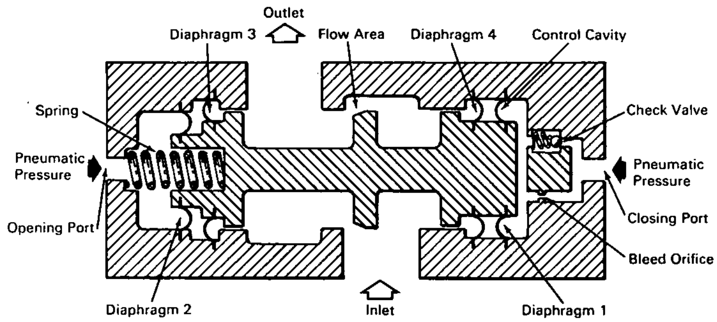
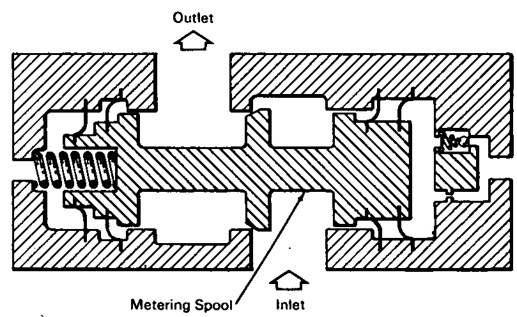
NASA TECH BRIEF

Pneumatic Shutoff and Time-Delay Valve Operates at Controlled Rate



INITIAL POSITION (Maximum Flow)



SHUTTLED POSITION (Minimum Flow)

The problem:

To design a valve which increases fluid-flow area at a uniform rate and incorporates shutoff and time-delay features.

The solution:

A valve incorporating a metering spool which moves at constant velocity under pneumatic pressure and spring compression to achieve uniform flow-area increase.

How it's done:

The flow of fluid occurs through the main section of the valve from inlet to outlet. The rate of fluid flow is controlled by changing the flow area as the metering spool is stroked at a uniform rate.

At the start of the operation, the spring holds the spool in the initial position. Pneumatic pressure is applied to the closing port, causing air to flow through the check valve and into the control cavity. The pres-

(continued overleaf)

sure builds up rapidly in the control cavity exerting a force on diaphragm 1, which moves the spool into its shuttled position. In this position the flow area is a minimum. If the desired minimum flow area is greater than zero, a mechanical stop within the valve will be required to hold the spool away from its seat. If the minimum flow desired is zero, the seat may act as the stop. To stroke the spool through its metering cycle, pressure is applied at the opening port at the same time that pressure is vented through the bleed orifice at the closing port. Pressure at the opening port exerts a force on diaphragm 2 to shuttle the spool to the open position.

As the pressure in the cavity around diaphragm 2 is essentially constant, and the force exerted by the spring is also essentially constant over the displacement of the spool, the force on the spool is constant, and therefore produces a constant gas pressure in the control cavity. As a result, gas flows at a uniform rate through the bleed orifice, and the spool will move at a constant speed.

It is also possible with this arrangement to achieve a time delay prior to the motion of the spool. If the effective area of diaphragm 2 is sufficiently smaller than that of diaphragm 1, and equal pressures are applied in the cavities around the two diaphragms, then the force on diaphragm 1 will be greater than the force (due to the pressure acting on diaphragm 2 and the spring compression) acting on the left end of the spool. This excess force will hold the spool against its seat or stop in the shuttled position. The pressure in the control cavity must be bled down to the point where the opposing forces are equal before the spool can begin to move to the right. The time required to bleed the control cavity to this lower pressure is the time delay desired. Diaphragms 3 and 4 are used to isolate the controlled fluid from the controlling fluid and to balance the fluid-line-pressure forces on the spool.

Notes:

1. Diaphragm areas, control cavity volume, and bleed-orifice size may be varied to give any desired combination of time delay and spool travel time.
2. Inquiries concerning this innovation may be directed to:

   Technology Utilization Officer
   Marshall Space Flight Center
   Huntsville, Alabama, 35812
   Reference: B66-10189

Patent status:

No patent action is contemplated by NASA.

Source: John L. Horning and
Lloyd E. Tomlinson of
North American Aviation, Inc.
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(M-FS-602)