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COMPENSATED MEANS FOR CONTROLLING THE SUPPLY OF
LIQUID FUEL TO JET-PROPELLED AERIAL BODIES
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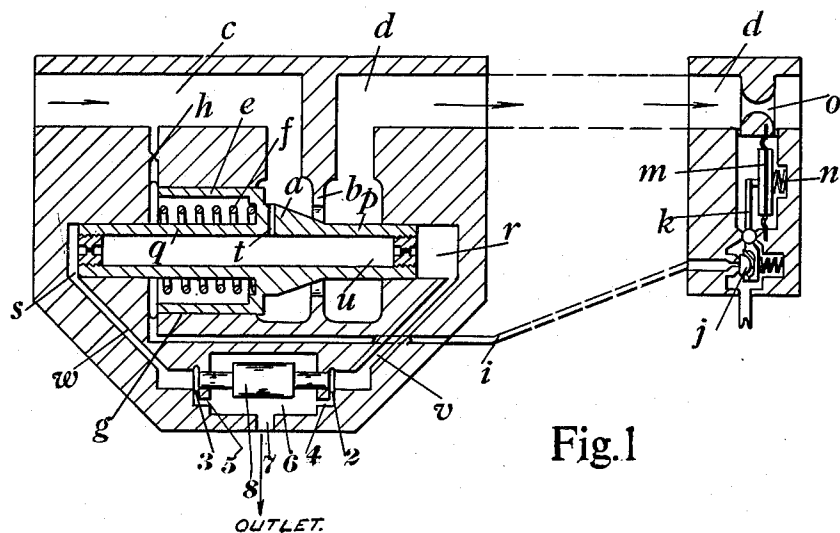


Fig. 1

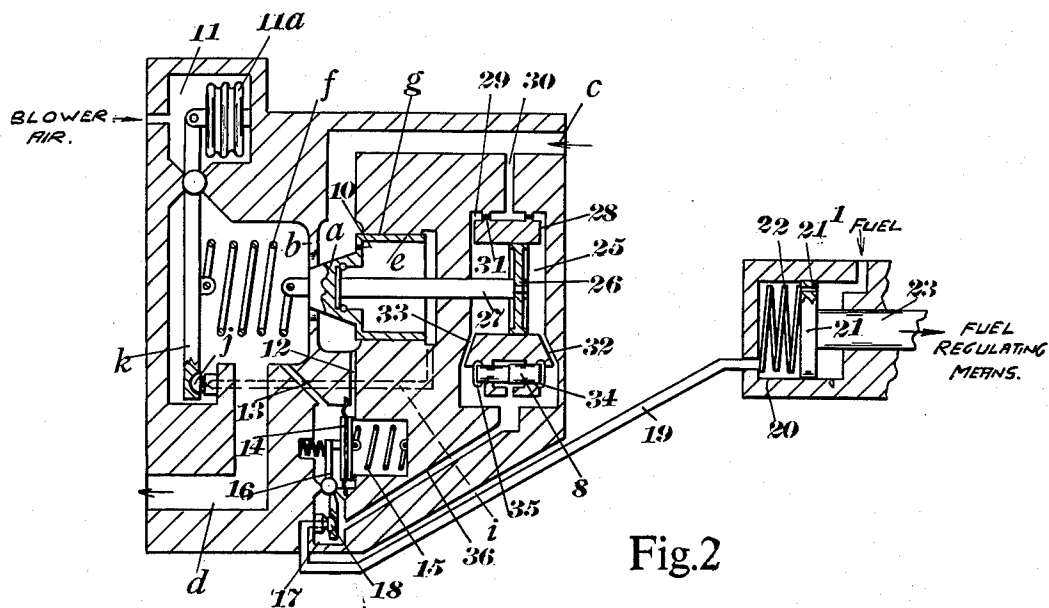


Fig. 2

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COMPENSATED MEANS FOR CONTROLLING THE SUPPLY OF LIQUID FUEL TO JET-PROPELLED AERIAL BODIES

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This invention relates to liquid fuel control means for jet-propelled aerial bodies, and more particularly to ram jet-propelled missiles, the said control means being of the kind actuated by a liquid-operated servo mechanism. It has been found that during rapid acceleration or deceleration of such an aerial body, the inertia effects associated with the fuel control means may interfere with the proper action of the said means, and the object of the present invention is to enable this condition to be obviated.

The invention comprises the combination with a fuel control means of the kind specified, of a hydraulic buffering device under the control of a freely movable member responsive to acceleration or deceleration of the body.

In the accompanying drawing:

Figure 1 is a diagrammatic representation of a liquid fuel control means constructed in accordance with the invention,

Figure 2 is a diagrammatic representation of a modified form of liquid fuel control means.

A known form of liquid fuel control means to which the invention is applicable and as shown in Figure 1 comprises an axially slidable throttle *a* arranged to control the flow of fuel through a seating *b* associated with the throttle. The liquid fuel enters along a passage *c* and emerges through a passage *d*. At one end the throttle is secured to or formed on a piston *e* loaded by a spring *f* and slidable in the cylinder *g* of the servo-mechanism. One end of the cylinder is in free communication with the passage *c* and the other end is in communication with the same passage through a restricted orifice *h*. The latter end of the cylinder is provided with a vent passage *i* which is controlled by a valve *j*. When the valve is closed, the spring *f* moves the piston and throttle in the direction for closing or restricting the passage through the seating *b*. When the vent is opened, the preponderating liquid pressure acting on the piston moves the latter against the spring for opening the passage through the seating. The motive fluid of the servo-mechanism is controlled by any appropriate means, and this feature forms no part of the present invention. In the example shown in Figure 1, the valve *j* is carried by a lever *k* which is operable by a diaphragm *m* loaded by a spring *n*, the diaphragm being acted on by a variable difference of liquid pressures at opposite sides of a restriction *o* in the passage *d*.

When the device above described is subjected during flight to any strong accelerating or decelerating force, the throttle *a* may be opened or closed by such force independently of the normal action of the associated servo-mechanism, and as already stated, it is the object of the present invention to obviate this condition.

In carrying the invention into effect as shown in Figure 1, there are combined with the throttle *a* a pair of coaxial plungers *p*, *q* extending from the opposite ends of the throttle into cylinders *r*, *s*. Liquid is fed to the cylinders through an inlet passage *t* in the throttle and along

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the axial bore *u*, the latter being in communication with the said cylinders through restricted orifices in the ends of the plungers. Outlet passages *v*, *w* from the said cylinders lead to valve seatings *2*, *3* the latter being in communication by way of passages *4*, *5* with a valve chamber *6* having an outlet *7*. In the chamber *6* is contained a freely slidable shuttle valve *8* having plunger-like ends adapted to cooperate with the seatings *2*, *3* for controlling the outflow of liquid from the cylinder *r*, *s* to the outlet *7*. The areas of the seatings *2*, *3* and the mass of the shuttle valve *3* are suitably proportioned in relation to the areas of the cylinders *r*, *s* and the mass of the throttle *a* and servo-piston *e*, so that the pressures set up in either of the cylinders *r*, *s* by the associated plunger *15* (when moved in response to acceleration or deceleration of the aerial body) can be counterbalanced by the shuttle valve.

When the aerial body is moving at a uniform speed liquid can pass freely from the inlet passage *t* to the outlet *7* (at a restricted rate) and the throttle is then free to move under the action of the servo-mechanism for performing its normal function. But in the event of rapid acceleration or deceleration of the aerial body, the shuttle valve *8* moves on to one or the other of seatings *2*, *3* and thereby arrests or restricts the flow from the associated cylinder *r*, or *s*. The plungers *p* and *q* in their respective cylinders *r* and *s* constitute a hydraulic buffering means and the shuttle valve *8* constitutes a means for differentially varying the buffering action in response to acceleration or deceleration of the aerial body and thereby either prevents or restricts undesired movement of the throttle relative to the seating *b*.

In the example shown in Figure 2 the throttle *a* cooperates with a seating *b* through which the liquid fuel can flow from an inlet passage *c* to an outlet passage *d*. The throttle is formed on or secured to a servo-piston *e* slidable in a cylinder *g*, and is loaded by a spring *f*. Liquid can pass from the inlet side of the seating *b* through a restricted orifice *10* to the closed end of the cylinder, and a vent passage *i* leading from this end of the cylinder is controlled by a valve *j*. The latter is carried by a lever *k* which at one end extends into a compartment *11* containing an evacuated elastic capsule *11a*. Air from the blower which supplies the combustion chamber of the engine is admitted to the chamber *11*, and the valve *j* in this example is therefore under the control of blower-air pressure. Alternatively it may be placed under the control of atmospheric air pressure in which case the compartment *11* is open to the atmosphere.

In addition provision is also made in this example, for actuating another servo-mechanism for controlling the output of a variable-delivery pump, or other means for regulating the rate of flow of fluid to the burner in the combustion chamber of the engine. The two sides of the throttle seating *b* communicate by way of passages *12*, *13* with compartments at opposite sides of a diaphragm *14* which is loaded by a spring *15*. The diaphragm serves to actuate a lever *16* which at one end extends into a chamber *17* and carries a valve *18* for controlling a vent passage *19* from one end of the cylinder *20* of the second servo-mechanism.

The lever *16* is spring loaded and bears on the diaphragm *14*, the spring loading being arranged so that it tends to hold the valve *18* to close the vent passage *19*. Thus a preponderating fluid pressure acting on the right hand side of the diaphragm *14* will tend to actuate the lever *16* to raise the valve *18* from its seating. The cylinder *20* of the second servo mechanism is connected to the vent by the aforesaid passage *19*. A piston *21* in the cylinder *20* is loaded by a spring *22*, and from the piston *21* extends a fuel regulating rod *23* which is connected to the fuel regulating means (not shown). Such fuel regu-

lating means may for example comprise a variable delivery pump of the swash plate type and the rod 23 may be connected to the swash plate to vary the inclination thereof. The two ends of the cylinder 20 are in communication through a restricted orifice 21¹ in the piston 21, and fuel is admitted to one end of said cylinder through the inlet passage 24. When the pressure difference at the opposite sides of the seating *b*, which is communicated to opposite sides of the diaphragm 14, is such that the lever 16 holds the valve 18 on its seating, no liquid will be vented from the left hand side of the piston 21 so that the spring 22 is enabled to move the piston to the right as viewed in Figure 2. The arrangement of the fuel regulating means previously mentioned is such that the corresponding movement of the fuel regulating rod 23 increases the supply of fuel. When the valve 18 is opened due to the action of the diaphragm in response to a change in the pressure difference at the opposite sides of the seating *b*, the piston 21 is moved by the preponderating liquid pressure acting on its right hand side, for reducing the rate of supply of fuel to the burner.

In applying the present invention to the arrangement shown in Figure 2, there is provided a cylindrical chamber 25 containing a piston 26 which is connected to the throttle *a* by a rod 27. Liquid is admitted to the two ends of the cylinder 25 from the inlet passage *c* by way of passages 28, 29, 30, containing restricted orifices 31. This liquid passes out of the cylinder through passages 32, 33 to seatings 34, 35 which lead to an outlet passage 36. Between the seatings 34, 35 is arranged a freely slidable shuttle valve 8 which at its ends is adapted to control the flow of liquid through the said seatings in the manner described with reference to Figure 1. So long as the speed of the aerial body is uniform, liquid flows at a restricted rate through both ends of the cylinder 25, but in the event of acceleration or deceleration of the body, the shuttle valve moves towards one or the other of the seatings 34, 35 and so sets up the desired differential buffer action on the cylinder 25 for preventing or restricting undesired movement of the throttle.

The invention is not, however, restricted to the above described examples, as the hydraulic buffer may be provided in any other like or equivalent manner for resisting undesired movements of the movable part of the fuel regulating means.

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

1. Means for controlling the supply of liquid fuel to jet-

propelled aerial bodies comprising, in combination, an axially slidable fuel throttle, a liquid-operated servomechanism for actuating the throttle, hydraulic buffering means arranged to oppose movement of said throttle in both directions, and means including a freely movable shuttle valve responsive to acceleration or deceleration of the aerial body and arranged to control the buffering means for differentially varying the buffering action according to the direction of movement of said valve to thereby compensate the effects of such acceleration or deceleration on the throttle.

2. Means for controlling the supply of liquid fuel to jet-propelled aerial bodies comprising, in combination, an axially slidable fuel throttle, a liquid-operated servomechanism for actuating the throttle, a pair of coaxial and oppositely extending plungers combined with the throttle, cylinders enclosing the free ends of the plungers, liquid inlet and outlet passages leading to and from said cylinders, and a freely movable shuttle valve responsive to acceleration and deceleration of the aerial body arranged to control the said outlet passages whereby according to the position of the shuttle valve one of the said outlets is restricted and a buffering action is exerted on the corresponding plunger to oppose movement of the throttle and thereby compensate the effects of acceleration or deceleration.

3. Means for controlling the supply of liquid fuel to jet-propelled aerial bodies comprising, in combination, an axially slidable fuel throttle, a liquid operated servomechanism for actuating the throttle, a piston operatively connected to one end of the throttle, a cylinder containing the piston and forming therewith hydraulic buffering means for opposing movement of the throttle in both directions, liquid inlet and outlet passages leading to and from the ends of the cylinder, and a freely movable shuttle valve responsive to acceleration and deceleration of the aerial body arranged to control the said passages for differentially varying the buffering action on the throttle according to the direction of movement of the valve and thereby compensating the effects of acceleration and deceleration.

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