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Fenne

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[54] **FUEL INJECTION SYSTEMS**

[75] Inventor: **Ivor Fenne**, Greenford, England

[73] Assignee: **C.A.V. Limited**, Birmingham, England

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

[58] **Field of Search** 239/90, 93, 94, 96, 239/88, 533

[56] **References Cited**

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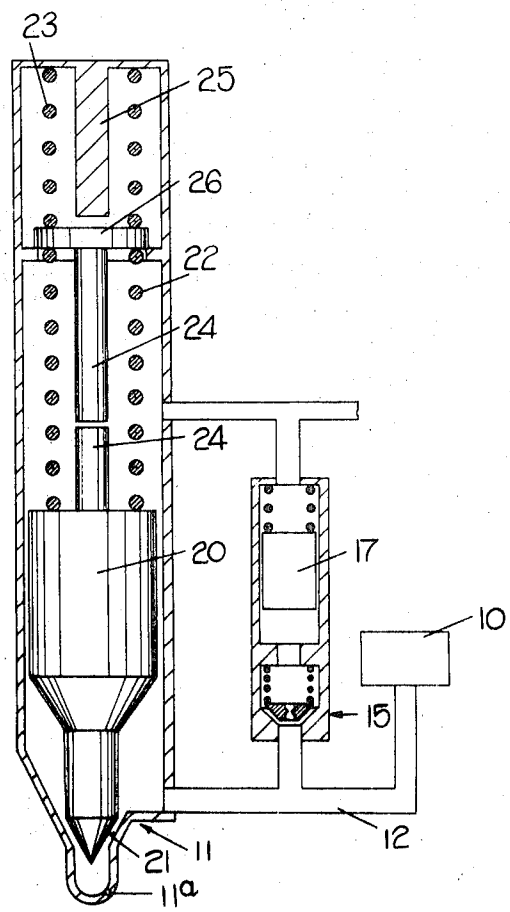
Primary Examiner—M. Henson Wood, Jr.
Assistant Examiner—John J. Love
Attorney—Holman & Stern

[57] **ABSTRACT**

A fuel injection system includes a fuel pump and a nozzle incorporating an orifice. There is disposed between the pump and nozzle, a restrictor. The pressure intermediate the restrictor and the pump is controlled by a relief valve and the fuel flowing past the relief valve passes into a chamber. During the initial delivery of fuel by the pump, fuel flows to the nozzle at a restricted rate by way of the restrictor and when a predetermined volume of fuel has past into the chamber substantially un-restricted flow of fuel takes place from the pump to the nozzle.

7 Claims, 2 Drawing Figures



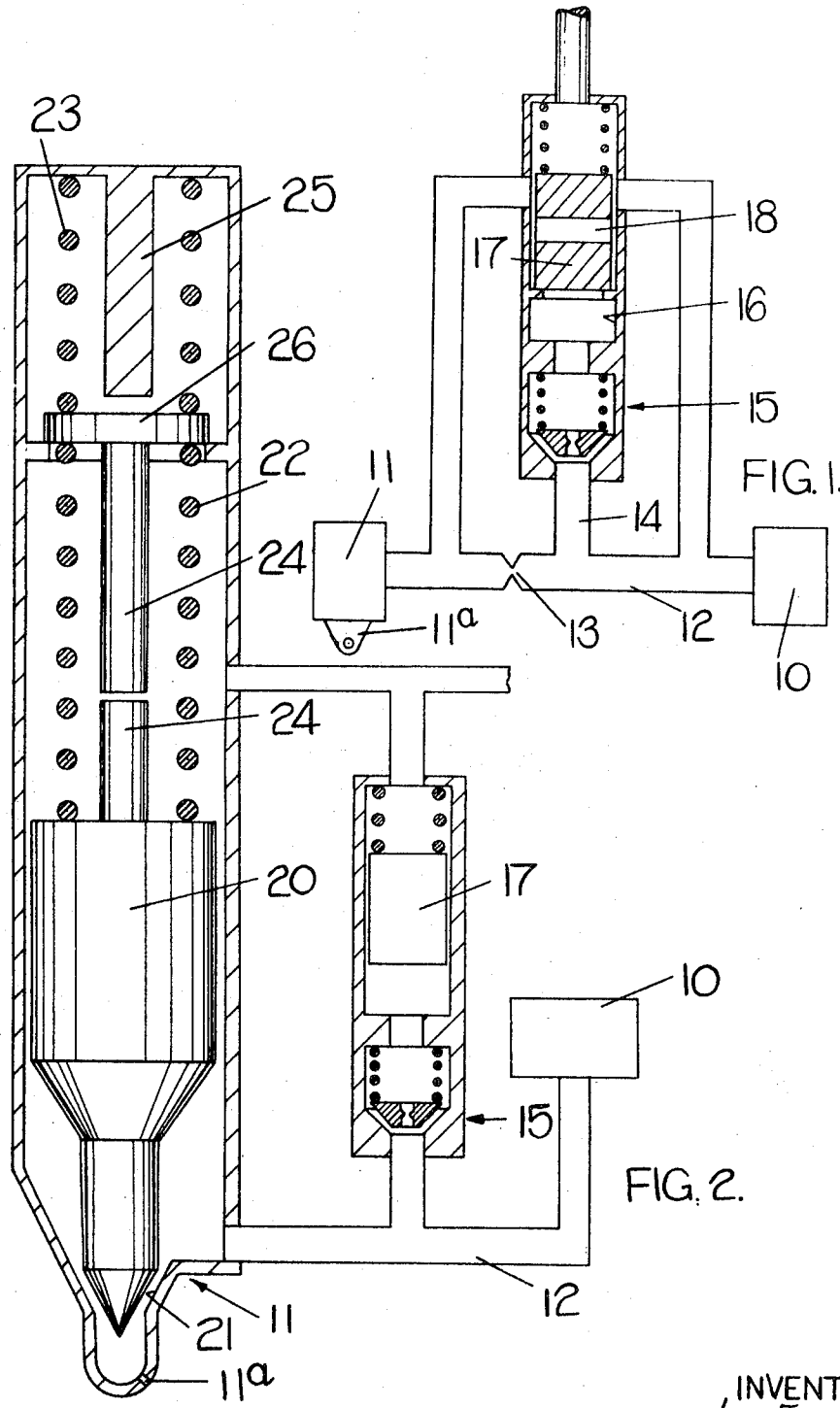


FIG. 1.

FIG. 2.

INVENTOR
Ivor Ferne

FUEL INJECTION SYSTEMS

BACKGROUND OF THE INVENTION

This invention relates to fuel injection systems of the kind comprising an orifice through which liquid fuel can flow and a fuel pump for delivering fuel under pressure to the orifice.

OBJECT AND SUMMARY OF THE INVENTION

The object of the invention is to provide such a system in a form in which the initial flow of fuel through the orifice is at a restricted rate.

According to the invention, a system of the kind specified includes a restrictor intermediate the orifice and the pump, a relief valve for controlling the pressure intermediate the pump and the restrictor, a chamber into which the fuel flowing past the relief valve can flow and means operable when a predetermined volume of fuel has flowed into the chamber to permit unrestricted flow of fuel to the engine.

BRIEF DESCRIPTION OF THE DRAWINGS

Two examples of fuel systems in accordance with the invention will now be described with reference to FIGS. 1 and 2 which are views in cross-section and partly in elevation of the two embodiments respectively.

Referring to FIG. 1, there is provided a fuel pump 10 and a conventional fuel injector 11 which includes a spring loaded valve for controlling the fuel flow through an orifice 11*a* formed in a portion of the injector which is mounted within the combustion chamber of a compression ignition engine. The fuel pump 10 and the injector are connected by a conduit 12 which includes a restrictor 13.

Extending from a point intermediate the pump and the restrictor 13 is a passage 14 which includes a spring loaded relief valve 15 and the passage 14 further includes a variable volume chamber defined by a cylinder 16 in which is mounted a spring loaded piston 17. The piston 17 is provided with a passage 18 which, when the piston has moved a predetermined amount against the action of its spring, registers with a pair of ports formed in the wall of the cylinder 16 and connected to the conduit 12 on opposite sides of the restrictor 13 respectively. The passage 18 forms part of a by-pass passage to allow fuel to flow at a substantially un-restricted rate between the ends of the conduit 12.

In operation, the flow of fuel to the injector 11 during an injection stroke of the pump is initially at a restricted rate due to the presence of the orifice 13. The relief valve 14 prevents the pressure upstream of the orifice 13 exceeding a predetermined value and the fuel which flows past the relief valve displaces the piston 17 against the action of its spring. During this period, the flow of fuel through the orifice of the injector is at a restricted rate. When the passage 18 in the piston registers with the aforementioned ports, the flow of fuel from the fuel pump to the injector takes place without hinderance.

When the flow of fuel from the injuection pump ceases, the relief valve closes and the piston 17 returns to its initial position by way of a restricted passage formed in the valve element of the relief valve 15.

In the arrangement shown in FIG. 2, the restrictor 13 is replaced by the restriction offered by the nozzle 11.

As shown, the nozzle 11 includes a spring loaded valve member 20 which is shaped at one end, for co-operation with a seating 21. The valve member is loaded into contact with the seating 21 by means of a pair of springs 22, 23, with spring 23 being stronger than spring 22. The extent of compression of spring 22 is limited by co-operating stops 24 and the extent of compression of spring 23 is limited by a stop 25 which co-operates with an abutment 26 interposed between the two springs.

In this example, the piston is not provided with a passage 18 and in operation, fuel flowing from the fuel pump 10 initially moves the valve member of the nozzle against the action of the spring 22 to allow restricted flow past the valve member and its seating. The relief valve 15 opens during this period to control the pressure of fuel intermediate the pump and the nozzle and the fuel flowing past the relief valve moves the piston 17 against the action of its spring. When the piston can move no further, the fuel pressure applied to the valve member increases and the spring 23 is compressed until the spring abutment 26 contacts the stop 25. The degree of restriction offered to the flow of fuel through the injector is decreased and the rate of fuel supply is increased. At the end of the injection period, the parts return to their initial position with, the piston 17 being allowed to return to its initial position by virtue of the restricted passage extending through the valve element of the relief valve 15.

I claim:

1. A fuel injection system of the kind comprising a fuel pump for supplying fuel under pressure, an injection nozzle including an orifice, conduit means connecting the fuel pump with the orifice so that fuel delivered by the pump will flow through the orifice, a restrictor located intermediate the orifice and the pump, a relief valve for controlling the pressure communicating with the conduit means intermediate the pump and restrictor, means defining a chamber, said chamber communicating with the relief valve and into which the fuel flowing past the relief valve can flow, and means operable when a predetermined volume of fuel has flowed into the chamber to permit unrestricted flow of fuel through the orifice.

2. The fuel injection system as claimed in claim 1 in which said chamber is defined by a cylinder containing a slidable spring loaded piston.

3. A fuel injection system of the kind comprising a fuel pump for supplying fuel under pressure, an injection nozzle including an orifice, conduit means connecting the fuel pump with the orifice so that fuel delivered by the pump will flow through the orifice, a restrictor intermediate the orifice and the pump, a relief valve for controlling the pressure intermediate the pump and the restrictor, a chamber into which the fuel flowing past the relief valve can flow, means operable when a predetermined volume of fuel has flowed into the chamber to permit unrestricted flow of fuel through the orifice, said chamber being defined by a cylinder containing a slidable spring loaded piston and, said piston acting as a valve member to open a by pass passage to allow substantially unrestricted flow of fuel to the orifice when the piston has moved a predetermined extent.

4. The fuel injection system as claimed in claim 3 in which the by pass passage includes a passage formed in the piston and which co-operates with a pair of ports

formed in the wall of the cylinder when the piston has moved said predetermined extent.

5. The fuel injection system as claimed in claim 2 in which the restrictor is defined by a spring loaded valve member located in the nozzle and which co-operates with a seating to control the flow of fuel through the orifice.

6. A fuel injection system as of the kind comprising a fuel pump for supplying fuel under pressure, an injection nozzle including an orifice, conduit means connecting the fuel pump with the orifice so that fuel delivered by the pump will flow through the orifice, a restrictor intermediate the orifice and the pump, a relief valve for controlling the pressure intermediate the pump and the restrictor, a chamber into which the fuel flowing past the relief valve can flow, means operable when predetermined volume of fuel has flowed into the chamber to permit unrestricted flow of fuel through the orifice, said chamber being defined by a cylinder containing a slidable spring loaded piston, the restrictor being defined by a spring loaded valve member located in the nozzle and which cooperates with a seating to control the flow of fuel through the orifice, and the valve member being loaded by a pair of springs acting in series, one of said springs being stronger than the other, the arrangement being such that the valve member is moved initially against the action of the weaker spring to allow flow of fuel at the restricted rate through the orifice and is moved further against the action of the stronger spring when said predetermined quantity of fuel has flowed into the chamber.

7. The fuel injection system as claimed in claim 6 including, a first stop to limit the extend of movement of the valve member against the action of the weaker spring and a second stop to limit the extend of movement of the member against the action of the stronger spring.

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