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FUEL INJECTION NOZZLE

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The present invention relates to fuel injection apparatus and more particularly to an improved fuel injection nozzle designed for use in intermittently introducing timed, metered charges of liquid fuel under pressure and in the form of a jet or spray to the cylinders of an internal combustion engine for combustion purposes.

The improved nozzle construction comprising the present invention is designed as an improvement over the spray nozzle construction shown and described in my prior Patent No. 2,294,029, dated August 25, 1942, for a Fuel Injector and Fuel Jet Construction and the general objects of the present invention are to provide an improved nozzle construction which is sensitive to low operating pressures and which will, in response to such low operating pressures, accurately control the beginning and ending of the fuel discharge cycle and prevent dribbling or bleeding of the fuel at such times, thus protecting the valve seat from erosion; to provide a nozzle having associated therewith valve mechanism which, despite such low operating pressures, will open and close sharply when the proper operating pressure is attained or relieved; and to produce an improved valve mechanism for spray nozzles of the type shown in the above mentioned patent which will attain the same results as my earlier valve mechanism but with improved performance over a prolonged period of time.

A more specific object of the invention is to provide a nozzle construction for use in connection with fuel injection systems having associated therewith a valve mechanism for controlling the flow of liquid fuel through the nozzle from the nozzle inlet to the nozzle outlet and including a valve spring for normally urging the valve parts toward their closed or fuel cut-off positions and in which the spring is disposed exteriorly of the valve parts and in the discharge region thereof as well as on the discharge side of the valve orifice or opening. By such an arrangement, the overall area of the pressure operating surfaces of the movable valve element proper may be increased relative to the size of the bore of the nozzle casing, thereby producing a valve mechanism which is extremely sensitive to pressure differentials.

Another related object of the invention is to provide a nozzle construction of this character in which the valve operating spring is widely removed from the valve orifice or opening, thus relieving this opening from obstruction when fuel is passing therethrough, and thereby permitting maximum flow of fuel through the opening when required.

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A further object of the invention is to provide a nozzle construction of greatly simplified design in which the nozzle casing itself constitutes one element of the valve construction, thus eliminating the necessity of employing the accurately machined heat treated or chrome plated valve sleeve ordinarily associated with such valve structures.

Yet another object of the invention is to provide a nozzle construction having a valve mechanism associated therewith in which the movable valve member proper is of simplified construction in that certain of the fuel conducting passages formerly provided therein, particularly in the head portion thereof, have been eliminated and placed in the nozzle casing assembly in such a manner as to attain equally efficient results while at the same time precluding the necessity of resorting to expensive machining operations in manufacturing the valve member. A similar and related object, in a nozzle construction of this character is to provide a valve mechanism including a movable valve member proper in which the head portion thereof is solid and completely devoid of fluid passages, thus simplifying the manufacturing problems in making the valve member.

The provision of a fuel injection nozzle which is extremely simple in its construction; one which is comprised of a minimum number of moving parts and which therefore is unlikely to get out of order; one which is rugged and durable and therefore is possessed of a comparatively long life; one which may be manufactured at a relatively low cost, and one which otherwise is well adapted to perform the services required of it, are further desiderata that have been borne in mind in the production and development of the present invention.

In the accompanying single sheet of drawings forming a part of this specification, one embodiment of the invention has been shown.

In these drawings:

Figure 1 is a longitudinal sectional view taken substantially centrally through a fuel injection nozzle assembly constructed in accordance with the principles of the present invention and showing the parts in the positions which they assume during a period of fuel injection.

Fig. 2 is an end elevational view of the nozzle assembly shown in Fig. 1.

Fig. 3 is a sectional view taken substantially along the line 3—3 of Fig. 1, and

Fig. 4 is a sectional view similar to Fig. 1 showing the parts in their normal positions.

Fig. 5 is a fragmentary sectional view taken substantially centrally through a slightly modi-

fied form of fuel injection nozzle assembly, similar to the nozzle assembly of Fig. 1, in the forward or discharge region thereof.

While the invention is susceptible of various modifications and alternative constructions, there is shown in the drawing and will herein be described in detail the preferred embodiments but it is to be understood that it is not thereby intended to limit the invention to the forms disclosed, but it is intended to cover all modifications and alternative constructions falling within the spirit and scope of the invention as expressed in the appended claims.

Referring now to the drawings in detail, the improved nozzle assembly comprising the present invention involves in its general organization a nozzle casing 10 having external threads 12 by means of which the nozzle assembly may be secured in position within the intake opening of an engine cylinder (not shown). The casing 10 is in the form of a tubular member having a central bore 14 extending therethrough the inlet end of which is enlarged and internally threaded as at 16 for threaded attachment to one end of a fuel conduit (not shown) which may constitute a part of a fuel injection apparatus or which may be suitably connected to a union 18 when the nozzle assembly is remotely associated with a fuel injector. The union 18 is adapted to be connected by means of the fuel conduit to a source of fuel supply that is intermittently subjected to pressure. During periods of injection, fuel admitted to the bore 14 is permitted to flow from the bore at the outlet end of the casing under the control of a normally closed valve member 20 in a manner that will be made clear presently when the nature of the invention is better understood. A fuel strainer or screen 22 may be positioned at the entrance to the bore 14 and retained in position by means of a snap spring 24.

The valve member 20 is axially movable within the bore 14 and is in the form of a cylindrical tubular member having an open rear end 26 and a solid head 28 which serves to close the forward end thereof. The bore 14 is provided with an enlarged portion or counterbore 30 at the forward region thereof in which the head portion 28 of the valve member 20 is movable upon reciprocation of the valve. The forward limit of movement of the valve member 20 is determined by the provision of a plug-like jet fixture 32 having a rearwardly extending boss-like protuberance 34 formed thereon and which constitutes an abutment or limit stop designed for engagement with the forward end of the valve member 20. The diameter of the head portion 28 of the valve member 20 is substantially equal to the diameter of the protuberance 34, and a coil spring 36 is centered around both of these members and serves to normally urge the valve member 20 rearwardly within the bore 14 toward the position it assumes in Fig. 4.

The jet fixture 32 is formed with a body portion 38 which bears on one side against the extreme forward end or rim of the nozzle casing 10 and on the other side against a circular disk-like member 40 having a discharge jet opening or spray orifice 42 formed centrally therein. A nozzle tip 44 is threadably received on the forward threaded end of the nozzle casing 10 and is provided with an inwardly extending retaining flange 46 providing a central opening 48 in register with the jet opening 42.

The fuel jet fixture 32 is thus tightly clamped

in position at the end of the nozzle casing 10 and is provided with suitable fuel passages leading to the discharge jet opening 42. These passages consist of a central passage 50 extending longitudinally of the fixture a slight distance and communicating with a series of tangentially disposed passages 52 (Figs. 1 and 3), of which four have been provided in the present instance. The tangential passages 52 communicate through respective longitudinally extending passages 53 with the forward end of the annular space 54 existing between the enlarged counterbore 30 in the nozzle casing 10 and the cylindrical surfaces of the valve head 28 and protuberance 34, the space 54 serving as a passageway for conducting fuel to the discharge jet opening 42.

The valve member 20 is provided with a plurality of radial ports 56, of which there may be four, in the cylindrical wall thereof immediately rearwardly of the head 28 and the plane of demarcation between the bore 14 and counterbore 30 provides a shoulder 58 which determines the cut-off position of the valve ports 56. Normally, when no fuel is being supplied under pressure to the bore 14, i. e. when the fuel in the bore is insufficient to overcome the compressional force of the spring 36, the valve member 20 is maintained by the spring in the position shown in Fig. 4 wherein the ports 56 are out of register with the space 54 within the counterbore 30. However, when pressure is built up in the bore 14 by the application of fuel thereto from the fuel injection device, the valve member 20 will move forwardly in the bore 14 in response to such pressure, thereby uncovering the ports 56 as shown in Fig. 4 and allowing fuel to flow from the screen or strainer 22, through the bore 14, the interior of the tubular valve member 20, ports 56, annular space 54, and passages 53, 52 and 50 to the discharge jet opening 42.

Immediately upon relief of the pressure of fuel in the bore 14, due to the fact that the fuel injection device has terminated its pressure or discharge stroke, the spring 36 urges the valve member 20 to the left as viewed in Fig. 4, thus closing the ports 56 and terminating the flow of fuel to the discharge jet orifice or opening 42.

It is to be noted that the momentum of the valve member 20 will be such as to cause the same to move beyond its normal position illustrated in Fig. 4 to a position illustrated in dotted lines in this view. Since at this time the ports 56 are closed during this overtravel of the valve member, a suction will be created in the system between the ports 56 and orifice 42. This suction tends to "suck" the fuel in and around the discharge jet orifice and thus minimize leakage of fuel through the orifice 42 at the end of the fuel injection cycle.

From the above description it will be noted that the valve member 20 is of the free floating type. This member is closely fitted within the bore 14 and to enhance such a fit and to minimize wear, the wall of the bore may be heat treated or chrome plated. Alternatively, the outer cylindrical surface of the valve member may be similarly so treated. In any event, the fit between the two surfaces is such as to prevent leakage of fuel around the body of the valve 20.

Due to the fact that the spring 36 is disposed on the discharge side of the valve member 20 in an out-of-the-way position, no obstruction to passage of fuel through the ports 56 is presented and the fuel flowing to the jet opening or spray orifice 42 completely bypasses the spring and is

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not obliged to enter the interstices afforded by the spring convolutions. Furthermore, the valve head 28 is of solid construction and the only passages provided in the valve member 20 are the radial ports 56 which may easily be machined therein without involving complicated tool processes. Finally, the nozzle construction of the present invention embodies a minimum number of parts, particularly moving parts, and the structure is readily capable of assembly and disassembly for purposes of inspection, cleaning, repair or replacement of parts.

In Fig. 5 a slightly modified form of nozzle assembly has been shown. In this form of the invention, the various operative parts of the structure are similar in their design to the operative parts of the structure shown in Fig. 1 and, accordingly, similar reference characters have been applied to the corresponding parts in this latter figure.

In this form of the invention, the valve member 120, the jet fixture 132, the circular disc-like member 140, the coil spring 136 and other operative parts of the assembly remain the same but the valve casing 110, instead of being provided with a removable nozzle tip such as that shown at 44 in Fig. 1, is of integral construction and the disc-like member 140 is retained in position forwardly of the jet fixture 32 by means of an intumed retaining flange 146 which may be formed by crimping the extreme forward end of the nozzle casing 110 inwardly after the various parts have been assembled within the casing. In substantially all other respects, the valve structure of Fig. 5 is identical with that of the valve structure of Fig. 1. Similarly, its operation is identical.

I claim as my invention:

1. In a fuel injection nozzle, a casing having a bore formed therein and an enlarged counterbore in communication with said bore at its downstream end, said casing having a fuel inlet in communication with said bore at its upstream end, a cylindrical valve member slidably disposed within said bore and having one end in constant communication with said inlet, said valve member having a fuel port formed in its wall and being movable from a retracted position with said port within said bore and closed by the wall thereof to an advanced position with

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said port moved downstream into communication with said counterbore, said valve member having a spring abutment disposed thereon downstream from said port, nozzle means positioned in said counterbore downstream from said valve member, and a compression coil spring disposed downstream from said port and between said abutment and said nozzle means, said nozzle means having an outlet passage therethrough extending from a point in said counterbore outside the coils of said spring so that fuel will flow entirely outside said spring from said port to said outlet passage.

2. In a fuel injection nozzle, a casing having a bore formed therein and an enlarged counterbore in communication with said bore at its downstream end, said casing having a fuel inlet in communication with said bore at its upstream end, a cylindrical valve member slidably disposed within said bore and having one end in constant communication with said inlet, said valve member having a fuel port formed in its wall and being movable from a retracted position with said port within said bore and closed by the wall thereof to an advanced position with said port moved downstream into communication with said counterbore, said valve member having a reduced head extending into said counterbore and forming a spring abutment shoulder disposed downstream from said port, nozzle means positioned in said counterbore downstream from said valve member, and a compression coil spring closely surrounding said reduced head and extending between said spring abutment shoulder and said nozzle means, said nozzle means having an outlet passage therethrough communicating with said counterbore at a point outside the coils of said spring so that fuel will flow entirely outside said spring from said port to said outlet passage.

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References Cited in the file of this patent

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Number	Name	Date
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2,090,350	Heinrich	Aug. 17, 1937
2,294,029	High	Aug. 25, 1942