

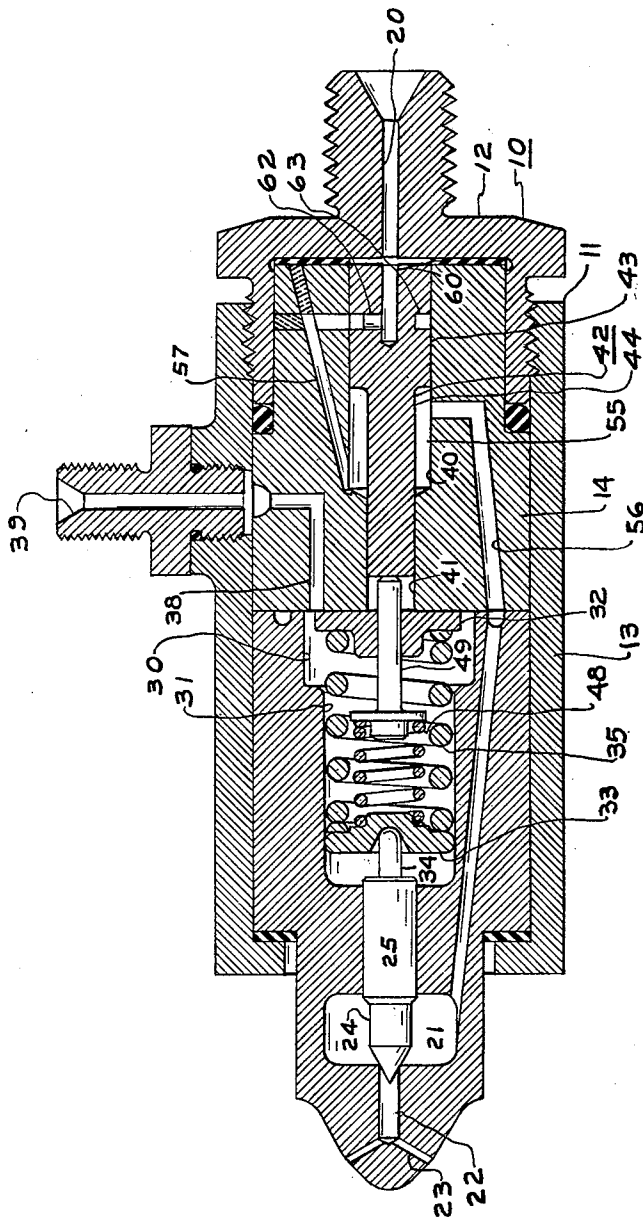
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TWO STAGE FUEL INJECTION NOZZLE

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TWO STAGE FUEL INJECTION NOZZLE

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This invention relates to fuel injection nozzles for diesel engines.

The new and improved injection nozzle of the present invention functions in a diesel engine fuel injection system to deliver two separate charges of fuel into a combustion chamber of the engine during each cycle of operation of the nozzle. The first charge in the cycle is a small quantity of fuel referred to as a pilot charge. The preliminary injection of the small quantity of fuel represented by the pilot charge into a combustion chamber creates a flame temperature which is sufficiently high to instantly ignite the subsequently injected main charge of fuel. For certain load conditions the quantity of the pilot charge of fuel required for satisfactory operation is constant over a wide speed range.

It is a main object of the present invention to provide a new and improved two stage injection nozzle which delivers a pilot charge and a main charge of fuel during each cycle of operation of the nozzle.

Another object of the invention is to provide a new and improved two stage injection nozzle in which the quantities of the pilot charges are equal for all load and speed conditions of the engine.

Another object of the invention is to provide a new and improved two stage injection nozzle in which a preliminary pilot charge of fuel is separately delivered to a combustion chamber of an engine by the nozzle at a lower pressure and therefore at a lower rate than a subsequently delivered main charge of fuel during each cycle of operation of the nozzle.

Other objects of the invention will become apparent from the following specification, the drawings relating thereto, and the appended claims.

In the drawing there is shown an elevational sectional view of one embodiment of a fuel injection nozzle constructed in accordance with the present invention.

The fuel injection nozzle shown in the drawing comprises several main parts which are stationary with respect to each other and these parts are referred to collectively herein as the body 10 of the injector. The main parts of the body 10 include a cylindrical casing member 11, a cap member 12, a valve body 13 and a control plunger body 14.

Cap member 12 has a fuel supply inlet conduit 20 for receiving fuel under pressure from an engine driven fuel metering distributor (not shown). The metering distributor functions to deliver a timed and metered charge of fuel to the nozzle for each cycle of operation of the nozzle.

Valve body 13 has a fuel chamber 21 and a discharge outlet which includes a conduit 22 and orifices 23. A needle valve 24 for opening and closing the discharge outlet is seated at the inner end of conduit 22. A fluid pressure operated piston 25 is connected to valve 24 and is slidably disposed in a bore provided in the valve body 13. Piston 25 has a differential area relative to needle valve 24 and the piston is moveable in response to fluid pressure in chamber 21 to open needle valve 24.

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Valve body 13 is formed with a relatively large bore 30 and counterbore 31 for housing resilient means which resist the opening of needle valve 24. A moveable abutment member 32 is disposed in bore 30 which has limited vertical movement by reason of being seatable in one direction on an abutment surface represented by the bottom of plunger body 14 and in the other direction by an abutment surface represented by the counter of bore 30. A moveable spring retaining or abutment member 33 engages a stem 34 attached to piston 25 and disposed between abutments 32 and 33 is a helical spring 35. Spring 35 biases valve 24 towards a closed position and biases abutment member 32 in the opposite direction towards a seated position.

A back leakage conduit 38 is formed in plunger body 14 which extends between bore 30 and a back leakage outlet 39. Conduit 38 functions to permit the removal of fuel which seeps into the chamber defined by bores 30 and 31.

Control plunger body 14 has formed therein a bore 40 and a counterbore 41. A control plunger 42 having cylindrical portions 43 and 44 slidably disposed in bores 40 and 41 is provided for controlling the fuel supplied to fuel chamber 21. A spring 48 is operably disposed between control plunger 42 and valve 24 for biasing the valve towards a closed position and biasing the plunger in the opposite direction towards the starting position for the stroke of the plunger. Spring 48 is nestled in spring 35 and is disposed between abutment member 33 and a rod member 49. Rod member 49 extends through a hole provided in abutment member 32 and engages the bottom of control plunger 42.

Cylindrical portion 43 of control plunger 42 is of shorter length than the bore 40 in which it is slidably disposed such that an expansible chamber 55 is formed. Chamber 55 is annular in shape by reason of being defined by cylindrical portion 44 of plunger 42 and the cylindrical wall of bore 40. In making reference herein after to the position of various conduits with respect to expansible chamber 55, the chamber will be considered from the structural standpoint as being fully expanded with the control plunger 42 being in a position corresponding to the start of its stroke.

A fuel passage 56 is formed jointly in plunger body 14 and valve body 13 which extends between expansible chamber 55 and fuel chamber 21. The inlet to fuel passage 56 is adjacent expansible chamber 55 and the outlet is adjacent fuel chamber 21.

A pilot charge conduit 57 is formed in plunger body 14 which extends between expansible chamber 55 and bore 40 at a point spaced from expansible chamber 55. The inlet of pilot charge conduit 57 is adjacent bore 40 and the outlet thereof is adjacent the expansible chamber 55.

The cylindrical portion 43 of control plunger 42 has conduit means 60 with the inlet thereof being at the upper end of cylindrical portion 43 in constant fluid communication with the fuel supply inlet 20. An outlet 62 surrounded by an annular groove 63 is provided for conduit means 60. Groove 63 registers with the inlet of pilot charge conduit 57 when plunger 42 is at the start of its stroke and with the inlet of fuel passage 56 when plunger 42 is at the end of its stroke.

The operation of the nozzle illustrated in the drawing and described above is as follows:

For a starting point it is assumed that control plunger 42 has completed a cycle of operation and is being held at the starting point of its stroke by the biasing force of spring 48. At this instant the fuel pressure at the fuel supply inlet 20 is at a minimum value and needle valve 24 is closed by the action of springs 35 and 48. When the pressure at fuel supply inlet 20 begins to rise there is first of all a flow of fuel to expansible chamber 55 through

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conduit 60 in the plunger 42 and through pilot charge conduit 57. When expansible chamber 55 is full the pressure at fuel supply inlet 20 causes downward movement of plunger 42 against the resistance of spring 48.

This downward movement of plunger 42 immediately closes the inlet to the pilot charge conduit 57. Further downward movement of plunger 42 causes fuel to be pumped from expansible chamber 55 to fuel chamber 21 through fuel passage 56 until the lower edge of cylindrical portion 43 covers the inlet to fuel passage 56. The pilot charge of fuel pumped from expansible chamber 55 to fuel passage 56 exerts a force again piston 25 to tend to open valve 24 against the resistance of springs 35 and 48. Springs 35 and 48 are selected so that valve 24 opens when a predetermined pressure is reached in fuel chamber 21 and, by way of example, this pressure could be 100 atmospheres. The quantity of the pilot charge of fuel pumped from expansible chamber 55 and discharged through orifices 23 is a constant for each cycle of operation of the nozzle and is constant for all load and speed conditions of the engine.

As plunger 42 moves further downwardly it contacts movable abutment 32 and begins to compress spring 35 just prior to the instant that cylindrical portion 43 covers the inlet to fuel passage 56. When cylindrical portion 43 of plunger 42 does close the inlet to fuel passage 56 the pressure in fuel chamber 21 drops and the biasing force of springs 35 and 48 close valve 24 to cut off the delivery of the pilot charge of fuel.

The extent of further downward movement of plunger 42 is limited by reason of movable abutment member 32 becoming seated on the counter of bore 30 which determines the end of the stroke of plunger 42. At this point springs 35 and 48 are compressed to a maximum value and the groove 63 of cylindrical portion 43 of the plunger registers with the inlet of fuel passage 56 to permit the main charge of fuel to be delivered to fuel chamber 21. The main charge of fuel is admitted from the fuel supply inlet 20 and flows through the conduit 60 of the cylindrical portion 43 of the plunger through fuel passage 56 to fuel chamber 21 where it exerts pressure on piston 25 against the biasing force of springs 35 and 48. Springs 35 and 48 are selected so that when they are compressed to the extent indicated it requires a predetermined pressure in fuel chamber 21 to effect opening of valve 24. By way of example this pressure could be 175 atmospheres as compared to 100 atmospheres to effect opening of the valve 24 to permit discharge of the pilot charge of fuel.

The pilot charges of fuel discharged by the nozzle of the present invention are constant during the operation of the nozzle for all load and speed conditions of the engine. The quantity of the main charge varies however and depends on the length of time that the engine driven fuel distributor (not shown) which supplies fuel to the nozzle maintains a pressure at fuel supply inlet 20 which is adequate to maintain valve 24 open against the biasing force of springs 35 and 48. It is only after the pressure at the fuel supply inlet 20 drops below a predetermined value that the discharge of the main charge of fuel through orifices 23 is cut off and concomitantly the biasing force of springs 35 and 48 cause valve 24 to close and cause plunger 42 to move upwardly to the starting point of its stroke. At this point one cycle of operation of the nozzle is completed and the plunger is in position for the next cycle to begin.

From the above description it is seen that the nozzle of the present invention discharges two separate and distinct charges of fuel during each cycle of operation. The quantity of the pilot charge of fuel is constant for all cycles of operation of the nozzle regardless of the speed and load of the engine with which the nozzle is associated. The quantities of the main charges of fuel discharged varies in accordance with the characteristics of

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the fuel distributor which supplies metered quantities of fuel under pressure to the nozzle.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiment of the invention is therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

It is claimed and desired to secure by Letters Patent:

1. A two stage fuel injection nozzle comprising a body having formed therein a fuel supply inlet and a discharge outlet and a fuel chamber communicating with said discharge outlet; a valve for opening and closing said discharge outlet; a fluid pressure operated piston connected to said valve and being movable in response to fluid pressure in said fuel chamber to open said valve; a control plunger slidably mounted in said body and being cooperable therewith to form an expansible pilot charge chamber; resilient means operably disposed between said control plunger and said valve for biasing said plunger in a direction away from said valve and for biasing said valve towards a closed position; fuel passage means in said body having the outlet thereof communicating with said fuel chamber; pilot charge conduit means having the outlet thereof communicating with said expansible chamber and the inlet thereof communicatable with said fuel supply inlet; and conduit means in said plunger which provide communication between said fuel supply inlet and said fuel passage means when said control plunger is at the end of its stroke.

2. A two stage fuel injection nozzle comprising a body having formed therein a fuel supply inlet and a discharge outlet and a fuel chamber communicating with said discharge outlet; a valve for opening and closing said discharge outlet; a fluid pressure operated piston connected to said valve and being movable in response to fluid pressure in said fuel chamber to open said valve; a control plunger slidably mounted in said body and being cooperable therewith to form an expansible pilot charge chamber; resilient means operably disposed between said control plunger and said valve for biasing said plunger in a direction away from said valve and for biasing said valve towards a closed position; fuel passage means in said body having the outlet thereof communicating with said fuel chamber; pilot charge conduit means having the outlet thereof communicating with said expansible chamber and the inlet thereof communicatable with said fuel supply inlet; conduit means in said plunger which provide communication between said fuel supply inlet and said fuel passage means when said control plunger is at the end of its stroke; said control plunger being movable towards said valve in response to fuel pressure applied through said fuel supply inlet to close the inlet of said pilot charge conduit means, pump a pilot charge of fuel from said expansible chamber through said fuel passage means to said fuel chamber, interrupt the flow of fuel from said expansible chamber to said fuel passage means, compress said resilient means to a predetermined length, and establish communication between said fuel supply inlet and said fuel passage means when said plunger is at the end of its stroke.

3. A two stage fuel injection nozzle comprising a body having formed therein a fuel supply inlet and a discharge outlet and a fuel chamber communicating with said discharge outlet; a valve for opening and closing said discharge outlet; a fluid pressure operated piston connected to said valve and being movable in response to fluid pressure in said fuel chamber to open said valve; first resilient means operably disposed between said piston and said movable abutment member for biasing said valve towards a closed position and biasing said movable abutment member towards a seated position; first and second

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bores in said body axially aligned with said piston, said second bore being counterbored with respect to said first bore; a control plunger having first and second cylindrical portions slidably disposed respectively in said first and second bores, said first cylindrical portion being of lesser length than said first bore to form an annularly shaped expansible pilot charge chamber; second resilient means operably disposed between said control plunger and said valve for biasing said plunger in a direction away from said valve and for biasing said valve towards a closed position; fuel passage means in said body having the inlet thereof communicating with said expansible chamber and the outlet thereof communicating with said fuel chamber; pilot charge conduit means in said body having the outlet thereof communicating with said expansible chamber and the inlet thereof communicating with said fuel supply inlet when said plunger is at the start of its stroke; conduit means in said first cylindrical portion of said plunger having an inlet in constant fluid communication with said fuel supply inlet and having one outlet which registers with the inlet of said pilot charge conduit means when said control plunger is at the start of its stroke and a second outlet which registers with the inlet of said fuel passage means when said plunger is at the end of its stroke; said control plunger being movable towards said valve in response to fuel pressure applied through said fuel supply inlet to close the inlet of said pilot charge conduit means, pump a pilot charge of fuel from said expansible chamber through said fuel passage means to said fuel chamber, close the inlet to said fuel passage means, operably engage and compress said first resilient means, and establish communication between the outlet of said conduit means in the first cylindrical portion of said plunger and the inlet of said fuel passage means when said plunger is at the end of its stroke.

4. A two stage fuel injection nozzle comprising a body having formed therein a fuel supply inlet and a discharge outlet and a fuel chamber communicating with said discharge outlet; a valve for opening and closing said discharge outlet; a fluid pressure operated piston connected to said valve and being movable in response to fluid pressure in said fuel chamber to open said valve; a movable abutment member seatable against an abutment surface of said body; first resilient means operably disposed between said piston and said movable abutment member for biasing said valve towards a closed position and biasing said movable abutment member towards a seated position; first and second bores in said body axially aligned with said piston, said second bore being counterbored with respect to said first bore; a control plunger having first and second cylindrical portions slidably disposed respectively in said first and second bores, said first cylindrical portion being of lesser length than said first bore to form an annular and expansible pilot charge chamber; second resilient means operably disposed between said control plunger and said valve for biasing said plunger in a direction away from said valve and for biasing said valve towards a closed position; fuel passage means in said body having the inlet thereof communicating with said expansible chamber and the outlet thereof communicating with said fuel chamber; pilot charge conduit means in said body having the outlet thereof communicating with said first bore at a point spaced from said expansible chamber; conduit means in said first cylindrical portion of said plunger having an inlet in constant fluid communication with said fuel supply inlet and having one outlet which registers with the inlet of said pilot charge conduit means when said control plunger

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is at the start of its stroke and a second outlet which registers with the inlet of said fuel passage means when said plunger is at the end of its stroke; said control plunger being movable towards said valve in response to fuel pressure applied through said fuel supply inlet to close the inlet of said pilot charge conduit means, pump a pilot charge of fuel from said expansible chamber through said fuel passage means to said fuel chamber, close the inlet to said fuel passage means, operably engage and compress said first resilient means, and establish communication between the outlet of said conduit means in the first cylindrical portion of said plunger and the inlet of said fuel passage means when said plunger is at the end of its stroke.

5. A two stage fuel injection nozzle comprising a body having formed therein a fuel supply inlet and a discharge outlet and a fuel chamber communicating with said discharge outlet; a needle valve for opening and closing said discharge outlet; a fluid pressure operated piston connected to said valve and being movable in response to fluid pressure in said fuel chamber to open said valve; a movable abutment member seatable against and movable between oppositely facing abutment surfaces of said body; first resilient means operably disposed between said piston and said movable abutment member for biasing said valve towards a closed position and biasing said movable abutment member towards a seated position; first and second bores in said body axially aligned with said piston, said second bore being counterbored with respect to said first bore; a control plunger having first and second cylindrical portions slidably disposed respectively in said first and second bores, said first cylindrical portion being of lesser length than said first bore to form an annularly shaped expansible pilot charge chamber between said second cylindrical portion of said plunger and said body; second resilient means operably disposed between said control plunger and said valve for biasing said plunger in a direction away from said valve and for biasing said valve towards a closed position; fuel passage means in said body having the inlet thereof communicating with said expansible chamber and the outlet thereof communicating with said fuel chamber; pilot charge conduit means in said body having the outlet thereof communicating with said first bore at a point spaced from said expansible chamber; conduit means in said first cylindrical portion of said plunger having an inlet at the end thereof opposite from said valve in constant fluid communication with said fuel supply inlet and having one outlet which registers with the inlet of said pilot charge conduit means when said control plunger is at the start of its stroke and a second outlet which registers with the inlet of said fuel passage means when said plunger is at the end of its stroke; said control plunger being movable towards said valve in response to fuel pressure applied through said fuel supply inlet to sequentially close the inlet of said pilot charge conduit means, pump a pilot charge of fuel from said expansible chamber through said fuel passage means to said fuel chamber, close the inlet to said fuel passage means, operably engage said movable abutment to move said abutment to a seated position to compress said first resilient means to a predetermined length, and establish communication between the second outlet of said conduit means in the first cylindrical portion of said plunger and the inlet of said fuel passage means when said plunger is at the end of its stroke.

No references cited.