

Dec. 23, 1958

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2,865,397

HYDRAULIC GOVERNOR

Filed Oct. 6, 1954

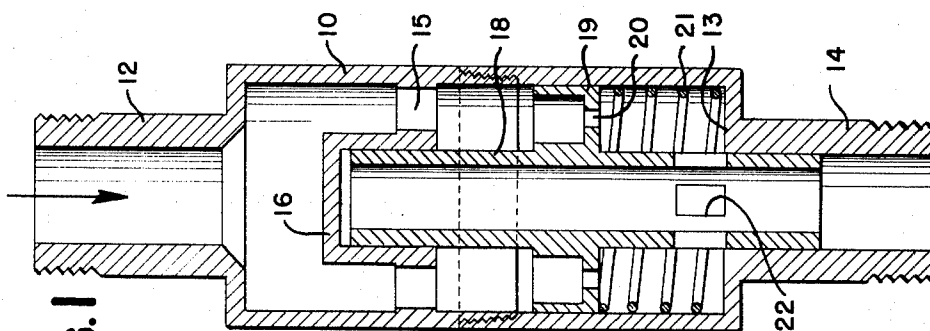


FIG. 1

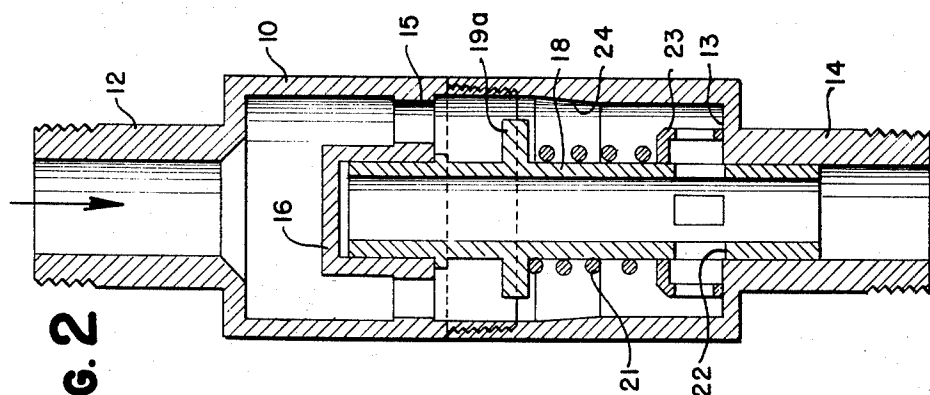


FIG. 2

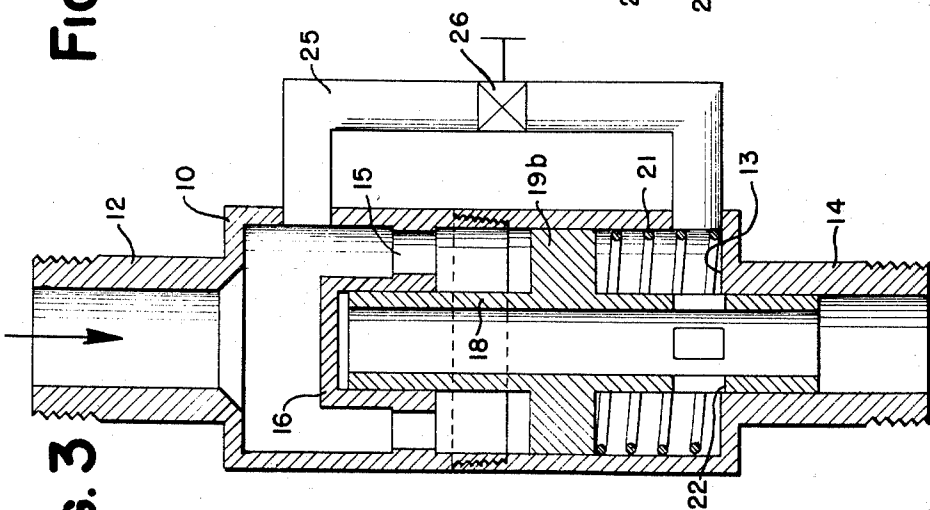


FIG. 3

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HYDRAULIC GOVERNOR

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Application October 6, 1954, Serial No. 460,729

3 Claims. (Cl. 137—504)

This invention relates to improved hydraulic governors for regulating flow of fluids.

Although not thus limited, the first two embodiments of my invention are specially suited for use with hydraulically operated subsurface pumps, such as those shown in my earlier Patents No. 2,191,369, dated February 20, 1940, and No. 2,679,806, dated June 1, 1954. In this type of pump the load on the hydraulic motor may drop suddenly, as when gas instead of liquid enters the pump intake, or if the connecting rod between the motor and pump breaks. Sudden loss of load tends to allow the motor to race and thereby damage itself. To overcome this tendency it is known to include a governor in the hydraulic circuit to the motor. If the rate of flow increases substantially the governor restricts the fluid passage and thus throttles the motor. However, previous governors with which I am familiar have not been altogether satisfactory. My observation has been that forces within such governors do not return to equilibrium after the position of the parts changes from that of normal operation. Consequently any change of position creates a continuing unbalance which causes hunting or chattering and interferes with proper operation of both the governor and the motor. Previous efforts to remedy such difficulties have produced unduly complex mechanisms. Simplicity of design is important, inasmuch as space available for a governor is severely limited and the parts must be of compact size.

An object of my invention is to provide improved governors which are of simplified mechanical design and yet are free of any tendency to hunt or chatter.

A further object is to provide improved governors in which the internal forces immediately assume a balance after a change in position of the parts.

A more specific object is to provide improved governors which include a flange subject to variable pressure differentials on its upstream and downstream sides and in which all other moving parts are subject to balanced pressures on the downstream side of the flange.

In accomplishing these and other objects of the invention, I have provided improved details of structure, preferred forms of which are shown in the accompanying drawing, in which:

Figure 1 is a longitudinal sectional view of a governor constructed in accordance with one embodiment of my invention;

Figure 2 is a longitudinal sectional view of a modification; and

Figure 3 is a longitudinal sectional view of another modification.

Figure 1 shows an embodiment of governor in accordance with the present invention which can be installed, for example, on either the inlet or discharge side of the motor of a hydraulically operated subsurface pump. The governor includes a cylindrical case 10 preferably formed of two threadedly connected sections to facilitate assembly. The upper end of the case carries an inlet 12. The lower end forms an internal shoulder 13 and it

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carries an outlet tube 14. A spider 15 is fixed within the case 10 intermediate its length and fixedly carries a cylinder 16, which is closed on the end facing the inlet 12 and open on the end facing the outlet 14. The cross sectional areas of the bores in the outlet tube 14 and cylinder 16 are equal.

A tubular valve member 18 is mounted within the case 10 and is shiftable axially thereof. The upper and lower end portions of this valve member are closely received in the cylinder 16 and outlet tube 14 respectively. The two annular end faces of the valve member have equal areas. Intermediate its length the valve member carries a flange 19, which preferably is integral therewith and contains a plurality of restricted orifices 20. A compression spring 21 encircles the valve member below the flange 19 and bears against this flange and the shoulder 13. The lower portion of the valve member adjacent the shoulder 13 contains a plurality of radial ports 22, preferably of rectangular outline. In this embodiment the flange 19 preferably fits closely within the case 10, whereby substantially all flow therepast is via the orifices 20.

In operation, hydraulic fluid enters the governor via the inlet 12, flows past the spider 15, through the orifices 20 and ports 22, and into the bore of the valve member 18, and discharges via the outlet tube 14. In accordance with known hydraulics principles, pressure on the fluid drops as the fluid passes the restricted orifices 20. Consequently the upper face of flange 19 is subject to a greater pressure than the lower face. The spring 21 opposes this pressure difference, and as long as the fluid velocity through the orifices remains constant, the position of the valve member 18 remains unchanged. An increase in the fluid velocity increases the pressure drop across the orifices proportionately to the square of the velocity increase. The magnitude of the pressure differential on opposite sides of flange 19 becomes greater, whereupon the valve member 18 moves downwardly against the action of the spring 21. The lower portions of the ports 22 pass below the shoulder 13, whereby these ports are partially blocked by the wall of the outlet tube 14. Thus the flow of fluid through the governor automatically is maintained at a nearly constant value. The reverse of this action takes place if velocity through the orifices returns to normal. The regulating action requires only a relatively short movement of the valve member 18; hence the force of the spring 21 remains substantially constant throughout the operating range.

Figure 2 shows a modification which is especially suited for very small installations where it would be difficult to form orifices of the proper size in the flange. In this modification the flange 19a is solid, but its circumferential edge is spaced from the inside face of the case 10. The space between the flange and case is in effect an annular orifice. A spring support 23 rests on the shoulder 13, and the lower end of the spring 21 bears against this support. Thus the spring is removed from the path of flow through the governor. The length of the spring is shortened to an extent that compression therein resulting when the valve member 18 moves downwardly increases the upward force which the spring exerts on the valve member. To compensate, the bore of the case has a downwardly tapered section 24 below the flange 19a. As the valve member 18 moves downwardly, the orifice opening in effect decreases, whereby there is a corresponding increase in the pressure differential between opposite faces of the flange.

Figure 3 shows a modification which is especially suited for larger installations where compactness is less essential. In this modification the flange 19b is solid and fits closely within the case 10. The restricted orifice is located in a by-pass pipe 25 which is connected into opposite end

portions of the case 10. Preferably the orifice is in the form of an adjustable valve 26. This modification is useful, for example, where a central power installation is used to drive several hydraulically operated pumps in different wells. Governors of this type can be placed in the lines to the respective pumps to hold the operation of each to a constant speed under normal conditions.

In each embodiment of my invention, the cylinder 16 seals the upper end of the valve member 18 from pressure on the upstream side of the flange 19, 19a or 19b. Instead the bore through the valve member transmits pressure from the downstream side of the flange and ports 22 to the upper end. This same downstream pressure of course acts directly on the lower end of the valve member. Since the areas of the two ends are equal and the pressures act in opposite directions, the resultant force on the valve member is zero. Fluid discharges from the ports 22 at right angles to the direction of travel of the valve member so that there are no dynamic forces acting on this member. The only forces which tend to move the valve member are those which result from pressure differences on opposite sides of the flange 19, 19a or 19b and from the spring 21. No part of the valve member is subjected to unwanted secondary pressure changes which prevent its achieving equilibrium.

While three embodiments of my invention have been shown and described, it will be apparent that other adaptations and modifications may be made without departing from the scope of the following claims.

I claim:

1. A hydraulic governor comprising a case having an inlet at one end and an outlet tube extending from the other end, a cylinder supported within said case and being closed toward said inlet and open toward said outlet tube, the bores of said outlet tube and said cylinder having equal cross-sectional areas, a tubular valve member mounted within said case for axial movement and having its upper and lower end portions received in said cylinder and said outlet tube respectively, the two ends of said valve member having equal areas, a flange carried by said valve member intermediate its length and having its circumferential edge spaced from the inside of said case to form an annular orifice, said orifice providing a path for flow of fluid between the portion of said case on the inlet side of said flange and that on the outlet side thereof to subject opposite sides of said flange to different pressures, and a spring bearing against said flange on the outlet side to oppose pressure differences, said valve member having radially directed ports adjacent said outlet tube adapted to be partially blocked thereby, said ports being adapted to discharge fluid at right angles to the direction of movement of said valve member to avoid dynamic forces on this member, the inner face of said case tapering toward said outlet tube opposite the working range of said flange to diminish the orifice area as said valve member moves toward its closed position and thereby increase the pressure differential to compensate for the increase in force which said spring exerts as it is compressed.

2. A hydraulic governor comprising a case having an inlet at one end, and an internal shoulder and an outlet tube at the other end, a cylinder supported within said case and being closed toward said inlet and open toward said outlet tube, the bores of said outlet tube and said cylinder having equal cross-sectional areas, a tubular valve member mounted within said case for axial movement and having its upper and lower end portions closely received

in said cylinder and said outlet tube respectively, the two ends of said valve member having equal areas, a flange carried by said valve member intermediate its length and having its circumferential edge spaced from the inside of said case to form an annular orifice, said orifice providing a path for flow of fluid between the portion of said case on the inlet side of said flange and that on the outlet side thereof to subject opposite sides of said flange to different pressures, and a spring bearing against said shoulder and said flange on the outlet side thereof to oppose the pressure difference, said valve member having radially directed ports adjacent said shoulder adapted to be partially blocked by the wall of said outlet tube, said ports being adapted to discharge fluid at right angles to the direction of movement of said valve member to avoid dynamic forces on this member, the inner face of said case tapering toward said outlet tube opposite the working range of said flange to diminish the orifice area as said valve member moves toward its closed position and thereby increase the pressure differential to compensate for the increase in force which said spring exerts as it is compressed.

3. A hydraulic governor comprising a case having an inlet at one end and an internal shoulder and an outlet tube at the other end, a cylinder supported within said case and being closed toward said inlet and open toward said outlet tube, the bores of said outlet tube and said cylinder having equal cross-sectional areas, a tubular valve member mounted within said case for axial movement and having its upper and lower end portions closely received in said cylinder and said outlet tube respectively, the two ends of said valve member having equal areas, a flange carried by said valve member intermediate its length and having its circumferential edge spaced from the inside of said case to form an annular orifice, said orifice providing a path for flow of fluid between the portion of said case on the inlet side of said flange and that on the outlet side thereof to subject opposite sides of said flange to different pressures, a spring support resting against said shoulder and extending upwardly therefrom, and a compression spring bearing against said support and said flange on the outlet side thereof to oppose the pressure difference, said valve member having radially directed ports adjacent said shoulder adapted to be partially blocked by the wall of said outlet tube, said ports being adapted to discharge fluid at right angles to the direction of movement of said valve member to avoid dynamic forces on this member, said support maintaining said spring out of the path of fluid flow, the inner face of said case tapering toward said outlet tube opposite the working range of said flange to diminish the orifice area as said valve member moves toward its closed position and thereby increase the pressure differential to compensate for the increase in force which said spring exerts as it is compressed.

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