Aug. 24, 1937. L. W. LINDBERG 2,090,688

FUEL SUPPLY PUMP

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Fig. 1.

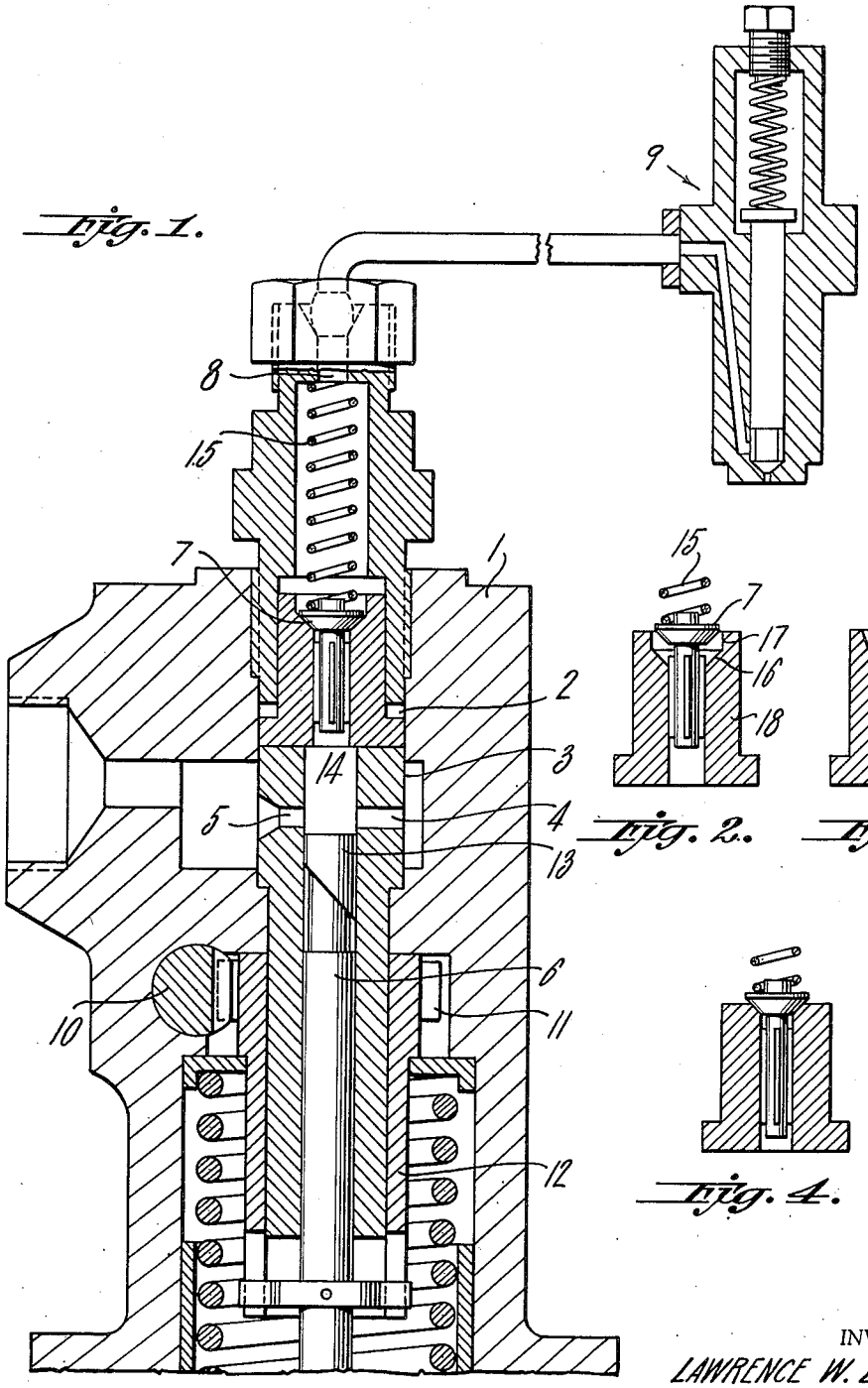


Fig. 2.

Fig. 3.

Fig. 4.

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FUEL SUPPLY PUMP

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1 Claim. (Cl. 103—41)

This invention relates to a fuel supply pump for internal combustion engines of the type in which liquid fuel under high pressure is injected into combustion supporting air through a suitable nozzle whereby it is atomized without the aid of compressed air.

In such engines the quantity of fuel supplied is controlled by regulating the effective stroke of the fuel pump, and especially in the case of small high speed engines the pump must be capable of metering very small quantities of fuel with a high degree of accuracy. A variation of a small drop in the fuel corresponds to a variation of a large per cent of any single charge. Also a very slight difference in the rate of injection corresponds to a large difference in terms of degrees of revolution of the crank shaft of the engine.

There has heretofore been considerable difficulty in providing uniform operation in such engines due to slight irregularities in the fuel supply. Slight dripping of the nozzle at the end of injection or a secondary injection, due to surging of the column of liquid fuel in the fuel supply line, after the termination of the main injection, causes an objectionable after burning which produces irregularities in operation and decreases the overall efficiency.

It is among the objects of the present invention to provide a fuel pump which will prevent drip at the nozzle, avoid any secondary injection, and also prevent other irregularities in the supply of fuel to the engine.

Referring to the drawing, Fig. 1 illustrates a fuel supply system constructed in accordance with the present invention; Fig. 2 shows the discharge valve in open position; Fig. 3 shows a modified form of the discharge valve shown in Fig. 2; Fig. 4 shows a conventional form of the same valve.

Referring to Fig. 1, reference numeral 1 indicates a pump housing having a central bore 2. A sleeve 3 forming a pump barrel is fitted in bore 2 and is provided with ports 4 and 5 forming intake and relief ports respectively. A plunger 6 is reciprocative in sleeve 3. A discharge valve 7 is provided in the upper end of the pump housing which is connected to a discharge conduit 8 leading to an injection valve 9.

The quantity of fuel supplied by pumps of this type is varied by the opening of the relief passage 5 at variable points in the discharge stroke of the plunger 6. In the instance shown, this is effected in a well known manner by rotation of the plunger 6 through a rack 10 coacting with a pinion 11, the rotation of which is transmitted to the lower end of the plunger by a sleeve 12. A regulating lip 13 adjacent the end of the piston opens communication between the pump chamber 14 and the relief port 5 at any desired point in the discharge stroke of the plunger which point is determined by the angular position of the plunger.

In the normal operation of pumps of this type, the upward movement of the plunger 6 closes the ports 4 and 5. The plunger is moving at relatively high speed by the time the ports are fully closed. A very abrupt pressure rise occurs in the pump chamber, the discharge valve opens after a slight lag due to its inertia, and upon leaving its seat, if this valve is of a conventional type such as shown in Fig. 4, it is open to its greatest extent immediately, and a pressure wave is transmitted along the conduit 8. A material time lag occurs in the transmission of this wave between the discharge valve and the injection valve. The impact of the wave upon the injection valve causes the abrupt opening of the latter and the consequent sudden injection of the fuel into the combustion space of the engine. If the pump discharge valve is heavy in such a structure, it is likely to move against the spring 15 until its inertia effect is dissipated, and then rebound to the seat, thus causing a slight interruption in the supply of fuel to the nozzle and a resulting decrease in the degree of atomization of the fuel. If this inward movement of the discharge valve happens to coincide with the opening of the spill or relief passage 5, the valve is forced to its seat with such velocity that it tends to rebound. This causes a secondary injection into the engine due to the fact that the valve head tends to act as an impact plunger. This secondary injection is of course at lower pressure than the main injection, is less thoroughly atomized and constitutes a slight overcharge. Inasmuch as the quantity of fuel in the line is decreased to this extent, the next injection is subnormal, thus causing irregularity in the operation of the engine.

To avoid this difficulty, I place the discharge valve seat in a depression having an internal diameter which is slightly larger than the diameter of the valve head. As shown in Figs. 2 and 3, the valve 7 coacts with a seat 16 which is countersunk as indicated at 17 in bushing 18. A small clearance is provided between the head and the countersunk portion so that as the valve leaves its seat the opening through which fuel may flow from the pump to the conduit 8 is limited to the

clearance between the valve head and bushing, full opening not being attained until the valve head rises slightly above the bushing. This results in a more gradual pressure rise in the conduit 8 without throttling the flow when maximum pressure is attained. This action tends to equalize the pressure in the pump chamber 14 and the conduit 8 before the valve is in its full open position. There is therefore less tendency for the valve to move so rapidly that its inertia carries it too far against spring 15, so that a material rebound in the closing direction is avoided. When the relief passage 5 is opened by the further upward movement of the plunger 6, the pressure in the pump chamber 14 is now reduced far below the pressure in the conduit 8. Downward movement of the head of valve 7 after the same passes the top of the bushing 18 tends to withdraw fuel from the conduit 8, thereby reducing the pressure in the conduit and permitting a quick closing of the injection valve without dribbling. Movement of the valve is sufficiently retarded by the friction of resistance of the film of oil between the valve head and the bore of countersunk portion 17 to prevent the valve from bouncing after contact with its seat.

I am aware that it has heretofore been proposed to provide a skirt on the discharge valve adjacent the head thereof for the purpose of preventing drip at the nozzle, the skirt closely fitting the bore provided for the discharge valve stem. The skirt acts as a piston to withdraw a small quantity of fuel from the nozzle during the downward movement of the valve after communication between the pump chamber and discharge conduit has been completely cut off. Such constructions are effective in preventing dribbling at relatively moderate speeds, but due to increased weight are more subject to the inertia effects described above, and secondary injections are therefore more pronounced at high speeds.

In the modification shown in Fig. 3, the countersunk portion of bushing 18 is slightly tapered so that the clearance between the valve head and bushing increases as the valve leaves its seat. The valve functions in the same manner as that shown in Figs. 1 and 2 except that there is at no time an abrupt change in the effective cross sectional area of the conduit controlled by the valve such as occurs when the head of the valve of Figs. 1 and 2 rises above the edge of bushing 18. This results in a still more evenly graduated pressure rise in the conduit leading to the nozzle.

It will be understood that the clearances shown between the valve head and bushing in Figs. 1, 2, and 3 are somewhat exaggerated to render them clearly visible.

Having thus described my invention, what I claim is:

A discharge device for a fuel supply system of the type having a chamber and a plunger reciprocative therein, a fuel nozzle, a delivery conduit leading from the chamber to the nozzle, and means to abruptly terminate the effective discharge stroke of said plunger, said device comprising a poppet valve between said chamber and said conduit, said valve seating in a depression the walls of which flare outwardly at a slight angle from said valve when the same is in closed position, the clearance between said wall and said valve head providing a highly restricted passage between said chamber and said conduit during the first portion of the opening movement of said valve.

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