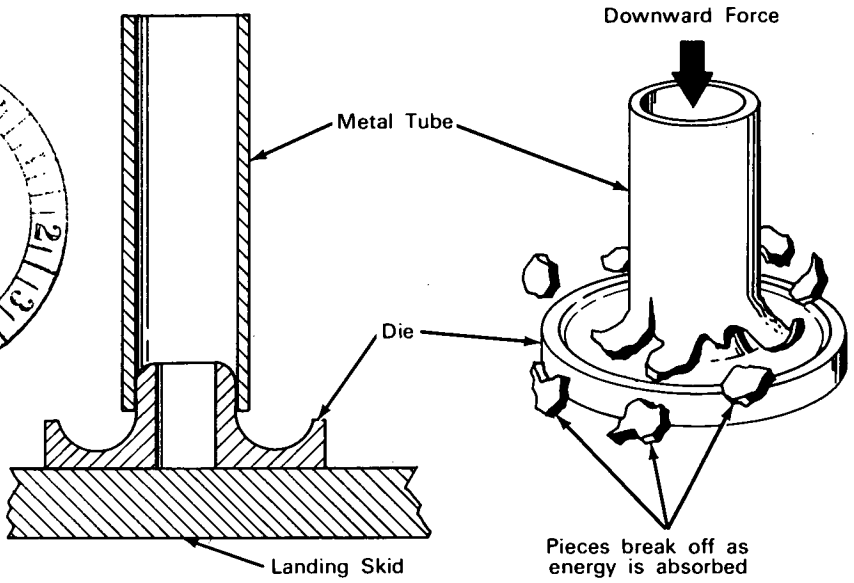
February 1964

Brief 63-10304

NASA TECH BRIEF

This NASA Tech Brief is issued by the Technology Utilization Division to acquaint industry with the technical content of an innovation derived from the NASA space program.

Break-up of Metal Tube Makes One-Time Shock Absorber, Bars Rebound



The problem: Design a lightweight shock absorber, or energy-absorbing system, which will safely dissipate the large amount of energy generated if a spacecraft lands with excess velocity on the Earth, the Moon, or another planet. Low rebound following shock absorption is highly desirable.

The solution: Place a metal tube—in this case a hard aluminum alloy—so that the downward motion of the spacecraft forces the tube against a suitably shaped die, such as a torus. As the tube presses against the die, it shatters by successive fragmentation.

How it's done: Energy absorption results when a force is required to fragment the tube through a large portion of its length. The energy absorption capability of frangible metal tubing, such as 2024-T3 aluminum alloy, has been shown by NASA investigations to be as high as 31,000 foot-pounds of energy per pound of tubing. Any number of frangible tube and die combinations could be used in a spacecraft landing system, depending upon design requirements. Length and diameter of the tubes could be varied, within limits, to suit the application.

The tube must be oriented so that the force is applied along the tube's longitudinal axis and not tangentially. Some mechanism, such as a linkage, could be used to ensure axial loading of the tubes.

Energy-absorption capability of this device is much greater than most existing energy absorption processes. Another valuable characteristic is the almost total lack of rebound. Putting a taper on the end of the tube contacting the die enables the designer to avoid the high initial forces otherwise required to start the frag-

(continued overleaf)

menting process and also permits some control of the rate of force application.

Notes:

1. Other applications of this one-time shock absorber might include elevator decelerators, instrument mountings, mountings for passenger seats and impact testing. Other potential industrial uses are in automobile and aircraft seat belts, guard rails on highways, and shock protection equipment for the transportation of high-cost or delicate machinery.
2. NASA TN D-1477 entitled "A Preliminary Experimental Investigation of an Energy-Absorption Process Employing Frangible Metal Tubing," by John R. McGehee, October 1962, provides information on this innovation.

Patent status: NASA encourages the immediate commercial use of this invention. It is owned by NASA and a patent application has been filed. When patented, royalty-free, nonexclusive licenses for its commercial use will be available. Inquiries concerning license rights should be made to NASA Headquarters, Washington, D.C., 20546.

Source: John R. McGehee, Melvin Hathaway, and Edmond Zavada
Langley Research Center (Langley 1-A)