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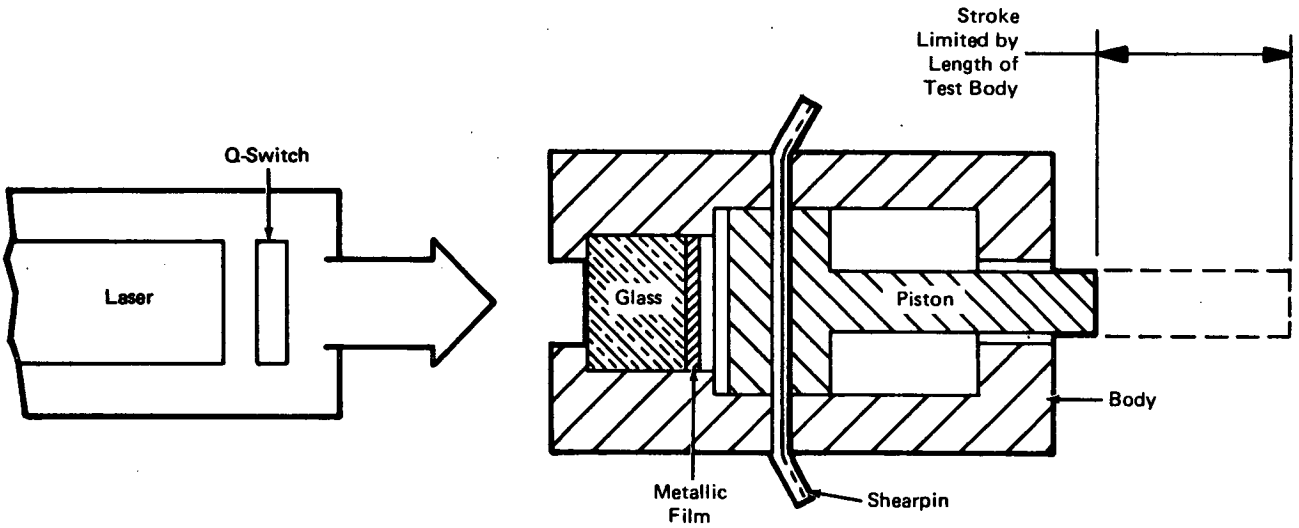
Laser-Actuated Mechanical Device



Laser-Actuated Mechanical Device

The problem:

Pyrotechnical devices are frequently used for the remote actuation of mechanisms located in inaccessible locations, i.e., environmental test chambers or on board spacecraft. This method of using explosives, however, has several disadvantages:

a. To be triggered, pyrotechnical devices require unwieldy electrical connecting wires with a power supply. Should they be types that are triggered with radio signals, the signals may interfere with the operation of other electronic equipment in the vicinity.

b. The end products of explosion, mixtures of solids and gases, often contaminate nearby equipment.

c. The explosions can cause mechanical shocks to measuring instruments.

d. Pyrotechnical devices are hazardous to handle and store.

The solution:

A mechanical actuator operated by a Q-switched laser is a safer and a more convenient alternative.

How it's done:

The actuator shown in the figure contains an aluminum film approximately 100 nm thick which is vacuum deposited on a transparent disk of high optical transparency and mechanical strength. A Q-switched ruby laser producing a 4.0-J pulse of 0.02-μs duration is directed at the metallic film. When the film vaporizes, the resultant high-intensity pressure pushes a piston to the limit (1 in. or 2.5 cm) of the test body and breaks a shearpin.

The piston is 0.68 in. (1.72 cm) in diameter and weighs approximately 0.4 oz (11 g). The shearpin is a brass wire 0.031 in. (0.078 cm) in diameter and shears when subjected to a force of 65 lb (290 N). The actuator

(continued overleaf)

characteristics and dimensions can be modified to meet different performance requirements.

The pressure pulse (as determined by using a quartz crystal gauge) has a peak pressure of 2×10^8 N/m^2 and a duration of 2 μs. The mass of the film is approximately 0.05 mg as compared to an equivalent pyrotechnic device which contains 40 mg of powder. Thus the new actuator minimizes the contamination problem. The energy required to shear the pin is of the order of 0.1 cal as compared to an equivalent pyrotechnic device which generates approximately 100 cal. As a result, the shock problem is also greatly minimized.

The actuator is portable and can be used in high-temperature (over 500° C) environments by incorporating a tungsten metal film and a quartz window. The actuator also can be triggered when it is not directly in the laser beam path by utilizing fiber optics. It is advantageous for remotely switching ultra-high voltage systems.

Notes:

1. The actuator may be of interest to test engineers and to manufacturers of remote-control mechanical actuators.
2. Requests for further information may be directed to:
   Technology Utilization Officer
   NASA Pasadena Office
   4800 Oak Grove Drive
   Pasadena, California 91103
   Reference: TSP74-10166

Patent status:

This invention has been patented by NASA (U.S. Patent No. 3,798,896). Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to:

Patent Counsel
NASA Pasadena Office
4800 Oak Grove Drive
Pasadena, California 91103

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