April 27, 1943. H. FISCHLMAYR 2,317,749

FUEL INJECTION NOZZLE

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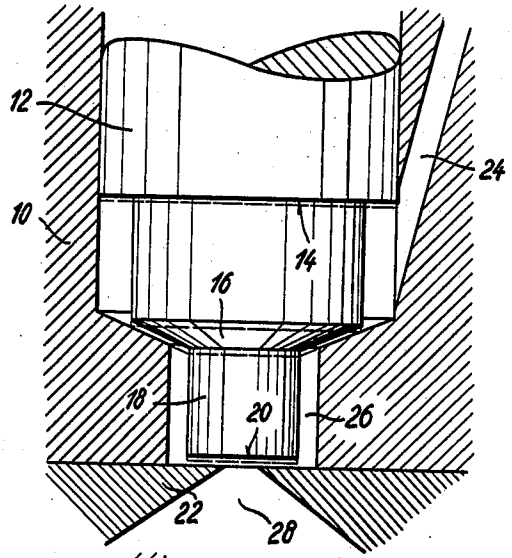


Fig. 1

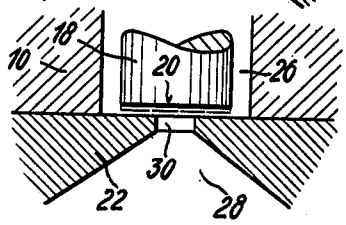


Fig. 2

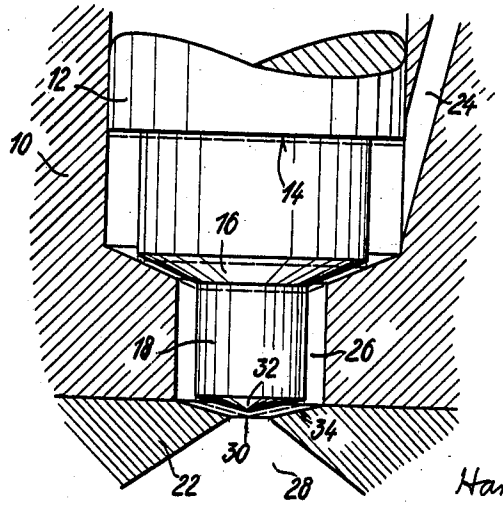


Fig. 3

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Fig. 9

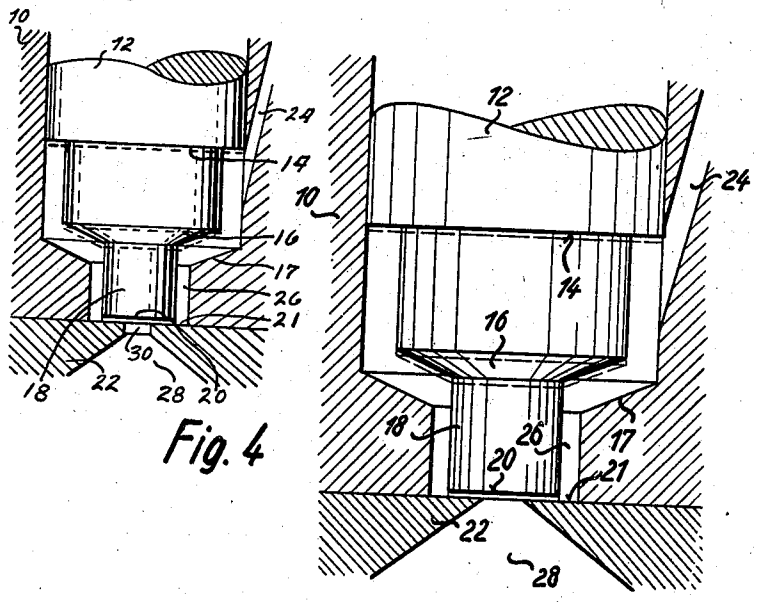


Fig. 4

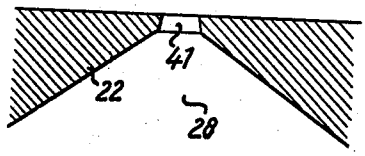


Fig. 5

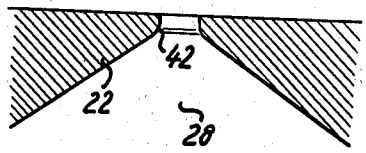


Fig. 6

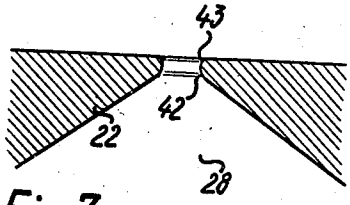


Fig. 7

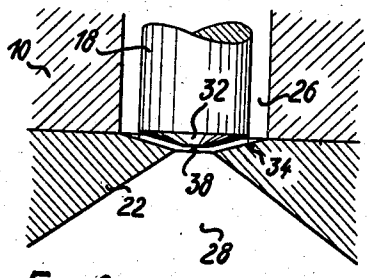


Fig. 8

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UNITED STATES PATENT OFFICE

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FUEL INJECTION NOZZLE

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Application July 13, 1940, Serial No. 345,362
In Germany March 16, 1939

8 Claims. (Cl. 299—107.6)

This invention relates to fuel injection nozzles for internal combustion engines of the injection type, such as Diesel and semi-Diesel engines.

The use of especially developed combustion spaces for internal combustion engines makes possible an exceptional saving of fuel in cases where perfect combustion is attained. Perfect combustion requires, however, that the fuel be introduced in the form of an injection cone with a wide angle, filled approximately uniformly with fuel, the speed of flow of the fuel being relatively low. These requirements are not met in injection nozzles heretofore known, since either the shape of the injection nozzle is unsuitable or the speed of flow is too high.

The object of the present invention is to create an improved and more satisfactory fuel injection nozzle, which meets the above mentioned requirements.

To these and other ends the invention resides in certain improvements and combinations of parts, all as will be hereinafter more fully described, the novel features being pointed out in the claims at the end of the specification.

In the drawings:

Fig. 1 is a cross section through the mouth of an injection nozzle according to one embodiment of the invention, and

Figs. 2 to 9, inclusive, are similar views each illustrating a different embodiment of the invention.

The same reference numerals throughout the several views indicate the same parts.

It is found that very favorable results are attained with the use of a nozzle so designed and constructed that the injected fuel is conducted from a place of high pressure, under considerable change in its direction of flow, to an approximately disk-shaped space, and then flows inwardly toward the center of this disk-shaped space, preferably from all directions, to a discharge opening located at or near the center of the disk-shaped space, the space being of such size and location that the resistance to flow at the inner annular edge of the disk-shaped space is at least as great as the flow resistance through the discharge opening, and the axial length of the discharge opening being, at most, not more than half the inner diameter of such opening. When the nozzle has these characteristics, the fuel expands or atomizes at the place of greatest dynamic pressure, as directly as possible into the combustion space, and excellent results are secured.

Referring now to Fig. 1 of the drawings, there is provided a nozzle body 10 in which a valve body 12 is longitudinally movable. This valve body 12 has a shoulder 14, and a second shoulder 16 of conical shape, seating against a corresponding conical shoulder of the body 10 and constituting the valve.

A portion 18, preferably cylindrical, extends forwardly from the conical seat 16 and terminates in an end 20 which is located in the immediate proximity of the nozzle plate 22, preferably only a few hundredths of a millimeter therefrom, when the valve is closed.

The fuel, under pressure from the fuel injection pump, enters through the duct or passageway 24 leading to an annular space beneath the shoulder 14. The pressure of the fuel acting upwardly on the shoulder 14 lifts the valve body against the pressure of a suitable spring (not shown) and this lifts the conical valve portion 16 off of its seat, permitting the fuel to flow along the conical surface 16 and into the annular space 26 surrounding the cylindrical extension 18. From the space 26, the direction of flow of the fuel is sharply deflected so that the fuel flows from all sides inwardly toward the center of the annular disk-like flow space between the end surface 20 and the nozzle plate 22. Immediately after flowing through this restricted disk-like flow space, offering relatively high resistance to flow, the fuel reaches the central opening in the nozzle plate 22, and then can expand freely through this opening into the combustion space 28, thus being practically completely atomized in a very favorable manner, through a wide angle, and approximately uniformly, with no individually directed streams or jets of fuel.

It will be understood that when the valve is opened or lifted by pressure of the fuel on the shoulder 14, the opening movement is very slight, so that the end 20 of the valve member still remains, even when opened, in close proximity to the upper surface of the nozzle plate 22, and the resistance to flow through the thin disk-like annular space between the surface 20 and the plate 22 is quite large, being greater than the flow resistance through the injection orifice in the plate 22.

When the injection orifice is made with a thin or sharp edge as shown in Fig. 1, manufacturing difficulties are involved, and also the thin edges are subjected to undesirable wear phenomena, especially if the fuel is not sufficiently cleaned or purified. It is preferable to make the injection opening of appreciable length, in order to avoid the sharp edges, and it

may be made as indicated at 30 in Fig. 2, the other parts in this figure being the same as in Fig. 1. For best results it is important, however, that the axial length of the orifice 30 must not exceed half of the diameter of the orifice.

It is not absolutely necessary that the annular disk-like flow space leading to the discharge orifice be in the form of a flat disk, and there is no objection to making it in the form of a somewhat dished disk; that is, of slightly conical form. Such an arrangement is shown in Fig. 3, where the flat end 20 of the valve member is replaced by a slightly conical end 32, the upper surface of the nozzle plate 22 being correspondingly shaped at 34, while the other parts remain as before. When this slightly dished or conical arrangement is used, the injection orifice may, as before, have thin or sharp edges as shown in full lines in Fig. 3, or the thin edges may be replaced by walls providing an injection orifice of substantial length (but not over half its diameter) as shown in dot-dash lines at 30 in Fig. 3.

There is shown in Fig. 4 a different embodiment of the invention, in which, instead of having the valve constituted by the conical shoulder 16 on the body 12, this shoulder remains always substantially separated from the corresponding conical shoulder 17 of the body 10, and the valve itself is constituted by the end 20 of the cylindrical extension 18 actually seating on the upper surface 21 of the nozzle plate 22. The other parts remain as before, and the fuel, entering through the duct 24, presses upwardly on the shoulder 14 to raise the valve member 12 against the pressure of the spring (not shown) thus raising the end 20 a slight distance away from the seat 21 and opening the valve. When the valve is opened, the flow takes place, through the annular disk-like space between the end 20 and the surface 21, in the same manner as already described.

When the injection orifice is made of substantial length to eliminate the sharp or thin edges, it is not necessary to make this orifice of strictly cylindrical shape as shown in Fig. 2 of the drawings, but it is frequently advantageous to make it as a somewhat conical bore, expanding in the direction of flow, as shown at 41 in Fig. 5. It is also advantageous to round off the inner edges of the bore as shown at 42 in Fig. 6, and this is true regardless of whether the bore is slightly tapered as in Fig. 5 or whether it has the strictly cylindrical shape as in Fig. 2. Moreover, advantages are also secured by rounding off both the outer and upper edges of the bore as shown at 43 in Fig. 7, and preferably both the outer and inner edges are rounded, as seen in this figure.

These arrangements in Figs. 5 to 7 have the advantage that any directional effect of injection is eliminated to a greater extent, as compared with the arrangement shown in Fig. 2.

In Fig. 8 there is illustrated a modification of the dished or conical arrangement described in connection with Fig. 3. This modification consists in slightly truncating the conical portion 32 by substituting a flat surface 38 for the point of the cone. This has the advantage that excessive heat stresses on the point of the cone are avoided. It may also be noted from Fig. 8 that when the valve member is made with a conical or truncated conical end as in Figs. 3 and 8, the lower end of the valve member can itself seat against the plate 22 to form the sealing portion of the valve, just as in the case of Fig. 4. Also, whether the lower end of the valve member be flat or whether it be conical, in either event the accompanying injection orifice can be developed in any of the ways described in connection with Figs. 5 to 7.

In Fig. 9 there is illustrated still another form of the invention, embodying the valve chamber and valve member of the same form shown in Fig. 4, in connection with an injection orifice of the same form shown in Fig. 2. The same reference numerals used for these parts in Figs. 4 and 2, respectively, have been used in Fig. 9.

While certain embodiments of the invention have been disclosed, it is to be understood that the inventive idea may be carried out in a number of ways. This application is therefore not to be limited to the precise details described, but is intended to cover all variations and modifications thereof falling within the scope of the appended claims.

I claim:

1. An injection nozzle and valve for internal combustion engines comprising a chamber having a substantially cylindrical portion and an end wall having an injection orifice extending therethrough, said orifice having an axial length of not more than half its greatest cross sectional dimension, and a valve member including a substantially cylindrical portion movable axially within said portion of said chamber and spaced from the side walls thereof to provide an annular flow passage between said portion of said valve member and said portion of said chamber, said valve member having an end surface lying closely adjacent said end wall of said chamber in overlapping relation to said orifice, said end surface of said valve member being sufficiently close to said end wall of said chamber when said valve member is in its open position so that the resistance to fluid flow toward said orifice in the space between said end surface and said end wall immediately around said orifice is at least as great as the resistance to flow outwardly through said orifice.

2. A construction as described in claim 1, in which said end surface of said valve member adjacent said end wall is substantially flat and in which the surface of said end wall cooperating with said end surface to form said flow space is also substantially flat.

3. A construction as described in claim 1, in which said end surface of said valve member adjacent said end wall is at least partially conical and in which the surface of said end wall cooperating with said end surface to form said flow space is also substantially conical.

4. A construction as described in claim 1, in which said end surface of said valve member adjacent said end wall is of truncated conical shape with a flattened end and in which the surface of said end wall cooperating with said end surface of said valve member to form said flow space is substantially conical.

5. A construction as described in claim 1, in which said injection orifice is of material axial length and in which said axial length is not more than half the diameter of said orifice.

6. A construction as described in claim 1, in which said injection orifice opens into a conical section with a relatively great apex angle of more than 90°, so that injected fuel issuing from said orifice may spread immediately through a relatively wide angle.

7. An injection nozzle and valve for internal

combustion engines comprising a chamber having a substantially cylindrical portion and an end wall having an injection orifice extending therethrough, said orifice having an axial length of not more than half of its greatest cross sectional dimension, and a valve member including a substantially cylindrical portion movable axially within said portion of said chamber and spaced from the side walls thereof to provide an annular flow passage between said portion of said valve member and said portion of said chamber, said valve member having an end surface lying closely adjacent said end wall of said chamber in overlapping relation to said orifice, said end surface of said valve member lying against said end wall of said chamber in sealing relation thereto when said valve is closed and moving rearwardly away from said end wall to open said valve and remaining sufficiently close to said end wall when said valve is open so that the resistance to fluid flow toward said orifice in the space between said end surface and said end wall immediately around said orifice is at least as great as the resistance to flow outwardly through said orifice.

8. An injection nozzle and valve for internal combustion engines comprising a chamber having a substantially cylindrical portion, a rearwardly faced shoulder associated with said portion, and an end wall spaced forwardly from said shoulder and having an injection orifice extending therethrough, said orifice having an axial length of not more than half of its greatest cross sectional dimension, and a valve member including a substantially cylindrical portion movable axially within said portion of said chamber and spaced from the side walls thereof to provide an annular flow passage between said portion of said valve member and said portion of said chamber, said valve member having a forwardly faced shoulder adapted to lie against said rearwardly faced shoulder of said chamber in sealing relation thereto when said valve is closed and moving rearwardly away from said rearwardly faced shoulder to open said valve, said valve member also having an end surface lying closely adjacent said end wall of said chamber in overlapping relation to said orifice, said end surface of said valve member being sufficiently close to said end wall of said chamber when said valve member is in its open position so that the resistance to fluid flow toward said orifice in the space between said end surface and said end wall immediately around said orifice is at least as great as the resistance to flow outwardly through said orifice.

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