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# NASA TECH BRIEF



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## Solid State Bistable Power Switch

Various combinations of polyester and metallic materials were investigated in order to provide high current and switching time capabilities for high-current reset-table fuses. Intensive testing established that tin and copper demonstrated the best performance for trip current, degree of reliability, and the lowest coefficients of thermal expansion in a group of metals which also included aluminum, zinc, lead, and stainless steel. Tin exhibited excellent switching speeds, stability, and high trip currents.

Early experiments with particle sizes indicated that high currents would cause small particles (~ 325 mesh) to melt and fuse together. In order to decrease the on-resistance and thereby increase the trip current, the total fraction of the metal was greatly increased over that normally used in low current devices. As an alternative, an increase in the area of the particles decreased the resistance per path. Desirable particle sizes varied between 40 and 20 mesh according to the metal and its degree of sphericity.

A commercial silicone-rubber compound was used with metal/matrix ratios, by volume, of 70/30 and 80/20. It was found that silicone compounds possessed low viscosity, produced residues, and had approximately the same coefficient of thermal expansion and dielectric as polyester. The silicone-rubber compound was used without a catalyst which produced a consistency more similar to a paste than a rubber. The addition of a catalyst produced failures of the testing device after the first trip.

The first trials of silicone compounds were unsuccessful because high voltages (~ 500 V) were required for reset and trip currents were low. It was shown that an increase in metal content up to a 90/10 ratio would allow a device to carry a 25-amp load for several seconds before tripping.

Electrode size and separation was investigated and found to be significant in performance of electrical devices. A comparison of circular copper electrodes with 5/16-in. and 0.5-in. diam indicated a reduction in width-at-half-maximum of the distribution of trip currents. Separation distances of 100 mils, 150 mils and 200 mils, average trip currents of 9, 7 and 5 amps, and reset voltages greater than 50 for the first two conditions and less than 100 for the last were tested in combination. It was shown that on-resistance varied inversely as trip current. The inverse dependence of trip current on electrode separation was also consistent with the same general rule. Devices with larger separations required higher reset voltages.

Although a previous study had demonstrated that low-current silicone-rubber devices can be cycled 30,000 times without failure, the current program had problems in device performance during extended cycling (tripping and resetting). It was found that encapsulation of the high current device was a fault. Much of the difficulty was eliminated when the expansion and contraction of tubing was controlled.

### Note:

The following documentation may be obtained from:

Clearinghouse for Federal Scientific  
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### Reference:

NASA-CR-86103 (N68-35634), Solid  
State Bistable Power Switch Study

(continued overleaf)

**Patent status:**

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

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