

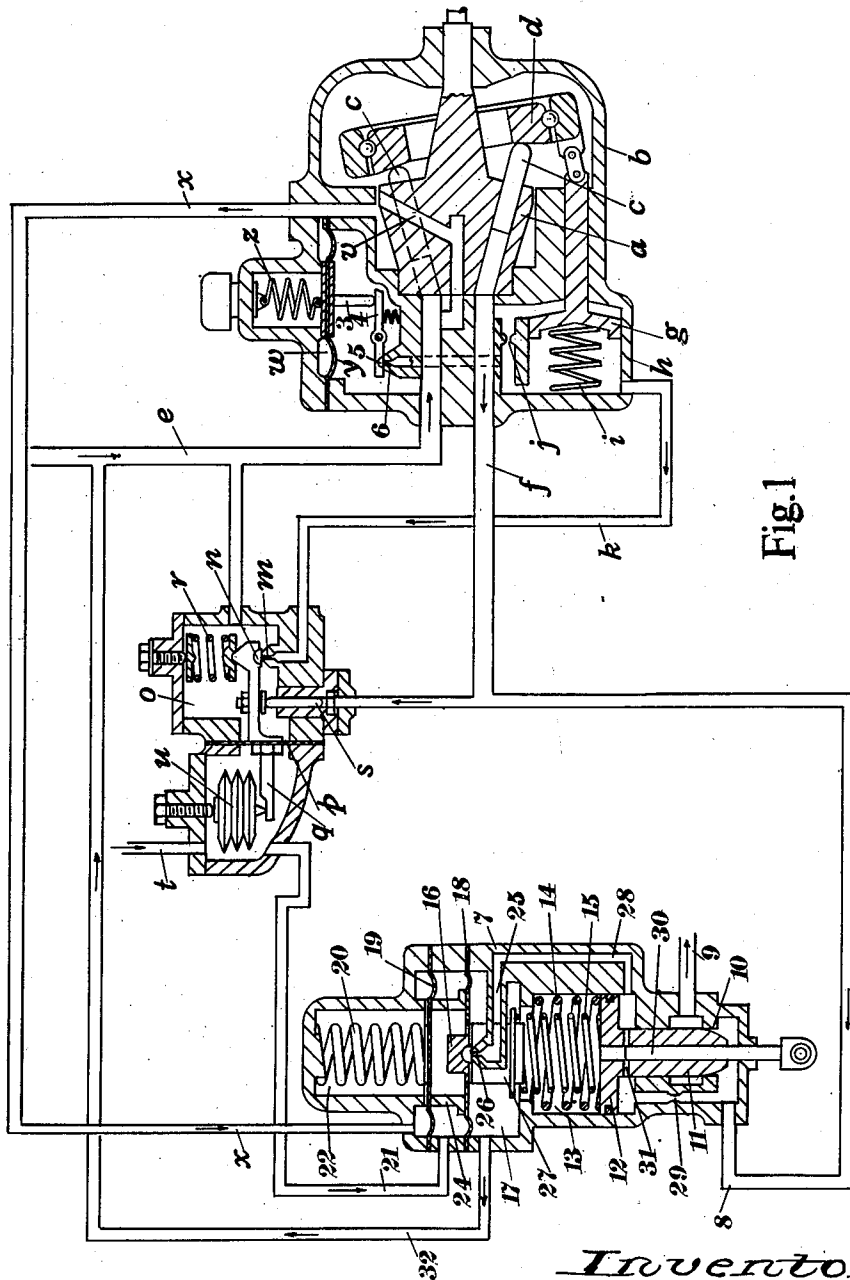
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LIQUID FUEL CONTROL MECHANISM FOR
INTERNAL-COMBUSTION PRIME MOVERS

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2 SHEETS—SHEET 1



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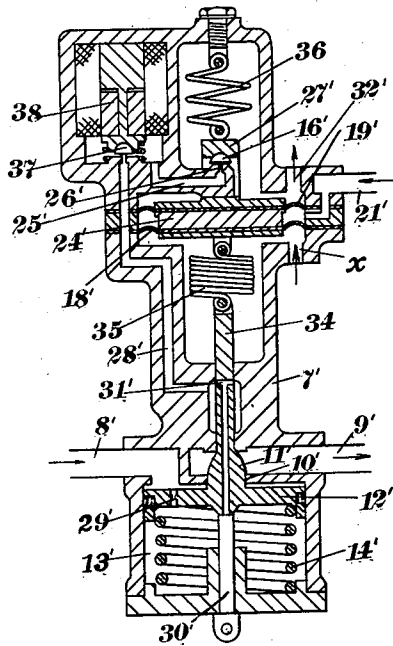


Fig.2

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INTERNAL-COMBUSTION PRIME MOVERSRichard Joseph Ifield, Dural, New South Wales,
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5 Claims. (Cl. 121-41)

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This invention relates to a liquid-fuel control mechanism for an internal combustion prime mover, and particularly a jet engine, gas turbine, or the like, the mechanism being of the kind which includes a throttle under the manual control of the driver. The object of the invention is to provide an improved mechanism adapted to prevent an excessively rapid rate of increase of supply of fuel to the prime mover in the event of an excessively rapid actuation of the manually operable throttle.

The invention comprises the combination with a throttle, of a liquid-operated servo-mechanism for actuating the throttle, and valving means associated with the servo-mechanism for controlling the movement of the throttle, the valving means comprising a manually operable valve for controlling the extent of movement, and a valve movable in part in response to movement of the servo-mechanism and in part to fluid pressure for controlling the rate of movement of the throttle.

In the accompanying drawings:

Figure 1 is a sectional diagram illustrating a system which includes a fuel control means embodying the invention, and

Figure 2 is a sectional diagram illustrating a modified construction of the said mechanism.

Referring to Figure 1, the fuel control mechanism shown at the left hand side of the diagram is arranged in association with a known form of variable delivery liquid fuel pump, and means for controlling the pump output. The pump comprises a rotary body *a* contained in a housing *b* and provided with reciprocating plungers *c* which co-operate with an angularly adjustable swash plate *d*. Liquid fuel enters the pump along the passage *e* and is discharged along the passage *f*. The swash plate is angularly adjustable by a servo-mechanism which comprises a piston *g* slidable in a cylinder *h* and loaded by a spring *i*. The two ends of the cylinder are in communication through a restricted orifice *j*. Liquid fuel can enter the cylinder from the passage *f*, and can emerge through a passage *k* to a vent *m* which is controlled by a valve *n*. When the valve *n* is closed, liquid acts with equal pressures on the two sides of the piston *g*, and the spring *i* then moves the piston to the right for increasing the obliquity of the swash plate, so enabling the pump to give its maximum output. When the valve *n* is opened, a preponderating liquid pressure acts on the right hand side of the piston *g*, causing it to move to the left against the action of the spring *i* for reducing the obliquity of the

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swash plate and thereby reducing the pump output.

The vent *m* and valve *n* are contained in a chambered part *o* which is divided into two compartments by a flexible diaphragm *p*, and on the latter is mounted a lever *q* which carries the valve *n*. The lever *q* is loaded by a spring *r* and is subject to the pressure of the liquid fuel in the passage *f* which pressure acts on the lever through a plunger *s*. Also the lever is subject to atmospheric pressure admitted to the said body part at *t*, this pressure acting on the lever through an evacuated deformable capsule *u*. By means of the valve *n* the pump output is under the automatic control of atmospheric pressure and the pressure of the liquid fuel in the discharge passage *f*.

The pump is also under the control of the speed of the rotary pump body *a*, which by means of a radial passage *v* supplied from the inlet passage *e* can act as a centrifugal pump, causing liquid to be discharged into the housing *b* at a pressure related to the speed of rotation of the part *a*. In the housing *b* is formed a chamber *w* in communication with a passage *x* leading from the said housing. One side of the chamber *w* is bounded by a flexible diaphragm *y* loaded by a tension spring *z*, and to the diaphragm is connected by a stem *3* a lever *4* carrying a valve *5* which controls a vent *6* in communication with a servo-cylinder *h*. When the liquid pressure acting on the diaphragm *y* exceeds a predetermined amount, the valve *5* is opened. Liquid can then escape from the cylinder *h* and the preponderating liquid pressure then acting on the right hand side of the piston *g* moves the latter to the left for reducing the pump output.

The pump and control means above described are already known, and are described only as an example of a system to which the present invention can be applied, the invention being concerned essentially with the additional control means shown at the left hand side of Figure 1.

In carrying the invention into effect in the manner shown in Figure 1, there are provided in a hollow body part *7* a liquid fuel inlet passage *8* and an outlet passage *9* with an intermediate throat *10*, the liquid being supplied to the passage *9* by the pump and being conducted by the passage *9* to the prime mover. Extending through the throat *10* is arranged an axially slidable throttle *11* having at one end a conical or otherwise suitably shaped end for varying the effective size of the throat *10*. The other end of the throttle has formed on or secured to it a piston *12* slidable in a cylindrical chamber *13* in

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the body part 7, the side of the piston remote from the throttle being loaded by compression springs, 14, 15. The spring 14 is supported at one end by a shoulder in the chamber 13. The other spring 15 serves to transmit motion from the piston 12 to a valve 16 to be hereinafter described.

The cylindrical chamber 13 opens into a compartment 17 which is bounded at one side by one of a pair of flexible and interconnected coaxial diaphragms 18, 19 of different effective areas, these diaphragms being loaded by another spring 20. A passage 21 admits atmospheric or other related pressure from the part 6 above described, to the region between the diaphragms, and a chamber 22 associated with the diaphragm 19 is adapted to receive liquid from the pipe 2 at a pressure related to the speed of the prime mover. The diaphragms 18, 19 are interconnected by an annulus 24.

In the compartment 17 is arranged a duct 25 terminating in a vent 26 with which co-operates the normally-closed valve 16 carried by the diaphragm 18. Motion is transmissible from the spring 15 to this diaphragm and valve by a thrust piece 27 which is gapped so that it extends around the duct 25. The duct 25 communicates with a passage 28 in the part 7 leading to the end of the cylindrical chamber 13 below the piston, which end is also in communication with the liquid fuel inlet 8 through a restricted orifice 29. Further, an axial bore is formed in the throttle 11 and piston 12 and in this bore is contained a slidable valve 30 controlling ports 31 in the throttle whereby both ends of the piston chamber 13 can be put into communication through the said bore. The other end of the valve 30 extends through the throttle and the adjacent portion of the body part, and at its outer end is adapted for attachment to any convenient manually operable actuating means.

The action of the mechanism is as follows: Starting with the throttle 11 in any steady working position, the valve 16 is closed and the valve 30 is open. Liquid can then flow past the valve 30 and through the piston 12 to the passage 32 leading to a sump or to the inlet passage *e* of the pump. To obtain an increased rate of fuel supply the driver moves the valve 30 to any desired extent for closing the ports 31. The fuel pressure acting on the piston 12 then increases and causes the extent of opening of the throttle 10 to be increased. The increase of opening is, however, restricted (at least in part) by the consequent opening of the valve 16 under the action of the spring 14, which acts in opposition to the pressures acting on the diaphragms 18, 19. But if the liquid pressure corresponding to increased engine speed should increase sufficiently to hold the valve 16 closed, the movement of the throttle is not arrested until the ports 31 are again opened by continued movement of the throttle relatively to the valve 30. It will be seen that the rate of increase of the opening of the throttle is dependent only on the rate of movement of the piston 12, and is independent of the rate at which the driver moves the valve 30 from one position to another. The extent of movement is controlled by the valve 30.

The modification shown in Figure 2, is essentially similar in principle to the mechanism above described and differs mainly in certain details of arrangement. At one end of the body part 7' is provided a cylindrical chamber 13' which contains the piston 12' and compression spring 14'. The throttle 11 extends from the

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piston through a throat 10' lying between the liquid fuel inlet passage 8' and outlet passage 9'. The inlet 8 communicates with one end of the chamber 13', and liquid can pass to the other end of the chamber through a restricted orifice 29' in the piston. From the throttle extends a stem 34, and through the piston, throttle, and a part of the stem is formed an axial passage leading to ports 31'. The manually operable valve 30' controls the inlet to this passage.

The end of the stem 34 remote from the piston 12' is connected to the diaphragm 18' by means of a tension spring 35. The two diaphragms 18', 19' (which are of different effective areas) are interconnected by an intermediate piece 24', and the diaphragm 19' is provided with a gapped yoke piece 27' which carries the normally-open valve 16'. Also this diaphragm is connected to the body part by a tension spring 36. The valve 16' co-operates with a vent 26' on a duct 25' which extends between the sides of the yoke piece 27', and this duct communicates with the ports 31' in the stem 34 by way of a passage 28' in the body part. If desired the passage 28' may be further controlled by a normally-open valve 37 which can be actuated by any convenient means responsive to, for example, exhaust gas, or combustion chamber, temperature. In the example shown, the said means comprises a solenoid 38 operable by current derived from a thermo-couple in the hot region.

Liquid under pressure related to the speed of the pump acts on the diaphragm 18' and is led to this diaphragm from the pump through the passage *x*. The region above the diaphragm 19' communicates with a sump or the pump inlet through a passage 32'. Air at atmospheric or other pressure is led to the region between the diaphragm through a passage 21'.

The other parts of Figure 2 not particularly mentioned correspond substantially to those of Figure 1 and bear corresponding, but primed, reference numerals.

The mode of action is as follows:

With the throttle in a steady working position, the valve 16 is open (as is also the valve 37 when this is provided), and the valve 30 is closed. To obtain an increased rate of fuel supply the driver opens the valve 30 to any desired extent. Liquid can then escape from the lower part of the cylinder 13 through the ports 31 and past the valve 16, to the outlet 32, and the piston 12 will move against the spring 14 and under the pressure of the liquid at its upper side, for increasing the throttle opening. As a consequence of this movement, the spring 35 will tend to close the valve 16, in opposition to the pressures acting on the diaphragms 18, 19, and so arrest continued movement of the piston. But if the liquid pressure related to the speed of the pump rises sufficiently rapidly to prevent closing of the valve 16, the piston will continue to move until the flow through the ports 31 is arrested by contact of the piston with the valve 30. As in the example above described the rate of movement of the throttle from one position to another is independent of the rate at which the driver moves the valve 30, the extent of movement being controlled by the valve 30.

The invention is not, however, restricted to the examples above described, as subordinate details of construction or arrangement may be varied to suit different requirements. Further, it is to be understood that the term diaphragm used in the foregoing description is intended to include an

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equivalent piston slidable in a cylindrical chamber.

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

1. A liquid-operated servo-mechanism comprising in combination a chamber, a liquid inlet communicating with said chamber, a member arranged in said chamber and movable by liquid under pressure admitted to said chamber through said inlet, a manually operable valve movable relatively to and arranged to co-operate with said member for determining the extent of movement of said member, a second valve for controlling the rate of movement of said member, means for moving said second valve in one direction under the action of said member, and means responsive to fluid pressure for moving said second valve in the opposite direction.

2. A liquid-operated servo-mechanism comprising in combination a cylinder, a liquid inlet communicating with one end of said cylinder, a piston arranged in said cylinder and movable by liquid under pressure admitted to said cylinder through said inlet, a spring acting on said piston in the direction for opposing movement thereof by liquid under pressure, a fluid outlet passage extending through said piston, a manually operable valve movable relatively to and arranged to co-operate with said piston for controlling liquid flow through said passage and thereby determining the extent of movement of said piston, a second valve for controlling the rate of movement of said piston, means for moving said second valve in one direction under the action of said piston, and means responsive to fluid pressure for moving said second valve in the opposite direction.

3. A liquid-operated servo-mechanism comprising in combination a chamber, a liquid inlet communicating with said chamber, a member arranged in said chamber and movable by liquid under pressure admitted to said chamber through said inlet, a manually operable valve movable relatively to and arranged to co-operate with said

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member for determining the extent of movement of said member, a second valve for controlling the rate of movement of said member, a spring through the medium of which said second valve is movable in one direction by said member, and at least one diaphragm operatively connected to said second valve and responsive to fluid pressure for moving said second valve in the opposite direction.

4. A liquid-operated servo-mechanism comprising in combination a cylinder, a liquid inlet communicating with one end of said cylinder, a piston arranged in said cylinder and movable by liquid under pressure admitted to said cylinder through said inlet, a spring acting on said piston in the direction for opposing movement thereof by liquid under pressure, a fluid outlet passage extending through said piston, a manually operable valve movable relatively to and arranged to co-operate with said piston for controlling liquid flow through said passage and thereby determining the extent of movement of said piston, a second valve for controlling liquid flow from said cylinder and thereby controlling the rate of movement of said piston, a spring through the medium of which said second valve is movable in one direction by said piston, and at least one diaphragm operatively connected to said second valve and responsive to fluid pressure for moving said second valve in the opposite direction.

5. A liquid-operated servo-mechanism as claimed in claim 1, and having a temperature-responsive valve arranged to control liquid flow from said chamber to said second valve.

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