TO: USI/Scientific & Technical Information Division  
Attention: Miss Winnie M. Morgan

FROM: GP/Office of Assistant General Counsel for Patent Matters

SUBJECT: Announcement of NASA-Owned U.S. Patents in STAR

In accordance with the procedures contained in the Code GP to Code USI memorandum on this subject, dated June 8, 1970, the attached NASA-owned U.S. patent is being forwarded for abstracting and announcement in NASA STAR.

The following information is provided:

- U.S. Patent No.: 3,324,388
- Corporate Source: Lewis Research Center
- Supplementary Corporate Source:
- NASA Patent Case No.: XLE-01246

Enclosure:
Copy of Patent
The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor. This invention relates to apparatus for determining meteoroid penetration of space vehicles, and more particularly, to an improved sensor for making direct measurements of meteoroid damage by recording the penetration rates of particles through known metal thicknesses.

Various devices have been proposed for mounting on satellites to determine the presence of meteoroids in outer space; for example, pressure capsules have been used which lose pressure when punctured to activate a switch. Another device utilizes a wire or foil grid which has an electrical continuity that can be disrupted by a particle impacting the grid or penetrating a protective cover over the grid. Such devices have been satisfactory where self-storing ability is of prime importance to enable the sensor to be interrogated at any time. However, these devices have a disadvantage of not being able to record every penetration.

This problem has been solved by the apparatus of the present invention which includes a sensor having a sandwich type construction with a centrally disposed metal sheet of known thickness that is electrically grounded. A layer of dielectric material covers each surface of the metal sheet and a film of metal is deposited on each dielectric layer to form a pair of capacitor assemblies. A coincidence counting technique is employed to determine when a penetration of the sandwich occurs. As a particle passes through the sandwich, each capacitor assembly is discharged in turn. If two voltage pulses arrive at a diode within a given time interval, a pulse is permitted to pass and is counted as a penetration.

It is, therefore, an object of the present invention to provide an improved apparatus for determining the presence of meteoroids in space which combines simplicity of construction with ruggedness.

Another object of the invention is to provide an improved apparatus for determining meteoroid damage in space vehicles which is inexpensive to manufacture and adaptable for use in various space applications.

A further object of the invention is to provide an improved meteoroid sensor which counts only the punctures which penetrate the entire sensor. Other advantages of the invention will be apparent from the specification which follows and from the drawings in which like numerals are used throughout to identify like parts.

In the drawings:

FIG. 1 is a vertical sectional view through a portion of an improved meteoroid sensor constructed in accordance with the invention, and

FIG. 2 is a schematic view showing the improved meteoroid sensor and its coincidence counting circuit.

Referring now to the drawings there is shown a sensor panel 10 which includes a ground plate 20 in the form of a thin metal sheet having a known thickness and layers 22 and 24 of a dielectric material are bonded to opposite surfaces of this metal sheet. These layers 22 and 24 are very thin and preferably comprise sheets of Mylar. However, it is also contemplated that the dielectric layers 22 and 24 may be a vapor deposit of silicon monoxide or other suitable vapor deposited coatings.

Aluminum films 26 and 28 engage the outer surfaces of the dielectric layers 22 and 24 respectively, and these films are vapor deposited. The sensor 10 is temperature controlled by using a thermal control coating 30 comprising a coating of silicon monoxide or other suitable material over the vapor deposit of aluminum 26. This combination of Al plus SiO limits the maximum temperature of the sensor 10 by controlling the ratio of solar absorptivity to low temperature emissivity. Fluctuations from the maximum temperature to much lower temperatures can be tolerated, but it is necessary to limit the maximum temperature.

The resulting sandwich is quite thin, and can be folded or rolled for compactness during the launching of the space vehicle. For example, sensor panels 10 have been successfully tested in which the ground plate 20 has a thickness in the range between approximately 1 and 10 mils while the dielectric layers 22 and 24 are 1/4 mil thick Mylar sheets. The aluminum films 26 and 28 are vapor deposited to a thickness of about 1,000 Angstroms. A typical thermal control coating 30 has a thickness in the range between about 1,000 Angstroms to about 10,000 Angstroms, depending upon the maximum temperature requirements.

Because of the extreme thinness of both the aluminum films 26 and 28 as well as the dielectric layers 22 and 24 penetration of the entire sandwich corresponds, in effect, to penetrations of only the metal, and it is possible to apply an effective coincidence counting technique to the sensor 10 because the complete penetration of the entire sandwich occurs in less than a microsecond. Also by using the coincidence circuit arrangement, only those punctures that penetrate the entire thickness of the sensor 10 are recorded, and this arrangement eliminates counts resulting from discharges due to other causes such as the aluminum vapor deposit burnoff when the dielectric is punctured or breakdown of the dielectric because of minor flaws.

A further advantage of this type of construction is that both sides of the metal surface exposed can be effective for measuring penetration if it is so desired. The sensor panel 10 may act as its own structural support which, when both sides are utilized for penetration measurement as in the aforementioned embodiment, reduces the weight per unit area exposed to a minimum.

In operation, the capacitor assemblies 16 and 18 are charged through resistors 32 and 34 respectively by the solar cell power supply 14 in the battery portion of the circuit 12 so that the stainless steel ground plate 20 has a negative charge. In a typical sensor panel 10 in which the various components have the aforementioned thicknesses, the potential of each of the aluminum layers 26 and 28 is raised to approximately 100 volts. The capacitor assemblies 16 and 18 have a capacitance of from 1 to 2 mf.

As a particle, such as a micrometeoroid M shown in FIG. 1, passes through the sensor 10, each capacitor 16
Apparatus for determining meteoroid damage to space vehicles, said apparatus comprising,
a pair of capacitors positioned on the space vehicle in close proximity with one another,
means for charging said pair of capacitors,
each of said capacitors being discharged by the penetration thereof by a meteoroid whereby an electrical pulse is generated,
a coincidence network electrically connected to each of said capacitors for receiving said electrical pulses and generating a single pulse in response to the receipt of a pair of substantially simultaneous electrical pulses generated by the substantially simultaneous discharge of both said capacitors by the penetration thereof by a meteoroid, and
recording means for counting said single pulses as meteoroid penetrations.

4. Apparatus for determining meteoroid damage comprising,
a pair of capacitors having a common ground plate positioned to be struck by meteoroids,
means for charging said pair of capacitors, each of said capacitors being discharged when penetrated by a meteoroid whereby a pair of substantially simultaneous electrical pulses is generated by the passage of said meteoroid through said common ground plate,
a coincidence network electrically connected to said pair of capacitors for receiving said pair of simultaneous electric pulses and passing the same as a single pulse, and
recording means connected to said coincidence network for receiving each of said single pulses therefrom and counting the same as a single penetration of said common ground plate.

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