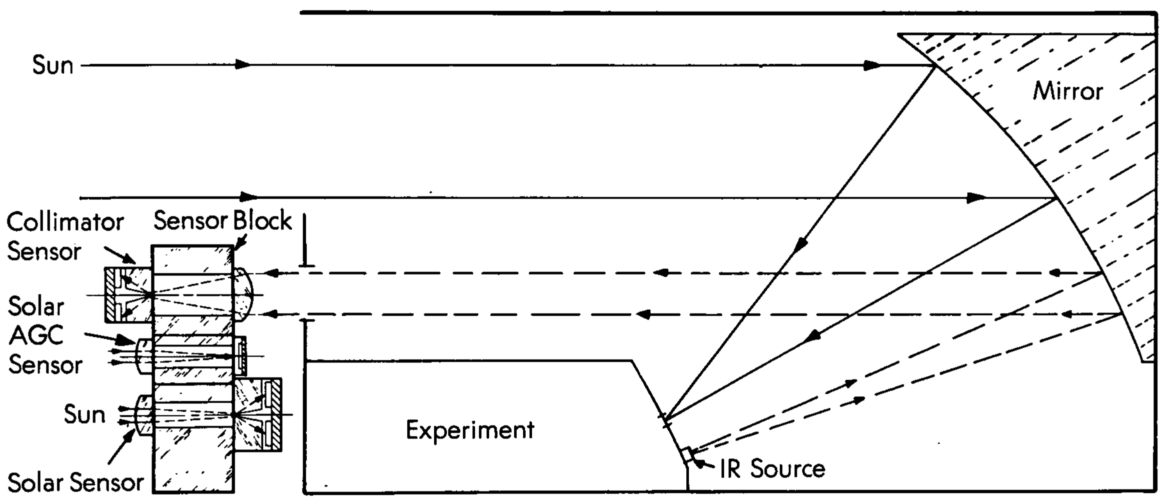
NASA TECH BRIEF

Ames Research Center

Solar Experiment Alignment System



The problem:

Changes in alignment of solar experiment packages due to launch shock, vibration, and flight thermal inputs limit the accuracy with which solar measurements can be made. Since advances in solar physics require examination of solar phenomena with progressively higher spatial resolution, the pointing and alignment of scientific instrument packages (such as telescopes) in space vehicles must be made with greater accuracy than before.

The solution:

A sensitive sensor system which determines the absolute alignment of the optical axis of the experiment package relative to the solar vector and provides control information to permit pointing the experiment anywhere on a solar disc to an absolute accuracy of the order of two arc seconds in the center and five arc seconds on the limb.

How it's done:

The experiment alignment system uses a stable dual-function sensor assembly to observe the sun in one direction and an experiment-oriented IR source in the reciprocal direction. The experiment alignment system is comprised of three principle assemblages: (1) A single-axis solar aspect sensor which provides indications of pointing accuracy; (2) A collimator sensor and an infrared (IR) source which locate the position of the focal image in the focal plane of the experiment; (3) An electronics package which drives the IR source and amplifies and sums sensor signals to obtain pitch and yaw control signals.

The heart of the experiment alignment system is the sensor block which supports the solar and collimator sensors; imaging-type energy-balance sensors are used. The sensor block is constructed from a single piece of ultralow expansion quartz onto which

(continued overleaf)

are cemented other optical components. As indicated in the diagram, the solar sensor assembly receives light from the sun and brings it into focus on an energy-dividing device consisting of a deposited-strip reticule; energy from opposite limbs of the source is divided by the reticule and reflected onto differentially-connected photovoltaic silicon p- on n-cells operated in the short circuit current mode. The output of the photocells is linear with irradiance over a wide range and is less sensitive to temperature variation than when the photocells are operated in the photovoltaic mode. The sensor also includes multilayer, thin-film optical filters with a bandpass of 0.6 to 0.85 μm to minimize thermal drifts of the detectors. When the solar sensor assembly is axially aligned with the solar vector, the image of the sun is centered on the energy-dividing reticule and each photocell receives equal energy, so their combined outputs cancel. As the sensor assembly is rotated, unequal portions of the image energy fall on each cell and the net output is now proportional to the angular deviation of the axis of the sensor from the solar vector.

The collimator sensor assembly is essentially similar to the solar sensor. An infrared light-emitting diode (LED), with monochromatic output modulated at 1000 to 1500 Hz, is in the focal plane of the telescope mirror; the infrared energy falling on the mirror is collimated and projected outward, but some of the energy is intercepted by the collimator sensor. The desired output of the photocells in the collimator sensor assembly is an AC signal derived from the modulated output of the light-emitting diode. The magnitude of the AC signal provides indication of the position of the focal spot; hence, if the position of the focal spot has been shifted because of distortion of the structures supporting the mirror or the experiment, the output of the collimator sensor assembly provides the signal which is used to change the pointing direction of the telescope so as to return the focal spot to the desired position.

A solar AGC sensor is also included in the quartz sensor block; in addition to providing an "on-sun" signal, its output is used to set the sensitivity of the solar sensor amplifier. A similar sensor (not shown in the diagram) provides an AGC signal for the light-emitting diode power supply; the AGC signal sets the DC level so that the light output of the diode is held constant.

The electronics package includes (1) circuits for powering and controlling the output of the light-emitting diode, (2) amplifiers for the solar sensor signals, to yield an output $K\Theta_S$, and (3) amplifiers to provide an output $K\Theta_A$ for signals from the collimator sensor. Additional circuitry sums the sensor outputs to produce a signal $K(\Theta_S - \Theta_A)$ which is processed by an external pointing control system and rocket attitude control system to maintain the experiment axis aligned with the solar vector. A selectable electronic offset to Θ_S permits pointing directions to be away from the solar center of illumination.

Note:

Requests for further information may be directed to:

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Reference: TSP72-10020

Patent status:

No patent action is contemplated by NASA.

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