Mechanics/Machinery

Improved Descent-Rate Limiting Mechanism

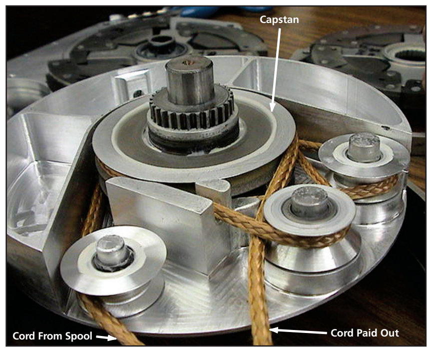
This braking device can be used to capture and slow a moving vehicle.

NASA's Jet Propulsion Laboratory, Pasadena, California

An improved braking cable-payout mechanism has been developed. Like other such mechanisms, this mechanism can be used as a braking or shock-absorbing device for any of a variety of purposes — for example, enabling a person to descend from an upper floor of a burning building at a safe speed, capturing and slowing a moving vehicle, or limiting the shock load generated by opening of a parachute. Whereas other such mechanisms operate at payout speeds that vary with the length of payout, this mechanism operates at approximately constant payout speed, regardless of the length of cord that has already been paid out.

In a prior mechanism of this type, a cord is paid out from a spool on a shaft connected to a centrifugal brake. Because the payout radius on the spool decreases as cord is paid out, the speed decreases by a corresponding amount.

The present mechanism (see figure) includes a spool, a capstan assembly, and centrifugal brakes. The spool is used to store the cord and, unlike in the prior mechanism, is not involved in the primary braking function. That is, the spool operates in such a way that the cord is unwound from the spool at low tension. The spool is connected to the rest of the mechanism through a constant-torque slip clutch. The clutch must slip in order to pay out the cord.



The **Cord Is Paid Out at Constant Radius** from the capstan, which is connected to the centrifugal brake.

As the cord leaves the spool, it passes into the capstan assembly, wherein its direction is changed by use of the first of three idler sheaves and it is then routed into the first of three grooves on a capstan. After completing less than a full circle in the first groove, the cord passes over the second idler sheave, which is positioned to enable the cord to make the transition to the second groove on the capstan. Similarly, a third idler sheave enables the cord to make the transition to the third groove on the capstan. After traveling less than a full circle in the third groove, the cord leaves the capstan along the payout path. The total wrap angle afforded by this capstan-and-idler arrangement is large enough to prevent slippage between the cord and the capstan.

The capstan is connected to a shaft that, in turn, is connected to a centrifugal brake. Hence, the effective payout radius, for purposes of braking, is not the varying radius of the remaining cord on the spool but, rather, the constant radius of the grooves in the capstan. The payout speed is determined primarily by this radius and by the characteristics of the centrifugal brake. Therefore, the payout speed is more nearly constant in this mechanism than in the prior mechanism.

This work was done by Tommaso P. Rivellini, Donald B. Bickler, Bradford Swenson, John Gallon, and Jack Ingle of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-40109

Alignment-Insensitive Lower-Cost Telescope Architecture

This next-generation architecture enables construction of very large telescopes.

Goddard Space Flight Center, Greenbelt, Maryland

This architecture features an active wavefront sensing and control scheme along with methods for measuring the relative positions of the primary to aft optics, such as the secondary mirror, and should enable larger and cheaper telescope architectures needed for future applications. This design overcomes the stability requirements of large telescope primary mirrors.

A wavefront source/sensor is placed at the center of curvature of the primary mirror. The system provides continuous light onto a primary mirror that is retroreflected onto itself. This allows the wavefront controller to constantly update the positions of the primary mirror segments (or deformable mirror actuators). For spherical primaries (where replicated mirrors can be used), a spherical source is used. For aspheric primaries, a null is used. The return beam can be analyzed through focus by using established wavefront sensing and control techniques, including prisms for coarse alignment, multi-wavelength interferometry, or phase retrieval. The light can be monochromatic or white light. This same source and sensor can also be used to check out the system during assembly.

Another function of this innovation involves using a concave mirror on the back of the secondary mirror (or other aft optic) that has the same center-of-curvature location (in defocus) as the primary mirror. The two return beams can be aligned next to each other on a detector, or radially on top of each other. This provides a means with which to measure the relative position of the primary to the secondary (or other aft optics), thus allowing for the removal of misalignment of the center-of-curvature source/sensor (meaning it doesn't need precision placement) and also provides a means with which to monitor the relative alignment over time.

This innovation does not require extremely good thermal stability on the primary mirror and can thus be used in any thermal environment and with cheaper materials. This factor could be critical in enabling the construction of very large telescopes, and provides a means for testing a very large telescope as it is being assembled. In addition to this, the architecture lets one phase (or align) the primary mirror independent of whether a star or scene is in the field. The segmented, spherical primary allows for cost-effective three-meter class (e.g. Midex and Discovery) missions as well as enabling 30-meter telescope solutions that can be manufactured in a reasonable amount of time. The continuous wavefront sensing and control architecture enables missions for low-Earth-orbit.

This work was done by Lee Feinberg, John Hagopian, Bruce Dean, and Joe Howard for Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-14982-1

Micro-Resistojet for Small Satellites

Goddard Space Flight Center, Greenbelt, Maryland

An efficient micro-resistojet has been developed with thrust in the millinewton level, with a specific impulse of approximately 250 seconds and power input of 20 watts or less that is useful for applications of up to 1,000 hours of operation or more. The essential feature of this invention is a gas-carrying tube surrounding a central heating element. The propellant is flashed into vapor and then passes through a narrow annulus between the tube and the heater where it is cracked (in the case of methanol, into CO and H_2) before being discharged through a de Laval nozzle to produce thrust.

A multi-layer radiation shield around the gas tube minimizes heat loss. Also, if methanol is used as the propellant, the simultaneous heating and cracking does not need an additional device. This unit would be especially useful for small satellites, with mass up to 100 kg, and for delta v up to 500 m/sec, and is suited for use with “green” methanol as the propellant where a specific impulse of 220 seconds is expected. Noble metal alloys are the optimal materials of construction. While the microresistojet is especially suited to methanol, many other propellants may be used such as water or, in the case of de-orbiting, many other residual liquids onboard the vehicle.

This work was done by Thomas Brogan, Mike Robin, Mary Delichatsios, John Duggan, Kurt Hohman, and Vlad Hruby of Busek Co. Inc. for Goddard Space Flight Center. For further information, contact the Goddard Innovative Partnerships Office at (301) 286-5810. GSC-15053-1

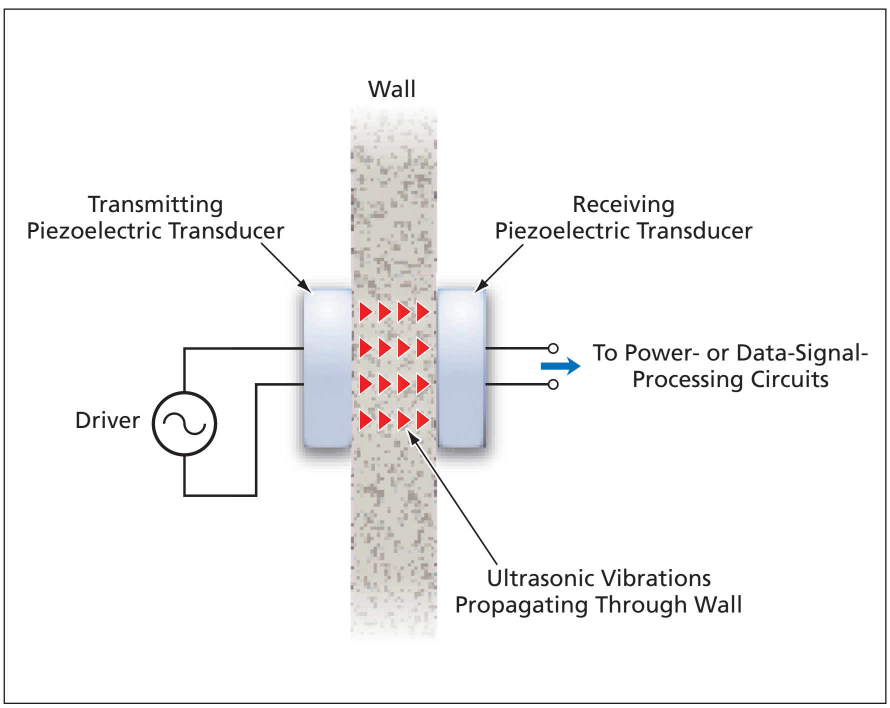
Using Piezoelectric Devices To Transmit Power Through Walls

It would not be necessary to make holes in walls for wires.

NASA’s Jet Propulsion Laboratory, Pasadena, California

A method denoted wireless acoustic-electric feed-through (WAEF) has been conceived for transmitting power and/or data signals through walls or other solid objects made of a variety of elastic materials that could be electrically conductive or nonconductive. WAEF would make it unnecessary to use wires, optical fibers, tubes, or other discrete wall-penetrating signal-transmitting components, thereby eliminating the potential for structural weakening or leakage at such penetrations. Avoidance of such penetrations could be essential in some applications in which maintenance of pressure, vacuum, or chemical or biological isolation is required.

In a basic WAEF setup (see figure), a transmitting piezoelectric transducer on one side of a wall would be driven at resonance to excite ultrasonic vibrations in the wall. A receiving piezoelectric transducer on the opposite side of the wall would convert the vibrations back to an ultrasonic AC electric signal, which would then be detected and otherwise



Ultrasonic Waves would be used to transmit a power or data signal through a wall.