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HYDRO-PNEUMATIC PRESSURE CONTROL APPARATUS

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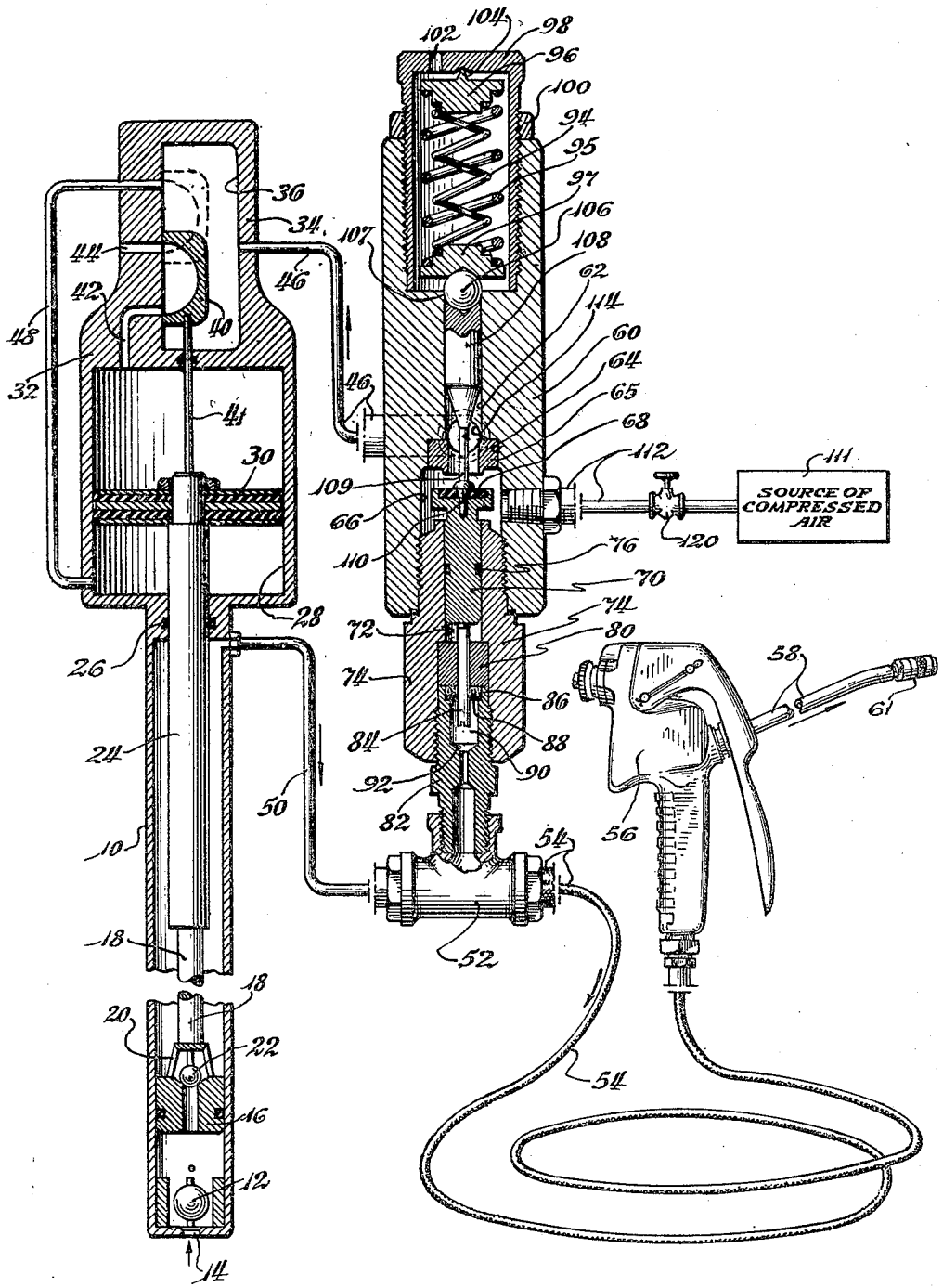

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HYDRO-PNEUMATIC PRESSURE CONTROL APPARATUS

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The invention relates generally to pressure control apparatus, and more particularly to means for preventing the production of excessive pressure at the outlet of a pneumatically operated pump for lubricants and other fluids.

When grease, oil, or other materials are pumped by a compressed air operated motor and supplied to a bearing, or into a container, through a manually operable control valve, there is danger that variations in the pressure at which the compressed air is supplied to the air motor will result in excessive variations in the pressure in the conduit connecting the pump to the control valve. Such excessive pressure may cause bursting of the conduit or damage to the control valve or the part to which the material is being supplied.

It is therefore the primary object of the invention to provide a control valve which will accurately limit the pressure developed at the outlet of the pump.

Another object is to provide a pressure regulating control valve for the supply of air to an air motor, which is operated in response to the pressure of the material at the discharge of a pump driven by the air motor, in which means are provided to prevent the build-up of excessive pressures at the outlet of the pump even though the pressure regulating control valve does not seat properly.

Other objects will appear from the following description, reference being had to the accompanying drawing which shows a lubricant pump and air motor for driving the same in more or less schematic section, a pressure regulating control valve in central vertical section, and a manually operable material flow control valve in perspective.

The compressed air operated material pump is diagrammatically illustrated as of the type which may have a portion thereof inserted within a shipping drum and be supported thereby to remove the contents thereof. For the purposes of this application, it will be assumed that the material handled is a lubricant.

The pump comprises a cylinder 10 having a foot valve 12 cooperating with the foot valve seat 14 and suitably restrained against more than limited movement from its seat. A piston 16 is reciprocable in the cylinder and is secured to a piston rod 18 by means of a suitable cage structure 20 enclosing a check valve 22. The piston rod 18 is secured to or integral with an air motor piston rod 24 extending through a suitable packing gland 26 into a cylinder 28. A suitable piston 30 is secured to the upper end of the rod 24. At the upper end of the body 32, which provides the cylinder 28, there is a valve housing 34 providing a valve chamber 36 in which a "D" slide valve 40 is reciprocable. Valve 40 is operated by a stem 41 which, as shown in the prior patent to E. W. Davis, No. 2,556,680, is suitably shifted upwardly to the position shown in dotted lines near the upper end of the stroke of the piston 30, and shifted downwardly as the piston approaches the end of its downward stroke. When in the lower position, shown in full lines, the valve

connects passageway 42 leading to the upper end of the cylinder 30 to the atmosphere through an exhaust port 44. Air flowing into the chamber 36 through a supply conduit 46 flows from the chamber 36 to the lower end of cylinder 28 through a conduit 48. In its upper position, the valve 40 permits air under pressure to flow to the upper end of the cylinder and permits exhaust of the cylinder in the customary manner.

The lubricant discharged from the pump flows through a conduit 50 to a T 52 and thence through a flexible hose 54 to a manually operable control valve 56, the latter having a discharge pipe 58 which may be provided with a suitable coupling device 61 at its free end.

In order to assure that the hose 54 and other parts of the system, and the parts supplied with lubricant thereby, are not subjected to excessive pressure, an adjustable air pressure regulating device has been provided which is effective to prevent the lubricant pressure at the discharge of the pump to exceed a valve predetermined by the adjustment of the valve. This pressure regulating device comprises a body 60 provided with a central bore 62, a counterbore 64 in which a centrally open control valve seat 65 has a press fit, and a valve chamber 66. A movable control valve 68 is cooperable with the valve seat 65 and has a stem 70 reciprocable in a bore 72 formed in a valve stem guide 74 which is threaded at the lower end of the chamber 66, the valve stem being provided with an O-ring seal 76. The lower end of the bore 72 is enlarged to provide a shoulder against which a plunger guide 80 is pressed by a fitting 82 threaded in the lower end of the valve stem guide 74. A plunger 84 is reciprocable in the guide 80 and is surrounded by suitable packing 86 which is located between the lower surface of the guide 80 and a washer-like supporting plate 88. The lower end of guide 74 is connected to the T 52 by a centrally bored fitting 82, having a counterbore 92 in the upper end of the fitting which defines with the packing 86 and the movable plunger 84 a pressure chamber 90 isolated from communication with either the upstream or downstream side of the air pressure control valve 68 and connected through the fitting 82 to pump outlet pressure in the T 52.

The valve 68 is biased to move to open position by two coil springs 94 and 95 which are compressed between spring saddles 96 and 97 within a hollow cap 98 threaded in the upper end of the body 60 and held in adjusted position by a lock nut 100. This cap is provided with an air escape opening 102. The spring saddle 96 has a central projection 104 which bears in a cooperating depression formed in the center of the top of the cap 98, while the lower spring saddle 97 has a central conical depression for centering engagement with a steel ball 106 which, in turn, is centered in a conical recess in the upper end of valve stem 108. The ball 106 forms an exhaust valve adapted to bear against an exhaust valve seat 107 encircling the open upper end of the bore 62. The valve stem 108 slides freely in the bore 62. The stem 108 is made slightly smaller than the bore 62 to provide a small unsealed clearance or vent along the bore for bleeding a small flow of air under pressure from the downstream side of the valve seat 65 out through the port 102 whenever the ball valve 106 is not seated. The lower portion 109 of the stem 108 is of reduced diameter and has an enlarged head 110 and extensions thereof which press against the valve stem 70 and hold the valve disc 68 in position on the stem.

Air under pressure from a source 111 is supplied to the valve chamber 66 through a conduit 112 and a shut-off valve 120, and is discharged from the valve body through a port 114 and conduit 46.

The restricted bleed passage to the atmosphere formed by the slight clearance between the valve stem 108 and

the bore 62 provides assurance that even if there were some slight leakage when the valve 68 is in its closed position, the pressure of the compressed air supplied to the pump would not gradually rise to an excessive pressure with resultant excessive pressures in the lubricant discharge conduits, and, what is more important, protection against the development of excessive pressure at the bearing or other part to which lubricant is supplied. The air which leaks past the valve stem 108 can escape to the atmosphere through the small opening 102 in the cap 98. However, such leakage is prevented when the valve 68 is in fully open position, the position in which it is shown, by virtue of the fact that the ball valve 106 is seated. The stem 108 extending between the control valve 68 and the exhaust valve 106 is dimensioned to coordinate movement of the two valves so that upon seating of either valve the other valve is moved away from its seat to open position. To preclude the possibility of the accumulation of lubricant in the bore 72 beneath valve stem 70, due to unexpected leakage past the plunger 84, this space may be provided with a minute vent to the atmosphere.

In operation, the source of compressed air is turned on by opening valve 120 and, assuming that there is no substantial pressure at the discharge of the lubricant pump, the springs 94, 95 will hold the valve 68 away from its seat, and air will flow past this valve through the conduit 46 to the valve chamber 36 of the reciprocable air motor. The latter will commence operating and raise the pressure on the discharge side of the pump. Assuming that the manually operable control valve 56 is closed, the pressure in the chamber 90 will build up until the pressure operating against the lower end of the plunger 84 is sufficient to expand the chamber 90 by moving plunger 84 upwardly. The plunger 84 moves the valve 68 and its associated parts upwardly against the combined force of the springs 94 and 95 to seat the valve 68.

If the valve 68 does not form a perfect airtight seal with its seat 65, resulting leakage of air would, if there were no slight clearance between the stem 108 and its bore 62, tend gradually to raise the pressure applied to one of the faces of the air motor piston 30, and thereby increase the grease pressure to an excessive extent. It is thus of some considerable importance that this slight clearance be provided, although obviously it should not be sufficient to result in unnecessarily wasteful escape of compressed air.

As soon as the manual control valve 56 is operated to permit discharge of grease to the bearing or other part to be supplied with lubricant, the lubricant pressure effective against the lower end of the stem 84 will drop, permitting the springs 94, 95 to force the valve 68 from its seat and again permit air to flow to the air motor. In this connection it should be noted that the operation of the hydropneumatic pressure control valve is independent of the pressure of the compressed air, because the diameters of the bores 62 and 72 are the same. The effective diameter of the valve seat 65 is also the same as that of the valve stem 70 and substantially the same as that of valve stem 108. As a result, the only forces acting to move the valve 68 are those due to the lubricant pressure at the lower end of the plunger 84 and the force due to the compression of the coil springs 94, 95. When the manually operated control valve 56 is permitted to close, the lubricant pressure will again rise to the value preset by the degree of compression of springs 94 and 95, whereupon the valve 68 will again be forced to closed position.

While I have shown and described a preferred embodiment of my invention, it will be apparent that numerous variations and modifications thereof may be made without departing from the underlying principles of the invention. I therefore desire, by the following claims, to include within the scope of the invention all such variations and modifications by which subtantially the results of my invention may be obtained through the use of substantially the same or equivalent means.

I claim:

1. Apparatus for controlling and limiting the effective supply and pressure of one fluid medium in response to the pressure of another fluid medium, comprising, in combination, means defining a control valve opening, a control valve mounted for movement between an open position and a closed position in relation to said control valve opening, means defining a fluid inlet connection to the upstream side of said control valve opening for a first fluid medium, means defining a fluid outlet connection from the downstream side of said control valve opening for the first fluid medium, means defining an exhaust valve opening, means forming a bleed passage of very small effective flow area extending from the downstream side of said control valve opening to exhaust through said exhaust valve opening, an exhaust valve mounted for movement between an open position and a closed position in relation to said exhaust valve opening, valve coordinating means connected to said control valve and to said exhaust valve and dimensioned to effect movement of said exhaust valve to open position upon movement of said control valve into closed position and to effect movement of said exhaust valve to closed position upon movement of said control valve to open position, means defining an expandable chamber adapted to receive a second fluid medium under pressure and including means movable in opposite directions upon expansion and contraction of the chamber, means isolating said chamber from communication with both the upstream and the downstream sides of said control valve opening, resilient means associated with said chamber defining means to yieldably urge contraction of said chamber, and means connecting said movable chamber defining means to said control valve to effect upon predetermined expansion of said chamber closing of said control valve and through operation of said coordinating means opening of said exhaust valve and to effect upon predetermined contraction of said chamber opening of said control valve and through operation of said coordinating means closing of said exhaust valve.

2. Apparatus for controlling the supply of compressed air to a pneumatically operated pump in response to the discharged pressure of the pump, comprising, in combination, valve body means defining an inlet and an outlet for compressed air, means forming a control valve seat defining an opening between said inlet and said outlet, a control valve separably engageable with the upstream side of said seat to close off said inlet from said outlet, first and second guide stems extending from the upstream and downstream sides respectively of said control valve, said valve body means defining two bores therein receiving said respective stems for translation therein, means forming beyond the end of said first stem a chamber adapted to be connected with a pump outlet, means isolating said chamber from communication with said control valve, a plunger extending reciprocably into said chamber and having one end exposed to the interior thereof and the other end opposing the adjacent end of said first stem to apply force thereto in accordance with the fluid pressure within said chamber, said valve body bore receiving said second stem opening outwardly to the atmosphere from the outlet side of said control valve seat, said second stem being dimensioned transversely in relation to said last mentioned bore to form therewith a bleed passage of very small effective flow area between the downstream side of said valve seat and the atmosphere, means defining an exhaust valve seat encircling the outer end of said last mentioned bore, a spherical member engaging the outer end of said second stem and dimensioned to form an exhaust valve separably engageable with said exhaust valve seat to close said bleed passage, a compression spring mounted to urge said exhaust valve into engagement with

the exhaust valve seat therefor, and said second valve stem being dimensioned to force said exhaust valve away from the seat therefor upon movement of said control valve into engagement with the seat thereof by said pressure actuated plunger and to force said control valve away from the seat therefor upon engagement of said exhaust valve with said seat therefor by said compression spring.

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