

Jan. 14, 1969

R. F. DE MARCO

3,421,545

FREE DELIVERY AND VARIABLY RESTRICTED RETURN VALVE

Filed Feb. 28, 1967

Fig. 1.

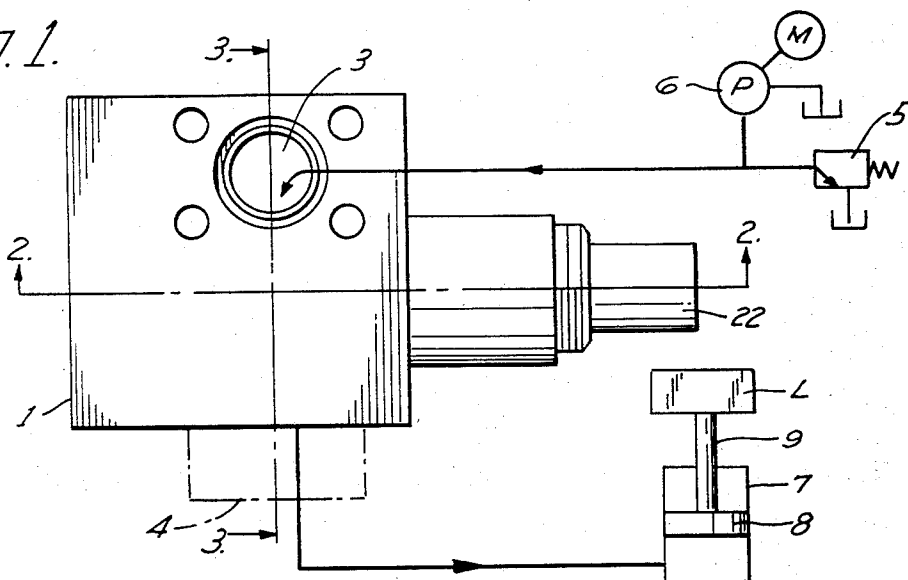


Fig. 2.

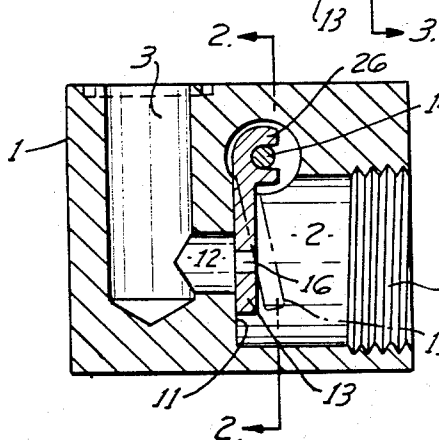
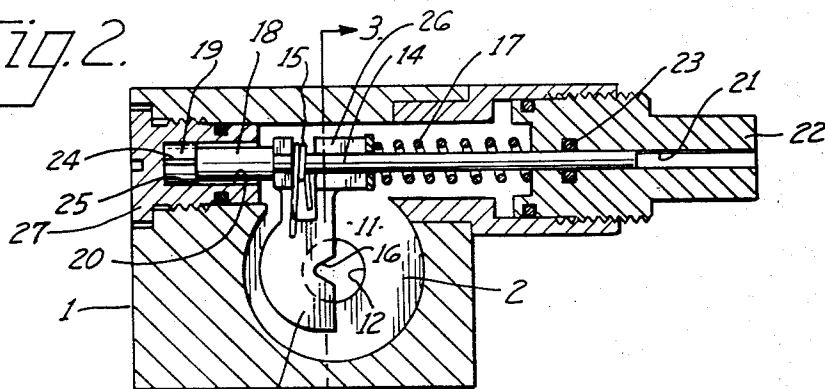


Fig. 3.

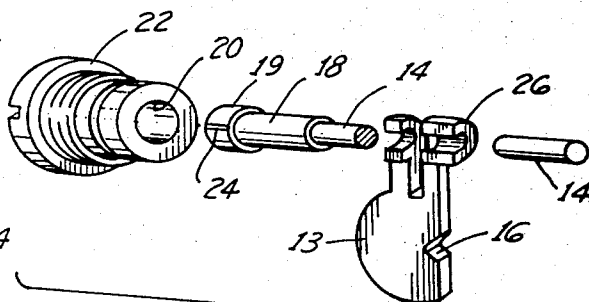


Fig. 4.

INVENTOR.
Robert F. De Marco,
BY *John H. Leonard*,
Attorney.

1

3,421,545

FREE DELIVERY AND VARIABLY RESTRICTED RETURN VALVE

Robert F. De Marco, Mentor, Ohio, assignor to Fluid Controls, Inc., Mentor, Ohio, a corporation of Ohio

Filed Feb. 28, 1967, Ser. No. 619,372

U.S. Cl. 137—513.3

10 Claims

Int. Cl. F16k 17/04; F15d 1/02

ABSTRACT OF THE DISCLOSURE

A valve having a generally axially pivotable valve plug to permit free flow of fluid in one direction through an orifice in the valve when the plug is pivoted away from its seated position. The valve plug is also mounted to be selectively moved transversely of the axis of the orifice to a number of set positions for variably restricting the flow of fluid in the return direction as desired, depending upon the selected position of the valve plug.

Description of the invention

This invention relates to a free delivery and variably restricted return valve, and particularly to a valve suitable for permitting relatively free flow of pressure fluid from a pump to a hoist cylinder to hoist a load and for restricting the return of fluid at various controlled rates, dependent upon the weight of the load, so as to lower loads at safe speeds.

The valve is shown for purposes of illustration connected in the hydraulic circuit of a hydraulic hoist for providing safe rates of lowering loads thereby, its use for other purposes being apparent from the illustrative example.

This invention is an improvement on the load lowering valve described in my co-pending application Ser. No. 448,919, filed Apr. 19, 1965, and entitled Load Lowering Valve for Hydraulic Hoists.

As more fully disclosed in the above-entitled application, a number of problems are presented in connection with hoisting and lowering of loads with fork lift trucks. It is desirable economically that the load be hoisted as rapidly as is commensurate with safety and generally safe hoisting is maintained due to the capacity of the pump and its drive. Upon lowering, however, high inertial forces are developed which make it desirable to restrict the return flow of the pressure fluid in a proper relation to the weight of the load. The rate of lowering should be reduced, relative to what it would be were the valve fully open for free flow, as the load is increased. However, it is also economically desirable that the load be lowered as rapidly as is consistent with safety, and hence that the return flow through the valve be adjusted accordingly in relation to the weight of the load, the return flow being greatly restricted in case of heavy loads and progressively less restricted in case of progressively lighter loads.

In the above entitled application, the desirable and safe delivery and return flows are obtained by providing a valve having an orifice which is normally closed or restricted by a check valve plug which permits free flow through the orifice from the inlet of the valves to the outlet for hoisting. Upon return flow, the plug seats and thereby restricts the orifice to preselected maximum effective orifice area for return flow. Thus the valve permits free flow for hoisting and a large, but somewhat restricted return for rapid lowering of light loads. The plug was arranged, however, so that it could be set for progressively greater restriction for progressively greater loads. This setting depends upon the pressure of the working fluid in the valve. In the above co-pending application, this setting is accomplished by means of a piston exposed to the

2

pressure fluid in the valve body and connected to the valve plug by a flexible tension applying connector or wire which pulls the valve plug, while unseated, to set positions for reduced return flow against the force of a return spring which biases the valve plug to the setting for maximum return flow. The set positions to which the plug is pulled by the piston are for progressively less flow the farther the piston is moved by the fluid. Thus the higher the pressure of the fluid becomes, the more restricted becomes the return flow. While this valve performs effectively, an objection is that, should the connecting tension means between the valve and the piston break during hoisting, the plug would be moved by the return spring before seating to the least restricting position, so that the load might be lowered much too rapidly for safety.

The present valve is one which is designed to perform the same basic operations as the valve of the above application, but is improved so as to "fail safe." Instead of the valve plug being pulled to progressively more restricting positions, upon increases in load, by tensioning forces pulling it to those positions, as in the application, the valve plug of the present improvement is pushed or moved to progressively more restricting positions, upon increases in load, by compressive forces exerted on the plug by the piston. The means for pushing the plug to more restricting positions is such that no valve failure which would permit the spring to move the valve plug toward its least restricted position can occur.

Specific new features of the present invention, other than the fail safe feature, will become apparent from the following description wherein reference is made to the drawings, in which:

FIG. 1 is a top plan view of the valve embodying the principles of the present invention and showing diagrammatically, its connection in the hydraulic circuit of a hoist;

FIG. 2 is a vertical sectional view taken on the line 2—2 of FIGS. 1 and 3;

FIG. 3 is a cross sectional view taken on the line 3—3 in FIG. 2; and

FIG. 4 is an exploded view of the control cylinder and piston, and the valve plug assemblage which may be used in the present invention for convenience in installation.

Referring to the drawings, the valve comprises a body 1 having a cavity 2 into which leads an inlet 3 and from which leads outlet 4. For convenience in description, the inlet 3 is shown as connected in a circuit including an overload relief valve 5 and a motor driven pump 6. The outlet 4 is connected to a cylinder 7 in which is operable a piston 8 having a rod 9 which is operable to hoist a load L.

Within the cavity 2, between the inlet 3 and the outlet 4, is a wall 11 having an orifice 12 therein and providing a seating area in surrounding relation to the orifice. Mounted within the cavity 2 is a check valve plug 13 which is arranged to seat on the wall 11 for restricting the effective area of the orifice 12 through which the return fluid flows, and to be unseated by the delivery fluid to permit free flow of fluid through the valve from the inlet 3 to the outlet 4 from the pump to the cylinder 7. For supporting the plug for movement toward and away from the wall 11, the plug is mounted on a support 14 for swinging about an axis offset from and disposed in a plane normal to the axis of the orifice 12.

A suitable spring 15 is provided for lightly biasing the valve plug 13 into seating relation on the wall 11. The spring may be a coil spring extending about the axis of the support 14 with one end bearing on the valve plug and the other end bearing against, and sliding along, the wall of the cavity in which the plug is located. Since in all cases, it is desirable to have a return flow past the seated valve plug, the valve plug may be arranged so

that it does not entirely close the orifice when seated. This may be accomplished simply by supporting the valve plug 13 on the support 14 so that when the plug normally seats in its adjusted position, it does not fully cover the orifice 12, or by providing a suitable notch 16 in the valve plug. The valve plug is supported not only for swinging toward and away from seating position generally axially of the orifice, but also for movement in a direction transversely of the axis of the orifice to set positions. This is accomplished by making the support 14 movable endwise of its own axis. If a notch is used, its shape is chosen in relation to the size of the orifice 12 so that in set positions to which the valve plug 13 is moved in a direction transversely of the axis of the orifice 12, the desired rate of return flow, depending upon the set position of the valve plug, is obtained.

The valve plug 13 is normally biased in a direction transversely of the orifice axis by a spring 17 toward the position in which the plug 13 least restricts the orifice. Therefore, assuming that no load being supported by the piston 8, a relatively free flow of fluid in the return direction through the valve can be obtained. The valve plug is moved in a direction transversely of the axis of the orifice 12, which direction is parallel to the axis of the supporting member 14, by a reciprocable compression means.

In the form illustrated, the compression means comprise a piston, indicated generally at 18, having a head 19, and a rod which provides the support 14. The piston is arranged so that, when driven by fluid pressure, it is driven in opposition to the spring 17 and thus forces the plug 13 to the right in FIG. 2 against the opposition of the spring 17. It is desirable that the valve plug 13 be moved increasingly in the restricting direction for reducing the effective size of the orifice 12 as the pressure in the cavity 11 increases. This adjustment of the valve, as in the co-pending application, is effected while the valve is unseated by the introduction of fluid into the inlet 3 and therefore is not frictionally bound in seated position against the wall 11. This requires only a very light fluid pressure as the only resistance to be overcome is that of the spring 17, whereas when the plug 13 is seated by the return flow of fluid, the differential pressure built up on the discharge side of the wall 11 holds the plug sufficiently tightly against the wall 11 so as to frictionally prevent its adjustment or change in position in a direction transversely of the axis of the orifice 12.

The piston has a head 19 and may be guided in a cylinder 20 which may be formed in a separate plug screw fitted and sealed in a suitable bore in the body 1. The member 14 preferably is rigid and integral and coaxial with the piston and extends into a suitable bore 21 in a plug 22, which is secured in a bore in the body in coaxial relation with the cylinder 20. The length of the portion of the rod 14 extending into the bore 21 may be sufficiently long and fit sufficiently closely to provide an effective non-friction seal. However, an O-ring seal 23 may be provided, if desired. The bore 21 is open at its outer end to the atmosphere so that the outer end of the rod 21 is not subjected to the pressure fluid in the cavity. Thus, assuming that the fluid in the cavity can readily reach both sides of the piston, a differential in pressure is provided on the reciprocal member as a whole, the differential in pressure being equal to the area of the end of the rod or support 14 and being the effective pressure on the head end of the piston.

The cylinder 20 is not essential, but it does have advantages. Even if the piston head were directly exposed in the cavity to the pressure fluid therein without a cylinder, the differential in pressure would still drive the piston to the right. However, the cylinder 20 does provide a guide and a means for controlling the rate of flow of fluid to the head end of the piston. If the left end of the piston 18 were exposed directly in the cavity, it might

be too sensitive in its response in many instances. The controlled rate of admission of pressure fluid to the left end of the piston head 19 in FIG. 2 is preferable and can be obtained in a number of ways. For more rapid response, a notch 24 may be provided in the head for by-passing fluid between the right and left ends of the piston. On the other hand, if a slower response is desired, the notch may be reduced greatly, or it may be omitted entirely, and proper selected radial clearance be provided between the periphery of the head and cylinder wall, as indicated at 25. The clearance may be so chosen as to permit an adequate rate of flow of pressure fluid to and from the head end of the piston while providing a damping action to eliminate flutter and control the response of the piston more effectively.

It is apparent with this structure that pressure fluid delivered by the pump may flow relatively freely through the inlet and pass through the orifice 12, unseating the valve plug 13 and flowing through freely out of the outlet 4 to the cylinder 7 to hoist the load. The pressure developed in the fluid system depends upon the weight of the load and the rate at which it is being hoisted, and is reflected in the pressure in the valve cavity at the outlet side of the plug 13. As the pressure at the outlet side increases, it drives the reciprocable compression means, comprising the piston 18 and rod 14 to the right in FIG. 1 against the resistance of the spring 17, thus moving the valve plug 13, which is unseated during the hoisting, to progressively move to restricting positions, depending upon the increase in pressure. Thus the valve plug 13 is being set for proper return flow for the particular load at all times during the delivery from the pump to the cylinder 7 for hoisting the load. Again, when picking up a load, a very free flow through the valve is provided from the inlet to the outlet for rapidly raising the piston 8 in the cylinder. In this rapid rise the piston suddenly is subjected to the load and the pressure rises almost instantly to a very high degree. However, the piston 19 responds immediately to force the unseated valve plug 13 to the desired restricting position, depending upon the effective load or force on the hoist piston 9.

As soon as the hoisting by the piston 9 ceases, the pressure on opposite sides of the plug 13 tends to equalize, whereupon the spring 15 seats the plug, in its set position, against the wall 11. Upon reducing pump pressure or opening the circuit for free flow of the fluid pressure back to the sump, the pressure on the outlet side of the valve plug 13 seats and frictionally binds the plug against the wall 11 in the position into which it has been adjusted while it was unseated.

It is apparent that this structure has an advantage over that described in the above entitled application in that practically no valve failure can occur due to breakage of any connection between valve plug 13 and the piston head 19, which would allow the plug to be returned by the spring 17 to the least restricting position. Breakage in no case would free the plug 13 for movement to the minimum restricting position.

For convenience in manufacture, the cylinder 20, piston 19 and plug 13 can be made as illustrated in FIG. 4. The cylinder 20 may be provided in a detachable screw threaded plug 27. The piston head 19 and rod 14 may be integral with each other or fixedly secured together. The valve plug 13 may be provided with a connecting portion 26 which is offset from its orifice restricting portion. The portion 26 may be in the form of a channel so that the plug 13 may be connected pivotally to the rod 14 by moving the channel radially of the rod to seat the rod in the channel. Thus access of the plug 13 to the rod 14 can be gained through an open face of the valve body for radial assembly as distinguished from axial assembly.

A cover closing one side of the valve body, when secured in place, prevents the channel portion 26 from becoming detached from the rod 14.

Having thus described by invention, I claim:

1. A valve comprising a hollow body having an inlet and an outlet,

settable throttling valve means in the body including a valve seat having an orifice, and a valve plug movable out of seated position on the seat to permit a relatively large orifice area for flow of pressure fluid from a source through the body from the inlet to the outlet and movable into seated position to restrict the orifice area for flow from the outlet to the inlet, said plug being settable, while unseated, to set positions wherein it will upon reseating, restrict the orifice area in varying degrees depending upon said set positions,

resilient means normally urging the plug to a position for maximum orifice area for flow of fluid from the outlet to the inlet,

fluid pressure operable means connected to the valve plug and arranged to be subjected to the pressure of fluid in the body during changes in said pressure and operable thereby to set the unseated valve plug into set positions during increases of pressure of the fluid at the outlet side of the seat, for decrescent degrees of orifice area for flow from the outlet to the inlet, depending upon said increases of pressure,

and means to return the valve plug to seated position while it is held by the fluid pressure operable means in the position in which it has been set before the occurrence of substantial flow of pressure fluid from the outlet to the inlet,

characterized in that said fluid pressure operable means comprises a reciprocable compression member with one end drivingly connected to the valve plug so as to push the valve plug in the opposite direction from that in which the plug is urged by the resilient means, when the pressure at the outlet side of the seat reaches a predetermined value.

2. The structure according to claim 1 wherein the plug has an orifice therethrough alignable in different degrees with the orifice of the seat, and at least one of the orifices is shaped to cause predetermined rates of change in the flow of fluid from the outlet toward the inlet past the plug in relation to the axial position of the piston.

3. The structure according to claim 1 wherein supporting means support the plug for movement in one path extending generally endwise of the axis of the orifice toward and away from said seating position by the fluid and for movement by the reciprocable member in a second path generally transversely of the axis of the orifice to set positions in all positions of the plug along said one path, while the plug is unseated.

4. The structure according to claim 3 wherein the supporting means support the plug for rocking about a predetermined axis in a direction toward and away from the seat and for movement endwise of said predetermined axis to said set positions.

5. The structure according to claim 4 wherein said supporting means is a rigid member extending generally endwise of the path of the reciprocable member.

6. The structure according to claim 5 wherein the reciprocable member is a piston and the rigid member is a piston rod coaxial with and secured in fixed position on the piston.

7. The structure according to claim 1 wherein the reciprocable member has a portion at one end exposed for access to fluid in the interior of the body and a portion at the other end which is free from access of said fluid so that the reciprocable member is driven in the direction for pushing the valve in said opposite direction by pressure of the fluid applied on said one end.

8. The structure according to claim 7 wherein the reciprocable member has a shoulder facing in the pushing direction and bearing against the plug so as to transmit to the plug, in said pushing direction, compressive forces applied to the piston by the fluid in the body.

9. The structure according to claim 1 wherein a cylinder is carried by the body, the reciprocable compression member is a piston reciprocable in the cylinder and having a rod at said one end, and duct means are provided which connect the head end of the cylinder with the interior of the body.

10. The structure according to claim 1 wherein the reciprocable member is a piston having a rod portion and being rockable about, and movable endwise of, an offset axis offset from the axis of the orifice and lying in a plane normal to the orifice axis, and the plug is mounted on the rod portion for rocking about said offset axis toward and away from seated position relative to the seat in all axial positions of the piston.

References Cited

UNITED STATES PATENTS

2,886,065	5/1959	Hershman	138—46
3,146,792	9/1964	Donnelly et al.	137—513.3 X
3,298,393	1/1967	Mosier	137—513.3

LEONARD D. CHRISTIAN, *Primary Examiner.*

U.S. Cl. X.R.

138—46