

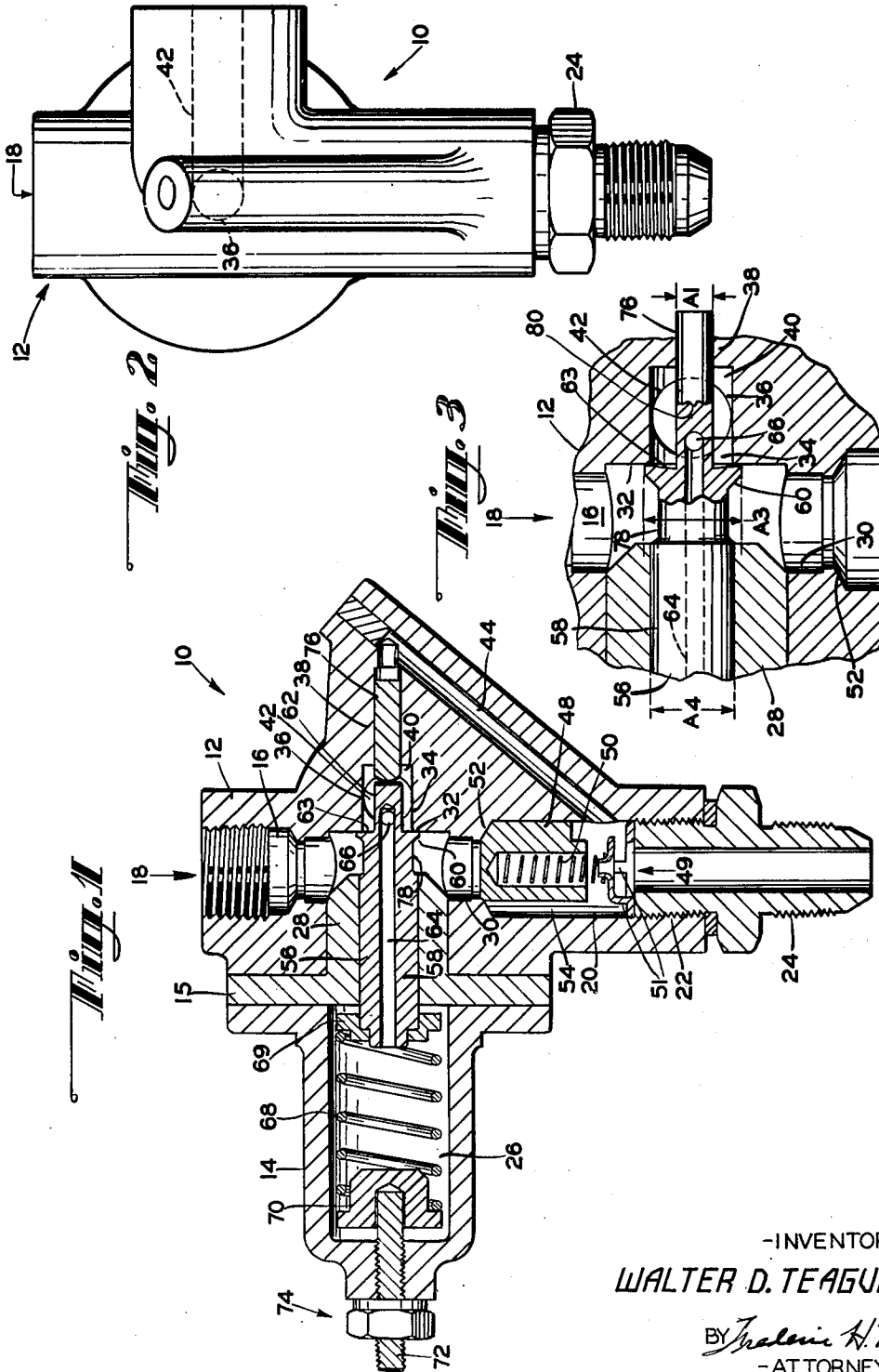
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PUMP UNLOADING VALVE

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PUMP UNLOADING VALVE

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The invention hereof relates to valves, and particularly a valve for retaining pressure in an accumulator while unloading a pump to reduce the average power used.

Among the objects of the invention are to overcome disadvantages of former valves of such character and to do so by novel effective means.

Another object is to provide novel area relation between piston and valve disc elements whereby spring and hydraulic pressures are considerably in excess of possible opposing friction forces.

Another object, in association with an area arrangement ensuring rapid and complete opening and closing, of an unloading valve, is to provide means including a plurality of pistons operative as one piston in effecting the opening and closing movements.

Another object is to provide novel means to compensate for discrepancies which may occur in the alignment of such elements.

Another object is to provide novel means for draining a spring or pressure chamber to the closed side of a valve while the valve is in normal position closing the drain to a main fluid.

Another object is to provide a valve of the type noted which is light in weight.

Another object is to provide an unloading valve that is simple and durable in construction, economical to manufacture and effective in its operation.

These and other objects and features of the invention are pointed out in the following description in terms of the embodiment thereof which is shown in the accompanying drawing. It is to be understood, however, that the drawing is for the purpose of illustration only, and is not designed as a definition of the limits of the invention, reference being had to the appended claims for this purpose.

In the drawing:

Figure 1 is a side view in section of a valve constructed in accordance with the invention in one form;

Figure 2 is an elevation taken at right angles to Figure 1; and

Figure 3 is an enlarged detail of a modification of a valve and piston element, as viewed in Figure 1.

Referring to the drawing, the device comprises a housing 10 including portions 12, 14 and 15, a through bore conduit 16 in the portion 12 including an inlet 18 adapted to receive fluid from a pump, a check valve chamber 20, an outlet 22 adapted to receive a tube coupling 24 for com-

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munication with a fluid pressure accumulator, a spring chamber 26 in the housing portion 14, and a cylinder 28 in the housing portion 15 and located between the inlet 18 and the check valve chamber 20 and extending at a right angle or transversely to the conduit 16 between the spring chamber 26 and one side 30 of the conduit. A valve seat 32 at the opposite side of the conduit opens into one end 34 of a drain chamber 36, and, for facility of manufacture, may have a diameter substantially the same as the outer diameter of the cylinder 28. A second cylinder 38 of smaller inner diameter than, and aligned with, the first cylinder 28, extends from the other end 40 of the drain chamber 36. A drain 42 communicates with the drain chamber, and a passage 44 communicates between the second cylinder 38 and the outlet side of the check valve chamber 20 downstream of the inlet 18 and the pump when connected thereto.

A check valve 48, in the chamber 20, is normally biased by a spring 50 against a seat 52 in the conduit 16, and opens under pump pressure to the outlet 22, the check valve being provided with side passages 54 for this purpose.

A retainer 49, for the spring 50 and in this instance seated on the coupling 24, comprises upper and lower portions joined, as by three legs 51 to provide free fluid flow past or through the retainer.

A pressure relief piston 56 includes a body 58 in the first cylinder 28 and a seating portion or valve disc 60 for the seat 32 normally closing the drain chamber 36 relative to the conduit 16, and in this instance is provided with an extension 62 in the drain chamber 36. An axial duct 64 normally communicates between the spring chamber 26 and the drain chamber 36 through an orifice 66 in the extension 62. Also, in this instance, a plane face 63, at the right hand or valve closing side of the portion 60, it at right angles to the valve axis.

A compression spring 68 acts between a seat 69 on the relief piston 56 and a seat 70 on a screw 72, and normally biases the relief piston to close the drain chamber 36. The seat 70, the screw 72, and a lock nut device 74 constitute means whereby the pressure of the spring 68 may be adjusted from a position exteriorly of the spring chamber 26.

In the form of Figure 1, a separate piston 76, in the second cylinder 38, is responsive to fluid pressure in the passage 44 to engage and bias the relief piston 56 against the action of the spring 68, and against fluid pressure in the con-

duit 16. The pistons 56 and 76 may be one integral member 80, as shown in Figure 3, but having them separate as shown, compensates for discrepancies in alignment which may occur between the cylinders 28 and 38.

The relief piston 56 includes a constricted portion 78 between the piston body 58 and the seating portion 60 normally across the conduit 16 providing for fluid passage through the conduit past the piston.

In this instance, the cross sectional area of the seating portion 60, minus the cross sectional area of the relief piston body 58, is equal to substantially three tenths of the cross sectional area of the separate or second piston 76.

In operation, when the pressure in the accumulator, represented by the pressure in the check valve chamber 20 and the passage 44, attains a predetermined value, the second piston 76, acting against the spring 68, pushes the relief piston 56 to the left, thus unseating the portion 60 from the seat 32 and providing communication from the inlet 18 to the drain chamber 36 and the drain 42, to unload, and reduce the average power used in operating the pump. Upon the first unseating movement of the portion 60, the fluid pressure in the conduit 16, which had been assisting the spring 68 to hold the portion 60 closed, is immediately nullified, so that the valve opens quickly and completely. It closes in the same manner.

To have the valve open, as described, at a pressure, for example, such as 1500 pounds per square inch, and close at say 1000 p. s. i., the diameter of the seating portion or valve disc 60 is made slightly larger than that of the piston 56. Also, with the valve of approximately the size originally illustrated herein, the cross sectional areas are substantially as above set forth, so that the spring and hydraulic pressures acting on the piston 56, the valve disc 60 and the piston 76 are considerably in excess of possible frictional forces.

The duct 64 and the orifice 66 operate to drain the chamber 26 of fluid which may pass thereto past the piston 56, so that the device may be easily effectively sealed and the piston 56 maintained free from effects of accumulated fluid in the chamber.

As shown in Figure 3, the pistons 58 and 76 are in one integral piece, and the face 63, instead of being plane and at right angles to the valve axis, as in the above-described form, is of dished or frusto-conical shape symmetrical to the axis to further ensure good sealing entirely around the perimeter of the portion 60.

In this figure, the piston 76 has a cross sectional area A_1 , the portion 60 has an area A_3 , and the piston 58 has an area A_4 .

To determine the pressure spread between loading and unloading parts:

If

A_1 = the area of the piston 76.

A_2 = the area A_3 of the seating portion 60 minus the area A_4 of the body 58.

F = the force of the spring 68.

P_o = unloading pressure at which the valve opens.

P_c = loading pressure at which the valve closes.

At the point of opening:

$$P_o A_1 = P_o A_2 + F$$

At the point of closing:

$$P_c A_1 = F$$

Therefore:

$$\begin{aligned} P_o A_1 - P_o A_2 &= P_o A_1 \\ P_o (A_1 - A_2) &= P_o A_1 \end{aligned}$$

$$P_o / P_c = \frac{A_1}{A_1 - A_2}$$

Thus, the relation of A_1 to $(A_1 - A_2)$ governs the pressure "spread" between opening and closing.

The spring force F governs the absolute values of the opening and closing pressures.

Although only two embodiments of the invention have been illustrated and described, various changes in the form and relative arrangements of the parts, which will now appear to those skilled in the art, may be made without departing from the scope of the invention. Reference is, therefore, to be had to the appended claims for a definition of the limits of the invention.

What is claimed is:

1. A valve assembly comprising a housing having a through conduit including, in alignment, an inlet adapted to receive fluid under pressure from an outside source, a check valve chamber, and an outlet adapted to communicate with a fluid pressure accumulator, a valve seat in said chamber at the inlet side thereof, a piston slidably mounted in said chamber and adapted at one end thereof to engage said valve seat, a spring normally operative to hold said piston in engagement with said valve seat, said piston having a side passage providing for the passage of fluid through said check valve chamber when said piston is moved away from said valve seat in response to inlet fluid pressure, said piston being responsive to fluid pressure at said outlet to close said check valve chamber to inlet fluid pressure, said housing having a drain chamber communicating with said through conduit including a valve seat normally disposed to said conduit, a drain communicating with said drain chamber, a relief piston having a body portion slidably mounted in said housing and a valve portion of greater cross-sectional area than said body portion, said valve portion being adapted to engage the valve seat of said drain chamber, spring means adjustably mounted in said housing and operatively associated with said relief piston to effect a predetermined bias on said relief piston in a direction whereby said valve portion engages the valve seat of said drain chamber, said relief piston having a constricted portion intermediate the body and valve portion thereof and disposed normally across said through conduit, said constricted portion defining relatively different pressure areas on said body and valve portions of said relief piston, the effective pressure area of said valve portion being greater than the effective pressure area of said body portion and disposed in said conduit whereby fluid pressure passing through said conduit and around said constricted portion effects a predetermined bias on said relief piston in a direction augmenting the biasing effect of said spring means when said valve portion is engaged with said valve seat, a second piston of lesser cross-sectional area than the body and valve portions of said relief piston slidably mounted in said housing and having one end thereof operatively associated with the valve portion of said relief piston, a passage communicating with the check valve chamber at the outlet side thereof and with the opposed end of said second piston whereby fluid pressure at the outlet side of said check valve chamber in excess of the

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predetermined biasing of the relief piston as aforesaid, actuate said second piston to overcome the predetermined biasing of said relief piston, thereby unseating the valve portion of the relief piston from said valve seat and permitting fluid from said inlet to flow through said drain chamber to said drain, and simultaneously moves the piston in said check valve chamber in a direction to close said check valve chamber to said inlet, said relatively different pressure areas being effective when said valve portion is unseated from said valve seat to assist movement of said relief piston against said spring means.

2. A valve assembly comprising a housing having a through conduit including, in alignment, an inlet adapted to receive fluid under pressure from an outside source, a check valve chamber, and an outlet adapted to be connected to a fluid pressure accumulator, a check valve in said check valve chamber opening to said outlet and responsive to the fluid pressure at both said inlet and outlet, said check valve including a piston having a side passage providing for fluid flow through said check valve chamber when said check valve is opened in response to inlet fluid pressure, a drain chamber in said housing normally disposed to said conduit and having a valve seat adjacent said conduit, a drain in communication with said drain chamber, a relief piston having a body portion mounted for reciprocating movement in said housing and having a constricted portion extending across said conduit, a valve head formed at one end of said constricted portion adapted to engage said valve seat to close communication between said conduit and drain chamber, said valve head having a greater cross-sectional area than said body portion, said constricted portion defining relatively different pressure areas on the body and valve head portions, the effective pressure area on said valve portion being greater than the effective pressure area of said body portion and disposed in said conduit for effecting a predetermined biasing load on said relief piston when fluid under pressure passes through said conduit and around said constricted portion, spring means adjustably mounted in said housing and operatively associated with said relief piston for effecting a predetermined load on said relief piston augmenting the biasing load produced by the different pressure areas on the body and valve head of said relief piston, the predetermined loading of the relief piston normally being operative to hold said valve head in engagement with said valve seat, relief piston operating means mounted for reciprocation in said housing and operatively associated with the valve head of said relief piston for effecting the unseating of said valve head, and a passage in said housing between the outlet side of said check valve chamber and a portion of said relief piston operating

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means whereby said relief piston operating means is actuated in response to a predetermined fluid pressure at said outlet to move the relief piston against the predetermined biasing loads aforesaid, thereby permitting fluid flow from said inlet through said drain chamber to said drain, said relatively different pressure areas being effective in response to said last mentioned flow to assist movement of said relief piston against said spring means.

3. In combination a valve comprising a through conduit including an inlet and outlet in alignment therewith, a check valve in said through conduit opening to the outlet, said check valve including a check-valve piston movable in response to both inlet and outlet pressure, a drain communicating with said through conduit, a main piston at right angle to said through conduit and movable to a position to close said drain from said through conduit, spring means operatively associated with one end of said main piston for moving and maintaining said main piston to and in said closed position, said main piston having a constricted portion extending across said through conduit, said constricted portion defining relatively different pressure areas on said main piston, the effective pressure area of the main piston closing said drain being greater than the effective pressure area of the main piston remote therefrom, said pressure areas being positioned in said conduit and operative in response to pressure flow in said conduit from said inlet through said outlet to augment said spring means in maintaining said main piston in said closed position, a smaller piston at the opposite end of said main piston, and a passage from said outlet adapted to subject said smaller piston to back pressure therefrom to overcome said spring and pressure areas maintaining said main piston in closed position, and thereby establish communication between said through conduit and said drain, said pressure areas of said main piston being effective to assist said smaller piston to overcome said spring means upon the opening of said conduit to said drain.

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