1593112

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(54) A FUEL INJECTION NOZZLE FOR INTERNAL COMBUSTION ENGINES

(71) We, ROBERT BOSCH GmbH, a German company of Postfach 50, 7 Stuttgart 1, Federal Republic of Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to a fuel injection nozzle whose valve needle is controllable by means of an adjusting piston.

In known fuel injection nozzles of this type the adjusting piston always acts upon the valve needle after the latter has travelled a specific stroke. Some disadvantages of this method of control are that firstly, it is impossible to hydraulically press the valve needle onto its seat, secondly it is impossible to make opening control of the valve needle independent of the fluid pressure of the fuel to be supplied to the engine and thirdly the adjusting piston always comes into operation with the valve needle after the latter has travelled a specific stroke. It is an object of the present invention to solve at least some of these problems.

In accordance with this invention there is provided a fuel injection nozzle for an internal combustion engine embodying a hollow valve member displaceable within a nozzle body against spring pressure, by the pressure of fuel supplied for injection, to open one or more fuel injection openings in the body, a valve needle accommodated within the hollow valve member for relative and independent movement therein also by the pressure of the same fuel supplied for injection, to open one or more other fuel injection openings in the body, an adjusting piston arranged to control movement of the valve needle and by displacement in a closing direction of the valve optionally to over-ride the movement of the valve needle on the application of control fluid pressure to the piston, and means for applying fluid pressure to the adjusting piston.

In comparison with the known fuel injection nozzles the fuel injection nozzle in accordance with this invention has the advantage that a greater degree of freedom is possible in forming the injection characteristics of the nozzle than with the known nozzles.

The invention will be further described hereinafter, by way of example, with reference to the accompanying drawings in which:

Fig. 1 is a partial longitudinal section through one embodiment of the present invention;

Figs. 2 and 3 are sections on different scales showing more details of the embodiment illustrated in Fig. 1;

Fig. 4 is a partial longitudinal section through another embodiment of this invention, and

Fig. 5 is a section on a different scale showing further details of the embodiment illustrated in Fig. 4.

In both embodiments, a nozzle body 1 is clamped by means of a retaining nut 2 onto a nozzle holder 3. A pressure connection 4, a leakage connection 5 and a control connection 6 are provided on the nozzle holder. The fuel supplied through the pressure connection 4 passes on through a pressure channel 7 extending along and within the nozzle holder 3 and the nozzle body 1. The control fluid is supplied through the control connection 6 and an adjoining control channel 8 to an adjusting piston 9 which is displaceable against a restoring spring 10. In the unloaded state, i.e. in the starting position, the adjusting piston 9 has no controlling action upon the injection nozzle. A chamber 11 accommodating the spring 10 and a chamber 13 accommodating the spring 10 and a chamber 13 accommodating a closure spring 12 of a hollow valve member 16 is relieved of pressure through the leakage connection 5.

A valve needle 15 and the hollow valve member 16 accommodating the former are also disposed in the nozzle body 1, these elements controlling fuel flow to injection openings 17 and 18 respectively.

In the first embodiment shown in Figs. 1 to 3, the valve needle 15 is not loaded by its own closure spring. Between the adjusting piston 9 and the end of the valve needle there is a gap corresponding to the maximum stroke,

H_1, of the needle. A cylindrical member 19, which is screwed into the nozzle holder 3 and accomodates the adjusting piston 9, may be screwed from outside the nozzle holder so as to adjust the distance H_1 and hence the maximum stroke of the valve needle 15. A sealing ring 20 prevents fuel leakage. The hollow valve member 16 is loaded by the spring 12 acting against a spring abutment sleeve 21 inserted between one end of the spring and member 16 (Figs. 1 and 2). An intermediate plate 22, through which the pressure channel 7 also extends, is clamped between the nozzle body 1 and the nozzle holder 3. The pressure channel 7 terminates in a pressure chamber 23 disposed in the nozzle body 1. When the hollow valve member 16 has been raised, it opens the injection openings 18 to the pressure chamber 23 to that injection may occur through them. The fuel does not act until then upon the valve needle 15. If the adjusting piston 9 does not prevent its opening, the valve needle 15 is displaced and opens the injection openings 17 to the pressure chamber 23. If, however, the adjusting piston 9 is urged by pressure in the control channel 8 against the action of spring 10 onto the valve needle 15 (closing gap H_1) and preventing displacement of needle 15, the total injection cross-section is limited to the cross-section of the injection openings 18, which may result in a prolonged injection period. It may, however, also be desirable to control the exact injection sequence of the injection openings 18 and 17 with the valve needle 15, as it is important to do, for example, for pre-injection. Without operation of the adjusting piston 9 from its illustrated position, on the other hand, the injection openings 17 and 18 are both opened almost simultaneously for injection.

In the second embodiment shown in Figs. 4 and 5, the valve needle 15 is loaded, into a position in which it closes openings 17, by a closure spring 24. A mandrel 25 serving as an operational connection with the valve needle 15 is fixed on the adjusting piston 9. The mandrel 25 is loaded by the closure spring 24 of the valve needle 15. A bush 26 disposed around the spring 24 serves to transmit force from the hollow valve member 16 to the spring abutment sleeve 21 of the closure spring 12 which loads the hollow valve member. The distance between the valve needle 15 and the mandrel 25 is again the maximum stroke H_1 of the needle. The maximum stroke H_2 (Fig. 4) of the hollow valve member is determined by the distance between the spring abutment sleeve 21 and a stop 27, in whose central bore the mandrel 25 is guided. The fuel supplied is conveyed through the pressure channel 7 into a pressure chamber 28 disposed between the valve needle 15 and the hollow valve member 16. For this purpose, radial bores 29 (Fig. 5) are provided in the hollow valve member 16. The supplied fuel therefore acts simultaneously upon the valve needle 15 and the hollow valve member 16 in an opening direction. Depending upon which of the springs 24 and 12 provides the greater or smaller force relative to the surfaces of the valve needle and the valve member respectively which act in an opening direction, the valve needle or the hollow valve member will be the first to move. This opening sequence, which is determined from the start, is influenced additionally by the adjusting piston 9. When control fluid is supplied through the control connection 6 and the control channel 8 to the piston 9 and the latter is displaced, the valve needle 15 is held on its seat when pressure is supplied through connection 4. The supplied fuel is therefore only injected through the injection openings 18. If the hollow valve member 16 normally moves before the valve needle 15, the injection cross-section is restricted to that of the openings 18. On the other hand, if the valve needle 15 normally moves before the hollow valve member 16, the control sequence may be reversed through intervention at the adjusting piston 9. Injection may therefore occur firstly through the injection openings 18 and then, after relieving of the adjusting piston 9, through the injection openings 17, it being possible for the closure spring of the valve needle to push the latter back onto its seat. The range of application is therefore relatively great. A nozzle controlled in this manner may on the one hand be used for pre-injection, for extending the injection time and the like and on the other hand it may serve as a changeover nozzle in order to change from one injection opening series (for example 17) to another injection opening series (for example 18) as is necessary, for example, in the "M-system" or "Meurer system" wherein, when the engine is cold, injection is effected into a central region of the combustion chamber whilst, when the engine is warm, it is effected onto the cylinder wall of the chamber.

Conveniently the pressurised control fluid which actuates the adjusting piston 9 may be applied and released as a servo fluid by an engine speed dependently actuable solenoid valve independently of the fuel which is supplied under pressure for injection through the nozzle to an internal combustion engine. The servo fluid, acting as a control fluid may be that from a supply (pre-supply) pump, or it may conveniently be the brake oil from a servo system of the motor vehicle to which the nozzle is fitted.

In the application of the invention to a pintle-type valve, the stroke of the valve needle having the throttle pintle thereon extending through the respective valve seat is

limited by the adjusting piston so that the pintle always remains partially within the respective injection opening.

In our United Kingdon Patent Specification No. 1,200,202, we have described and claimed a fuel injection valve for an internal combustion engine, which valve has a hollow valve needle and a second valve needle guided therewithin, each of the needles controlling at least one fuel injection opening which is completely separated from the injection opening controlled by the other, both needles having surfaces arranged to be subjected simultaneously to fuel delivered under pressure to the valve, in the opening direction against closure forces applied to the needle.

WHAT WE CLAIM IS:—

1. A fuel injection nozzle for an internal combustion engine embodying a hollow valve member displaceable within a nozzle body against spring pressure, by the pressure of fuel supplied for injection, to open one or more fuel injection openings in the body, a valve needle accommodated within the hollow valve member for relative and independent movement therein also by the pressure of the same fuel supplied for injection, to open one or more other fuel injection openings in the body, an adjusting piston arranged to control movement of the valve needle and by displacement in a closing direction of the valve optionally to over-ride the movement of the valve needle on the application of control fluid pressure to the piston, and means for applying fluid pressure to the adjusting piston.

2. A fuel injection nozzle as claimed in claim 1, in which a spring acts upon the adjusting piston in the opening direction of the valve needle.

3. A fuel injection nozzle as claimed in claim 1 or 2, in which the needle valve is in the form of a pintle type valve having a valve seat, upstream of a injection opening into which a throttle pintle extends, and the adjusting piston limits the stroke in such a manner that the throttle pintle remains at least partially in the injection opening.

4. A fuel injection nozzle as claimed in any one of claims 1 to 3, in which the needle valve can be pressed by the adjusting piston onto its co-operating valve seat against the supplied fuel pressure which acts in an opening direction upon the needle valve, whereby the or each injection orifice controlled by the needle valve remains blocked.

5. A fuel injection nozzle as claimed in any one of claims 1 to 4, in which the supplied fuel passes initially into a pressure chamber for a valve member and only then passes into a pressure chamber for a needle valve after raising the valve member.

6. A fuel injection nozzle as claimed in any one of claims 1 to 5, in which the adjusting piston is loaded by a spring acting in the opening direction of the valve so that when control pressure is not applied to it the needle valve opens its injection opening or openings, and on over-riding of the adjusting piston by application of the control pressure thereto closes it or them.

7. A fuel injection nozzle as claimed in any preceeding claim, in which the pressurised control fluid which actuates the adjusting piston may be applied and released as a servo fluid by a valve independently of the fuel which is supplied under pressure for injection.

8. A fuel injection nozzle as claimed in claim 7, in which fuel from a supply pump (pre-supply pump) serves as a servo fluid.

9. A fuel injection nozzle as claimed in claim 7, in which brake oil from a servo system of a motor vehicle, to which the nozzle is fitted, serves as a servo fluid.

10. A fuel injection nozzle as claimed in any one of claims 7 to 9, in which a solenoid valve, which is speed-dependently actuable, is provided for applying and releasing the pressurised control fluid.

11. A fuel injection nozzle constructed and adapted to operate substantially as herein described with reference to and as illustrated in Figs. 1 to 3 of the accompanying drawings.

12. A fuel injection nozzle constructed and adapted to operate substantially as herein described with reference to and as illustrated in Figs. 4 and 5 of the accompanying drawings.

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1593112 COMPLETE SPECIFICATION
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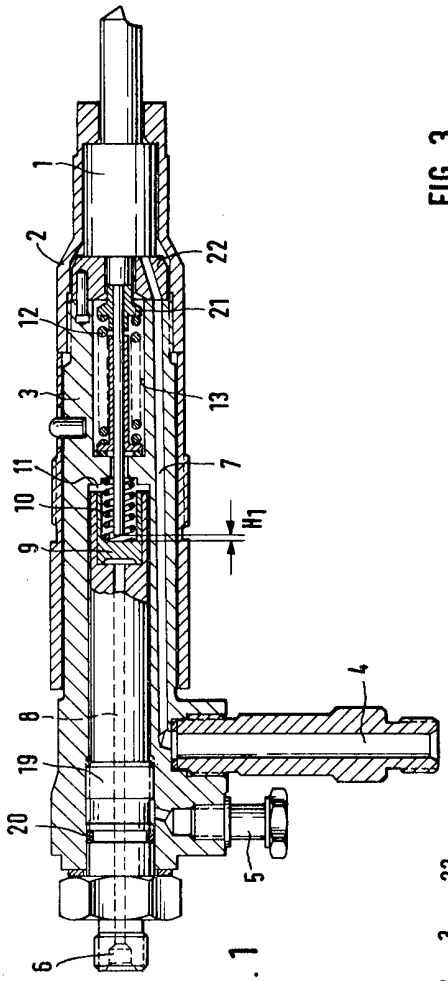

FIG. 1

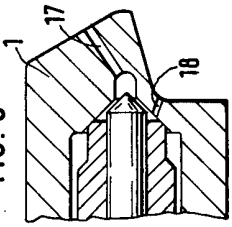

FIG. 3

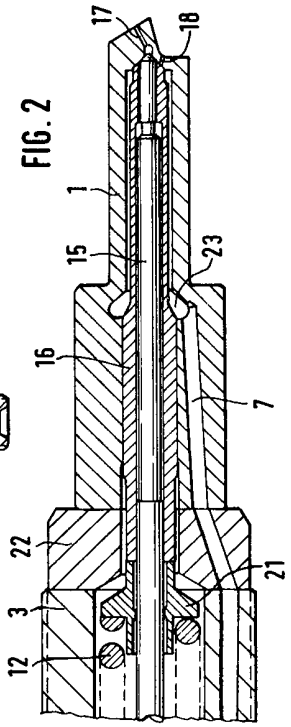

FIG. 2

1593112 COMPLETE SPECIFICATION
2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 2

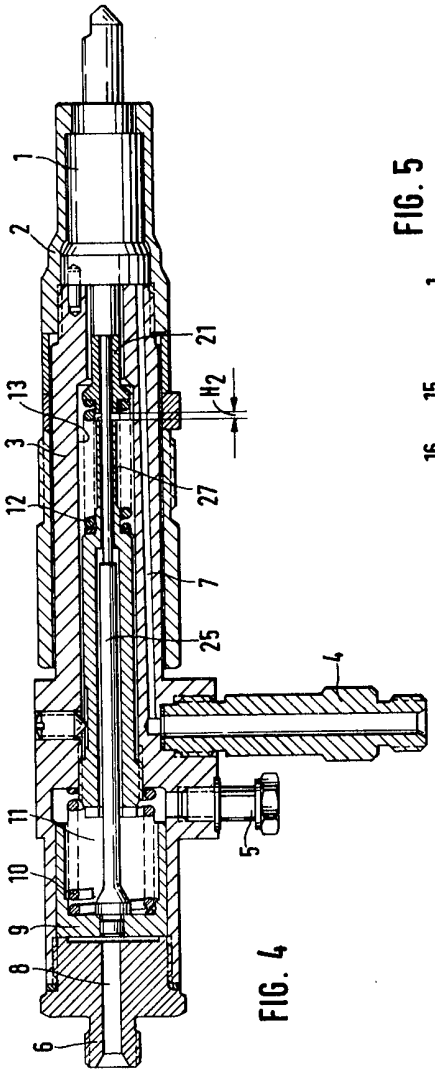

FIG. 4

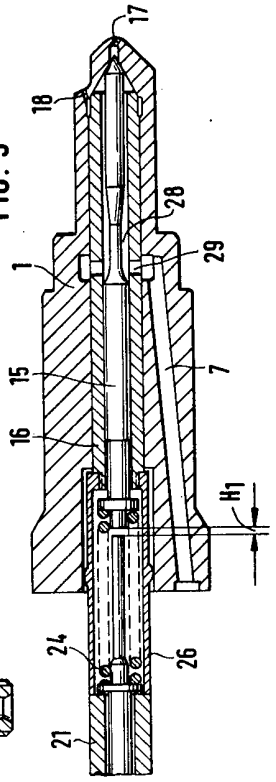

FIG. 5