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Reduction of Valve Leakage: A Concept

In a new type of poppet valve, pressure on the poppet seat is increased by heating the poppet plunger or cooling the valve body. By the exertion of a force of between 4.45 and 44.5 kN at the poppet-seat interface, leakage may be either eliminated or reduced to an acceptable level. Such valves are especially desirable for handling corrosive fluids.

The technique is justified mathematically. Analyses show that, with temperature increases of 30 K, valve plungers made of aluminum, copper, stainless steel, or similar metals expand the few thousandths of an inch necessary for a satisfactory seal. With modification, the technique is reversible; i.e., the valve seat could be cooled to generate comparable force by contraction.

Designing a low-leakage valve for corrosive fluids requires close attention to coefficients of thermal expansion, moduli of elasticity, and thermal conductivities of the materials in the strained element (the poppet stem) and the valve's restraining walls. One objective is to minimize the temperature gradient in the walls; fins added to the valves outer walls could improve heat transfer. Heating (or cooling) need not be electric; it could be produced by convection (with hot or cold fluids), thermoelectrics, or chemical reactions.

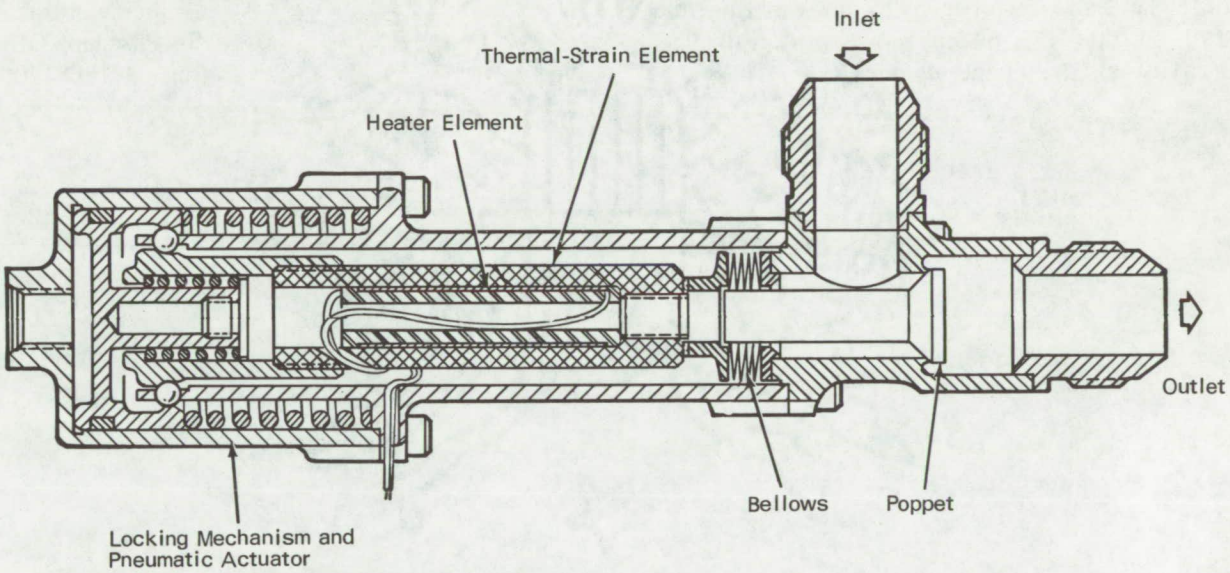

Figure 1. Longitudinal Section, Closed Shutoff Valve

Figure 1 shows one type of shutoff valve, in the closed position, with an electrothermally strained poppet stem. The valve is actuated pneumatically, and its seating is locked by a ball-detent mechanism.

(continued overleaf)

Because the poppet plunger is heated before the valve is closed, subsequent cooling of the plunger generates great pressure between poppet and seat. Generation of 90% of the required temperature differential between valve body and stem takes approximately 1 min. The valve is opened by pressurizing the actuator so that the piston moves, the ball falls into a cavity, and the plunger unlocks.

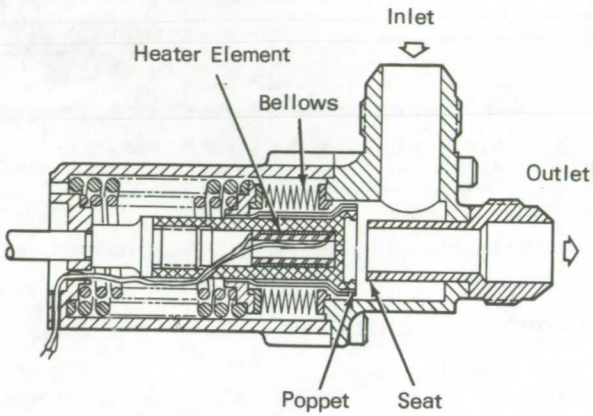

Figure 2. Longitudinal Section, Open Wagon-Wheel Valve

In the wagon-wheel concept (Fig. 2), a ring is thermally caused to contract around a cylindrical seat. When closed, the heated valve is sealed initially by contact between its seat and the flat top of the poppet. Subsequent cooling clamps the poppet ring extremity around the tubular seat. Any suitable actuator can be incorporated in this design.

Note:

Requests for further information may be directed to:

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No patent action is contemplated by NASA.

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