NASA TECH BRIEF

NASA Pasadena Office

Magnetic Latching Valve

The problem:

To develop a latching, fast-acting 2-port poppet valve for use in gas chromatograph—mass spectrometer combinations; a positive actuation time of the order of a few hundredths of a second is a prime requisite, and a static force must hold the valve in position at all times.

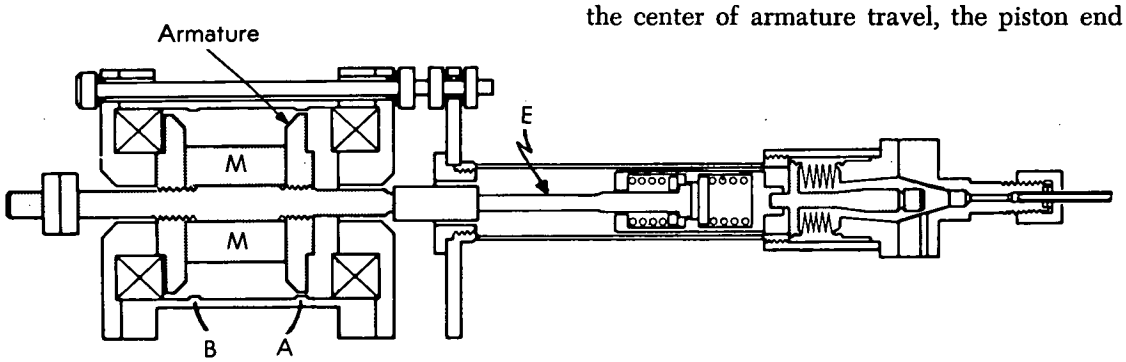
The solution:

A linear, bistable magnetic actuator which utilizes a permanent magnet to hold the poppet in position and requires electrical power only for shifting the valve poppet from one position to the other.

How it's done:

The device shown in the diagram consists of three distinct subassemblies, a valve, a spring capsule, and a magnetic actuator. The valve is of conventional 2-port design; the poppet stroke is about 1.5 mm (0.060 in), and leakage and operational friction is kept to a minimum by use of a bellows instead of a packing gland.

The spring capsule is located in a coupling barrel, and it can move freely within the barrel; the capsule itself is rigidly attached to the valve poppet stem. An extension of the armature shaft, E, acts as a piston within the capsule and compresses either of two springs. The springs are attached to the two ends of the capsule, but not to the armature shaft; in fact, at the center of armature travel, the piston end of the armature shaft extension has an unloaded clearance of about 0.51 mm (0.020 in). Armature motion is restricted so that either spring is compressed 0.25 mm (0.01 in) when the poppet is fully open or closed; additionally, the springs are selected so that they exert a force of about 1.6 kg (3.5 lbs) when compressed to this extent.



The actuator consists of a cylindrical, axially symmetric armature of soft iron (or other material of high permeability and low coercive force) with a permanent magnet of high coercive force, and a cylindrical stator of soft iron with end caps of the same material; the actuator shaft is made of nonmagnetic metal. Two

(continued overleaf)

actuating solenoids are mounted in the end caps. In the diagram, the armature is shown at the limit of its travel and at one of its two bistable positions. The armature will remain at either end of the stator enclosure because of the attraction between the permanent magnet in the armature and the soft iron caps of the stator. When the armature end is in contact with the end cap, the basic flux path is such that the majority (88%) of the flux lines pass through the contact interface parallel to the armature shaft and return via the stator shell through cylindrical tab A. The magnetic holding force is of the order of 2.7 kg (6 lbs); thus, since the spring in the spring capsule exerts a return force of 1.6 kg (3.5 lbs), the poppet is held open (or closed) by a net force of 1.1 kg (2.5 lbs).

The actuator is changed over to the other bistable position by energizing the solenoids to an extent that the effective flux in the armature-stator system is decreased and the return force exerted by the spring capsule can move the armature away from one end cap. The solenoids are energized in series; one coil bucks the magnetic flux in the end cap nearest the armature and the other coil establishes in the opposite end cap a flux which can attract the armature magnet. Referring to the diagram, when the solenoids are energized, the capsule spring accelerates the armature away from tab A, breaking the flux path which held the armature against the left end cap; the armature rapidly moves towards the right end cap and establishes a new flux path through tab B. When power to the solenoids is removed, the armature remains locked in its new position.

Note:

Requests for further information may be directed to:

Technology Utilization Officer
NASA Pasadena Office
4800 Oak Grove Drive
Pasadena, California 91103
Reference: TSP 73-10026

Patent status:

NASA has decided not to apply for a patent.

Source: Joseph M. Conley of
Caltech/JPL
under contract to
NASA Pasadena Office
(NPO-11790)