



(11) **EP 1 717 439 B9**

(12) **CORRECTED EUROPEAN PATENT SPECIFICATION**

(15) Correction information:
Corrected version no 1 (W1 B1)
Corrections, see
Claims EN

(51) Int Cl.:
F02M 57/02 (2006.01) **F02M 59/18** (2006.01)
F02M 51/04 (2006.01) **F02M 51/06** (2006.01)

(48) Corrigendum issued on:
03.12.2008 Bulletin 2008/49

(45) Date of publication and mention
of the grant of the patent:
09.01.2008 Bulletin 2008/02

(21) Application number: **06112490.5**

(22) Date of filing: **11.04.2006**

(54) **Fuel injection system for internal combustion engines**

Brennstoffeinspritzsystem für Brennkraftmaschine

Système d'injection de carburant pour moteurs à combustion interne

(84) Designated Contracting States:
DE FR IT

• **Grassia, Pasquale**
80125, Napoli (IT)

(30) Priority: **18.04.2005 IT MI20050688**

(74) Representative: **Faggioni, Giovanmaria et al**
Fumero-Studio Consulenza Brevetti Snc
Pettenkoferstrasse 20-22
80336 München (DE)

(43) Date of publication of application:
02.11.2006 Bulletin 2006/44

(73) Proprietor: **DELL'ORTO S.P.A.**
20038 Seregno (Milano) (IT)

(56) References cited:
EP-A- 0 288 216 **EP-A- 0 953 764**
WO-A-94/18449 **US-A1- 2003 047 625**

(72) Inventors:
• **Dell'Orto, Pierluigi**
20045, Besana Brianza (MILANO) (IT)

EP 1 717 439 B9

Note: Within nine months of the publication of the mention of the grant of the European patent in the European Patent Bulletin, any person may give notice to the European Patent Office of opposition to that patent, in accordance with the Implementing Regulations. Notice of opposition shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

Description

[0001] The device subject of the present invention falls in the sector of fuel supply systems for internal combustion engines. A large part of internal combustion engines is currently supplied with fuel injection systems which, according to applications, have operating pressures varying between 2 bar and 150 bar. The need arises therefrom to equip the above-mentioned systems with pumps to supply pressurised fuel.

[0002] Depending on the desired pressure level, different types of variously-operated pumps are used. In particular, for pressure levels between 2 and 5 bar, roller rotary electropumps operated by a direct-current motor (as well as go-devil pumps or liquid-ring pumps) are widely used in the technical practice. For higher pressure levels, mechanically-operated alternative pumps are nearly always employed. In this type of systems, by-pass pressure adjusters are normally employed.

[0003] Current anti-pollution regulations impose to adopt ever more advanced fuel-injection systems even in small motorcycle engines. The need to limit costs and to keep such engines efficient requires such systems not only to be functional and to have construction simplicity, but also to consume little power.

[0004] Fig. 1 shows the diagram of a conventional fuel-injection system. The fuel to be processed is drawn from tank 1 and arrives, through a filtering system 2, at pump 3 which provides to pressurise it and to send it to injector 4. Injector 4 adjusts the fuel flow, which reaches the engine through the intake manifolds or is directly injected into the combustion chamber.

[0005] Supply pressure adjustment is the task, as already mentioned, of a pressure adjuster 5 which, arranged downstream of the pump, is generally integrated in a by-pass circuit. Pressure adjustment through a by-pass system provides for the pump capacity to be over-size, according to the maximum flow rate required by the injector. In substance, pump capacity is defined according to the value of the flow rate required the injector upon maximum power delivery by the engine, and is further suitably increased in order to take into account the part of fuel which is in any case led into the by-pass circuit by the adjuster. When, at low engine loads, the flow rate of the fuel to be injected is smaller than the maximum flow rate, the exceeding flow is recirculated through the by-pass. Thereby, maximum pump capacity is always processed, but only a part thereof is actually used; thereby, all the energy imparted to the recirculated part of fuel is lost. The pump will always operate at maximum power causing large energy consumption with low engine loads.

[0006] It is an object of the present invention to propose a supply device for internal combustion engines which overcomes the mentioned drawbacks and which is both simpler - and hence cheaper from the point of view of the manufacture thereof - and more easily controllable in its use, so as to achieve pressurisation and adjustment of fuel pressure, as well as being cheaper from an energy

point of view. These objects are achieved through the features mentioned in claim 1.

[0007] In other words, the object of the present invention is achieved by employing a fuel pressurisation system which provides both to pressurise the fuel and to adjust the desired pressure value without using additional external devices, of the type of known pressure adjusters.

[0008] Further features and advantages of the invention are in any case more evident from the following detailed description of a preferred embodiment, given merely by way of a non-limiting example and shown in the accompanying drawings, wherein:

fig. 1 shows, as already mentioned, a fuel supply system according to the known art;

fig. 2 shows, in an extremely diagrammatic manner similar to that of fig. 1, a supply system according to the present invention;

fig. 3 shows an axial section of a possible practical embodiment of the device according to the invention;

fig. 4 shows a diagram of the excitation current of the electromagnet operating the supply pump, in a system according to the present invention, as well as the piston displacement diagram of an internal combustion engine supplied by such pump; and

fig. 5 is a diagram of the synchronisation signals of the supply pump and of the injector, in a system according to the present invention.

[0009] As outlined in fig. 2, the system according to the present invention consists of the same essential elements already seen in connection with fig. 1 of the known art, i.e.:

- a tank 1;
- a filter 2;
- an electromagnetic pump 3;
- an injector assembly 4;

but is devoid of the by-pass pressure adjuster 5; this remarkably simplifies system architecture and reduces the manufacturing and mounting costs thereof, but also carries the further advantages highlighted in the following.

[0010] The operation of the proposed system provides that the fuel taken from tank 1 flows through filtering system 2 and arrives at pump-injector assembly 3-4, which is capable of adjusting the pressure to a preset value.

[0011] This result is possible if a pump is adopted such as the one described for example in patents EP-0.288.216 in the name of EATON, EP-0.953.764-B1 in the name of MARELLI which, however, refer exclusively to pumps, for use in water supply to coffee machines or in oil supply to 2-stroke engines; in the known art resulting from these patents, excitation of the operating electromagnet causes displacement of the piston in its fuel intake run, whereas the fuel supply run occurs under the thrust of a pressure spring, which has been loaded during the intake run.

[0012] In US-2003/ 0047625-A1 a pump device fully similar to the above-cited ones is shown, which is preferred to as injector due to the fact that the pump supply chamber is directly equipped with an outlet port; the injecting function, however, is directly driven by the pump piston. Similar considerations apply to EP-1.306.544 and to EP-0.962.649.

[0013] In the arrangement according to the invention, which is better understandable if reference to the practical embodiment shown in fig. 3 is made it has instead been suggested to combine a pump body 3 with an injector body 4 to form a single assembly, wherein the pumping function and the injecting function are controlled in a substantially independent manner, even though from a single electronic control unit.

[0014] In pump 3, a bell body 10 is housed, wherein a chamber 11 is formed, where the fuel arrives, within which a contrast spring 12 is housed; said spring rests above against a fixed collar 3b of the fuel supply conduit 3a to pump unit 3, and rests below against the upper surface of a piston 15. Said piston has at the same time the function both of intake and supply piston of the fuel coming from conduit 3a, and that of movable anchor, sensitive to the magnetic field generated by an electromagnet. As a matter of fact, on the outside of body 10 and of piston 15, reel 13 of said electromagnet is arranged, inwardly closed by a metal sheet 13a and housed in a supporting body 14. The wall of said metal sheet 13a builds, together with wall 14a of body 14, a cylinder guiding the displacements of piston 15.

[0015] Piston 15 is hollow and its inner cylindrical chamber in turn builds a guide of the same piston 15 on a cylindrical extension 16 of closing base 17 of body 3. In extension 16, a central cavity 18 is formed, which extends into an axial hole 18a in the same base 17; hole 18a puts in communication chamber 18 with end chamber 19 mounting injector unit 4, as better described in the following. In chamber 18, a non-return valve is housed, consisting of a valve body 20, for example a spherical one, and of a contrast spring 21.

[0016] When electromagnet reel 13 is electrically energised, it causes the upward (with reference to the drawing) displacement of anchor 15; structure, size and arrangement of spring 12 and valve 20-21, known per se, are such that the upward displacement of anchor 15 determines, in addition to compression of spring 12, the opening of valve 20 and the flow of fuel from chamber 11, i.e. from conduit 3a, to chamber 18.

[0017] When piston 15 has reached the upper end stop and stops, spring 21 causes the closure of valve 20. If, at this stage, electromagnet reel 13 is de-energised, the fuel in chamber 18, 18a, 19 - not being able to be released towards the injector (as better explained in the following), nor backwards towards chamber 11 - remains pressurised, under the action of piston 15, pushed by spring 12. The value of this pressure is determined by the ratio between the load of said spring 12 on piston 15 and the useful surface of piston 15.

[0018] Injector unit 4 is directly connected with pump unit 3 by way of the engagement of extension 4a of body 4 into chamber 19, for example by simple screwing in.

[0019] The structure of the injector unit, known per se and hence not described in further detail, essentially comprises: a first hollow cylindrical body 22, forming a first injector supply chamber 22a; a bell body 23, in whose central chamber a contrast spring 24 is housed; a movable anchor 25, shaped as a cylinder and equipped with an axial boring 25a; an reel 26, which partly surrounds the chamber housing spring 24 and partly anchor 25; and a fuel injection nozzle 27, with corresponding closing needle 28, housed in a chamber 29 formed at the bottom of the sliding seat of anchor 25. Needle 28 is integral with anchor 25 and is therefore normally closed when electromagnet 26 is not energised and spring 24 pushes anchor 25 downwards.

[0020] According to the present invention, chamber 18 of the pump unit is directly and freely in communication with conduit 18a, with chamber 19, with chamber 22a, with the chamber housing spring 24, with conduit 25a and with chamber 29 supplying injector 4. Therefore, when the fuel is pressurised in chamber 18, it is equally so in chamber 29.

[0021] Thanks to this arrangement, it can be appreciated that, according to the main feature of the present invention, an integrated assembly of pump and injector is accomplished, in which, however, the operation of the pump unit can be considered somewhat distinct from injector operation, due to the reasons set forth in the following.

[0022] The sizing of the pump unit, in relation to the delivery capability of the injector, is such that, when the engine is operated at high rpm, i.e. when the maximum quantity of supply fuel is required, a pump supply impulse must occur at each opening of the injector. However, it is not necessary to guarantee the coincidence of the actuation instant of electromagnet 13 controlling the displacements of piston 15, with the actuation instant of electromagnet 26 controlling the opening of the injector; but rather, the two actuation instants are preferably alternate, as appears clearly from the diagrams of figs. 4 and 5, shown below.

[0023] With such a sizing of the pump unit, it then becomes also possible - when the engine is operated at low rpm, i.e. at idle, and the fuel flow injected by the injector is consequently relatively small - to actuate electromagnet 13 which controls the displacements of piston 15 not following each actuation of electromagnet 26 which controls the opening of the injector, but rather following a sequence of an integer number of actuations of electromagnet 26, for example every two or three times. As a matter of fact, the full run capacity of piston 15 may correspond - at these low rpm - to two or three fuel injections into the engine, and at each fuel fuel-injection, piston 15 will cover only half or a third of its run, to stop as soon as needle 28 of the injector closes.

[0024] In general, if the duration of the fuel injection

phase is short and injector capacity is accordingly small, only part of the fuel contained in chamber 18 will be released and, as a result, in the following intake phase, piston 15 will suck only the fuel amount required to replenish chamber 18. Thereby, flow rate adjustment occurs only according to injector opening time. The energy used during each intake run is constant upon varying of actuation frequency. If frequency decreases, cycle duration increases and, once intake duration has been set, the time in which the magnet is not actuated increases and, as a result, the energy used decreases. This is an obvious great advantage over the known art in which, even at low engine rpm, when fuel demand is low, the pump processes the entire flow even if most of it is bypassed, so that the entire energy employed in such process is wasted.

[0025] The diagram of fig. 4 - which refers to the case of engine supply at the highest rpm, and shows the piston position on the y axis and the progress of time on the x axis - shows in the upper half that the displacement of piston 13 comprises an initial supply phase a), a subsequent holding phase b), and a final return phase c). Phase a) corresponds to piston rise, with reload of spring 15 and simultaneous fuel intake towards chamber 18; phase b) is a piston holding phase while waiting to supply the injector with fuel; and phase c) corresponds to the fuel injection phase, wherein the fuel is released and the piston is moved downwards. It must here be remembered that holding of piston 15 is carried out hydraulically, in the sense that it is determined simply by closure of injector needle 28, which prevents the fuel from flowing. The lower half of the diagram of fig. 4, to be compared directly with the upper half thereof, shows the development of the excitation current (value on the y axis) over time (value on the x axis); here it shows clearly that the excitation current increases dramatically during phase a) which controls and displaces the piston, then drops to zero in phase b) which holds the pressure of the piston, and in phase c) when the injector control is activated.

[0026] The diagram of fig. 5 shows instead the time ratio between the activation signals of electromagnet 13 of the pump and of injector 26, respectively; here it is evident that the pump activation signal is generated immediately after the end of the injector one. In other words, electromagnet 26 controlling the opening of injector needle 28 is energised and kept energised for the time necessary for the injection of the required fuel amount according to the engine rpm; for all this time, fuel supply is guaranteed by the displacement of piston 15 under the action of spring 12, which extends itself. Following de-energising of electromagnet 26, pump unit electromagnet 13 is then energised, which causes piston 15 to rise and spring 12 to reload.

[0027] By the described structure of the pump-injector assembly according to the present invention, various advantages are hence obtained, which may be summed up in the following:

- the use of a pressure adjuster is abandoned. By opening electrically-controlled injector 27, the fuel is pumped thanks to the extension of spring 12, which provides to automatically keep the pressure at the desired value; this value, determined according to the preload assigned to the spring, remains virtually constant, given the modest variability of the spring load during extension thereof;
- the injector supply phase can be completed in a very short time because the energy required is already available and stored in the previously loaded spring. Since the spring can be reloaded between an injection phase and the other, it is therefore not necessary to keep to the characteristic movement times of electromagnet 13;
- the electric power installed to activate electromagnet 13 can be remarkably lower because the work required for displacing piston 15 and for compressing spring 12 can be produced over a longer time, i.e. precisely in the time between an injection phase and the other;
- considerable energy savings are made, due to the following factors: the fact that the pump must not treat excess fuel (i.e. the one normally recycled from the pressure adjuster of the prior art); the fact that a single run of pump piston 15 can be used, at low engine rpm, for multiple injector supplies; and the fact that, at intermediate rpm, the supply run of piston 15 is limited and spring 12 does not extend completely, hence the intake run is also limited to the one strictly necessary for the partial reload of spring 12;
- further energy savings are obtained, due to the fact that no power consumption exists in phase b) of holding of the cycle time, the holding being guaranteed hydraulically by the temporary closure of the injector.
- it is further possible to simplify the control algorithm in the electronic control unit, since the injector closure signal can be used as a control signal for the activation of electromagnet 13, simplifying the synchronisation between pump and injector;
- reduced cost of the system, due to the reduction of the components (doing without the pressure adjuster) and to the greater construction simplicity (integrated pump-injector assembly);

[0028] It is understood, however, that the invention is not to be considered limited to the particular arrangement illustrated above, which represents only an exemplary embodiment thereof, but that different variants are possible, all within the reach of a person skilled in the field, without departing from the scope of protection of the present invention, as defined in the following claims.

Claims

1. Fuel-injection system for internal combustion engines, comprising a pump unit (3) cooperating with

an injector unit (4), the pump unit comprising a piston-cylinder assembly (15; 13a-14a), an electromagnet (13) exercising its force of attraction on a movable anchor (15), consisting of the piston or integral therewith, a spring (12) acting on the anchor or piston (15) with an elastic force of a sign opposite to that of the force of attraction of the electromagnet, the action of the electromagnet on said anchor-piston causing the loading of said spring (12) during the fuel intake phase, whereby

- said pump unit (3) is directly associated with an injector unit (4),
- said spring (12) controls the supply run of the piston (15) through the elastic energy stored in said spring,
- said supply run pressurises the fuel, so as to supply it directly to the injector unit (4), **characterised in that**
- fuel supply to the engine is driven only by the opening of the injector unit needle (28).

2. Fuel-injection system for internal combustion engines as claimed in claim 1, **characterised in that** said fuel chamber (18) of the pump unit (3) is closed upstream by a non-return valve (20) and, downstream, it is in direct communication with a supply chamber (29) formed in said injector unit (4), the fuel in said fuel chamber (18) and in said supply chamber (29) is kept under pressure by the action of the pump unit piston (15), under the thrust of said spring (12).
3. Fuel-injection system for internal combustion engines as claimed in claim 2), **characterised in that** said supply chamber (29) is in direct, continuous communication with said fuel chamber (18) formed in the pump unit (3).
4. Fuel-injection system for internal combustion engines as claimed in claim 1), 2) or 3), **characterised in that** the needle (28) of said injection unit is driven by an electromagnetic actuation, and the opening of said needle drives the supply run of said pump unit piston (15).
5. Fuel-injection system for internal combustion engines as claimed in claim 1) or 2), **characterised in that** the adjustment of the injector fuel supply pressure is determined by the ratio between the load of said spring (12) and the useful surface of the piston (15).
6. Fuel-injection system for internal combustion engines as claimed in claim 1) or 2), **characterised in that** the closure signal of the injector needle (28) is used, in an electronic control unit, as a signal activating the electromagnet (13) of the pump unit (3).

7. Fuel-injection system for internal combustion engines as claimed in claim 6), **characterised in that**, at the maximum engine rpm, said electronic control unit sends a signal activating the electromagnet (13) of the pump unit (3) following each deactivation signal of the electromagnet (26) driving the needle (28) of the injector unit (4).
8. Fuel-injection system for internal combustion engines as claimed in claim 6), **characterised in that**, at the minimum engine rpm, said electronic control unit sends a signal activating the electromagnet (13) of the pump unit (3) following a multiple integer number of deactivation signals of the electromagnet (26) driving the needle (28) of the injector unit (4).
9. Fuel-injection system for internal combustion engines as claimed in any one of the preceding claims, **characterised in that** between said pump unit (3) and a fuel tank (1), there is a filter (2) only.
10. Fuel-injection system for internal combustion engines as claimed in any one of the preceding claims, **characterised in that** said non-return valve (20) is placed between said fuel chamber (18) and a cylinder chamber (11), wherein said spring (12) is housed, said cylinder chamber (1) being directly connected with a fuel tank (1).
11. Fuel-injection system for internal combustion engines as claimed in any one of claims 1) to 10), **characterised in that** said piston (15) is hollow and is guided on the outside within a cylinder consisting at least in part of the containment wall (13a) of the electromagnet reel (13).
12. Fuel-injection system for internal combustion engines as claimed in any one of the preceding claims, **characterised in that** the electromagnet reel (13), closed on the inside by a metal sheet forming said wall (13a), is housed in a support body (14), the base of which forms a further cylindrical wall (14a) guiding the movements of the piston (15).
13. Fuel-injection system for internal combustion engines as claimed in claim 11), **characterised in that** said hollow piston (15) is further guided, on the inside, along a cylindrical appendix (16) of a base (17) closing the pump unit body (3).
14. Fuel-injection system for internal combustion engines as claimed in claim 2) or 13), **characterised in that** said fuel chamber (18) of the pump unit is formed in said appendix (16) guiding the piston (15), in said chamber (18) being housed said non-return valve (20) and a respective pressure spring (21), the seat of said non-return valve (20) being formed in the piston head.

15. Fuel-injection system for internal combustion engines as claimed in claim 14), **characterised in that** said fuel chamber (18), formed in said appendix (16), extends into an axial hole (18a) of the base (17) of the pump unit, which puts said chamber (18) in communication with an end chamber (19) mounting the injector unit (4).
16. Fuel-injection system for internal combustion engines as claimed in claim 2) or 15), **characterised in that** said injector unit (4) is directly connected with the pump unit (3) by the engagement of an extension (4a) of the same with said end chamber (19), preferably by simple screwing.

Patentansprüche

1. Kraftstoffeinspritzsystem für Brennkraftmaschinen, umfassend eine Pumpeneinheit (3), die mit einer Einspritzventileinheit (4) zusammenwirkt, wobei die Pumpeneinheit eine Kolben-Zylinder-Baugruppe (15; 13a-14a) umfasst, einen Elektromagneten (13), der seine Anziehungskraft auf einen beweglichen Anker (15) ausübt, bestehend aus dem Kolben oder einer damit einstückigen Feder (12), die mit einer Federkraft mit einem Vorzeichen, das dem der Anziehungskraft des Elektromagneten entgegengesetzt ist, auf den Anker oder Kolben (15) wirkt, wobei die Wirkung des Elektromagneten auf den genannten Anker-Kolben die Belastung der genannten Feder (12) während der Kraftstoffansaugphase verursacht, wobei
- die genannte Pumpeneinheit (3) direkt einer Einspritzventileinheit (4) zugeordnet ist,
 - die genannte Feder (12) den Zuführhub des Kolbens (15) durch die in der genannten Feder gespeicherte Federenergie steuert,
 - der genannte Zuführhub den Kraftstoff druckbeaufschlagt, um ihn der Einspritzventileinheit (4) direkt zuzuführen, **dadurch gekennzeichnet, dass**
 - die Kraftstoffzufuhr zum Motor nur durch das Öffnen der Nadel (28) der Einspritzventileinheit erfolgt.
2. Kraftstoffeinspritzsystem für Brennkraftmaschinen nach Anspruch 1, **dadurch gekennzeichnet, dass** die genannte Kraftstoffkammer (18) der Pumpeneinheit (3) in Durchflussrichtung stromaufwärts durch ein Rückschlagventil (20) verschlossen ist und stromabwärts in direkter Kommunikation mit einer in der genannten Einspritzventileinheit (4) gebildeten Versorgungskammer (29) steht, der Kraftstoff in der genannten Kraftstoffkammer (18) und in der genannten Versorgungskammer (29) durch die Wirkung des Kolbens (15) der Pumpen-

einheit unter der Schubwirkung der genannten Feder (12) unter Druck gehalten wird.

3. Kraftstoffeinspritzsystem für Brennkraftmaschinen nach Anspruch 2, **dadurch gekennzeichnet, dass** die genannte Versorgungskammer (29) in direkter kontinuierlicher Kommunikation mit der in der Pumpeneinheit (3) gebildeten genannten Kraftstoffkammer (18) steht.
4. Kraftstoffeinspritzsystem für Brennkraftmaschinen nach Anspruch 1, 2 oder 3, **dadurch gekennzeichnet, dass** die Nadel (28) der genannten Einspritzventileinheit durch eine elektromagnetische Betätigung angetrieben wird und dass das Öffnen der genannten Nadel den Zuführhub des genannten Kolbens (15) der Pumpeneinheit antreibt.
5. Kraftstoffeinspritzsystem für Brennkraftmaschinen nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** die Einstellung des Kraftstoffzufuhrdrucks des Einspritzventils von dem Verhältnis zwischen der Belastung der genannten Feder (12) und der Nutzfläche des Kolbens (15) bestimmt wird.
6. Kraftstoffeinspritzsystem für Brennkraftmaschinen nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** das Schließsignal der Einspritzventilnadel (28) in einem elektronischen Steuergerät als ein den Elektromagneten (13) der Pumpeneinheit (3) aktivierendes Signal verwendet wird.
7. Kraftstoffeinspritzsystem für Brennkraftmaschinen nach Anspruch 6, **dadurch gekennzeichnet, dass** das genannte elektronische Steuergerät bei der maximalen Motordrehzahl, auf jedes Deaktivierungssignal des die Nadel (28) der Einspritzventileinheit (4) antreibenden Elektromagneten (26) folgend, ein den Elektromagneten (13) der Pumpeneinheit (3) aktivierendes Signal sendet.
8. Kraftstoffeinspritzsystem für Brennkraftmaschinen nach Anspruch 6, **dadurch gekennzeichnet, dass** das genannte elektronische Steuergerät bei der Mindestdrehzahl des Motors, auf eine mehrfache ganze Zahl von Deaktivierungssignalen des die Nadel (28) der Einspritzventileinheit (4) antreibenden Elektromagneten (26) folgend, ein den Elektromagneten (13) der Pumpeneinheit (3) aktivierendes Signal sendet.
9. Kraftstoffeinspritzsystem für Brennkraftmaschinen nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** sich zwischen der genannten Pumpeneinheit (3) und einem Kraftstoffbehälter (1) nur ein Filter (2) befindet.
10. Kraftstoffeinspritzsystem für Brennkraftmaschinen

nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** das genannte Rückschlagventil (20) zwischen der genannten Kraftstoffkammer (18) und einer Zylinderkammer (11) angeordnet ist, in der die genannte Feder (12) untergebracht ist, wobei die genannte Zylinderkammer (11) direkt mit einem Kraftstoffbehälter (1) verbunden ist.

11. Kraftstoffeinspritzsystem für Brennkraftmaschinen nach einem der Ansprüche 1 bis 10, **dadurch gekennzeichnet, dass** der genannte Kolben (15) hohl ist und an der Außenseite in einem Zylinder geführt wird, der wenigstens teilweise aus der Umschließungswand (13a) der Elektromagnetenspule (13) besteht.
12. Kraftstoffeinspritzsystem für Brennkraftmaschinen nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Elektromagnetenspule (13), die an der Innenseite durch ein Blech geschlossen ist, das die genannte Wand (13a) bildet, in einem Lagerungsgehäuse (14) untergebracht ist, dessen Basis eine weitere zylindrische Wand (14a) bildet, welche die Bewegungen des Kolbens (15) leitet.
13. Kraftstoffeinspritzsystem für Brennkraftmaschinen nach Anspruch 11, **dadurch gekennzeichnet, dass** der genannte hohle Kolben (15) ferner an der Innenseite an einem zylindrischen Fortsatz (16) einer Basis (17), die das Gehäuse der Pumpeneinheit (3) schließt, entlang geführt wird.
14. Kraftstoffeinspritzsystem für Brennkraftmaschinen nach Anspruch 2 oder 13, **dadurch gekennzeichnet, dass** die genannte Kraftstoffkammer (18) der Pumpeneinheit in dem genannten den Kolben (15) leitenden Fortsatz (16) ausgebildet ist, wobei in der genannten Kammer (18) das genannte Rückschlagventil (20) und eine jeweilige Druckfeder (21) untergebracht sind, wobei der Sitz des genannten Rückschlagventils (20) im Kolbenkopf ausgebildet ist.
15. Kraftstoffeinspritzsystem für Brennkraftmaschinen nach Anspruch 14, **dadurch gekennzeichnet, dass** die in dem genannten Fortsatz (16) gebildete genannte Kraftstoffkammer (18) in ein Axialloch (18a) der Basis (17) der Pumpeneinheit hinein verläuft, was die genannte Kammer (18) mit einer auf der Einspritzventileinheit (4) sitzenden Endkammer (19) in Kommunikation bringt.
16. Kraftstoffeinspritzsystem für Brennkraftmaschinen nach Anspruch 2 oder 15, **dadurch gekennzeichnet, dass** die genannte Einspritzventileinheit (4) durch den Eingriff einer Verlängerung (4a) derselben mit der genannten Endkammer (19), vorzugsweise durch einfaches Schrauben, direkt mit der Pumpen-

einheit (3) verbunden ist.

Revendications

1. Système d'injection de carburant destiné à des moteurs à combustion interne, comprenant une unité de pompe (3) coopérant avec une unité d'injecteur (4), l'unité de pompe comprenant un ensemble piston-cylindre (15 ; 13a à 14a), un électroaimant (13) exerçant sa force d'attraction sur une ancre mobile (15), constituée du piston ou intégrée à celui-ci, un ressort (12) agissant sur l'ancre ou piston (15) avec une force élastique d'un signe opposé à celui de la force d'attraction de l'électroaimant, l'action de l'électroaimant sur ladite ancre-ledit piston provoquant le chargement dudit ressort (12) durant la phase d'admission de carburant, grâce à quoi
 - ladite unité de pompe (3) est directement associée à une unité d'injecteur (4),
 - ledit ressort (12) commande la course d'alimentation du piston (15) par l'intermédiaire de l'énergie élastique emmagasinée dans ledit ressort,
 - ladite course d'alimentation met sous pression le carburant, de façon à le fournir directement à l'unité d'injecteur (4), **caractérisé en ce que**
 - l'alimentation en carburant au moteur est commandée uniquement par l'ouverture du pointeau (28) de l'unité d'injecteur.
2. Système d'injection de carburant destiné à des moteurs à combustion interne selon la revendication 1, **caractérisé en ce que** ladite chambre de carburant (18) de ladite unité de pompe (3) est fermée en amont par un clapet anti-retour (20) et en aval, elle est en communication directe avec une chambre d'alimentation (29) formée dans ladite unité d'injecteur (4), le carburant dans ladite chambre de carburant (18) et dans ladite chambre d'alimentation (29) est maintenu sous pression par l'action du piston d'unité de pompe (15), sous la poussée dudit ressort (12).
3. Système d'injection de carburant destiné à des moteurs à combustion interne selon la revendication 2, **caractérisé en ce que** ladite chambre d'alimentation (29) est en communication directe continue avec ladite chambre de carburant (18) formée dans l'unité de pompe (3).
4. Système d'injection de carburant destiné à des moteurs à combustion interne selon la revendication 1, 2 ou 3, **caractérisé en ce que** le pointeau (28) de ladite unité d'injection est commandé par un actionnement électromagnétique, et **en ce que** l'ouverture dudit pointeau commande la course d'alimentation

- dudit piston d'unité de pompe (15).
5. Système d'injection de carburant destiné à des moteurs à combustion interne selon la revendication 1 ou 2, **caractérisé en ce que** le réglage de la pression d'alimentation en carburant d'injecteur est déterminé par le rapport entre la charge dudit ressort (12) et la surface utile du piston (15). 5
 6. Système d'injection de carburant destiné à des moteurs à combustion interne selon la revendication 1 ou 2, **caractérisé en ce que** le signal de fermeture du pointeau d'injecteur (28) est utilisé, dans une unité de commande électronique, en tant que signal activant l'électroaimant (13) de l'unité de pompe (3). 10
 7. Système d'injection de carburant destiné à des moteurs à combustion interne selon la revendication 6, **caractérisé en ce que**, au régime en tours par minute du moteur maximum, ladite unité de commande électronique envoie un signal activant l'électroaimant (13) de l'unité de pompe (3), après chaque signal de désactivation de l'électroaimant (26) commandant le pointeau (28) de l'unité d'injecteur (4). 15
 8. Système d'injection de carburant destiné à des moteurs à combustion interne selon la revendication 6, **caractérisé en ce que**, au régime en tours par minute du moteur minimum, ladite unité de commande électronique envoie un signal activant l'électroaimant (13) de l'unité de pompe (3), après un nombre entier multiple de signaux de désactivation de l'électroaimant (26) commandant le pointeau (28) de l'unité d'injecteur (4). 20
 9. Système d'injection de carburant destiné à des moteurs à combustion interne selon l'une quelconque des revendications précédentes, **caractérisé en ce que** entre ladite unité de pompe (3) et un réservoir de carburant (1), il n'y a qu'un filtre (2). 25
 10. Système d'injection de carburant destiné à des moteurs à combustion interne selon l'une quelconque des revendications précédentes, **caractérisé en ce que** ledit clapet anti-retour (20) est placé entre ladite chambre de carburant (18) et une chambre de cylindre (11), où ledit ressort (12) est logé, ladite chambre de cylindre (1) étant directement reliée à un réservoir de carburant (1). 30
 11. Système d'injection de carburant destiné à des moteurs à combustion interne selon l'une quelconque des revendications 1 à 10, **caractérisé en ce que** ledit piston (15) est creux et est guidé sur l'extérieur à l'intérieur d'un cylindre constitué au moins en partie de la paroi de confinement (13a) de la bobine d'électroaimant (13). 35
 12. Système d'injection de carburant destiné à des moteurs à combustion interne selon l'une quelconque des revendications précédentes, **caractérisé en ce que** la bobine d'électroaimant (13), fermée sur l'intérieur par une feuille métallique formant ladite paroi (13a), est logée dans un corps de support (14), dont la base forme une autre paroi cylindrique (14a) guidant les mouvements du piston (15). 40
 13. Système d'injection de carburant destiné à des moteurs à combustion interne selon la revendication 11, **caractérisé en ce que** ledit piston creux (15) est en outre guidé, sur l'intérieur, le long d'un appendice cylindrique (16) d'une base (17) fermant le corps d'unité de pompe (3). 45
 14. Système d'injection de carburant destiné à des moteurs à combustion interne selon la revendication 2 ou 13, **caractérisé en ce que** ladite chambre de carburant (18) de l'unité de pompe est formée dans ledit appendice (16) guidant le piston (15), dans ladite chambre (18) étant logés ledit clapet anti-retour (20) et un ressort de pression respectif (21), le siège dudit clapet anti-retour (20) étant formé dans la tête de piston. 50
 15. Système d'injection de carburant destiné à des moteurs à combustion interne selon la revendication 14, **caractérisé en ce que** ladite chambre de carburant (18), formée dans ledit appendice (16), s'étend dans un trou axial (18a) de la base (17) de l'unité de pompe, lequel place ladite chambre (18) en communication avec une chambre d'extrémité (19) installant l'unité d'injecteur (4). 55
 16. Système d'injection de carburant destiné à des moteurs à combustion interne selon la revendication 2 ou 15, **caractérisé en ce que** ladite unité d'injecteur (4) est directement reliée à l'unité de pompe (3) par l'engagement d'une extension (4a) de celle-ci avec ladite chambre d'extrémité (19), de préférence par un simple vissage.

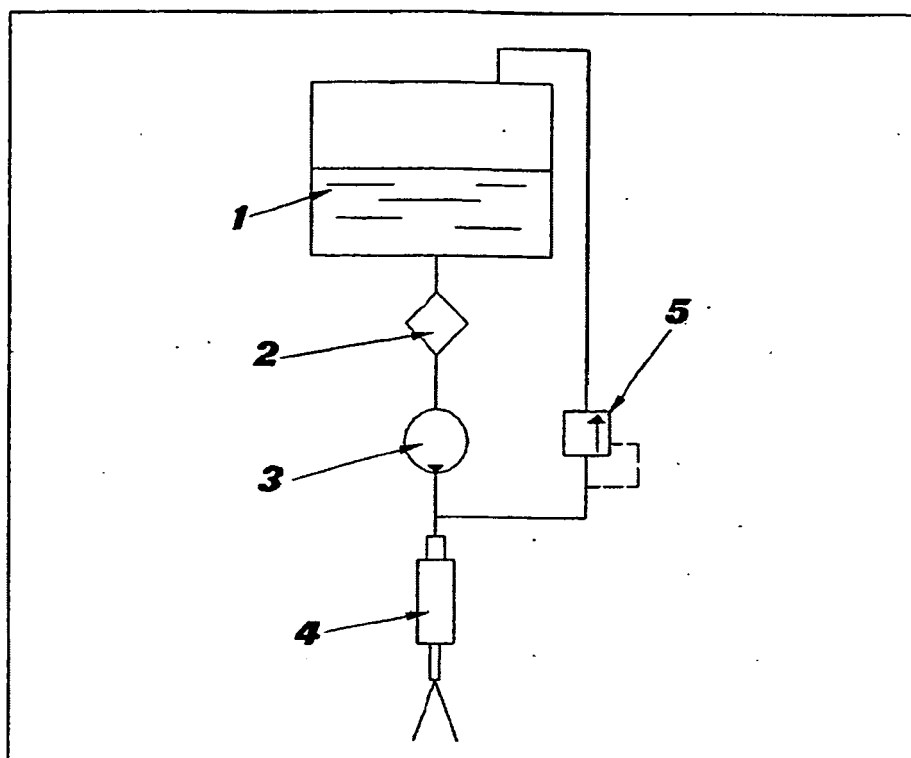


Fig. 1

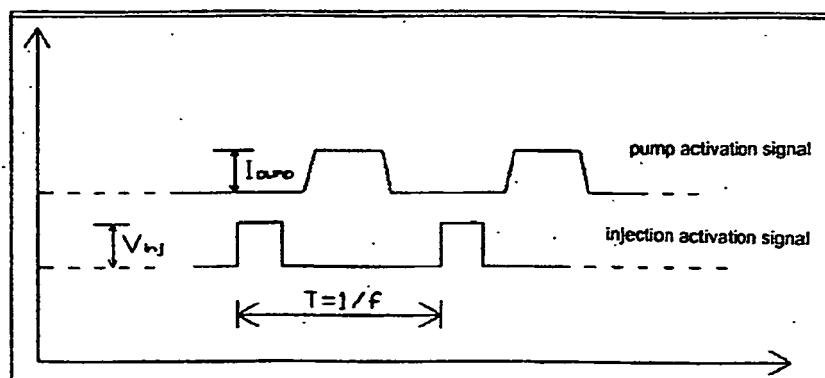


Fig. 5

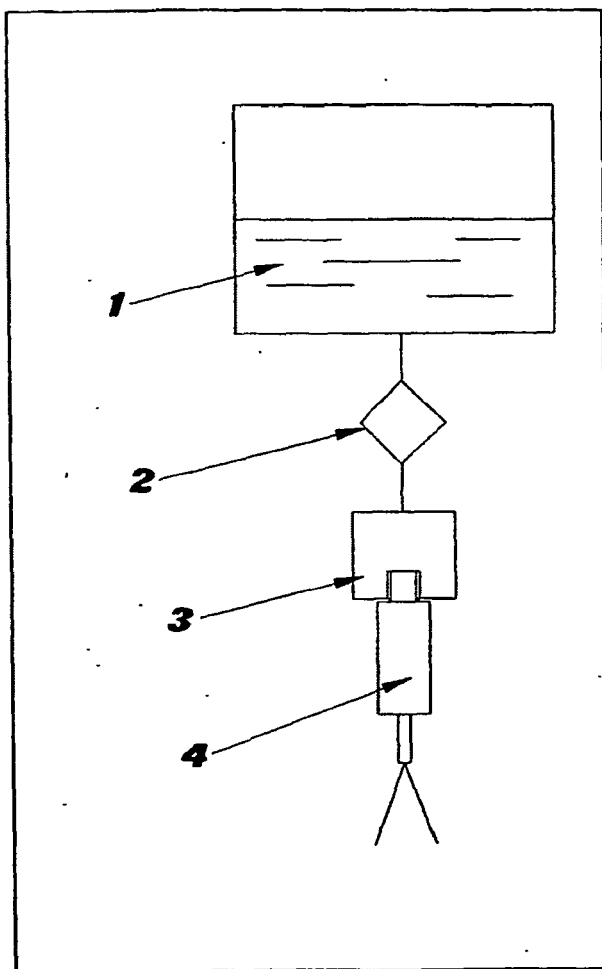
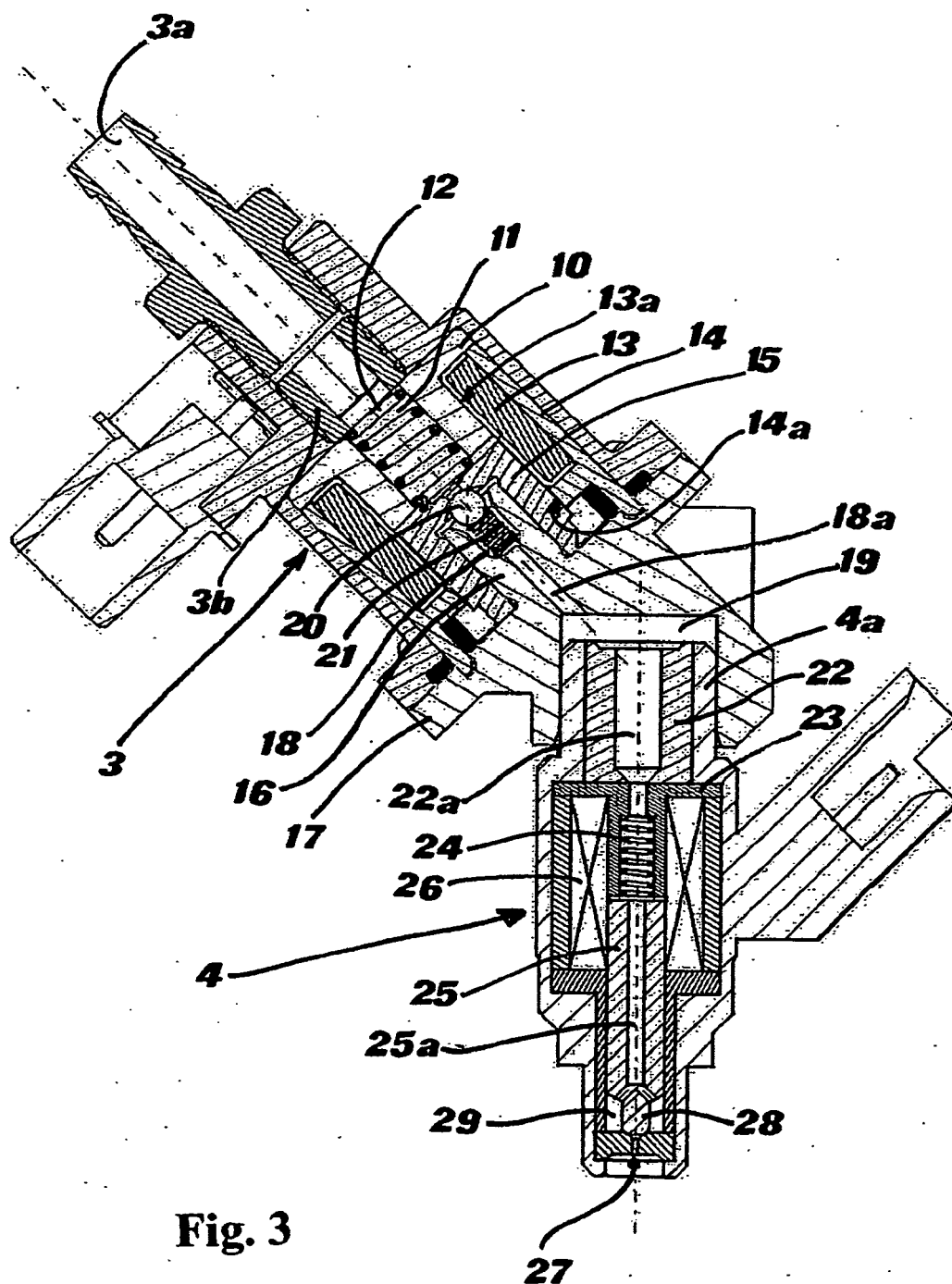


Fig. 2



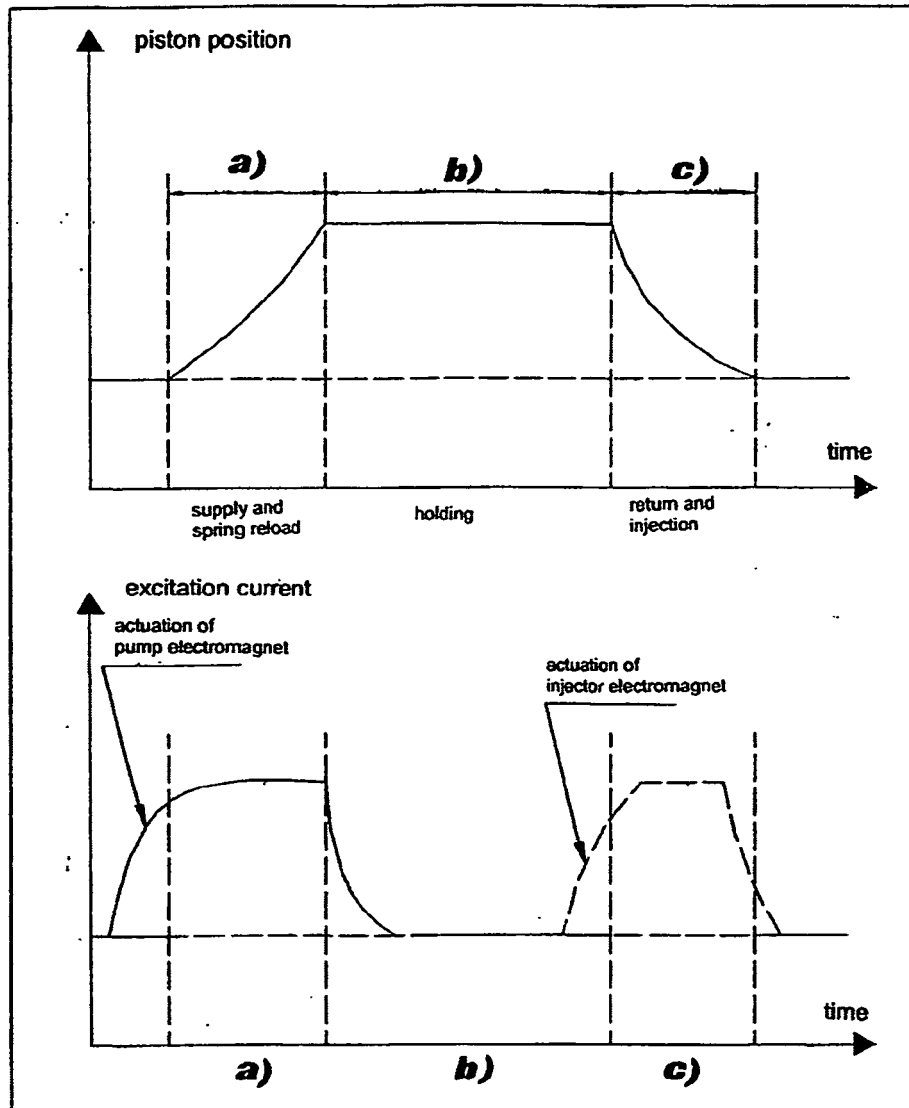


Fig. 4

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

- EP 0288216 A **[0011]**
- EP 0953764 B1 **[0011]**
- US 20030047625 A1 **[0012]**
- EP 1306544 A **[0012]**
- EP 0962649 A **[0012]**