United States Patent

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[31] **P 19 07 340.6**

[54] **VALVE FOR THE ADVANCE AND MAIN INJECTION OF FUEL**
5 Claims, 2 Drawing Figs.

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[51] Int. Cl. B05b 1/30
[50] Field of Search 239/533

[56] **References Cited**

UNITED STATES PATENTS

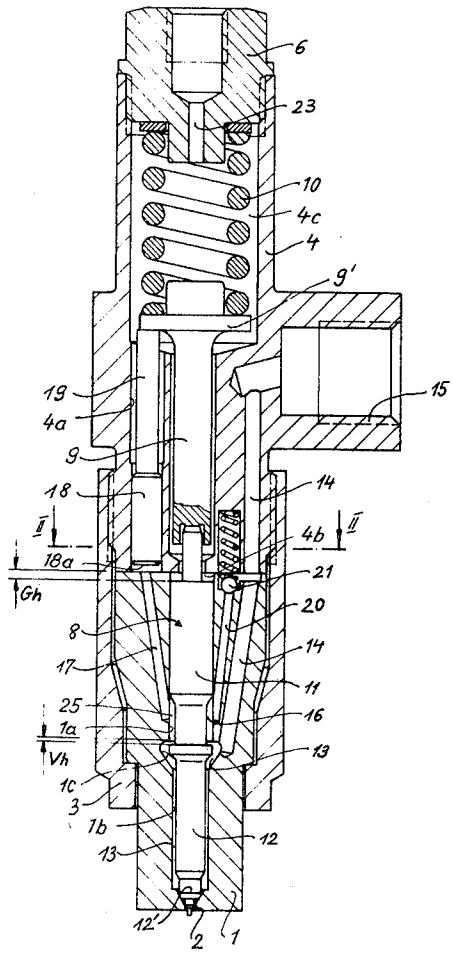
1,771,875	7/1930	Cowardin et al.	239/533
3,446,440	5/1969	Pelz, Jr. et al.	239/533 X
3,115,304	12/1963	Humphries	239/533 X

FOREIGN PATENTS

499,937	7/1930	Germany	239/533

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ABSTRACT: In a fuel injection valve, the initial opening motion of the valve needle (advance injection) is effected by the fuel pressure exerting a force directly on the valve needle and also on pistons connected therewith. Upon a predetermined displacement, the valve needle, by means of a control groove provided therein, cuts off the pressure supply to said pistons so that an elevated pressure level is required to cause further displacement (main injection) of the valve needle.



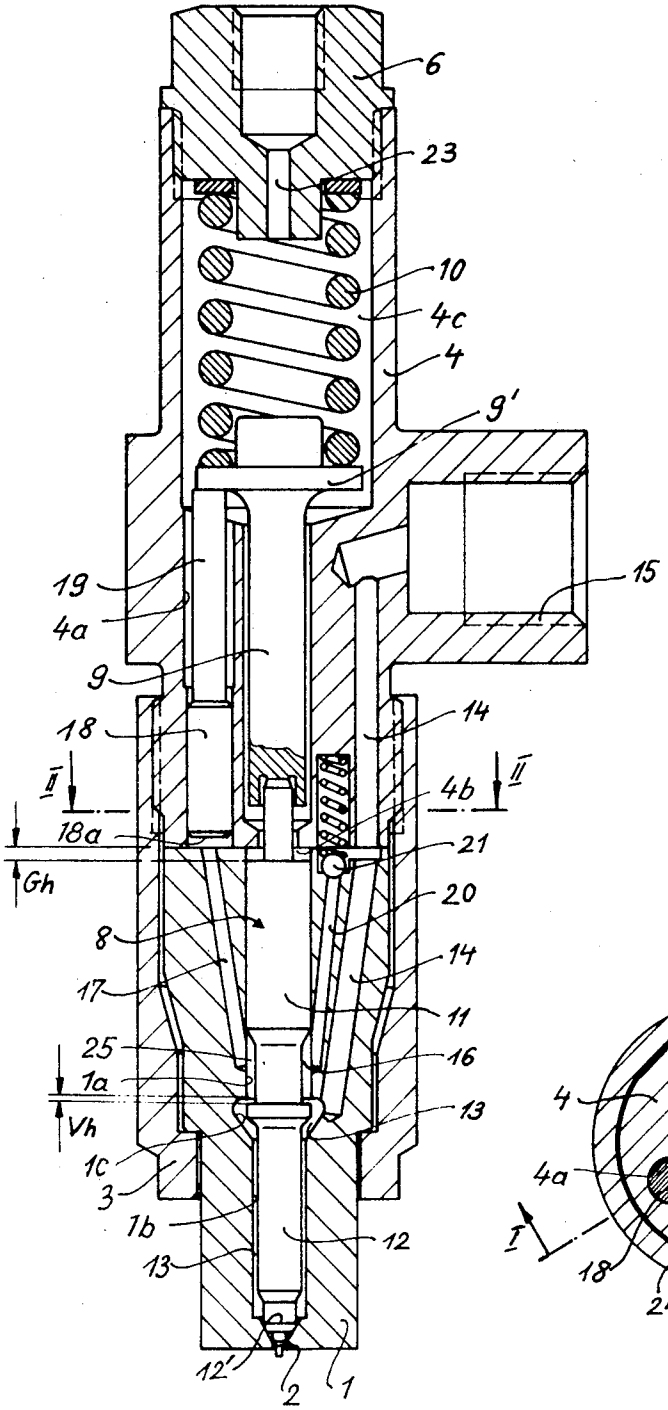


Fig. 1

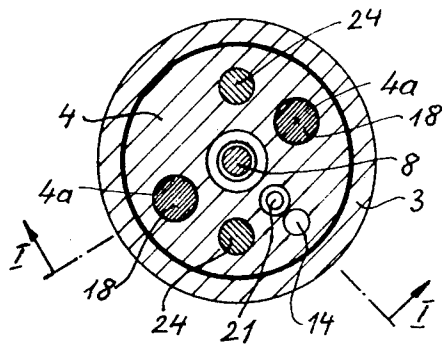


Fig. 2

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VALVE FOR THE ADVANCE AND MAIN INJECTION OF FUEL

BACKGROUND OF THE INVENTION

This invention relates to a fuel injection valve for an advance and main injection of fuel and is of the type that is provided with a reciprocating valve needle adapted to be opened by the pressure of the admitted fuel against the force of a closing spring and which, with a shaft portion guided in a nozzle body, controls hydraulic communication between two pressure chambers. In each chamber there is arranged a valve needle face adapted to be exposed to fuel pressure in a valve opening direction. For the advance injection both faces are affected by fuel, while for a further displacement of the valve needle in the opening direction to effect the main injection upon pressure increase of the admitted fuel, only one valve needle face is exposed to pressure.

In a known fuel injection valve of the aforenoted type (as disclosed, for example, in German Pat. No. 1,252,002), the fuel is introduced directly into one pressure chamber to effect the advance injection, whereas fuel is introduced into the other pressure chamber through an advance injection piston. As soon as the latter engages its abutment, only that valve face remains operational that is exposed to the directly admitted fuel. Consequently, the valve needle is additionally displaced for effecting the main injection only when the admitted fuel has reached a higher pressure level.

In order to obtain in known valves a different pressure level for the advance injection and for the main injection, in addition to the provision of the advance injection piston, the valve needle shaft has to be stepped and two shaft portions of different diameters have to be guided in a possibly hermetic manner. This requires a very accurate machining which renders the manufacturing involved and expensive.

OBJECT AND SUMMARY OF THE INVENTION

It is an object of the invention to provide an improved fuel injection valve wherein the advance and main injection of fuel is effected by different pressure levels as outlined above, and which is of a simpler and more economical structure than fuel injections valves known heretofore.

Briefly stated, according to the invention, both aforenoted pressure chambers are hydraulically connected with one another prior to and during the advance injection, and, after the valve needle has traveled a predetermined distance, the admission of fuel to one pressure chamber is blocked by a shaft portion of the valve needle. The communication between the pressure chambers is preferably controlled by an annular groove provided in a shaft portion of the valve needle.

As noted before, the manufacture of a stepped valve needle shaft is involved and expensive. For this reason, according to a preferred embodiment of the invention, the pressure in the chamber closable by the displaced valve needle affects the frontal face of at least one hermetically guided piston which is connected to the valve needle and which exerts an opening force thereon in response to said pressure.

The invention will be better understood, as well as further objects and advantages will become more apparent, from the ensuing detailed specification of a preferred, although exemplary, embodiment of the invention taken in conjunction with the drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is an axial sectional view of the fuel injection valve according to the invention along lines I–I of FIG. 2; and

FIG. 2 is a sectional view along line II–II of FIG. 1.

DESCRIPTION OF THE EMBODIMENT

Turning now to the figures, a nozzle body 1 having an axial cylindrical bore 1*a* and 1*b* terminating in a nozzle opening 2 is tightened to a nozzle holder 4 by means of a threaded sleeve 3. The nozzle holder 4 is closed by means of a plug 6.

In the nozzle body 1 there is held a valve needle generally indicated at 8 which is biased closed by a closing spring 10. The latter engages with one end a face of the plug 6 and engages with its other end a spring seat disc 9′ integral with a pusher rod 9 connected and axially aligned with the valve needle 8.

The valve needle 8 includes a shaft portion 11 which is hermetically guided in bore 1*a* and a shaft portion 12 which, together with the walls of bore 1*b* and an enlarged cavity 1*c*, defines a pressure chamber 13. A supply channel 14, leading from a coupling nipple 15 of the nozzle holder 4 and extending partly in the nozzle body 1 and partly in the nozzle holder 4, merges into chamber 13. To coupling nipple 15 there is attached a pressure conduit (not shown) leading directly from a fuel injection pump (also not shown) to carry fuel to the fuel injection valve.

The shaft portion 11 of the valve needle 8 is provided with an annular groove 16 which, together with the wall of bore 1*a*, defines a second pressure chamber 25.

In two diametrically opposed, axially parallel bores 4*a* of the nozzle holder 4, there is reciprocably held, in a snug fit, a piston 18 which has an integral stem 19 engaging the underside of the spring seat disc 9′. The chamber 25 is connected by a channel 17 with the space delimited by piston face 18*a* of each piston 18.

The pressure chamber 25 communicates with the supply channel 14 by means of a channel 20 which contains a check valve 21 preventing the flow of fuel in the direction of the pressure chamber 25.

As long as the fuel a valve is closed (as shown in FIG. 1), the annular groove 16 and thus the second pressure chamber 25 is in communication with the first pressure chamber 13. The pressure of the fuel admitted through the supply channel 14 exerts a force, first, on an annular face which is formed between the valve head edge 12′ and the shaft portion 11 of valve needle 8 and, secondly, on the frontal face 18*a* of the pistons 18. These two forces, overcoming the force of the closing spring 10, open the valve needle 8 and as a result, an advance injection takes place. As soon as the valve needle 8 is displaced a distance V*h* during the advance injection, the annular groove 16 submerges entirely into the guide bore 1*a*. Upon this occurrence, communication between the pressure chambers 13 and 25 is interrupted. Consequently, the pressure of the fuel admitted to chamber 13 through supply channel 14 is cut off from pistons 18. Thus, from the moment of such hydraulic separation between chambers 13 and 25, only the above-named annular face of the valve needle 8 is affected by the fuel pressure. Because of the reduction of the effective surface exposed to the opening pressure, a further displacement of the valve needle 8 required for executing the main injection takes place only in response to a correspondingly elevated pressure level. As soon as the last-named pressure is reached, the valve needle 8 is displaced an additional distance G*h*—V*h*, whereupon it abuts the frontal face 4*b* of the nozzle holder 4 to provide a maximum opening (main injection) of the injection nozzle 2.

During the return motion (closing operation) of the valve needle 8 following the injection step, the pistons 18 displace fuel across the channel 17, the pressure chamber 25 and the channels 20 into the supply conduit 14 up to the moment when the annular groove 16 emerges from the bore 1*a* and thus reestablishes communication between the pressure chamber 13 and the pressure chamber 25.

The space 4*c* in the nozzle holder 4 accommodating the closing spring 10 is depressurized by means of a throughgoing bore 23 provided in the plug 6 communicating with the fuel tank, not shown.

As seen in FIG. 2, the nozzle body 1 is immobilized with respect to the nozzle holder 4 by two pins 24.

The fuel injection valve according to the invention has a further particular advantage in that the fuel quantity to be injected is not interrupted by means of an additional control edge as in valves known heretofore, but, on the basis of pressure difference, is divided through the additional pressure

level. This is particularly of significance, since the displacement of the valve needle towards its seat adjacent the nozzle opening is at no time throttled; consequently, disadvantageous throttle losses are avoided.

That which I claim is:

1. In a fuel injection valve of the type performing an advance and a subsequent main injection of fuel and having (A) a nozzle body, (B) a valve needle reciprocably held in said nozzle body and displaceable in the opening direction by the pressure of fuel admitted to said fuel injection valve, (C) a closing spring connected to said valve needle and opposing said pressure, the improvement comprising,

A. a first pressure chamber in continuous communication with the fuel admitted under pressure to said fuel injection valve,

B. first face means in continuous communication with said first pressure chamber and exposed to and displaceable by said pressure to cause movement of said valve needle in the opening direction,

C. a second pressure chamber communicating with said first pressure chamber,

D. second face means in continuous communication with said second pressure chamber and exposed to and displaceable by said pressure to cause movement of said valve needle in the opening direction, and

E. means integral with said valve needle effecting an interruption of communication between said first chamber and said second chamber upon a predetermined displacement of said valve needle.

2. An improvement as defined in claim 1, wherein said means integral with said valve needle is formed of a circumferential groove.

3. An improvement as defined in claim 1, wherein said second face means is formed of a frontal face of at least one fluidtight piston operatively connected with said valve needle.

4. An improvement as defined in claim 3, including a spring seat disc connected to said valve needle and urged by said closing spring in a valve-closing direction, said at least one piston engages said spring seat disc and imparts a force thereto in a valve-opening direction.

5. An improvement as defined in claim 1, including

A. a fuel supply channel admitting fuel under pressure to said first chamber,

B. a channel establishing communication between said fuel supply channel and said second chamber, and

C. a check valve disposed in said last-named channel to prevent fuel flow from said fuel supply channel into said second chamber.