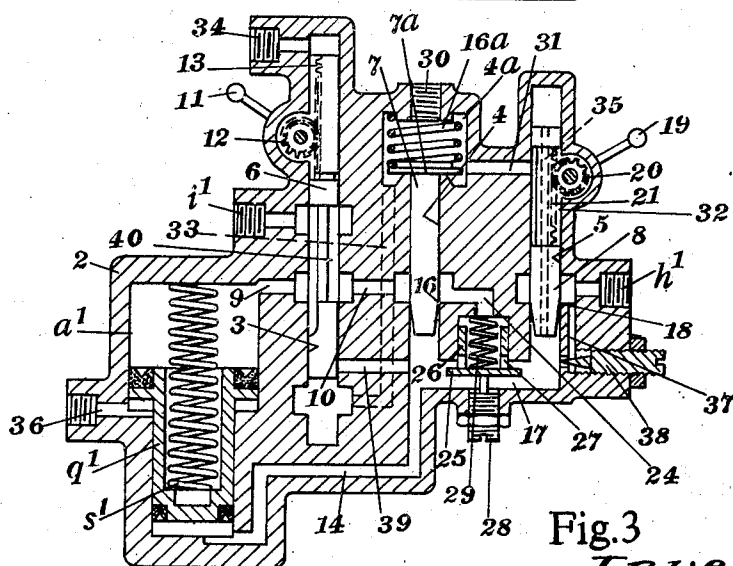
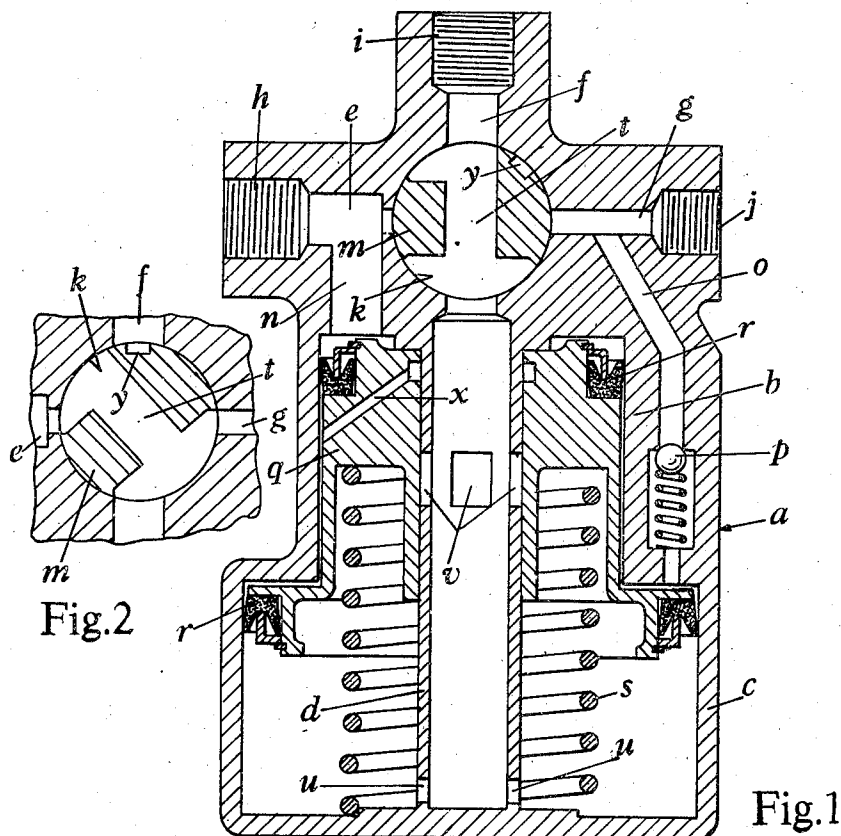


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LIQUID FUEL SUPPLY DEVICE FOR USE WITH INTERNAL-
COMBUSTION PRIME MOVERS
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LIQUID FUEL SUPPLY DEVICE FOR USE WITH INTERNAL-COMBUSTION PRIME MOVERS

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This invention has for its object to provide an improved liquid fuel supply device for use with an internal combustion prime mover of the kind having a fuel supply system which is fed by a pump, the latter deriving its motion from the prime mover. The purpose of the device is to supply an adequate initial charge to the system when starting the prime mover, the rate of actuation of the pump at that period being normally inadequate and a supplementary supply device being in consequence necessary.

In the accompanying sheet of explanatory drawings:

Figure 1 is a diagrammatic sectional side view of a liquid fuel supply device constructed in accordance with the invention.

Figure 2 is a fragmentary sectional view showing the control valve in a different position.

Figure 3 is a view similar to Figure 1 illustrating a modified form of the invention.

In carrying the invention into effect as shown in Figures 1 and 2, I employ a hollow cylindrical body *a* having a pair of coaxial parts *b*, *c* of different internal diameters, and provided in its interior with an axially arranged hollow stem *d*. In the outer end of the body part *b*, which is of smaller internal diameter than the body part *c*, are formed three passages *e*, *f*, *g* which at their outer ends terminate in connections *h*, *i*, *j* for pipes (not shown) leading respectively to the supply pump, the prime mover, and a sump. The inner ends of the passages *e*, *f*, *g* and the adjacent end of the hollow stem *d* are terminated by a transverse bore *k* in the body part *b*, and in this bore is arranged a rotary valve *m* adapted to effect the controls hereinafter described. Also the inlet passage *e*, that is, the passage communicating with the pump connection *h*, is provided with a branch passage *n* leading to the adjacent end of the interior of the body part *b*. Likewise the passage *g*, that is, the passage communicating with the sump connection *j* is provided with a branch passage *o*, this being arranged in communication with the adjacent end of the interior of the body part *c*, and being provided with a non-return valve *p*.

Within the body *a* is slidably arranged a stepped piston *q* consisting of two parts of different diameters situated respectively in the body parts *b*, *c*. The piston *q* is provided with packing rings *r* of U- or equivalent cross-section, and is loaded by a spring *s* arranged to move the piston towards the end of the body *a* containing the valve *m*.

The mode of action is as follows:

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Assuming the larger capacity body part *c* to have previously been filled with liquid fuel, and the valve *m* to be in the position shown in Figure 1 in which it connects the hollow stem *d* with the delivery passage *f* leading to the prime mover connection *i*, the setting of the pump in motion by actuation of the starting motor of the prime mover, causes fuel to be supplied by the pump to the adjacent end of the smaller capacity body part *b*. The rate of this supply may be slow, but its effect on the piston *q* is to move the latter against the action of its loading spring *s* in the direction for displacing the content of the larger capacity body part *c* along the hollow stem *d* and through a transverse passage *t* in the valve *m* to the connection *i* leading to the prime mover, openings *u* in the end of the stem remote from the valve providing the required communication between the body part *c* and the stem. This displacement is made in sufficient volume and at a sufficient rate to ensure the required adequate initial supply of liquid fuel to the prime mover until the pump can establish the normal direct supply. Meanwhile the piston *q* slides along the stem *d* under the pressure of the liquid supplied by the pump, and when it approaches the end of its movement the small end of the piston uncovers ports *v* in the stem which allow fluid to flow from the pump into the stem and thence through the valve *m* to the prime mover. At the same time fuel can enter the enlarging space between the larger end of the piston *q* and the inner end of the body part *c* from the passage *g* leading to the sump. In this phase the valve *m* prevents direct intercommunication between the pump and sump passages *e*, *g*. When it is required to stop the prime mover the valve *m* is turned to the position shown in Figure 2 in which it cuts off the connection with the delivery passage *f* and interconnects the pump and sump passages *e*, *g* and the stem *d*. The piston *q* now returns to its initial position under the action of the spring *s*, and while so doing liquid flows from the pump into the larger capacity body part *c* through the stem *d*, thereby providing the volume of liquid fuel to be used in the next starting operation of the prime mover. During the return of the piston *q* the fuel previously drawn into the body part *c* past the non-return valve *p* is displaced past the larger piston packing ring *r*.

In addition to the passages above described, I preferably also provide a balancing passage *x* in the smaller end of the piston *q*, this balancing passage being arranged to co-operate with the ports *v* in the stem *d* for putting the latter into

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communication with the inner end of the body part *o* when the piston approaches the end of its movement under the action of the liquid supplied by the pump, thus balancing the fluid pressures on the two sides of the large end of the piston. Further I may provide in the periphery of the valve *m* a groove *y* for establishing communication between the delivery passage *f* and the atmosphere or a drain when the supply of fuel to the prime mover is cut off.

For enabling the valve *m* to effect the controls above described, the ends of the transverse passage *t* in the valve are enlarged as shown.

In the modified construction shown in Figure 3 I employ a body 2 which is provided with inlet and delivery connections *h*¹, *i*¹ for pipes (not shown) leading respectively to the delivery side of the supply pump and the prime mover. At a position adjacent to the outlet connection *i*¹ the body 2 is bored to form a stepped cylinder *a*¹, and in this cylinder is slidably arranged a stepped piston *q*¹, the latter being loaded by a spring *s*¹. Parallel with the bore of the cylinder *a*¹ there are formed in the body 2 three other and smaller bores 3, 4, 5, and in these three bores are respectively arranged three slidable plunger-like valves 6, 7, 8.

The first bore 3 communicates with the outlet connection *i*¹, and is connected by passages 9, 10 to the larger end of the cylinder *a*¹ and the second bore 4. Communication between the outlet connection *i*¹ and the passages 9, 10 is controlled by the valve 6 (herein termed the control valve) which is slidable in the bore 3. The control valve 6 is operable by an external lever 11 through a pinion 12 and a rack 13, or by any other suitable means.

At one end the second bore 4 communicates with a passage 14 leading to the smaller end of the cylinder *a*¹, and at or near its other end this bore is formed with an enlargement 4^a. The valve 7 (herein referred to as the automatic valve) in the bore 4 is loaded by a spring 16^a situated in the bore enlargement 4^a and acting on a head 7^a on the adjacent end of the valve. The other end of the automatic valve 7 is of conical or other form, and co-operates with an annular seating or shoulder 16 in the bore 4 for controlling communication between the passages 10, 14.

The third bore 5 communicates with the inlet connection *h*¹, and is connected at one end to second bore 4 and the associated passage 14 by another passage 17. The adjacent end of the valve 8 (herein termed the throttle valve) in the bore 5 is of conical or other form, and co-operates with an annular seating or shoulder 18 in this bore for regulating the rate of flow of liquid fuel from the inlet connection *h*¹ to the passage 17. The throttle valve 8 is operable by an external lever 19 through a pinion 20 and a rack 21, or by any other suitable means.

To permit a restricted quantity of liquid fuel to flow from the passage 17 to the passage 10, and thence to the outlet connection *i*¹ when the prime mover is being started, a by-pass passage 24 is provided between the passages 17, 10, this by-pass passage being controlled by a valve 25 responsive to the liquid pressure in the passage 17. The by-pass valve 25 may consist as shown of a spring-loaded hollow piston which is slidable in a chamber 26 connecting the by-pass passage 24 to the passage 17, and which has a closed end exposed to the interior of the last mentioned passage, the peripheral wall of the piston being

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formed at or near its closed end with ports 27 through which liquid can flow from the passage 17 to the chamber 26 when the by-pass valve is in an appropriate position. The initial position of the by-pass valve 25 is determined by an adjustable abutment 28 on which the valve rests under the action of its loading spring 29. In this position of the by-pass valve 25 a restricted quantity of liquid fuel can flow through the ports 27 from the passage 17 to the chamber 26 and thence to the by-pass passage 24.

It will be seen that the end of the automatic valve 7 remote from its loading spring 16 is exposed to the fuel pressure in the passage 17. When this pressure rises to a predetermined amount the automatic valve 7 opens and establishes free communication between the passages 17, 10.

The enlargement 4^a of the bore 4 containing the automatic valve 7 communicates with a connection 30 for a pipe (not shown) leading to the suction side of the supply pump. Also the bore enlargement 4^a is connected by a passage 31 to a space 32 in the body 2 containing the rack 21 and pinion 20 associated with the throttle valve 8. Moreover, the bore enlargement 4^a is connected by another passage 33 to one end of the bore 3 containing the control valve 6, the other end of this bore (which contains the rack 13 associated with the control valve) being in communication with a vent or drain opening 34. Further, the throttle valve 8 is formed with an axial bore 35 for permitting access of fuel from the passage 17 to the remote end of the throttle valve, so that the ends of this valve are subject to balanced fuel pressures.

Assuming that the throttle valve 8 is open, the larger end of the cylinder *a*¹ is filled with liquid fuel, and the control valve 6 is in its open position as shown in which the larger end of the cylinder communicates with the outlet connection *i*¹, the setting of the pump in motion causes fuel to be supplied by the pump to the prime mover through the by-pass valve 25 and the delivery connection *i*¹, the initial pressure of the liquid fuel in the passage 17 being insufficient to open the automatic valve 7, or to overcome the spring *s*¹. As the pump accelerates the difference in the fluid pressures acting on opposite sides of the by-pass valve 25 increases until it reaches a value which causes the by-pass valve to close quickly against the action of its loading spring 29. The consequential rise of pressure in the passage 17, by acting on the smaller end of the piston *q*¹, moves the latter against the action of its loading spring *s*¹ and discharges liquid fuel from the larger end of the cylinder through the delivery connection *i*¹. Further rise of pressure in the passage 17 opens the automatic valve 7, enabling the full supply of liquid fuel required by the prime mover to flow from the passage 17 past the automatic valve to the delivery connection *i*¹. This enables the piston *q*¹ to return to its initial position, and the larger end of the cylinder *a*¹ to be refilled through the passage 9 with the volume of liquid fuel to be used in the next starting operation of the prime mover. The cylinder *a*¹ is provided at the junction of its larger and smaller parts with a venting passage 36 to prevent entrapped air or leakage fluid from interfering with the proper action of the piston *q*¹. To stop the prime mover the control valve 6 is moved to its closed position in which it interrupts communication between the delivery connection *i*¹ and the passages 9, 10, and establishes communication

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between the delivery connection and the drain opening 34. Simultaneously the passage 17 is connected to the suction side of the pump by way of another passage 39 in the body 2, a recess 40 in the adjacent side of the control valve 6, the passage 33 in the body, the chamber 4^a, and the connection 30. Subsequently the automatic and by-pass valves 7, 25 return to their initial positions preparatory to the next starting operation.

For enabling a small quantity of liquid fuel, sufficient for slow running of the prime mover, to flow from the inlet connection 7¹ to the passage 17 independently of the throttle valve 8, any convenient by-pass passage 37 is provided in the body 2, this passage being controlled by a manually adjustable needle valve 38.

By this invention I am able to effect the required initial supply of fuel to the prime mover in a very satisfactory manner. The invention is not, however, restricted to the examples described as subordinate details may be modified to suit different requirements.

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

1. For use with an internal combustion prime mover of the kind specified, a liquid fuel supply device comprising in combination a body formed with a cylindrical bore of two different diameters, and with liquid fuel inlet and delivery openings, liquid fuel passages for connecting the smaller part of the bore to the inlet opening and the larger part of the bore to the delivery opening, a stepped and spring loaded piston slidable in the bore under the action of liquid fuel supplied under pressure to the smaller part of the bore from the inlet opening, a control valve movable to different positions for establishing and interrupting communication between the delivery opening and

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the passage connected to the larger part of the bore, and means for establishing communication between the said passages under the control of the fuel pressure acting on the piston.

2. A liquid fuel supply device as and for the purpose claimed in claim 1, in which the fuel passage connecting the larger part of the cylindrical bore in the body to the delivery opening is formed in part by a hollow stem on which the piston is slidable, the stem being formed with ports whereby the smaller part of the said bore is connectible with the interior of the stem under the control of the piston.

3. A liquid fuel supply device as and for the purpose claimed in claim 1, in which the fuel passage connecting the larger part of the cylindrical bore in the body to the delivery opening is formed in part by a hollow stem on which the piston is slidable, the stem being formed with ports whereby the smaller part of the said bore is connectible with the interior of the stem under the control of the piston, and the control valve being of rotary form and arranged between one end of the hollow stem and the inlet and delivery openings.

4. A liquid fuel supply device as and for the purpose claimed in claim 1, in which the means for establishing communication between the liquid fuel passages includes a second valve responsive to the fuel pressure acting on the piston.

5. A liquid fuel supply device as and for the purpose claimed in claim 1, in which the means for establishing communication between the liquid fuel passages comprises in combination a second valve responsive to the fuel pressure acting on the piston, and a spring loaded by-pass valve responsive to fuel pressure for providing a restricted communication between the passages when the second valve is closed.

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