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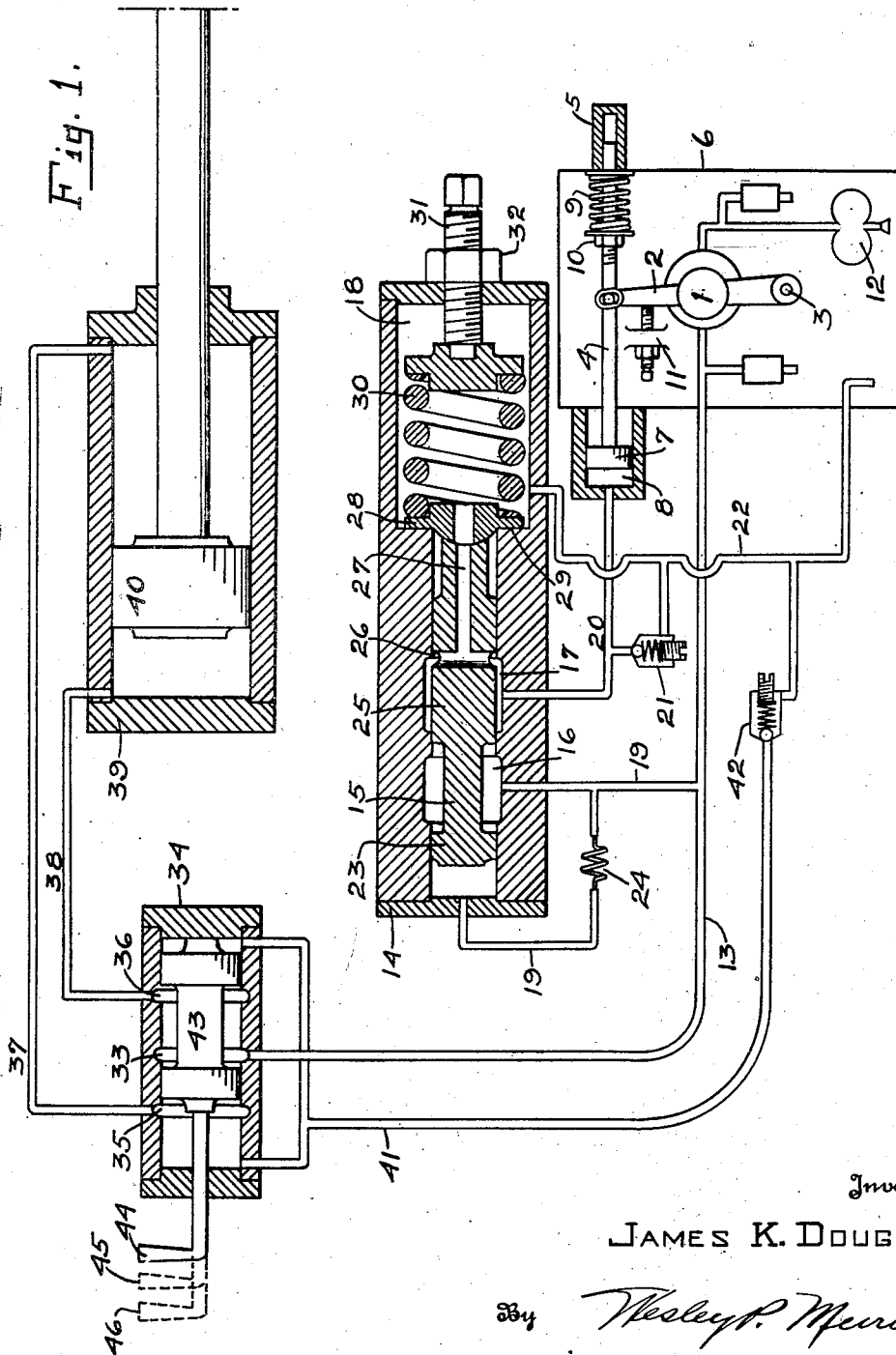
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2,009,608

PUMP CONTROL

Filed June 27, 1931

2 Sheets-Sheet 1



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Fig. 2.

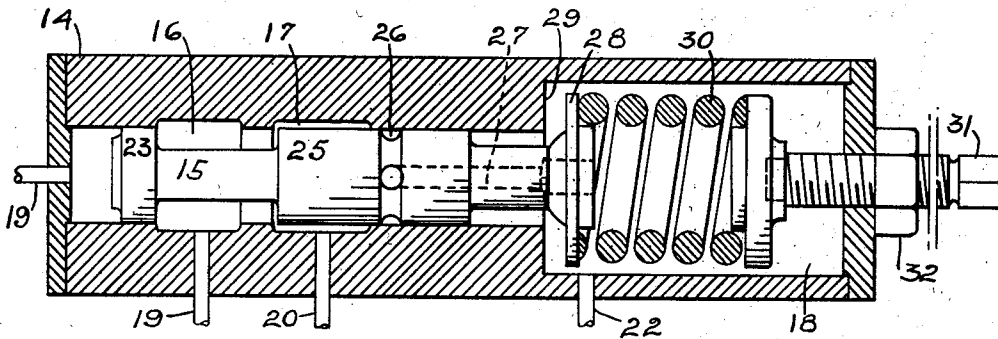
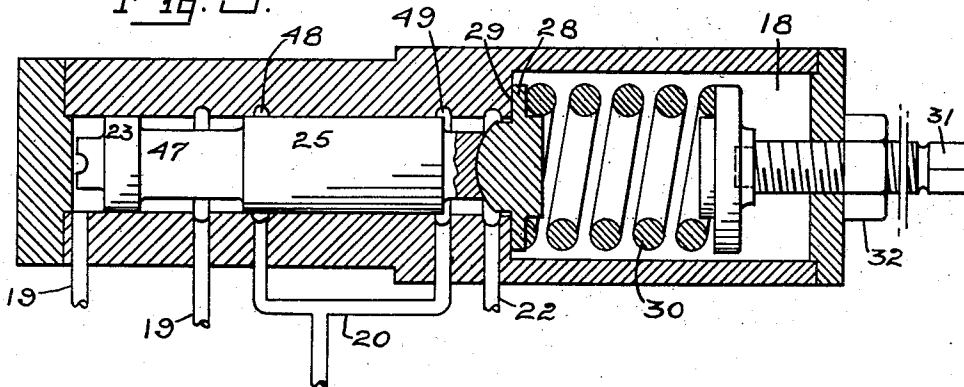


Fig. 3.



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PUMP CONTROL

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11 Claims. (Cl. 103—38)

This invention relates to controls for variable displacement pumps.

The pump control to which the invention applies in particular enables a variable displacement pump to function as either a variable delivery pump or a constant delivery pump until the pressure created thereby reaches a predetermined maximum and to then function as a substantially constant pressure pump.

A pump control of this character ordinarily has a spring for urging the stroke changing mechanism of the pump toward full stroke position and a fluid motor acting in opposition to the spring to move the stroke changing mechanism toward zero stroke position, such as the pump control disclosed in Patent No. 1,578,233 issued March 23, 1926 to Walter Ferris.

The stroke control motor was ordinarily open at all times to pump pressure and the spring had to have its tension so adjusted that it would hold the stroke changing mechanism stationary until the pressure created by the pump exceeded a predetermined maximum and then yield to allow the motor to reduce the stroke of the pump. However, as the resistance of a spring increases as it is deflected, pressure in excess of the predetermined maximum was required to compress the spring sufficiently to reduce the pump stroke to substantially zero.

As the maximum pump pressure is often high, for instance 1500# per sq. in., and as the resistance increase in a spring varies inversely according to its length, a small diameter control motor and a long flexible spring were employed but, in practice, it was found that the pump pressure sometimes rose as much as 400# above the desired maximum pressure before the stroke of the pump was reduced sufficiently to hold the pump pressure constant.

The invention is applicable to various types of pumps but, for the purpose of illustration, it will be described herein in connection with a radial pump such as that disclosed in Patent No. 1,578,233.

That pump has a circular actuator or driver which is driven from an external source of power and rotates on a stationary axis to rotate a cylinder barrel having a number of radial cylinders formed therein. The cylinder barrel is journaled upon a shaft or pintle which is rigidly secured in an arm or pendulum and normally held out of axial alignment with the driver by a spring, the spring being opposed by a hydraulic control motor which is open at all times to pump pressure and tends to move the pintle into axial alignment

with the driver. The cylinders have pistons fitted therein which are reciprocated by the driver whenever the axis of the pintle is out of alignment with the axis of the driver, and the pintle has an intake port and passageway for the delivery of liquid to the cylinders and a discharge port and passageway for the discharge of liquid from the cylinders.

Each cylinder communicates with the intake and discharge ports alternately during rotation of the cylinder barrel and, as the cylinders move from the one side of the pintle to the other side thereof, the pressure existing in the high pressure port acts successively on the pistons, and intermittent forces called bridge reactions are created which tend to move the pintle laterally. The pump is ordinarily so constructed that the lateral components of all these forces tend to move the pintle toward zero stroke position.

Consequently, both these intermittent pintle forces and the force exerted by the stroke control motor must be resisted by the stroke control spring until the pump pressure reaches the predetermined maximum. Further, the pintle forces vary as the pintle moves toward zero stroke position which makes it still more difficult to control the maximum pump pressure with any degree of accuracy.

An object of the invention is to provide a pump control which will cause a variable displacement pump to deliver fluid at predetermined volumes until a predetermined pressure had been exceeded and thereafter adjust the pump displacement to hold that pressure constant.

Another object is to provide a control of this character which is susceptible of close adjustment.

Another object is to provide a pump control which is unaffected by variation in the internal forces created within the pump.

Another object is to provide a pump control which is unaffected by variations in spring resistance.

Another object is to operate the stroke control motor at pressures below pump pressure.

Another object is to provide a pump control which may be adjusted during operation of the pump to regulate the pressure created by the pump.

Another object is to provide a control which will cause the pump to respond instantly to adjustment of the control.

Another object is to provide a pump control which may be accurately adjusted by turning a single screw.

Another object is to provide a pump control which is compact and efficient.

Another object is to provide a control of this character with a free return resistance valve for controlling the delivery of fluid to the stroke changing mechanism of the pump.

According to the invention in its principal aspect, the stroke control motor is free from pump pressure until pump pressure reaches a predetermined maximum and then fluid is delivered under pressure to the motor to operate it.

According to another aspect of the invention, fluid is delivered to the control motor at a pressure below pump pressure.

The invention further provides a free return resistance valve which is interposed between the control motor and the outlet of the pump and prevents pressure fluid from reaching this motor until pump pressure has reached a predetermined maximum.

The invention is illustrated in the accompanying drawings in which the views are as follows:

Fig. 1 is a schematic drawing showing a variable displacement pump connected into a hydraulic circuit and provided with a control in which the invention is embodied.

Fig. 2 is a central longitudinal section through the free return resistance valve shown in Fig. 1.

Fig. 3 is a central longitudinal section through a modified form of free return resistance valve.

The invention is shown applied to a variable displacement pump 1 which is not illustrated nor described in detail herein as it is substantially the same as the pump shown in Patent No. 1,578,233 except for the stroke changing mechanism employed.

The stroke or displacement of the pump 1 is varied by moving the upper end of its pendulum 2, the lower end of which is journaled upon a stationary shaft 3. The upper end of the pendulum 2 is pivoted to a control rod 4 which has one of its ends arranged in a guide 5 carried by the casing 6 of the pump 1 and its other end provided with a piston 7 which is fitted in a cylinder 8 also carried by the pump casing 6. The piston 7 and the cylinder 8 constitute a fluid motor for reducing the stroke of the pump upon the pump pressure exceeding a predetermined maximum.

The rod 4 has a helical compression spring 9 arranged thereon between a wall of the casing 6 and a nut 10 which is threaded upon the rod 4 and adjustable to vary the initial tension of the spring 9. A pendulum 2 is urged toward full stroke position by the spring 9 which holds it against a stroke adjusting mechanism 11 until the pressure created by the pump reaches a predetermined maximum and then liquid acting upon the piston 7 moves the pendulum 2 toward zero stroke position against the action of the spring 9 until the pump is delivering just sufficient liquid to maintain the predetermined maximum pressure constant.

The stroke adjusting mechanism 11 has been shown as simply a stop screw threaded through a stationary rib and adjustable to vary the stroke of the pump, but stroke adjusting mechanism may be employed which is operable either manually or automatically to vary the stroke of the pump and thus adjust its delivery as desired for all conditions except when the pump pressure exceeds a predetermined maximum, such as the stroke adjusting mechanism shown in Patent No. 1,753,562 issued April 8, 1930 to John P. Ferris.

The pump 1 is supplied with liquid at a low

pressure by a gear pump 12 and discharges its output into a supply pipe 13 from which liquid is supplied to the cylinder 8 through a free return resistance valve 14 whenever the pressure in the supply pipe 13 reaches a predetermined maximum.

The flow of liquid through the valve 14 is controlled by its plunger 15 which controls communication between an inlet chamber 16 and a port 17 and between the port 17 and an exhaust chamber 18.

Liquid is supplied to the valve 14 through a pipe 19 which connects the inlet chamber 16 to the supply pipe 13. When the valve 14 is open, liquid is supplied to the cylinder 8 through a pipe 20, which connects the cylinder 8 to the port 17, and liquid delivered through the pipe 20 in excess of the requirements of the cylinder 8 is exhausted through a low pressure relief valve 21 connected between the pipe 20 and a drain pipe 22 which connects the exhaust chamber 18 with the sump of the pump 1.

The plunger 15 is urged at all times toward open position by liquid acting upon a piston 23 which is arranged upon the end of the plunger and fitted in the left end of the valve casing.

Liquid from the pipe 13 is supplied to the left end of the valve 14 through a branch of the pipe 19 which has a choke coil 24 connected therein to reduce the rate of flow of liquid therethrough.

The port 17 is normally closed to the pipe 19 by a piston 25 which is formed upon the plunger 15 and spaced from the piston 23 so that the pistons 23 and 25 are arranged at opposite ends of the inlet chamber 16 and prevent liquid from escaping therefrom when the plunger 15 is in closed position.

The port 17 is normally open to an annular groove 26 which is formed in the periphery of the piston 25 and connected to the exhaust chamber 18 by a duct 27 which extends through the right end of the plunger 15.

The valve 14 is so arranged that the cylinder 8 and the pipe 20 are kept flooded with liquid at all times but, as the cylinder 8 is normally open to the drain pipe 22, no pressure can be created therein until the plunger 15 is forced to the right to close the port 17 to the groove 26 and open it to the inlet chamber 16. Consequently, the full force of the spring 9 is available for holding the pendulum 2 firmly against the adjusting mechanism 11 and the pump is thereby prevented from vibrating under the influence of the pntle forces.

The liquid supplied to the left end of the valve 14 urges the plunger 15 to the right against a stop plate 28 which is suitably apertured to provide communication between the duct 27 and the exhaust chamber 18 and normally rests against a shoulder 29 formed in the valve casing.

The stop plate 28 may be provided with a convex face to engage a complementary concave face on the plunger 15, and it is urged against the shoulder 29 by a helical compression spring 30 which is arranged within the exhaust chamber 18 between the stop plate 28 and an adjusting screw 31 threaded through the end of the valve casing and held in adjusted position by a lock nut 32.

The liquid in the left end of the valve 14 is always at pump pressure, and the force exerted by this liquid upon the piston 23 is resisted by the spring 30 which is adjusted by the screw 31 to hold the stop plate 28 against its seat until the

pump pressure reaches a predetermined maximum.

For the purpose of illustration, the pump 1 is shown as having its supply pipe 13 connected to a port 33 in a control valve 34 which has two other ports 35 and 36 arranged upon opposite sides of the port 33 and connected, respectively, by pipes 37 and 38 to opposite ends of a hydraulic motor 39 for delivering liquid thereto to reciprocate its piston 40.

Both ends of the control valve 34 are connected to a return pipe 41 which is connected to the drain pipe 22 and may have a low pressure relief valve 42 connected therein for preventing air from entering the valve 34 and the motor 39 and for providing back pressure upon the piston 40.

The flow of liquid through the valve 34 is controlled by its plunger 43 which is provided with a handle 44 for operating it. When the plunger 43 is in the position shown, liquid delivered by the pump 1 will flow from the pipe 13 through the valve 34 and the pipe 38 to the rear end of the motor 39 and advance its piston 40 which will expel liquid from the front end of the motor through the pipe 37 and the valve 34 into the return pipe 41.

If the handle 44 is moved to the position shown in dotted lines at 45, the plunger 43 will block the ports 35 and 36 and the piston 40 will remain stationary.

If the handle 44 is moved to the position shown in dotted lines at 46, liquid will flow from the pipe 13 through the valve 34 and the pipe 37 to the front end of the motor 39 and retract its piston 40 which will expel liquid from the rear end of the motor 39 through the pipe 38 and the valve 34 into the return pipe 41.

The pressure created by the pump 1 will vary in accordance with the load carried by the motor 39 and, if the motor should be subjected to a load greater than a predetermined maximum or if the control valve 34 should be operated to close communication between the pipe 13 and the motor 39, the pump pressure would rise above the predetermined maximum determined by the adjustment of the spring 30 and the liquid entering the left end of the valve 14 would move the plunger 15 against the resistance of the spring 30 into the position shown in Fig. 2.

The plunger 15 would first move the groove 28 out of communication with the port 17, thereby closing communication between the cylinder 8 and the drain pipe 22, and would then open the port 17 slightly to the chamber 16 to allow liquid to flow through the pipe 20 into the cylinder 8 and force the piston 7 to the right against the resistance of the spring 9 and thereby move the pendulum 2 toward zero stroke position.

The pendulum 2 moves toward zero stroke position until the pump is delivering just sufficient liquid to maintain the pressure in the pipe 13 at the predetermined maximum determined by the adjustment of the spring 30.

When the pressure in the pipe 13 drops below the predetermined maximum, the spring 30 returns the plunger 15 to its initial position, thereby opening the cylinder 8 to the drain pipe 22 and allowing the spring 9 to swing the pendulum 2 against the stroke adjusting mechanism 11 and causing the pump to again deliver liquid at the predetermined maximum.

As the liquid in the cylinder 8 remains at atmospheric pressure until the valve 14 is opened and as the high pressure liquid is throttled

through a restricted opening formed by the adjacent edges of the port 17 and the piston 25, the liquid enters the cylinder 8 at low pressure and acts upon the piston 7 which has sufficient area to enable liquid at low pressure to compress the spring 9 and move the pendulum 2 toward zero stroke position.

As the liquid enters the cylinder 8 at low pressure and increases in pressure only enough to overcome the resistance of the spring 9, the pressure in the pipe 13 does not rise an appreciable amount above the predetermined maximum before the displacement of the pump has been reduced sufficiently to maintain the predetermined maximum pressure constant.

The choke 24 restricts the flow of liquid to and from the left end of the valve 14 sufficiently to prevent violent movements of the plunger 15 but it is large enough to allow the passage of sufficient liquid to move the plunger 15 promptly and smoothly.

When the pump is operating against a positive resistance, as by closing the control valve 34, and the screw 31 is turned, the pressure created by the pump will vary practically simultaneously with the movement of the screw 31.

The valve shown in Fig. 3 is similar in many respects to the valve shown in Figs. 1 and 2, and like parts of the two valves and the pipes connected thereto have been indicated by like reference numerals.

The flow of liquid through this valve is controlled by its plunger 47 which is held against the stop plate 28 by liquid supplied to the left end of the valve through the pressure pipe 19.

The plunger 47 controls two ports 48 and 49 both of which are connected to the cylinder 8 of the stroke changing mechanism by the pipe 20.

The port 48 is normally closed and the port 49 is normally open to the drain pipe 22 so that the cylinder 8 is free from pressure until the plunger 47 is operated.

When the pump pressure reaches a predetermined maximum, the force exerted by the liquid upon the left end of the plunger 47 moves it to the right to close the port 49 and open the port 48. High pressure liquid then flows through the restricted opening formed by the edges of the piston 25 and the port 48 and reaches the cylinder 8 at low pressure and operates the stroke changing mechanism as previously described.

The invention herein set forth is susceptible of various modifications and adaptations without departing from the scope thereof as hereafter claimed.

The invention is hereby claimed as follows:

1. A control for a variable displacement pump having mechanism for changing its stroke and a fluid motor for operating said mechanism, comprising a resistance valve provided with a casing having an axial bore communicating with a drain channel and connected to said motor and to the outlet of said pump, a spring arranged within said casing, and a valve plunger fitted in said bore for controlling the flow of fluid therethrough and normally held by said spring in position to close communication between said pump and said motor and to maintain communication between said motor and said drain and adapted to move against the resistance of said spring in response to a predetermined pump pressure to close said motor to said drain and then open it to said pump to permit fluid to flow from said pump to said motor to operate it and thereby cause said stroke changing mechanism to reduce the output of said pump until it is just suffi-

cient to maintain said maximum pressure within a narrow pressure range, a pipe for directing fluid from said pump to the end of said bore to act upon the end of said plunger, and a choke connected into said pipe for modulating the effect of said fluid upon said plunger.

2. A control for a variable displacement pump having mechanism for changing its stroke and a fluid motor for operating said mechanism, comprising a resistance valve provided with a casing having an axial bore communicating with a drain channel and connected to said motor and to the outlet of said pump, a spring arranged within said casing, and a valve plunger fitted in said bore for controlling the flow of fluid there-through and normally held by said spring in position to close communication between said pump and said motor and to maintain communication between said motor and said drain and subjected to pump pressure whereby it is caused to move against the resistance of said spring in response to a predetermined pump pressure to close said motor to said drain and then open it to said pump to permit fluid to flow from said pump to said motor to operate it and thereby cause said stroke changing mechanism to reduce the output of said pump until it is just sufficient to maintain said maximum pressure within a narrow pressure range, and a relief valve connected between said resistance valve and said motor to limit the pressure of the liquid delivered to said motor.

3. A control as defined in claim 1, including a relief valve connected between said resistance valve and said motor to limit the pressure of the liquid delivered to said motor.

4. A control, for a pump having mechanism for varying its displacement and a fluid motor for operating said mechanism, comprising a valve casing communicating with a drain channel and connected to said fluid motor and to the outlet of said pump, a valve arranged in said casing for controlling the flow of fluid to and from said fluid motor, means exerting a continuous force upon said valve for holding it in position to close communication between said fluid motor and said pump and to establish communication between said fluid motor and said drain, and a servo-motor mechanically connected to said valve and hydraulically connected to said pump for moving said valve against said force into position to close communication between said fluid motor and said drain and to establish communication between said fluid motor and said pump upon pump pressure reaching a predetermined maximum to thereby enable said fluid motor to operate said displacement varying mechanism to reduce pump output until it is just sufficient to maintain said predetermined pressure within a narrow pressure range.

5. A control as defined in claim 4, including a relief valve connected between said valve casing and said fluid motor to limit the pressure of the liquid delivered to said motor.

6. A control as defined in claim 4, including a choke connected between said servo-motor and said pump to limit the rate at which pump displacement may be varied.

7. A control as defined in claim 4, including a relief valve connected between said valve casing and said fluid motor to limit the pressure of the liquid delivered to said motor, and a choke connected between said servo-motor and said pump to limit the rate at which pump displacement may be varied.

8. A control, for a pump having mechanism for varying its displacement and a fluid motor for operating said mechanism, comprising a valve casing communicating with a drain channel and connected to said fluid motor and to the outlet of said pump, a valve arranged in said casing for controlling the flow of fluid to and from said fluid motor, means exerting a continuous force upon said valve for holding it in position to close communication between said fluid motor and said pump and to establish communication between said fluid motor and said drain, means operable from outside said casing for adjusting said means to vary the initial force exerted thereby upon said valve, and a servo-motor mechanically connected to said valve and hydraulically connected to said pump for moving said valve against said force into position to close communication between said fluid motor and said drain and to establish communication between said fluid motor and said pump upon pump pressure reaching a predetermined maximum to thereby enable said fluid motor to operate said displacement varying mechanism to reduce pump output until it is just sufficient to maintain said predetermined pressure within a narrow pressure range.

9. A control as defined in claim 8, including a choke connected between said servo-motor and said pump to limit the rate at which pump displacement may be varied.

10. A control, for a pump having mechanism for varying its displacement and a fluid motor for operating said mechanism, comprising a valve casing communicating with a drain channel and connected to said fluid motor and to the outlet of said pump, a valve arranged in said casing for controlling the flow of fluid to and from said fluid motor, a spring arranged within said casing and normally holding said valve in position to close communication between said fluid motor and said pump and to establish communication between said fluid motor and said drain, and a servo-motor mechanically connected to said valve and hydraulically connected to said pump for moving said valve against said spring into position to close communication between said fluid motor and said drain and to establish communication between said fluid motor and said pump upon pump pressure reaching a predetermined maximum to thereby enable said fluid motor to operate said displacement varying mechanism to reduce pump output until it is just sufficient to maintain said predetermined pressure within a narrow pressure range.

11. A control as defined in claim 10, including an adjusting screw operable from outside said casing for adjusting the tension of said spring, and a positive stop for limiting the action of said spring upon said valve.

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