May 10, 1949. N. BASHARK 2,469,362

FLUID PUMP AUTOMATIC AIR BLEED VALVE

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FIG. 1.

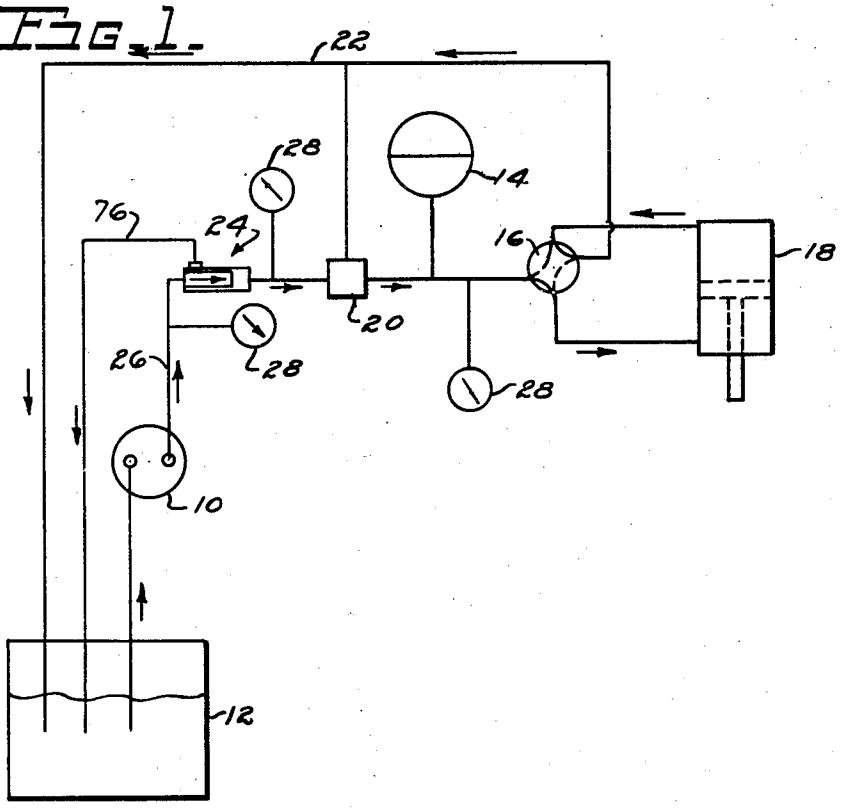


FIG. 2.

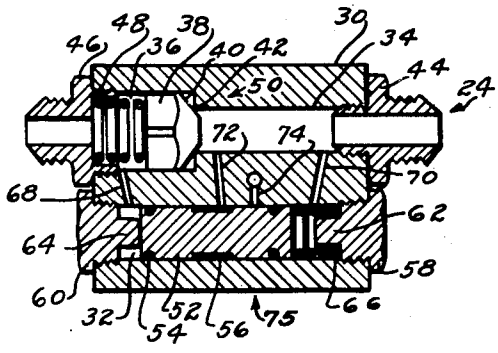
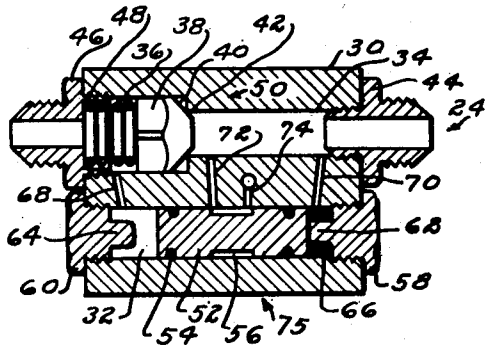


FIG. 3.



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Fig. 4.

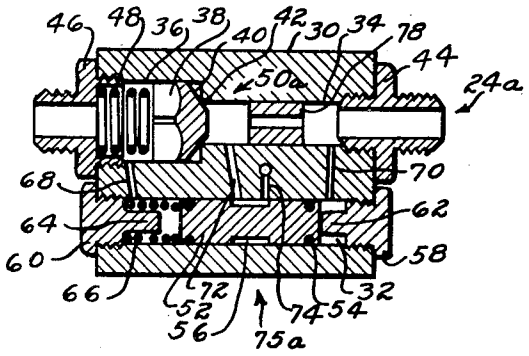
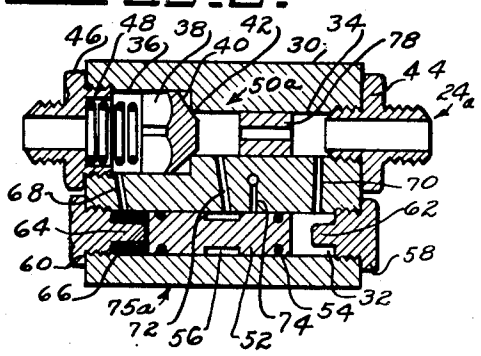


Fig. 5.



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FLUID PUMP AUTOMATIC AIR BLEED VALVE

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8 Claims. (Cl. 277—60)

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The invention described herein may be manufactured and used by or for Government for governmental purposes, without the payment to me of any royalty thereon.

This invention relates to fluid pressure systems of that class in which a fluid is required to be maintained under a substantially constant pressure by a pumping or similar means, and more particularly to a means for separating air from oil or other liquid which is being pumped.

In systems of this character, particularly where the pump of the system has its suction or low pressure side connected to a supply tank or reservoir from which it takes fluid and discharges it into the high pressure side of the system it happens frequently that air gets into the suction line and the system becomes air locked.

Air locks in hydraulic systems occur from a number of causes, such as the uncovering of the open end of the suction line in certain flight maneuvers, leaks in the suction line or suction side of the pump, loss of head in the suction line where the pump is above the reservoir and the system has been inactive, foaming due to poor reservoir design, etc.

If the volume of air which enters the suction side of the pump is minute, the pump may be able to discharge it into the high pressure side of the system, which will of course momentarily cause a slight pressure drop in the high side but not enough to result seriously. However, if the volume of air entering the pump is larger, the pump may lose, and be unable to regain, its prime, in which case the unprimed pump may be permanently disabled, since the fluid in the system is relied on for lubrication of the pumps.

It is therefore an object of this invention to provide, in a system of this kind, a simple, inexpensive and effective means to relieve air coming through the pump from the suction side to the discharge side, and return it to the vented interior of the supply reservoir without causing the air to air lock the pump.

More specifically stated it is an object of the invention to retain the conventional check valve which is usually placed between the discharge side of the pump and the remainder of the high pressure side of the system to prevent the return of the fluid under pressure through the pump, but supplement this conventional check valve with a vent valve which opens in response to a drop in pressure at the upstream side of the check valve caused by the introduction of a quantity of air by the pump brought from its suction side to its discharge side.

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Where this check valve is used as it is in common practice, i. e., without means to eliminate air from the passageway between the pump discharge port and the upstream side of the valve, considerable difficulty is had by the pump to regain a lost prime, because of the fact that the pump must operate against the back pressure of the air being pumped into this passageway.

It is therefore another object of this invention to provide a vent means in the passageway between the discharge side of the pump and the check valve which is normally open, whereby the pump, in endeavoring to regain a lost prime, need not discharge against a relatively high back pressure of air and will therefore create a greater suction in the low pressure side to thereby regain its prime more readily.

Other objects and advantages will become evident from the following description when taken in conjunction with the drawing, wherein:

Fig. 1 is a schematic layout of a hydraulic system of the kind to which my invention is particularly applicable.

Fig. 2 is a longitudinal axial sectional view through a simple form of my air bleed valve, when combined with a conventional check valve the air bleed valve in this exemplification being normally closed as here shown.

Fig. 3 shows the device of Fig. 2, but with the air bleed valve in the active or open position.

Fig. 4 is a longitudinal axial sectional view through an improved form of my invention, the air bleed valve in this exemplification being normally open as here shown.

Fig. 5 shows the improved device of Fig. 4 but with the air bleed valve in the closed position.

Like reference characters refer to like parts throughout the drawings.

In the hydraulic system Fig. 1, a pump 10 draws hydraulic fluid from the reservoir 12 and delivers it to an accumulator 14 from which a selector valve 16 directs it to one or the other sides of the piston of the servomotor 18 as required.

A relief valve or equivalent pressure regulating means 20 is adjusted to the desired pressure, excess fluid being returned to the tank by way of the pipe 22. The valve assembly 24, which combines the check valve of common practice with the air bleed valve of subject invention, is interposed in the pipe line 26 which connects the discharge side of the pump 10 to the pressure regulator 20. Gauges 28 may be inserted at several points to facilitate checking of the system.

Referring to Figs. 2 and 3, a valve body 30 is provided with two parallel openings 32 and 34,

the opening 34 being enlarged at one end as at 36 to slidably receive valve head 38. Valve head 38 is beveled as at 40 to engage a seat 42 in the body. Threaded plugs 44 and 46 close the inlet and outlet ends respectively of the bore. A spring 48 holds the valve head 38 on the seat 42, whereby fluid may pass through the bore 34 from right to left only. The parts 38, 40, 42, and 48 may collectively be referred to as the check valve 50.

A small piston 52 is slidably fitted to the bore 32. Seal rings 54 may be provided to prevent leakage past the piston, although small leakage may be tolerated. An annular recess 56 is made in the piston intermediate its ends. Threaded plugs 58 and 60 close the ends of the bore 32 pressure tight. Piston stops 62 and 64 extend from the plugs 58 and 60 respectively. A light spring 66 urges the piston 52 to the left and against the stop 64.

A passageway 68 connects the downstream side of the check valve 50 to the space in the bore 32 at the left end of the piston 52. A passageway 70 connects the bore 34 to the space at the right end of the piston 52. A passageway 72 connects the bore 34 to the annular groove 56, and a passageway 74 extends from the bore 32 upwardly then laterally to the outside of the valve body from which point a pipe 76 (see Fig. 1) extends to the vented reservoir 12. With the piston 52 in the normal position shown in Fig. 2, the bleed vent 74 is closed, while in the operated position shown in Fig. 3, the bleed vent 74 is open. The piston 52 with its groove 56, vents 68, 70, 72, and 74, stops 62 and 64 and spring 66 may collectively be referred to as the bleed valve 75.

In the modification shown in Figs. 4 and 5, the structural details are substantially like those of Figs. 2 and 3 except that the spring 66 is at the opposite end of the piston 52, whereby, when the piston 52 is in the normal position Fig. 4, the bleed vent 74 is open, while in the operated position shown in Fig. 5, the bleed vent 74 is closed. There is the further difference that a restriction 78 is placed in the bore 34 to assist in raising the pressure on the upstream side of the restriction. The changes in structure between Figs. 2 and 4 are minor but are important as will appear when the operation of the invention is described. The valve assembly shown in Figs. 4 and 5 may be broadly designated by the reference character 24*a*, the check valve as 50*a* and the bleed valve as 75*a*.

The operation of a fluid system equipped with my improved valve arrangement is substantially as follows:

When the system is operating normally, fluid is taken by the pump 10 (see Figs. 1, 2, and 3) from the reservoir 12 and discharged through the pipe 26 and valve assembly 24 into the system. There will be a slight pressure drop as between the upstream and the downstream side of the check valve 50, the extent of the drop depending principally on the strength of the spring 48. Since the pressure in the bore 34, acting through the passageway 70, is greater than the pressure in the bore 36, acting through the passageway 68, the natural tendency of the piston 52 is to move to the left. This tendency is augmented by the spring 66. As long, therefore, as the pump maintains a sufficient pressure on the upstream side of the check valve 50, the bleed valve 75 will remain closed as in Fig. 2.

If, however, any substantial volume of air is discharged by the pump into the bore 34, a sharp pressure drop will take place in the bore, since an almost insignificant expansion of the liquid in the bore will reduce its pressure to near zero, while the reduction in volume of the air caused by this expansion of the liquid is insufficient to increase the pressure of the air content except very minutely. The net pressure in bore 34 upon introduction of a relatively small volume of air is therefore much below the normal pressure.

When, therefore, due to air being brought into the bore 34, the pressure in the bore drops far enough below that in the bore 36 to slightly more than balance the effort of the spring 66, the piston 52 will move to the right as seen in Fig. 3, and the air will flow through the passageway 72, groove 56, and passageway 74, returning to the reservoir 12 through the pipe 76.

With the air thus eliminated, the pressure will rise rapidly in the bore 34, and, as soon as this pressure, plus the effort of the spring 66, exceeds the pressure at the downstream side of check valve 50, the piston 52 will return from the open bleed valve position of Fig. 3 to the normal position of Fig. 2.

As a more concrete example of the operation of the device of Figs. 2 and 3, let it be assumed that the relief valve 20, Fig. 1, is set to maintain a pressure in the bore 36 of 1000 lbs.; that the check valve spring 48 is under a stress of 10 lbs., in which case the pump 10 must have capacity to raise the pressure in the bore 34 to slightly over 1010 lbs., and that the spring 66 is under a stress of 20 lbs.

If a sufficiently large volume of air now enters the bore 34, the pressure in the bore may drop as low as say 500 lbs. When this happens the 1000 lb. pressure in the bore 36 will move the piston 52 to the right as seen in Fig. 3, thus opening the vent passage 74.

As the pump continues to operate, the air will first be discharged through the vent 74, or if the air is admixed with the hydraulic fluid, the mixture will pass through the vent opening 74. It should at this point be noted that the vent 74, or some other part of the channel through which the air must pass, must be of such size, with respect to the capacity of the pump, that as long as air, or mixed hydraulic fluid and air, is still present and is passing out the vent 74, the pump is not able to build up pressure in the bore 34 great enough to close the bleed valve 75, but when the air or mixture has all been discharged and the pump is again pumping the more viscous medium, the pump can build up pressure in the bore 34 sufficient to close the bleed valve, in spite of the temporary leakage of the more viscous medium through the vent 74.

When the pressure in the bore 34 is thus built up to 981 pounds, this pressure, plus the 20 pound stress of the spring 66 making 1001 lbs. pressure, urges the piston 52 toward the left, and since the pressure in the bore 36 is only 1000 lbs. the piston 52 moves to the left and closes the vent 74.

Since the pressure in the bore 34 is now only 981 lbs., and the pressure in the bore 36 plus the spring 48 is 1010 lbs., the check valve 50 is still closed. However, if the air is no longer present, several additional seconds operation of the pump will make up this deficiency and the check valve 50 will open, and the system be back to normal.

In the foregoing description of the operation of the system of Fig. 1, equipped with the valve assembly of Figs. 2 and 3, no account is taken of a situation in which the pump 10 has not been cleared entirely of air. Since various combina-

tions of air and oil mixtures are possible in the suction line to the pump, as in the case of a foaming condition in the reservoir, and since the pump may be airlocked due to back pressure in bore 36 at any pressure from zero up to the working pressure of the system depending upon the air and oil mixture which the pump is required to work against, the 981 lbs. pressure previously mentioned may be all that the pump can maintain. Since this is not sufficient to overcome the 1000 lbs. pressure within bore 36 plus 10 lbs. of the spring 48, no flow of fluid will result in bore 34 with the piston 52 closing off passage 74 as in Fig. 2. This will result in the pump burning out due to lack of circulation of a cooling fluid. In such a situation, if there is still sufficient pressure in the system downstream of the check valve 50 to overcome the spring 66, the piston 52 will be forced to the right as seen in Fig. 3, wherein the bleed valve will be open and the air, which the pump must force into the chamber 34 before it can regain its prime, passes out through the bleed passageway 74 and the pump may be able to pick up its prime. If, however, in the same situation, there is not sufficient pressure in the system downstream of the check valve 50 to move the piston to the right as in Fig. 3, the bleed valve 50 will remain closed as in Fig. 2, and the pump, in order to pick up its prime, must pump against a back pressure of air in the chamber 34, which greatly increases the time in which reprimming may be effected, if at all, and consequently greatly increases the number of pumps which burn out due to the lack of lubrication. This is one of the difficulties which prompted the improvement shown in Figs. 4 and 5.

If, now, in the system of Fig. 1, the valve assembly 24*a*, Figs. 4 and 5, is used, the bleed valve 75*a* will be normally held open by the spring 66 whether there is any pressure or no pressure downstream of the check valve 50*a*. If, under these circumstances, the pump 10, Fig. 1, has completely lost its prime and must deliver a considerable volume of air into the bore 34, Fig. 4, before it can pick up its prime, the air being pumped will readily pass through the vent 74, whereby the pump need not operate against any considerable back pressure of air in the bore 34, and will therefore pick up its prime in such a short time that the danger of burning out the pump is minimized.

As a more concrete example, assume the same relation of pressures and spring forces as before, the back pressure on valve 38 being 1000 lbs. due to the pressure in bore 36 plus 10 lbs. due to spring 48, making a total of 1010 lbs. When air is introduced into bore 34, lowering the pressure to 500 lbs. as before, piston 52 is now moved to the right as in Fig. 4 due to the difference in pressure on its two ends, causing automatic venting of air or air and oil mixture in port 34 through port 74. Since the piston 52 now cannot move to the left and close off the returning air-oil mixture until the pressure in bore 34 is higher than 1000 lbs. plus 20 lbs. for spring 66 or 1020 lbs., the pump cannot become air locked since flow at 1020 lbs. in bore 34 will be sufficient to overcome the 1010 lbs. in valve 38. Thus, the system will insure continuous circulation of fluid or air and oil mixtures to either the venting port 74 or the system proper through bore 36. Moreover, the restriction 78 is so designed and placed that, as soon as liquid unmixed with air begins to enter the bore 34, the pressure at the right end of the piston will build up more rapidly and will therefore sooner close the bleed valve 75*a* against the

resistance of the spring 66 plus whatever pressure may at the time exist in the bore 36. The valve assembly 24*a* thus has a considerable advantage over the valve assembly 24 in pressurizing the system de novo.

Since, in the improved design 24*a*, the bleed valve 75*a* is normally open, there is a further distinct advantage in the improved design when starting the system under extreme low temperature conditions. Under such conditions, the open bleed valve temporarily acts as a relief valve for the cold fluid by returning all or a part of that which the pump is able to deliver back to the reservoir through the pipe 76 until the pump is able to take up its load and deliver full pressure into the system.

I claim:

1. A valve mechanism comprising a body having a flow passage therethrough, with inflow and outflow ends adapted respectively to receive and to discharge hydraulic fluid under pressure, a check valve in said flow passage intermediate said ends biased for flow from the inflow to the outflow end, a passageway connecting a point in said flow passage upstream of said check valve to a point in said flow passage downstream of said check valve, a vent connecting said passageway to the atmosphere, an opening connecting said passageway to said flow passage upstream of said check valve, an air bleed valve movable in said passageway to open or close said vent, one end of said air bleed valve being sensitive to the pressure upstream of said check valve to be moved by said upstream pressure to the closed position, and the other end of said air bleed valve being sensitive to the pressure downstream of said check valve to be moved by said downstream pressure to the open position, and a resilient means urging said air bleed valve to its open position.

2. A valve mechanism comprising a body having a flow passage therethrough, with inflow and outflow ends, the inflow end being adapted to receive a hydraulic fluid under pressure and the outflow end being adapted to discharge said hydraulic fluid under pressure, a check valve in said flow passage intermediate said ends biased to prevent flow from said outflow to said inflow end, a passageway connecting a point in said flow passage upstream of said check valve back to a point in said flow passage downstream of said check valve, a vent in the wall of said passageway intermediate its ends, said vent having two branches, one branch extending from said passageway to said flow passage upstream of said check valve and the other branch connecting said passageway to the atmosphere, a piston slidable in a portion of said passageway having an external groove adapted by movement toward the downstream end of said passageway to be positioned to disconnect the two branches to close said vent and adapted by movement toward the upstream end of said passageway to be positioned to connect the two branches to open said vent, and a spring biased to urge said piston to the open position whereby when the pressure in said flow passage downstream of said check valve, together with the pressure of said spring, exceeds the pressure in said flow passage uptream of said check valve, the air vent will be open.

3. In a fluid valve mechanism comprising a body having a flow passage therethrough with inflow and outflow ends adapted respectively to receive and to discharge a hydraulic fluid under pressure, a check valve in said flow passage biased for preventing return flow through said passage,

a pair of spaced branch passages in said body, one communicating with the atmosphere the other communicating with the flow passage upstream of said check valve, a piston bleed valve having a passage arranged to interconnect said branch passages when in open position, said piston bleed valve being spring biased to an open position but movable from an open to a closed position and operative in the open position to connect the flow passage upstream of the check valve to the atmosphere, the ends of the piston bleed valve being yieldable to the pressure of thehydraulic fluid to move it from one of its positions to the other, and passageways for connecting the ends of the piston to the flow passage, one passageway upstream of the check valve and the other passageway downstream of the check valve.

4. In a fluid valve mechanism comprising a body having a flow passage therethrough with inflow and outflow ends adapted respectively to receive and to discharge a hydraulic fluid under pressure, a check valve in said flow passage biased for preventing return flow through said passage, a piston bleed valve axially slidable in said body, a spring urging said piston to one end of its travel which is the open position of the bleed valve, but adapted to yield and permit said piston to move to the other end of its travel which is the closed position of the bleed valve, a passageway operative only in the open position of said piston valve to connect the flow passage upstream of the check valve to the atmosphere, the ends of the piston being yieldable to pressure for moving it from one of its positions to the other, and passageways for connecting the ends of the piston to the flow passage, the one passageway upstream of the check valve being connected to the end of the piston opposite the spring and the other passageway downstream of the check valve being connected to the end of the piston against which the spring bears.

5. A fluid valve mechanism comprising a body having a flow passage therethrough with inflow and outflow ends adapted respectively to receive and to discharge a hydraulic fluid under pressure, a check valve in said flow passage biased for preventing return flow through said passage, bleed means including a pair of spaced branch passages in said body, one communicating with the atmosphere the other communicating with the flow passage upstream of said check valve, and a piston bleed valve having a passage arranged to interconnect said branch passages when in open position and operative when open to connect the flow passage on the side upstream of the check valve to the atmosphere, a pressure sensitive part associated with said bleed valve operative by fluid pressure to move said bleed valve to the closed position, a passageway connecting the flow passage upstream of the check valve to said pressure sensitive part, a second pressure sensitive part associated with said bleed valve operative by fluid pressure to move said bleed valve to the open position, a passageway connecting the flow passage downstream of the check valve to the said second pressure sensitive part, and a resilient means, apart from said fluid pressure, urging said bleed valve to the open position.

6. The combination in a fluid valve of a body having a flow passage threthrough with inflow and outflow ends adapted respectively to receive and discharge a hydraulic fluid under pressure, a check valve in said flow passage biased for preventing return flow through said passage, a flow

restricting means in said flow passage between said inflow end and said check valve, bleed means including a bleed valve operative when open to connect the flow passage between the flow restricting means and the check valve to the atmosphere, a pressure sensitive part associated with said bleed valve operative by fluid pressure to move said bleed valve to the closed position, a passageway connecting the flow passage upstream of the restricting means to the pressure sensitive part, a second pressure sensitive part associated with said bleed valve operative by fluid pressure to move said bleed valve to the open position, a passageway connecting the flow passage downstream of the check valve to the said second pressure sensitive part, and a resilient means apart from the fluid pressure urging said bleed valve to the open position.

7. In a fluid valve mechanism comprising a body having a flow passage therethrough with inflow and outflow ends adapted respectively to receive and to discharge a hydraulic fluid under pressure, a check valve in said flow passage biased for preventing return flow through said passage, a flow restricting means in said flow passage between said inflow end and said check valve, bleed means including a piston bleed valve movable axially in said body from an open to a shut position, operative when open to connect the flow passage between the flow restricting means and the check valve to the atmosphere, a pressure sensitive part associated with the piston of said piston bleed valve operative by fluid pressure to set said bleed valve in the closed position, a passageway connecting the flow passage upstream of the restricting means to said pressure sensitive part, a second pressure sensitive part associated with said piston operative by fluid pressure to set said bleed valve in the open position, a passageway connecting the flow passage downstream of the check valve to the second said pressure sensitive part, and a resilient means apart from the fluid pressure urging said piston to the position which opens the bleed valve.

8. The combination in a fluid valve mechanism which comprises a body having a flow passage therethrough with inflow and outflow ends adapted respectively to receive and to discharge a hydraulic fluid under pressure, a check valve in said flow passage biased for preventing return flow through said passage, a flow restricting means in the flow passage between said inflow end and said check valve, a piston, a cylinder for supporting said piston for axial movement, stops in said cylinder for limiting the travel of said piston, a spring in one end of said cylinder holding the piston in its normal position against the opposite end stop, a passageway connecting the bore of the cylinder at the spring end of the piston to the flow passage downstream of the check valve, a passageway connecting said bore at the end opposite the spring to the flow passage between the inflow end and the restricting means, a passageway connecting said bore at a point intermediate the ends of the piston to the flow passage between the restricting means and the check valve, a passageway connecting said bore at a point intermediate the ends of the piston and spaced apart from the first said point to the atmosphere, and a passageway in the piston operative in the normal position of said piston to connect the two said points.

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