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F. M. EVANS
LIQUID FUEL PUMP

2,657,631

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2 Sheets-Sheet 1

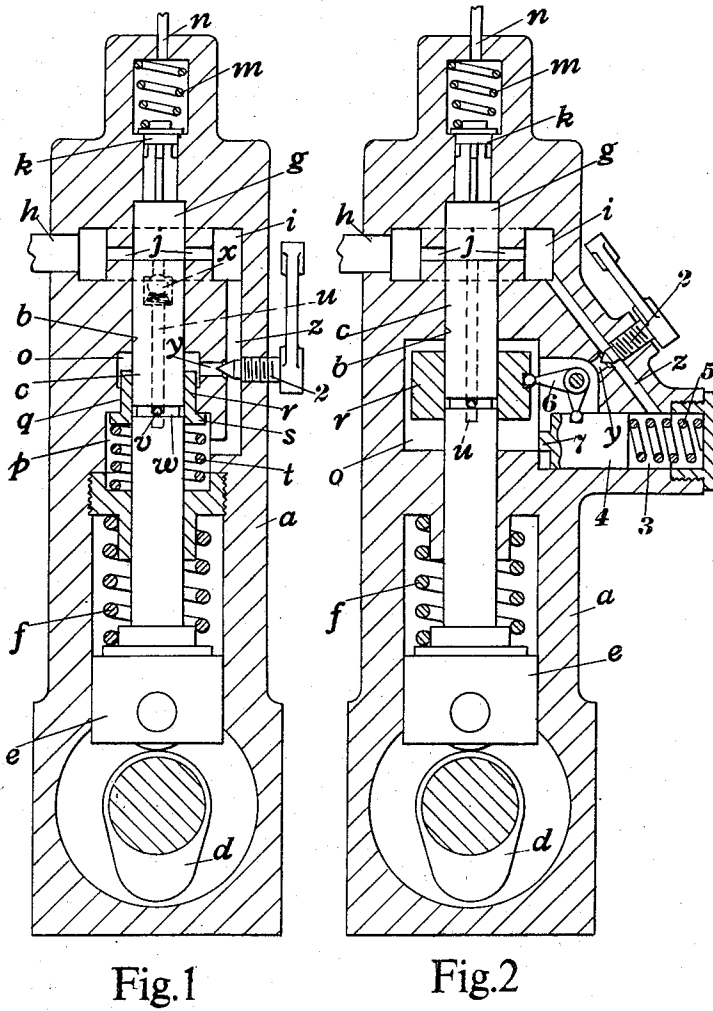


Fig.1

Fig.2

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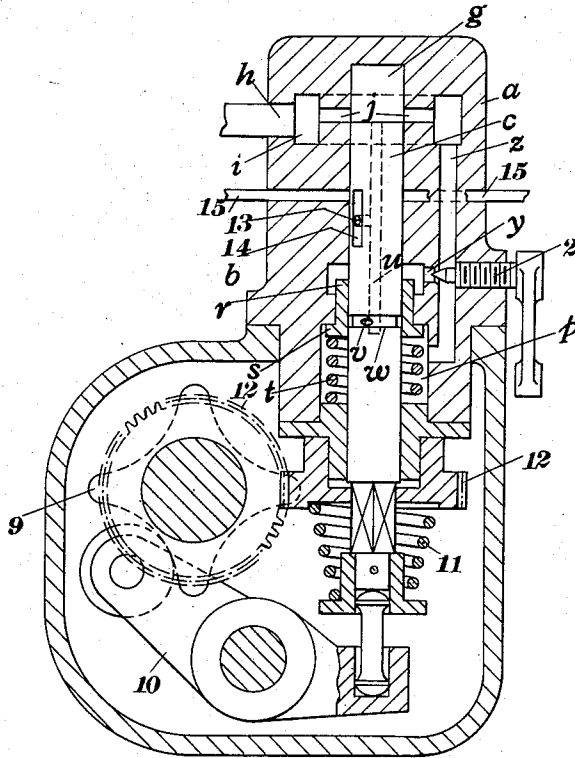


Fig. 3

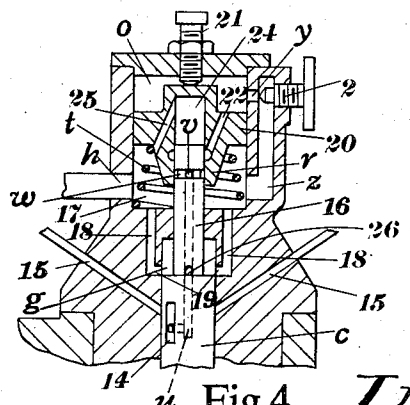


Fig. 4

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LIQUID FUEL PUMP

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6 Claims. (Cl. 103—2)

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This invention relates to variable-delivery liquid fuel injection pumps for internal combustion engines, of the kind in which a reciprocatory plunger (or each of a plurality of such plungers) has mounted on it a slidably adjustable sleeve for controlling a spill passage in the plunger. The object of the invention is to enable the rate of output of such a pump to be automatically controlled in a simple manner.

According to the invention there is provided in a pump of the kind above specified, a control means comprising the combination of a spill chamber, a sleeve adapted to control communication between the spill passage in the plunger and the spill chamber, a throttle adapted to control a discharge passage from the spill chamber, a stop which determines the normal position of the sleeve, and a spring adapted to move the sleeve towards the stop, the liquid pressure in the spill chamber being utilised for moving the sleeve away from the said position.

In the accompanying drawings:

Figures 1, 2, 3 and 4 are sectional views illustrating diagrammatically four typical embodiments of the invention.

Referring to Figure 1, there is formed in the body *a* of the pump, a bore *b* in which is slidable the plunger *c*. The discharge stroke of the plunger is effected by a rotary cam *d* acting on a slipper *e* which supports one end of the plunger, the suction stroke being effected by a spring *f*.

The working chamber *g* of the pump is supplied from the fuel inlet *h* through an annular chamber *i* and ports *j*. At the discharge end of the chamber *g* is arranged a delivery valve *k* loaded by a spring *m*. Fuel discharged past the valve is delivered through the outlet *n*.

In the body part *a* is formed a spill chamber *o*, and adjacent to this chamber is formed a sub-chamber *p*, the two chambers being separated by an annular land *q* through which extends the sleeve *r* which is slidable on the plunger. The sleeve has formed on it a collar *s* which abuts against one end of the sub-chamber under the action of a spring *t* contained in the sub-chamber. The end of the sub-chamber against which the collar *s* abuts serves as a stop for determining the normal position of the sleeve *r*.

In the plunger *c* is formed the spill passage *u* leading from the working chamber of the pump

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by way of radial ports *v* to an annular groove *w* on the plunger, which groove is controlled by the sleeve. If desired a non-return valve *x* may be provided in the plunger, as shown, or elsewhere between the working chamber *g* and the sub-chamber *p*.

The drawing shows the plunger at the commencement of its delivery stroke. The first effect of the plunger during this stroke is to cut off the ports *j*. Later the fluid is discharged through the valve *k*. When the plunger approaches the end of this stroke, the groove *w* on the plunger passes out of the sleeve, and so allows fuel to escape to the spill chamber, so preventing further discharge through the valve *k*.

To enable the pump output to be automatically controlled, the spill chamber is provided with an outlet passage *y* leading to a passage *z* which communicates with the inlet chamber *i*, and for controlling the rate of flow through the passage *y* there is provided a throttle *2*. In the example shown the throttle is adjustable by a lever which is operable manually or automatically. Or alternatively provision may be made for adjusting the spring *t*. The sub-chamber *p* may also be arranged in communication with the passage *z*.

The arrangement is such that so long as the output of the pump does not exceed a predetermined rate, then for a given setting of the throttle, the fuel entering the spill chamber will pass out to the passage *z* at a rate which will allow the spring *t* to hold the sleeve *r* in its normal position as shown in the drawing. But if the rate of pump output exceeds the predetermined amount, liquid fuel pressure will build up in the spill chamber sufficient to move the sleeve against the action of the spring *t* and so allow the liquid fuel to escape into the spill chamber at a correspondingly earlier period in the discharge stroke of the plunger, the extent of movement of the sleeve being dependent (for a given setting of the throttle) on the rate of output of the pump. Consequently, so long as the rate of actuation of the pump remains normal, the sleeve will remain in its normal position but when the said rate of actuation is exceeded, the sleeve will move and reduce the rate of fuel output from the pump. The normal setting can be varied by appropriate adjustment of the throttle.

The modified construction shown in Figure 2;

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is essentially the same as that shown in Figure 1, but differs in the following details.

At one side of the spill chamber *o* there is formed in the body part *a* of the pump, a cylindrical chamber 3 which contains a piston 4 loaded by a spring 5. The piston 4 is connected to the sleeve *r* by a bell-crank lever 6. The extent of movement of the piston 4 under the action of the spring 5 is limited by a projection 7 on the piston which can abut against the adjacent wall of the spill chamber, which wall serves as a stop. The spill chamber is provided with an outlet passage *y* which is controlled by the throttle 2. This throttle may be adjustable as shown, or alternatively the spring 5 may be adjustable. As in the arrangement shown in Figure 1, the passage *y* opens into a passage *z* leading to the inlet chamber *i*. Also the chamber 3 is in communication with the passage *z*.

The normal position of the sleeve *r* is that shown in the drawing, and the sleeve remains in this position so long as a normal pressure exists in the spill chamber. But in the event of the rate of output of the pump exceeding a predetermined amount, the pressure in the spill chamber increases, and by its action on the piston 4, causes the latter to move the sleeve *r* in the direction for allowing fuel to escape from the working chamber of the pump at an earlier instant during the delivery stroke of the plunger *c*.

In the examples illustrated by Figures 1 and 2, only the plunger *c* is shown. But it will be understood that two or more plungers may be provided, each having associated with it a controlling sleeve *r*, spill chamber *o*, and throttle 2 as above described.

Figure 3 illustrates an application of the invention to a pump of the kind in which the reciprocatory motion of a single plunger serves to effect the pumping action, and in which rotary motion of the plunger about its longitudinal axis serves to distribute successive discharges to each in turn of a plurality of engine cylinders. In the example shown, reciprocation of the plunger is effected by the alternate actions of a rotary cam 9 on a lever 10, and a spring 11. Rotary motion is imparted to the plunger through helical gear wheels 12. Liquid fuel is supplied at the inlet *h*, from which it passes through the chamber *i* to the ports *j* leading to the working chamber *g* of the pump. During the delivery stroke of the plunger *c* the liquid passes down the axial bore *u* to a radial port 13 and thence, by way of a longitudinal groove 14 in the plunger to each in turn of the outlet passages 15 (of which two are shown in the drawing).

The application of the present invention to the pump shown in Figure 3 is essentially similar to that shown in Figure 1, corresponding parts being identified by the same reference letters.

Figure 4 illustrates the application of the invention in a modified form to a pump of the kind shown in Figure 3. In this modification, the plunger *c* has formed on it a coaxial extension 16, and the working chamber *g* of the pump is of annular form. Liquid fuel is admitted to the working chamber from an inlet *h* through a cylindrical chamber 17, passages 18 and ports 19, and liquid can pass from the working chamber to the bore *u* through a radial port 26, the bore *u* being closed at its upper end. On the plunger extension 16 is slidably mounted a control sleeve *r* which is closed at one end and on which is formed a piston 20. In this example the spill chamber *o* is formed by the upper portion of the chamber

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17, and the sleeve *r* is held in its normal position against an adjustable stop 21 by the spring *t*. The spill chamber is provided with an outlet *y* which is controlled by a throttle 2 and which opens into a passage *z* leading to the inlet chamber 17. The action of the sleeve *r* is essentially similar to that already described. When the plunger *c* approaches the end of its discharge stroke, the annular groove *w* on the plunger extension 16 (which communicates with the axial bore *u* through ports *v*) comes opposite the passage 22 in the sleeve and allows liquid to escape from the working chamber *g* to the spill chamber *o*. So long as the rate of output of the pump remains below the amount determined by the throttle 2, the sleeve remains in its normal position, but when the rate is exceeded, the liquid pressure in the spill chamber moves the sleeve in opposition to the spring *t* for effecting earlier discharge from the working chamber to the spill chamber.

As already mentioned, the sleeve in the example shown in Figure 4 is closed at one end, thus forming a chamber 24 between one end of the plunger extension and the closed end of the sleeve. This chamber is in permanent communication with the inlet chamber 17 by way of a passage 25.

By this invention, automatic restriction of the rate of output of pumps of the kind described to any desired amount, can be effected in a very simple and convenient manner.

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

1. In a variable-delivery liquid fuel injection pump for an internal combustion engine, of the kind having a reciprocatory plunger means slidable in a bore, the combination comprising a spill chamber surrounding the plunger means, passage means adapted to afford communication between the effective end of the plunger means and the spill chamber, a sleeve surrounding the plunger means for controlling communication between the said passage means and the spill chamber, a discharge passage communicating with the spill chamber, throttle means in said discharge passage for restricting flow therein, stop means for determining the position of the sleeve to afford normal pump output by permitting spill to occur towards the end of the plunger stroke, spring means for urging the sleeve towards the said stop means, and piston means operatively associated with the sleeve and exposed to the liquid pressure afforded in the spill chamber by the aforesaid throttle means whereby the sleeve will be moved away from the stop means and thereby reduce the effective stroke of the plunger when said pressure overcomes the force of the spring means.

2. A fuel pump according to claim 1, comprising a sub-chamber associated with the spill chamber, the sleeve being slidably mounted on the plunger at a position between the spill chamber and the sub-chamber, one end of the sleeve being exposed to pressure liquid in the spill chamber and the other end having a formation adapted to co-operate with a part of the sub-chamber wall which constitutes the stop means.

3. A fuel pump according to claim 1, in which the sleeve is slidable on a part of the plunger extending through the spill chamber and comprising a spring-loaded piston arranged to be subject to the liquid pressure in the spill cham-

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ber, an operative connection between said piston and the sleeve, and stop means engageable by the piston for determining the normal position of the sleeve.

4. A fuel pump according to claim 1, in which the plunger receives both reciprocatory and rotary movements, the rotary movement serving to distribute successive charges to a plurality of engine cylinders.

5. A fuel pump according to claim 1, in which the plunger receives both reciprocatory and rotary movements, the rotary movement serving to distribute successive charges to a plurality of

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engine cylinders, and in which the sleeve is associated with an extension of the plunger.

6. A fuel pump according to claim 1, in which the throttle means is adjustable.

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