This invention relates to means for controlling the supply of liquid fuel from a rotary pump to a jet-engine or gas turbine.

The object of the invention is to obviate excessive supply of fuel during acceleration of the engine.

The invention comprises the combination of a throttle for controlling the rate of flow of fuel in a fuel-supply pipe between the pump and burner, liquid-actuated means for actuating the throttle, a control valve responsive to fuel pressure for controlling the throttle-actuating means, and a governor for controlling the liquid acting on the throttle-actuating means.

The accompanying drawings:

Figures 1 to 4 represent diagrammatically four typical embodiments of the invention.

Referring to Figure 1, there is arranged in a main fuel-supply pipe a between a centrifugal pump b (adapted to be driven by the engine) and a burner c, an axially slidable throttle d for controlling the rate of supply of fuel from the pump to the burner, the throttle being of the kind comprising a conical or like plug co-operating with an orifice e in a hollow body part f. The throttle-actuating means comprises a piston g formed on or secured to one end of the throttle, the piston being slidable in a cylindrical chamber h in the said part f and being loaded by a spring i which tends to move the throttle to its full open position. The end of the chamber h remote from that through which passage q between the throttle extends is connected by a branch passage j to the main fuel supply pipe at the inlet side of the throttle. Also there is combined with the said means a stop k for restricting the extent to which the throttle can be moved towards its closed position under the action of fuel pressure. This stop extends from a piston m loaded by a spring n and slidable in a cylindrical chamber o which at one end is connected by a passage p to the said passage j, so that the stop can be retracted by fuel pressure in opposition to the spring when a predetermined fuel pressure is reached.

The end of the cylindrical chamber h remote from the passage j is connected by a passage q to a control valve. This latter comprises a hollow body part r which is divided into two compartments by a diaphragm s (or piston) which carries a closure member t co-operating with a seat u at the entrance to the said pipe, the closure member being held on its seating by a spring v. The said compartments are respectively connected by passages w, x, to the inlet and outlet sides of the pump, so that when the fuel pressure in passage x reaches a predetermined amount it can open the valve.

Also in the said passage q between the control valve and the throttle actuating means there is arranged any suitable governing means for controlling the pressure of the fuel supplied through the said passage to the throttle-actuating means, the said governing means being responsive to the speed of the pump in the system.

The particular form of governing means shown in Figure 1 comprises a hollow body part 2 in which is formed a chamber 3 enclosing a gap in the passage q, and adjacent to this gap is arranged a transversely movable shutter 4 which can obstruct the flow of liquid across the gap from one part of the passage q to the other. The shutter is operable by a diaphragm 5 which divides another chamber in the part 2 into two compartments one of which contains a spring 6 acting on the diaphragm. The other compartment is connected by a passage 7 to the fuel pipe q, or to any other source of liquid under pressure related to the speed of the engine. Excess liquid from the chamber 3 is returned to the pump by way of a passage 8.

The action of the governor is such that when the shutter is retracted full pressure is exerted on the left hand side of the throttle-actuating piston. In this condition both sides of the said piston are subject to substantially equal liquid pressures and the piston is moved by the spring i to the position in which the throttle d is fully open. When the shutter 4 is moved into the gap in the passage q, the liquid pressure acting on the left hand side of the piston g is reduced, and the preponderating liquid pressure then acting on the right hand side moves the throttle d against the action of the spring i for reducing the supply of liquid fuel to the burner.

The mode of action of the system shown in Figure 1 is as follows: On starting the pump b the throttle d is fully open, but when a certain fuel pressure is attained this moves the throttle into contact with the stop k for restricting the rate of supply of fuel to the burner, so obviating risk of over-fuelling while the speed is increasing. Later, and when the fuel pressure reaches a higher amount, the control valve t opens and admits fuel to the left hand end of the cylinder h of the throttle-actuating means, so enabling the throttle to be retarded by the associated spring for increasing the rate of fuel supply to the burner. When the fuel pressure reaches its normal working amount, it retracts the stop k, and thereafter the position of the throttle is determined by the governing means acting on the fuel supplied through the valve l to the throttle-actuating means.

In the embodiment of the invention shown in Figure 2, the throttle d consists of a piston-type valve, having a reduced and suitably shaped part 9 for controlling the rate of flow of fuel through the orifice e. At one end the throttle is connected to actuating means as above described (excepting that the stop is omitted). The other end can enter a cylindrical chamber 10 the end 11 of which is closed by a valve 12. This valve is carried by a diaphragm 13 loaded by a spring 14. The diaphragm divides a chamber 15 into two compartments, one of which is connected by a passage 16 to the inlet side of the pump, the other being connected by a passage 17 to the pipe q of the throttle controlling means. When the left hand end of the throttle d enters the chamber 10 the fuel thereby entrapped in the said chamber serves as a stop, so long as the valve 12 remains closed.

The mode of action of the system shown in Figure 2 is essentially similar to that of the system shown in Figure 1. On starting the pump, the fuel pressure acting on the right hand side of the piston g moves the throttle to its restricted position, the extent of this movement being limited by the liquid entrapped in the chamber 10. With increase of the fuel pressure the control valve t is opened, and also the valve 12. Thereafter the rate of flow of fuel to the burner is controlled by movement of the throttle d in response to the control of the governing means.

In the embodiment of the invention shown in Figure 3, the throttle d is of a similar form to that shown in Figure 1 (excepting that the stop is omitted) and in parallel with the throttle is arranged a by-pass device 20 which contains a normally open valve 21. The valve is operable
by fuel pressure acting on a piston 22 loaded by a spring 23 which is stronger than the spring i, the piston being contained in a cylindrical chamber which at its ends is connected by passages 24—25 to the fuel pipe a and the pump inlet respectively.

The arrangement is such that during the starting condition the throttle is fully closed by the fuel pressure, and the by-pass valve 21 is fully open. The rate of supply of liquid fuel to the burner is, in this condition, determined by the by-pass valve. With increased fuel pressure the by-pass valve is closed, and the control valve is opened, the rate of fuel supply being then determined by the throttle in response to the action of the governor. In other respects the arrangement shown in Figure 3 is essentially similar to that shown in Figure 1, excepting that the spring i acting on the piston g is weaker than that of the Figure 1 arrangement and allows the throttle to be closed under relatively low fuel pressure.

The embodiment of the invention shown in Figure 4 differs from that of Figure 1, mainly in that a different governor and control valves are provided and the two ends of the cylinder k of the throttle-actuating means are interconnected by an additional passage 39 containing a restricted orifice 40. In this arrangement the governor comprises a hollow body part 27 which includes two chambers. One of the chambers contains a valve seating 28 in communication by way of a passage 29 with the seating of the control valve i. The other chamber is divided into two compartments by a diaphragm 30 which acts on one end of a lever 31 having parts in both chambers. The other end of the lever carries a valve 32 and is loaded by a spring 33, the lever 32 being normally closed, and the lever being operable by fuel pressure acting on one side of the diaphragm.

The control valve i is normally open and is carried by a diaphragm s loaded by a spring v, the side of the diaphragm remote from the spring and valve being subject to liquid fuel pressure.

The mode of action is as follows:
When starting the throttle d is moved by fuel pressure to the restricted position determined by the stop k. When the fuel pressure reaches a predetermined amount the control valve r is closed and the consequent balancing of the fuel pressures acting on the piston by way of the passage 39, enables the spring i to move the throttle to its fully open position. Thereafter the rate of flow of fuel to the burner is controlled by movement of the throttle in response to the action of the governor which, with opening of the valve 32, enables the fuel pressure acting on the piston g to vary the position of the throttle.

Having thus described our invention what we claim as new and desire to secure by Letters Patent is:
1. A liquid fuel supply system comprising in combination a centrifugal pump having an inlet and an outlet for liquid fuel, a fuel delivery pipe communicating with said outlet, a spring-loaded throttle arranged to provide a variable fuel-flow restriction in said pipe, a liquid-operated device connected to said throttle for effecting actuation thereof, and thereby varying fuel flow through said pipe, a first passage forming means connecting said pipe at the upstream side of said throttle to said device so that the latter tends to move said throttle against its spring loading towards a closed position in response to the delivery pressure of said pump, a second passage forming means connected to said device so that pressure liquid admitted to said device through said second passage forming means opposes the effect of the pump delivery pressure on said device, a valve arranged in association with said device to control the pressure of the liquid admitted to said device through said second passage forming means, a governor responsive to the speed of said pump also arranged in association with said second passage forming means to control the pressure of the last mentioned liquid after said valve has assumed a predetermined position, and means responsive to the delivery pressure of said pump for moving said valve to said predetermined position before said governor becomes effective.
2. A liquid fuel supply system according to claim 1, and having in combination with the throttle a stop for limiting the closing movement of said throttle, said means connected to said stop and responsive to the delivery pressure of the pump for putting the stop out of action.
3. A liquid fuel supply system according to claim 1, and having in combination with said throttle a slidably retractable stop for limiting closing movement of said throttle, and means connected to said stop and responsive to the delivery pressure of said pump for retracting said stop.
4. A liquid fuel supply system according to claim 1, and having in combination with the throttle a device for presenting a liquid obstruction to said throttle in order to limit closing movement thereof, and a valve responsive to the delivery pressure of the pump for creating said obstruction.

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