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NASA TECH BRIEF
Goddard Space Flight Center

Cosmic Dust or Other Similar Outer-Space Particles Location Detector

The problem:

One of the principal interests in the study of radiation from outer space is the cosmic dust that is generated by solar, cometary, and galactic phenomena. Cosmic dust, comprising solid particles condensed from interstellar gas and/or ejected from comets and other celestial bodies, moves through space at speeds of several kilometers per second. In large quantities, this dust is a serious radiation hazard to man and electronic equipment caught in its path. This phenomenon, not completely understood, has been studied with the aid of detectors that collect these particles and determine their velocity. Resolution of these detectors, however, has been inadequate because of the wide particle scattering over the large detector areas. In addition, the detectors have been bulky as a result of a multitude of electronic amplifiers used to determine the points of particle impact on the detector surface.

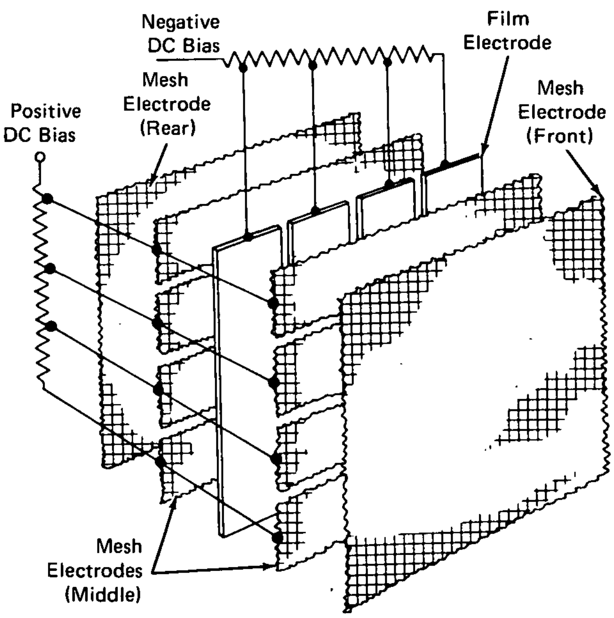

Figure 1. Particle Detector Showing the Five Planar Electrodes

The solution:

An improved cosmic dust detector uses only two operational amplifiers and offers narrower areas for collection of cosmic dust. The detector provides excellent resolution as a result of which the recording of particle velocities as well as the positions of their impact are more accurately determined.

How it's done:

The detector (see Figure 1) comprises five mutually insulated metal planar electrodes positioned in stacked relationships so that each lies in a different parallel plane. The four mesh electrodes shielding the middle one are metal grids which allow cosmic dust or other particles to pass through with relative ease. The middle electrode is an extremely thin film of either copper, molybdenum, tantalum, or plastic material, such as Mylar or parylene, coated with a conductive material which produces a relatively dense plasma stream in response to the impinging particles. This electrode is biased with a negative voltage. Mesh electrodes on the immediate opposite sides of the film electrode are biased with positive dc voltage. Finally, mesh electrodes at the extreme ends are biased negative.

In operation, a cosmic dust particle enters the electrode array by passing through the two front, mesh electrodes and impinges on the film electrode. The film then generates a plasma stream of electrons and of positive ions directed toward the two mesh electrodes in the rear. Additional plasma is also sprayed forward anisotropically to the two front electrodes. The positive ions in both cases are returned to the film electrode because of the attracting force of the negative bias. Most electrons, on the other hand, are trapped by the positive bias of the adjacent mesh electrodes. Electrons that have sufficient energy to escape are turned back by the force of the negative bias from electrodes on the extreme ends.

(continued overleaf)

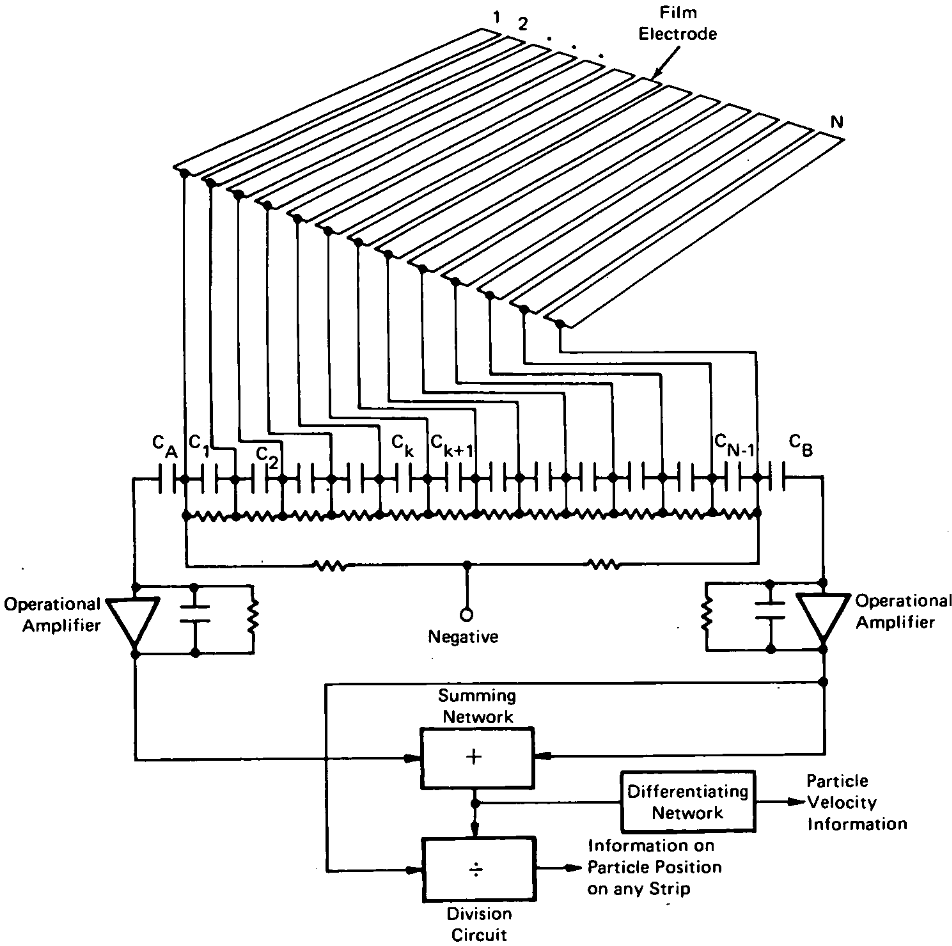

Figure 2. Particle Detector Circuit

To monitor the strip on which a particle impinges, a charge-dividing mechanism is provided by a string of (N – 1) series-connected capacitors C_1, C_2, C_k . . . $C_{(N-1)}$ shown in the Figure 2. One electrode of each of the capacitors in the string is connected to a corresponding capacitor (1 through N). The values of these capacitors are selected to be considerably greater than the stray capacity between strips 1 through N and ground, to stabilize the capacitance between the strips at a predetermined level. The values of the capacitors can be selected on any basis, as long as this criterion is maintained.

The end terminals at opposite ends of the string are connected through capacitors C_A and C_B to input terminals of the dc operational amplifiers, respectively. Voltages commensurate with the charge levels at either end of the capacitor string are amplified by these circuits.

The relative amplitudes of the peak voltages of the waveforms derived from the amplifiers in response to one of the strips collecting a charge provide an indication of the strip on which charge was collected. The differentiating network provides information on particle velocity.

Note:

Requests for further information may be directed to:

Technology Utilization Officer
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Greenbelt, Maryland 20771
Reference: TSP73-10282

Patent status:

This invention has been patented by NASA (U.S. Patent No. 3,694,655). Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to:

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