

[54] **FUEL INJECTION NOZZLES**

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[51] Int. Cl.**B05b 1/30**

[58] Field of Search.....239/585, 533

[56] **References Cited**

UNITED STATES PATENTS

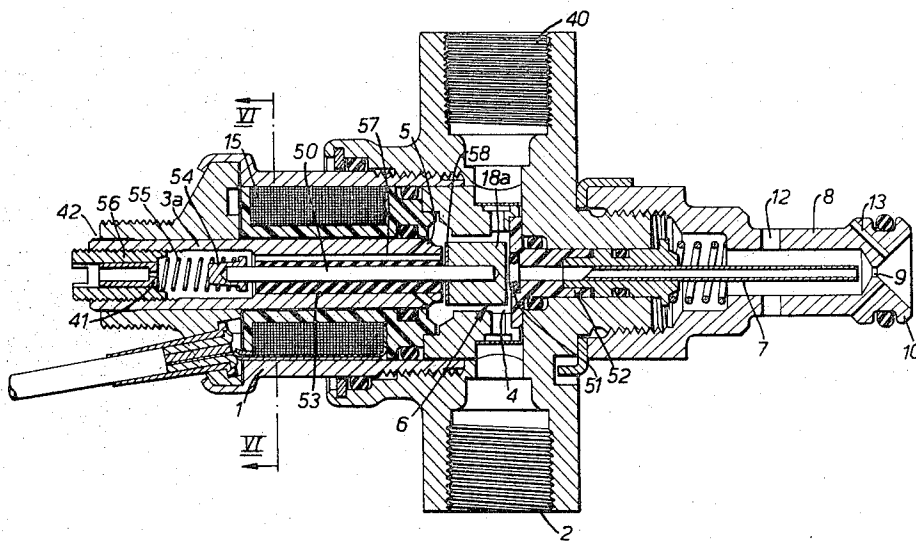
3,460,760 8/1969 Bluhm239/533 X
 3,680,794 8/1972 Romann et al.239/585

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[57] **ABSTRACT**

Fuel injector nozzles are described including electromagnetically-operable interrupter valves whereby the nozzles can be operated to discharge fuel intermittently. In one form, the movable valve member of the interrupter valve is spherical. In another form, a through-flow fuel path is provided to permit the continuous circulation of fuel through the nozzle even when the interrupter valve is closed, and a vapor separating path is provided to remove fuel vapor. In yet another form, a non-magnetizable element is provided to reduce operating delays in the interrupter valve as a result of residual magnetism.

18 Claims, 8 Drawing Figures



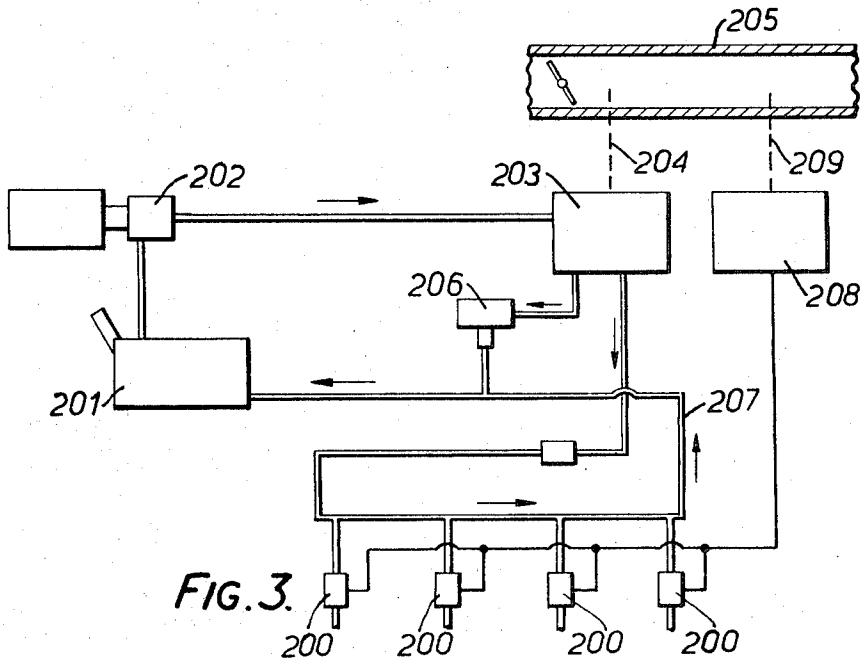


FIG. 3.

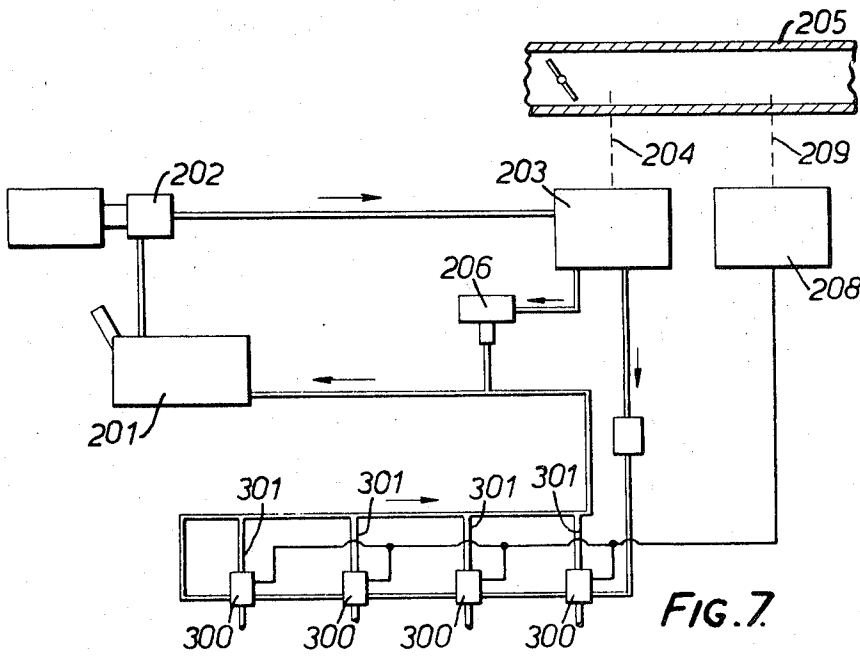


FIG. 7.

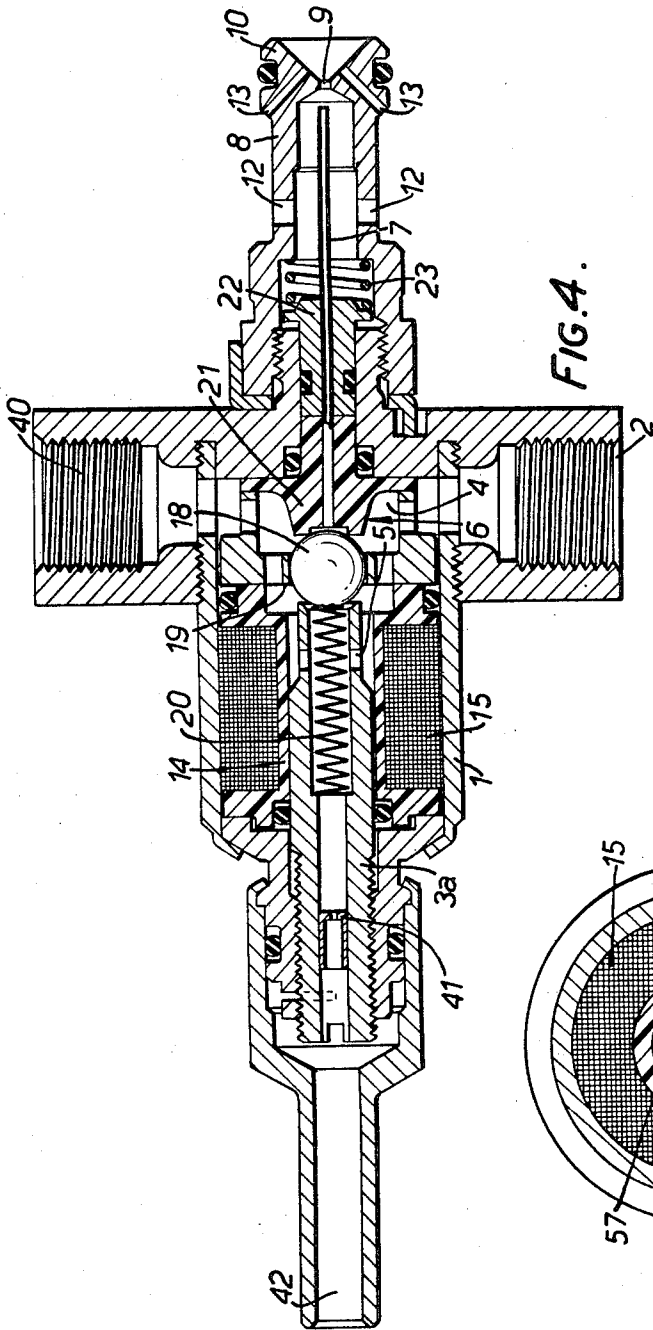


FIG. 4.

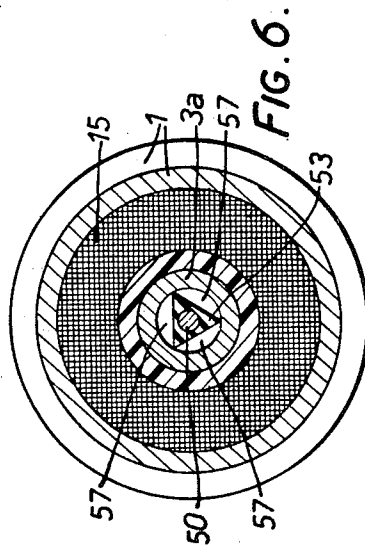
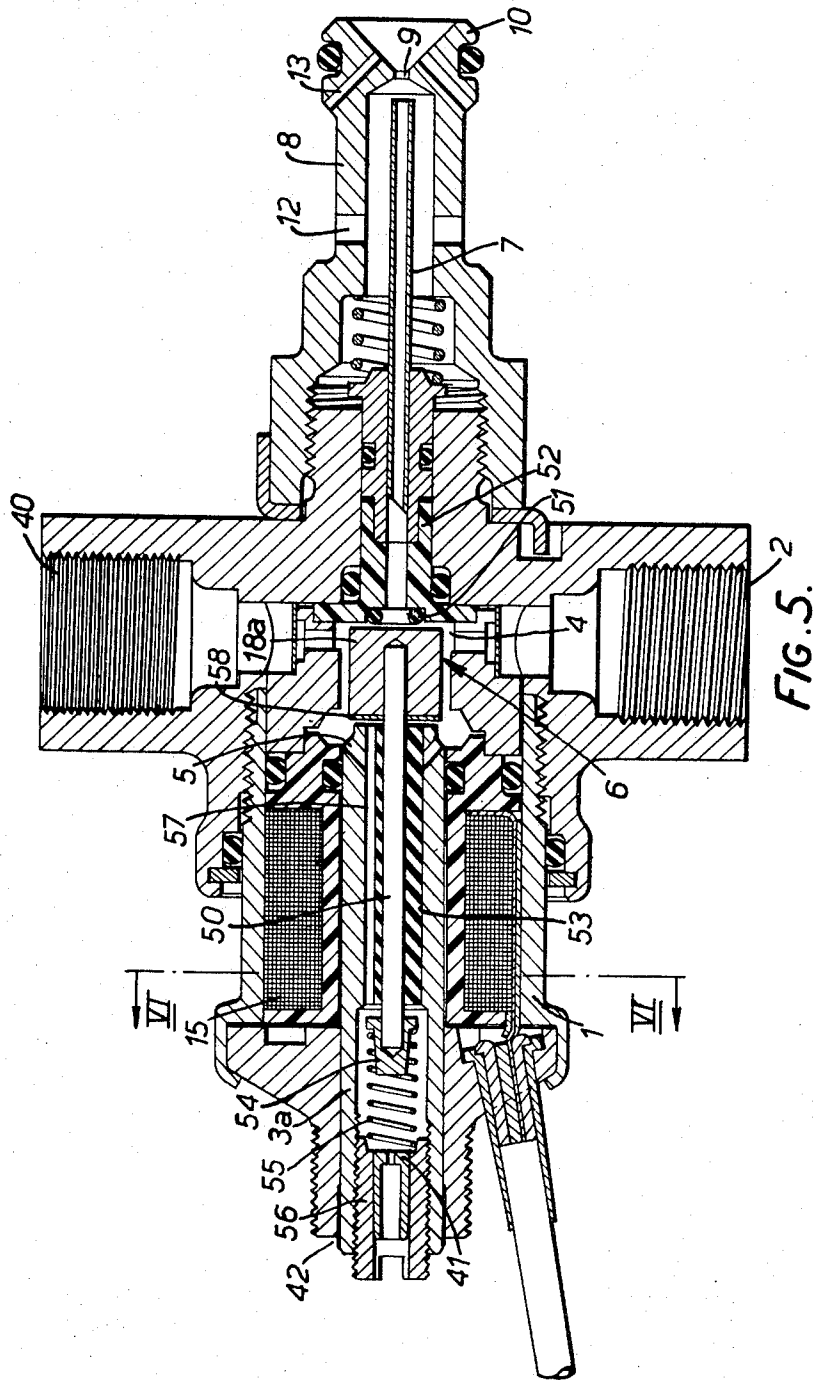


FIG. 6.



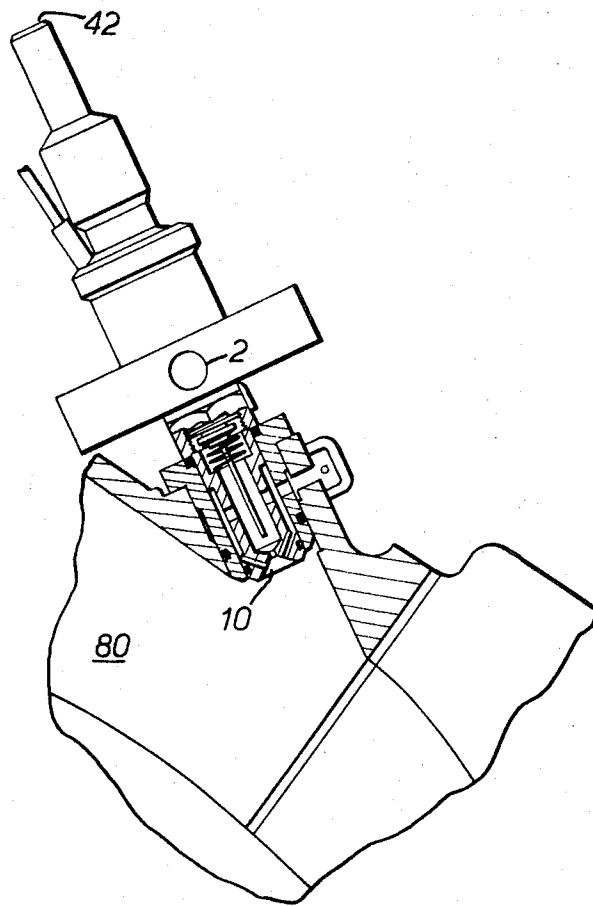


FIG. 8

FUEL INJECTION NOZZLES

This invention relates to fuel injector nozzles for fuel injection systems for internal combustion engines and, in particular, to nozzles which can be operated to discharge fuel intermittently.

Injector nozzles are usually positioned to discharge fuel into the intake manifold system of the internal combustion downstream of the throttle valve: each nozzle may, for example, be positioned to discharge fuel into a respective branch pipe leading from the intake manifold to an engine cylinder. Alternatively, each nozzle may be positioned to discharge fuel directly into a respective engine cylinder downstream of the cylinder intake valve. In some systems, the injector nozzles are of the so-called "open" type and operate to discharge fuel continuously. Other systems, however, operate to discharge fuel intermittently and to this end each injector nozzle may include an interrupter valve which, when operated, opens the nozzle to discharge fuel.

The present invention provides a fuel injector nozzle including a fuel inlet, a fuel discharge path connected to receive fuel from the inlet, and an electromagnetically-operable interrupter valve including a spherical valve member movable between open and closed positions to control fuel flow along the discharge path to a discharge orifice.

The discharge path may be connected to receive fuel from the inlet through a fuel inlet path defined by a tubular member within the nozzle. Alternatively, the discharge path may be connected to receive fuel from a through-flow fuel path within the nozzle, which connects the inlet to a through-flow fuel outlet, the nozzle also including a vapor separating path connected to the through-flow path to remove vapor therefrom.

The present invention accordingly also provides a fuel injector nozzle including a fuel inlet, a through-flow fuel path within the nozzle connecting the inlet to a through-flow outlet, a vapor separating path connected to the through-flow path to remove vapor therefrom, a fuel discharge path connected to receive fuel from the inlet, and an electromagnetically-operable interrupter valve including a valve member movable between open and closed positions to control fuel flow along the discharge path to a discharge orifice.

When the nozzle includes a vapor separating path as defined above, the operating position of the nozzle is such that the connection between the vapor separating path and the through-flow path is located above the surface level of liquid fuel in the nozzle and the connection between the discharge path and the through-flow path is located below that surface level.

The vapor separating path may be defined by a tubular member within the nozzle. The end of the tubular member may provide a stop, positioned to limit movement of the valve member in response to energization of the interrupter valve: the nozzle may then include a non-magnetizable element positioned to prevent engagement between the valve member and the stop, and thereby prevent the valve member being retained in the energized position under the influence of residual magnetism following de-energization of the interrupter valve.

The invention accordingly also provides a fuel injector nozzle including a fuel inlet, a fuel discharge path

connected to receive fuel from the inlet, an electromagnetically-operable interrupter valve including a valve member movable between open and closed positions to control fuel flow along the discharge path to a discharge orifice, a stop positioned to limit movement of the valve member in response to energization of the interrupter valve and a non-magnetizable element positioned to prevent engagement between the valve member and the stop. The non-magnetizable element may be movable with the valve member, or may be mounted on the stop.

In each of the above forms of the invention, the fuel discharge path may be defined by a fuel discharge tube located within an outer jacket in which the discharge orifice is formed, the fuel discharge tube having an outlet aligned with the discharge orifice and the outer jacket having at least one vent through which air is drawn into the jacket during operation of the nozzle. In one form of nozzle, the outer jacket includes a vent upstream of the discharge tube outlet and a further vent downstream of the discharge tube outlet; preferably, the further vent is positioned downstream of the injector nozzle discharge orifice. The fuel tube may be a constant fine-bore tube which forms a fuel flow restrictor. Preferably, the fuel tube is removable from the nozzle without disturbing the interrupter valve.

By way of example, fuel injector nozzles constructed in accordance with the invention will be described with reference to the accompanying drawings, in which:

FIG. 1 is a cross-section of one form of injector nozzle;

FIG. 2 is a view on the line II—II in FIG. 1;

FIG. 3 illustrates the use of the injector nozzle shown in FIGS. 1 and 2 in a fuel injection system;

FIG. 4 is a cross-section of another form of injector nozzle;

FIG. 5 shows a modified form of the nozzle shown in FIG. 4;

FIG. 6 is a view on the line VI—VI of FIG. 5;

FIG. 7 illustrates the use of injector nozzles of the type shown in FIGS. 4 to 6 in a fuel injection system; and

FIG. 8 shows partly in cross-section, an injector nozzle in accordance with the invention mounted on the intake manifold of an internal combustion engine.

The injector shown in FIGS. 1 and 2 has an outer casing 1 in one end of which is defined a fuel inlet 2 communicating with the bore of a tubular element 3 located centrally within the casing 1. The bore of the tubular element 3 forms an inlet path from the fuel inlet 2 to a chamber 4 with which the bore communicates through apertures 5 in the wall of the tubular element. An interrupter valve, indicated generally at 6, controls communication between the chamber 4 and a fuel discharge tube 7 aligned with the tubular element 3 and located within an outer jacket 8 which is screwed onto the outer casing 1 as indicated at 11. The distal end of the fuel discharge tube 7 is open and aligned with a discharge orifice 9 formed in the tip 10 of the outer jacket 8 whereby fuel flowing through the tube 7 is discharged from the nozzle through the orifice 9. The interior of the jacket 8 is vented to atmosphere upstream of the open end of the fuel discharge tube 7 through ports 12 formed in the jacket wall and additional vent ports 13 are formed downstream of the orifice 9 in the nozzle tip 10.

Located around the tubular element 3 is a spool-shaped member 14 on which is wound a solenoid 15 connected to electrical terminals 16 on a casing 1, which in use of the nozzle in a fuel injection system are connected by leads 17 to a suitable control unit operable to energize the solenoid.

The interrupter valve 6 includes a spherical magnetizable valve member 18 which is located within a guide 19 formed in the chamber 4 and is biased by a spring 20, seated in the tubular element 3, against a valve seating member 21 to cut off communication between the chamber 4 and the fuel discharge tube 7. The bias exerted by the spring 20 can be varied to adjust the seating pressure of the valve member 18 by adjustment of the tubular element 3 which is in screw-threaded engagement with the casing 1 for this purpose, as indicated at 24.

In use, the injector nozzle is connected in a fuel injection system as will be described below, by way of example, with reference to FIG. 3 and is mounted on the intake manifold of an internal combustion engine so that fuel passing through the orifice 9 is discharged into the manifold. The vents 12 and 13 are connected to atmosphere at the engine air cleaner through a longitudinal gallery in the intake manifold in a manner similar to that described below with reference to FIG. 8. Fuel is supplied to the nozzle inlet 2 and if the solenoid 15 is energized then magnetic forces act on the valve member 18 to move the latter away from the seating member 21 against the bias of the spring 20 and open communication between the chamber 4 and the fuel discharge tube 7. The adjacent end of the tubular element 3 forms a stop to limit movement of the valve member 18 away from the seating 21, and fuel flows from the injector inlet 2, along the bore of the tubular element 3, through the apertures 5 and the chamber 4 into the tube 7 and is discharged through the orifice 9 into the intake manifold system of the internal combustion engine. The depression in the intake manifold system causes air to be drawn into the interior of the outer jacket 8 through the ports 12 and this serves to atomize the fuel stream emerging from the fuel discharge tube 7 and also to ensure that the interior of the jacket 8 is maintained at atmospheric pressure so that the depression existing in the intake manifold system has no effect on fuel flow through the tube 7. Air is also drawn through the additional vent ports 13 in the nozzle tip 10 and this additional air stream impinges on fuel emerging from the discharge orifice 9 and effects further atomization. The atomizing effect of the air flow through the vent ports 12, 13 enables a very fine spray of fuel to be produced, this being of particular importance when the engine is being operated on a weak fuel/air mixture to minimize exhaust emissions.

The fuel discharge tube 7 is a stainless steel tube having a bore of small, constant diameter of several thousandths of an inch, for example 0.022 inch. The fuel discharge tube 7 acts as a flow restrictor and is the main restriction to fuel flow through the nozzle when the valve member 18 is in the open position. The tube 7 is flow-rated during assembly of the nozzle, and when a plurality of the nozzles are to be employed in a fuel injection system and fed from a common fuel supply, nozzles having fuel discharge tubes 7 of comparable ratings would be chosen thereby ensuring that fuel will be distributed equally between the nozzles. It will be

noted that this flow restricting function of the nozzle is completely independent of the interrupter valve 6. Furthermore, the flow restricting characteristics of the nozzle can be modified readily if desired (for example, to suit different fuel injection systems) by replacing the fuel discharge tube 7 with another tube having a different flow rating. To this end, it will be noted that the fuel discharge tube 7 is located in a mounting block 22 which forms a continuation of, but is separate from, the valve seating member 21, being held against the seating member by a spring 23 seated on a stepped portion of the outer jacket 8. To replace the fuel tube 7, it is, therefore only necessary to unscrew the outer jacket 8 thereby releasing the block 22 and the tube 7 which can then be replaced by another: throughout the operation, the interrupter valve 6 is untouched. The electromagnetic unit of the nozzle can, accordingly, be manufactured as a standard component.

FIG. 3 illustrates the use, in a fuel injection system, of nozzles 200 each of the type shown in FIGS. 1 and 2. The system is of the type described in the Complete Specification of our copending British Patent applications Nos. 32531/69 and 45806/69 and includes a tank 201 from which fuel is drawn by any suitable form of pump 202 and supplied to a fuel pressurizing device 203. The device 203 pressurizes fuel in dependence on engine air intake as indicated by the dotted line connection 204 to the engine air intake conduit 205 and pressurized fuel then passes to the injector devices 200. Excess fuel from the pressurizing device 203 is returned to the fuel tank 201 via a relief valve 206, and excess fuel from the nozzles 200 is also returned to the tank through conduit 207. A control device 208, which is also responsive to engine air intake as indicated by the dotted line connection 209 to the intake conduit 205, generates intermittent electrical pulses which are applied to the solenoids 15 (not shown in FIG. 3) of the nozzles 200 to operate the associated interrupter valves 6 and allow the nozzles to discharge fuel. In the systems described in our above-mentioned co-pending applications, the control device 208 generates electrical pulses at regular time intervals but adjusts the length of the pulses as engine air intake varies: nozzles constructed in accordance with the present invention could, however, be used in other types of systems, for example systems of the type in which a control device generates electrical pulses to operate the injector nozzles in dependence on engine speed.

The nozzle shown in FIG. 4 is similar to that shown in FIGS. 1 and 2 and corresponding parts carry the same reference numeral. In this nozzle, however, the fuel inlet 2 is not formed in one end of the casing 1 but in one side and communicates directly (through the chamber 4 containing the spherical valve member 18) with a through-flow fuel outlet 40 formed in the other side of the casing. The nozzle includes a tubular element 3a aligned with the fuel discharge tube 7 and corresponding to the tubular element 3 shown in FIGS. 1 and 2 but in this case the tubular element 3a defines a vapor separating path which functions to remove fuel vapor from the chamber 4 rather than deliver fuel to the chamber, and to this end the bore of the tubular element 3a contains a restrictor 41. The fuel tube 7 and the vapor separating path 3a are perpendicular to the through-flow fuel path between the inlet 2 and the outlet 40.

In use, the injector nozzle shown in FIG. 4 is connected in a fuel injection system as will be described below, by way of example, with reference to FIG. 7 and is mounted on the intake manifold 80 of an internal combustion engine as illustrated in FIG. 8, so that fuel passing through the orifice 9 is discharged into the manifold. The vents 12 and 13 connect with an annular space 81 which is formed between the outer jacket 8 and the nozzle mounting and which, in turn, is connected to the engine air cleaner through a longitudinal gallery 82 in the manifold 80.

Fuel is supplied to the inlet 2 and, if the valve member 18 is seated, passes directly through the chamber 4 and leaves the nozzle via the through-flow outlet 40. This through-flow of fuel, which takes place even when the valve member 18 is in the closed position, has a cooling effect and reduces the tendency for fuel to vaporize within the nozzle. If any vaporization does occur, however, the vapor together, possibly, with a small amount of fuel passes through the apertures 5 in the wall of the tubular element 3a, along the bore of the tubular element, through the restrictor 41 and leaves the nozzle through a vapor outlet 42 formed at the end of the casing 1. The separation of vapor in this manner is assured by the positioning of the nozzle when installed in an internal combustion engine, this being such that the tip 10 of the outer jacket 8 is the lowest point of the nozzle as illustrated in FIG. 8. Any vapor present in the chamber 4 will rise to the top of the chamber from which point the vapor can pass directly through the apertures 5 etc. to the vapor outlet 42.

When the solenoid 15 is energized, magnetic forces act on the spherical valve member 18 to move the latter away from the seating 21 against the bias of spring 20 (this movement being limited by the end of the tubular element 3a) and fuel then flows from the inlet 2, through the chamber 4 and the seating member 21 into the fuel discharge tube 7 and is discharged through the orifice 9 into the intake manifold 80 of the internal combustion engine. As in the nozzle shown in FIGS. 1 and 2, the depression in the intake manifold system causes air to be drawn in through the vent ports 12 and 13 in the jacket 8 surrounding the fuel discharge tube 7 to atomize the fuel and ensure that the interior of the jacket 8 is maintained at atmospheric pressure. Excess fuel which does not pass into the discharge tube 7 leaves the nozzle via the through-flow outlet 40 and any fuel vapor which forms in the chamber 4 passes to the vapor outlet 42 as described above. The positioning of the nozzle when installed in an internal combustion engine as shown in FIG. 8 ensures that the valve seating 21 is always below the liquid fuel level in the chamber 4 and, accordingly, that only liquid fuel will pass into the discharge tube 7.

As in the nozzle shown in FIGS. 1 and 2, the flow restricting characteristics of the nozzle shown in FIG. 4 can be modified if desired by replacing the fuel discharge tube 7 with another tube having a different flow rating, and this can be done without disturbing the interrupter valve 6 by unscrewing the outer jacket 8 to release the block 22 in which the fuel discharge tube is located. Also, as in FIGS. 1 and 2 the flow restricting function of the nozzle is completely independent of the fuel control function of the interrupter valve 6.

The nozzle shown in FIGS. 5 and 6 is similar to that shown in FIG. 4 in that the fuel inlet 2 is formed in one

side of the casing 1 and communicates directly, through a chamber 4 containing an interrupter valve 6, with a through-flow fuel outlet 40 formed in the other side of the casing. Corresponding parts of the nozzles carry similar reference numerals. The nozzle of FIGS. 5 and 6 differs from that shown in FIG. 4 as regards the particular construction of the interrupter valve 6 and the vapor outlet path from the chamber 4 to the vapor outlet 42.

In the nozzle shown in FIGS. 5 and 6, the interrupter valve 6 includes a magnetizable valve member in the form of a cylindrical flow control member 18a located on one end of a guide rod 50, and a valve seating defined by an O-ring 51 located in a valve seating member 52. The guide rod 50 extends from the cylindrical member 18a through a guideway 53 located within the vapor removing tubular element 3a and terminates in a spring seating member 54. A spring 55 is located between the seating member 54 and a stop 56 inserted in the vapor outlet 42 at the end of the nozzle casing 1 and biases the valve member 50, 18a towards the O-ring seating 51.

The guideway 53 is triangular in shape as best shown in FIG. 6, the faces of the triangle defining, with the bore wall of the tubular element 3a, three vapor outlet passages 57. The chamber 4 communicates with the outlet passages 57 through apertures 5 formed in the wall of the tubular element 3a as in FIG. 4, and the outlet passages 57, in turn, communicate with a restrictor 41 located within the stop 56 in the vapor outlet 42.

A non-magnetizable washer 58 is located between the cylindrical flow control member 18a and the adjacent end of the tubular element 3a and is a close fit around the valve member guide rod 50 for movement therewith.

In use, the injector nozzle shown in FIGS. 5 and 6 is connected in a fuel injection system as will be described below, by way of example, with reference to FIG. 7 and is mounted on the intake manifold 80 of an internal combustion engine in a similar position to that illustrated in FIG. 8. Fuel is supplied to the inlet 2 and, if the flow control member 18a is seated, passes directly through the chamber 4 and leaves the nozzle via the through-flow outlet 40. As in the nozzle shown in FIG. 4, this through-flow of fuel, which occurs even when the interrupter valve 6 is closed, has a cooling effect and reduces the tendency for fuel to vaporize within the nozzle. If any vapor does form within the chamber 4 then the positioning of the nozzle when installed in an internal combustion engine (that is with the nozzle tip 10 being the lowest point as illustrated in FIG. 8) ensures that the vapor together, possibly, with a small amount of fuel passes through the apertures 5 in the wall of the tubular element 3a, along the passages 57 and leaves the nozzle through the restrictor 41 within the outlet 42.

As in the nozzles shown in FIGS. 1 and 2, and FIG. 4, the interrupter valve 6 is operated by a solenoid 15. When the solenoid 15 is energized, magnetic forces act on the valve member 50, 18a, to move the valve member away from the O-ring seating against the bias of the spring 55, this movement being limited by the end of the tubular element 3a. Fuel then flows from the inlet 2 through the chamber 4, the seating member 52, the fuel discharge tube 7 and is discharged through the

orifice 9 into the intake manifold system of the internal combustion engine. Excess fuel leaves the nozzle via the through-flow outlet 40 and any vapor which forms in the chamber 4 leaves the nozzle through the vapor outlet 42 as described above. The positioning of the nozzle when in use as illustrated in FIG. 8 ensures that the valve seating 51, 52 is always below the liquid fuel level in chamber 4 and, accordingly, that only liquid fuel passes into the fuel tube 7.

When the interrupter valve 6 is open, the non-magnetizable washer 58 prevents the magnetizable flow control member 18a from coming into contact with the magnetizable tubular element 3a and from being held in the open position under the influence of residual magnetism following de-energization of the solenoid 15. It will be appreciated that the washer 58, rather than being mounted to move with the guide rod 50 could be stationary and mounted on the tubular element 3a. It will also be appreciated that washers of this type, although not illustrated, could be incorporated in the nozzles shown in FIGS. 1 and 2 and FIG. 4, being mounted, for example, on the tubular elements 3, 3a.

As in the nozzles shown in FIGS. 1 and 2 and FIG. 4, the intake manifold depression of the internal combustion engine causes air to be drawn into the jacket 8 of the nozzle shown in FIG. 5 through vents 12 and 13, to atomize fuel leaving the fuel tube 7 and ensure that the interior of the jacket is maintained at atmospheric pressure. The flow restricting characteristics of the nozzle shown in FIG. 5 can also be modified, as described above, by replacing the fuel discharge tube 7 by another tube having a different flow rating it being possible, as described above, to carry out this operation without interfering in any way with the interrupter valve 6.

FIG. 7 illustrates the use of nozzles 300, each of the type shown in FIG. 4 or FIGS. 5 and 6, in a fuel injection system. This system is generally similar to that shown in FIG. 3 and corresponding components carry the same reference numerals. It will be noted that the manner of connection of the nozzles 300 in the system differs from that of the nozzles 200 in that the nozzles are connected in series with each other, the through-flow outlet 40 of one nozzle being connected to the inlet 2 of the next. As a result, pressurized fuel supplied to the nozzles by the pressurizing device 203 passes through each of the nozzles 300 in turn and fuel which is not discharged by the nozzles is returned to the fuel tank 201 via the conduit 207, so that fuel is circulated through the nozzles 300 continuously and, unlike the system shown in FIG. 3, no fuel remains static within the nozzles even when the nozzle interrupter valves 6 are closed. This reduces any tendency for fuel to vaporize within the nozzles 300 but any vapor that does form is separated out within the nozzles as described above and returned to the fuel tank 201 via the conduits 301.

The use of a spherical valve member 18 in the nozzles shown in FIGS. 1 and 2 and FIG. 4 is advantageous in that, if the valve member undergoes any sideways movement when the solenoid 15 is energized (which movement would bring the valve member into engagement with the guide 19) then the valve member will roll against the guide 19 and opening of the interrupter valve 6 will not be resisted to any substantial extent by

frictional effects. This enables the interrupter valve 6 to be operated at lower power levels.

The use of the vent ports 12 and 13 in the nozzles described above, although advantageous, is not essential and could be omitted. In addition, the vapor separating arrangements 5, 41, 42 and through-flow fuel paths 2, 4, 40 shown in the nozzles of FIGS. 4 to 6 could be utilized in nozzles incorporating alternative forms of interrupter valves to those illustrated.

I claim:

1. A fuel injector nozzle including a fuel inlet; a through-flow outlet; a through-flow fuel path within the nozzle connecting the inlet to the through-flow outlet; a vapor separating path connected to the through-flow path to remove vapor therefrom, a fuel discharge path having a discharge orifice and connected to receive fuel from the inlet, and an electromagnetically-operable interrupter valve including a valve member movable between open and closed positions to control fuel flow along the discharge path to a discharge orifice.

2. A fuel injector nozzle as claimed in claim 1, in which the nozzle has an operating position in which the connection between the vapor separating path and the through-flow path is located above the surface level of liquid fuel in the nozzle and the connection between the discharge path and the through-flow path is located below that surface level.

3. A fuel injector nozzle as claimed in claim 1, including a vapor outlet connected to receive vapor from the vapor separating path, and a flow restrictor located in the vapor separating path.

4. A fuel injector nozzle as claimed in claim 1, including a chamber formed in the through-flow path, the discharge path and the vapor separating path being connected to the said chamber and the interrupter valve being located in the said chamber.

5. A fuel injector nozzle as claimed in claim 1, in which the discharge path and the vapor separating path are aligned and perpendicular to the through-flow path.

6. A fuel injector nozzle as claimed in claim 1, including a tubular member which defines the vapor separating path within the nozzle.

7. A fuel injector nozzle as claimed in claim 6, in which the valve member comprises a flow control member; a valve seat with which the flow control member is co-operable, and an elongated guide member on which the flow control member is mounted and which extends along the bore of the tubular member.

8. A fuel injector nozzle as claimed in claim 7, including a guide way within which the guide member is movable, the vapor separating path being formed by at least one passageway defined between the tubular member and the guideway.

9. A fuel injector nozzle as claimed in claim 6, in which the vapor separating path is in communication with the through-flow path through at least one aperture in the wall of the tubular member.

10. A fuel injector nozzle as claimed in claim 6, in which the end of the tubular member provides a stop, positioned to limit movement of the valve member in response to energization of the interrupter valve, and including a non-magnetizable element positioned to prevent engagement between the valve member and the stop.

11. A fuel injector nozzle as claimed in claim 1, in which the fuel discharge path is defined by a fuel discharge tube located within an outer jacket in which the discharge orifice is formed, the fuel discharge tube having an outlet aligned with the discharge orifice, and the outer jacket having at least one vent through which air is drawn into the jacket during operation of the nozzle.

12. A fuel injector nozzle as claimed in claim 11, in which the outer jacket has a vent upstream of the discharge tube outlet and a further vent downstream of the discharge tube outlet.

13. A fuel injector nozzle as claimed in claim 12, in which the further vent is positioned downstream of the discharge orifice.

14. A fuel injector nozzle as claimed in claim 11, in which the fuel discharge tube is a constant fine bore tube which forms of fuel flow restrictor.

15. A fuel injector nozzle as claimed in claim 11, in which the fuel discharge tube is removable from the nozzle without disturbing the interrupter valve.

16. A fuel injector nozzle as claimed in claim 1, in which the fuel discharge path is defined by a tube which is removable from and replaceable in the nozzle without disturbing the interrupter valve.

17. A fuel injector nozzle as claimed in claim 16, including a fuel tube holder from which the fuel discharge tube extends; an outer jacket which surrounds the discharge tube and in which the discharge orifice is formed in alignment with an outlet in the discharge tube; seating means formed in said outer jacket, and resilient means located on said seating means and engaging the fuel tube holder to bias the holder against the interrupter valve, the outer jacket and the fuel tube holder being removable from and replaceable in the nozzle without disturbing the interrupter valve.

18. A fuel injector nozzle as claimed in claim 17, in which the nozzle has a main body portion and the outer jacket is in screw-threaded engagement with the main body portion.

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