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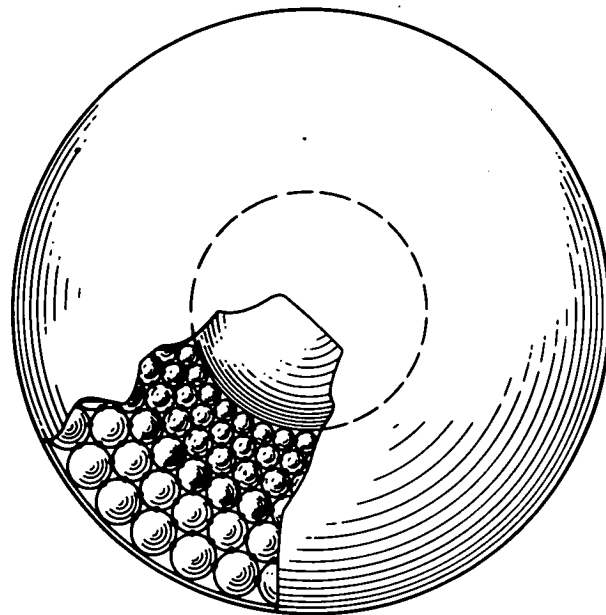
Energy Absorbing System for Mechanical Impacts

A wide variety of protective impact-absorbing systems have been studied for interposition between a landing spacecraft and the surface of a planet. Unfortunately, many shock-absorbing systems are of little value for they are based on the use of resilient frangible materials, and it is difficult to avoid the tendency of an impacting object to rebound with such materials. Shock-absorbing systems which employ fluids forced through restrictive orifices are also of limited use inasmuch as the viscosities of fluids normally undergo severe changes as a function of temperature. On the other hand, shock-absorbing systems which utilize crushable structures for dissipating energy on a one-shot basis appear to have more readily definable and reproducible characteristics; however, when metallic structures are used, rebound is not entirely eliminated because of the inherent resiliency of metals.

The improved energy-absorbing system shown in the diagram is based on the use of an arrangement of crushable hollow spheres bonded together in layers of progressively different diameter, with the largest diameter spheres positioned to receive the impact forces initially. The material chosen for fabrication of the spheres characteristically must be brittle and hence readily fracturable, but it also must be capable of suffering minimum deformation prior to sudden fracture, so that impact force may first be strongly resisted and then absorbed by cave-in of the sphere; sudden collapse eliminates possibility of rebound.

As suggested by the diagram, the payload delivered to the planet surface is surrounded by the protective device and the larger diameter spheres are first exposed to the force of impact; hence, greater amounts

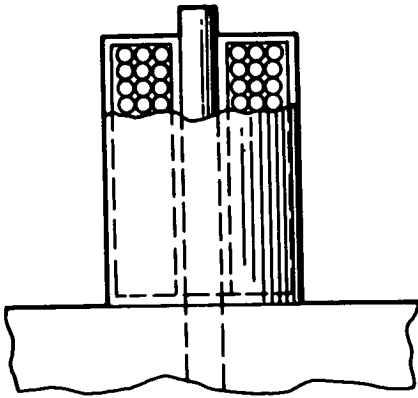
of impact force will be absorbed initially, with lesser and lesser amounts sequentially absorbed by the layers of progressively smaller spheres. The overall rate of energy absorption may be varied by control of



(1) the relative size of the spheres in each layer, (2) the ratio of wall-thickness to sphere diameter, (3) the type of materials used in the spheres in each layer, and (4) the characteristics of the adhesive used to bond spheres.

Although the energy-absorbing system is particularly useful for delivery of payloads by air-drop techniques when constructed as a sphere, in the cylindrical form, as shown in the following diagram, it

(continued overleaf)



can be used for absorption of impact energy or as a protective barrier around impact-prone obstacles such as those commonly found along the shoulders of highways or viaducts.

Patent status:

This invention has been patented by NASA (U.S. Patent No. 3,637,051). Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to:

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(NPO-10671)