Aug. 14, 1956 O. N. LAWRENCE 2,758,638

LIQUID FUEL SUPPLY SYSTEMS

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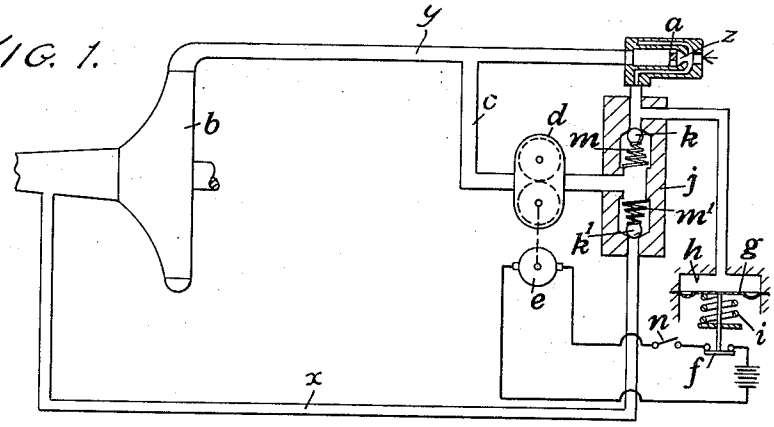
FIG. 1.



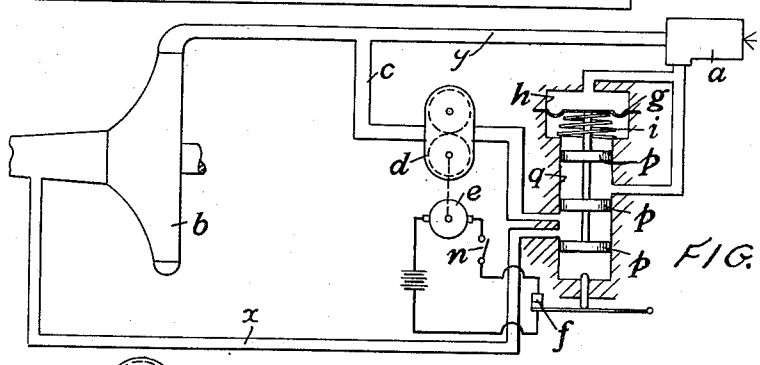




FIG. 2.

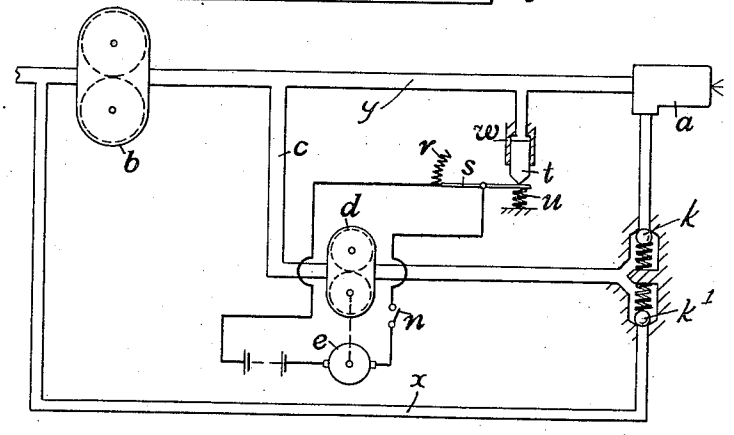



FIG. 3.

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# LIQUID FUEL SUPPLY SYSTEMS

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2 Claims. (Cl. 158—36.3)

This invention relates to a system for supplying liquid fuel from a pump to the combustion chamber of, for example, a jet engine, gas turbine, or industrial furnace, through a burner nozzle or nozzles of the swirl type. To ensure adequate so-called atomization of the fuel on emergence from the nozzle in such a system, the fuel is supplied to the swirl chamber of the nozzle at a rate in excess of that required to be discharged and, in the type of system for which the invention is required, the excess fuel is returned to the system by means of a pump. The need for the excess supply usually exists under low or medium load conditions. Under full load conditions the rate of supply is adequate to ensure the desired atomization.

One object of the present invention is to enable the pump to be controlled automatically in response to the rate of supply of fuel to the burner nozzle. A further object of the invention is to enable the excess-return pump to supply liquid fuel to the system under starting conditions.

The invention comprises a system in which there is combined with the excess-return pump, an electric motor, a controlling switch, and means responsive to the fuel pressure in the system for actuating the switch.

The invention also comprises a system as specified in the preceding paragraph having combined therewith valving means whereby the excess-return pump can be connected to either the discharge or the entrance end of the system.

In the accompanying drawings:

Figures 1, 2 and 3 represent diagrammatically three typical embodiments of the invention.

Referring to Figure 1, the fuel is supplied to a burner nozzle *a* (or each of a group of associated nozzles) of the swirl type by a power-driven pump *b*, hereinafter referred to as the supply pump. This pump may be a centrifugal pump as indicated in the drawing, or it may be a pump of any other convenient form. Between the pump *b* and the swirl chamber of the burner nozzle is arranged a by-pass pipe *c* in which is located the excess-return pump *d*. This pump is driven at a constant rate by an electric motor *e*, and the motor is controlled by a normally-closed switch *f* which is operable by a diaphragm *g* (or piston) forming part of or contained in a chamber *h*, the diaphragm (or piston) being loaded by a spring *i*. The chamber *h* is connected to the swirl chamber *z* of the nozzle *a*.

The arrangement is such that during low or medium load conditions fuel is circulated in the system by the excess-return pump *d*. But under full load conditions, the fuel pressure then acting on the said diaphragm *g* (or piston) is sufficient to open the switch and thereby put the said pump out of action.

When the supply pump *b* is arranged to be driven by a rotary part of a jet engine or gas turbine, it is convenient to be able to utilise the excess-return pump *d* for priming the system, and to meet this requirement there is provided at the inlet side of the pump *d* a valving



means for connecting this pump to either the source of fuel supply, or to the burner nozzle or nozzles. In the arrangement shown in Figure 1 there is provided a valve chest *j* containing a pair of non-return closure-members $k^1$ of the ball or other convenient type which are loaded respectively by springs *m*, $m^1$, the spring *m* being stronger than the spring $m^1$. The member *k* controls the communication between the nozzle *a* and the inlet of the excess-return pump *d*, and the other member $k^1$ controls the communication between the said inlet and a pipe *x* leading to the inlet side of the supply pump *b* which communicates with the fuel source, the inlet of the excess-return pump *d* being in communication with the valve chest *j* at a position between the closure members *k*, $k^1$. When starting, the excess-return pump motor *e* is set in motion by closing a switch *n* and the pump *d* causes the closure member $k^1$ to open and then draws fuel from the source for priming the system. As soon as the pipe *y* between the supply pump *b* and the burner is full the pressure of the fuel opens the closure member *k* and closes the second closure member $k^1$, so enabling the excess-return pump to perform its normal function. Also, if during normal working conditions the pressure of the fuel supplied by the pump *b* falls below the amount sufficient to maintain an adequate supply of fuel to the nozzle, the supply is supplemented from the source by the pump *d* which causes the closure member $k^1$ to open.

In the drawing shown in Figure 1, only sufficient of the system has been illustrated to elucidate the invention. It will be understood however that the system may be provided with any normal control means for automatically varying the supply of fuel to the nozzle in response to variations of load or other conditions.

The arrangement shown in Figure 2 is essentially similar to that shown in Figure 1, but differs in that a piston type valve is provided in association with the pump *d*. This valve comprises a plurality of interconnected pistons *p* slidable in a cylinder *q* and operable by the diaphragm *g*, the pistons being adapted to control communication between the pump *d*, the burner nozzle *a* and the pipe *x* leading to the inlet side of the pump *b*. The pistons *p* may be adapted as shown to transmit movement from the diaphragm *g* to the switch which controls the motor *e* of the pump *d*. In operation the arrangement shown in Figure 2 is essentially similar to that shown in Figure 1. Thus, when starting, the motor *e* is set in motion by closing the switch *n*, and the pump *d* then draws fuel from the source via the pipe *x* for priming the system. As soon as this is accomplished, the pressure of the fuel on the diaphragm *g* moves the piston-type valve to a position in which communication between the excess-return pump *d* and the pipe *x* is interrupted and communication between this pump and the burner nozzle *a* is established, so enabling the excess-return pump to perform its normal function. Also, if during normal working conditions the pressure of the fuel supplied by the pump *b* falls below the amount sufficient to maintain an adequate supply of fuel to the burner nozzle, the piston-type valve assumes a position in which the supply of fuel can be supplemented by the pump *d*.

In the arrangement shown in Figure 3, the pressure-responsive switch includes a variable resistance *r* for enabling the speed of the motor *e* to be progressively reduced to zero under the action of increasing fuel pressure. The pivoted contact arm *s* which co-operates with this resistance is operable by a plunger *t* loaded by a spring *u*, the plunger being slidable in a cylinder *w* in communication with the fuel supply pipe. In this arrangement, the valving means *k*, $k^1$ associated with the pump *d* is similar to that shown in Figure 1. The pump *b* is shown as a pump of the gear-type (instead of a centrifugal pump) but, as already mentioned, this pump

may be of any convenient type. In other respects and in operation the arrangement shown in Figure 3 is essentially similar to that shown in Figure 1.

It is clear, therefore, that the liquid fuel supply system of the invention includes the compensation of a main fuel pump, at least one burner nozzle having a swirl chamber therein adapted to receive atomized fuel, the nozzle having an outlet through which atomized fuel can emerge and an auxiliary fuel pump and a conduit means arrangement with which is associated motor control means and valve means that effect the operation of the system for the purpose set forth. The conduit means includes a first conduit means providing communication between the discharge side of the main pump and the nozzle for leading fuel to the swirl chamber; a second conduit means including one end communicating with the first conduit means upstream of the nozzle and another end communicating with said swirl chamber. The auxiliary pump is interposed in the second conduit means between the ends thereof so as to provide with said second conduit means and the part of said first conduit means between the said one end of the second conduit means and the nozzle; a fuel circulating path whereby excess fuel supplied by the main pump to the swirl chamber for assisting atomization of the fuel emerging from the chamber and out the outlet of the nozzle can be circulated by the auxiliary pump. Means including an electric motor are operably connected to the auxiliary pump to drive the same. There is a control circuit for the motor which in addition to the starter switch includes motor control means normally biased to a position in which the motor is energized and pressure responsive means operatively associated with said motor control means and communicating with and subjected to the pressure of the fuel in said circulating path and operable to actuate the motor control means to motor deenergizing position in response to a predetermined rise in pressure in the fuel in the circulating path. The system also includes what can be termed further conduit means *x* which communicate between the inlet side of the main pump and the second conduit means at a point in the fuel circulating path between the auxiliary pump and the swirl chamber. Pressure responsive valve means are operatively associated with said further conduit means and said second conduit means respectively, for controlling the flow of fuel to the auxiliary pump, the pressure responsive valve means being operable depending upon the pressure of the fuel at the discharge side of the main pump to connect the auxiliary pump to allow the inlet side of the main pump or the swirl chamber as the pressure increases or decreases below and above a predetermined value respectively.

The invention is not, however restricted to the above described examples, as subordinate details may be varied to suit different requirements.



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

1. A liquid fuel supply system comprising in combination a main fuel pump, at least one burner nozzle having a swirl chamber therein adapted to receive and atomize liquid fuel, said nozzle further having an outlet through which atomized fuel can emerge, an auxiliary fuel pump, a first conduit means providing communication between the discharge side of the main pump and the nozzle for leading fuel to said chamber, a second conduit means including one end communicating with the first conduit means upstream of said nozzle and another end communicating with said swirl chamber, said auxiliary pump being interposed in said second conduit between the ends thereof so as to provide with said second conduit means and the part of said first conduit means between said one end of the second conduit means and the nozzle a fuel circulating path whereby excess fuel supplied by the main pump to the swirl chamber for assisting atomization of the fuel emerging therefrom can be circulated by the auxiliary pump, means for driving the auxiliary pump including an electric motor operably connected to the auxiliary pump, and a control circuit for the motor including motor control means normally biased to a position in which the motor is energized and pressure responsive means operatively associated with said motor control means and communicating with and subjected to the pressure of the fuel in said fuel circulating path and operable to actuate said motor control means to motor deenergizing position in response to a predetermined rise in pressure in the fuel in said fuel circulating path.

2. A liquid fuel supply system as claimed in claim 1 and also including further conduit means communicating between the inlet side of the main pump and said second conduit means at a point in said fuel circulating path between said auxiliary pump and the swirl chamber, and pressure responsive valve means operatively associated with said further and said second conduit means respectively for controlling flow of fuel to said auxiliary pump and operable depending upon the pressure of the fuel at the discharge side of the main pump to connect the auxiliary pump to either the inlet side of the main pump or the swirl chamber, as the fuel pressure decreases or increases below and above a predetermined value respectively.

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