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FUEL INJECTION DEVICE

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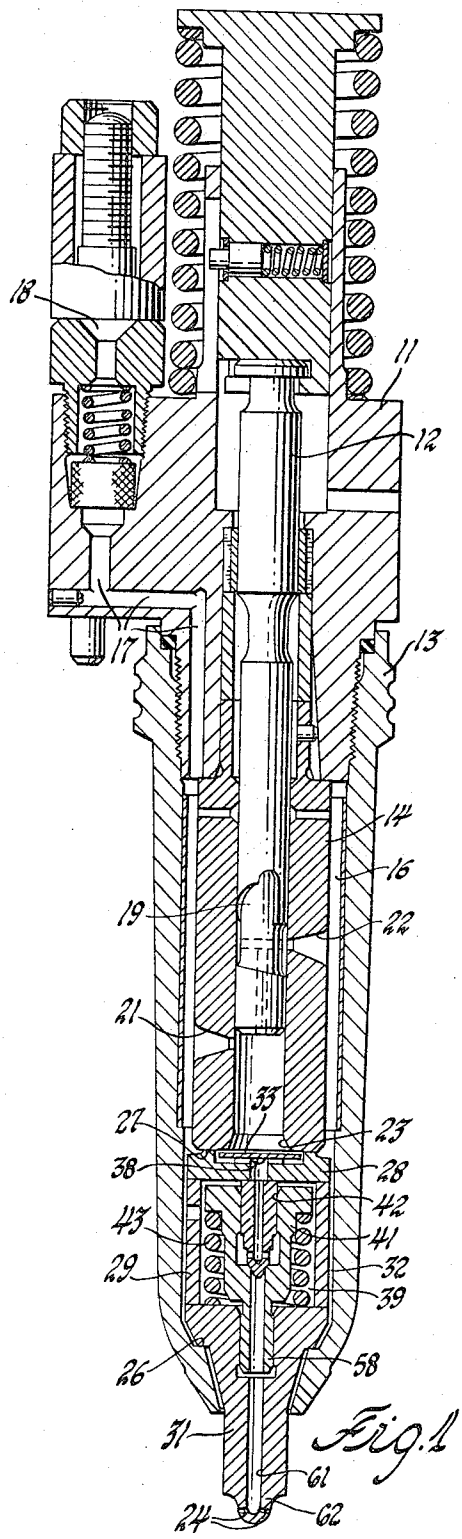

Fig. 1

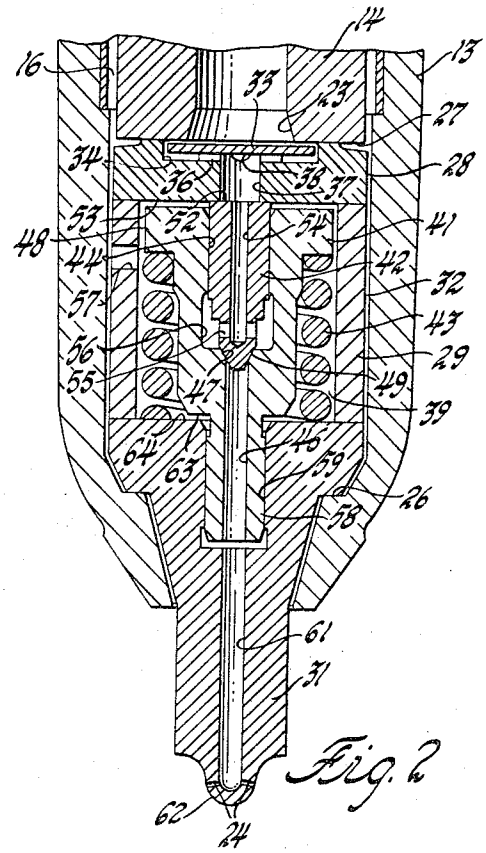

Fig. 2

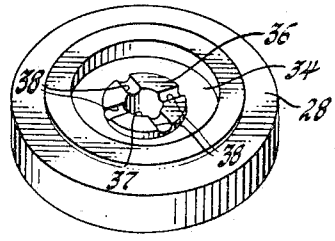

Fig. 3

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FUEL INJECTION DEVICE

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This invention relates to fuel injection devices of the type utilized for the injection of fuel into the cylinders of internal combustion engines and more particularly to improved valve arrangements for such devices.

In its more particular aspects, the invention relates to an improved valve and nozzle arrangement for unit fuel pump injectors of the type shown in United States Patent No. 3,006,556 Shade et al.

While unit injector assemblies of the general type shown in the above-mentioned patent have given very satisfactory service in a wide range of engine applications, the fact that the needle valve is carried directly in the spray tip member makes it necessary to replace this complete unit whenever wear or damage to either portion of the unit occurs. In addition, the flow path of the fuels from the plunger body to the spray tip is relatively indirect being through a series of small passages, both straight and annular, bypassing the needle valve and its biasing spring assembly.

The present invention proposes an improved valving and injector tip arrangement which provides a nearly direct axial flow of fuel through the center of the valve and nozzle portions to the spray tip, thereby permitting larger passages and offering less restriction to flow. Additionally, the arrangement separates the needle valve assembly from the spray tip so as to permit replacement or reconditioning of either one of the members separately should the occasion arise, thereby reducing the cost of servicing or reconditioning the injector assembly.

These and other advantages of the invention will be better understood from the following description of a preferred embodiment selected for purposes of illustration, having reference to the drawing, wherein:

FIGURE 1 is a longitudinal, sectional view through a unit fuel pump injector having an improved nozzle and valving arrangement according to the invention;

FIGURE 2 is an enlarged view showing the nozzle and valving arrangement of FIGURE 1; and

FIGURE 3 is a pictorial view showing certain features of a check valve body for use with the preferred embodiment of FIGURES 1 and 2.

Referring now in more detail to the drawing, and in particular to FIGURE 1, the upper portion of the unit is conventional and comprises a housing **11** in which a plunger **12** is reciprocable. Forming an extension of and threaded to the lower end of the housing **11** is a nut **13** within which is supported a bushing **14**, forming the pump cylinder for the plunger **12**. An annular space **16** surrounding the bushing **14** within the nut is supplied with fuel via passages **17** in the housing from an external fuel connection **18**.

The plunger has the usual external metering groove **19** adjacent its lower end by which opening and closing of ports **21** and **22** in the bushings are controlled during each downward stroke of the plunger to deliver a predetermined volume of fuel through the lower open end **23** of the bushing for injection into the engine (not shown) via the spray orifices **24** at the bottom of the unit. Other details of the upper or pump part of the unit are not important to the present invention, and are common to construction shown and described in such prior patents as Engel, Jr. 2,951,643 and Teichert 2,898,051, hence will not require further description here.

As is best shown within the nut **13** in FIGURE 2, and clamped between the shoulder **26** in its lower end and the lower end face **27** of the bushing **14** are a check valve body **28**, spacer **29** and a spray nozzle **31**. These members are formed with a small annular clearance **32** between them and the nut **13** to assure their being tightened into sealing engagement upon tightening of the nut **13** on the housing **11**.

The lower end face **27** of the bushing acts as a closure seat for a circular check valve disc **33**. This disc is disposed in a recess or cavity **34** formed in the top portion of the check valve body **28**. The sides of the cavity **34** extend laterally beyond the extremities of the open end **23** of the bushing and serve to loosely guide the disc **33**. A central annular protuberance **36** is formed in the bottom of the cavity **34** and serves as a stop to limit opening travel of the check valve disc **33**. A central opening **37** extends axially through the check valve body and connects with the recess **34** through radial grooves **38** formed in the surface of stop **36** so that communication is provided between the recess and opening in all positions of the valve disc **33**.

Within spacer **29** is a cylindrical cavity **39** in which are disposed a valve seat member **41**, needle valve **42** and coil spring **43**. The valve seat member includes an axial passage extending therethrough which is separated into larger and smaller diameter portions **44** and **46** respectively by a frusto-conical valve seat **47** intermediate the ends of the passage. The valve seat member **41** is reciprocably movable within cavity **39** and is biased upwardly by the surrounding spring **43** acting against nozzle **31** and an annular shoulder **48** of the seat member such that the valve seat **47** is forced into engagement with the conical end **49** of the needle valve **42**. This forces the other end **52** of the needle valve into sealing engagement with the lower face **53** of the check valve body.

The needle valve **42** includes an axial bore **54** which terminates short of its lower end **49** and connects through a cross-drilled bore **55** in a reduced diameter portion of the needle valve with an annular chamber **56** defined between the lower end of the needle valve and a slight enlargement of the larger diameter portion **44** of the passage through valve seat member **41**. The remainder of the larger diameter passage portion **44** is closed by engagement with the outer surface of needle valve **42**. This engagement is preferably a lapped fit to provide for reciprocating movement of seat member **41** with respect to the needle valve without permitting substantial leakage between the lapped surfaces of the members. Spacer **29** includes a drain opening **57** which permits the escape of fuel leaking into cavity **39** by escape through the annular clearance **32** into the annular space **16** thereabove.

On its lower end, valve seat member **41** carries a cylindrical extension **58**. The extension is reciprocably received, preferably as a lapped fit, in the enlarged upper portion **59** of a central bore **61** which extends nearly through spray nozzle **31** and connects with spray orifices **24** in the spray tip portion **62** of the spray nozzle. An annular stop surface **63** surrounds the extension and is adapted to engage the upper face **64** of the spray nozzle and limit opening of the needle valve.

In operation, reciprocating action of the plunger **12** delivers metered amounts of fuel intermittently through lower end **23** of the bushing **14**. The fuel passes around valve disc **33** through grooves **38** and opening **37** into bore **54** of the needle valve and cross-bore **55** to annular chamber **56**. As the pressure in the chamber **56** increases, the differential area between the upper and lower ends of the chamber causes a downward force upon valve seat member **41** which, at a predetermined pressure, over-

comes the force of spring **43** and moves seat member **41** downwardly into engagement with the upper face **64** of the nozzle member **31**. At the same time, upward pressure of the fuel upon needle valve **42** holds the valve in its fixed position against check valve body **28**. Thus valve seat **47** moves away from the end **49** of the valve member and permits fuel to flow from chamber **56** through small diameter passage portion **46** and central bore **61** of the nozzle out through spray orifices **24**.

When the delivery of fuel is cut off by action of the plunger, the fuel pressure in chamber **56** decreases until, at a predetermined pressure, spring **43** again lifts the valve seat member **41** until seat **47** engages end **49** of the needle valve cutting off further flow of fuel to the nozzle. If for any reason an undue surge of pressure occurring in the cylinder while the needle valve is open should attempt to cause fuel to flow in reverse through the nozzle and valve assembly, this action will seat disc valve **33** against the lower end face **27** of plunger **14**, preventing any backflow of fuel to the bushing **14**.

Having disclosed in detail a preferred embodiment of my invention, it is apparent that many variations within the spirit and scope of the invention will occur to those skilled in the art and it is therefore intended that the invention not be limited except by the language of the following claims.

I claim:

1. A fuel injection device comprising

a stationary nozzle having a central bore and a discharge orifice at one end of said bore,

a reciprocable valve seat member having an axial passage with a valve seat intermediate its ends and separating said passage into larger and smaller diameter portions, said smaller diameter portion connecting with said nozzle bore,

a stationary needle valve having a body portion sealingly engaging said larger diameter portion, an end of smaller diameter than said body portion and engageable by said valve seat and an axial bore terminating short of said end and connecting with an annular chamber formed between said needle valve and the larger diameter portion of said seat member passage adjacent said valve seat and

biasing means urging said valve seat member in a direction to engage said valve seat with said valve member end,

said biasing means being adapted to yield to the force caused by delivery of a predeterrmined pressure of fuel to said annular chamber whereby to move said valve seat away from said needle valve end and permit fuel to flow past said valve seat and axially into said nozzle.

2. The device of claim **1** and further including stop means on said valve seat member and engageable with said nozzle to limit the travel of said valve seat away from said needle valve and assist prompt re-engagement of said valve seat and valve upon reduction of the fuel delivery pressure to a predetermined value.

3. The device of claim **2** wherein said valve seat member includes a cylindrical extension surrounding said passage, said extension being sealingly received in an enlarged portion of said nozzle bore to prevent substantial leakage of fuel from between said nozzle and said valve seat member.

4. The device of claim **1** and further including check valve means upstream of said stationary needle valve and arranged to permit the supplying of fuel to said needle valve but to prevent the return flow of fuel from said needle valve to the source of supply.

5. The device of claim **4** wherein said check valve means includes

a fuel delivery member having an end and a fuel delivery opening located centrally thereof,

a valve body between and engaging said fuel delivery member and said needle valve and having a central opening connecting said fuel delivery opening with said needle valve bore,

a flat valve disc received in a recessed portion of said valve body and engageable with the end of said fuel delivery member to prevent the return flow of fuel thereto and

an annular stop surrounding the opening in the recessed portion of said valve body and engageable by said valve disc, said stop having radial grooves in its disc engaging surface to provide a path for fuel to bypass said valve disc when in engagement with said stop.

6. A fuel injection device comprising

a stationary nozzle having a central bore,

a reciprocable valve seat member having an axial passage connecting with said nozzle bore and a valve seat surrounding said passage,

a stationary needle valve having an end engageable by said valve seat to shut off flow through said passage, said needle valve having an axial bore terminating short of said end and connecting with an annular chamber partially defined by said valve seat member and

biasing means urging said valve seat member in a direction to engage said valve seat with said valve member end,

said chamber defining surfaces of said valve seat member being arranged such that fuel pressure in said chamber exerts a force on said valve seat member opposing the force of said biasing means

whereby upon delivery of a predetermined pressure of fuel to said chamber through said needle valve, said valve seat will move away from said needle valve end permitting fuel to flow axially into said nozzle central bore.

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