Sept. 18, 1934. J. P. FERRIS ET AL 1,974,138

PUMP CONTROL

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Fig. 1.

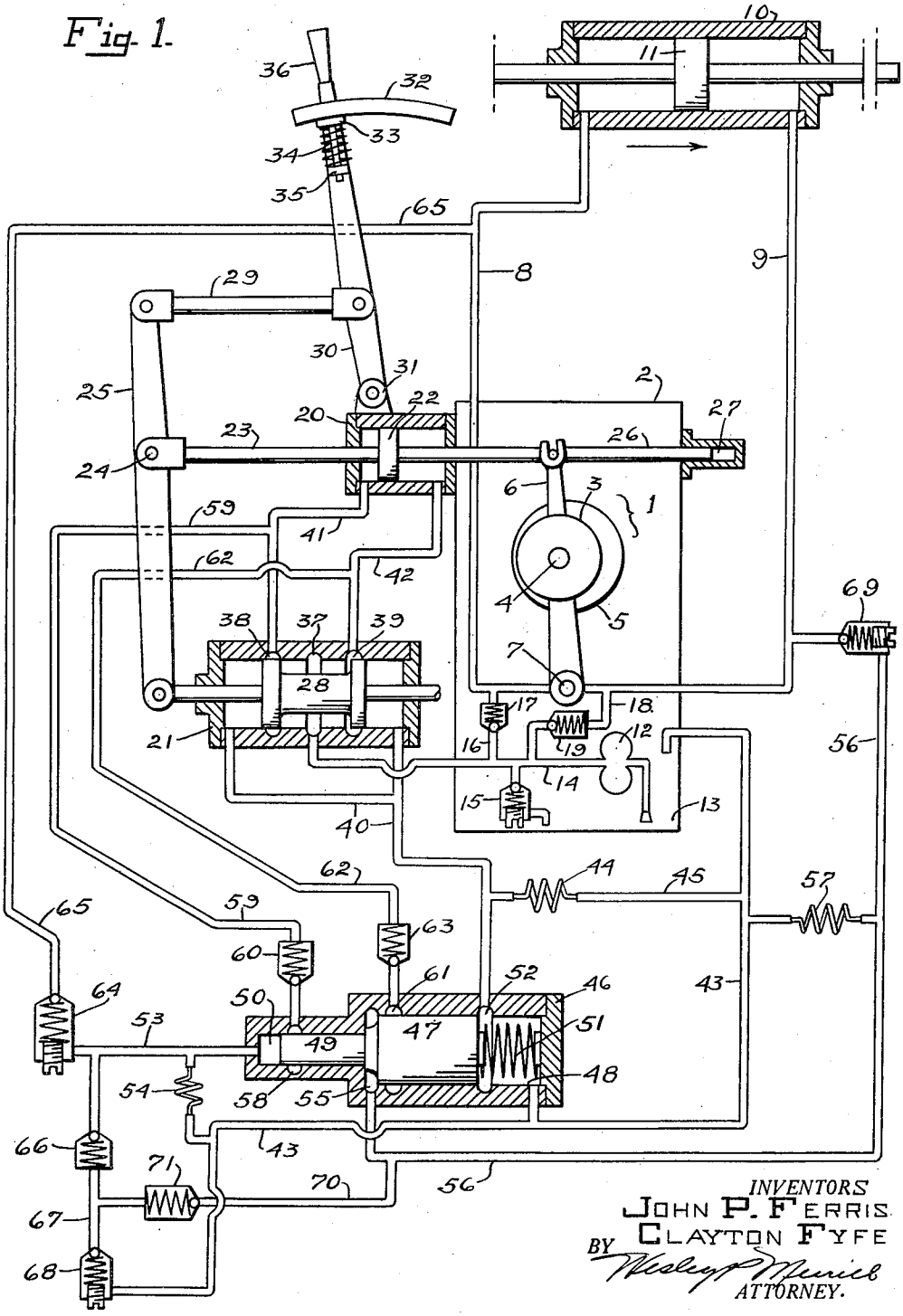

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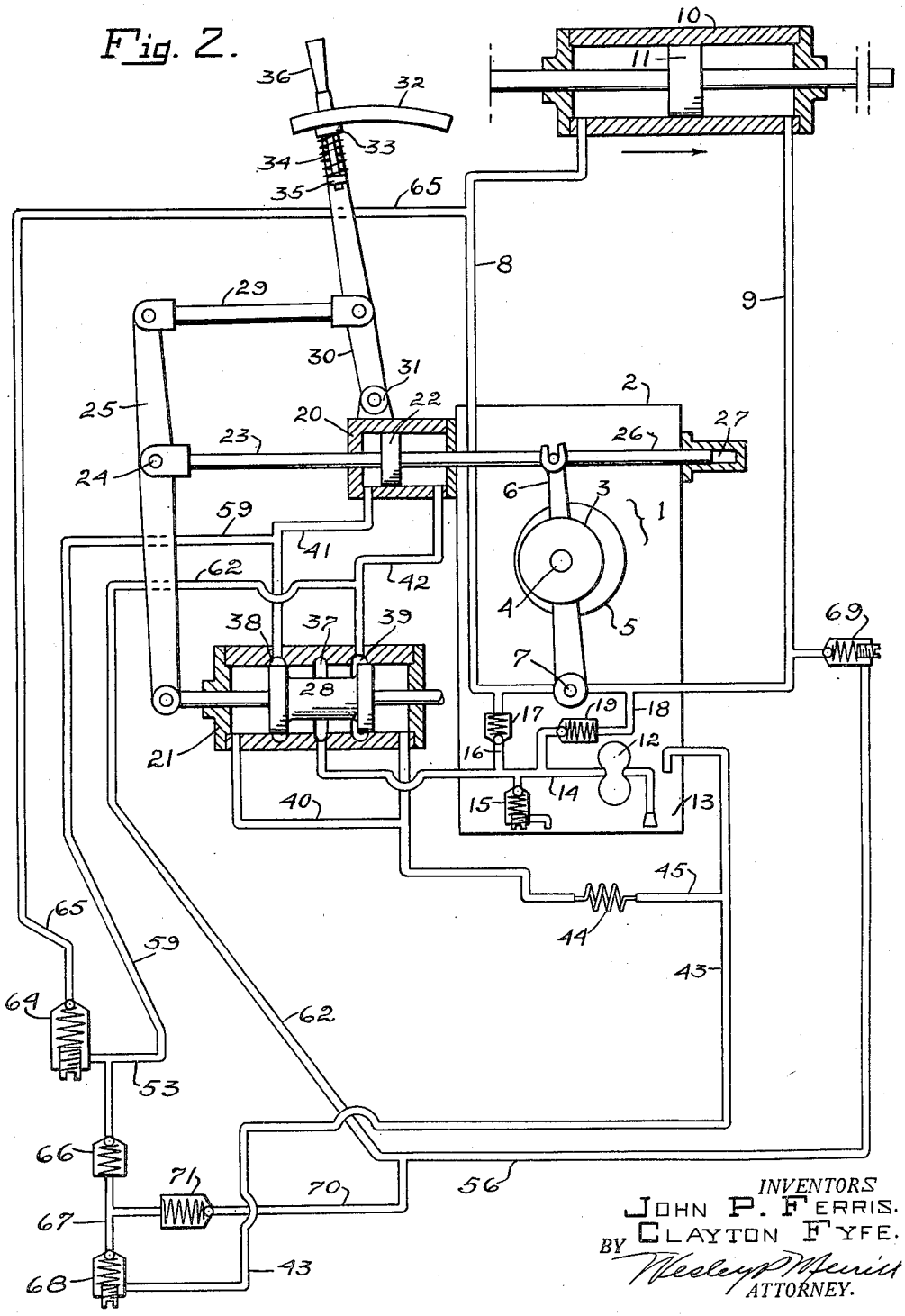
Fig. 2.



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1,974,138

PUMP CONTROL

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Application January 8, 1932, Serial No. 585,528

9 Claims. (Cl. 103—38)

The invention relates to controls for variable delivery pumps of the type in which stroke changing mechanism is employed to vary pump displacement and thereby vary pump delivery.

The control to which the invention applies in particular enables a variable displacement pump to function either as a variable delivery pump or as a constant delivery pump until pump pressure reaches a predetermined maximum and to then function as a constant pressure pump, such as the pump control described and claimed in Patent No. 1,798,198, issued March 31, 1931, to Walter Ferris and John P. Ferris.

The pump disclosed in the patent delivers liquid in one direction only and its output is directed alternatively into either side of a hydraulic circuit through a reversing valve.

An object of the invention is to provide a control which will enable a pump to deliver liquid in either direction of flow and at either constant or variable rates until pump pressure reaches a predetermined maximum and to then reduce its delivery sufficiently to maintain that pressure constant.

A reversible variable displacement pump equipped with the invention may be employed to operate a hydraulic motor in either direction and to limit the force exerted thereby.

Other objects and advantages will appear from the following description of the embodiments of the invention illustrated in the accompanying drawings in which the views are as follows:

Fig. 1 is a schematic drawing of a hydraulic circuit having a reversible variable displacement pump incorporated therein and provided with a control in which the invention is embodied.

Fig. 2 is a schematic drawing of a modified form of the control shown in Fig. 1.

The control is shown applied to a reversible variable displacement pump 1 which is of the type disclosed in Patent No. 1,798,198 referred to above.

The pump 1 is arranged within a housing 2 and has its pistons fitted in cylinders which are arranged radially in a cylinder barrel or block 3. Liquid is delivered to the cylinders and discharged therefrom through a valve or pintle 4 upon which the cylinder barrel is journaled, the cylinder barrel is arranged within a circular driver 5 which is driven from an outside source of power and rotates the cylinder barrel upon the pintle. The pistons are reciprocated in the cylinders by the driver whenever its axis is eccentric to the axis of the pintle, and the pintle 4 is carried by an arm or pendulum 6 which has one of its ends pivoted upon a stationary shaft 7 and its other end connected to the control mechanism, as fully illustrated and described in said patent.

When the axes of the pintle and the driver coincide, the pump is at zero stroke and no liquid will be delivered thereby. When the axis of the pintle is eccentric to the axis of the driver, the pump will deliver liquid at a rate determined by the degree of eccentricity and in a direction determined by the direction in which the pintle was moved from its neutral or zero stroke position.

When the axis of the pintle 4 is at one side of the axis of the driver 5, the pump 1 will deliver liquid into the hydraulic circuit through a pipe 8 and receive liquid therefrom through a pipe 9 and, when the axis of the pintle 4 is at the other side of the axis of the driver 5, the pump will deliver liquid into the circuit through the pipe 9 and receive liquid therefrom through the pipe 8. The pipes 8 and 9 are shown connected to opposite ends of a hydraulic motor 10 for delivering liquid thereto to reciprocate its piston 11.

The pump 1 is supplied with liquid to compensate for leakage losses by a gear pump 12 which is arranged in the housing 2 and draws its supply of liquid from a reservoir 13 formed in the lower part thereof.

The gear pump 12 delivers its output into a low pressure supply pipe 14 which has a low pressure relief valve 15 connected thereto to limit the pressure created by the gear pump and through which is discharged the liquid delivered by the gear pump in excess of requirements.

The pipe 14 is connected to the pipe 8 by a pipe 16, which has a check valve 17 connected therein, and to the pipe 9 by a pipe 18 which has a check valve 19 connected therein. The check valves 17 and 19 allow liquid to flow from the gear pump to the hydraulic circuit but prevent it from flowing in the opposite direction.

The mechanism described above is of ordinary construction and forms no part of the present invention.

The volume and direction of delivery of the pump 1 is controlled by a hydraulic motor 20 which is connected to the pendulum 6 and controlled by a control valve 21.

The motor 20 and the valve 21 are so connected and interrelated that a movement of the valve causes a corresponding movement of the motor and, when the motor has completed that movement, it automatically closes the valve and comes to rest. That is, the motor starts to move as soon as the valve is opened, moves through a

distance proportional to the distance through which the valve moves, and comes to rest when it has moved through that distance.

The pump control shown in Patent No. 1,798,198 has a rotary motor and a rotary control valve arranged in the motor, the valve has a casing which functions also as the rotor of the motor, and the pistons of the motor are secured to the rotor which is connected through linkage to the stroke changing mechanism of the pump to operate the same.

When the control valve is rotated in a given direction and through a given distance, ports in the casing or rotor are opened through which liquid flows to the motor and rotates the piston and the casing or rotor in the same direction and through the same angular distance at the end of which the casing or rotor has closed the port and the motor comes to rest.

A rotary motor and a rotary valve of the type shown in Patent No. 1,798,198 are ordinarily employed in practice but, for the purpose of illustration, the invention is shown provided with a reciprocating motor 20 and a reciprocating control valve 21 which operate differently but bear exactly the same relation to each other and produce exactly the same results.

The motor 20 has its piston 22 provided with a piston rod 23, which extends through the left end of the motor cylinder and is connected by a pin 24 to an operating lever 25 intermediate the ends thereof, and with a piston rod 26 which extends through the right end of the motor cylinder and is connected to the upper end of the pendulum 6. The rear end of the rod 26 may be supported in a suitable guide 27 carried by the housing 2.

The operating lever 25 has its lower end connected to the plunger 28 of the control valve 21 and its upper end connected by a link 29 to a control lever 30 intermediate the ends thereof.

The control lever 30 has its lower end pivoted to a stationary support 31 and its upper end frictionally held in adjusted position by a quadrant 32 which is arranged in a stationary position and engaged upon its under side by a friction block 33 carried by the lever 30. The block 33 is urged into engagement with the quadrant 32 by a helical compression spring 34 arranged between the block 33 and a lug 35 secured to the lever 30.

The lever 30 is provided at its upper end with a handle 36 by means of which it may be moved forcibly along the quadrant 32, thereby swinging the lever 25 and, as the piston 22 is held against movement by the liquid in the motor 20, the lever 25 pivots upon the pin 24 and moves the plunger 28 of the control valve 21.

The plunger 28 controls communication between an admission port 37 and two distributing ports 38 and 39 and between the distributing ports and a discharge pipe 40 which is connected to both ends of the valve casing.

The port 37 has the low pressure supply pipe 14 connected thereto, the port 38 is connected by a pipe 41 to the left end of the motor 20, and the port 39 is connected by a pipe 42 to the right end of the motor 20.

The distance between the adjacent edges of the ports 38 and 39 is ordinarily slightly less than the distance between the adjacent edges of the pistons on the valve plunger 28 so that both of these ports are normally slightly open to the port 37. The port 39 is shown open to the port 37 but the clearance between the edge of the port and the edge of the valve piston has been exaggerated for the purpose of illustration.

The gear pump 12 is discharging continuously through the relief valve 15 which is adjusted to maintain a predetermined low pressure in the pipe 14, for instance 100# per square inch, and this pressure extends through the slight openings in the ports 38 and 39 to both ends of the motor 20 and holds the piston 22 firmly in its adjusted position.

When the handle 36 of the control lever 30 is moved in one direction, either manually or by movement transmitted thereto from the motor 10, the lever 25 pivots upon the pin 24 and moves the valve plunger 28 in the opposite direction to allow liquid from the gear pump 12 to flow into one end of the control motor 20. This liquid moves the piston 22 and the pendulum 6 in the same direction in which the handle 36 was moved, and the movement of the piston 22 is transmitted through the rod 23 and the lever 25 to the valve plunger 28 to return it to its initial position.

For instance, movement of the handle 36 to the right will cause the plunger 28 to move to the left and open the port 38 to the port 37 and the port 39 to the discharge pipe 40 which is connected to a drain pipe 43 through a choke 44 and a pipe 45. The drain pipe 43 discharges into the reservoir 13.

Liquid from the gear pump may now flow through the port 38 and the pipe 41 to the left end of the motor 20 and move the piston 22 and the pendulum 6 to the right and expel liquid from the right end of the motor 20 through the pipe 42 and the valve 21 into the discharge pipe 40.

Due to the frictional engagement of the block 33 with the quadrant 32, more force is required to move the handle 36 than is required to move the valve plunger 28.

Consequently, movement is transmitted from the piston 22 through the rod 23 and the lever 25 to the valve plunger 28 and moves it to the right until both of the ports 38 and 39 are slightly open to the port 37 so that gear pump pressure may extend to both ends of the motor 20 and hold the piston 22 stationary at which time the piston 22 will have been moved through a distance which is proportional to the distance through which the handle 36 was moved.

The valve plunger 28 moves simultaneously with the handle 36, and the piston 22 starts to move as soon as the plunger 28 has moved sufficiently to close one of the distributing ports and open the other port wider.

After the plunger 28 has moved, and if the handle 36 is being moved an appreciable distance at a uniform rate, the piston 22 will move with the handle 36 and the valve plunger 28 will remain substantially stationary until the handle comes to rest.

After the handle 36 comes to rest, the piston 22 will continue and move until it has moved the plunger 28 to its initial position and then the piston 22 and plunger 28 come to rest and the piston 22 is held in its new position by the pressure of the liquid in both ends of the motor 20.

When the liquid expelled into the pipe 40 is compelled to pass through the choke 44, as would be the case at all times in the apparatus shown in Fig. 2, the piston 22 will move at a speed determined by the rate at which the liquid flows through the choke and, consequently, it will lag behind the movement of the valve plunger 28.

In order that the piston 22 may move practically simultaneously with the valve plunger 28, the apparatus shown in Fig. 1 is provided with

a valve 46 for bypassing the exhaust liquid around the choke 44.

The function of the valve 46 is to provide a free path for the liquid expelled from the motor 20 whenever the same is being operated in response to operation of the control lever 30 and to close this free path and cause the expelled liquid to flow through the choke 44 whenever the motor 20 is being operated in response to a predetermined maximum pressure created by the pump 1.

The flow of liquid through the valve 46 is controlled by its plunger 47 which is fitted in a bore 48 and provided upon its left end with a smaller plunger 49 which is fitted in a smaller bore 50.

The right end of the bore 48 is connected to the drain pipe 43 and contains a helical compression spring 51 which normally holds the plunger 47 against the left end of the bore 48 and thereby normally maintains communication between the drain pipe 43 and a port 52 which is formed in the wall of the bore 48 and has the pipe 40 connected thereto so that liquid may be expelled freely from the motor 20 to the drain pipe 43 unless the plunger 47 has been moved to the right.

The left end of the bore 50 has a pipe 53 connected thereto through which liquid is delivered to force the plungers 49 and 47 to the right whenever pump pressure exceeds a predetermined maximum, and the pipe 53 is connected to the drain pipe 43 through a choke 54 through which liquid is expelled when the valve plunger 49 is returned to its initial position by the spring 51.

The left end of the bore 48 has a port 55 formed therein and connected to a pipe 56 through which liquid is delivered to force the plungers 47 and 49 to the right whenever the pump pressure exceeds a predetermined maximum, and the pipe 56 is connected to the drain pipe 43 through a choke 57 through which liquid is expelled when the valve plunger 47 is returned to its initial position by the spring 51.

The bore 50 has a port 58 formed in the wall thereof and connected to the pipe 41 by a pipe 59 which has a check valve 60 connected therein to allow liquid to flow to the pipe 41 but to prevent it from flowing in the opposite direction, and the bore 48 has a port 61 formed in the wall thereof and connected to the pipe 42 by a pipe 62 which has a check valve 63 connected therein to allow liquid to flow to the pipe 42 but to prevent it from flowing in the opposite direction.

The pipe 53 is connected to the pipe 8 through a high pressure resistance valve 64 and a pipe 65, and to the drain pipe 43 through a check valve 66, a pipe 67 and a low pressure resistance valve 68 which is adjusted to open at a low pressure, for instance 200# per square inch.

The pipe 56 is connected to the pipe 9 through a high pressure resistance valve 69 and to the drain pipe 43 through a pipe 70, a check valve 71, the pipe 67 and the resistance valve 68.

The resistance valves 64 and 69 are adjusted to open at a predetermined high pressure, and, when that pressure is reached, liquid breaks through these valves and operates the control motor 20 to reduce the stroke and delivery of the pump 1 until that pressure is maintained constant.

The liquid which breaks through the resistance valve 64 acts upon the end of the plunger 49, and the liquid which breaks through the resistance valve 69 acts upon the shoulder which is formed by the junction of the plungers 47 and 49 and which ordinarily has the same effective area as the end of the plunger 49.

The check valves 66 and 71 allow liquid to flow from the pipes 53 and 56 to the drain pipe 43 but prevent it from flowing from one pipe to the other so that liquid which passes through the resistance valve 69 cannot act upon the end of the plunger 49 and the liquid which passes through the resistance valve 64 cannot act upon the shoulder formed by the junction of the plungers 47 and 49.

Any liquid which breaks through either the resistance valve 64 or the resistance valve 69 in excess of the volume required to operate the motor 20 will flow to the drain pipe 43 through either the choke 54 or the choke 57 and through the resistance valve 68 which is adjusted to open at a pressure slightly higher than the pressure required to operate the valve 46 and the motor 20.

The pump control shown in Fig. 2 is identical to the control shown in Fig. 1 except that the bypass valve 46, the check valves 60 and 63 and the chokes 54 and 57 have been omitted. Consequently, like parts have been indicated by like reference numerals, and the pipes 53 and 56 have been shown connected, respectively, to the pipes 59 and 62.

If the pump 1 is delivering liquid into the pipe 8 and the pressure therein exceeds a predetermined maximum, the resistance valve 64 will open and liquid from the pump 1 will enter the left end of the control motor 20 and force the piston 22 and the pendulum 6 to the right until the pump 1 is delivering just sufficient liquid to maintain that pressure constant, and the piston 22 will expel liquid from the right end of the motor 20 through the valve 21 and the relief valve 15.

In the control shown in Fig. 2, the liquid which breaks through the resistance valve 64 flows through the pipes 53, 59 and 41 to the left end of the motor 20 and, in the control shown in Fig. 1, the liquid which breaks through the resistance valve 64 flows through the pipe 53, forces the plungers 49 and 47 of the bypass valve 46 to the right to close the port 52 and then flows through the check valve 60 and the pipes 59 and 41 to the left end of the motor 20. In either case, the only liquid which can escape from the pipe 41 must flow through the choke 44.

When the piston 22 first starts to move, it ejects liquid from the right end of the motor 20 through the slight opening in the port 39 and then the plunger 28 moves with the piston 22 and opens the port 39 wider so that the expelled liquid may escape freely therethrough.

The movement of the plunger 28 to the right also opens the port 38 to the pipe 40 but the choke 44 restricts the escape of the liquid therethrough sufficiently to allow the motor 20 to operate and reduce pump delivery.

If the volume of liquid which breaks through the resistance valve 64 is in excess of the volume required to operate the motor and the volume which escapes through the chokes 44 and 54, the resistance valve 68 will open and allow the excess liquid to escape into the drain pipe 42.

When the pump pressure drops, the valve 64 closes and liquid delivered by the gear pump moves the piston 22 to the left to increase pump delivery, and liquid is expelled from the left end of the motor 20 through the pipe 41, the valve 21, the pipe 40 and the choke 44 into the drain pipe 43.

In the control shown in Fig. 1, the reduction in pump pressure will allow the spring 51 to move

the plunger 47 to the left and open the port 52 so that the liquid expelled from the left end of the motor 20 has a free path to the drain pipe 43.

If the pump 1 is delivering liquid into the pipe 9 and the pressure therein exceeds the predetermined maximum, liquid will break through the resistance valve 69 and operate the control in the opposite direction and in the same manner as previously described except that, in the control shown in Fig. 1, the liquid will act upon the plunger 47 and move it to the right to close the port 52.

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. The combination with a reversible variable delivery pump, an auxiliary source of pressure fluid and mechanism for changing the stroke of said pump, of a pump control comprising a fluid motor for moving said stroke changing mechanism in either direction from a neutral or zero stroke position to a maximum stroke position to thereby vary pump delivery from zero to maximum in either direction of flow, means for delivering fluid from said auxiliary source to said motor including a control valve controlling said delivery of fluid and connected to said motor whereby operation of said valve allows fluid to flow from said auxiliary source to said motor and operate the same and the resulting operation of said motor operates said valve to interrupt delivery of fluid to said motor upon said motor having been operated through a distance corresponding to the distance through which said valve was operated, and means connecting said motor to said pump and responsive to a predetermined maximum pump pressure for delivering fluid from said pump to said motor to operate the same and thereby move said stroke changing mechanism toward zero stroke position to reduce pump delivery until said pump pressure does not exceed said predetermined maximum.

2. The combination with a reversible variable delivery pump, an auxiliary source of pressure fluid and mechanism for changing the stroke of said pump, of a pump control comprising a fluid motor for moving said stroke changing mechanism in either direction from a neutral or zero stroke position to a maximum stroke position to thereby vary pump delivery from zero to maximum in either direction of flow, means for delivering fluid from said auxiliary source to said motor including a control valve controlling said delivery of fluid and connected to said motor whereby operation of said valve allows fluid to flow from said auxiliary source to said motor and operate the same and the resulting operation of said motor operates said valve to interrupt delivery of fluid to said motor upon said motor having been operated through a distance corresponding to the distance through which said valve was operated, means connecting said motor to said pump and responsive to a predetermined maximum pump pressure for delivering fluid from said pump to said motor to operate the same and thereby move said stroke changing mechanism toward zero stroke position to reduce pump delivery until said pump pressure does not exceed said predetermined maximum, and a choke connected in series with said motor for limiting the speed at which said motor operates.

3. The combination with a reversible variable delivery pump, an auxiliary source of pressure fluid and mechanism for changing the stroke of said pump, of a pump control comprising a fluid motor for moving said stroke changing mechanism in either direction from a neutral or zero stroke position to a maximum stroke position to thereby vary pump delivery from zero to maximum in either direction of flow, means for delivering fluid from said auxiliary source to said motor including a control valve controlling said delivery of fluid and connected to said motor whereby operation of said valve allows fluid to flow from said auxiliary source to said motor and operate the same and the resulting operation of said motor operates said valve to interrupt delivery of fluid to said motor upon said motor having been operated through a distance corresponding to the distance through which said valve was operated, means connecting said motor to said pump and responsive to a predetermined maximum pump pressure for delivering fluid from said pump to said motor to operate the same and thereby move said stroke changing mechanism toward zero stroke position to reduce pump delivery until said pump pressure does not exceed said predetermined maximum, a choke for limiting the speed of said motor and means normally rendering said choke ineffective and responsive to a maximum pump pressure for rendering it effective.

4. The combination with a reversible variable delivery pump, an auxiliary source of pressure fluid and mechanism for changing the stroke of said pump, of a pump control comprising a fluid motor for moving said stroke changing mechanism in either direction from a neutral or zero stroke position to a maximum stroke position to thereby vary pump delivery from zero to maximum in either direction of flow, means for delivering fluid from said auxiliary source to said motor including a control valve controlling said delivery of fluid and connected to said motor whereby operation of said valve allows fluid to flow from said auxiliary source to said motor and operate the same and the resulting operation of said motor operates said valve to interrupt delivery of fluid to said motor upon said motor having been operated through a distance corresponding to the distance through which said valve was operated, means connecting said motor to said pump and responsive to a predetermined maximum pump pressure for delivering fluid from said pump to said motor to operate the same and thereby move said stroke changing mechanism toward zero stroke position to reduce pump delivery until said pump pressure does not exceed said predetermined maximum, a choke for limiting the speed of said motor, and means including a valve for normally providing a bypass around said choke and operable in response to a maximum pump pressure for closing said bypass.

5. The combination with a reversible variable delivery pump, a low pressure auxiliary pump and mechanism for changing the stroke of said variable delivery pump, of a pump control comprising a fluid motor for moving said stroke changing mechanism in either direction from a neutral or zero stroke position to a maximum stroke position to thereby vary pump delivery from zero to maximum in either direction of flow, means for delivering liquid from said auxiliary pump to said motor including a control valve controlling said delivery of liquid and connected to said motor whereby operation of said valve allows liquid to flow from said auxiliary pump to said motor and operate the same and the resulting operation of

said motor operates said valve to interrupt delivery of liquid to said motor upon said motor having been operated through a distance corresponding to the distance through which said valve was operated, means connecting said motor to said variable delivery pump and responsive to a predetermined maximum pump pressure for delivering liquid from said variable delivery pump to said motor to operate the same against the force exerted by the liquid delivered from said auxiliary pump and thereby move said stroke changing mechanism toward zero stroke position to reduce pump delivery until said pump pressure does not exceed said predetermined maximum, a choke connected in series with said motor for restricting the discharge of liquid therefrom to thereby limit the speed thereof, and means normally rendering said choke ineffective and responsive to a maximum pump pressure for rendering it effective.

6. The combination with a reversible variable delivery pump, a low pressure gear pump and mechanism for changing the stroke of said variable delivery pump, of a pump control comprising a fluid motor for moving said stroke changing mechanism in either direction from a neutral or zero stroke position to a maximum stroke position to thereby vary pump delivery from zero to maximum in either direction of flow, means for delivering liquid from said gear pump to said motor including a control valve controlling said delivery of liquid and connected to said motor whereby operation of said valve allows liquid to flow from said gear pump to said motor and operate the same and the resulting operation of said motor operates said valve to interrupt delivery of fluid to said motor upon said motor having been operated through a distance corresponding to the distance through which said valve was operated, and means connecting said motor to said variable delivery pump and responsive to a predetermined maximum pump pressure for delivering liquid from said variable delivery pump to said motor to operate the same against the force exerted by the liquid delivered from said gear pump and thereby move said stroke changing mechanism toward zero stroke position to reduce pump delivery until said pump pressure does not exceed said predetermined maximum, a choke connected in series with said motor for restricting the discharge of liquid therefrom to thereby limit the speed thereof, and means including a valve for normally providing a bypass around said choke and operable in response to a maximum pump pressure for closing said bypass.

7. The combination, with a variable delivery pump, an auxiliary source of pressure fluid and mechanism for changing the stroke of said pump, of a pump control comprising a fluid motor having a stationary cylinder and a piston fitted in said cylinder and connected to said stroke changing mechanism to operate the same, means for delivering pressure fluid from said source to said motor cylinder including a control valve having a stationary cylinder and a plunger fitted therein to control the flow of fluid therethrough and normally arranged in a position to cause said motor piston to be held in a selected stationary position by fluid pressure transmitted thereto from said source, means for connecting said valve plunger to said motor piston to transmit motion from said piston to said plunger, means connected to said connecting means for operating said valve plunger to direct liquid selectively into either end of said motor cylinder to cause said piston to operate said stroke changing means selectively in either direction, means for holding said valve operating means in adjusted positions to enable said connecting means to return said valve plunger to its normal position, and means responsive to a predetermined maximum pump pressure for directing fluid from said pump to said motor to cause the same to operate said stroke changing mechanism and thereby reduce pump delivery.

8. The combination, with a variable delivery pump, an auxiliary source of pressure fluid and mechanism for changing the stroke of said pump, of a pump control comprising a fluid motor having a stationary cylinder and a piston fitted in said cylinder and connected to said stroke changing mechanism to operate the same, means for delivering pressure fluid from said source to said motor cylinder including a control valve having a stationary cylinder and a plunger fitted therein to control the flow of fluid therethrough and normally arranged in a position to cause said motor piston to be held in a selected stationary position by fluid pressure transmitted thereto from said source, means for connecting said valve plunger to said motor piston to transmit motion from said piston to said plunger, means connected to said connecting means for operating said valve plunger to direct liquid selectively into either end of said motor cylinder to cause said piston to operate said stroke changing means selectively in either direction, and means for holding said valve operating means in adjusted positions to enable said connecting means to return said valve plunger to its normal position, means responsive to a predetermined maximum pump pressure for directing fluid from said pump to said motor to cause the same to operate said stroke changing mechanism and thereby reduce pump delivery, and a choke connected in series with said control valve to restrict the discharge of fluid from said motor.

9. The combination, with a variable delivery pump, an auxiliary source of pressure fluid and mechanism for changing the stroke of said pump, of a pump control comprising a fluid motor having a stationary cylinder and a piston fitted in said cylinder and connected to said stroke changing mechanism to operate the same, means for delivering pressure fluid from said source to said motor cylinder including a control valve having a stationary cylinder and a plunger fitted therein to control the flow of fluid therethrough and normally arranged in a position to cause said motor piston to be held in a selected stationary position by fluid pressure transmitted thereto from said source, means for connecting said valve plunger to said motor piston to transmit motion from said piston to said plunger, means connected to said connecting means for operating said valve plunger to direct liquid selectively into either end of said motor cylinder to cause said piston to operate said stroke changing means selectively in either direction, and means for holding said valve operating means in adjusted positions to enable said connecting means to return said valve plunger to its normal position, means responsive to a predetermined maximum pump pressure for directing fluid from said pump to said motor to cause the same to operate said stroke changing mechanism and thereby reduce pump delivery, a choke connected in series with said control valve to restrict the discharge of fluid from said motor, and a valve providing a bypass around said choke and responsive to a predetermined pump pressure for closing said bypass.

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