Oct. 23, 1951 J. J. RIGHTON 2,572,390

FLUID-OPERATED SERVO MECHANISM

Filed March 14, 1950

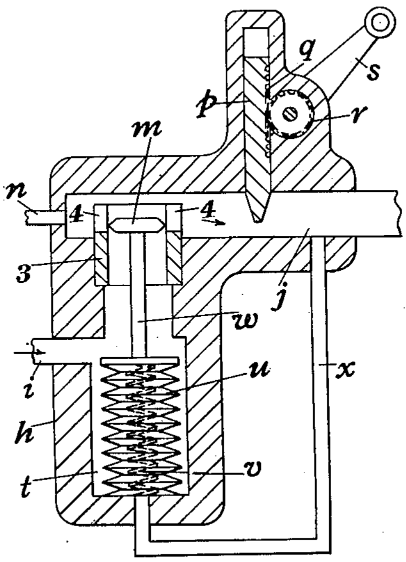

Fig.2

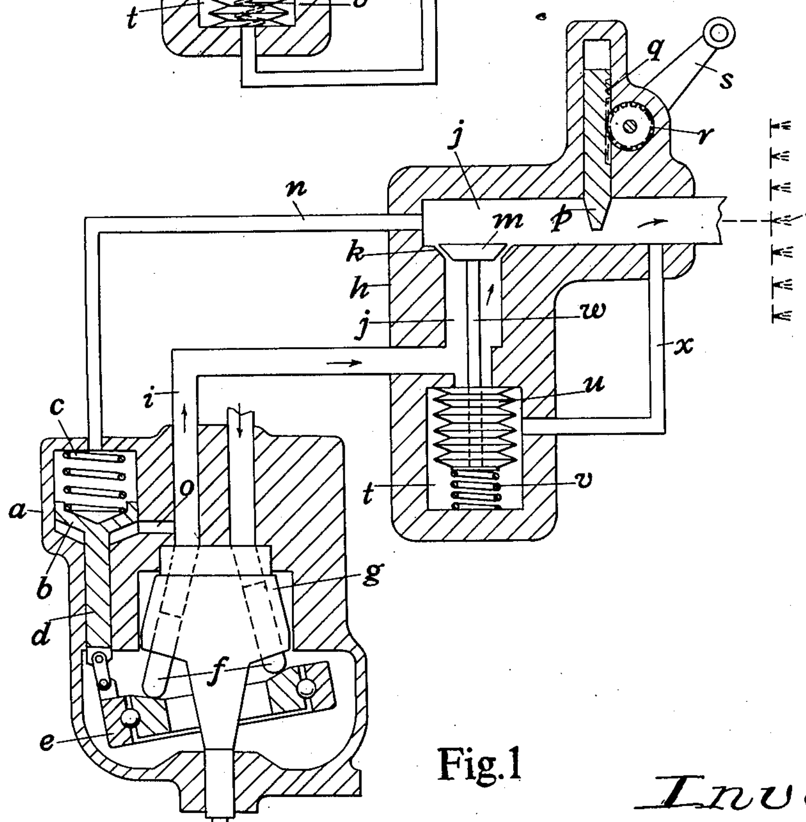

Fig.1

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Patented Oct. 23, 1951 2,572,390

UNITED STATES PATENT OFFICE

2,572,390

FLUID-OPERATED SERVO MECHANISM

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Application March 14, 1950, Serial No. 149,495
In Great Britain March 23, 1949

4 Claims. (Cl. 121—38)

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This invention relates to fluid-operated servo-mechanisms of the type in which a spring-loaded piston is slidable in a cylinder, and is responsive to the difference of fluid-pressure acting on the opposite sides of the piston.

The object of the invention is to provide improved means for controlling the action of a servo-mechanism of the said type.

The invention comprises the combination of a valve adapted to set up a pressure difference in a fluid flowing in a duct, the regions at the opposite sides of the valve being adapted to be connected to the opposite ends of the servo-cylinder, an adjustable throttle through which the said fluid can flow after passing through the valve, and means responsive to the pressure difference across the throttle for actuating the valve.

In the accompanying drawings:

Figures 1 and 2 illustrate diagrammatically two embodiments of the invention.

A servo-mechanism of the type aforesaid can be employed for a variety of purposes. In particular it can be used as shown in Figure 1 for regulating the output of a variable-delivery pump employed for supplying liquid fuel to a prime mover or a furnace, or for actuating any device for regulating the rate of supply of fuel. For such, or any other analogous use, the servo-mechanism comprises a cylinder *a*, a piston *b* slidable in the cylinder, and a spring *c* acting on one side of the piston, and a rod *d* extending from the piston through one end of the cylinder. In the example shown the said rod serves to impart movement to an angularly adjustable swash plate *e* with which co-operate the outer ends of plungers *f* carried by a rotary pump body *g*.

In carrying the invention into effect as shown in Figure 1 there is provided a hollow body part *h* adapted to be connected to a liquid fuel delivery pipe *i* connected to the pump, and having therein a passage *j* through which the fluid can flow. The passage includes a seating *k* for a poppet-type valve *m*, and at the delivery side of the valve is provided a passage or pipe *n* leading to one end of the servo-cylinder. The other end of this cylinder is in communication with the delivery passage of the pump by way of a passage *o*.

Between the valve *m* and the outlet end of the passage *j* is provided a slidable throttle *p*, the latter being movable by any appropriate manually or automatically actuated means such as a rack *q*, pinion *r* and lever *s*. Alternatively it may be responsive to the fluid pressure in any part of the associated system, or to a thermostat, or a barometric device or a centrifugal governor.

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In association with the valve *m* there is provided in the body part *h* a chamber *t* containing a deformable capsule *u* which is loaded by a spring *v* and which at one end is open to the inlet side of the valve, the valve being connected to the closed end of the capsule by a stem *w*. Also the said chamber *t* is in communication (by way of a branch passage *x*) with the part of the main passage *j* through which the fluid flows after it has passed the throttle *p*. Alternatively the capsule and spring may be arranged as shown in Figure 2, where the pressure of the liquid in the passage *i* acts upon the exterior of the capsule, and the pressure of the liquid in the passage *x* acts on the interior.

In the example shown in Figure 1, the fluid is a liquid fuel required to be supplied to a burner indicated by *z*.

The arrangement is such that the valve *m* serves to set up a fluid pressure difference in the two regions at the opposite sides of the valve, which regions are in communication with the ends of the servo-cylinder. The fluid pressure in the anterior region also acts on the capsule and balances the fluid pressure acting on the anterior side of the valve. The fluid pressure in the posterior region is variable under the control of the throttle *p*, as is also the pressure in the chamber *t* containing the capsule.

As already indicated, the servo-mechanism is responsive to the difference of fluid pressure at the opposite sides of the valve *m*. When this pressure difference is relatively large (as when the valve is closed or partially closed) the pressure acting on the side of the piston remote from the spring in the servo-cylinder, will move the piston in opposition to the spring and so effect a reduction of the fluid flow in the system. On the other hand when the pressure difference is relatively low (as when the valve is fully open) the spring will move the piston in the opposite direction for increasing the flow in the system. The extent of opening of the valve *m* depends on the pressure difference across the throttle *p* which is variable as above indicated. Thus, as the pressure difference across the throttle *p* varies with the position of the throttle, the fluid pressure acting on the capsule *u* also varies correspondingly, and determines the position of the valve *m* for any given setting of the throttle. Consequently, the extent of opening of the valve *m*, and the pressure difference across it, also vary with the position of the throttle *p*, and as the position of the piston *b* depends on the pressure difference across the valve, it follows that the output of the pump is variable in response to variation in the throttle setting. With any given open position of the throttle *p* the fuel flow to the burner *z* can be maintained constant. By opening the throttle *p* wider, the pressure difference across the throttle is reduced, causing the fluid pressure acting on the capsule *u* to be increased. Consequently the valve *m* is opened further, and the pressure difference across it is correspondingly reduced, with the result that the fluid pressure supplementing the action of the spring *c* on the piston *b* is increased, and the latter is moved in the direction for increasing the pump output until a new condition of equilibrium is reached. By moving the throttle *p* to restrict the fluid flow through the passage *j*, the pressure difference across the throttle *p* is increased, causing the fluid pressure acting on the capsule *u* to be reduced. Consequently the valve *m* is moved towards its closed position, and the pressure difference across it is correspondingly increased, with the result that the fluid pressure supplementing the action of the spring *c* on the piston *b* is reduced, and the latter is moved in the direction for reducing the pump output until a new condition of equilibrium is reached. It will be seen, therefore that the pump delivers more fuel with increased opening of the throttle *p*, and less fuel when the throttle is moved in the opposite direction.

Instead of the poppet-type valve shown in Figure 1, a piston-type valve may be used as shown in Figure 2. In this case the valve head *m* is contained in a cylindrical and open-ended part **3** having therein lateral ports **4**. It is convenient though not essential to shape the valve head as shown, so that it presents a sharp peripheral edge to the inner surface of the part **3**, but a plain cylindrical head could be used. The effective area of the ports **4** is dependent on the position of the head *m* which is variable in the same way as the valve *m* shown in Figure 1. Further, in this figure there is shown the alternative arrangement of capsule and spring above mentioned.

By this invention, the control of a servo-mechanism for regulating the rate of flow of liquid fuel in a system can be effected in a very simple

and convenient manner. The invention may, however, be applied to servo-mechanisms for other analogous uses, and subordinate details of construction or arrangement of the means constituting the invention 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. Mechanism comprising the combination with a servo-cylinder, a servo-piston slidable in the cylinder under fluid pressure, and a loading spring whereby the piston is movable in one direction, of a duct through which fluid under pressure can flow, a valve arranged in said duct to create a pressure difference in the fluid flowing therethrough, a passage for conducting pressure fluid from the duct at the outlet side of the valve to the end of the cylinder away from which the piston is movable by its loading spring, another passage for conducting pressure fluid from the duct at the inlet side of the valve to the other end of the cylinder, an adjustable throttle arranged to control the flow of fluid through the duct at the outlet side of the valve, and means responsive to the pressure difference across the throttle for actuating the valve.

2. In means as claimed in claim 1, the combination with a body part containing the valve, of a chamber, a deformable capsule and spring contained in the said chamber, the capsule forming the means responsive to the pressure difference across the throttle, and means interconnecting the capsule and valve.

3. Means as claimed in claim 1, in which the valve is of the poppet-type.

4. Means as claimed in claim 1, in which the valve is of the piston-type.

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