Dec. 17, 1940. A. F. SCHWENDNER 2,225,321

GOVERNING APPARATUS

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FIG. 1.

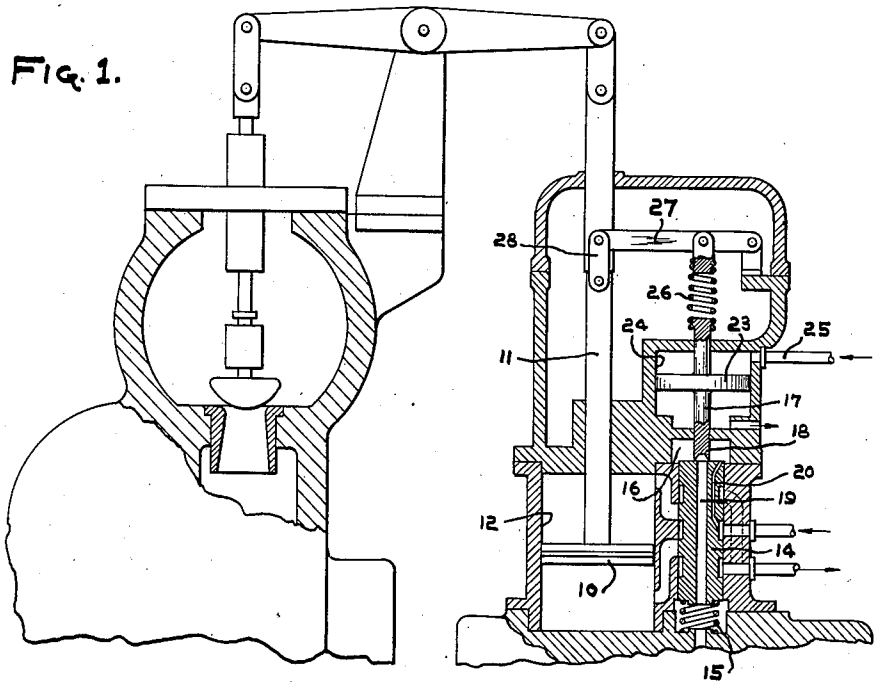
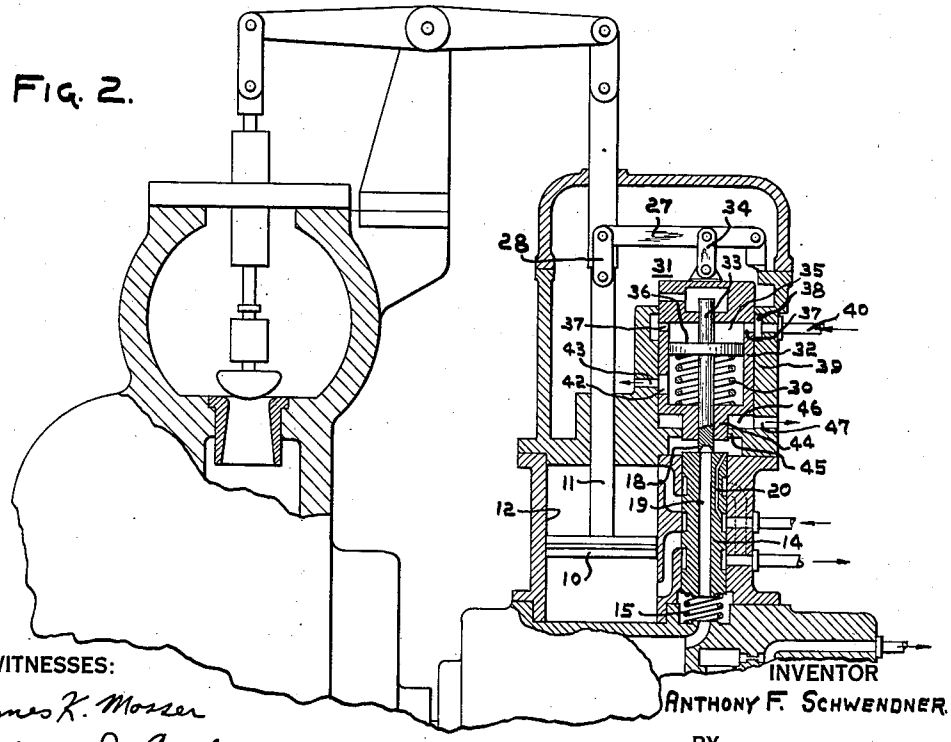


FIG. 2.



WITNESSES:

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GOVERNING APPARATUS

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2 Claims. (Cl. 121—41)

My invention relates to servo-motors of the pressure-responsive type and it has for an object to provide apparatus of this character which operates with little, if any, hunting.

A servo-motor ordinarily includes an operating piston arranged in an operating cylinder, a pilot valve or relay for controlling the admission and exhaust of motive fluid to the operating cylinder, means for operating the pilot valve to cause movement of the operating piston, and follow-up mechanism operated by the operating piston to restore the pilot valve to its normal or neutral position. Where the pilot valve or relay is moved by a controlling force derived from a controlling pressure by means of a piston or abutment area, the latter may be conveniently arranged as an element of a simple linkage between the follow-up mechanism and the pilot or piston valve, in which case, it is also necessary that the linkage shall include a spring providing for relative displacement of the pilot valve and the operating piston so that the pilot or piston valve may be restored to neutral position for all positions of the operating piston. The spring permits of pilot valve movement when the controlling pressure changes incident to load change and then the operating piston moves and causes change in the spring force until the latter balances the fluid pressure force at the new load condition and with the piston or pilot valve restored to neutral position. With a spring arranged in this way, the slightest friction sets up oscillatory motion of the operating piston. In accordance with the present invention, this oscillatory motion of the operating piston or hunting difficulty is overcome by a different location of the spring. Instead of having the spring arranged as a link in series with the pressure-responsive element between the follow-up lever and the pilot or piston valve, the pressure-responsive device for the pilot valve is connected by an inelastic link to the follow-up lever and it includes telescopic members with the spring arranged therebetween and arranged to exert force thereon in opposition to the controlling fluid pressure force. With this arrangement, the only effect of sticking or friction is to vary the extent of initial relative movement of the telescopic members, that is, such friction or sticking only prevents the telescopic member moved by change in force of fluid pressure from assuming its proper position in relation to such pressure and the scale of the spring; however, irrespective of the position taken by such telescopic member, the operating piston will travel only an amount required to move the other telescopic member the same distance but in the opposite direction as the first telescopic member was moved. Thus, by avoiding the use of a spring arranged as a direct-connecting link between the follow-up lever on the one hand and the member moved in response to controlling pressure on the other, a resonant on hunting relation is avoided.

A further object of my invention is to provide a servo-motor with a link between the follow-up lever and the relay or piston valve thereof, the link including a pressure-responsive device comprising inner and outer members with a spring between the members and arranged so that its force acts on the members in opposition to the force of controlling fluid pressure exerted thereon.

These and other objects are effected by my invention as will be apparent from the following description and claims taken in connection with the accompanying drawing forming a part of this application, in which:

Fig. 1 is a diagrammatic view of a prior arrangement; and,

Fig. 2 is a sectional view showing my improved servo-motor.

Referring first to the prior arrangement in order that my improvement may be more clearly understood, in Fig. 1, there is shown a servo-motor including an operating piston 10 connected to the usual rod 11, the piston being arranged in an operating cylinder 12. Motive fluid is admitted to and exhausted from the operating cylinder at opposite sides of the operating piston 10 by means of the relay or pilot valve 14. As shown, the pilot valve is moved by the opposed forces of a spring 15 and of fluid pressure in the chamber 16, the fluid pressure in the chamber 16 being modified by a pressure responsive member or element 17. The member 17 is provided with an inverted cup 18 which covers a drain passage 19 in the piston or pilot valve, fluid under pressure being supplied to the chamber 16 through a suitable orifice 20. To avoid reaction from changing oil pressure in the chamber 16 from affecting the sensitivity of the pressure responsive member 17 to pressure responses in the cylinder 24, the area of the cup valve and the area of the stem passing through the seal of the chamber 16 are made equal. Thus, it will be seen that the magnitude of pressure in the chamber 16 depends upon the annular orifice between the edge of the cup valve and the upper end of the relay or pilot valve.

The upper end of the piston or pilot valve 14 has a piston or abutment face exposed to the interior of the chamber 16. If the inverted cup valve is moved, thereby changing the flow area of the annular orifice, it will be apparent that

the pressure in the chamber 16 will change, the arrangement being such that the force of pressure in the chamber 16 acting on the pilot valve and the force of the spring 15 acting thereon causes it to move to follow the motion of the pressure-responsive member 17.

The pressure-responsive device including the pressure-responsive member 17 may be of any suitable type, and, in Fig. 1, the pressure-responsive member 17 is shown as including a piston 23 arranged in a cylinder 24, controlling pressure being supplied by a connection 25 to the space of the cylinder above the piston 23. A spring 26 has its lower end connected to the member 17 and its upper end connected to the follow-up lever 27 having a connection 28 with the rod 11.

With the arrangement shown in Fig. 1, the slightest friction tends to set up a continuous oscillatory motion of the operating piston, the reason for this being that the pressure abutment 23 and the spring 26 together constitute a link arranged between the follow-up lever 27 and the relay or piston valve 14; and, with this arrangement, not only must the operating piston move sufficient to overcome the frictional resistance and the change in controlling fluid pressure, but, as soon as motion of the pressure-responsive element begins, there is a sudden decrease in frictional resistance with the result that the pilot valve is moved beyond its neutral position, causing the operating piston to reverse its direction and travel until the spring load overcomes the frictional resistance, whereupon the pilot valve again overtravels and the cycle is repeated indefinitely.

In Fig. 2, the aforementioned difficulty, on account of hunting, is avoided by so arranging the scale spring 30 that it is isolated from the follow-up lever 27. To this end, the follow-up lever 27 is connected by means of a telescopic link, at 31 to the relay or piston valve 14, the arrangement preferably including a lower inverted cup valve 18 cooperating with the relay or piston valve 14 to secure operation of the latter in the manner already set forth.

The link, at 31, preferably includes outer and inner telescopic members 32 and 33, the outer member 32 being pivotally connected, at 34, to the follow-up lever 27 and the inner member 33 having its lower end modified to provide the inverted cup 18. A pressure chamber 35 is formed between the outer and inner members 32 and 33 and includes a pressure abutment or piston area 36 on the inner member and disposed so that the force of fluid pressure acting thereon is opposed to the force of the spring 30. Controlling pressure is supplied to the chamber 35 by means of ports 37 extending through the wall of the outer member 32 and connecting with the annular channel 38 formed in the guide 39 for the outer member, the annular channel 38 communicating with a suitable controlling pressure connection 40.

Below the piston 36, the outer member 32 has a port 42 communicating with drain passage 43. As shown, the member 32 has a depending tubular portion 44 telescoping with the stem 33 and extending through the partition wall 45 of the guide structure 39, the tubular portion defining, with the member 39, a drain space 46 communicating with the drain passage 47. Not only are the areas of the stem and the cup valve subject to pressure in the chamber 16 equal, as in Fig. 1, but the annular areas of the tubular portion 44 and of the valve 14 exposed to pressure of that chamber are also equal. Thus, it will be seen that the responsiveness of the apparatus to pressure change is not impaired by differential effects of areas of component parts.

With the improved arrangement shown in Fig. 2, controlling pressure applied to the piston area or abutment 36 moves the inner member 33 downward against the scale spring 30 arranged in the outer member 32; and as the latter member is connected to the follow-up lever 27, the motion of the inner member will move the relay or piston valve 14 down the same amount as the inner member 33 is moved. The piston valve or relay 14 admits oil under the operating piston 10 and the latter will move upward until the follow-up link 27 moves the outer or sleeve member 32 upwardly the same amount as the inner member 33 was moved downwardly. A certain amount of sticking between the inner and outer members of the link, at 31, will only prevent the inner member 33 from assuming its proper position in relation to the control pressure supplied to the chamber 35 and the scale of the spring. To whatever position the inner member 33 is moved, the operating piston 10 will travel only the amount required to move the outer member 32 the same distance but in the opposite direction as the inner member 33 is moved.

While I have shown my invention in but one form, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various changes and modifications without departing from the spirit thereof, and I desire, therefore, that only such limitations shall be placed thereupon as are specifically set forth in the appended claims.

What I claim is:

1. In a servo-motor, an operating cylinder with an operating piston therein, a relay controlling the admission and exhaust of motive fluid to and from the operating cylinder, a follow-up lever connected to the operating piston, first and second members movable relatively to change the over-all length thereof, said members defining a fluid pressure chamber therebetween, a spring arranged between the members and exerting its force thereon in opposition to that exerted by pressure of fluid in said chamber, means for connecting the first member to the follow-up lever, means for causing the relay to follow the motion of the second member, and means for supplying fluid under controlling pressure to said pressure chamber.

2. In a servo-motor, an operating cylinder with an operating piston therein, a relay controlling the admission and exhaust of motive fluid to and from the operating cylinder, a follow-up lever connected to the operating piston, outer and inner telescopic members movable relatively to change the over-all length thereof, a body providing a guide for the outer member, said members defining a fluid pressure chamber therebetween, a spring arranged between the members and exerting its force thereon in opposition to that exerted by pressure fluid in said chamber, means for connecting the outer member to the follow-up lever, means for causing the relay to follow the motion of the inner member, and means including communicating passages formed in said body and in the outer member for supplying fluid under controlling pressure to said chamber.

ANTHONY F. SCHWENDNER.