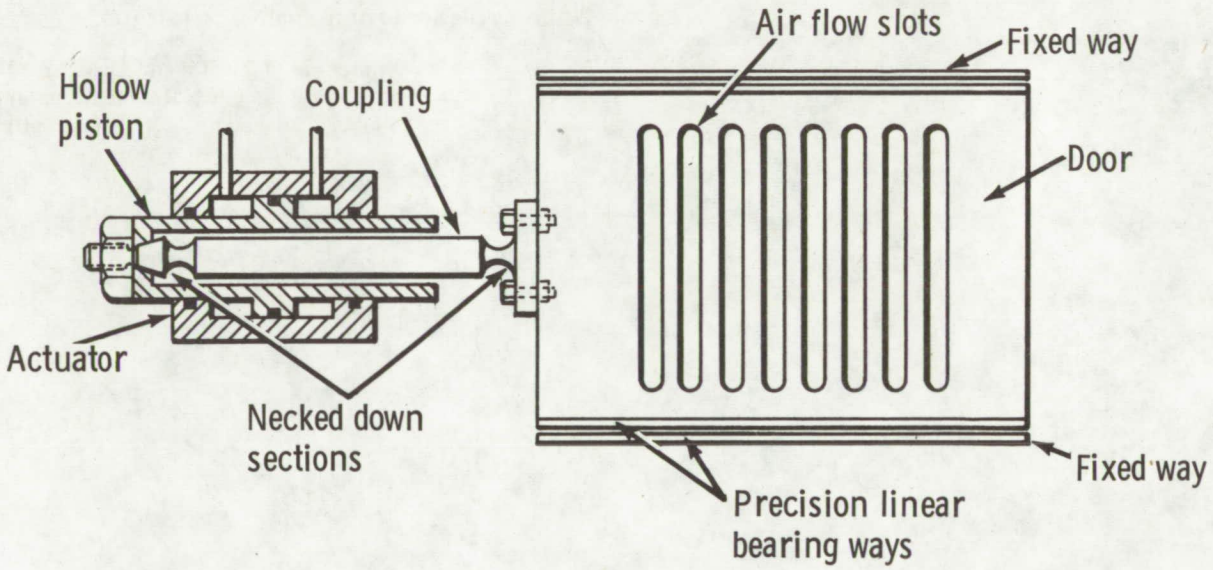
NASA TECH BRIEF

Lewis Research Center

Mechanical Coupling for High Cyclic Loading



The Problem:

To design a mechanical coupling between an actuator and a load that will allow for slight misalignment, will introduce no backlash, and has sufficient axial strength for high cyclic loading.

The Solution:

A one piece flexure-bar coupling that has low stiffness in all directions except that parallel to the motion of the load.

How It's Done:

A mechanical coupling was needed for a high speed hydraulic positioning servo system in which both the actuator and load were required to move with precise linear motion. In this case, the actuator is a piston and the load is a slotted plate valve used in a supersonic jet engine inlet (door) bypass system. If a solid coupling without flexures were used in this application, a slight misalignment would create side forces on the actuator and door bearings causing high frictional loads with rapid deterioration and failure. A two-piece ball and socket linkage between the two parts would fail due to backlash problems caused by high acceleration forces. Therefore, the coupling had to meet the following physical requirements: high reliability under high cyclic loads, zero backlash, low mass, close spacing between actuator and load, allowance for misalignments and deflections without causing high side loading on the components, and high stiffness in the direction of motion.

The problem has been solved by designing a one-piece cylindrical coupling (see sketch) with "necked-down" regions at each end to form flexures that allow for small misalignments between actuator and load. The flexure-bar

(continued overleaf)

coupling is installed inside a hollow piston rod. One end of the coupling is fastened to the piston rod, the other end is bolted to the valve plate. The coupling material is 18% Ni 300 maraging steel with full heat treatment. The necked-down regions are designed with an eliptical contour and the surface is provided with a fine machine finish (32 RMS).

With this design, no problems have been encountered from misalignment. The door weighing about 4.1 kg (9 lbs) was oscillated through a stroke of 0.254 cm (1/10 in) producing a load of about 1360 kg (3000 lbs). Twenty-four hours of operation while sweeping the operating frequency from 5 Hz to 200 Hz demonstrated successful operation with no perceptible wear on either actuator or load.

Notes:

1. Further information is available in the following report:
   Reference: NASA TM-X-2812 (N73-25097), Improved Design of a High-Response Slotted-Plate Overboard Bypass Valve for Supersonic Inlets
   Copies may be obtained at cost from:
   Aerospace Research Applications Center
   Indiana University
   400 East Seventh Street
   Bloomington, Indiana 47401
   Telephone: 812-337-7833
   Reference: B74-10001
2. Specific technical questions may be directed to:
   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B74-10001

Patent Status:

NASA has decided not to apply for a patent.

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