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FUEL VALVE AND NOZZLE FOR INTERNAL-COMBUSTION ENGINES

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Fig. 1.

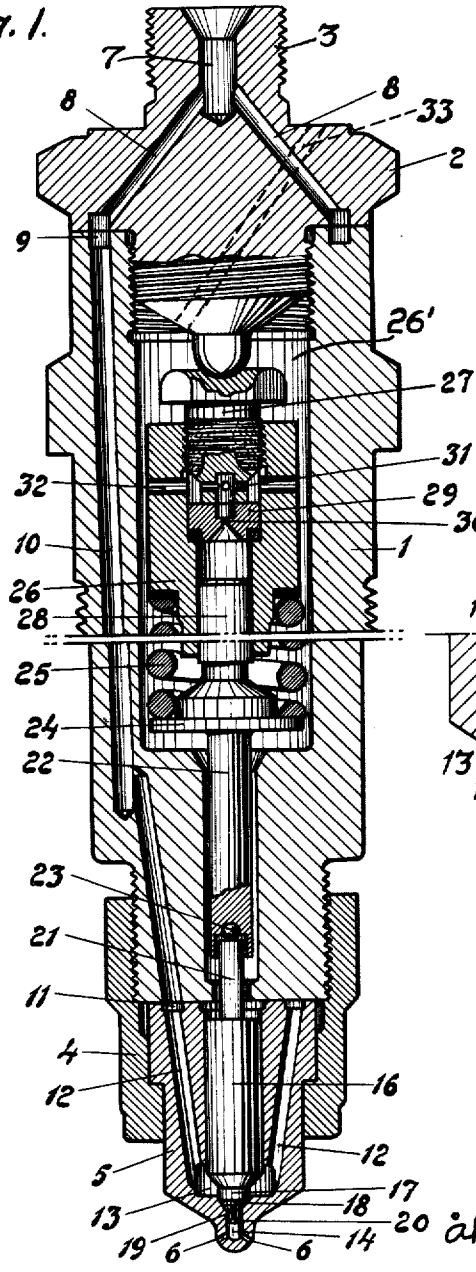
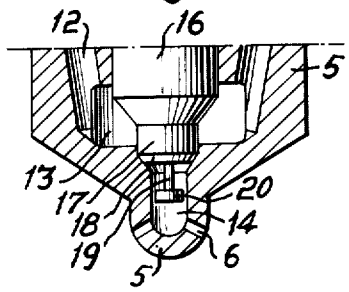


Fig. 2.



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FUEL VALVE AND NOZZLE FOR INTERNAL-COMBUSTION ENGINES

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3 Claims. (Cl. 299—107.6)

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The present invention relates to fuel valves for internal combustion engines of the liquid injection type. In these engines the fuel has to be injected in such a way, that the fuel quantity injected before the ignition of the air-fuel-mixture is relatively small but after the ignition the rest of the fuel should be injected very quickly.

One object of the invention is to provide a simple fuel valve which operates according to the principle described above and which functions satisfactorily under the most varying working conditions of the engine. According to the invention the fuel valve comprises a valve member, which is actuated in opening direction by the fuel pressure and includes a throttling member which is withdrawn from a fuel passage after an initial opening movement of the valve member, whereby the preinjection of fuel prior to ignition is at a low or restricted rate and the subsequent injection of the fuel is at a high or unrestricted rate. In accordance with the invention, the timing of the change-over from restricted to unrestricted fuel injection is regulated by a damping device which, in accordance with variations of the fuel pressure under different conditions of engine speed and load, controls the velocity of the valve member during the opening movement. That end of the valve member which is opposed to the valve end, is preferably constructed and arranged to actuate a damping piston sliding in a cylinder which is filled with liquid and in which there is provided a throttle opening through which liquid passes during the opening movement. Hereby is attained a very expedient relation between the duration of the pre-injection and the speed of the engine.

A fuel valve in accordance with the invention is illustrated in the accompanying drawings in which:

Fig. 1 is a longitudinal section through the valve; and

Fig. 2 is an enlarged section of the nozzle tip.

The fuel valve shown comprises a valve housing 1 which at its upper end is provided with a plug 2, formed with a threaded part 3 for connection with a fuel pipe. To the lower part of the valve housing is by means of a nut 4 secured a nozzle member 5 with nozzle openings 6.

From a bore 7 in the plug 3 there are bores 8 leading to a ringshaped channel 9 provided between the plug 2 and the housing 1. From the channel 9 a bore 10 leads down to another ringshaped channel 11 in the upper surface of the nozzle member 5 and this channel 11 is connected to a space 13 in the nozzle member 5 by means of bores 12.

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Between the nozzle openings 6 and the space 13 there is a channel 14, which is controlled by a valve member 16. This valve member 16 consists of a cylindrical piston the lower end 17 of which is turned and provided with a conical valve head 18 which cooperates with a corresponding valve seat in the nozzle member. Below said valve head 18 projects a pin 19 downward from the valve member 16, which pin at its lower end is provided with a throttling disc 20, which to a great extent fills up the cross-section of the channel 14.

At that end which is opposed to the valve end the piston 16 is provided with a stem 21 which extends into an axial recess in a pressure rod 22 and is engaged by a ball 23 carried by rod 22. The rod 22 is provided with a disc 24, which supports one end of a coil spring 25, the other end of which bears against a shoulder on a damping cylinder 26 located in a bore 26' of the valve housing 1. At the top the cylinder 26 terminates with a screw 27, the head of which bears against the spherical lower end of the plug 2.

From the disc 24 projects upwardly a piston 28, which is inserted in the cylinder 26. At the top the cylinder chamber is limited by a removable metering disc 29, which is provided with a throttle opening 30 which communicates with the bore 26' of the housing 1 through channels 31 in the lower end of the screw 27 and bores 32 in the cylinder wall. The cylinder and surrounding space are filled with fuel by leakage around the valve 16, and excess liquid escapes to a sump, not shown, through the relief passage 33.

The valve operates as follows:

When the fuel pressure increases during the delivery stroke of the fuel pump the pressure in the space 13 raises the valve member 16. As soon as the conical end 18 leaves the valve seat fuel is injected in the engine cylinder through the nozzle openings 6. At first, however, the disc 20 offers a relatively heavy resistance to the fuel stream so that only a relatively small quantity of fuel per unit of time is injected. Under the action of

the fuel pressure, however, the valve member **16** is raised still higher so that the disc **20** soon is entirely extracted from the channel **14** whereby the fuel quantity per unit of time is rapidly increased.

At the opening movement of the valve member **16** the spring **25** is compressed and at the same time the piston **28** moves inward in the cylinder **26**. The rate of movement of the valve member **16**, and thereby the point in a cycle at which the rate of fuel injection is abruptly increased, is determined by the size of the throttling opening **30** of the metering disc **29** since the valve member **16** must lift the piston **28**, and the latter can move upwardly only as rapidly as the liquid in the cylinder **26** escapes through throttle opening **30**. When the fuel pressure decreases the spring **25** forces the valve member **16** downward, so that the valve is closed and the cylinder **26** is again filled with liquid. At the next delivery stroke of the fuel pump the cycle is repeated.

During in other respects equal conditions the duration of the pre-injection is determined by the area of the throttle opening **30**, which is provided in the detachable disc **29**, and the rate of pre-injection is determined by the dimensions of the annular throttling opening between the disc **20** and the wall of the passage **14**. The length of the pre-injection period decreases with increasing engine speed since the fuel pressure at the nozzle increases at increasing speeds of engine operation. This is advantageous as the ignition delay, i. e. the period between the beginning of the fuel injection and the ignition, is also shortened at increasing speed. Furthermore, the pre-injected fuel quantity is essentially constant at varying speed, engine load, injection pressure and fuel viscosity. This follows from the fact that the rate of pre-injection and the duration of the pre-injection period are each determined by a throttling of fuel flow through a restricted opening and a change in a factor, for example the viscosity of the fuel, which reduces the rate of fuel injection will effect a similar reduction in the rate of opening of the valve member. It is therefore only necessary to select a suitable relation between the area of the throttle opening **30** and the area of the ringshaped slot round the disc **20** to reach a convenient pre-injection.

The details of the invention may be varied within the scope of the following claims. Thus, the throttle opening **30** may be provided in some suitable way in the piston **28**, and there can be provided a non-return valve to permit quick refilling of the cylinder **26**. The means for the rapid increase of the fuel quantity may be replaced by other means, known per se.

What I claim is:

1. A fuel valve for internal combustion engines, comprising a valve casing having at opposite ends thereof an axial bore and fuel ejection apertures, said casing being provided with a fuel passage including a valve seat adjacent said fuel ejection apertures and a connecting passage extending from said valve seat to said apertures, a valve member slidable axially in said casing and coaxial with said valve seat, said valve member including a valve cooperating with said valve seat and an enlarged portion at the inlet side of said valve seat for opening said valve upon increase of the fuel pressure in said fuel passage, throttling means on said valve member and extending into said connecting passage to restrict the flow of fuel therethrough during the initial stage of an opening movement of said valve, said throttling means being spaced from said valve to move out of said connecting passage prior to the completion of an opening movement of said valve, thereby affording unrestricted flow of fuel through said connecting passage during the remainder of a fuel injection period, and means controlling the timing in a fuel injection cycle of the movement of said throttling means out of said connecting passage; said controlling means including a cylinder within said bore of said valve casing and having a throttling opening affording restricted communication with said bore, a piston movable in said cylinder, means connecting said piston to said valve member for actuation thereby during opening movement of said valve member, and means for supplying said bore and cylinder with a liquid.

2. A fuel valve for internal combustion engines, comprising a valve casing having at opposite ends thereof an axial bore and fuel ejection apertures, said casing being provided with a fuel passage including a valve seat adjacent said fuel ejection apertures and a connecting passage extending from said valve seat to said apertures, a valve member slidable axially in said casing and coaxial with said valve seat, said valve member including a valve cooperating with said valve seat and an enlarged portion at the inlet side of said valve seat for opening said valve upon increase of the fuel pressure in said fuel passage, throttling means on said valve member and extending into said connecting passage to restrict the flow of fuel therethrough during the initial stage of an opening movement of said valve, said throttling means being spaced from said valve to move out of said connecting passage prior to the completion of an opening movement of said valve, thereby affording unrestricted flow of fuel through said connecting passage during the remainder of a fuel injection period, and means controlling the timing in a fuel injection cycle of the movement of said throttling means out of said connecting passage; said controlling means including a cylinder within said bore of said valve casing and having a member removably secured across one end thereof and provided with a throttling opening affording restricted communication with said bore, a piston movable in the other end of said cylinder, means connecting said piston to said valve member for actuation thereby during opening movement of said valve member, and means for supplying said bore and cylinder with a liquid.

3. A fuel valve for internal combustion engines, comprising a valve casing having at opposite ends thereof an axial bore and fuel ejection apertures, said casing being provided with a fuel passage including a valve seat adjacent said fuel ejection apertures and a connecting passage extending from said valve seat to said apertures, a valve member slidable axially in said casing and coaxial with said valve seat, said valve member including a valve cooperating with said valve seat and an enlarged portion at the inlet side of said valve seat for opening said valve upon increase of the fuel pressure in said fuel passage, throttling means on said valve member and extending into said connecting passage to restrict the flow of fuel therethrough during the initial stage of an opening movement of said valve, said throttling means being spaced from said valve to move out of said connecting passage prior to the completion of an opening movement of said valve, thereby affording unrestricted flow of fuel through said connecting passage during the re-

mainder of a fuel injection period, and means controlling the timing in a fuel injection cycle of the movement of said throttling means out of said connecting passage; said controlling means including a cylinder within said bore of said valve casing and having a throttling opening affording restricted communication with said bore, a piston movable in said cylinder, means connecting said piston to said valve member for actuation thereby during opening movement of said valve member, resilient means opposing displacement of said piston by said valve means, and means for supplying said bore and cylinder with a liquid.

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