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LIQUID FUEL SUPPLY SYSTEMS FOR INTERNAL COMBUSTION ENGINES

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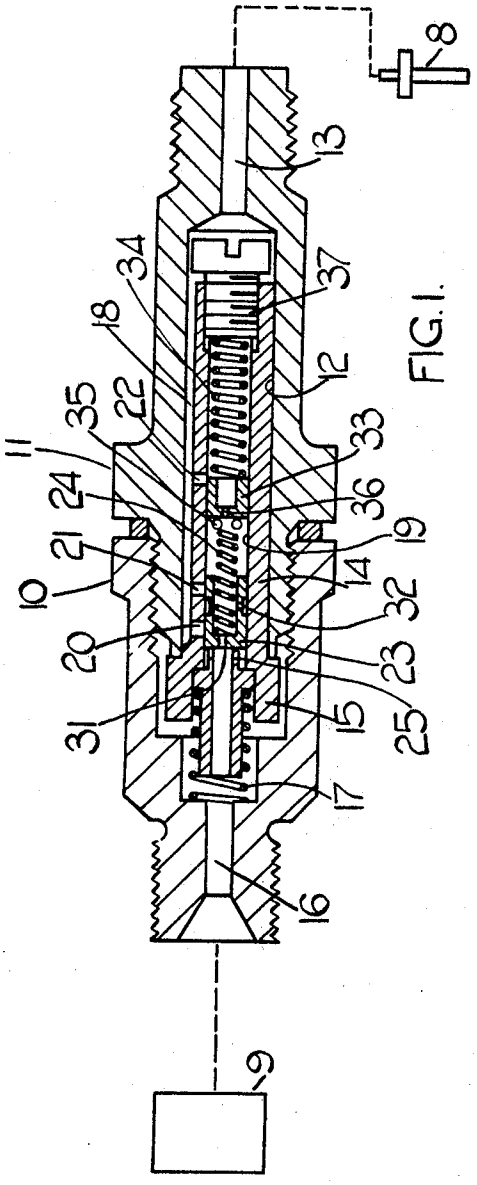

FIG. 1.

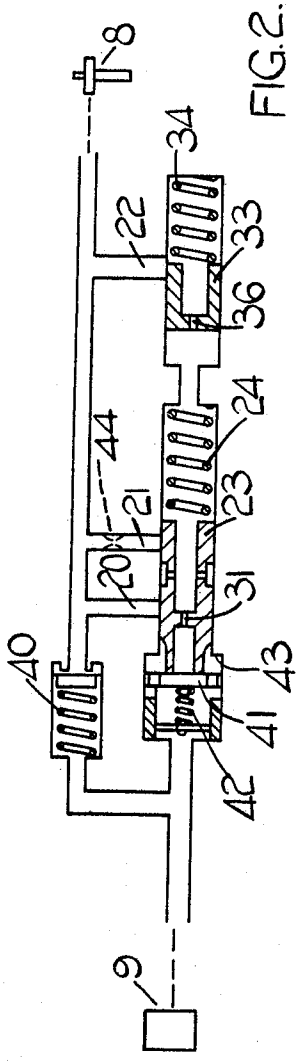

FIG. 2.

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LIQUID FUEL SUPPLY SYSTEMS FOR INTERNAL COMBUSTION ENGINES

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U.C. Cl. 123—32 7 Claims

ABSTRACT OF THE DISCLOSURE

A fuel supply system for internal combustion engines including a restricted orifice through which the initial quantity of fuel supplied by the injection pump passes to the fuel injection nozzle, a by-pass passage including a port which is arranged to be opened to permit the remaining quantity of fuel to be injected to the engine, the size of the port being controlled by a piston which is spring loaded and which acts to vary the effective size of the port in accordance with the pressure upstream of the piston.

In the complete specification of British patent No. 1,060,181 there is described a liquid fuel supply system for internal combustion engines and of the kind including an injection nozzle which is mounted in the body of the engine and through which fuel can be delivered to a combustion space of the engine and a fuel pump for supplying fuel to the nozzle in timed relationship to the engine, said nozzle incorporating a pressure responsive valve for controlling the flow of fuel therethrough, and a device associated with or adjacent to the nozzle, the device comprising in combination a valve member slidable in a cylinder, one end of said cylinder being in communication with the fuel pump and the other end of said cylinder being in communication with the nozzle through a first restriction, resilient means urging the valve member towards said one end of the cylinder, and a by-pass passage arranged to be opened by the valve member when the latter has been moved a predetermined extent against the action of the resilient means, the movement of the member towards said other end of the cylinder serving to displace a predetermined quantity of fuel to the nozzle at a restricted rate, said by-pass passage serving, when opened, to place said one end of the cylinder in communication with a point between said nozzle and said restriction.

The object of the present invention is to provide such a system in an improved form.

According to the invention in a system of the kind specified the restriction is constituted by a variable restriction which forms part of a flow controller whereby the rate of flow of the predetermined quantity of fuel can be controlled.

In the accompanying drawings:

FIGURE 1 is a sectional side elevation of one example of a device in accordance with the invention, and,

FIGURE 2 is a diagrammatic view showing a modification of the device of FIGURE 1.

Referring to FIGURE 1 of the drawing the device comprises a body which is formed of two parts **10** and **11** which are in screw thread engagement with each other. In the part **11** is defined a cylindrical bore **12** the inner end of which is in communication with an outlet passage **13**. In use, the outlet passage **13** is in communication with the inlet of a fuel injection nozzle **8**. The fuel injection nozzle is of the kind which includes a resiliently loaded valve member for controlling the flow of fuel through an orifice. The outer end of the bore **12** opens into

a chamber which is defined in the part **10** and slidably mounted within the bore is a valve element **14** a portion of which including a head **15**, is accommodated in the chamber. In use, the chamber is connected by way of an inlet passage **16** formed in the part **10**, with the outlet of a fuel injection pump **9**. Moreover, the valve element **14** is loaded by means of a coiled compression spring **17** such that an annular portion of the head **15** bears against the end portion of the part **11** to define a fluid seal therebetween. Moreover, the valve element has formed in its periphery a longitudinal groove or grooves **18** through which, when the element is moved against the action of the spring **17**, fuel can flow from the outlet passage **13** to the inlet passage **16**.

Within the valve element is a cylinder defined by a bore **19** and formed within the wall of the valve element are three axially spaced ports **20**, **21** and **22** and these extend from the cylinder to the groove **18**.

Located within the cylinder is a valve element **23** which is loaded by a coiled compression spring **24** into contact with a stop **25** carried by the head **15** of the valve element. When the valve member is in contact with the stop and as shown in the drawing, the ports **20** and **21** are closed. Formed in the end wall of the valve member is an orifice **31**. Moreover, the valve member incorporates a bore which accommodates the spring **24** and formed in the wall of the valve member is a port which places the aforesaid bore in communication with a circumferential groove **32** formed in the periphery of the valve member. As shown, when the valve member is against the stop **25** the groove **32** lies substantially midway between the ports **20** and **21** and is out of communication therewith.

Also slidably mounted within the cylinder is a further valve member **33** and this is loaded by a coiled compression spring **34** into contact with a stop **35**. In this position and as shown in the drawing, the rear edge of the valve member partially covers the port **22** in order to define a variable restricted orifice. Moreover, the portions of the cylinder on opposite sides of the valve member are in communication by way of an orifice **36** formed in the further valve member. It should be noted that the end of the cylinder adjacent the outlet passage **13** is closed by a plug **37** which also acts as an abutment for the spring **34**.

In use, fuel flowing from the fuel injection pump passes by way of the inlet passage **16** into the chamber which accommodates the head **15**. The fuel pressure acts upon the end of the valve member **23** and moves the latter against the action of its spring **24**. In so doing fuel is displaced through the orifice **36** and the restricted orifice defined by the port **22** and the further valve member **33**. The valve member **33** moves against the action of the spring **34** in response to the pressure drop which occurs across the orifice **36** and movement of the valve member against the action of the spring reduces the size of the restricted orifice and consequently the flow rate of fuel to the engine by way of the port **22**, the groove **18** and the outlet passage **13** is restricted. The further valve member **33**, the port **22** and the spring **34** form the components of a flow controller and by suitable design of each of these components, the flow rate can be varied and can be made to vary in accordance with the pressure of fuel immediately upstream of the orifice **36**.

When the valve member **23** has moved such that the port **20** is opened, flow of fuel in the manner described above ceases and the remaining quantity of fuel supplied by the injection pump **9** flows by way of the port **20**, the groove **18** and the outlet passage **13**. The quantity of fuel which is supplied to the engine at the restricted rate is determined by the movement which the valve member **23** must undertake before the port **20** is opened. When the injection pump ceases to deliver fuel and if it is of the

type in which relieving of the pressure in the pipe lines connecting the injection pump and the injection nozzle, takes place after the injection period then the valve element **14** will move against the action of the spring **17** to allow fuel to return towards the injection pump by way of the groove **18** which is now placed in communication directly with the chamber which accommodates the head **15**. During this time the valve members move relative to the valve element under the action of their springs respectively. When the return flow of fuel stops the valve element **14** returns to the position in which it is shown in the drawings and the valve members complete their movement relative to the valve element if they have not already done so.

A modification of the above arrangement is shown in FIGURE 2. In this figure the same reference numerals are used where applicable, as are used in FIGURE 1 and the slidable valve element **14** is shown as a spring loaded non-return valve. In accordance with the modification the orifice **31** is effectively closed by a plate valve **41**. During the initial injection period the plate valve **41** moves with the valve member **23** against the action of a coiled tension spring **42**, but it is arranged that as the port **20** is opened by the valve member, the plate valve is prevented by a shoulder **43**, from continuing its movement with the valve member. In this manner flow of fuel through the orifice **31** is prevented during the initial injection period.

In both the devices described above the rate of opening of port **20** by the valve member **23** can be controlled by providing a restriction **44** in the port **21**. This restriction shown in FIGURE 2. This has the effect of limiting the rate at which fuel can escape from the volume defined between the valve members **23** and **33**, thereby it acts to restrict the rate at which the valve member **23** can move during the time when port **20** is being uncovered.

Additional or alternative modification of the rate of opening of port **20** can be obtained by varying the relative axial distance between the ports **20** and **21**.

With the arrangements described it is essential to ensure that at the end of the injection stroke of the pump the fuel pressure pertaining within the pipes—lines interconnecting the pump **9** and injection nozzles is at a predetermined value at each engine speed and total fuel quantity. In this manner positive and accurate control of the pilot quantity of fuel can be obtained for all speeds of operation irrespective of the total quantity of fuel injected to the engine. Various ways of ensuring that this occurs can be employed and these do not form the subject of the present invention. For example in a conventional in-line pump where each injection pump is complete in itself, each pump may have associated therewith a residual pressure valve which reduces the pressure in the pipe-lines to the predetermined value at the end of the injection stroke. In the case of a distributor type pump where a single injection pump serves a plurality of injection nozzles a special groove associated with a residual pressure valve may be brought into communication with the pipe line at the end of the injection period.

Having thus described my invention what I claim as new and desire to secure by Letters Patent is:

1. A liquid fuel supply system for an internal combustion engine and including an injection nozzle mounted on the engine and through which fuel can be delivered to a combustion space of the engine, a pressure responsive valve in the nozzle for controlling the flow of fuel therethrough, a fuel pump for supplying fuel to the nozzle in timed relationship with the engine and a device located adjacent the nozzle and through which fuel flows from the pump to the nozzle, said device comprising a cylinder one end of which is in communication with the fuel pump, a valve member slidable in said cylinder, resilient means urging the valve member towards said one end of the cylinder, a flow controller through which the other end of the cylinder is in communication with the nozzle, the valve member being urged against the action of the resilient means to deliver fuel to the engine at a rate which is determined by the flow controller, and a by-pass passage arranged to be opened after a predetermined movement of the valve member against the action of the resilient means, said by-pass passage serving when opened, to place said one end of the cylinder in communication with a point intermediate the flow controller and the nozzle, thereby to allow fuel to flow to the engine at a substantially unrestricted rate.

2. A liquid fuel supply system as claimed in claim **1** in which said flow controller comprises a further cylinder one end of said further cylinder being in communication with the other end of said cylinder, a further valve member slidable within said further cylinder, resilient means biasing the further valve member in a direction towards said one end of said further cylinder, a restricted flow path through which the opposite ends of the further cylinder are in communication, and a port formed in the wall of said further cylinder, said port being in communication with the nozzle, the port being partially covered by the end of the valve member remote from said one end of the cylinder, the arrangement being such that the effective size of the port which constitutes the variable restriction, is responsive to the pressure drop across said restricted flow path.

3. A liquid fuel supply system as claimed in claim **2** in which said restricted flow path is constituted by a second restriction formed in the further valve member intermediate the ends thereof.

4. A liquid fuel supply system as claimed in claim **3** including a passage formed intermediate the ends of the valve member and a third restriction formed in said passage.

5. A liquid fuel supply system as claimed in claim **4** including a valve for preventing the flow of fuel through said third restriction until the by-pass passage is opened.

6. A liquid fuel supply system as claimed in claim **1** including a further port formed in the wall of said cylinder, a groove formed on the periphery of said valve member, said groove being in communication with the other end of said cylinder and being opened to said second port during movement of the valve member against the action of the resilient means.

7. A liquid fuel supply system as claimed in claim **6** including a fourth restriction in said further port whereby the rate of opening of said by-pass passage can be controlled.

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U.S. Cl. X.R.

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