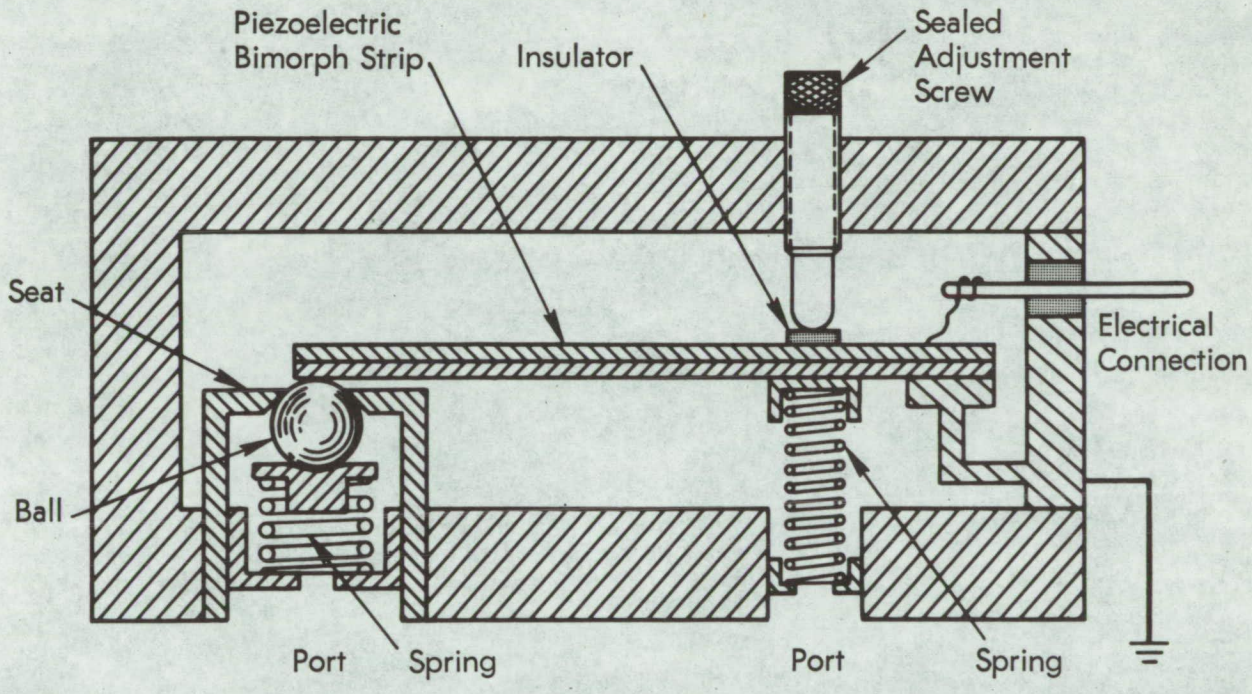
NASA TECH BRIEF

Ames Research Center

A Piezoelectrically Actuated Ball Valve

The problem:

To develop a small, lightweight valve that is not operated by bulky coils or structures carrying magnetic flux.



The solution:

A valve which utilizes the piezoelectric effect.

How it's done:

A piezoelectric bimorph strip closes and opens the valve. The strip is composed of two layers of poled piezoelectric ceramic material. The two outer surfaces are covered with a conductive plating and, when a voltage is applied across them, the strip curves much as a bimetal strip curves when heated. The ceramic layers are bonded together so that they are poled in opposite directions across the thickness, and a thin metal shim may be interposed between the two layers to enhance conductivity. In the device shown in the figure, a voltage of the proper polarity applied to the electrical connection will make the left-hand end of the strip move downward, and the opposite polarity will make it move upward. When the voltage is removed, the strip returns to its initial position and the ball rests against its seat. Since the

(continued overleaf)

piezoelectric strip performs like a capacitor, there is an initial inrush of current when the valve is energized, and then only a small leakage current flows as the valve remains energized.

A typical value of maximum voltage gradient for piezoceramic material is 0.59 volts per μm (15 volts per mil). Thus, if the total thickness of the strip is 762 μm (30 mils), 450 volts will be required to obtain the maximum deflection. Although this voltage appears high compared to the voltages required by conventional magnetically actuated valves, the energy consumed by the valve in watt-seconds per actuation will be very much lower than conventional valves. However, since high voltages are required, the piezoelectric valve can only be used in gases and nonconductive liquids unless it is fully insulated.

In low flow rate, low pressure applications, the valve is advantageous because of its small size, light weight, and low electrical power consumption. It is also capable of sharp, repetitive action because its inductance is negligible.

Note:

No additional documentation is available. Specific questions, however, may be directed to:

Technology Utilization Officer
Ames Research Center
Moffett Field, California 94035
Reference: B72-10204

Patent status:

No patent action is contemplated by NASA.

Source: Louis R. Erwin, Harlow W. Schwartz, and Bernard R. Teitelbaum of
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