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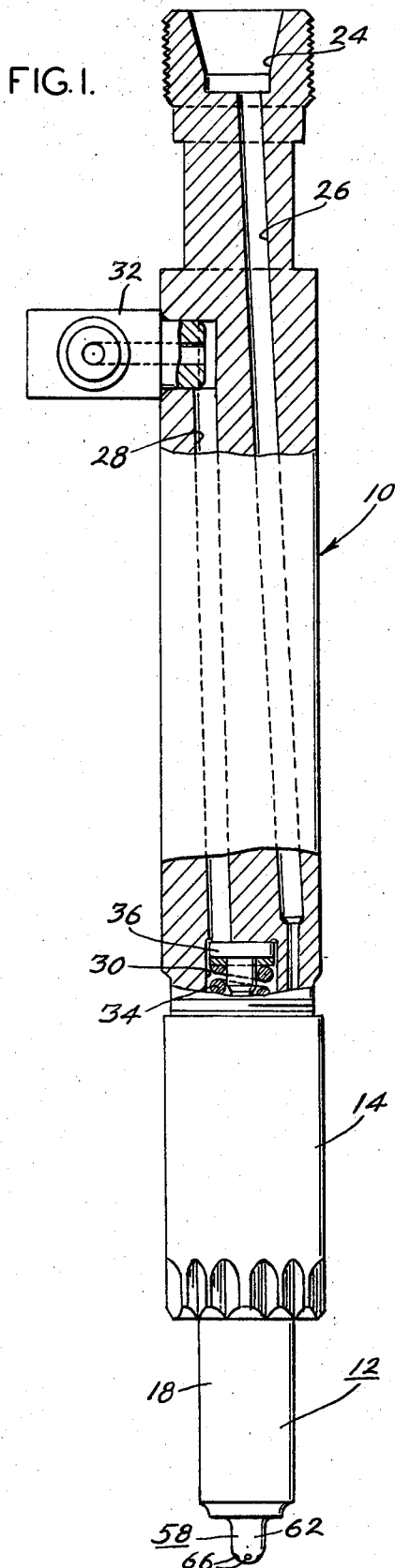
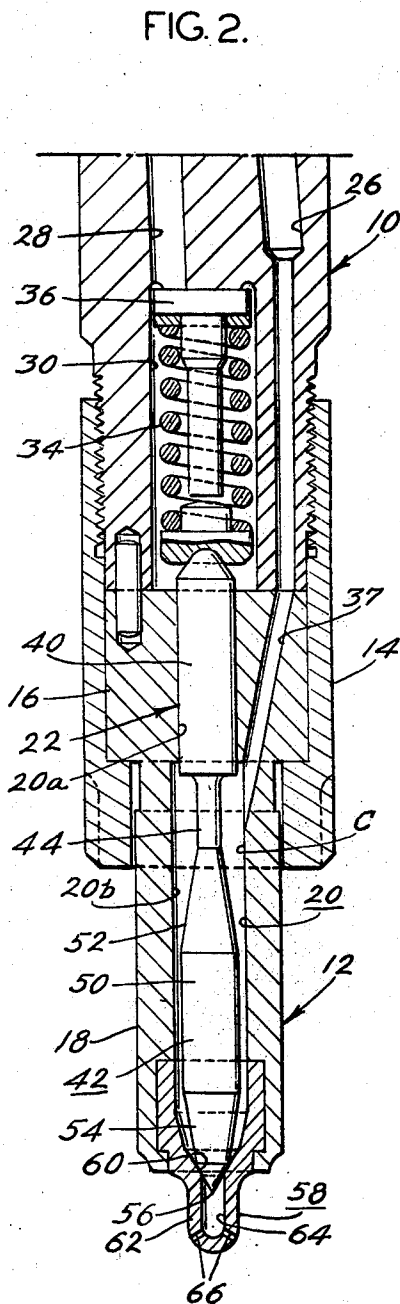
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SUMPLESS FUEL INJECTION NOZZLE

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SUMPLESS FUEL INJECTION NOZZLE

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1 Claim

ABSTRACT OF THE DISCLOSURE

A sumpless fuel injection nozzle comprising a body portion and an elongated generally cylindrical shank depending from the body portion, means defining a axial bore extending the length of the nozzle, said axial bore consisting of an upper section and a lower section of slightly enlarged cross section, and a valve element mounted in said axial bore. The valve member comprises a guide portion slideably mounted in the upper bore section and a streamlined head portion connected to the guide portion and spaced from the inner wall of the lower bore section to define an annular space therebetween and means defining an angled passageway in the body portion directly communicating with the lower axial bore section.

The application is a continuation-in-part of our application Ser. No. 550,742, filed May 17, 1966, for "Sumpless Fuel Injection Nozzle" now abandoned.

This invention relates to improvements in fuel injection nozzles and more particularly to a sumpless fuel injection nozzle.

Some conventional fuel injection nozzle assemblies comprise a holder, a nozzle mounted at one end of the holder and a valve member mounted in an axial bore in the nozzle. In these assemblies fuel is delivered through the holder from a suitable supply source to the annulus in the axial end face of the nozzle confronting the holder, through two or more fuel ducts in the nozzle to an enlarged annular sump in the nozzle body and through the area defined as the nozzle shank to the seat or tip area of the nozzle shank. The valve which is mounted for axial movement in the nozzle body bore and closely fitted in the guided upper section of the nozzle body is lifted upward from its seat by differential pressure, allowing the fuel to escape through the seat area and orifices into the engine combustion chamber. To insure proper seating of the valve in the nozzle tip area, the bore is enlarged to permit this seating and by reason of this design, more fuel is present in the seat area than is necessary for optimum functioning of the nozzle.

These sump-type nozzles are comparatively expensive since the sump configuration and annulus are difficult to machine.

Additionally, several functional drawbacks are noted in connection with the sump-type nozzles. The sump tends to trap dirt and foreign particles and is difficult to clean thoroughly. The sump, annulus and seat area provide an excess "parasitic" or dead fuel volume, which is a factor affecting the control of fuel injection characteristics. By reason of the sump in the upper section of the nozzle body and the seat configuration in the lower shank section, the flow of fuel through the nozzle passageway and the directional change in flow of fuel is inherently turbulent, which is a factor in cavitation erosion. Furthermore, the presence of the sump increases the distortion factor on assembly of the nozzle and cap nut to the nozzle holder.

The present invention provides a new and improved nozzle assembly characterized by novel features of con-

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struction and arrangement including a single fuel duct or passage in the nozzle body portion which is aligned with the single passageway in the nozzle holder and which discharges directly into the bore proper of the nozzle body, and a streamlined valve configuration, the combination producing a streamline or laminar flow of fuel through the nozzle assembly to the discharge orifices. It has been found that this arrangement overcomes some of the drawbacks of the conventional fuel injection nozzles. For example, the nozzle of the present invention is more economical to machine since the annulus, sump and additional ducting in the upper section of the nozzle body are eliminated.

Moreover, the nozzle-valve assembly of the present invention permits miniaturization of the nozzle and nozzle holder, which is obviously desirable from a cost standpoint and also minimizes the amount of space taken up by the fuel injection nozzle assembly in the engine. Reducing the size of the nozzle assembly and holder permits larger intake and exhaust passages to be used in the engine, which in turn, improves the volumetric efficiency of the engine. As a result of the reduced parasitic fuel volume in the nozzle assembly and the streamline flow through the entire nozzle assembly, engine performance is improved by lower fuel consumption and less smoke. With the specific configuration of the nozzle-valve assembly of the present invention, the valve has more flexibility to insure concentric seating of the valve to its mating seat in the nozzle body tip area, which in turn eliminates sluggishness of valve operations, still further extending trouble-free engine operation.

With the foregoing in mind, another object of the present invention is to provide a new and improved nozzle and valve assembly which is characterized by novel features of construction and arrangement, producing a streamline flow of fuel to its orifice, thus having less tendency for cavitation erosion.

Another object of the present invention is to provide a "sumpless" fuel injection nozzle assembly which is easy and economical to manufacture and which may be produced in smaller sizes in the same design characteristics than was heretofore the case.

Still another object of the present invention is to provide a novel "sumpless" fuel injection nozzle, which by reason of its lower parasitic volume, improves engine performance characteristics by lowering fuel consumption and producing less smoke.

Another object of the present invention is to provide a novel "sumpless" fuel injection nozzle wherein the tendency of the valve to stick or hang up is substantially reduced providing a more reliably performing nozzle over an extended period of time.

Still another object of this invention by nature of its sumpless features is the versatility of the nozzle body seat area which is conducive to the application of an inserted tip in the nozzle body lower lower section. Accordingly, in higher temperature operations the main portion of the nozzle may be manufactured from low cost material and the nozzle tip insert may be made from more exotic materials to withstand the higher temperatures.

These and other objects of the present invention and various features and details of the operation and construction thereof are hereinafter more fully set forth with reference to the accompanying drawings, wherein:

FIG. 1 is a side elevational view of a holder and nozzle assembly incorporating the present invention;

FIG. 2 is an enlarged longitudinal section of a nozzle and a portion of the holder;

FIG. 3 is an enlarged fragmentary sectional view of another embodiment of holder and nozzle assembly in accordance with the present invention;

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FIG. 4 is a view similar to FIG. 3 of still another embodiment of the holder and nozzle assembly;

FIG. 5 is an enlarged fragmentary sectional view of another embodiment of holder and nozzle assembly; and

FIG. 6 is a sectional view through the nozzle taken on lines 6—6 of FIG. 5.

Referring now to the drawings and particularly to FIG. 1 thereof, there is illustrated an assembly of a nozzle holder 10 and a fuel injection nozzle 12 supported at one axial end of the holder by means of a cap nut 14. The nozzle as best illustrated in FIG. 2 includes a generally cylindrical body portion 16 and an elongated shank 18 of reduced cross section depending from one axial end of the body portion. The nozzle further has a centrally located axially extending bore 20 within which is mounted a valve element 22.

The holder is conventional and includes an inlet 24 and an axial passage 26 through which fuel from a suitable supply source is delivered to the nozzle 12. The holder also includes another axial channel 28 connecting a spring chamber 30 at the forward end of the holder to a fitting 32 to vent leakoff fuel from the chamber 30 back to a fuel tank. Biasing means in the form of a spring actuator 34 for the valve 22 is mounted in the spring chamber 30 and a valve lift stop 36 is provided for controlling lift of the valve element 22 during operation of the nozzle.

In accordance with the present invention the nozzle is sumple and the valve element is of a predetermined configuration to provide certain functional advantages in the operation of the valve such as laminar flow, elimination of sticking or hanging up of the valve and others. To this end in accordance with the embodiment of the invention illustrated in FIGS. 1 and 2, a fuel passageway 37 is provided in the nozzle body portion 16 which, as illustrated, is disposed angularly relative to the central axis of the nozzle and communicates at one end with the fuel passage 26 in the holder and at its lower terminal end connects directly with a lower bore section 20b which defines a fuel chamber C, the lower bore section 20b in the present instance being of a slightly enlarged cross section. The passage 37 is preferably disposed at an angle of approximately between 4 to 5 degrees relative to the central axis X—X of the nozzle assembly to provide laminar flow of fuel. Further, in the present instance the valve member 22 comprises an upper guide portion 40 which is of a predetermined cross section to provide a snug sliding fit in the upper bore section 20a in the nozzle body 16 and streamlined head portion 42 spaced from and connected to the guide portion by means of a reduced neck 44. More specifically, as shown in FIG. 2, the head portion 42 of the valve has a generally cylindrical center segment 50, a tapered or conical tail segment 52 which connects the center segment to the neck 44 and a double tapered tip segment 54 including a conical tip 56 which engages the valve seat in the closed position of the valve. The central segment 50, as illustrated, is of a smaller cross section than the forward bore section or fuel chamber 20b so that the entire forward portion of the valve element serves as a venturi for the fuel passing through the fuel chamber C.

In the present instance a tip insert 58 is mounted in the lower terminal end of the nozzle tip 18, the insert having an annular frusto-conical surface defining a seat 60 against which the tip 56 of the valve element is normally biased and an elongated nose 62 depending from the seat which defines a sac hole 64 between the valve tip 56 and the spray orifices 66. As best illustrated in FIG. 2, the inner wall of the insert adjacent the seat is also slightly tapered at approximately the same angle of taper as the tapered tip segment 54 of the valve element. By this arrangement, the area of the fuel chamber C adjacent the inner terminal and of the passageway 37 is enlarged, narrows in the vicinity of the center segment of the valve element and is slightly enlarged adja-

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cent the tapered tip segment 54. This facilitates laminar flow of fuel passing through the fuel chamber to the spray orifices. It is noted that the tip insert is optional and permits the valve body and shank to be made of a less expensive material than the tip which may be made of a more exotic material in high temperature applications.

Thus, in the operation of the nozzle, when the fuel pressure in the fuel chamber builds up sufficiently to develop a lifting force on the valve element to overcome the bias of the spring 34, the valve element is raised upwardly to permit fluid to pass from the fuel chamber to the sac hole 64 and out through the spray orifices 66. It is noted that the fuel passageway 37 in the nozzle body 16 communicates directly with the fuel chamber C and that fuel from the passageway 37 flows around the head portion of the valve element to provide a smooth laminar flow with less tendency to cause cavitation or erosion as is sometimes experienced with the conventional nozzle where there is a resultant cross flow of the fuel in the nozzle. It has been found that engine performance characteristics are improved with the nozzle of the present invention by lowering fuel consumption and minimizing smoke. Additionally, the particular nozzle and valve configuration insures concentric seating of the valve and eliminates valve sticking. More specifically the reduced neck of the valve is so tempered in hardness as to allow the valve to find its own seat in the nozzle area and therefore, may be termed "self-aligning." Also, by this construction the valve is better able to absorb impact stresses during operation. Additionally the nozzle of the present invention is much simpler and more economical to make. For example, the angled fuel passageway 37 may be formed simply by drilling a hole from the upper end of the body portion until it intercepts the main axial bore of the nozzle.

There is illustrated in FIG. 3 another embodiment of fuel injection nozzle assembly in accordance with the present invention. The assembly includes a nozzle holder 100 and a fuel injection nozzle 112 supported at one end of the holder by means of a cap nut 114. The nozzle includes a generally cylindrical body portion 116 and an elongated shank 118, the nozzle having an axial bore 120 for mounting a valve member 122. The holder 110 has a fuel passage 126 adapted to be connected to a suitable supply source.

Similar to the previously described embodiment, a fuel passageway 137 is provided in the nozzle body portion which is angularly disposed relative to the central axis of the nozzle and which communicates at its inner end with the fuel passage 126 and at its lower discharge end directly with the lower bore section 120b of the fuel chamber C'. The passage 137 is preferably disposed at an angle of approximately between 4 to 5 degrees relative to the central axis X'—X' of the nozzle assembly to provide laminar flow of fuel. The valve member 122 is also of a streamlined configuration so that in the overall assembly the flow of fuel through the nozzle is laminar. More specifically, the valve member 122 comprises a head portion 142, a tapered or conical tail segment 152 merging with a reduced neck 144 which in turn connects to the guide portion 140 engageable in the upper bore section 120a. The head portion 142 also includes a double tapered tip segment 154 including a conical tip 156 which engages the valve seat 157 in the closed position of the valve and a pintle 159 projecting from the tip 156 through a discharge opening 161 in the free terminal end of the nozzle shank, the opening 161 being of larger cross section than the pintle 159 to permit discharge of fuel when the valve is raised. It is noted that in the present instance, the nozzle shank is one integral unit having formed therein the valve seat 157 and an upwardly diverging section 165 spaced from and generally conforming to the tapered tip segment 154 of the valve member 122. This pintle type valve operates in substantially the same manner as the above-described embodiment and has all of the operational ad-

vantages noted above, for example, laminar fuel flow, self-alignment, impact stress absorption, no valve sticking, etc.

The fuel injection nozzle assembly shown in FIG. 4 is generally similar in construction and operation to the fuel injection nozzle assemblies discussed above and includes a holder 210 and a nozzle 212 supported at one axial end of the holder by a cap nut 214, the nozzle consisting of a body portion 216 and an elongated shank 218 and a valve member 222 mounted in a central axial bore 220 in the nozzle.

In the operation of the fuel injection nozzle assembly, fuel from a suitable supply source passes through an axial passage 226 in the holder through an angular fuel passageway 237 in the nozzle 212 to a fuel chamber C". In the present instance the axial bore 220 is of uniform cross section for substantially its entire length having a stepped inwardly converging lower section defining a valve seat 239. The valve member 222 is of generally cylindrical form comprising an upper guide portion 240 and a lower portion 241 of reduced cross section to define an annular space between the lower portion of the valve and the inner wall of the fuel chamber C". The angular fuel passage 237 merges with the fuel chamber adjacent the step in the valve in the closed position of the valve member. The passage 237 is preferably disposed at an angle of approximately 4 to 5 degrees relative to the central axis X"—X" of the nozzle assembly to provide laminar flow of fuel. In this arrangement, the parasitic fuel volume is substantially reduced and the fuel flow is laminar so that the performance of an engine in which the fuel injection nozzle is used is improved by lower fuel consumption and less smoke. Further, this sumless fuel injection nozzle assembly is as economical to make as the previously described embodiments.

The fuel injection nozzle assembly shown in FIGS. 5 and 6 is generally similar in construction and operation to the fuel injection nozzle assembly discussed above and includes a holder 310 and a nozzle 312 supported at one axial end of the holder by a cap nut 314, the nozzle consisting of a body portion 316 and an elongated shank 318 of reduced cross section projecting from the body portion. A valve member 322 is mounted in a central axial bore 320 normally biased to a closed position (see FIG. 5) and an open position wherein the conical valve tip 323 seats on the seat 325 to prevent flow through the discharge orifices 327 and a raised position to permit flow of fuel through the orifices 327.

In the operation of the fuel injection nozzle assembly, fuel from a suitable supply source passes through an axial passage 328 in the holder through an angular fuel passageway 327 in the nozzle 312 to a fuel chamber C". The angular fuel passageway 327 is preferably disposed at a very small angle to the central axis X"—X" of the assembly at an angle of approximately 4°30'. In the present instance the axial bore 320 is of uniform cross section for substantially its entire length and is slightly enlarged

as at 350 adjacent the lower terminal end of the fuel passageway 327 to provide a pocket at this location into which fuel from the passageway enters the fuel chamber C". The pocket 350, as illustrated in FIG. 6, is of a key-hole shape at its largest cross section and has a downwardly flared wall portion 352. This pocket may be economically formed in the nozzle 312 by an electrochemical process. The valve member 322 is of generally cylindrical form comprising an upper guide portion 340 and a lower portion 341 of reduced cross section to define an annular space between the lower portion of the valve and the inner wall of the fuel chamber C". The step in the valve is disposed in the pocket 350 when the valve is in the closed position. By this arrangement fuel flow through the valve is laminar whereby the performance of an engine in which the fuel injection nozzle is used is improved by lower fuel consumption and less smoke. Additionally, this arrangement is extremely economical to manufacture.

We claim:

1. A sumless fuel injection nozzle comprising a body portion and an elongated generally cylindrical shank depending from the body portion, means defining an axial bore extending the length of the nozzle, said axial bore consisting of an upper section and a lower section, said lower bore section having a double tapered configuration, the lowermost tapered portion defining a conical seat, said shank terminating in an elongated nose having a sac hole therein and a plurality of spray orifices in the free end of the nose, and a valve mounted in said axial bore, said valve member comprising a guide portion slideably mounted in the upper bore section and a head portion connected to the guide portion and spaced from the inner wall of the lower bore section to define an annular space therebetween said head portion terminating in a double tapered tip adapted to engage a conical seat in the tip of the shank of the nozzle, and means defining an angled passageway in the body portion disposed at an angle of about between 4 to 5 degrees to the central axis of the valve directly communicating with the lower axial bore section, said arrangement substantially reducing parasitic fuel volume and providing for laminar fuel flow.

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