

[54] **FUEL INJECTION NOZZLE UNITS**

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[58] Field of Search 239/533, 464, 453, 460

[56] **References Cited**

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[57]

ABSTRACT

A liquid fuel injection nozzle unit includes a valve member which is loaded by a spring into contact with a seating and is movable away from said seating by the action of fuel under pressure. The head of the valve member is provided with groove means to promote swirling of the fuel downstream of the valve member as the valve member is opened. The groove means is so constructed that the effective cross sectional area of the grooves attains a maximum value before the valve member has moved to its fully opened position whereby the proportion of the total flow of fuel which flows through the groove means decreases as the valve member attains its fully opened position.

6 Claims, 4 Drawing Figures

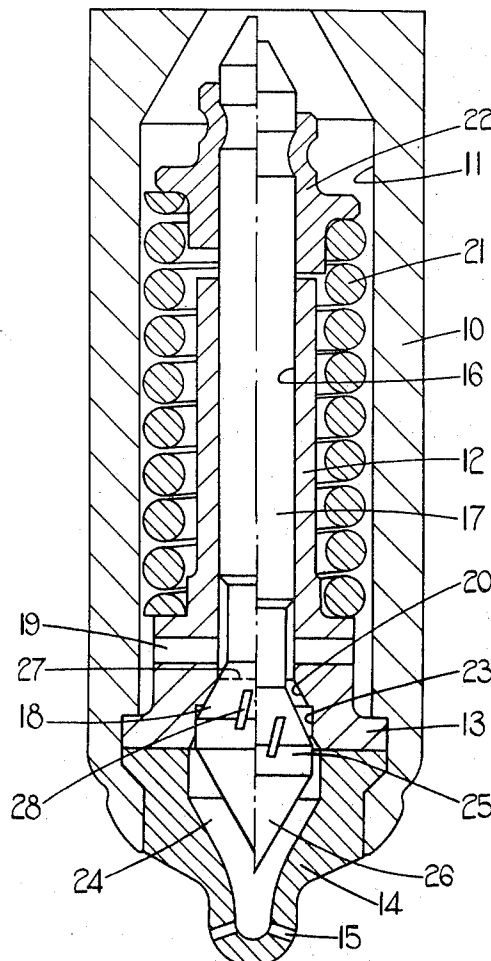
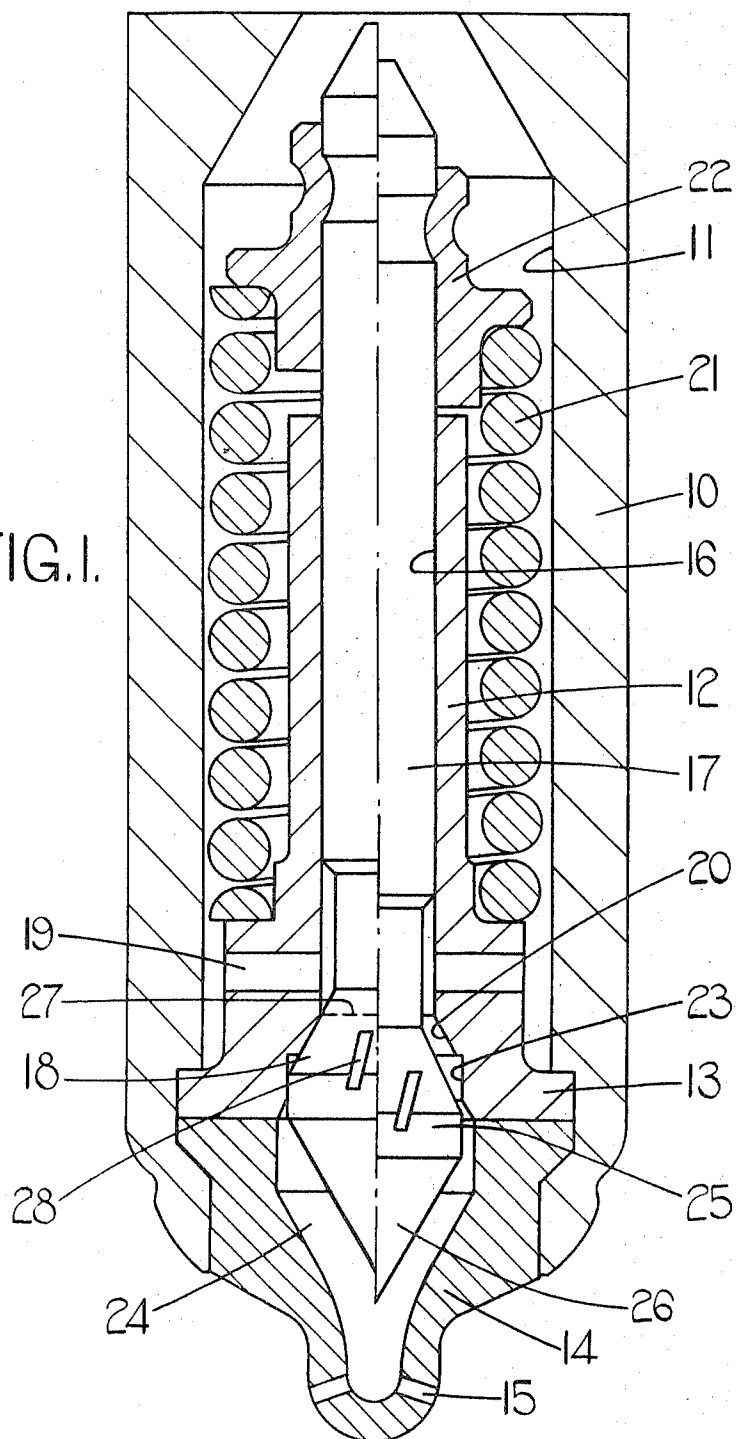


FIG. 1.



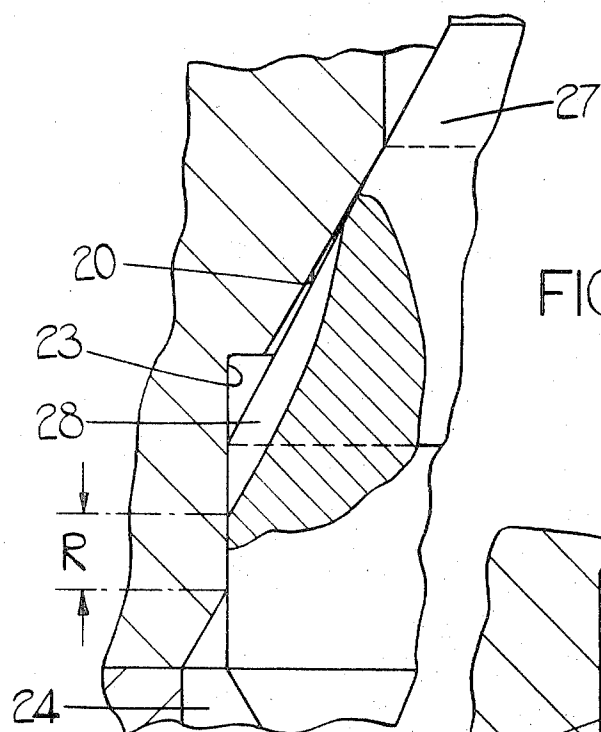


FIG. 2.

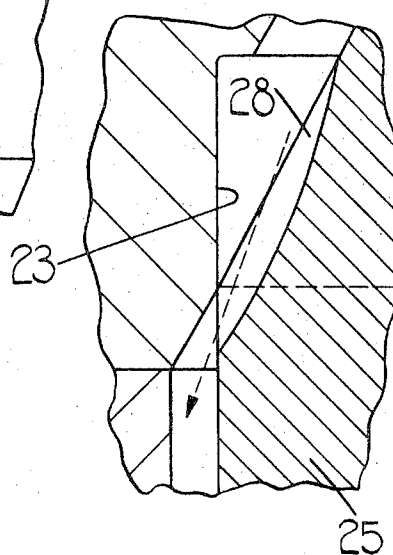


FIG. 3.

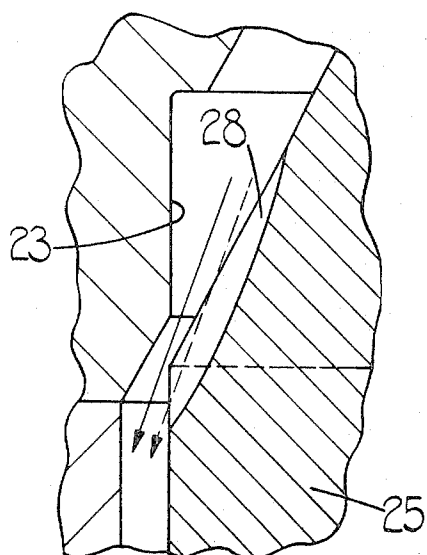


FIG. 4.

FUEL INJECTION NOZZLE UNITS

This invention relates to a fuel injection nozzle unit of the kind comprising a valve member mounted in a valve housing the valve member having a head which can co-operate with a seating defined on the housing, resilient means acting to urge the head into contact with said seating thereby to prevent flow of fuel from an inlet to an outlet, the valve member being movable by the pressure of fuel against the action of the resilient means to permit flow of fuel from the inlet to the outlet.

The object of the invention is to provide such a nozzle unit in a simple and convenient form.

According to the invention in a nozzle unit of the kind specified groove means is provided on the valve head and through which flow of fuel occurs as the valve member is opened by the fuel under pressure, the effective cross sectional area of the groove means increasing as the valve member moves, to a maximum value, the groove means being so formed as to promote swirling of the fuel downstream of the valve member.

According to a further feature of the invention after the effective cross sectional area of the grooves has attained a maximum value the valve member can move an additional amount and during this movement the proportion of the total flow of fuel which flows through said groove means progressively decreases.

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

FIG. 1 is a sectional side elevation of the nozzle showing the valve member in two positions, and

FIGS. 2, 3 and 4 show enlarged views of a portion of the nozzle of FIG. 1 with the valve member in different positions.

With reference to FIG. 1 of the drawings there is provided an elongated body 10 in one end of which is defined a cylindrical cavity 11 which communicates with a fuel inlet (not shown). The fuel inlet in use is connected to a fuel injection pump and body 10 is constructed so that it can be mounted within the wall of a combustion chamber of the engine.

Mounted within the cavity 11 is a valve housing 12 having at one end an enlarged flange 13 which is located against a step defined in the body. Moreover, closing the open end of the cavity is a tip 14 in which is formed a plurality of fuel outlets 15 through which fuel is directed into the combustion chamber of the associated engine. Conveniently the tip is maintained in sealing engagement with the flange and the two are retained relative to the body by folding over the end portion of the body 10.

The housing 12 is provided with a central bore 16 in which is slidably mounted the stem 17 of a valve member. The valve member includes an outwardly tapered head 18 which is located at one end of the stem 17, the stem 17 at this end being of reduced diameter and constituting with the wall of the bore 16 an annular space which communicates with the cavity 11 by way of a plurality of radial passages 19. The housing defines an outwardly tapered seating 20 for co-operation with the head 18 of the valve member to prevent fuel flow to the outlets 15. The seating has a larger included angle than the tapered portion of the head so that line contact as indicated at 27 is established between the head and seating. Moreover, the valve member is loaded by a

coiled compression spring 21 which at one end bears against a step defined on the outer periphery of the housing and which at its other end bears against an abutment 22 secured to the stem 17 of the valve.

At the wider end of the seating 20 there is formed in the housing, cylindrical chamber 23 and this opens into an outlet chamber 24 defined in the tip 14 and from which extend the outlets 15. Moreover, the head 18 of the valve member is provided with a complementary cylindrical portion 25 which in the closed position of the valve member as seen on the left hand side of FIG. 1, lies partially within the cylindrical chamber 23. In the fully open position of the valve the cylindrical portion of the valve head moves out of the cylindrical chamber 23. As seen in the drawings, the valve is provided with a conical end portion 26.

The operation of the valve so far described is as follows. In the closed position of the valve as shown on the left hand side of FIG. 1, the seating 20 makes line contact which is generally indicated at 27, with the valve head 18 and the valve member is maintained in the closed position by the action of the spring 21. When fuel under pressure is supplied through the aforesaid inlet, a force is exerted on the valve member which tends to move the valve member against the action of the spring 21 towards the outlets 15.

In accordance with the invention there is formed on the valve head groove means comprising a plurality of grooves 28. These grooves are inclined to the axis of movement of the valve member in two directions. It will be appreciated that the grooves are formed in the surface of the outwardly tapered head 18 and also as will be seen from FIG. 1 they are inclined in the other direction. Moreover, the grooves extend into the cylindrical portion of the head. FIG. 2 shows to an enlarged scale, a section through a portion of the housing and also the valve member and the difference between the conic or included angle of the seating 20 and the valve head is clearly seen. It will also be noted from FIG. 2 that in the closed position of the valve the ends of the grooves 28 are covered by the wall of the chamber 23. Moreover, it will be noted that the valve member must move through the distance R before the grooves communicate with the outlet chamber 24, the distance R being less than the full lift of the valve.

FIG. 3 shows the condition when the valve member has been partially opened by the pressure of fuel and it will be seen that the flow of fuel as indicated by the dotted arrow, is entirely along the grooves. FIG. 3 also shows the position in which the cylindrical portion 25 of the valve member is just about to clear the wall of the chamber 23. In FIG. 4 there is shown the condition when the valve member is fully opened and it will be seen that the cylindrical portion 25 of the valve member is now well clear of the wall of the cylindrical chamber 23. In this case the flow of fuel to the outlet chamber 24 takes place mainly through the annular space defined between the valve head and the housing although it will be appreciated that a certain quantity of fuel will continue to flow along the grooves 28. FIGS. 2, 3 and 4 represent particular positions of the valve member and it will be appreciated that as soon as the valve member has moved through the distance R fuel will commence to flow along the grooves 28. In this condition the effective cross-sectional area of the grooves 28 through which fuel flows is small and as the pressure of the fuel increases so that the valve opens

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further, the cross sectional area increases until it reaches its maximum value when the valve member reaches the position shown in FIG. 3.

As soon as the position shown in FIG. 3 is passed the proportion of the total fuel flow past the valve and which occurs along the grooves 28 decreases until the valve member reaches the fully open position in which the proportion of fuel flowing through the grooves 28 is small as compared with the fuel flowing through the aforesaid clearance.

As has been mentioned the grooves 28 are inclined in two directions and the effect of the inclination in the direction illustrated in FIG. 1, is to promote swirling of the fuel as it flows into the outlet chamber 24. It will be appreciated that when the fuel is supplied only through the grooves 28 maximum swirl in the chamber 24 will be attained however, as the valve member opens further and the proportion of fuel flowing through the grooves 28 decreases, the rate of swirl will decrease.

It will be appreciated that the grooves 28 need not be provided with the inclination which is illustrated in FIG. 1 but at their ends communicating with the chamber 24, may be so shaped as to promote the desired swirling action described above.

In the arrangement described above all the grooves 28 are opened after a predetermined axial movement of the valve member and all the grooves open simultaneously. It will be understood however that the grooves 28 may be so arranged that they open at different axial positions of the valve member and also that one or more of the grooves may be in permanent communication with the chamber 24 so that as soon as the valve member starts to move against the action of its spring, fuel flows into the chamber 24.

I claim:

1. A fuel injection nozzle unit comprising a valve housing, a seating defined on the housing, a valve member mounted in the valve housing, a head forming part of the valve member, resilient means acting to bias the head into contact with the seating thereby to prevent flow of fuel from an inlet to an outlet both of which are formed in the housing, the valve member being movable by the pressure of fuel supplied to the inlet against the action of the resilient means to permit flow of fuel from the inlet to the outlet, groove means defined on the valve head and through which flow of fuel occurs as the valve member is opened by the fuel under pressure, the effective cross sectional area of the groove means increasing as the valve member moves, to a maximum value, the valve member when the effective cross sectional area of the during means has attained its maximum value, continuing to move during which movement the proportion of the total flow of fuel which

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flows through said groove means progressively decreases, the groove means being so formed as to promote swirling of the fuel downstream of the valve member.

2. A fuel injection nozzle unit comprising a valve housing, a seating defined on the housing, a valve member mounted in the housing, a head forming part of the valve member, resilient means acting to bias the head into contact with the seating thereby to prevent flow of fuel from an inlet to an outlet both of which are formed in the housing, the valve member being movable by the pressure of fuel supplied to the inlet against the action of the resilient means to permit flow of fuel from the inlet to the outlet, said seating tapering outwardly in the direction towards the outlet, a cylindrical chamber defined in the housing downstream of the seating, the head of the valve member being of complementary shape to the seating, a cylindrical portion defined on the head and disposed within said cylindrical chamber in the closed and partially open positions of the valve member, said cylindrical portion in the fully open position of the valve member being withdrawn from said chamber, groove means formed in the tapered and cylindrical portions of the valve head, said groove means acting to convey fuel to the outlet and being shaped so as to promote swirling of the fuel downstream of the valve member, the effective cross sectional area of the groove means increasing as the valve member moves, to a maximum value.

3. A nozzle unit as claimed in claim 2 in which said groove means comprises a plurality of grooves some at least of which are opened progressively beyond the end of the chamber as the valve member moves towards the open position, said grooves being fully open before the valve member attains its fully open position whereby as the valve member moves further towards its fully open position, the proportion of the total flow of fuel which flows through the grooves will progressively decrease.

4. A nozzle unit as claimed in claim 3 including an outlet chamber positioned downstream of said cylindrical chamber, said outlet extending from said outlet chamber, the head of the valve member being provided with a generally conical portion disposed in said outlet chamber.

5. A nozzle unit as claimed in claim 4 in which said grooves are inclined to promote the swirling of the fuel.

6. A nozzle unit as claimed in claim 4 in which the downstream end portions of said grooves are shaped to promote the swirling of the fuel.

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