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A liquid pump that self-limits and detects output pressure

HP INC

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Abstract:

In this disclosure, we describe a device that pumps fluid from an inlet to an outlet while regulating the maximum pressure on the outlet of the device. When the regulation pressure is achieved, the device can detect this and send an electric signal to a control.

Description of the Invention:

A diaphragm pump works by expanding a flexible diaphragm (referred to as “active diaphragm) to pull fluid past a one way check valve from an inlet, then collapsing that diaphragm to push the fluid past another one way check valve to an outlet. This concept takes a diaphragm pump and modifies it by adding one or more passive diaphragms (also known as expansion chamber) that are spring loaded to either the collapsed or expanded state. During normal, low pressure operation, these diaphragms have little to no effect on the operation of the pump.

In the case of a passive diaphragm that is spring loaded in the collapsed state, the pump behavior is modified. When the outlet of the pump is either blocked or reaches a sufficient positive pressure, the operation of the pump is passively modified as follows: on the collapsing stroke of the pump, the fluid will be directed to fill the passive diaphragm rather than being pushed to the outlet, causing the passive diaphragm to expand. On the subsequent expansion stroke, the fluid that is in the passive diaphragm will be pulled back into the active diaphragm rather than fluid being drawn in from the inlet. This handoff will repeat until the high pressure or blockage on the outlet is relieved in some manner. This can be detected by a switch or sensor on the passive diaphragm that detects when it is expanded, thus sending a signal to a control that the regulation pressure has been reached.

In the case of a passive diaphragm that is spring loaded in the expanded state, the pump behavior is modified. When the inlet of the pump is either blocked or reaches a sufficient negative pressure, the operation of the pump is passively modified as follows: on the expanding stroke of the pump, the fluid will be directed to fill the active diaphragm from the passive diaphragm rather than being pulled frin the inlet, causing the passive diaphragm to collapse. On the subsequent collasping stroke, the fluid that is in the active diaphragm will be pushed back into the passive diaphragm rather than fluid being pushed out the outlet. This handoff will repeat until the low pressure or blockage on the inlet is relieved in some manner. This can be detected by a switch or sensor on the passive diaphragm that detects when it is collapsed, thus sending a signal to a control that the regulation pressure has been reached.

Both a passive collapsed and a passive expanded diaphragm can be added to the same pump to achieve the function of each. In addition, multiple of either type of passive diaphragm can be attached to the same system with different spring forces and therefore different regulation pressures to detect multiple pressure levels. The regulation pressure is selected by modifying the spring force or the size of the diaphragm.

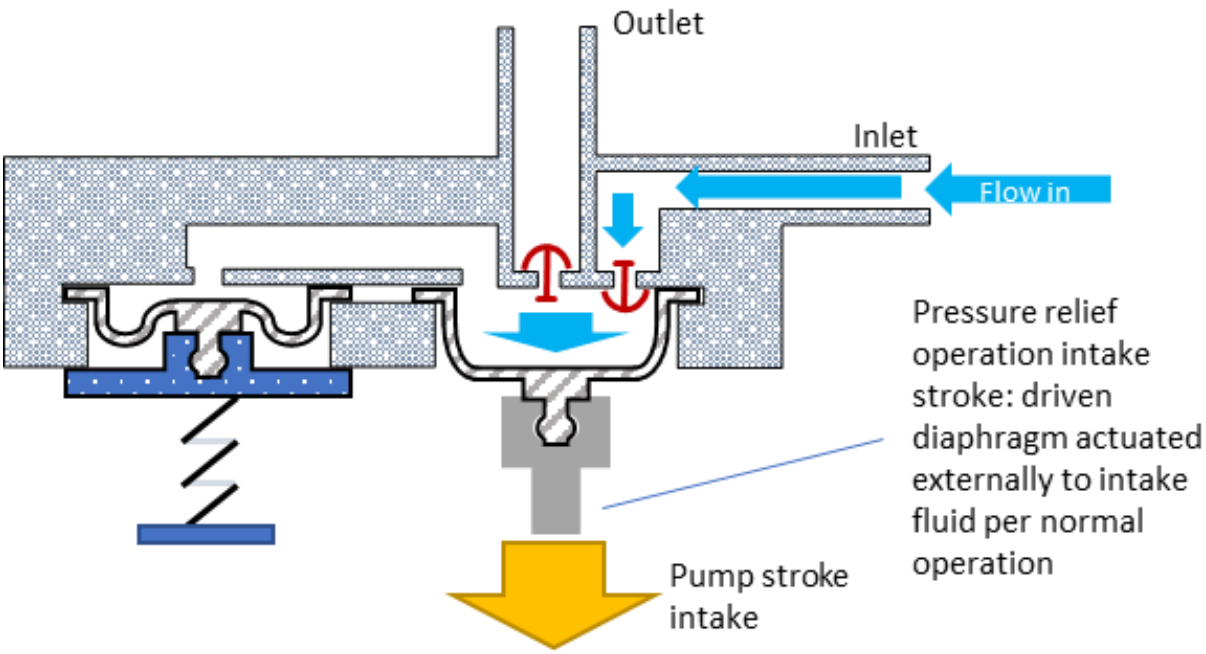

Fig 1. Example of an outlet pressure relief design expansion stroke

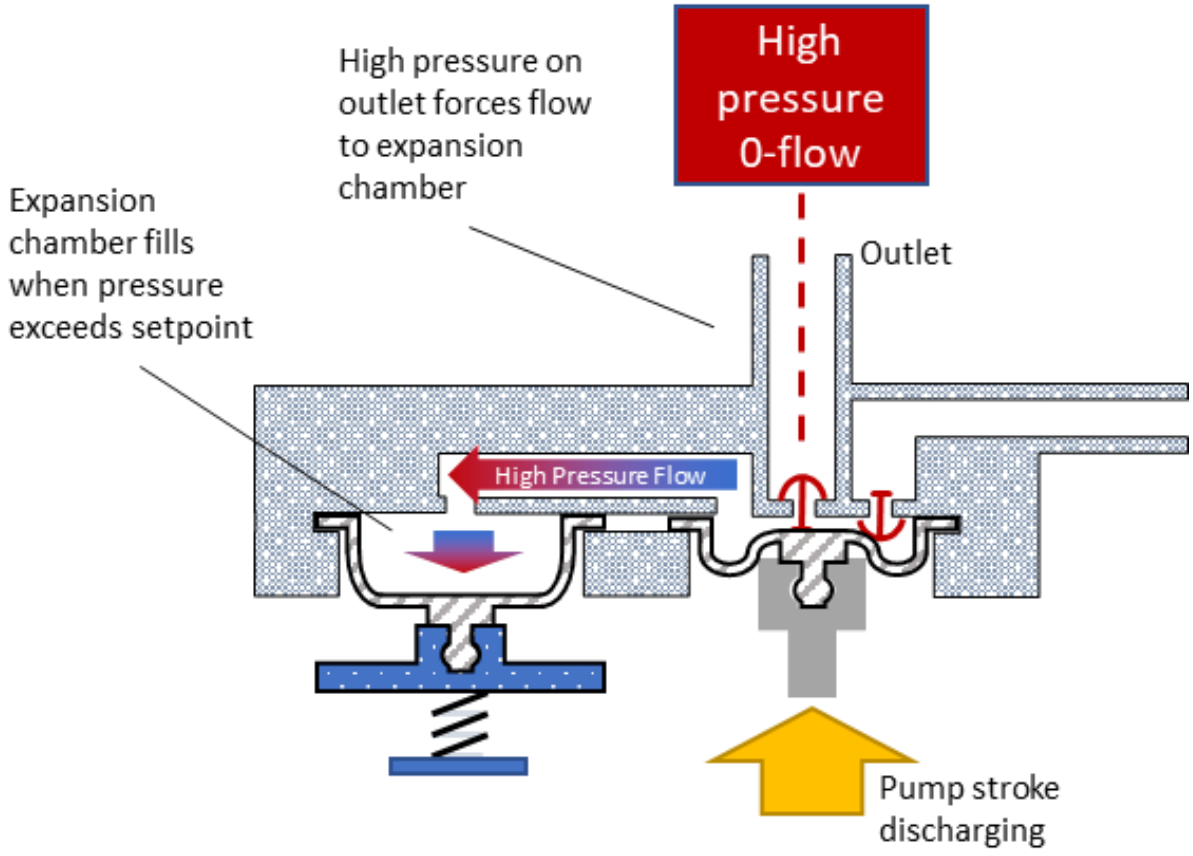

Fig 2. Example of an outlet pressure relief design collapse stroke with a plugged outlet

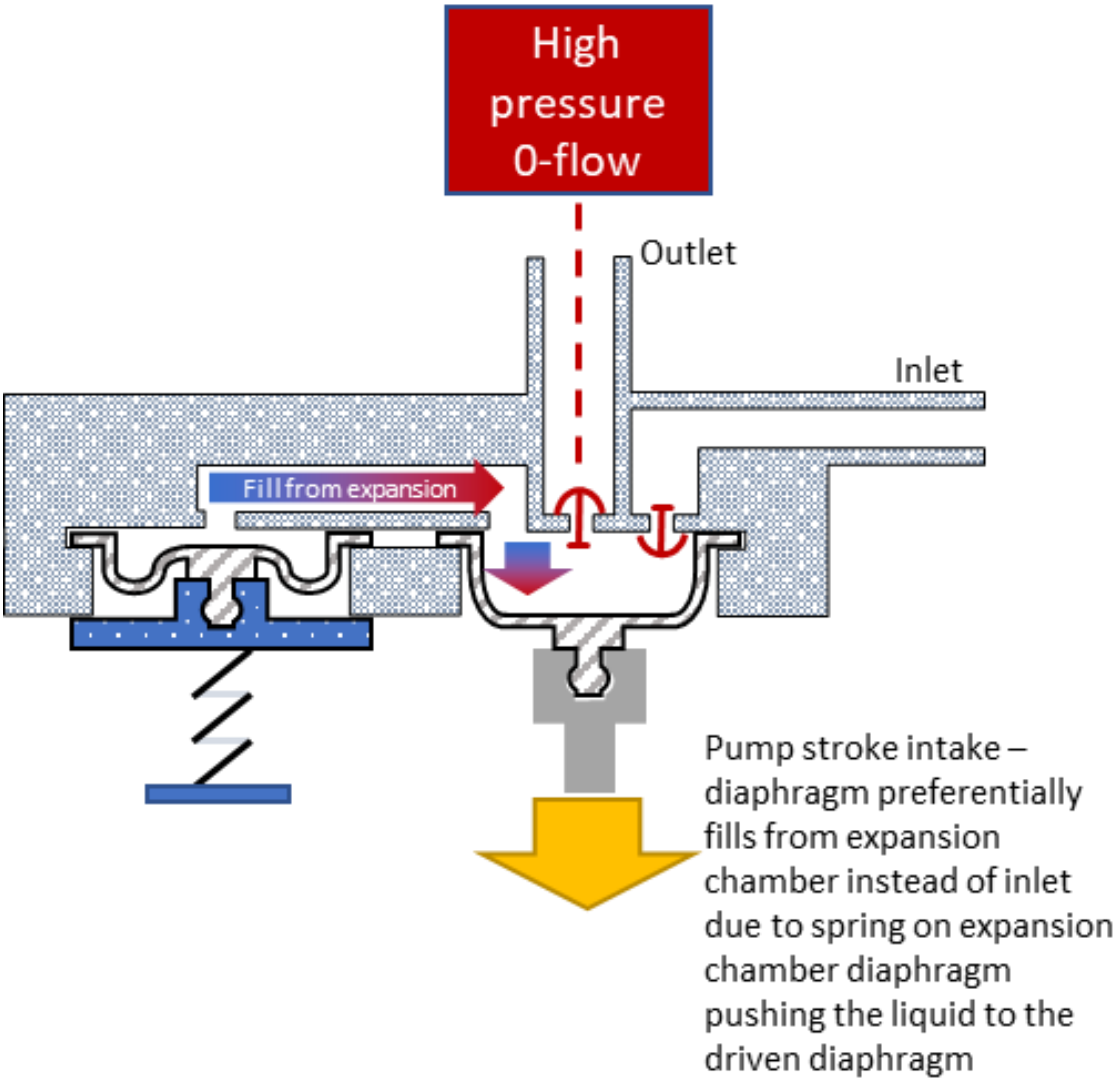

Fig 3. Example of an outlet pressure relief design expansion stroke with a plugged outlet

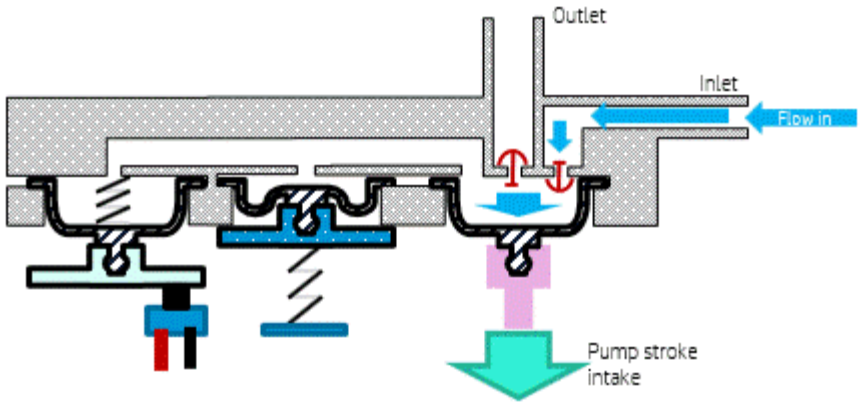

Fig 4. Example of an pressure relief design with both inlet and outlet pressure regulation and inlet pressure detection with a microswitch

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