Sept. 9, 1930. J. P. FERRIS 1,775,613

PUMP

Filed Feb. 1, 1926

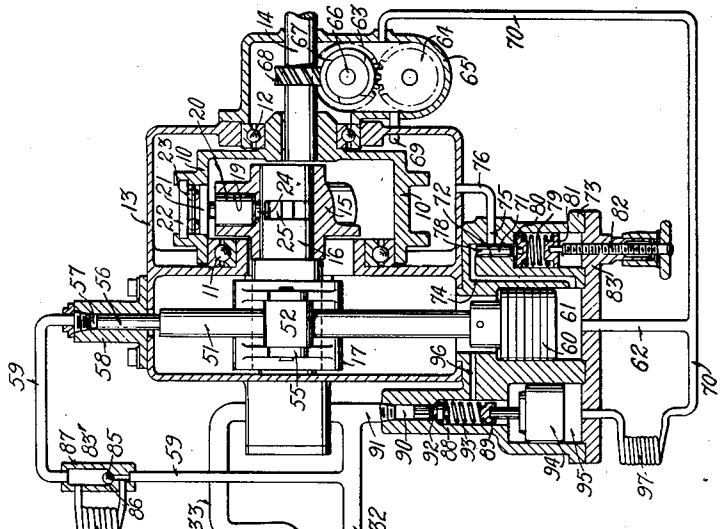


Fig. 2.

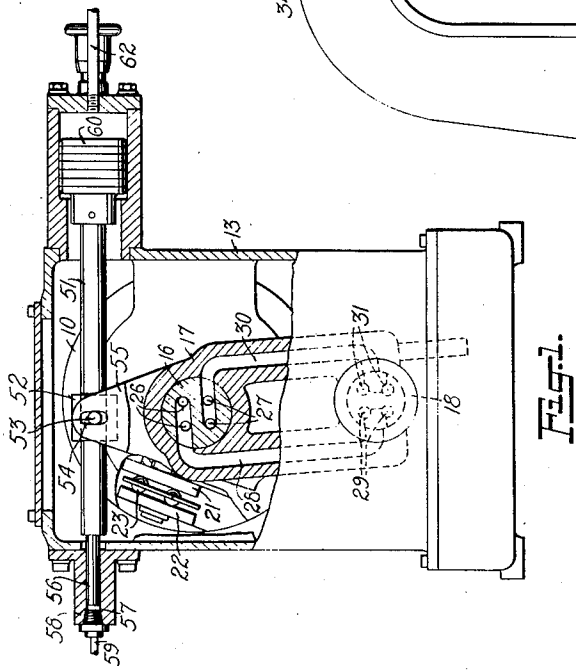


Fig. 1.

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Patented Sept. 9, 1930 1,775,613

UNITED STATES PATENT OFFICE

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PUMP

Application filed February 1, 1926. Serial No. 85,178.

This invention relates to variable displacement pumps of the type employed in hydraulic transmissions.

A variable displacement pump of the type mentioned is fully described in my co-pending application, Serial No. 701,356, filed March 24, 1924. The pump therein described includes mechanism, involving a spring loaded plunger, for effecting an automatic reduction in pump displacement, when the pressure in the discharge side of the pump exceeds a predetermined maximum degree. A high pressure relief valve is also provided therein for guarding against excessive pressures, in the event that the automatic displacement regulating means does not act with sufficient promptness to insure against excessive pressures. The automatic regulating means is adjusted to respond to pressures lower than the pressure required to open the relief valve, and this relation should always be maintained. Because of the many and varied uses to which such a pump is applied, it becomes necessary, or at least highly desirable, to be able to vary the pressure at which the automatic regulating means will function, and every material change in the setting of the regulating means ordinarily requires a change in the setting of the relief valve, in order to maintain the above mentioned relation between them. In the pump described in the above named application, separate devices are employed for adjusting the regulating means and the relief valve, which devices require a separate and independent setting.

One object of the present invention is the provision of means for effecting a simultaneous and properly coordinated adjustment in the setting of the displacement regulating mechanism and the relief valve, in a pump of the type referred to.

Another object is the provision of improved means for effecting the automatic reduction in pump displacement when the working pressure exceeds a predetermined degree.

Other objects and advantages will appear from the following description of an illustrative embodiment of the present invention.

In the drawings:—

Figure 1 is a side elevation, partly in section, of a variable displacement pump embodying the present invention.

Fig. 2 is a horizontal sectional view of the pump diagrammatically illustrating its application to the power cylinder of a hydraulic press.

The pump selected for illustration is, in the main, substantially identical with that described in the above entitled application. It comprises a rotary driver 10, journalled in spaced bearings 11 and 12, within the main housing 13, and driven by a shaft 14. A cylinder barrel 15, disposed within the driver 10, rotates upon a pintle 16, carried by an upright arm 17, rockably supported upon a shaft 18, fixed in the bottom of the housing. The cylinder barrel 15 is provided with a series of radial cylinder bores 19, each containing a piston 20 reciprocable therein. Each piston is provided with a cross-head 21, extending parallel to a reaction plate 22 tangentially disposed in the driver 10, an appropriate roller bearing 23 being interposed between each cross-head 21 and reaction plate 22. Each cylinder bore 19 is open to the pintle 16 through a port 24, disposed to register successively with gashes formed in the upper and lower surfaces of the pintle. The upper pintle gash is shown at 25 in figure 2. The pintle contains a pair of longitudinal passages 26 communicating with the gash 25 and a second pair of longitudinal passages 27 communicating with the other gash in the lower face of the pintle. Passages 26 communicate through a passage 28, in the arm 17, with a pair of longitudinal passages 29 in the shaft 18; and passages 27 communicate, through a similar passage 30 in the arm, with similar passages 31 in the shaft. Passages 29 communicate with a pipe 32 constituting one side of the hydraulic circuit fed by the pump, and passages 31 communicate with another pipe 33 constituting the other side of the circuit.

The arrangement is such that when the arm 17 is tilted toward the left as indicated in Figure 1, the axis of rotation of the cylinder

barrel 15 is laterally offset with respect to the axis of rotation of the driver 10, as indicated in Figure 2. The pump normally rotates counter-clockwise (Fig. 1) so that, in this position of the parts, the pump delivers liquid through passages 26, passage 28, and passages 29 to the pipe 32 and receives liquid from the pipe 33 through passages 31, passage 30 and passages 27. As the arm 17 is swung toward the right from this tilted position pump displacement is reduced causing a reduction in the rate of liquid flow, until the arm 17 has reached a vertical position, with the axis of rotation of the cylinder barrel coincident with the axis of rotation of the driver, in which position pump displacement is zero.

The pump is shown in Figure 2 connected to the power cylinder 34 of a conventional hydraulic press 35, through a reversing valve 36 of well known form. The valve shown comprises a housing 37 having a cylindrical bore 38 therein. Passages 39 and 40 leading from the bore 38 communicate with the upper and lower ends respectively of the cylinder 34. A passage 41, leading from the bore 38, intermediate the passages 39 and 40, is connected with the pipe 32. Passages 42 and 43 leading from the bore 38, adjacent the ends thereof, communicate through a passage 44 and are connected with the pipe 33. A piston valve, lengthwise movable within the bore 38, has three heads 45, 46 and 47 connected by reduced portions 48 and 49. The intermediate head 46 controls communication between passage 41 and passages 39 and 40. The upper head 45 controls communication between passage 39 and passage 42. The lower head 47 controls communication between passage 40 and passage 43. The valve is shown in intermediate position with the passage 41 blocked by the head 46, and the piston 48 within the cylinder 34 is at rest. By lowering the valve, communication is established between passages 41 and 39, and between passages 40 and 43, so that liquid delivered by the pump through pipe 32 is admitted to the upper end of the cylinder 34 to force the cylinder 34 down, and liquid from the lower end of the cylinder escapes through passages 40, 43, and 44, and pipe 33 back to the pump. When lifted the valve opens communication between passages 41 and 40, and between passages 39 and 42, so that liquid from pipe 32 is delivered into the lower end of the cylinder to force the cylinder upwardly, liquid from the upper end of the cylinder escaping through passages 39 and 42 to the pipe 33. The valve is controlled by an appropriate hand lever 50 connected thereto through a stem 50'. The construction, arrangement and functioning of the parts hereinabove mentioned correspond exactly with parts fully described in the above entilted application, and a further or more detailed description thereof is deemed unnecessary for a complete understanding of the present invention.

In the pump shown herein the position of the upright arm 17 is controlled by a rod 51, having a block 52 fixed thereto and provided with trunnions 53 snugly engaged in appropriate slots 54 formed in upstanding ears 55 carried by the arm 17. One end of the rod 51 is reduced to form a plunger 56 closely fitted for reciprocation within a bore 57 formed in a block 58 fixed to the main housing 13. A pipe 59 connects the bore 57 with the delivery pipe 32, leading from the pump, so that the pressure within the bore corresponds to the working pressure within pipe 32. The other end of the rod 51 is connected to a piston 60, closely fitted for reciprocation within a cylinder 61, fixed to the main housing 13. The cylinder 61 is maintained flooded with liquid under constant pressure, delivered through a pipe 62 from an appropriate fluid pressure source.

In this instance the fluid pressure source constitutes a gear pump of standard form, comprising a pair of intermeshing gears 63 and 64, enclosed in the usual housing 65, fixed to the main housing 13 adjacent the bottom thereof. The gears are driven from the main drive shaft 14, through a vertical shaft 66, operatively connected to shaft 14 through appropriate spiral gears 67 and 68. The gear pump receives liquid from the base of the main housing 13 through a pipe 69 and delivers this liquid through a pipe 70, to which pipe 62 is connected.

An adjustable low pressure relief valve of appropriate form determines the fluid pressure maintained in pipes 70 and 62. The relief valve shown comprises a plunger 71 closely fitted for lengthwise reciprocation within a bore 72, formed in a block 73 constituting an integral part of the cylinder 61. A passage 74 maintains communication between the cylinder 61 and the bore 72, beneath the plunger 71. The plunger 71 controls the flow of liquid through a discharge port 75, which is open to the main housing 13 through a drain pipe 76, and to obtain a nice regulation of this flow the end of the plunger is preferably formed with a series of tapered grooves 78. A coiled spring 79 confined between a collar 80 on the plunger and a collar 81 on a control stem 82, maintains a substantially constant pressure on the plunger in opposition to the fluid pressure within the bore 72. The pressure exerted by the spring 78 may be varied by adjusting the stem 82, which is screwed through a cover plate 83 fixed to the cylinder block. The arrangement is such that, as the pressure in pipes 70 and 62, and consequently in the cylinder 61, and bore 72, builds up, the plunger 71 is forced outwardly against the pressure of the spring 79 until the port 75 is uncovered sufficiently to permit

some of the liquid to escape from the bore 72, and until the spring pressure is balanced by the pressure of the liquid in the bore. The pressure in the bore, and hence in the cylinder 61, is thus maintained constant. To vary this pressure it is only necessary to vary the spring pressure by adjusting the stem.

From the foregoing it will be noted that since the liquid pressure within the cylinder 61 is maintained substantially constant, a constant thrust is maintained upon the piston 60, tending to hold the rod 51, and arm 17, in the position shown in Figure 1. As the working pressure in the delivery pipe 32 builds up, this pressure is transmitted through the pipe 59 to the bore 57, and, acting on the plunger 56, opposes the thrust which is maintained by the piston 60. When the pressure in pipe 32 and bore 57 has increased sufficiently to overcome the constant thrust of the piston 60, the rod 51 shifts toward the right and swings the arm 17 in such direction as to reduce pump displacement. Assume for instance that the valve 36 has been lowered, so that the piston 48 is forcing the press plunger downwardly under the pressure of the liquid delivered to the upper end of the cylinder 34 through pipe 32 from the pump. The instant that the plunger strikes the work, further advance is checked, and the pressure within pipe 32 and bore 67 builds up suddenly, causing the rod 51 and arm 17 to be shifted toward the right to reduce pump displacement. The plunger thus applies and maintains a predetermined pressure upon the work, the degree of pressure depending upon the fluid pressure in cylinder 61, which as above pointed out depends on the setting of the control stem 82 of the low pressure relief valve.

In order to avoid the transmission of slight fluctuations in pressure from the pipe 32 to the bore 57 a check valve 83′ and choke coil 84 are interposed in the pipe line 59. The check valve shown comprises a ball valve 85 resting upon a conical seat 86 within the valve casing 87 so as to permit a free flow of liquid through the pipe 59 toward the bore 57 only.

A length of small diameter tubing forming the coil 84 forms a by-pass around the check valve, and permits only a restricted flow of liquid from the bore 57 to the pipe 32.

A high pressure relief valve of appropriate form is provided for relieving the pipe 32 of excessive pressures, in the event that the pump displacement regulating means does not respond with sufficient promptness to avoid such pressures. A high pressure relief valve for this purpose is shown at 88 in Figure 2. This valve is contained within a block 89, constituting an integral part of the cylinder 61, and having a port 90 connected through a pipe 91 with the pipe 32. The port 90 is controlled by a valve element 92 normally retained in closing position on its seat under the pressure of a coiled spring 93. A piston 94, within a cylinder 95, maintains the spring 93 under compression, the piston being exposed to constant fluid pressure admitted to the cylinder 95, through the pipe 70. It will be noted that the tension in the spring 93, and hence the pressure tending to maintain the valve 92 on its seat, corresponds always to the degree of fluid pressure maintained in the pipe 70, so that any change in the setting of the stem 82 of the low pressure relief valve, not only determines the degree of pressure in pipe 32 at which the displacement regulating means will respond, but also determines the degree of pressure in pipe 32, at which this high pressure relief valve will respond. When the pressure in pipe 32 is sufficient to open the valve 92 against the pressure of spring 93, fluid escapes past this valve through a drain passage 96, which is open to the interior of the main housing 13. The pistons 94 and 60 are so proportioned that the displacement regulating means will respond to pressures within pipe 32, lower than the pressures required to open the valve 92.

In order to avoid the transmission of sudden irregularities in pressure from pipe 70 to the cylinder 95, a choke coil 97, similar to coil 84 is interposed in pipe 70 between the pipe 62 and the cylinder 95. A sudden increase in pressure in the pipe 70 might be caused by a sudden outward movement of the piston 60, which, if it were not for the coil 97, might be transmitted to piston 94 and interfere with the proper functioning of the valve 92.

Various changes may be made in the embodiment of the invention hereinabove specifically described without departing from or sacrificing any of the advantages of the invention as defined in the appended claims.

I claim:—

1. In a variable displacement pump the combination of displacement varying means, fluid actuated means for yieldably maintaining said displacement varying means in one position, an auxiliary pump for supplying pressure to said fluid actuated means, means responsive to the delivery pressure of the variable displacement pump for resisting said fluid actuated means to thereby operate said displacement varying means when said pressure attains a predetermined degree, and pressure relief mechanism adjusted to operate at a pressure in excess of said predetermined degree.

2. In a variable displacement pump the combination of displacement varying means, an auxiliary pump, means actuated from said auxiliary pump for yieldably maintaining said displacement varying means in one position, means responsive to the delivery pressure of the variable displacement pump for resisting said yielding means to operate said displacement varying means when said pump

pressure exceeds a predetermined degree, means for varying the degree of pressure applied to said yielding means to thereby vary the degree of pump pressure at which said resisting means will respond, and pressure relief mechanism for limiting the delivery pressure of the variable displacement pump.

3. In a variable displacement pump the combination of displacement varying means, means responsive to pump pressure for operating said displacement varying means, fluid actuated means offering a predetermined resistance to the operation of said pressure responsive means, an auxiliary pump for supplying pressure to said fluid actuated means, and a relief valve associated with said auxiliary pump for determining the resistance offered by said fluid actuated means.

4. In a variable displacement pump the combination of displacement varying means, means responsive to pump pressure for operating said means, fluid actuated means offering a predetermined resistance to the operation of said pressure responsive means, a fluid pressure source, a relief valve adjustable to determine the degree of pressure applied to said fluid actuated means, and a relief valve for limiting the pump pressure.

5. In a variable displacement pump the combination of displacement varying means, means responsive to pump pressure for operating said means, fluid actuated means for maintaining a predetermined resistance to the operation of said pressure responsive means, pressure relief mechanism for limiting said pump pressure, and means adjustable to simultaneously vary the resistance offered by said fluid actuated means and the setting of said relief mechanism.

6. In a variable displacement pump the combination of means responsive to pump pressure for varying pump displacement, fluid actuated means resisting the operation of said pressure responsive means, a relief valve for limiting the pump pressure, fluid actuated means for yieldably maintaining said relief valve closed, a fluid pressure source connected with both of said fluid actuated means, and a relief valve for determining the degree of pressure applied to said fluid actuated means.

7. In a variable displacement pump the combination of means responsive to pump pressure for varying pump displacement, pressure relief mechanism for limiting pump pressure, and means adjustable to simultaneously vary the degrees of pressure at which said displacement varying means and said relief mechanism will respond.

8. In a variable displacement pump the combination of drive means therefor, means responsive to pump pressure for varying pump displacement, fluid actuated means for resisting the operation of said displacement varying means, an auxiliary pump driven by said drive means for supplying fluid pressure to said fluid actuated means, and means for determining the degree of pressure applied to said fluid actuated means to thereby determine the degree of pump pressure at which said displacement varying means will respond.

9. In a variable displacement pump the combination of drive means therefor, means responsive to pump pressure for varying pump displacement, an auxiliary pump driven by said drive means, means responsive to pressure generated by said auxiliary pump for resisting said displacement varying means, and means adjustable to vary the pressure generated by said auxiliary pump to thereby vary the pump pressure at which said displacement varying means will respond.

10. In a variable displacement pump the combination of drive means therefor, means responsive to pump pressure for varying pump displacement, an auxiliary pump driven by said drive means, means responsive to pressure generated by said auxiliary pump for controlling the operation of said pressure responsive means, and pressure relief mechanism controlled by the pressure generated by said auxiliary pump for limiting the pressure of said first named pump.

In witness whereof, I hereunto subscribe my name this 15th day of January, 1926.

JOHN P. FERRIS.