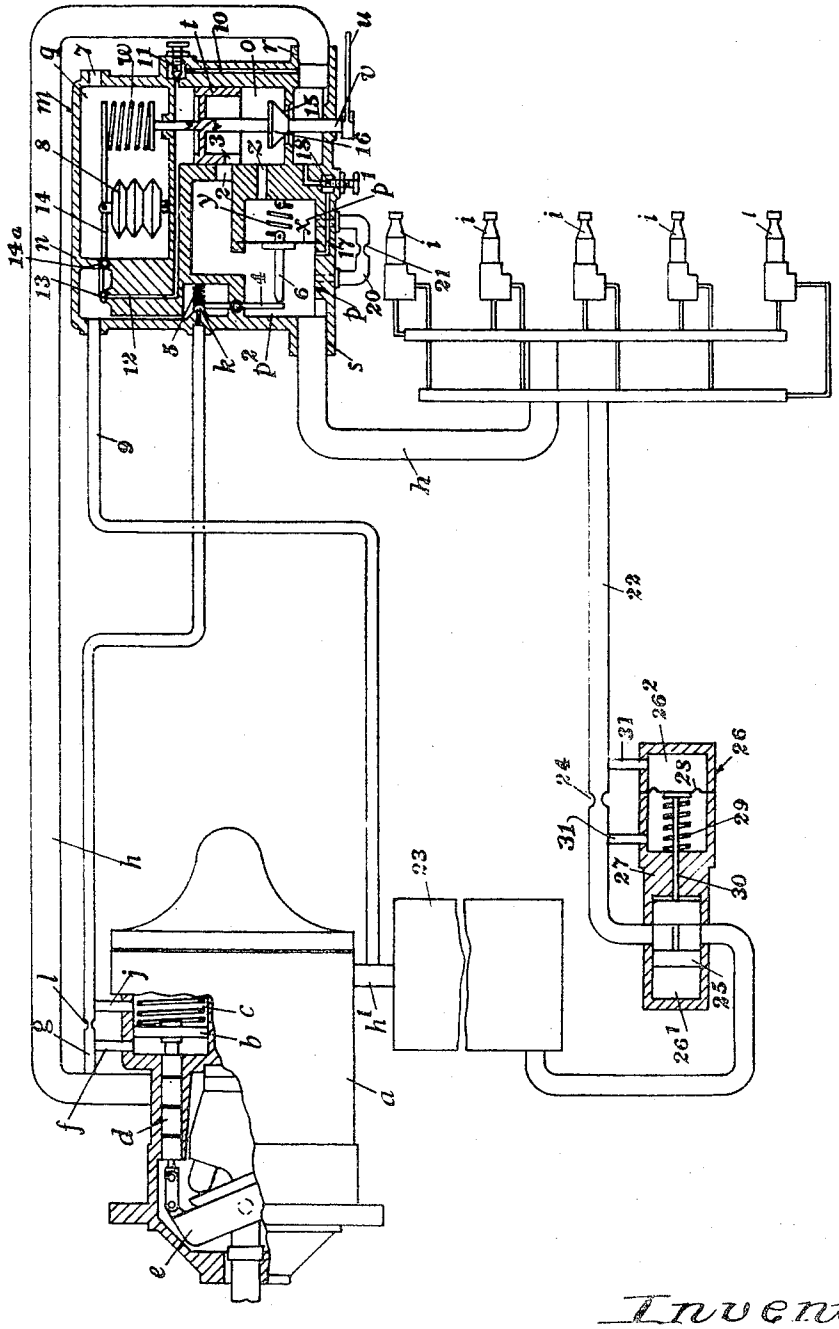
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LIQUID FUEL SUPPLY SYSTEM FOR INTERNAL-COMBUSTION PRIME MOVERS

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LIQUID FUEL SUPPLY SYSTEM FOR INTERNAL-COMBUSTION PRIME MOVERS

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This invention relates to liquid fuel supply systems for internal combustion prime movers, of the kind comprising a variable-delivery pump, one or more swirl-type jets for supplying the liquid fuel to a combustion chamber in the form of a spray, and controlling means responsive to liquid fuel pressure, and other conditions associated with the system (such as atmospheric pressure) for automatically regulating the quantity of liquid supplied to the jet or jets.

The required swirl of the liquid on emerging from the jet or jets depends in part on the velocity at which the liquid fuel is supplied, and to enable this velocity to be adequate under all conditions of flow it is already known to supply the liquid to the jet or jets at a rate which is in excess of that required to meet load requirements, the excess liquid being returned to the system before emergence from the jet or jets.

The object of the present invention is to provide in combination with a system of the kind above specified, improved means for supplying and returning the excess fluid required for maintenance of the desired rate of swirl in the jet or jets.

The invention comprises a system of the kind aforesaid having in combination with the pump controlling means, a by-pass adapted to allow the desired amount of excess liquid to pass from the pump to the jet or jets, and an automatic valve for controlling the flow in an excess-return duct, the said valve being responsive to a pressure difference set up in the said duct.

The accompanying diagram illustrates one mode of carrying the invention into effect.

In the diagram *a* indicates a variable delivery pump of the swash plate type, which is adapted to be driven by, and to supply liquid fuel to, a prime mover (not shown). The pump *a* has combined with it fluid-operable means for automatically varying the rate of delivery of liquid fuel by the pump. Such means may consist as shown of a spring loaded piston *b* which is slidable in a cylindrical chamber *c*, and which is connected by a rod *d* to the angularly adjustable swash plate *e* of the pump *a*. One end of the chamber *c* is connected by a passage *f* to a second passage *g* which at one end communicates with a third passage *h*, the latter serving to convey liquid fuel from the outlet of the pump *a* to one or more swirl-type jets *i* of the prime mover, and being herein termed the pump delivery passage. The other end of the chamber *c* is also connected to the second passage *g* by another passage *j*. Also, the second passage *g*

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is provided with a restriction *l* at a position between the adjacent ends of the passages *f*, *j*. Moreover, the end of the second passage *g* remote from the pump delivery passage *h* is controlled by a release valve *k*. The function of the fluid-operable means above described is well known and does not require description. It is sufficient to say that the piston *b* moves under fluid pressure in the direction for reducing the pump output when the release valve *k* is opened, and in the opposite direction for increasing the pump output when the release valve is closed.

Between the pump *a* and the jet or jets *i* there is arranged in the pump delivery passage *h* means *m* for controlling the output of the pump, such means being responsive to the liquid pressure in the pump delivery passage, and to atmospheric or other pressure or pressures. In the example shown the pump controlling means *m* comprises a body *n* adapted to provide three main chambers *o*, *p*, *q*, and having an inlet *r* and outlet *s* communicating with adjacent parts of the pump delivery passage *h*.

The chamber *o* is of cylindrical form, and communicates at one end with the body inlet *r*. Within the chamber *o* is arranged a spring-loaded piston valve *t* which is both rotatable and axially slidable in the chamber. Rotary movement is imparted to the piston valve *t* by a manually operable or other lever *u* on the valve stem *v*. Axial movement is automatically imparted to the piston valve *t* in one direction by fluid pressure as hereinafter described, and in the opposite direction by a compression spring *w* acting on the valve stem.

The chamber *p* is situated adjacent to the cylindrical chamber *o* and is divided into two compartments p^1, p^2 by a flexible diaphragm *x*, the latter being loaded by a tension spring *y*. The compartment p^1 communicates through a passage *z* and the cylindrical chamber *o* with the body inlet *r*, and the other compartment p^2 communicates with the body outlet *s*. The compartment p^2 also communicates through a port 2 with the part of the chamber *o* communicating with the body inlet *r*, this port being controlled by a notch 3 in the skirt of the piston valve *t* so that the effective area of the port is variable by either rotary or axial movements of the piston valve. The diaphragm *x* is therefore subject to the difference created by the valve *t* between the fluid pressures in the chamber *o* at the inlet side of the piston valve *t* and in the compartment p^2 of the chamber *p*, and the deflection of the diaphragm under this pressure difference is used to

actuate a lever 4 carrying the release valve k, the lever being movable against the action of a loading spring 5 by a thrust piece 6 on the diaphragm.

The chamber q is open to the atmosphere through a passage 7, and in this chamber is arranged a barometric device 8 in the form of a series of capsules responsive to atmospheric pressure. The barometric device 8 is required to effect axial movement of the piston valve t in response to variations of atmospheric pressure. For this purpose the two ends of the cylindrical chamber o are interconnected by a narrow passageway 10 which is provided with an adjustable flow-restricting member 11, and which serves to conduct liquid fuel from the body inlet r to the remote end of the cylindrical chamber. Also this end of the cylindrical chamber o communicates with a discharge passage 12, the latter being controlled by a second release valve 13 on a lever 14 operable by the barometric device 8. The lever 14 is pivoted where indicated by 14^a at a position intermediate its ends to the body n, and the barometric device 8 is connected to the lever so that this device tends to move the lever in the direction for closing the release valve 13 in response to decrease in atmospheric pressure, and in the direction for opening the release valve in response to increase in atmospheric pressure. The region in the body n occupied by the second release valve 13 is isolated from the chambers o, p, q, and is connected by a passage 9 to the inlet passage h^1 of the pump a. If desired, the inlet end of the cylindrical chamber o may be formed with an orifice 15 which communicates with the body inlet r, and the effective area of which is variable by a closure member 16 mounted on the valve stem v so as to act in concert with the piston valve t in response to variations in atmospheric pressure. Also the body inlet r may communicate with the compartment p^2 through a narrow passageway 17 provided with a flow-restricting member 18.

The above described pump controlling means m, which enables the amount of fuel supplied by the pump to the prime mover to be varied automatically in response to variations in atmospheric pressure, is of known form and depends for its action on the difference between the fluid pressures at opposite sides of the diaphragm x, and flexure of the diaphragm due to excess of fluid pressure in the compartment p^1 serves to actuate the release valve k for causing the output of the pump a to be varied. Moreover, this pressure difference is variable by axial or rotary movement of the piston valve t. Manual or other rotational adjustment of the lever u serves by its action on the piston valve t to determine the output of the pump a, and thus the speed at which the prime mover is required to operate at any given altitude, the diaphragm x serving by its action on the release valve lever 4, to keep the output of the pump substantially constant until the setting of the piston valve is varied either through the medium of the lever u or in response to variations in atmospheric pressure. To compensate the normal tendency of the prime mover to speed up, and increase the speed of the pump, with decrease in atmospheric pressure (due to increase in the altitude of the prime mover), the piston valve t is moved under the control of the barometric device 8 to decrease the pump output. Thus, decrease in atmospheric pressure causes the barometric device 8 to close the release valve 13. This results in a pressure build-up at the upper side of the piston valve t. Consequently the spring w moves the piston valve t in the direction for reducing the effective area of the port 2, and thereby increasing the pressure difference across the diaphragm x so that the latter opens the release valve k to reduce the output of the pump a. Conversely, increase in atmospheric pressure (due to decrease in the altitude of the prime mover) causes the barometric device 8 to open the release valve 13 and allow the piston valve to be moved against the action of the spring w by the fluid pressure at the underside of the piston valve in the direction for increasing the effective area of the port 2. This reduces the pressure difference across the diaphragm x which enables the release valve k to close for increasing the output of the pump a.

The purpose of the present invention as applied to the system above described is to enable the pump a to supply at all times not only the quantity of liquid fuel required to emerge from the jets (which quantity varies with the position of the piston valve t) but also a substantially constant excess quantity of liquid fuel for maintaining the desired rate of swirl at the jets.

In applying the invention in the manner shown in the diagram to the system above described, I provide in association with the body n of the pump controlling means a by-pass 20 which at its ends communicates respectively with the compartments p^1, p^2 at opposite sides of the diaphragm x, and in the by-pass is provided a restricted orifice 21 for controlling the rate of flow through the by-pass. The purpose of the by-pass 20 is to allow the flow to the jet or jets i of the excess liquid required to maintain the desired swirl at the jet or jets, this flow being unaffected by the position of the piston valve t. Also in association with the jet or jets i is arranged to return duct 22 which conveys the excess liquid from the interior of the jet or jets back to a sump 23 or other part of the system communicating with the inlet passage h^1. In the duct 22 is provided a restricted orifice 24 for creating a difference between the liquid pressures at opposite sides of this orifice, and in association with the duct is provided any convenient valve 25. In the example shown this valve is of the piston type, and is mounted in a hollow body part 26 which is divided into two compartments 26^1, 26^2 by a partition 27, the valve being situated in the compartment 26^1 and adapted to control the rate of flow of liquid through this compartment which is in series with the duct 22. The other compartment 26^2 is divided by a transverse flexible diaphragm 28, the latter being loaded by a spring 29, and being connected by a stem 30 to the piston valve 25. The regions in the compartment 26^2 at opposite sides of the diaphragm 28 are connected by passages 31 to the duct 22 at opposite sides of the restricted orifice 24 so that the diaphragm 28 is subject to the pressure difference created by the orifice, and the piston valve 25 is moved for varying the flow through the valve in response to the pressure difference acting on the diaphragm. The amount of liquid fuel flowing through the by-pass 20 remains substantially constant under all conditions and is determined by the size of the restricted orifice 21 in the by-pass. The automatic valve 25 for controlling the flow in the excess return duct 22 is necessary to ensure that, with variations in pressure, the amount of liquid flowing through the return duct is neither more or less than that supplied through the by-pass 20.

By this invention I am able to supply the required excess liquid to the jet or jets in a very simple and convenient manner. The invention is not, however, restricted to the example described as subordinate details may be modified to suit different conditions.

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

A liquid supply system for an internal combustion prime mover, comprising in combination at least one swirl-type jet for delivering liquid fuel to the prime mover in the form of a spray, a variable-delivery liquid fuel pump having a movable output-controlling member, a passage through which liquid fuel can flow from the pump to the jet at a rate in excess of that necessary to meet the load requirements of the prime mover, a duct for returning the excess liquid fuel to the system at the inlet side of the pump before the excess liquid fuel emerges from the jet, a valve arranged in association with the passage to control and create a pressure difference in the liquid fuel flowing through the passage, fluid-pressure responsive means arranged to act on the output-controlling member of the pump and exposed at opposite sides respectively to the fluid pressures in the passage at opposite sides of the valve so that the said means is responsive to the pressure difference created in the passage by the valve, a by-pass which interconnects liquid fuel spaces in the system at opposite sides of the said means, and through which the excess liquid fuel supplied by the pump flows to the jet independently of the valve, a second

valve arranged in association with the excess return duct to control the flow of liquid fuel therethrough, flow-restricting means in the excess return duct to create a pressure difference in the liquid fuel flowing therethrough, and a second fluid-pressure responsive means arranged to actuate the second valve and exposed at opposite sides to the fluid pressures in the excess return duct at opposite sides of the flow-restricting means so that the second fluid-responsive means is responsive to the pressure difference created in the excess return duct.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,824,952	Graham et al.	Sept. 29, 1931
2,178,672	Perkins	Nov. 7, 1939
2,316,445	Marshall	Apr. 13, 1943
2,334,679	Mason et al.	Nov. 16, 1943
2,364,489	Taylor	Dec. 5, 1944
2,405,888	Holley, Jr.	Aug. 14, 1946
2,410,773	Chandler	Nov. 5, 1946
2,410,774	Chandler	Nov. 5, 1946
2,440,663	Ifield	Apr. 27, 1948

FOREIGN PATENTS

Number	Country	Date
526,988	Great Britain	Sept. 30, 1940
549,205	Great Britain	Apr. 7, 1941