United States Patent

Voit

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[54] **FUEL INJECTION VALVE FOR A SUCCESSIVE INJECTION OF AN ADVANCE AND A MAIN FUEL QUANTITY**

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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** **239/533**

[51] **Int. Cl.** **B05b 1/30**

[58] **Field of Search** 239/86–96, 533, 239/452, 453

[56] **References Cited**

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[57] **ABSTRACT**

In a fuel injection valve that includes a valve needle with two axially spaced work faces disposed in two separate pressure chambers and exposed to fuel pressure to unseat said valve, there is provided a throttle channel maintaining continuous communication between the two pressure chambers.

3 Claims, 5 Drawing Figures

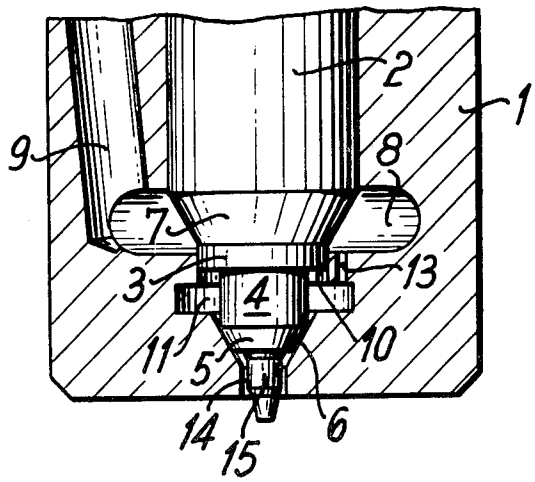


FIG. 1

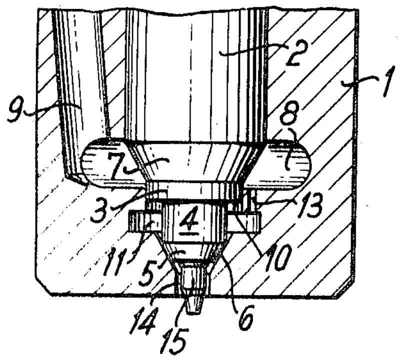


FIG. 2

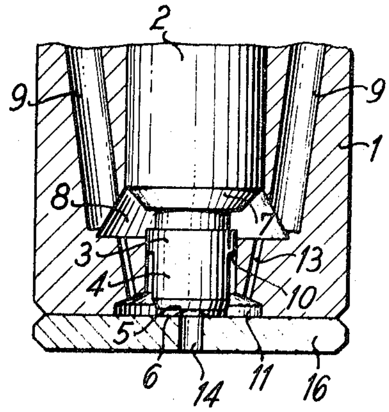


FIG. 3

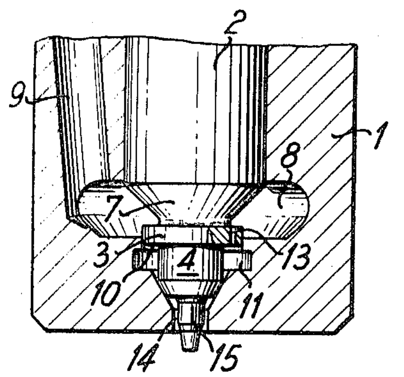


FIG. 4

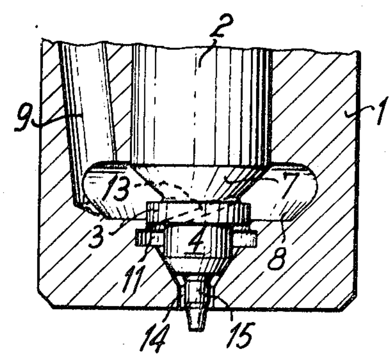
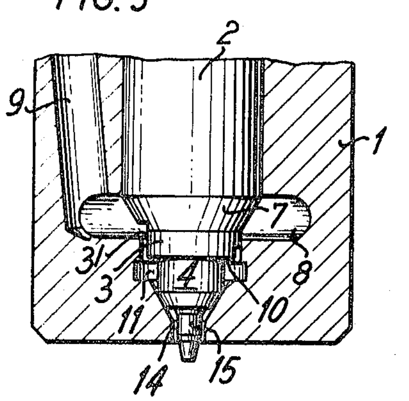


FIG. 5



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FUEL INJECTION VALVE FOR A SUCCESSIVE INJECTION OF AN ADVANCE AND A MAIN FUEL QUANTITY

BACKGROUND OF THE INVENTION

This invention relates to a fuel injection valve which is associated with an internal combustion engine and which comprises a stepped valve needle slidably disposed in a nozzle body and displaceable by the pressure of fuel to be injected by said valve into said engine. The valve needle includes work faces formed by annular shoulders between two immediately adjacent valve needle portions of differing diameters. Said work faces are disposed upstream of a valve seat and are exposed to said pressure in the opening direction of the valve. Each work face is disposed in a pressure chamber and is separated from the others by a valve needle portion guided in a fluidtight manner in the nozzle body. The valve needle, during the course of its strokes, controls the fuel admission between the pressure chambers.

In a fuel injection valve of the aforegoing type (disclosed, for example in German Pat. No. 733,041), the fuel admission from one pressure chamber to the other is effected through channels, the total flow passage section of which is varied during the course of the opening stroke of the valve needle. Such a change of the flow passage section is effected by means of two radial bores of different diameters provided in the cylindrical guide portion of the nozzle body. The bores merge into a channel which, in turn, communicates with one of the pressure chambers. In the position of rest of the valve needle, only the smaller bore is open. During the course of the stroke of the valve needle, the smaller bore is closed and the bore of larger cross section is opened. The total flow passage section between the pressure chambers varies during the stroke of the valve needle according to a pattern dependent upon the position of the bores or the valve needle edges which control said bores.

A control of two bores in the above manner has the disadvantage that there are required a pair of very accurately coordinated control edges and controlled bores. The manufacture of such structures is involved and expensive. Further, the deflection of the fuel flow from one bore to the other during the relatively short injection periods generates unavoidably eddy currents which impart disadvantageous pressure pulses on the valve needle and thus, dependent upon the r.p.m. of the engine, affect the control process in a varying extent. Further, in such a flow passage control technological difficulties are encountered in trying to maintain, during the opening stroke of the valve needle, a total flow passage section which remains constant for the idling fuel qualities (i.e., for the idling operation of the internal combustion engine), and then, without dropping, increases for the full load fuel quantities.

OBJECT AND SUMMARY OF THE INVENTION

It is an object of the invention to provide an improved fuel injection valve of the aforenoted type in which the aforenoted disadvantages are eliminated.

Briefly stated, according to the invention, the two pressure chambers are interconnected by means of at least one continuously open throttle channel. The flow passage section of the throttle channel is selected in such a manner that during idling r.p.m., the entire delivered fuel quantity flows solely through said throttle channel.

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

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is an axial sectional view of a first embodiment;

FIG. 2 is an axial sectional view of a second embodiment;

FIG. 3 is an axial sectional view of a third embodiment;

FIG. 4 is an axial sectional view of a fourth embodiment; and

FIG. 5 is an axial sectional view of a fifth embodiment.

DESCRIPTION OF THE EMBODIMENTS

In a nozzle body 1 there is provided a stepped valve needle which comprises a portion 2 of larger diameter and a portion 3 of smaller diameter. Both portions are guided in a fluidtight manner in the nozzle body. An adjoining further portion 4 of smallest diameter includes a sealing face 5 which, in a closed position of the fuel injection valve, engages a valve seat 6 formed in the nozzle body 1.

The shoulders separating the different valve needle portions 2, 3 and 4 form annular work faces which are exposed to the fuel pressure in the opening direction of the valve needle. The work face 7 formed between the valve needle portions 2 and 3 operates in a pressure chamber 8 formed in the nozzle body 1. Into the pressure chamber 8 there merges a fuel supply channel 9. The work face 10 formed between the valve needle portions 3 and 4 operates in a pressure chamber 11 also formed in the nozzle body 1. The pressure chamber 11 is delimited at its downstream end by the cooperating sealing face 5 and the valve seat 6.

The pressure chambers 8 and 11 are in continuous communication by means of a throttle channel 13. As soon as fuel flows from the fuel injection pump through the supply channel 9 into the pressure chamber 8, one part of said fuel passes through the throttle channel 13 into the pressure chamber 11. The pressure of the fuel in the pressure chambers exerts a force on the work faces of the valve needle in the opening direction thereof. As soon as said force overcomes the opposing force with which the valve needle is maintained in a closed position, the valve needle moves away from the seat 6 and thus fuel is injected into the internal combustion engine. The valve needle and the guide portions of the nozzle body cooperate in such a manner that the valve needle portion 3 emerges from its guiding bore thus permitting a substantially unthrottled fuel flow from chamber 8 to chamber 11 (from which it is injected into the engine) only when the fuel injection pump delivers to the fuel injection valve fuel quantities that are in excess of those needed for idling. Stated differently, the flow passage section of throttle channel 13 is so designed that during idling r.p.m. of the internal combustion engine the entire fuel quantity that flows from chamber 8 to chamber 11 passes solely through the throttle channel 13.

In the embodiments according to FIGS. 1, 3, 4 and 5, the flow passage section of the nozzle opening 14 is controlled by a terminal pin 15 integral with the valve needle; the sealing face 5 and the valve seat 6 are of a complemental conical configuration. According to the embodiment shown in FIG. 2, the pressure chamber 11 is delimited at its downstream end by a frontal plate 16 containing the nozzle opening 14 and serving as a planar seat 6 for the planar sealing face 5 of the valve needle.

In the embodiments of FIGS. 1 and 2, the throttle channel 13 extends in the nozzle body 1, whereas, in the embodiments shown in FIGS. 3 and 4, it extends in the valve needle portion 3 which, for this purpose, has a collarlike configuration. In the embodiment depicted in FIG. 5, the throttle channel 13 extends between the nozzle body 1 and a flattened part 3' provided in the valve needle portion 3.

What is claimed is:

1. In a fuel injection valve associated with an internal combustion engine and being of the type that has (a) a nozzle body, (b) a reciprocating valve needle guided in said nozzle body in a fluidtight manner, (c) at least two axially spaced work faces provided on said valve needle and affected by fuel pressure for moving said valve needle, (d) a supply channel carrying fuel under pressure, the improvement comprising,

A. a first pressure chamber associated with one of said work faces and communicating with said supply channel,

B. a second pressure chamber associated with another of said work faces and spaced from said first pressure chamber,

C. a nozzle opening communicating with said second pressure chamber,

D. a valve seat formed between said second pressure chamber and said nozzle opening for cooperating with said valve needle,

E. a first passage means interconnecting said first and second pressure chambers for maintaining continuous communication therebetween independently of the position of said valve needle,

F. a second passage means interconnecting said first and second chambers and cooperating with said valve needle, said second passage means being opened by said valve needle upon reaching a predetermined distance from said valve seat during reciprocation, said second passage means being maintained open by said valve needle when situated beyond said predetermined distance.

2. An improvement as defined in claim 1, wherein said second passage means is formed of a bore traversed by said valve needle; said valve needle includes a portion disposed within said bore and obturating said second passage means when said valve needle is spaced from said valve seat at less than said predetermined distance, said portion of said valve needle is disposed externally of said bore and opening said second passage means when said valve needle is spaced from said valve seat farther than said predetermined distance.

3. An improvement as defined in claim 1, wherein said predetermined distance is greater than the maximum excursion of said valve needle during idling operation of said internal combustion engine.

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