über ein erstes druckreduzierendes Mittel (9) in Verbindung stehend angeordnet ist.
4. Kraftstoffeinspritzventil nach Anspruch 3, **dadurch gekennzeichnet, dass** ein Rückschlagventil (10) zwischen der Druckerfassungskammer (6) und dem ersten druckreduzierenden Mittel (9) angebracht ist.
5. Kraftstoffeinspritzventil nach Anspruch 2, **dadurch gekennzeichnet, dass** das zweite druckreduzierende Mittel (9') zwischen der Druckerfassungskammer (6) und der Rückführungsleitung (8) angebracht ist.
6. Kraftstoffeinspritzventil nach Anspruch 5, **dadurch gekennzeichnet, dass** ein zweites Rückschlagventil (10') zwischen dem zweiten druckreduzierenden Mittel (9') und der Kraftstoffrückführungsleitung angebracht ist.
7. Kraftstoffeinspritzventil nach Anspruch 3 oder 5, **dadurch gekennzeichnet, dass** die druckreduzierenden

den Mittel (9, 9') eine Bohrung, eine Düse oder einen Flansch geeigneter Größe aufweisen.

8. Verfahren zur Kraftstoffeinspritzung, wobei Kraftstoff unter einem erhöhten Druck, der durch eine Ventilinadel (2'), die in einem Ventilkörper (1) angeordnet ist, gesteuert wird, aus einer Kraftstoffkammer (5) zu einem Zylinder (11) eines Motors geführt wird, **dadurch gekennzeichnet, dass** Kraftstoff von der Kraftstoffkammer (5) unter einem erhöhten Druck über ein druckreduzierendes Mittel (9), das im Ventilkörper angeordnet ist, zu einer Druckerfassungskammer (6) geführt wird, in der ein druckmessendes Mittel (7) zur Überwachung des Betriebs des Einspritzventils angeordnet ist.
9. Verfahren nach Anspruch 8, **dadurch gekennzeichnet, dass** der Kraftstoffdruck auf mindestens ein Zehntel des Drucks herabgesetzt wird, der in der Kraftstoffkammer (5) herrscht, wenn der Kraftstoff über das druckreduzierende Mittel (9) zu der Druckerfassungskammer (6) geführt wird.
10. Verfahren nach Anspruch 8, **dadurch gekennzeichnet, dass** der Kraftstoff von der Druckerfassungskammer (6) zu einer Kraftstoffrückführungsleitung (8) geführt wird.

Revendications

1. Soupape d'injection de carburant comprenant une soupape à pointeau (2) disposée dans un boîtier de soupape (1), dans lequel un pointeau de soupape (2') est disposé de manière à contrôler l'injection de carburant dans un cylindre (11) d'un moteur à partir d'une chambre de carburant (5) disposée dans le boîtier de soupape (1), **caractérisée par le fait que** la soupape d'injection comprend une chambre sensible à la pression (6) disposée de manière à communiquer avec la chambre de carburant (5), et que des moyens de mesure de pression (7) sont disposés de manière à communiquer avec la chambre sensible à la pression (6).
2. Soupape d'injection de carburant selon la revendication 1, **caractérisée par le fait que** la chambre sensible à la pression (6) est reliée à une conduite de retour de carburant (8) destinée à amener le carburant déchargé hors de la soupape d'injection.
3. Soupape d'injection de carburant selon la revendication 1 ou 2, **caractérisée par le fait que** la chambre sensible à la pression (6) est disposée de manière à communiquer avec la chambre de carburant (5) par l'intermédiaire de premiers moyens de diminution de pres-

sion (9).

4. Soupape d'injection de carburant selon la revendication 3, **caractérisée par le fait qu'une** soupape de retenue (10) est installée entre la chambre sensible à la pression (6) et le premier moyen de diminution de pression (9).
5. Soupape d'injection de carburant selon la revendication 2, **caractérisée par le fait que** des seconds moyens de diminution de pression (9') sont installés entre la chambre sensible à la pression (6) et la conduite de retour de carburant (8).
6. Soupape d'injection de carburant selon la revendication 5, **caractérisée par le fait qu'une** seconde soupape de retenue (10') est installée entre le second moyen de diminution de pression (9') et la conduite de retour de carburant.
7. Soupape d'injection de carburant selon la revendication 3 ou 5, **caractérisée par le fait que** les moyens de diminution de pression (9, 9') comportent un alésage, une tuyère ou une bride de taille adaptée.
8. Procédé d'injection de carburant, dans lequel le carburant est amené à une pression élevée, contrôlée par un pointeau de soupape (2') disposé dans un boîtier de soupape (1) d'une chambre de carburant (5) vers un cylindre (11) d'un moteur, **caractérisé par le fait que** le carburant est amené à partir de la chambre de carburant (5) à une pression élevée par l'intermédiaire de moyens de diminution de pression (9) disposés dans le boîtier de soupape vers une chambre sensible à la pression (6), dans laquelle des moyens de mesure de pression (7) sont disposés pour contrôler le fonctionnement de la soupape d'injection.
9. Procédé selon la revendication 8, **caractérisé par le fait que** la pression du carburant est abaissée à au moins un dixième de la pression régnant dans la chambre de carburant (5) quand le carburant est amené par l'intermédiaire des moyens de diminution de pression (9) à la chambre sensible à la pression (6).
10. Procédé selon la revendication 8, **caractérisé par le fait que** le carburant est amené de la chambre sensible à la pression (6) à une conduite de retour de carburant (8).

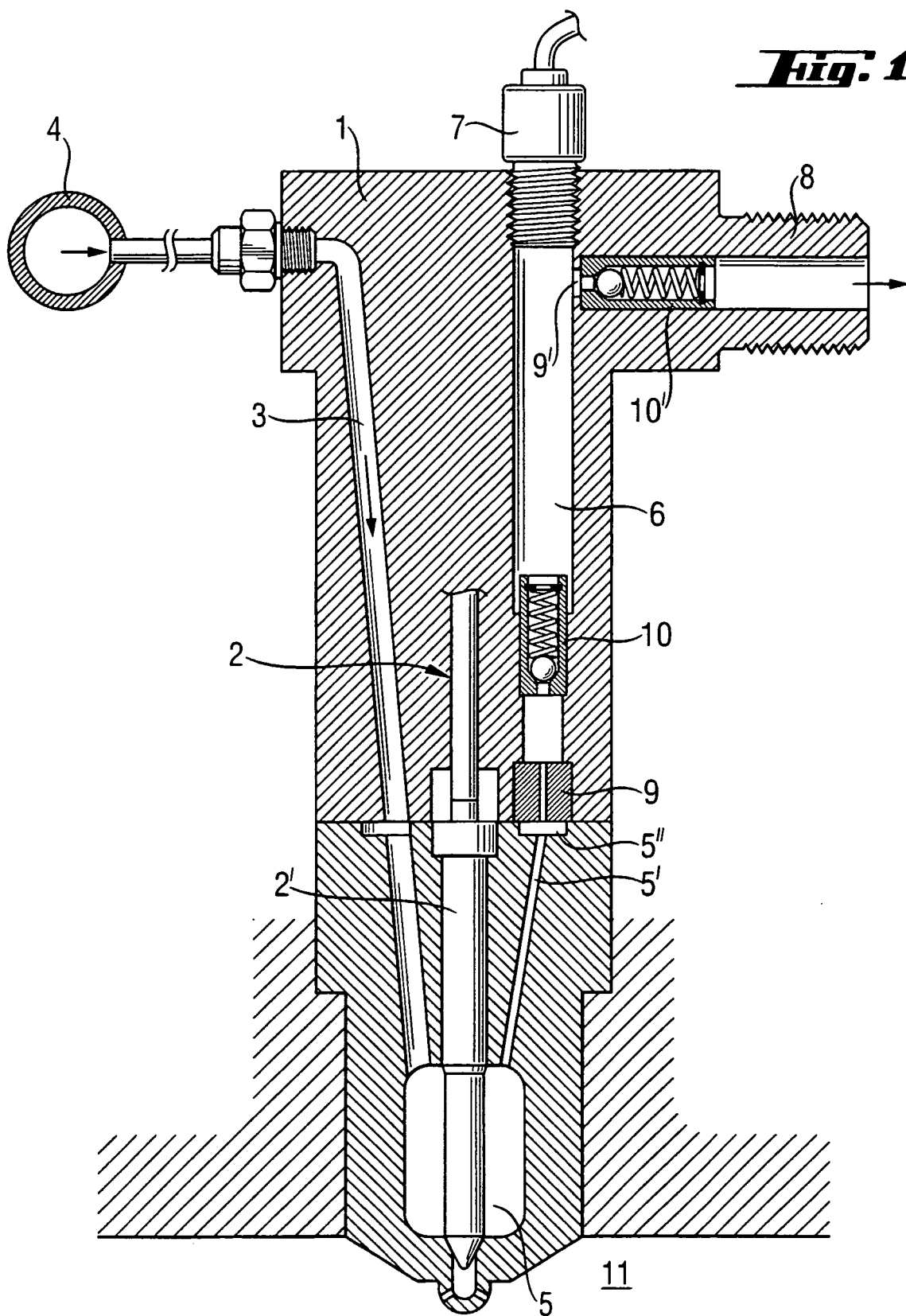


Fig. 2

