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DOUBLE INJECTION SYSTEM WITH ONE NOZZLE

Filed June 14, 1967

FIG. 1.

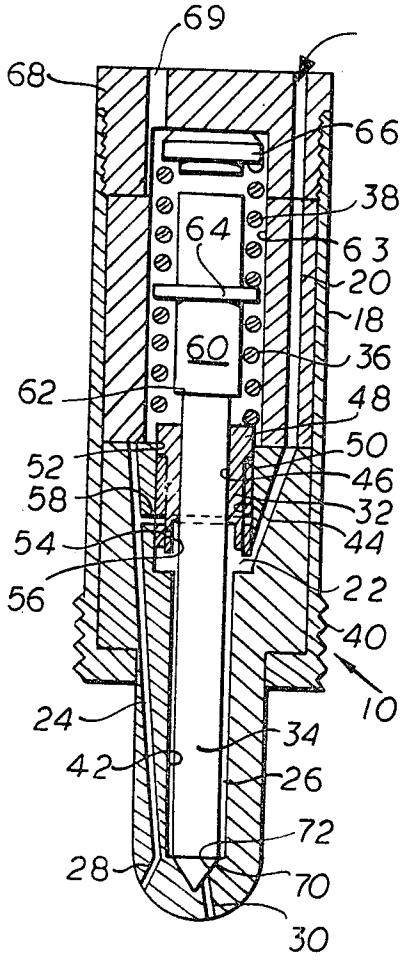


FIG. 2.

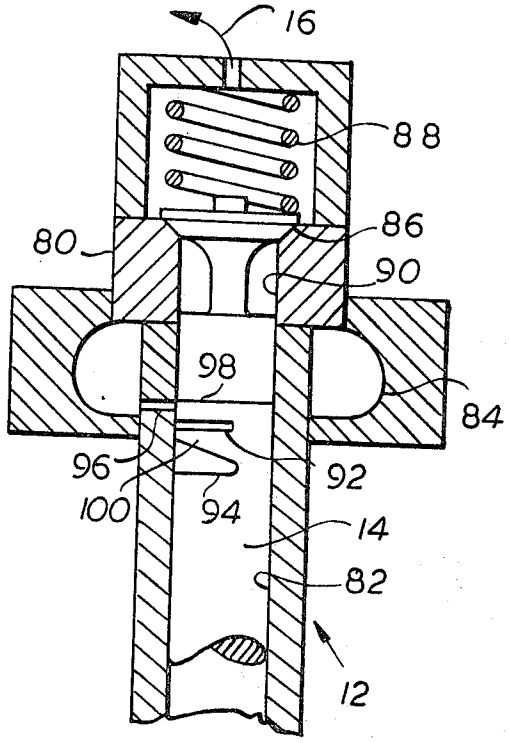
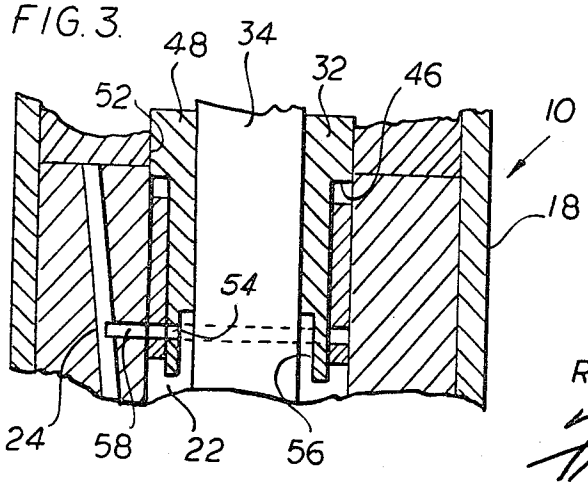


FIG. 3.



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DOUBLE INJECTION SYSTEM WITH ONE NOZZLE

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6 Claims

ABSTRACT OF THE DISCLOSURE

A fuel injection nozzle having a plurality of orifices and valve means associated with the nozzle to permit independent injections through said orifices at predetermined fuel pressures. The nozzle is designed to provide a pilot spray through one orifice means and a main injection through another orifice means.

This invention relates to a fuel injection device and more specifically to a fuel injection nozzle having a plurality of orifices.

For certain applications it is desirable to have two fuel sprays into a combustion chamber which are independent of each other in time and direction. This could be achieved by the use of two injection pumps and two injection nozzles, but the uneconomical aspect of this arrangement is apparent. Accordingly, it is herein proposed to provide a fuel injector device of simple construction in which two orifice means are provided to inject fuel at different predetermined times and in different predetermined directions and using only one fuel injection pump.

It is a principal object of this invention to provide a fuel injection device, having a plurality of orifice means each controlled by a separate valve element.

Another object is to provide a fuel injection device which first can inject a pilot spray and then inject a main spray in response to different pressures of the liquid fuel in the injection device.

The above and other objects and advantages of the invention will be more readily apparent when considered in connection with the accompanying drawings in which:

FIGURE 1 is an elevation view partially in section of a fuel injector device showing the valves thereof in a closed position;

FIGURE 2 is an elevation view of a portion of a fuel injection pump; and

FIGURE 3 is an enlarged view of a portion of the fuel injection device showing the sleeve valve in an open position.

Referring now to the drawings wherein like reference characters in the several views represent the same parts, reference character **10** designates a fuel injection device and **12** a portion of a fuel injection pump which supplies pressurized fuel to the injector device **10**. The injection pump **12** has a pumping plunger **14** actuated at its lower end by a cam (not shown). The plunger **14** moves up and down and builds up enough pressure during its upward stroke as viewed in FIGURE 2 to open a fuel delivery valve and force pressurized fuel through conduit **16** to the injector device **10** into an inlet passage, through a pair of valves and through spray orifices to the cylinder of an internal combustion engine with which the injector device is associated.

The injector device **10** comprises a nozzle body **18** having an inlet fuel passage **20** formed therein, a fuel chamber **22**, a second fuel passage **24** and a third fuel passage **26**. The device **10** also includes first and second orifice means **28** and **30**, through which fuel is injected into the cylinder of an engine. The device **10** further includes a first valve means in the form of a cylindrical sleeve valve member **32**, for controlling the flow of fuel to orifice means **28** and a second valve means in the form of a needle valve **34** for controlling the flow of fuel to orifice means **30** and first and second compression spring means **36** and **38**.

The injection device **10** may be secured in the engine block by suitable means such as the threads **40** formed on a portion of the nozzle body. The nozzle body may have formed therein a bore **42**, somewhat larger in diameter than the needle valve **34** disposed therein to form the circumferential passage **26** which communicates with the fuel chamber **22** at its upper end and orifice means **30** at its lower end. A bore **44** is formed above the fuel chamber **22** to slidingly receive the sleeve valve member **32**. Pressurized fuel in the fuel chamber **22** exerts an upward force on the sleeve valve **32**.

The sleeve valve **32** is formed with a bore **46** to slidingly receive the needle valve **34** therethrough. The sleeve valve **32** is also formed with an enlarged head **48** at the upper end thereof to define a shoulder **50** which seats in a counterbore **52** formed in the upper end of bore **44**. A fuel duct **54** extends through the wall of the sleeve valve **32** at its lower end. Liquid fuel reaches this duct **54** through counterbore **56** formed on the lower end of the sleeve valve **32**. When fuel pressure acting on the lower end of sleeve valve **32** moves the latter upwardly, the duct **54** is brought into registry with fuel passage **58** which is in communication with fuel passage **24**.

The needle valve **34** has an enlarged portion **60** formed at its upper end which defines a shoulder **62** against which the upper end of sleeve valve **32** is adapted to seat during its upward movement. This shoulder **62** acts as a stop for the sleeve member **32** to restrain its upward movement so long as the fuel pressure on the lower end of the sleeve valve is below a predetermined amount. When the fuel pressure rises above such predetermined amount, the upward movement of the sleeve valve is transmitted to the needle valve **34** to raise the latter from its seat. The upper portion of the needle valve and the compression spring members **36** and **38** are disposed in a bore **63** in upper part of the nozzle body. A radially extending flange **64** is formed on the upper portion **60** of the needle valve **34** and spring means **36** and **38** act against opposite sides of this flange. The compression spring means **36** surrounds upper portion **60** and seats on the flange **64** and upper surface of sleeve valve **32**. It urges sleeve valve **32** to a closed position, i.e., seated on the shoulder **50** to hold the fuel duct **54** out of registry with fuel passage **58** and positioned below passage **58** as viewed in FIGURE 1. Compression spring **36** is a weaker spring than compression spring **38** thus allowing the sleeve valve **32** to be raised by a relatively small fuel pressure without disturbing the needle valve from its seated position. The compression spring **38** is a relatively strong member and is disposed between the upper side of flange **64** and a reaction member **66** seated in a nozzle body cap member **68**. The latter may be threaded onto the upper part of the nozzle body. A leak-off channel **69** may be provided in the nozzle body to carry leakage fuel back to the fuel supply reservoir (not shown). The lower end of the needle valve may have a valve face **70** formed thereon to seat on a complementary valve seat **72** formed in the nozzle to control the opening to main injection orifice means **30**.

Orifice means **28** may comprise a single orifice or a plurality of orifices in communication with fuel passage **24**, and orifice means **30** may comprise a single orifice or a plurality of orifices adapted to be controlled by needle valve **34**. The orifice means **28** is positioned to direct a certain amount of fuel into or close to a high temperature

source. Its purpose is to provide a pilot injection to help ignite the main spray. The main injection is provided by orifice means **30**, and this orifice means **30** is directed into or close to the flame created by the combustion of the pilot injection. The two valves, sleeve valve **32** and needle valve **34**, open in succession in response to the different pressures built up in an injection pump such as pump **12**.

Injection pump **12** is the subject of copending application for U.S. Letters Patent, Ser. No. 646,033, filed on June 14, 1967. Injection pump **12** will be described here only generally. The pump **12** comprises in part a housing **80**, defining a bore **82** in which pumping plunger **14** is disposed for reciprocating movement in response to the action of a cam (not shown), at its lower end. The pump **12** also comprises a fuel chamber **84** adapted to be connected to and receive fuel from a fuel supply reservoir (not shown). A delivery valve **86** normally closed by the action of compression spring **88** is adapted to be opened by an increase of fuel pressure in a pumping chamber **90** wherein pressure is built up as the plunger **14** moves upwardly. With this increase in pressure, fuel under pressure is sent to the fuel injector device **10** through conduit **16** connected to the injection pump. It will be observed that the upper portion of pumping plunger **14** has a narrow notch **92** and a substantially triangular notch **94** communicating by passage means (not shown) in the plunger **14** with the pumping chamber **90**. Spill port means, one of which is shown at **96** in the housing **80**, provides flow communication between the fuel chamber **84** and the pumping chamber **90** whereby fuel flows from fuel chamber **84** to pumping chamber **90**. When the plunger **14** moves upwardly, a shoulder **98** on the upper end thereof blocks the flow of fuel from the fuel chamber through the spill port means **96**. At that point, pressure begins to build up in pumping chamber **90** and fuel is forced past the delivery valve **86** against the force of spring **88** through conduit **16** to the fuel injector device **10**. The notch **92** is provided to relieve the pressure in the pumping chamber as it moves into registry with spill port means **96**. As the plunger **14** continues to move upwardly, a land **100** in the form of a helix between the notches **92** and **94** again seals off the spill port **96** and pressure in the pumping chamber **90** continues to build up.

While the operation of the injector device is probably apparent from the above description of its construction, a brief summary of its operation will now be given. When the plunger **14** of the injection pump moves upwardly to the point where the shoulder **98** cuts off the spill port means **96**, pressure is built up in the pumping chamber **90**, opening delivery valve **86** and sending pressurized fuel through conduit **16** to the injector device **10**. The pressurized fuel moves through inlet fuel passage **20** to the fuel chamber **22** and acts on the sleeve valve **32** to move it upwardly against the shoulder **62** on the needle valve. In doing so, the fuel duct **54** of the sleeve valve is brought into registry with fuel passage **58** and fuel is sent to orifice means **28** via passage **24**. This occurs at a predetermined relatively low fuel pressure such, for example, as about 1500 p.s.i., because the spring **36** is made relatively weak. This provides a pilot spray to give a high energy source for the main injection. As the plunger **14** continues to move upwardly, the notch **92** in the plunger registers with spill port means **96** and fuel flows from the pumping chamber **90** back to the fuel chamber **84**, relieving the pressure in the system. Then spring **36** reseats the sleeve valve **32** on shoulder **50**, closing off fluid communication with the fuel duct **58**. As the plunger **14** continues to move upwardly, land **100** again blocks spill port **96** and pressure in the pumping chamber continues to build up. The construction of the plunger is such that fuel pressure can now build up to a considerably higher amount such, for example, as 3000 p.s.i. This fuel pressure moves the sleeve valve **32** up against the shoulder **62** with sufficient force to overcome the relatively stronger spring **38** and lift the needle valve **34** from its seat **72** thus permitting fuel to pass through orifice means **30**. This is the main injection and the velocity and quantity of fuel pumped during this main injection generally will be larger than during the pilot injection. As the sleeve valve **32** moves up with the needle valve **34**, the lower edge of the sleeve valve closes off duct **58** feeding orifice **28**. As the plunger **14** moves downwardly at the end of the pumping stroke, the pressure is decreased, of course, and the valves **32** and **34** are reseated, and the cycle is then repeated.

It will be appreciated that the quantities of fuel to be injected through each orifice means and the duration of the respective injections are independently variable. These can be varied by controlling the spring strengths of springs **36** and **38** as well as the notch formations in the pumping plunger which provides for relief of pressure in the pumping chamber of the fuel injection pump.

Thus it will be apparent that we have advantageously provided a fuel injection device of relatively simple construction, which is capable of providing two injections of fuel through separate orifices independent of each other, one being a pilot or prespray and the other a main injection. The device uses a minimum of parts, and, as can readily be seen, the parts are uncomplicated structures.

We claim:

1. In a fuel injection device adapted to receive pressurized fuel from a source of supply and to inject the fuel into an internal combustion engine, the combination comprising: a nozzle body; first fuel passage means in said nozzle body adapted to be connected to a source of pressurized fuel; first and second orifice means in said nozzle body for injecting fuel into the engine; first and second valve means for controlling the flow of pressurized fuel to said first and second orifice means respectively; yieldable biasing means associated with said first and second valve means to hold said first and second valve means in a closed position; bore means in said nozzle body; second fuel passage means in communication with said first orifice means and said bore means; said first valve means comprising a cylindrical sleeve valve slidably disposed in said bore means, and adapted to have fluid pressure act on one end thereof, said first valve means including, first means therein for establishing fluid communication between said first fuel passage and said second fuel passage means including, a fuel duct adapted to be placed in communication with said second fuel passage means in response to pressurized fuel acting on said sleeve valve.

2. A fuel injection nozzle for an internal combustion engine, comprising: a nozzle body having central bore means extending longitudinally thereof, said bore means partially defining a chamber in fluid communication with a source of pressurized fuel; first fuel ejection orifice means in said nozzle body in fluid communication with one end of said bore means; first valve means operatively interposed between said first fuel ejection orifice means and said bore means for controlling the flow of pressurized fuel through said first fuel ejection orifice means; second fuel ejection orifice means in said nozzle body; recess means formed in a wall portion of said bore means; fuel passage means in said nozzle body providing fluid communication between said second fuel ejection orifice means and said recess means; second valve means operatively interposed between said bore means and said recess means for controlling the flow of pressurized fuel through said second orifice means, said second valve means including a valve element disposed within said bore means and movable longitudinally with respect to said nozzle body between a first closed position wherein fluid communication between said bore means and said recess means is disestablished, an intermediate open position wherein fluid communication between said bore means and said recess means is established, and a second closed position wherein fluid communication between said bore means and said recess means is disestablished; yieldable biasing means associated with said first and second valve means for urging said first valve means closed and said valve element

of said second valve means toward its first closed position, said valve element being responsive to the pressure of the fuel in said bore means and movable to said intermediate open position upon the attainment of fluid pressure in said bore means at a first predetermined magnitude and movable to said second closed position upon the attainment of fluid pressure in said bore means of a second predetermined magnitude, said first valve means being responsive to the pressure of the fuel in said bore means to open only upon the attainment of fluid pressure in said bore means of said second predetermined magnitude.

3. A fuel injection nozzle as set forth in claim 2, wherein said valve element slidingly engages said bore means and includes a cylindrical sleeve-like end portion, said end portion covering said recess means when said valve element is in its first and second closed positions, said end portion having a radially extending aperture formed therethrough, said aperture being in radial registration with said recess means only when said valve element is in its intermediate open position.

4. A fuel injection nozzle as set forth in claim 3, wherein said first valve means includes an elongated needle valve extending longitudinally through and engaging said valve element for relative sliding movement; and interengaging abutment means carried by said needle valve and said valve element for limiting sliding movement of said valve element with respect to said needle valve in one direction, said valve element being in its intermediate open position when said interengaging abutment means are in engagement and said first valve means is closed.

5. A fuel injection nozzle as set forth in claim 4, wherein said needle valve is formed with an enlarged end section;

and said interengaging abutment means includes the annular shoulder formed at the juncture of said enlarged end section and the reduced diameter main body portion of the needle valve.

6. A fuel injection nozzle as set forth in claim 5, wherein said enlarged end section of said needle valve is provided with a radially extending, annular flange intermediate its ends; and said biasing means includes a first helically wound compression spring encircling said needle valve and having one end abutting said annular flange and its opposite end bearing against said valve element of said second valve means, and said bearing means further including a second helically wound compression spring encircling said needle valve and having one end abutting said annular flange and a stationary part of said nozzle body, said second spring exerting a relatively greater force on said annular flange than said first spring.

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EVERETT W. KIRBY, *Primary Examiner.*

U.S. Cl. X.R.

123—32.61; 239—533