(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 366 351 A2**

(12) **EUROPEAN PATENT APPLICATION**

(21) Application number: **89310738.3**

(51) Int. Cl.5: **F02M 45/08**

(22) Date of filing: **18.10.89**

(30) Priority: **27.10.88 GB 8825136**

(43) Date of publication of application: **02.05.90 Bulletin 90/18**

(84) Designated Contracting States: **DE ES FR GB IT**

(71) Applicant: **LUCAS INDUSTRIES public limited company**
Great King Street
Birmingham, B19 2XF West Midlands(GB)

(72) Inventor: **Scott, Robert Henry**
17 Bulldog Road Chatham
Kent ME5 98SL(GB)

(74) Representative: **Thompson, George Michael et al**
MARKS & CLERK Alpha Tower Suffolk Street
Queensway
Birmingham B1 1TT(GB)

(54) Fuel injection nozzle.

(57) A fuel injection nozzle including a fuel pressure actuated valve member 19 movable by fuel pressure against the action of a spring 22 to lift the valve member from a seating 15 to allow fuel flow through an outlet 16 has a piston 15 to allow fuel flow through an outlet 16 has a piston 25, a surface of which is exposed to the fuel pressure to assist the initial movement of the valve member. The piston is formed as a sleeve 25 through which the valve member extends and the surface against which the fuel under pressure acts is defined by a step on the external surface of the sleeve, the sleeve being slidable within a stepped cylinder 24.

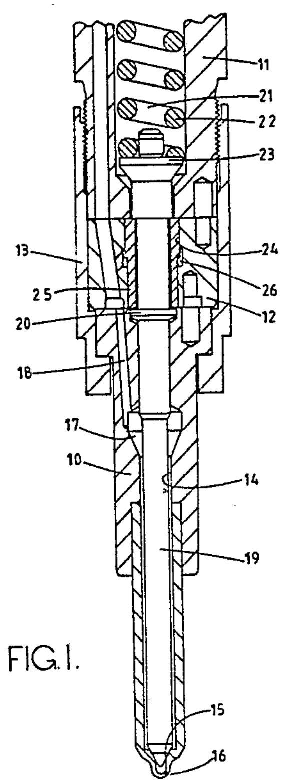

FIG.1.

EP 0 366 351 A2

FUEL INJECTION NOZZLE

This invention relates to a fuel injection nozzle for supplying fuel to an internal combustion engine, the nozzle comprising a valve member defining a surface against which fuel under pressure supplied to an inlet can act to lift the valve member away from a seating against the action of resilient means, the valve member when lifted from the seating allowing a flow of fuel from the inlet to an outlet, a piston member defining a surface against which fuel under pressure from the inlet can act, the piston member acting to assist the initial movement of the valve member against the action of the resilient means and stop means for limiting the movement of the piston member.

Fuel injection nozzles of the aforesaid kind provide for two stage lifting of the valve member away from the seating, the first stage of lift being such as to allow a fuel flow to the combustion chamber of the associated engine at a restricted rate and the second stage of lift allowing fuel flow at a substantially unrestricted rate. The fuel pressure required to lift the valve member from its seating is known in the art as the nozzle opening pressure and is lower than the fuel pressure required to lift the valve member through the second stage of lift.

The nozzle opening pressure depends upon the force exerted by the resilient means and the areas of said surfaces of the valve member and piston member exposed to the fuel pressure at the inlet. The pressure required to move the valve member alone depends upon the force exerted by the resilient means and the area of said surface although, when the valve member has been lifted from the seating the area of the valve member exposed to fuel pressure is slightly increased since a portion of the valve member is shielded from the fuel pressure when the valve member is in contact with the seating.

Fuel injection nozzles of the aforesaid type are known from British Patent Specification 1531580. In two of the examples described in the aforesaid specification the piston member is constituted by one or more pistons slidable in a bore or respective bores. In each example one end surface of the piston or pistons is exposed to the fuel pressure at the fuel inlet of the nozzle and the other end or ends of the piston engage the valve member or an abutment for the aforesaid resilient means. In the other two examples described in the specification the piston member is in the form of a slidable sleeve which surrounds the valve member and again one end surface of the sleeve is exposed to the pressure of fuel at the fuel inlet of the nozzle and the other end of the sleeve engages either the valve member or the aforesaid abutment.

A similar type of injection nozzle is shown in GB2145468B in which the piston member is in the form of a sleeve which engages with the valve member. In some applications for nozzles of the aforesaid kind, it is required that the increase in fuel pressure which is required to move the valve member through the second stage of movement should not be appreciably higher than the nozzle opening pressure in order to reduce the risk of the valve member being lifted from its seating by the action of reflected pressure waves in the pipelines connecting the fuel inlet of the nozzle to the associated fuel injection pump and also to reduce the risk of gas blow by which is the lifting of the valve member from its seating by the pressure of gases in the associated combustion chamber of the engine. These risks can be minimised by raising the nozzle opening pressure and the pressure required to lift the valve member through the second stage of movement, however, the latter pressure could then be undesireably high.

In order to reduce the difference between the two pressures, the areas of the piston member which are exposed to the fuel pressure can be reduced. However, in the case of the sleeve the reduced section can cause problems firstly in the production of the sleeve and secondly in that the thinner the section of the sleeve the more likely it is to be distorted either due to hydraulic forces or mechanical forces. Moreover, the area of the sleeve for engagement with the valve member or the abutment, is reduced unless the sleeve is provided with a flange. In the case of the piston the diameter can be reduced but again there is a risk of distortion occuring.

The object of the present invention is provide a fuel injection nozzle of the aforesaid kind in a simple and convenient form.

According to the invention in a nozzle of the kind specified the piston member has a stepped peripheral surface and is slidable in a stepped cylinder the stepped portion of the cylinder being relieved to define an annular chamber which is connected to the fuel inlet and the end surface of the piston member being exposed to the same pressure.

A example of a fuel injection nozzle in accordance with the invention will now be described with reference to the accompanying drawings in which:-

Figure 1 is a sectional side elevation showing a substantial part of the nozzle, and

Figure 2 is a view to an enlarged scale of a portion of the nozzle seen in Figure 1.

Referring to the drawings the injection nozzle comprises a stepped nozzle body 10 which is secured to a tubular elongated nozzle holder 11. Intermediate the holder and the nozzle body is a distance piece 12 and the aforesaid components are held in assembled relationship by means of a cap nut 13.

The nozzle body defines a blind bore 14 at the blind end of which there is formed a seating 15 which leads into a sac volume from which extends an outlet orifice 16. Intermediate the ends of the bore 14 there is defined an annular chamber 17 which is connected to a fuel inlet passage 18 extending through the distance piece and the holder to a fuel inlet (not shown) which in the use of the nozzle, is connected by a pipeline to the outlet of a fuel injection pump.

Within the bore 14 there is located a valve member 19, the portion of the valve member lying between the chamber 17 and the seating being of reduced diameter so as to define with the wall of the bore, an annular clearance. The portion of the valve member between the chamber 17 and the open end of the bore is a sliding fit with the wall of the bore. The inner end of the valve member is shaped for co-operation with the seating and the opposite end of the valve member extends from the bore the latter adjacent the distance piece 12, being enlarged to accommodate a flange 20 formed on the valve member.

The holder 11 defines a cylindrical chamber 21 in which is located a coiled compression sprng 22. The end of the spring remote from the distance piece is engaged with a suitable spring abutment which may be adjustably mounted in the holder. The end of the spring 22 closer to the distance piece is engaged with a spring abutment 23 which is in engagement with the end of the valve member 19 remote from the seating.

The distance piece 12 defines a bore 24 in which is slidably mounted a piston member in the form of a sleeve 25. As is clearly shown in the drawings the sleeve 25 is of stepped form with the narrower end located adjacent the nozzle body. The bore 24 is also stepped but the step in the bore is relieved so as to define an annular chamber 26 surrounding the sleeve, the chamber 26 communicating by way of a drilling 27 with the portion of the passage 18 lying within the distance piece. The diameter of the narrower end of the sleeve is slightly greater than the diameter of the enlarged portion of the bore 14 in the nozzle body so that a step is defined which acts to limit the downward movement of the sleeve. In the closed position of the valve member as shown, a clearance indicated by the reference letter A exists between the flange 20 on the valve member and the adjacent end of the nozzle body. Moreover, the reference letter B indicates the amount by which the spring abutment 23 projects beyond the end of the holder in the closed position of the valve member. Furthermore, with the narrower end of the sleeve 25 resting on the nozzle body 10 a small clearance indicated by the reference letter C exists between the wider end of the sleeve and the spring abutment. The end portion of the spring abutment 23 which engages the valve member, overhangs the valve member so that it can be engaged by the sleeve 25 as will be described.

The bore in the sleeve is larger in diameter than the valve so that a clearance exists between the valve member and the sleeve, the clearance communicating with the enlarged portion of the bore 14 which accommodates the flange 20 and also by way of a drilling 28 in the abutment 23 and a groove in the end face of the valve member or spring abutment, with the chamber 21 which accommodates the spring. This chamber in use, is connected to a drain. It will be understood that the opposite end surfaces of the sleeve are exposed to the same pressure.

In operation, when fuel under pressure is supplied through the fuel inlet, the fuel pressure acts upon the valve member to produce a force acting to lift the valve member away from the seating. In addition, the fuel under pressure supplied to the annular chamber 26 produces by virtue of the difference in the diameters of the sleeve 25, a force acting upwardly which causes the sleeve to move upwardly to take up the clearance C, into engagement with the spring abutment so that the force is applied to the spring abutment 23. The forces acting on the valve member and sleeve are therefore in the same direction and when the fuel pressure rises to a sufficient value, the force exerted by the spring 22 is overcome and the valve member is lifted from its seating to allow flow of fuel from the chamber 17 through the outlet orifice 16. The extent of movement of the valve member is determined by the clearance B because when the sleeve 25 engages with the holder 11 the force acting on the sleeve due to the fuel pressure is no longer transmitted to the spring abutment. This limited movement of the valve member allows by virtue of the throttling effect of the small gap between the valve member and its seating, a restricted flow of fuel to the associated engine. As the fuel pressure at the inlet continues to increase, the fuel pressure acting on the valve member will eventually produce a force which is sufficient to move the valve member against the action of the spring and the valve member will move to its fully open position in which the flange 20 engages the sleeve 25. The maximum movement of the valve member from the closed position to the fully open position is therefore the sum of the clearances A, B and C and the movement of the valve member in the first stage is equal to the clearance B. When the fuel pressure at the inlet falls, the valve member will return to the closed position and the sleeve due to the residual fuel pressure will tend to remain in contact with the spring abutment 23.

By providing the step on the periphery of the sleeve the force developed on the sleeve due to the fuel pressure at the fuel inlet can be easily adjusted by varying the difference in diameters of the wider and narrower portions of the sleeve. At the same time the wall of the sleeve can have sufficient thickness to enable it to withstand hydraulic and mechanical forces.

As shown in the drawings the nozzle body 10 is of two piece construction. It can of course be formed from a single piece of material.

If desired, the distance piece 12 can be formed integrally with the nozzle body.

Claims

1. A fuel injection nozzle for supplying fuel to an internal combustion engine comprising a valve member (19) defining a surface against which fuel under pressure supplied to an inlet can act to lift the valve member away from a seating (15) against the action of resilient means (22), the valve member when lifted from the seating allowing a flow of fuel from the inlet to an outlet (16), a piston member (25) defining a surface against which fuel under pressure from the inlet can act, the piston member acting to assist the initial movement of the valve member (19) against the action of the resilient means (22) and stop means for limiting the movement of the piston member, characterised in that said piston member (25) has a stepped peripheral surface and is slidable in a stepped cylinder (24), the stepped portion of said cylinder being relieved to define an annular chamber (26) which is connected to the fuel inlet, the end surfaces of the piston member (25) being exposed to the same pressure.

2. A fuel injection nozzle according to claim 1 characterised in that said piston member (5) is in the form of a sleeve through which the valve member extends.

3. A fuel injection nozzle according to claim 2 characterised in that said valve member (19) extends with clearance through said sleeve (25) and said clearance communicates with a drain whereby the opposite ends of said sleeve are exposed to drain pressure.

4. A fuel injection nozzle according to claim 3 characterised in that the end of said sleeve (25) remote from said seating (15) is engageable with a spring abutment (23) to assist the movement of the valve member (19) and said end of the sleeve is also engageable with an end surface of a nozzle holder (11) to limit the movement of the sleeve.

5. A fuel injection nozzle according to claim 4 characterised by a flange (20) on the valve member (19), said flange being engageable with the opposite end of the sleeve (25) to limit the total movement of the valve member (19) away from the seating (15).

6. A fuel injection nozzle according to claim 5 characterised in that said cylinder (24) is formed in a distance piece (12) located between a nozzle body (10) and a nozzle holder (11).

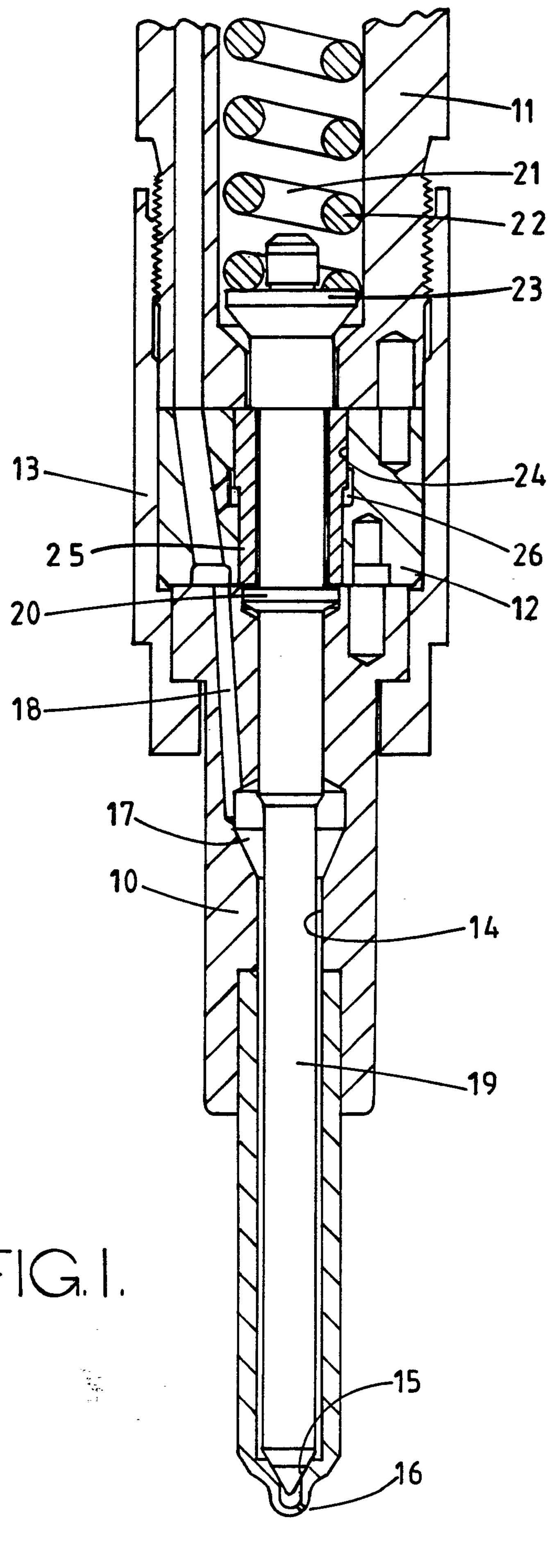

FIG.1.

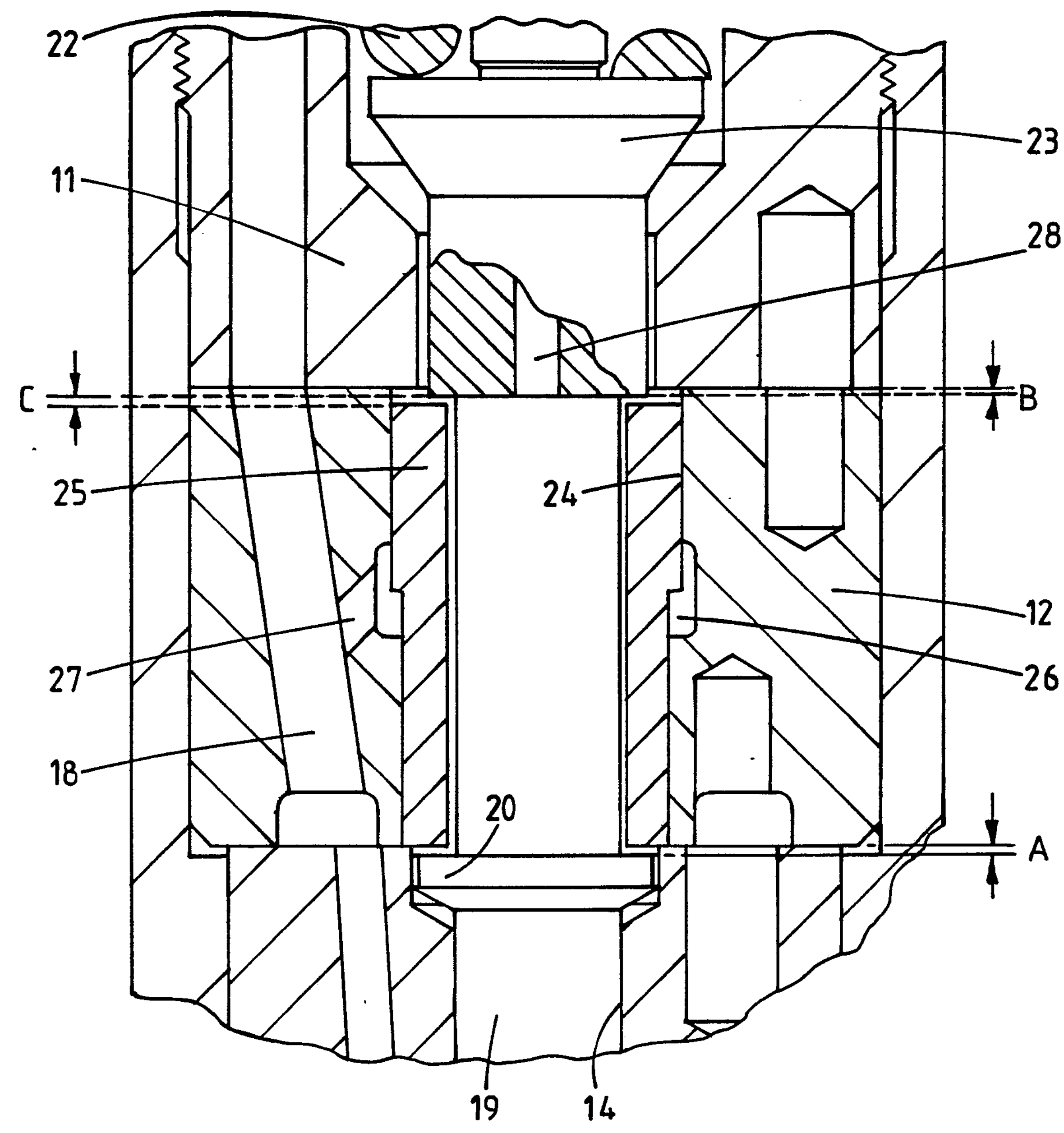

FIG.2.