Aug. 23, 1960 E. E. HEWITT 2,949,894

HYDRO-PNEUMATIC HOIST CONTROL APPARATUS

Filed March 19, 1957

Fig-1

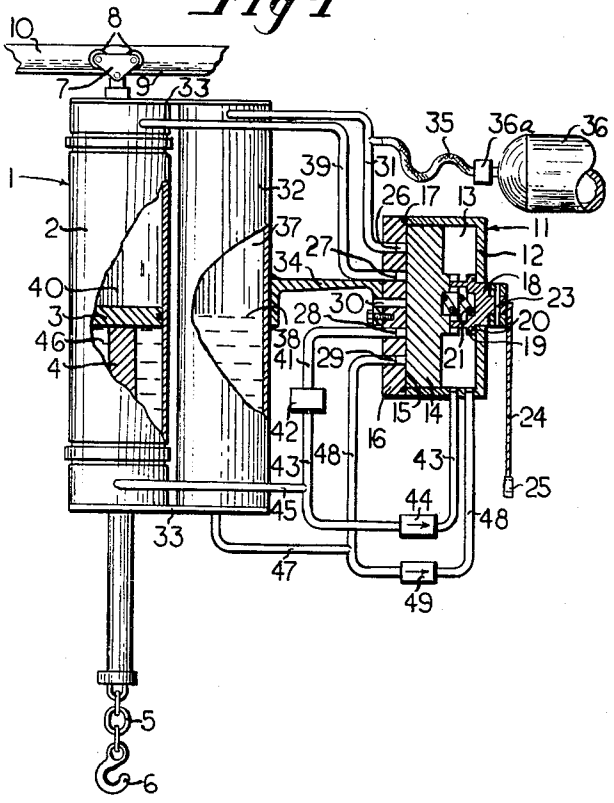



Fig-2

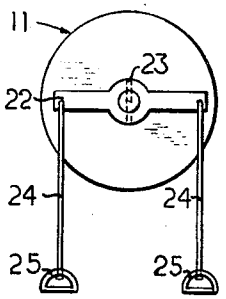



Fig 3

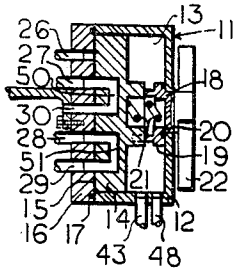
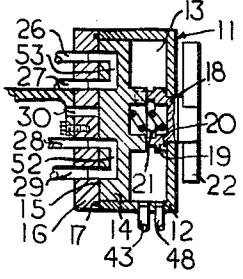



Fig-4




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# HYDRO-PNEUMATIC HOIST CONTROL APPARATUS

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This invention relates to power operated hoists of the type employed in machine shops and manufacturing plants in which a compressed air distribution system makes compressed air available at desired locations, and more particularly, to a hydro-pneumatic control apparatus for such hoist.

Hoisting apparatus employing a fluid pressure motor having a piston the opposite sides of which are respectively subjected to a compressible fluid under pressure, such as air, to raise or lower a load on the hoist are well known. In a hoisting apparatus using a compressible fluid as a power medium, the hoisting piston has a tendency to be erratic and jumpy due to the resiliency of the gas under pressure, and therefore it is difficult to positively position and smoothly move the piston and the connected load on the hoist.

It is the principle object of the present invention, therefore, to provide a fluid pressure motor type hoist in which the erratic action of the hoist is avoided notwithstanding use of fluid pressure, such as compressed air, for controlling the hoist. This object is attained by providing an arrangement including a hoist cylinder the piston of which is moved by hydraulic pressure under control of pneumatic pressure.

When the surface of oil contained in a reservoir is alternately subjected to a gas under pressure, such as air, and to atmospheric pressure, there is a tendency for small bubbles of gas to become entrained in the oil. Upon the release of the gas pressure, bubbles of gas rise to the surface of the oil where they expand to cause foaming of the oil.

If oil thus subject to fluid under variable pressure were used as the power source to operate the piston of a fluid motor type of hoist on its hoisting stroke, these entrained bubbles of gas may pass through the oil to the face of the piston to which the oil under pressure is supplied. If this phenomenon occurred, upon the release of pressure from the oil, these entrained bubbles of gas would expand and form a gas pocket filled with foam between the top surface of the oil and the face of the piston.

Accordingly another object of the invention is to provide a hydraulic pressure operated pneumatic pressure controlled hoist apparatus employing an oil reservoir, the oil in which is subjected to a constant or unvarying pressure, such as compressed air, thereby minimizing the likelihood of the occurrence of foaming of the oil and providing smoother and more positive hoisting and lowering action of the hoist.

Other objects and advantages will be apparent from the following more detailed description of the invention.

In the accompanying drawing:

Fig. 1 is a diagrammatic view, partly in section, of a fluid pressure operated hoisting system embodying a hydro-pneumatic control apparatus constructed and operated in accordance with the invention;

Fig. 2 is an exterior view of the control valve in Fig. 1, showing further details thereof.



Fig. 3 is a sectional view of the control valve of Fig. 1, showing fluid pressure connections established thereby in the position to effect raising of a load on the hoist; and

Fig. 4 is a sectional view of the control valve of Fig. 1, showing fluid pressure connections established thereby in the position to effect lowering of a load on the hoist.

*Description*

As shown in Fig. 1 of the drawing, the reference numeral 1 designates a fluid motor for effecting the raising and lowering of a load (not shown). The fluid motor 1 comprises a cylinder 2 having a bore in which a piston 3 is slidably operable. A piston rod 4 connected at one end to the piston 3 extends through the lower end of cylinder 2 to the exterior thereof and has secured to its opposite end a chain 5 having a hook 6 for supporting the load. The upper end of cylinder 2 is suspended from a movable carriage 7 provided with four rollers 8, two of which are shown riding on the upper surface of a flange 9 extending from one side of the web of a structural I-beam 10, the other two rollers (not shown) riding on the upper surface of a flange extending from the other side of the web of the I-beam 10. The I-beam 10 may be a part of the structural framework of the building in which the hoisting apparatus is used or may be supported above the floor of the building by any suitable supporting means (not shown).

A manually operative control valve device 11 is arranged for controlling supply of fluid under pressure to and release of fluid under pressure from the fluid motor 1 for controlling operation thereof.

The control valve device 11 comprises a casing section 12 having a chamber 13 in which is contained a rotary valve 14 cooperating with a valve seat 15 on a pipe bracket casing section 16 separated from the casing section 12 by a gasket 17 of some suitable resilient material such as rubber, the two casing sections being secured together by any suitable means (not shown). The rotary valve 14 is adapted to be rotated to several different control positions by a coaxially-arranged rotary stem 18, one end of which is suitably interlocked with the control portion of the rotary valve. The opposite end of the stem 18 extends through an opening in casing section 12 to the exterior thereof and, intermediate the ends thereof, said stem is provided with a flange 19 having a grommet ring seal 20 pressed into sealing contact with the interior wall of said casing by a spring 21 disposed between the rotary valve 14 and the bottom of a counterbore formed in the said one end of said stem. The end of the stem 18 extending exteriorly of the casing 12 is of reduced diameter and carried on the end of the stem is an operating lever 22 having arms extending in diametrically opposite directions from the stem. Lever 22 is secured to the reduced portion of the stem by a pin 23. The lever 22, adjacent each end thereof, is provided with a transverse bore through which a rope 24 extends, the end of rope 24 being provided with a knot to secure the rope to the handle. The opposite end of each rope 24 is provided with a hand grip 25 by which an operator can, by pulling down thereon, rotate the lever 22 and thus the rotary valve 14 to any one of three positions, one of which is shown in Fig. 1 and the other two in Figs. 3 and 4.

Opening at the valve seat 15 are a plurality of ports and passages 26, 27, 28, 29 and an atmospheric exhaust port 30. With the rotary valve 14 in the position in which it is shown in Fig. 1, all of these passages are lapped, that is closed, by said rotary valve.

The port and passage 26 is connected by a pipe 31 to an oil reservoir 32. The length and diameter of the reservoir 32 are substantially the same as the length and

diameter of the cylinder 2 of the fluid motor 1. The reservoir 32 is adapted to be movable with the fluid motor 1, as the carriage 7 is moved along the I-beam 10, by having its opposite ends secured to the opposite ends of the fluid motor 1 by means of suitable end plate members 33 which may be welded or otherwise secured to each two adjacent ends of said reservoir and motor.

The control valve 11 is adapted to be movable with the fluid motor 1 and reservoir 32 by having the pipe bracket 16 of the control valve 11 secured as by a cap screw, to one leg of a bracket 34 having the shape of a standard structural channel, illustrated as a U-channel, the other leg of which is secured to the reservoir 32 as by welding or other suitable means.

A flexible hose 35 is connected at one end to the pipe 31 and at the opposite end to a main reservoir 36 that is charged with a compressible fluid under pressure, such as air, by a fluid compressor (not shown). The hose 35 may be on a suitable reel to extend and contract in length automatically as the carriage 7 is shifted along the I-beam 10. For reasons explained more fully hereinafter, the fluid under pressure supplied from reservoir 36 is suitably regulated to a constant uniform pressure, as by a suitable regulating valve device 36*a*. The flexible hose 35 and pipe 31 provide a communication between the main reservoir 36 and the upper end of the reservoir 32 for charging a chamber 37 in the reservoir 32 to a chosen uniform pressure constantly maintained by the regulating valve device 36*a*. The reservoir 32 is partly filled with a hydraulic fluid, such as oil, to a level such as is indicated by the numeral 38, and the surface of the oil is at all times subjected to constant pressure of the compressible fluid always present in chamber 37. Foaming of the oil in the reservoir 32 is thus minimized because variation of the air pressure in the reservoir above the surface of the oil does not occur.

The port and passage 27 is connected by a pipe 39 to the cylinder 2 and opens into a chamber 40 at the upper side of piston 3 at a point a sufficient distance above the position in which the piston 3 is shown in Fig. 1 to permit the piston to raise a load which may be secured to the hook 6 to the maximum desired height without the piston closing the opening of pipe 39 to the chamber 40.

The port and passage 28 is connected by a pipe 41 to one end of an adjustable needle valve device 42 of any well-known type. The opposite end of needle valve device 42 is connected by a pipe 43 to the chamber 13 in the control valve 11 and interposed in pipe 43 is a one-way or check valve 44 to prevent backflow of fluid under pressure from chamber 13.

A branch pipe 45 is connected at one end to pipe 43 at a point between the needle valve 42 and check valve 44, and at the opposite end to the lower end of cylinder 2. The end of pipe 45 that is connected to cylinder 2 opens into a chamber 46 at the lower side of piston 3 at a point a sufficient distance below the position in which the piston 3 is shown in Fig. 1 to permit the piston to lower the load, which may be secured to the hook 6, into engagement with the floor of the building without the piston closing the opening of pipe 45 to the chamber 46.

The liquid under pressure in oil reservoir 32 is conducted to the port 29, opening at the seat 15 of rotary valve 14, through a pipe 47 and one branch of a pipe 48, the other branch of pipe 48 leading to rotary valve chamber 13. Thus, since the unit liquid pressures acting in opposite directions on the rotary valve 14 are equalized, and are moreover always effective over a larger area on the face of the rotary valve exposed to chamber 13, the rotary valve 14 is always firmly maintained seated on its valve seat 15 to prevent leakage thereto. A check valve 49 is interposed in the branch of pipe 48 between the junction of pipe 47 therewith and the rotary valve chamber 13 to prevent backflow of liquid under pressure from chamber 13. As will later be made more apparent, check valves 44 and 49 cooperate to assure complete isolation of the reservoir 32 from chamber 46 of the fluid motor 1 except for communication therebetween established under the control of the rotary valve 14.

*Operation*

In operation, let it be assumed that the reservoir 32 is partly filled with a hydraulic fluid, such as oil, that the reservoir 36 is charged with a compressible fluid, such as air, to some chosen pressure, such as one hundred pounds per square inch, and that the chamber 37 in reservoir 32 is likewise charged to a uniform pressure maintained by regulating valve device 36*a* through pipe 31 and flexible hose 35. Let it be further assumed that the piston 3 in the cylinder 2 occupies its lowermost position therein in which the piston rests against a stop (not shown) and a load to be hoisted is secured to the hook 6. Also assume that the lever 22 occupies the horizontal position in which it is shown in Fig. 2, and that the rotary valve 14 is correspondingly in the position in which it is shown in Fig. 1.

As will be seen in Fig. 1, with the rotary valve 14 in the position shown therein, the ports and passages 26, 27, 28, 29, and exhaust port 30 are all blanked, that is lapped, by the rotary valve.

To move the piston 3 and the load, connected thereto through the piston rod 4, chain 5, and hook 6, in an upward direction, the operator will first turn the rotary valve 14 from the position in which it is shown in Fig. 1 to the position in which it is shown in Fig. 3 by exerting a downward pull on the left-hand grip 25 shown in Fig. 2.

As will be seen in Fig. 3, with the rotary valve 14 in the position shown therein, a first cavity 50 in the rotary valve 14 connects the port and passage 27 and pipe 39 to the exhaust port 30, thus venting the chamber 40 at the upper side of piston 3, while a second cavity 51 in the rotary valve 14 is effective to supply oil, at the unit pressure maintained by regulating valve device 36*a* from the oil reservoir 32 through pipe 47, pipe 48, and port and passage 29 to the port and passage 28 and pipe 41 which pipe is connected through the adjustable needle valve device 42, pipe 43 and branch pipe 45 to the chamber 46 at the lower face of piston 3. Since the needle valve device 42 is adjustable, a build-up of force may be established on the piston 3 at any desired controlled rate, and when this force has increased to a value sufficient to lift the load secured to the hook 6, the piston 3 and load will move smoothly and positively upward at a rate corresponding to the position to which the needle valve device 42 has been adjusted.

When the load has been raised to the level desired, upward movement of the piston 3 and the load may be stopped by the operator exerting a downward pull on the right-hand grip 25, shown in Fig. 2, to effect, through right-hand rope 24 and lever 22, rotation of rotary valve 14 back to the position in which it is shown in Fig. 1.

When the rotary valve 14 is returned to the position in which it is shown in Fig. 1, the flow of oil under pressure from the oil reservoir 32 to the chamber 46 beneath the piston 3 is terminated and the oil in said chamber is trapped therein by the rotary valve 14 lapping the port and passage 28. Furthermore the rotary valve 14 laps the port and passage 27 so that air at atmospheric pressure in chamber 40 is trapped therein. This air acts as a cushion if, for any reason, the load is momentarily decreased.

It may be noted that, at this time, the port 28 and the chamber 13 at opposite sides of the rotary valve 14 are connected to chamber 46, and also that the port 26 is connected to regulating valve 36*a* and the port 29 is connected to the oil reservoir 32, the oil in which is subject to air under pressure supplied by the regulating valve device 36*a*. Since the oil in chamber 46 has been supplied thereto from the oil reservoir 32, normally the pressure of the oil in chamber 46 and oil reservoir 32 will be the same. However, if the load secured to the

hook 6 were increased, or the piston rod 4 subjected to some external force acting in a downward direction, there would be a tendency for the piston 3 to move downward and force the oil out of chamber 46 but, since the port and passage 28 is lapped by the rotary valve 14 and the oil is incompressible, this cannot occur, but the back pressure on the liquid in chamber 46 would be increased. Furthermore, with the oil in chamber 46 connected to port and passage 28 at the bottom of rotary valve 14 through branch pipe 45, pipe 43, needle valve device 42 and pipe 41, and to the chamber 13 through branch pipe 45, pipe 43, and check valve 44, such increase in the unit pressure of the oil in the chamber 46 acting on port 28 in a direction tending to unseat rotary valve 14 is opposed by a corresponding unit pressure in the chamber 13, so that the rotary valve 14 is prevented from being unseated from its seat by the predominating liquid pressure in chamber 13 present at all times.

It will be seen that check valve 49 acts in this situation to prevent the higher hydraulic pressure trapped in chamber 46 from acting reversely to increase the hydraulic pressure in the reservoir 32.

After the load has been raised to the desired height and the rotary valve operated to lap position in which it is shown in Fig. 1, the load may be removed from the hook.

If this is done, the check valve 44 prevents supply of hydraulic pressure from reservoir 32 to chamber 46 which would result in undesired upward movement of piston 3.

To lower the piston 3 with or without the load on the hook 6, the operator will turn the rotary valve 14 from the position, in which it is shown in Fig. 1, to the position in which it is shown in Fig. 4, by exerting a downward pull on the right-hand grip 25.

As will be seen in Fig. 4, with the rotary valve 14 in the position shown therein, a third cavity 52 in the rotary valve 14 connects the port and passage 28 to the port and passage 29 to permit the oil under pressure in oil reservoir 32 to remain connected to the chamber 46 as was the case when the rotary valve 14 occupied the position in which it is shown in Fig. 3.

With the rotary valve 14 in the position in which it is shown in Fig. 4, a fourth cavity 53 in the rotary valve 14 is effective to supply fluid under pressure from the main reservoir 36, at a pressure determined by the regulating valve device 36*a*, through hose 35, pipe 31, port and passage 26 to the port and passage 27, and through pipe 39 to the chamber 40 at the upper face of piston 3.

The area of the upper face of piston 3, which is subject to fluid under pressure from the main reservoir 36 at the pressure determined by the regulating valve device 36*a*, is greater than the area of the lower face of piston 3, which is subject to oil at the same unit pressure, by an amount equal to the area of piston rod 4. Therefore the force acting to move piston 3 downward is greater than the force acting to move the piston upward. Accordingly piston 3, piston rod 4, and the load (if there is one secured to hook 6) will move downward at a rate determined by the position to which the needle valve device 42 has been adjusted, since, as the piston 3 moves downward, it forces oil from chamber 46 through the needle valve device 42 back into the oil reservoir 32 to raise the oil level therein.

The operator may leave the rotary valve 14 in the position in which it is shown in Fig. 4 until the piston 3 displaces the oil out of the chamber 46 back into the oil reservoir 32, and the piston 3 comes to rest at the lower end of its stroke against a stop (not shown); or he may stop the piston 3 at any desired location within the cylinder 2 by exerting a downward pull on the left-hand hand grip 25 shown in Fig. 2 to effect, through left-hand rope 24 and the lever 22, rotation of rotary valve 14 from the position in which it is shown in Fig. 4 to the lap position in which it is shown in Fig. 1.



If the piston 3 is stopped at a point above its lowermost position, it may be subsequently raised or lowered within the cylinder 2 by, respectively, effecting rotation of the rotary valve 14 to the position in which it is shown in Fig. 3 or Fig. 4.

It may be noted that the flexible hose 35 permits a load secured to the hook 6 to be raised to some level above the floor and then transported, by moving the carriage 7, from which the fluid motor 1 and the load are suspended, along the track formed by the flanges 9 on the I-beam 10, to another location, after which the load may be lowered to the floor, onto a worktable, or into a vehicle for transportation to a distant destination.

Having now described the invention, what I claim as new and desire to secure by Letters Patent, is:

1. In a hoisting apparatus, in combination, a source of pneumatic pressure, a source of hydraulic pressure comprising a reservoir containing a quantity of liquid, means for constantly subjecting said quantity of liquid to said pneumatic pressure, a cylinder anchored to a support, a hoisting piston slidably operable in said cylinder and having a piston rod, one end of which extends to the exterior of said cylinder for connection with the load to be raised and lowered, and a manually operated valve means selectively operable to supply liquid under pressure from said reservoir to the piston rod side of said piston while venting the opposite side, to effect raising of the load, or to simultaneously supply said liquid under pressure to said piston rod side of said piston and fluid under pressure from said pneumatic pressure source to the opposite side of said piston to effect lowering of said load.

2. In a hoisting apparatus, in combination, a source of pneumatic pressure, a source of hydraulic pressure comprising a reservoir containing a quantity of liquid, means for constantly subjecting said quantity of liquid to said pneumatic pressure, a cylinder anchored to a support, a hoisting piston slidably operable in said cylinder and having a piston rod one end of which extends to the exterior of said cylinder for connection with a load to be raised and lowered, a manually operated valve means selectively operable to supply liquid under pressure from said reservoir to the piston rod side of said piston while venting the opposite side, to effect raising of the load, or to simultaneously supply said liquid under pressure to said piston rod side of said piston and fluid under pressure from said pneumatic pressure source to the opposite side of said piston to effect lowering of the load, and adjustable choke means disposed between said reservoir and said piston rod side of said piston to control the rate of flow of said liquid under pressure to and from said piston rod side of said piston.

3. In a hoisting apparatus, in combination, a cylinder movably suspended from a support, a hoisting piston slidably operable in said cylinder and having a piston rod one end of which extends to the exterior of said cylinder for connection with a load to be raised and lowered, a source of pneumatic pressure, means for regulating to a constant pressure the pneumatic pressure supplied from said source, a reservoir containing a quantity of liquid and being structurally secured to said cylinder and movable therewith, means for constantly subjecting said quantity of liquid to said constant pneumatic pressure, first conduit means through which said constant pneumatic pressure is delivered to said reservoir, manually operated valve means selectively operable to supply liquid under pressure from said liquid reservoir to the piston rod side of said piston while venting the opposite side, to effect raising of the load, or to simultaneously supply said liquid under pressure to said piston rod side of said piston and fluid under pressure from said penumatic pressure source to the opposite side of said piston to effect lowering of the load, second conduit means through which said constant pneumatic pressure is supplied to said valve means, and

third conduit means connecting said source of liquid pressure to said valve means and said valve means to each end of said cylinder to conduct fluid under pressure to and from said cylinder to operate the hoisting piston therein.

4. In a hoisting apparatus, in combination, a source of pneumatic pressure, means for regulating to a constant pressure the pneumatic pressure supplied from said source, a source of hydraulic pressure comprising a reservoir containing a quantity of liquid always subject to said constant pneumatic pressure, a cylinder suspended from a support, a hoisting piston slidably operable in said cylinder and having a piston rod one end of which extends to the exterior of said cylinder for connection with a load to be raised and lowered, a manually operated rotary valve for in one position effecting the supply of liquid under pressure from said reservoir to the piston rod side of said piston while effecting venting of the opposite side, to effect raising of the load, and being operative upon movement to a second position in which it causes liquid under pressure to be supplied to said piston rod side of said piston and fluid under pressure to be supplied from said source of pneumatic pressure to the opposite side of said piston to effect lowering of the load, and upon movement to a third or lap position to close all communications between said pressure sources and said sides of said piston to retain liquid trapped between said rotary valve and said piston rod side of said piston, means comprising a first communication connected at one end to a port and passage open to a limited area at one side of said rotary valve and at the other end to a chamber at the piston rod side of said piston, means comprising a second communication connected at one end to a rotary valve chamber at the opposite side of said rotary valve open to the entire area of said rotary valve and at the other end to said chamber at the piston rod side of said piston, and a one-way valve means disposed in said second communication for preventing backflow of liquid pressure from said rotary valve chamber, said rotary valve being maintained in a seated position by the predominating force of the liquid pressure in said rotary valve chamber.

5. In a hoisting apparatus, in combination, a source of pneumatic pressure, means for regulating to a constant pressure the pneumatic pressure supplied from said source, a source of hydraulic pressure comprising a reservoir containing a quantity of liquid always subject to said constant pneumatic pressure, a cylinder suspended from a support, a hoisting piston slidably operable in said cylinder and cooperating with said cylinder to form a chamber at each side of said piston, a piston rod connected at one end to said piston and having its opposite end extending to the exterior of said cylinder for connection with a load to be raised and lowered, a manually operated rotary valve device having a rotary valve and a chamber at one side thereof, said rotary valve having a first position ofr effecting the supply of liquid under pressure from said reservoir to the chamber at the piston rod side of said piston while venting the chamber at the other side of said piston, to effect raising of the load, a second position for simultaneously supplying said liquid under pressure to said chamber at the piston rod side of said piston and fluid under pressure from said source of pneumatic pressure to said other chamber, to effect lowering of the load, and a third or lap position to close all communications between said two pressure sources and said chambers at opposite sides of said piston to retain liquid trapped between said rotary valve and the piston rod side of said piston, means comprising a first communication connected at one end to a first port and passage open to a limited area at one side of said rotary valve and at the other end to said liquid reservoir, means comprising a second communication connected at one end to the rotary valve chamber at the opposite side of said rotary valve open to the entire area of said rotary valve and at the other end to said reservoir, a one-way valve means disposed in said second communication for preventing backflow of liquid pressure from said rotary valve chamber, said rotary valve being maintained in a seated position by the predominating force of the liquid pressure in said rotary valve chamber, means comprising a third communication connected at one end to a second port and passage open to a limited area at said one side of said rotary valve and at the other end to the chamber at the piston rod side of said piston, means comprising a fourth communication connected at one end to said rotary valve chamber at said opposite side of said rotary valve open to the entire area of said rotary valve and at the other end to said chamber at the piston rod side of said piston, and a second one-way valve means disposed in said fourth communication for preventing backflow of trapped liquid pressure from said rotary valve chamber, said rotary valve being maintained in a seated position by the predominating force of said trapped liquid pressure in said rotary valve chamber notwithstanding an increase in said trapped liquid pressure to a value above the pressure of the liquid in said reservoir.

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