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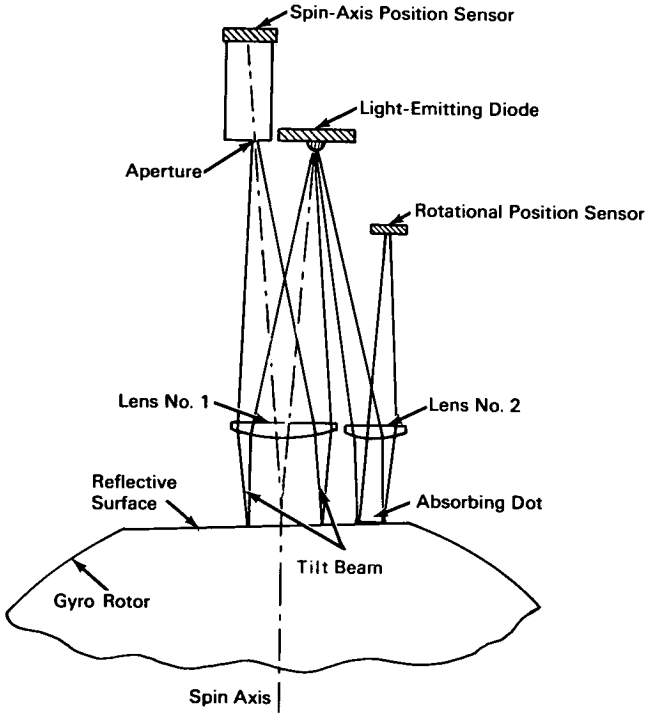
NASA TECH BRIEF

Optical Gyro Pickoff Operates at Cryogenic Temperatures



The problem:

To devise an efficient two-axis pickoff for cryogenic gyros. Conventional optical pickoffs, which are designed to operate at normal temperatures, require optical windows in the thermal shielding when used with a cryogenic gyro. These windows cause large heat leaks, which increase the refrigeration load on the cryogenic system. Furthermore, hot-filament or ionized-gas light sources used in conventional optical pickoffs decrease in efficiency at cryogenic temperatures.

The solution:

A two-axis pickoff using solid-state light sources and sensors which operate efficiently at cryogenic temperatures.

How it's done:

The pickoffs incorporate recently developed solid-state light sources that convert electrical energy directly to light energy (generally in the infrared range) with efficiencies ranging from 1% at room temperature (300° K) to 30% at 4° K.

(continued overleaf)

The schematic illustration shows a pickoff design that does not require a close alignment tolerance between the spin axis and the reference plane (mirror on gyro rotor). The reference plane is purposely tipped with respect to the spin axis to produce a wobble in the plane when the gyro rotor is spinning. Light from the light-emitting diode is projected through an autocollimating lens onto the wobbling mirror. The reflected image of the light source passes through the same lens and is focused on the aperture to the spin axis position sensor. As this spot of light moves around in a circle, because of rotation wobble, varying amounts of light pass through the aperture, going from a minimum to a maximum during half a rotation of the rotor and reversing during the second half. At one particular tilt position, the amount of light is constant in any rotational position, which is the pickoff zero. As the spinning axis tilts from this position, the ac signal component changes in a definite pattern.

To define a reference axis, a small light-absorbing dot is placed on the rotor flat outside the area of the tilt beam. This dot will produce an output pulse at the rotational position sensor, which will trigger a slaved oscillator. The output from this oscillator acts as a phase reference for separating tilt about the two axes perpendicular to the spin axis.

Notes:

1. The advantages of this system over other known pickoffs for cryogenic operation are: compactness of design (0.5 × 0.75 inch), high efficiency of light source, long life of solid-state light source and sensor (compared to standard incandescent source and photomultiplier), negligible drift, short response time (allowing operation at high frequencies), and good spectral match of light source and sensor.
2. Inquiries concerning this invention and other approaches to the design of a two-axis pickoff employing a solid-state light source and sensor may be directed to:

   Technology Utilization Officer
   Marshall Space Flight Center
   Huntsville, Alabama, 35812
   Reference: B66-10128

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C., 20546

Source: General Electric Company
under contract to
Marshall Space Flight Center
(M-FS-407)