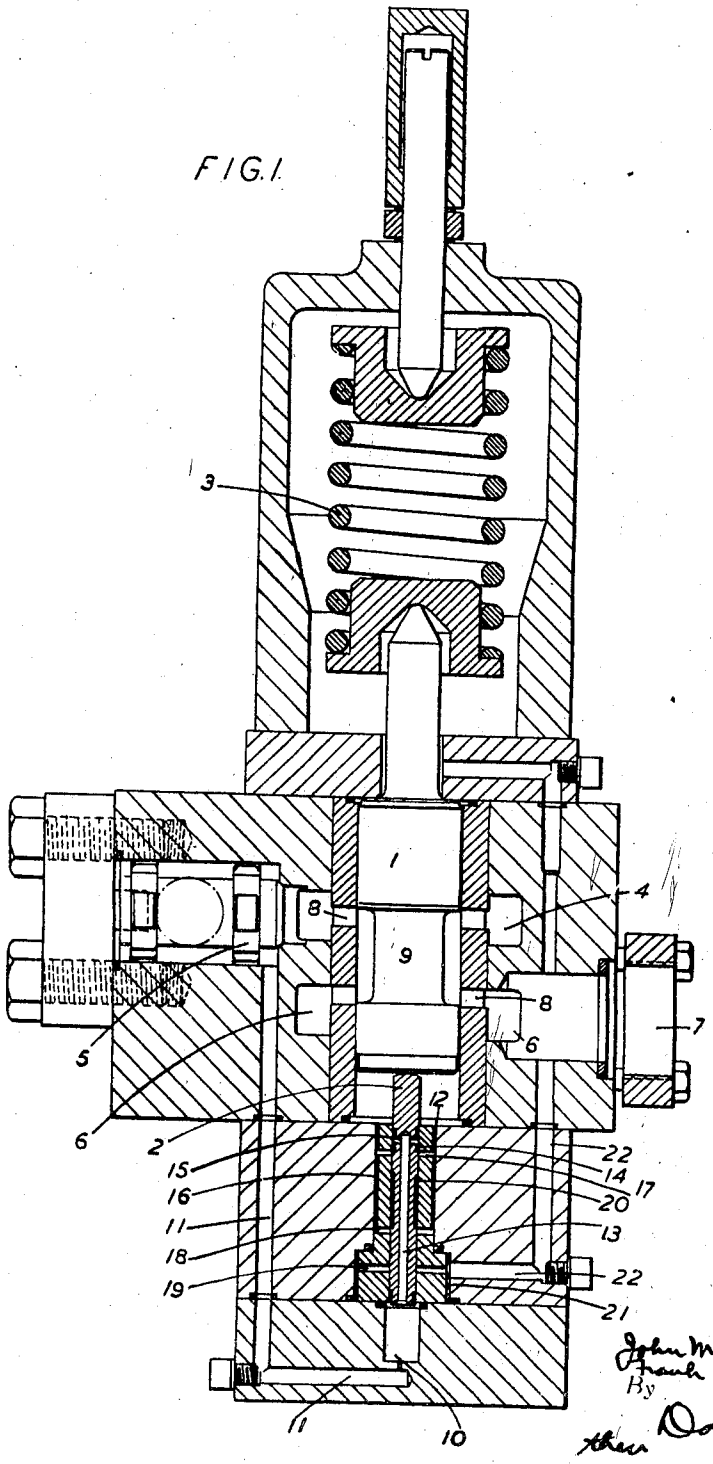
May 27, 1947. J. M. TOWLER ET AL 2,421,133

AUTOMATIC PRESSURE OPERATED HYDRAULIC PISTON TYPE ADMISSION AND EXHAUST VALVE

Filed Oct. 3, 1944 2 Sheets-Sheet 1

FIG. 1.



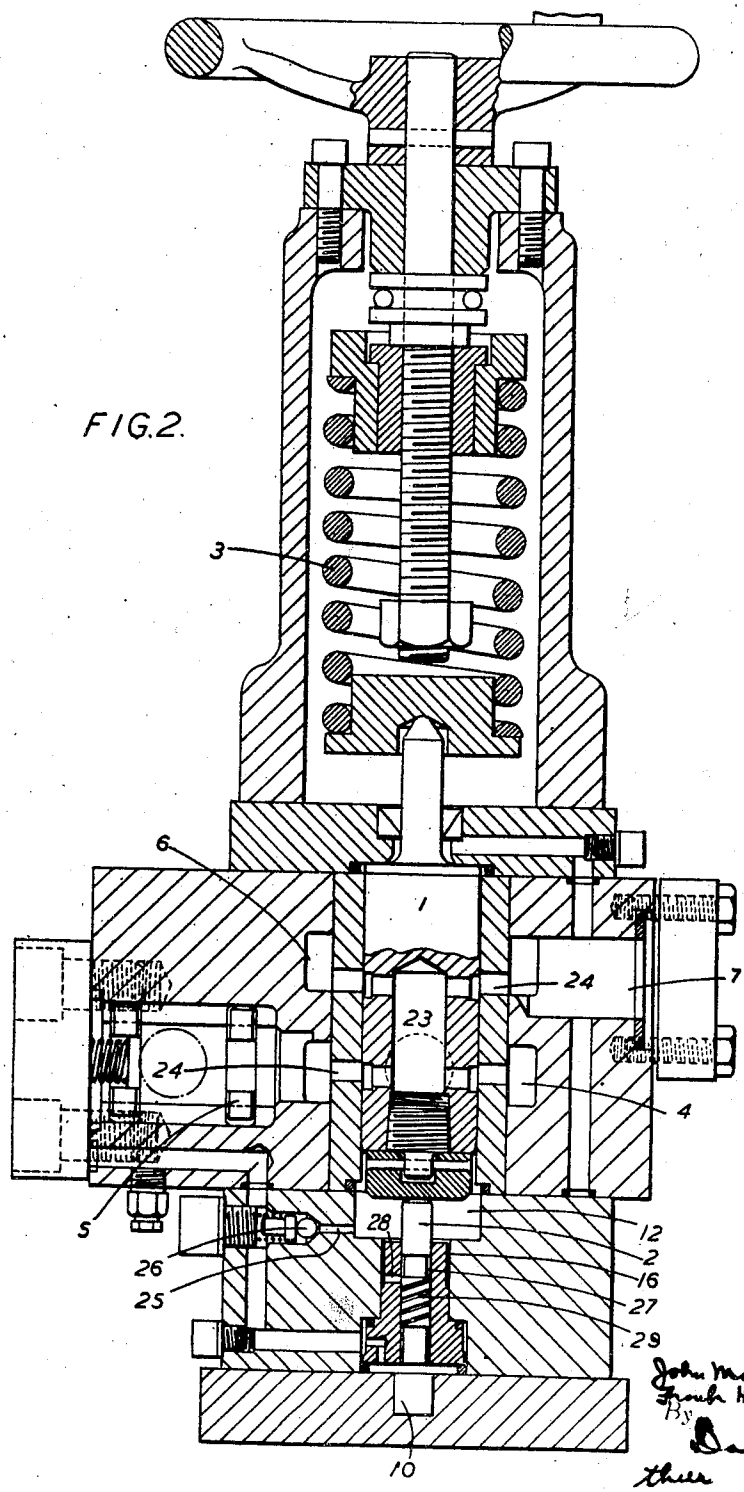
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AUTOMATIC PRESSURE OPERATED HYDRAULIC PISTON TYPE ADMISSION AND EXHAUST VALVE

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FIG. 2.



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AUTOMATIC PRESSURE OPERATED HYDRAULIC PISTON TYPE ADMISSION AND EXHAUST VALVE

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8 Claims. (Cl. 137—153)

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This invention relates to automatic pressure operated hydraulic piston type admission and exhaust valves, preferably of the packingless piston type, for use in conjunction with a hydraulic press or similar hydraulic mechanism which is directly supplied with pressure liquid by a continuously running hydraulic pump, the purpose of the admission valve being to admit pressure liquid to the press cylinder when the pressure which actuates the valve reaches a predetermined figure and the purpose of the exhaust valve being to unload the pump when the valve actuating pressure reaches a predetermined figure, or, if it is connected to a hydraulic cylinder, to open the cylinder to exhaust when the actuating pressure reaches a predetermined figure, the pressure fluid to actuate the valve being derived from the press cylinder or from subsidiary cylinders. By the term "continuously running pump" is meant a pump which runs at substantially constant speed and which delivers liquid at substantially constant pressure irrespective of the changing requirement of the press or other hydraulic cylinder.

The object of this invention is to provide a valve of the above kind with means to ensure that, immediately the fluid pressure which actuates the valve plunger reaches a predetermined figure, the passage from the inlet to the outlet shall be fully opened and it shall remain open until the said actuating pressure falls to a predetermined figure considerably below that which caused the valve to open, or vice versa.

Broadly the present invention consists of an automatic pressure operated hydraulic piston type admission or exhaust valve which is so constructed that when the liquid pressure which actuates the valve reaches a predetermined figure a passage from an inlet to an outlet is opened or closed and remains open or closed until the actuating pressure falls to a predetermined figure which is substantially less than the pressure which caused the valve to open or close.

In the preferred construction of valve according to the present invention actuation of the valve plunger in one direction is effected against opposing spring or other predetermined pressure by hydraulic pressure acting against different piston areas, the pressure on the smaller piston area serving to effect initial movement of the valve plunger and the pressure on the greater piston area serving to hold the valve plunger at the end of its movement, and, if desired, also to complete such movement, the admission and release of the pressure to and from the greater piston area being controlled automatically by valve means.

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These valve means may very conveniently comprise as the valve member an hydraulic ram constituting the means of smaller piston area used in actuating the main valve plunger.

In order that the invention may be clearly understood and carried into effect two embodiments of the improved control valve will now be described by aid of the accompanying drawings in which:

Fig. 1 is a vertical section through the valve according to the preferred embodiment showing the valve plunger in the raised or open position and

Fig. 2 is a similar view of the valve according to the second embodiment.

Referring now to Fig. 1 of the drawings the valve therein illustrated comprises a valve plunger 1 of the packingless piston type which is moved in the opening or upward direction by a small hydraulic ram 2 against an opposing spring 3. The pressure liquid is delivered to an annular space 4 by a continuously running pump, not shown, from whence it has free access to the cylinder of the press, or other hydraulic apparatus to be supplied, past a non-return valve 5. Spaced longitudinally from the annular space 4 is a further annular space 6 and this further space is in permanent open connection with an outlet 7 which may either lead to exhaust, where the present valve operates as an exhaust valve, or to the cylinder of further hydraulic apparatus where the valve operates as an admission valve. In either case the valve plunger 1 operates to isolate these two annular spaces from each other when in the lowered or closed position and to connect the spaces together when in the raised or open position shown. For this purpose the spaces 4 and 6 communicate with the interior of the valve plunger bore by transverse ports 8 which when the valve is open, are bridged by a portion 9 of reduced diameter in the length of the valve plunger.

In the valve illustrated the initial opening movement of the valve plunger is intended to be effected by the hydraulic ram 2 whilst the final opening movement and the holding of the plunger in the fully open position is intended to be effected by hydraulic pressure acting against the underside of the valve plunger, which, as will be seen, has an area subject to the pressure of the liquid considerably greater than the corresponding area of the hydraulic ram. For the above purpose the lower end of the hydraulic ram 2 is open to a space 10 which in turn is in permanent communication with the interior of the pressure

liquid receiving annular space 4 through passages 11. In consequence, when the pressure of the liquid in the space 4 attains a predetermined figure the pressure in the ram overcomes the opposing pressure of the spring 3 and so moves the valve plunger upwards towards its open position. In so doing the hydraulic ram by its construction functions as a control valve and admits pressure liquid from the space 10 to a space 12 beneath the valve plunger to effect the final upward movement of said plunger. The means for this purpose, in the example illustrated, comprises a longitudinal hole 13 up the centre of the ram which hole is open at the bottom and closed at the top where it communicates with an annular space 14 formed by reducing the diameter of the ram for a portion of its length, through transverse ports 15. The pressure liquid in the space 10 thus has open access to the space 14 and controlled access to an annular space 16 through transverse ports 17 when the upward movement of the ram brings the annular space 14 into registration with the ports 17. The annular space 16 is open, at its upper end, to the space 12 beneath the valve plunger so that when said space 16 receives pressure liquid it is enabled to enter the space 12 and so act on the underside of the valve plunger. Similarly the space 16 and with it the space 12 is enabled to be placed in communication with the exhaust or other outlet 7 as a result of downward movement of the hydraulic ram by means of longitudinally spaced transverse ports 18 and 19, which, in the lower position of the ram, are bridged by an annular space 20 formed by a further reduced portion of the ram. These latter ports 19 open into an annular space 21 which in turn communicates with the outlet 7 by passages 22.

In the valve illustrated in Fig. 2 the transfer of liquid from the annular space 4 to the annular space 6 when the valve plunger is in the open position shown takes place as a result of an internal passage 23 within the valve plunger and longitudinally spaced sets of lateral ports 24 and the escape of liquid from the space 12 at the base of the valve plunger occurs through the displacing action of the plunger in its downward movement through the passage 25 past the non-return valve 26 into the line 11 supplying the space 10 beneath the hydraulic ram 2.

Pressure liquid under the control of the ram, passes from the space 10 to the annular space 16 for entry into the space 12 from an annular space 27 formed by a portion of reduced diameter in the ram by way of one or more lateral ports 28. This liquid travels from the space 10 to the space 27 through a helical groove 29 cut in the intermediate portion of the ram.

It is understood that the diameter of the portion of the plunger acting to open or close communication between the pressure liquid inlet and the outlet, which is shown in the figures as greater than the diameter of the ram, is immaterial to the purposes of the present invention and may be equal to or smaller than the diameter of the ram as long as the plunger defines an area subject to the pressure liquid passed by the ram which is larger than the corresponding area of the ram itself. Likewise said larger area subject to the pressure liquid may be defined in a separate element or second ram associated with the valve plunger which receives the pressure liquid upon actuation of the ram and which functions as a unit with the plunger. The expression "plunger" as used in the appended claim is intended to comprise also this latter structure.

As previously described a valve according to the present invention is so constructed that when the liquid pressure which actuates the valve reaches a predetermined figure, a passage from an inlet to an outlet is opened to release said pressure and remains open until the actuating pressure falls to a predetermined figure which is substantially less than the pressure which caused the valve to open. Such a valve is particularly suitable to act as a combined pump unloading valve and relief valve. In such capacity the pressure liquid delivered to the control valve by the pump is made to serve as the pressure liquid to actuate the valve so as to unload the pump when the pressure in the press cylinder or pressure line reaches a predetermined figure. To this end the pump delivers to the inlet connection of the control valve and the outlet is connected to exhaust and a branch connection is provided in the valve body, connecting the inlet with the press cylinder past an interposed non-return valve. Both the illustrated valves are constructed to function in the above capacity.

What we claim is:

1. An automatic hydraulic valve comprising a body having an inlet for pressure liquid and an outlet, a valve plunger reciprocable in said body between a position to open and a position to close communication between said inlet and outlet, a spring for normally maintaining said plunger in its closing position, a space in said body at one end of the plunger normally isolated from the pressure liquid, a bore, a ram slidable in said bore having one end associated with the plunger and subject at its other end to the pressure of the liquid at the inlet for actuation thereby to displace the plunger to the opening position thereof upon attainment of a predetermined pressure of the liquid, the area of said ram open to the pressure liquid being substantially smaller than the free area of the plunger in said space, and means effective in the movement of the ram to control admission of pressure liquid to and release of pressure liquid from the space at the end of the plunger to cause the plunger to be held in the opening position thereof until the pressure of the liquid has fallen considerably below the pressure required for actuating the ram.

2. An automatic hydraulic valve as in claim 1, wherein the means effective in the movement of the ram to control admission of pressure liquid to and release the pressure liquid from the space at the end of the plunger comprise a longitudinal passage within the ram open to the inlet pressure liquid, longitudinally spaced reduced portions in the ram, ports connecting one of said reduced portions with said longitudinal passage, a first annular space surrounding the ram bore communicating with the space at one end of the plunger, a second annular space surrounding the ram bore communicating with the outlet of the valve body, two sets of transverse ports spaced longitudinally of the ram bore and leading from the bore to the first annular space, and a further set of transverse ports connecting the ram bore with the second mentioned annular space, the arrangement being such that in the actuation of the ram the reduced portion of the ram connected to the longitudinal passage within the ram is brought into registration with one of the sets of ports connecting the ram bore with the first annular space to admit pressure liquid to the space at the end of the plunger, and in the return

movement of the ram the other reduced portion thereof is caused to bridge the other sets of ports to connect the first with the second annular space to permit escape of liquid from the space at the end of the plunger to the outlet.

3. An automatic hydraulic valve comprising a body having an inlet for pressure liquid and an outlet, a valve plunger reciprocable in said body between a position to open and a position to close communication between said inlet and outlet, a spring for normally maintaining said plunger in its closing position, a space in said body at one end of the plunger normally isolated from the pressure liquid, a bore, a ram slidable in said bore having one end associated with the plunger and subject at its other end to the pressure of the liquid for actuation thereby to displace the plunger against said spring to the opening position thereof upon attainment of a predetermined pressure of the liquid, the area of said ram open to the pressure liquid being substantially smaller than the free area of the plunger in said space, an annular space surrounding the ram bore communicating with the space at the end of the plunger, ports leading from the ram bore to said annular space, a reduced portion at the end of the ram subject to the pressure liquid, a second reduced portion in the ram, a helical groove connecting said reduced portions, said second reduced portion being brought into registration with said ports upon completion of a predetermined actuating movement of the ram to admit pressure liquid to the space at the end of the plunger to hold the plunger in its opening position, and an outlet port for said space controlled by a check valve permitting escape of the pressure liquid from said space in the return movement of the plunger determined by the spring when the pressure of the liquid falls substantially below the pressure required for actuating the ram.

4. An automatic pressure operated hydraulic valve comprising an inlet and an outlet for pressure liquid, a valve plunger movable between a position to close and a position to open communication between said inlet and outlet, loading means opposing the movement of said valve plunger in one direction, means comprising differential piston areas permitting said plunger to be urged by hydraulic pressure to one of said positions against said load when said pressure reaches a predetermined figure, said means comprising an hydraulic ram which is normally subject to the pressure liquid, said ram constituting the smaller piston area and serving to effect initial movement of the valve plunger when said predetermined pressure is reached, and means controlled by the ram and effective, upon completion of a predetermined actuating movement of the ram, to admit pressure liquid to the greater piston area to hold the valve plunger at the end of its movement, and upon completion of a predetermined return movement to release said pressure liquid and permit the loading means to effect the return movement of the valve plunger.

5. An automatic pressure operated hydraulic valve comprising an inlet and an outlet for pressure liquid, a valve plunger movable between a position to close and a position to open communication between said inlet and outlet, loading means opposing the movement of said valve plunger in one direction, means comprising differential piston areas permitting said plunger to be urged by hydraulic pressure to one of said positions against said load when said pressure reaches a predetermined figure, said means comprising an hydraulic ram which is normally subject to the pressure liquid, said ram constituting the smaller piston area and serving to effect initial movement of the valve plunger when said predetermined pressure is reached, valve means effective in said movement of the ram to admit pressure liquid to the plunger to permit action of the pressure liquid on the larger piston area, whereby to hold the plunger at the end of its movement until the pressure of the liquid has fallen substantially below the pressure required for actuating the ram, and valve means for controlling the release of the liquid acting on the greater piston area to permit the return movement of the plunger by the loading means.

6. An automatic pressure operated hydraulic valve comprising a body having an inlet for pressure liquid and an outlet, a valve plunger slidable in said body between a position to close and a position to open communication between said inlet and outlet, loading means for normally maintaining said plunger in one of said positions, a space at one end of the plunger normally isolated from the pressure liquid, means comprising differential piston areas permitting said plunger to be urged by hydraulic pressure to one of said positions against said load when said pressure reaches a predetermined figure, said means comprising an hydraulic ram which is normally subject to the pressure liquid, said ram constituting the smaller piston area and serving to effect initial movement of the valve plunger when said predetermined pressure is reached, passages in the valve body and in the ram connectable in the movement of the ram to open said space to the pressure liquid to permit action of the pressure liquid on the larger piston area of the plunger, and means for controlling the release of the pressure liquid from said space, whereby to hold the plunger in said position thereof until the pressure of the liquid has fallen substantially below the pressure required for actuating the same.

7. An automatic pressure operated hydraulic valve comprising a body having an inlet for pressure liquid and an outlet, a valve plunger slidable in said body between a position to close and a position to open communication between said inlet and outlet, loading means for normally maintaining said plunger in one of said positions, a space at one end of the plunger normally isolated from the pressure liquid, means comprising differential piston areas permitting said plunger to be urged by hydraulic pressure to one of said positions against said load when said pressure reaches a predetermined figure, said means comprising an hydraulic ram which is normally subject to the pressure liquid, said ram constituting the smaller piston area and serving to effect initial movement of the valve plunger when said predetermined pressure is reached, passages in the valve body and in the ram connectable upon completion of a predetermined actuating movement of the ram to open said space to the inlet pressure liquid to permit action of the pressure liquid on the larger piston area to cause the plunger to complete its movement to said position and hold the same in said position, and passages in the valve body and in the ram connectable in the return movement of the ram following the return movement of the plunger to permit escape of the pressure liquid from said space to the outlet.

8. An automatic pressure operated hydraulic valve comprising a body having an inlet for pressure liquid and an outlet, a valve plunger slidable in said body between a position to close and a po-

sition to open communication between said inlet and outlet, loading means for normally maintaining said plunger in one of said positions, a space at one end of the plunger normally isolated from the pressure liquid, means comprising differential piston areas permitting said plunger to be urged by hydraulic pressure to one of said positions against said load when said pressure reaches a predetermined figure, said means comprising an hydraulic ram which is normally subject to the pressure liquid, said ram constituting the smaller piston area and serving to effect initial movement of the valve plunger when said predetermined pressure is reached, passages in the valve body and in the ram connectable in the movement of the ram to open said space to the pressure liquid to permit action of the pressure liquid on the larger piston area of the plunger, and a passage

provided with a non-return valve for controlling the release of the liquid from said space, whereby to hold the plunger in said position thereof until the pressure of the liquid has fallen substantially below the pressure required for actuating the ram.

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