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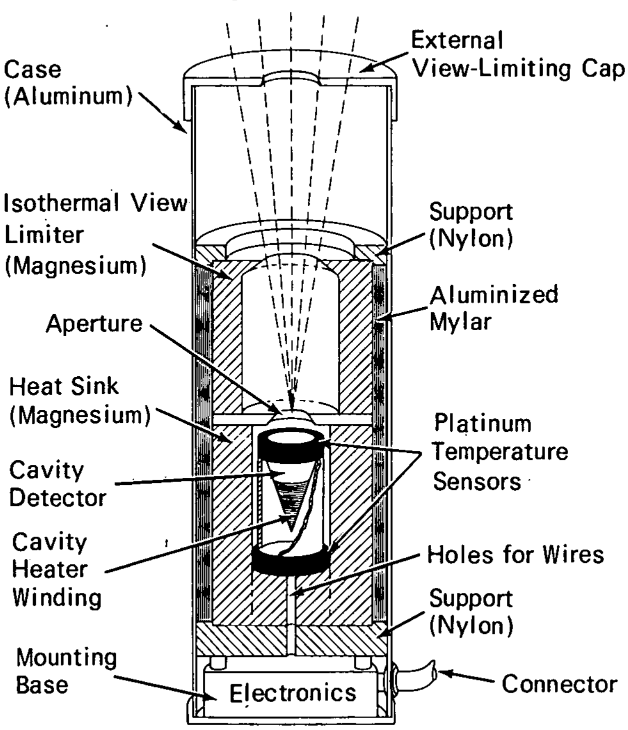
NASA TECH BRIEF

NASA Pasadena Office

Active Cavity Radiometer, Type III: An Automatic, Absolute Standard, Highly Accurate Detector

A highly accurate, cavity radiometer automatically measures the total energy from radiant sources, in absolute units. The instrument is of relatively simple construction, can operate without a vacuum enclosure



over a wide pressure range and at temperatures from 218 to 398 K (−55° to +125°C), and can define the absolute radiometric scale to within less than $\pm 0.5\ mW/cm^2$.

The instrument has potential application in the fields of meteorology and climatology. A global network could automatically measure solar insolation on a day-to-day basis and report the results by radio transmission to central receiving stations. Remote stations could be interrogated by satellites which would relay the data to selected points on the earth for analysis. Another application would be the measurement of ground and atmospheric reflectance and emission properties measurements, along with incident solar flux from aircraft, satellites, or high-altitude balloons. The fast response time of the instrument —on the order of 1 millisecond—would facilitate high temporal and spatial resolution of ground reflectance phenomena, even when measured from high-speed aircraft or low orbiting earth satellites.

The instrument operates on the principle of the electrical substitution calorimeter. It includes a conical cavity detector which is connected to a massive thermal guard and heatsink by a low thermal impedance. Platinum windings sense the temperature of the cavity and the heatsink ends of the thermal impedance. A fixed-resistance heater winding is in intimate thermal contact with the back of the conical cavity. An aperture plate defines the detecting aperture, and an isothermal view limiter provides a surrounding of known temperature for the entire detector field of view outside the instrument's acceptance angle for the radiation flux to be measured. A modular electronic circuit package acts as a mounting base and secures the radiometer assembly to its tubular case. A cap seals the back of the instrument and provides a mounting surface. Removable caps with centered circular holes of various sizes may be placed over the front of the tubular case, restricting the instrument's field of view to any desired value.

(continued overleaf)

A relatively simple, solid-state modular electronic circuit is used to provide complete, automatic operation of the radiometer. It consumes less than two watts, drawing only 55 mA at 30 Vdc, and can be operated by a battery or suitable substitute.

The instrument operates in a differential mode. In one phase, the radiant flux to be measured is admitted to the cavity. In a second phase, a shutter blocks the radiant flux. In both phases, a fixed temperature difference is maintained across the thermal impedance, implying equal total power inputs to the detector in each phase. The circuit ensures identical thermodynamic conditions for the detector in both phases of measurement.

The radiant flux to be measured provides a power input to the detector in the shutter-open phase, but not in the closed phase. Maintenance of a constant temperature difference across the thermal impedance then requires that the detector be electrically heated by different amounts in each phase. This is accomplished using platinum windings on the thermal impedance as temperature sensors and a low temperature-coefficient winding on the detector as a joule heater. The effects of small radiometer-temperature differences between the two phases of measurement may be reduced to insignificance by shuttering at a rapid rate.

The standard detector constant is dependent on the effective conical cavity absorptance for radiant flux, the effective detector area, and the resistance of the cavity-heater winding. Cavity absorptance is a function of the surface absorptance properties of the material used to coat the inside surface of the cavity, the cavity geometry, and the location and configuration of the aperture plate. The aperture area is defined by the hole in the aperture plate and is approximately 1 cm^2.

Note:

Requests for further information may be directed to:

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Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to:

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