United States Patent

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[33] **Germany**
[31] **P 18 13 167.4**

[54] **PRESSURE-RELIEF VALVE**
11 Claims, 1 Drawing Fig.

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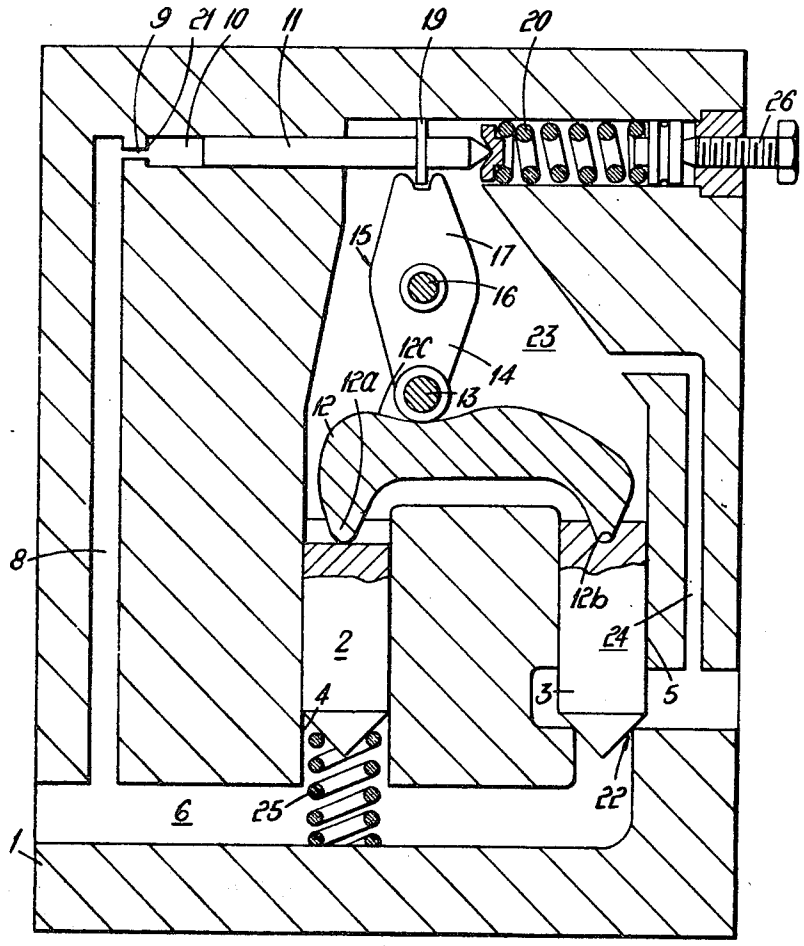
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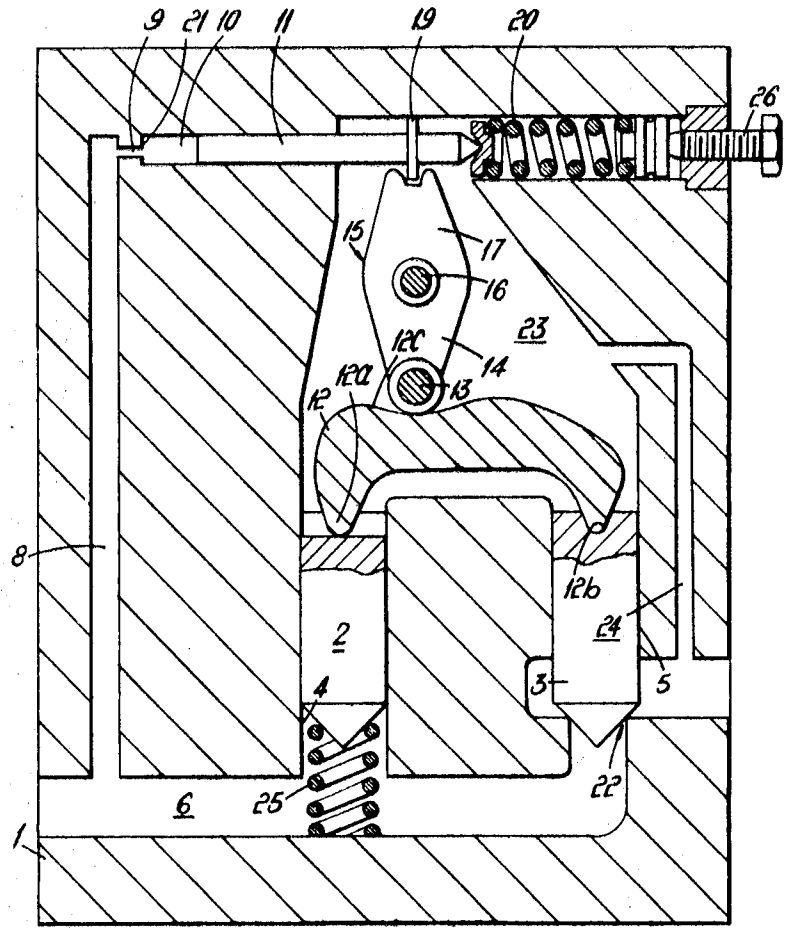
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ABSTRACT: A pressure-relief valve including a housing having a slide valve which closes against the flow of fluid from a source whose pressure is to be controlled, a control piston movable in a cylinder parallel to the valve and acted upon by the fluid pressure, a balance lever having one end contacting the back of the valve and a fulcrum which is movable by a pilot piston in response to the source pressure so as to vary the lever ratio and allow the valve to open when the pressure exceeds a predetermined value. The opening pressure of the valve is variable over a wide range by changing the preload on a compression spring acting against the pilot piston.





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PRESSURE-RELIEF VALVE

CROSS-REFERENCE TO RELATED APPLICATION

This application is filed under the provisions of 35, USC 119 with a claim for the benefit of the filing date of an application covering the same invention filed on Dec. 6, 1968, Ser. No. P 18, 13, 167, 4, in the Federal Republic of Germany.

BACKGROUND OF THE INVENTION 1. Field of the Invention

The invention relates to pressure-relief valves.

2. Description of Prior Art

Pressure-relief valves which are controlled by the hydraulic pressure itself are known. Generally, a control piston which is acted upon by hydraulic pressure and balanced by a spring opens the actual pressure-relief valve when the control pressure is exceeded. As soon as the pressure drops, the spring returns the control piston to the initial position.

German Pat. No. 1,087,863 discloses a pressure-relief valve having a valve element which is opened by a lever actuated by a spring-loaded control piston which communicates with the source of fluid to pressure which is to be controlled. The lever opens the spring-loaded ball valve against the direction of flow via a push rod.

A pilot operated pressure-relief valve is shown in German Patent No. 1,230,637. This valve has a valve shutter consisting of a differential piston whose larger front face remote from the valve seat is acted upon by the pressure which is to be controlled via a throttle valve. A chamber formed adjacent the larger front face of the valve shutter communicates with the valve outlet via an auxiliary valve responsive to excess pressure.

German Pat. No. 1,077,019 discloses another pilot operated pressure-relief valve which opens in direction of flow and provides a counterpressure chamber in which an auxiliary control member responding to the flow pressure is formed by a sleeve valve. In normal operating condition of the valve this sleeve valve connects the counterpressure chamber with the pressure side of the valve and interrupts this connection to the pressure side only when the predetermined excess pressure is reached, thus connecting the counterpressure chamber with the outlet. The sleeve valve is an adjustably spring-loaded differential piston which provides an axial through bore. The sleeve valve is supported in outlet direction in a guide sleeve having axially spaced annular slots on its periphery, one of the slots being connected with the pressure side of the valve and the other with the counterpressure chamber. In addition, both slots communicate with the inner of the guide sleeve through bores spread over the periphery of the sleeve. Between the two parts of the differential piston a shaft of smaller diameter is inserted which joins the two slots in rest position via the bores. The piston part of smaller diameter provides a guiding edge whose breadth is larger than the diameter of the bores communicating with the annular slot connected to the counterpressure chamber. The piston part has an adjacent annular groove communicating with the axial bore of the piston through one or several radial bores and connects the counterpressure chamber with the outlet by means of the guide edge when the predetermined excess pressure has been reached and the connection between the two slots has been interrupted by the shaft of the differential piston.

Disadvantages of these known valves are that they need complicated damping dependent on viscosity and they tend to vibrate. Another disadvantage is that the cross-sectional flow area of the passage and the response pressure adjustment depend on the following pressure spring.

SUMMARY OF THE INVENTION

An object of this invention is to provide a pilot operated pressure-relief valve which is suitable for the control and passage of large quantities and has a large range of pressure adjustment. It is a further object that the valve ensure damping independent of viscosity and that it operate without vibrations.

The present invention achieves these objects by varying, in response to the pressure which is to be controlled, the lever ratio of a balance lever having one end acting against the back of a lift valve, the front of which is subject to the controlled pressure, and the other end acting against the back of a piston which is also subject to the controlled pressure. The lever ratio is changed by providing a fulcrum in the form of a roller movable along the balance lever. A pilot piston acted upon by controlled pressure on one side and an adjustable compression spring on the other moves one end of a lever, the other end of which carries the fulcrum roller which is the pivot point for the balance lever. Preferably, the roller moves in a synclinal recess in the balance lever. The chamber in which the levers are located communicates with the downstream side of the valve so that it is maintained at the reference pressure of the system and is always filled with fluid. In order to ensure that the valve is closed when the controlled pressure is very low, the control piston is spring loaded so that it presses the valve element, or shutter, towards its closed position via the balance lever.

BRIEF DESCRIPTION OF THE DRAWING

The drawing is a longitudinal cross-sectional view taken through a pilot operated pressure-relief valve embodying the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawing, there is shown a valve housing **1** having a control piston **2** and a valve shutter **3**, designed as a closing piston, which are movable in parallel bores **4** and **5** respectively. The front faces of the piston and valve element communicate with the inlet **6** to the valve housing 1. A balance lever or beam 12 pivoted about a bearing roller 13 has one end 12*a* which acts against the back of the control piston 2 and the other end 12*b* which acts against the back of the valve element or shutter **3**.

The bearing roller is attached to one end 14 of a lever 15 having a fixed axis 16 transverse to the balance lever. The other end 17 of the lever is notched to engage the edge of a collar 19 which is fixed to a pilot piston 11 movable in a bore 10 which communicates to the inlet of the valve via a passageway **8** and a choke bore **9**. A compression spring **20** acts against the end of the pilot piston 11 to counteract the pressure acting on the other end. The loading of the spring is adjustable through an adjusting screw **26**.

The chamber **23** in which the levers and rear ends of the pilot piston, control piston and valve element are located communicates with the downstream side of the valve via a passageway **24** so that the pressure differential across each of the hydraulic elements if the difference between the pressure to be controlled and the reference pressure of the system.

OPERATION

When the pressure at the inlet of the housing is low, the pilot piston 11 is forced into contact with the abutment 21 by the compression spring **20** and the piston or valve element **3** is held against the valve seat **22** by the compression spring **25** acting through the control piston **2** and the balance lever 12. As the pressure increases, the pilot piston moves to the right in the drawing and away from the abutment as it overcomes the force of the compression spring, thereby turning the lever 15 clockwise about the fixed axis 16 so that the bearing roller 13 moves to the left along the curved section 12*c* of the balance lever. At some point in the movement of the lever 15 the change in lever ratio of the balance lever 12 allows the fluid pressure acting on the front face of the valve to overcome the combined fluid pressure and spring force acting through the control piston **2** to cause the valve to lift off its seat and open. As the valve lifts, fluid flows from the inlet to the outlet of the

housing through the annular opening between the valve element and the seat 22 until the pressure decreases and the pilot piston moves back toward the left, thereby changing the balance lever ratio in the opposite direction until the combined force of the compression spring 25 and the pressure upstream of the valve are sufficient to overcome the pressure acting on the front face of the valve element to close the valve.

To stabilize the system and prevent overbiasing, the choke bore 9 is arranged in the passageway to the pilot piston 11.

The pressure differential at which the valve will open may be adjusted over a wide range by use of the adjusting screw 26 which varies the load on the pilot piston 11.

It will be appreciated that the invention illustrated and described herein may be modified by those skilled in the art without deviating from the spirit and scope of the invention as set forth in the following claims.

I claim as my invention:

1. A pressure control system comprising a valve which closes against the flow of fluid from a source whose pressure is to be controlled, a control piston acted upon by fluid pressure from the source, a lever system connecting the control piston and valve, and means for moving the fulcrum of the lever system in response to the pressure of the source to vary the lever ratio.

2. The pressure control system of claim 1 wherein the lever system connecting the control piston and valve comprises a balance lever having one end acting against the back of the control piston and the other end acting against the back of the valve.

3. The pressure control system of claim 2 wherein the means for moving the fulcrum of the lever system comprises a pilot piston acted upon by the source pressure and a linkage connecting the pilot piston to the fulcrum of the lever system so that the fulcrum is moved toward the control piston when the pressure increases and toward the valve when the pressure decreases.

4. The pressure control system of claim 3 including a spring which acts against the pilot piston and means for varying the preload on the spring to adjust the pressure at which the valve opens.

5. The pressure control system of claim 4 wherein a compression spring acts against the control piston to bias the valve toward the closed position.

6. The pressure control system of claim 3 wherein the fulcrum is a bearing roller and the linkage is a lever having a fixed pivot, one end attached to the roller, and the other end connected to move with the pilot piston.

7. A pressure-relief valve assembly comprising: a housing having an inlet, an outlet and a passageway connecting the inlet to the outlet; a slide valve mounted in the housing for controlling the flow through the passageway; a control piston and cylinder in the housing, the front of the piston communicating with the passageway upstream of the slide valve; a balance lever having one end contacting the back of the valve, the other end contacting the back of the piston and a fulcrum which is movable to change the lever ratio; and means responsive to the pressure upstream of the slide valve for moving the fulcrum to change the lever ratio.

8 The pressure-relief valve assembly of claim 7 wherein the means for moving the fulcrum of the balance lever comprises a pilot piston communicating with the passageway upstream of the valve and means for connecting the pilot piston to the balance lever fulcrum so that the fulcrum moves toward the control piston as the upstream pressure increases and toward the valve as the upstream pressure decreases.

9. The pressure-relief valve assembly of claim 8 wherein the balance lever, back of the control piston, and the back of the valve are all in a chamber which communicates with the passageway downstream of the valve.

10. The pressure-relief valve assembly of claim 9 wherein the valve is biased toward a closed position by a spring acting on the control piston.

11. The pressure-relief valve assembly of claim 9 wherein an adjustable preload acts against the pilot piston to determine the pressure at which the valve opens.