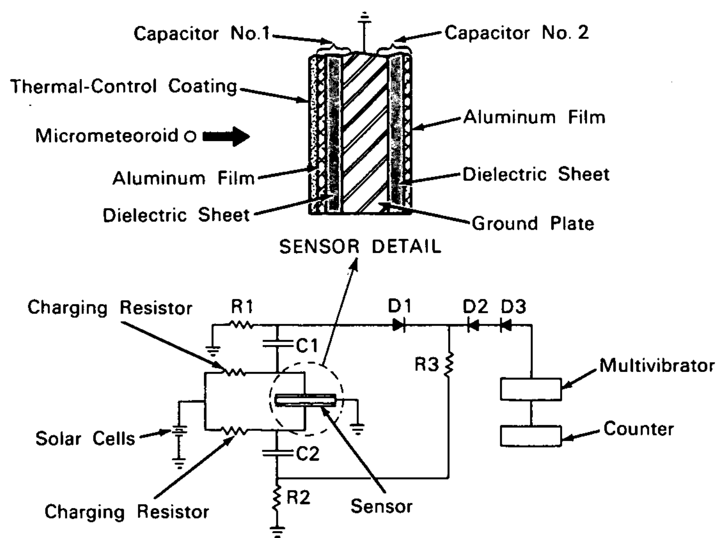
NASA TECH BRIEF

Improved Sensor Counts Micrometeoroid Penetrations



SENSOR CONNECTED IN COINCIDENCE COUNTING CIRCUIT

The problem: To design a simple, rugged device which can be used on space vehicles to detect and count meteoroid particles that penetrate known thicknesses of metal.

The solution: A sensing device consisting of a thin dual-capacitor assembly with an outer film of thermal-control material on which the micrometeoroids impinge. A coincidence counting circuit is employed to record the micrometeoroid penetrations.

How it's done: The sensor comprises a sandwich-type construction forming a pair of capacitors, No. 1 and No. 2. This sensor includes a stainless steel ground plate in the form of a thin metal sheet of known thickness and a layer of very thin dielectric material bonded to opposite faces of the ground plate. Each of the outer surfaces of the dielectric layers is covered with a film of aluminum. Successful tests have been made on representative units in which the ground plate had a thickness in the range between 1 mil and 10 mils, and the dielectric layers were each 0.25 mil thick. The aluminum films were vapor-deposited to a thickness of approximately 1,000 angstroms.

The aluminum surface of the sensor that is exposed as a target to the micrometeoroids is coated with a thin layer of silicon monoxide to limit the maximum temperature of the device by controlling the ratio of solar absorptivity to low-temperature emissivity. The thickness of the thermal-control coating, of vapor-deposited silicon monoxide, can range between approximately 1,000 angstroms and 10,000 angstroms, depending upon the maximum temperature that can be tolerated.

(continued overleaf)

Because of the extreme thinness of the aluminum films and the dielectric layers, the net resistance to penetration of the entire sandwich is essentially due to the resistance of the ground plate. Complete penetration of the entire sandwich occurs in less than a microsecond, making it possible to use conventional coincidence counting circuits with the sensor. With this counting method, only those micrometeoroids that penetrate the entire thickness of the sensor are recorded. Spurious counts from other causes, such as aluminum-vapor burnoff when the dielectric is punctured or accidental breakdown of the dielectric, are thus avoided.

In the operation of the system, the two capacitors (each having a capacitance of 1 to $2\mu f$) comprising the sensor are charged by the solar cell, placing a negative charge on the ground plate and raising the potential of each of the aluminum layers to approximately 100 volts. As a micrometeoroid particle passes through the sensor, the two capacitors are sequentially discharged, and if two voltage pulses arrive at diode D1 in the counting circuit in a given time interval, a pulse will pass through D2 and D3 to a bistable multivibrator and be recorded as a penetration in the counter.

In the event that the micrometeoroid strikes the left side of the sensor and does not pass through the entire sandwich, but discharges only capacitor No. 1, for example, the resulting discharge of capacitor C1 sends a pulse through resistor R1, and not through D1. If the micrometeoroid strikes the right side of the sensor, without passing through the entire sandwich, and discharges capacitor No. 2, the resulting discharge of C2 sends a pulse through R2 and R3. Because the resistance of R3 is much greater than that of R1 and R2, the signal is not strong enough to pass through D2 and D3 to the counter.

Note:

The sensor may act as its own structural support which, together with the fact that both sides can be used for penetration measurement, minimizes the weight of the device per unit area exposed.

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