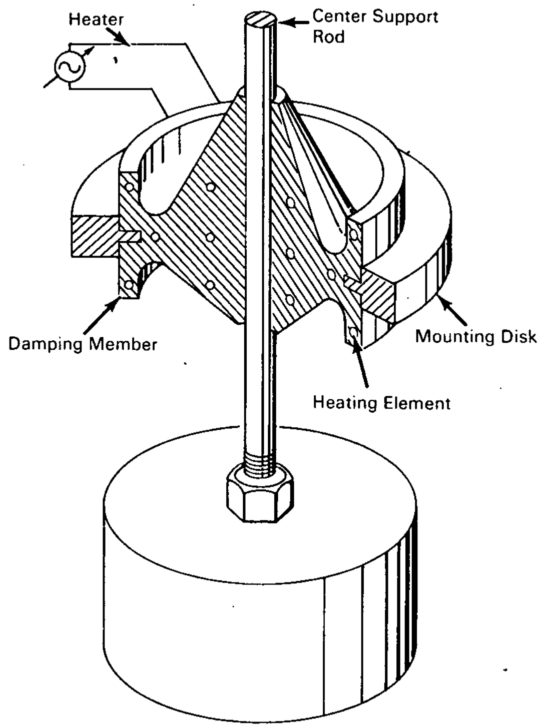
# NASA TECH BRIEF



## Concept for Design of Variable Stiffness Damper




### The problem:

To provide a simple and reliable mechanical damping mechanism applicable to a wide range of shock and vibration attenuation purposes without some of the attendant disadvantages inherent in conventional, fluid-filled viscous dampers and elastomeric isolators.

### The solution:

As the damping mechanism, utilize polymeric-like materials that demonstrate large increases in energy absorption capability at temperatures in the region of their glass transition temperatures. This region is characterized as that wherein the polymeric-like material changes from a relatively stiff material to a relatively soft, rubbery material. A special feature is that the energy absorption characteristics and stiffness are controllable with temperature.

### How it's done:

The damper consists of a solid, substantially amorphous, polymeric-like material of any suitable shape, appropriately implaced between a support and a device. The damper can be used for the isolation of the device from the motion of the support or vice

(continued overleaf)

versa. Heating coils in the proximity of the damping material may be used to control the temperature of the damping material thus providing control of the characteristics of the damper as follows:

(1) In the glass transition temperature range, which may extend over a bandwidth of from 10° to 50°C or more, a high damping capability from 10 to 100 times greater than the capability of the damper at either higher or lower temperatures is obtained, thus allowing control of the damping capability by simply controlling the temperature of the material.

(2) Stiffness of the damper material decreases as the temperature increases through the transition range, thus allowing the stiffness of the damper to be varied for control of the resonant frequency of the system by simply controlling the temperature of the material.

Thus, variation of the temperature of the damping material allows simple and remote means of varying the damping and stiffness of the mechanism while in use.

**Notes:**

1. Transmissibility measurements of polyvinyl chloride and polymethyl methacrylate in their transition ranges indicate transmissibilities of not greater than 1.25 at resonance which corresponds to a damping ratio of approximately 1. This is significantly better than transmissibilities of 3 to 4 or damping ratios of about 0.15 found in conventional dampers employing elastomeric materials.
2. Different polymeric-like materials have different glass transition temperatures, thus allowing a wide choice of design characteristics.
3. A unique feature of the use of these materials is that if they are used in the temperature range below their glass transition temperature, an increase in temperature causes an increase in damping capability, thus providing a factor of safety.
4. If high damping is only a temporary requirement, the damper may be heated to its glass transition temperature to meet the requirement, and subsequently cooled to a temperature below its glass transition temperature where it will serve as a rigid mount.
5. By using a polymeric-like material which returns to its original shape upon heating to a temperature above its glass transition temperature region, the damping mechanism may be restored to its original shape after creeping by simply heating to a sufficiently high temperature.
6. Additional details are contained in *A Concept for Design of Variable Viscosity, Variable Stiffness Dampers,* by Jerome J. Lohr; a paper presented at the First Aerospace Mechanisms Symposium, University of Santa Clara, Santa Clara, California, 19 May 1966.
7. Copies of this paper are available from:
   Technology Utilization Officer
   Ames Research Center
   Moffet Field, California 94035
   Reference: B67-10483

**Patent status:**

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

Source: Jerome J. Lohr
(ARC-11225)