May 1972 B72-10192

NASA TECH BRIEF

Ames Research Center

Solar Sensor with Autocollimator

The problem:

To measure accurately the angle between a reference surface on a spacecraft and the solar vector with a device that compensates for errors caused by changes in the alignment of its mountings or its component parts.

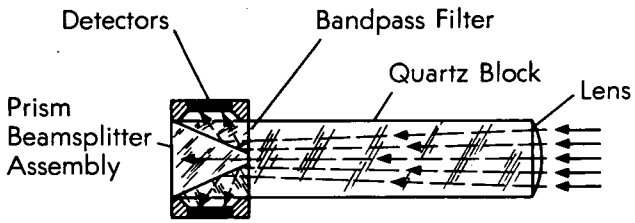

Figure 1

The solution:

A solar sensor and an autocollimator, each fabricated from fused quartz, are integrated into a monolithic structure. The motions of the entire assembly relative to a reference surface (such as a mirror) are monitored by the autocollimator and, at the same time, the solar sensor monitors the angle of the assembly with reference to the solar vector. Any changes in alignment that are detected by the autocollimator can be subtracted from the sensor output, thereby eliminating a major source of error in the determination of the spacecraft's aspect.

How it's done:

The operation of the solar aspect sensor is based on the division of the energy contained in an image of the sun between a pair of silicon solar cell detectors (see figure 1). When the solar vector is coincident with the optical axis of the solar sensor, equal energy falls on the two detectors, and since the cells are connected in opposition, the signal issued by the cells is zero under these circumstances.

The autocollimator utilizes the same structure and optical configuration. However, it is illuminated by its own light source instead of the sun. If an angular tilt exists, the light going out is collimated and it will return from a reference surface causing an imbalance in its detector output (figure 2).

The sensor and the autocollimator are fabricated out of identical, clear quartz bars with the front surface of each polished to form a spherical lens. The prism beamsplitter assembly (reticle block) is fastened to the rear surface of each quartz bar by means of a high-quality optical cement, and then

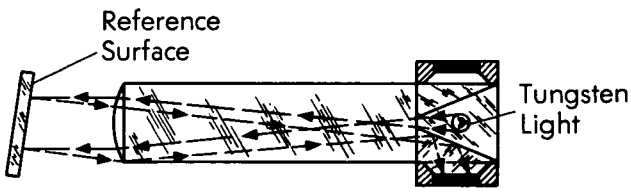

Figure 2

the two bars are cemented together as shown in figure 3. The rear surface of the bar for the solar sensor is coated with a thin-film, multilayered filter which blocks ultraviolet radiation. The filter improves the stability of the sensor over a wide range of temperature and prevents darkening of the cement layers used in the optical assembly.

Each reticle block is made of 3 quartz prisms; special attention is required to ensure the flatness of the faces that are to be joined, and it is necessary to provide straight and unbroken edges in the face

(continued overleaf)

of the reticle block. To do this, the two joining surfaces of the central prism are aluminized, the three prisms are cemented together to form a solid block, and then the face is polished down to produce a slit. Solar cells are mounted on a Kovar substrate which is cemented directly to the two side-forming prisms.

A small hole is drilled through the center of the autocollimator's reticle block to permit insertion of a small, tungsten light bulb. Spectral filters are cemented to the reticle block directly in front of the detectors to eliminate their being swamped by light passing through the cement layer between the reticle assembly and the lens block. In addition, this filter location saves gain by avoiding a double pass of the light through the filter as it would have if the filter were located on the back of the lens block.

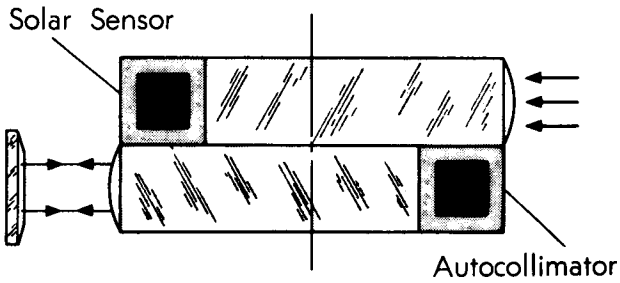

Figure 3

Reference:

Melugin, R. K.; Hall, J. M.; and Johnson, D. F.: A Precision Autocollimator Solar Sensor. AIAA Guidance, Control, and Flight Mechanics Conference, Princeton, New Jersey, August 18-20, 1969, Paper No. 69-858.

Notes:

1. The following documentation may be obtained from:

   National Technical Information Service
   Springfield, Virginia 22151
   Single document price $3.00
   (or microfiche $0.95)
   Reference: NASA CR-73260 (N69-16972), Design, Development, and Fabrication of a Precision Autocollimator Solar Sensor (PASS).
2. A single solar sensor unit is only sensitive to angular motion in one axis (requiring a pair of sensor packages for two-axis information) and should be entirely insensitive to small (several arc minutes) angular motions in the orthogonal axis.
3. The use of the integrated concept may be advantageous whenever sensor mounting errors constitute a problem.
4. No additional documentation is available. Specific questions, however, may be directed to:

   Technology Utilization Officer
   Ames Research Center
   Moffet Field, California 94035
   Reference: B72-10192

Patent status:

No patent action is contemplated by NASA.

Source: David L. Fain, James M. Hall, and Dennis F. Johnson of
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