HUGHES Research Laboratories

A DIVISION OF HUGHES AIRCRAFT COMPANY
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MALIBU, CALIFORNIA

25 October 1965

RESEARCH CONTRACT STATUS REPORT

Title: Research on Gravitational Mass Sensors

Contract: NAS W-1035

Period: 15 September 1965 to 15 October 1965

I. ACCOMPLISHMENTS

A number of different diameter, double ended, torsion wire sensor mounts were tested during the report period, but none of them were satisfactory. The thicker wires would couple the sensor too tightly to the chamber and the various translational modes of the sensor would be shifted down to the same frequency as the gradient sensing mode and would not separate under rotation. With the thinner wires, the various vibrational modes were found to be well separated, but under rotation, the translational mode formed by the torsion wire spring constant and the total sensor mass shifted up in frequency to just below the frequency of the gradient sensing mode. A single ended torsion wire mount is now being studied. This is a very thin, low frequency mount which will be operated far above its translational resonance point in a manner similar to an ultra-centrifuge. However, this type of mount is limited to operation in a vertical position and other mount designs will have to be found.

Because of the sensor mount problem, we have not yet been able to rotate a sensor at the desired operating speed without having at least one vibration sensitive translational mode within a few cycles of the gradient sensing mode frequency. Despite this problem, a series of tests were run to investigate the sources of noise in the present models. The noise was determined to be primarily due to slip ring wobble and there was no noticeable decrease in the noise when the sensor chamber was spun in a vacuum rather than in air, indicating that windage is not yet a problem. The noise level with a specially designed, very light slip ring brush gave a maximum noise peak of about 5 mV at the gradient sensing frequency of 108 Hz when the sensor was rotated at the desired speed of 3240 rpm (54 rps). This measured noise level is quite high and it is felt that it should decrease substantially when we can separate the shifted translational modes from the gradient sensing mode.

The effect of the motor drive during synchronous operation was also quite noticeable. We are not sure whether this is due to pickup or drive torques since the present four-pole motor operates at the frequency of the sensor mode. As soon as time permits, the new eight-pole motor will be installed and tested.

The telemetry unit was constructed and then operated with the same sensor in an effort to obtain comparative noise measurements, both with and without slip rings. However, the telemetry unit proved to be difficult to balance and it has not been possible to obtain consistent measurements up to the time of this report.

An optimization analysis of the piezoelectric transducers used to detect the strains in the arms of the sensors was carried out. It was found that the present barium titanate transducers are quite suitable for our work.

No problems have arisen which will impede the performance of the contract.

II. FUTURE PLANS

Noise tests will continue on the present sensors under free-rotation, synchronous and asynchronous operation conditions at various vacuum levels to identify and measure the noise contributions due to electrical pickup, windage, drive torques and hash, slip ring wobble, bearing noise and other sources. Studies of methods to improve the sensor mounting will continue. A visit will be made to CAMBION on 10 November 1965 to inspect the three-axis magnetic bearing before delivery.

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