$$B = 7.427(0.10605 - 0.01791) + 700 \times 0.10605 \times 0.03592$$
$$= 0.6546 + 2.6665$$
$$= 3.321 \text{ deg/hr}/g^2$$
$$E = 7.427 \times 0.03592 + 700 \times 0.10605 \times 0.01791$$
$$= 0.2668 + 1.3295$$
$$= 1.596 \text{ deg/hr}/g^2$$

By tumble testing this gyroscope, we obtain the following values:

$$B = 3.011 \text{ deg/hr}/g^2$$
$$E = 1.537 \text{ deg/hr}/g^2$$

Conclusions

The analysis presented here allows the engineer to accurately predict the acceleration squared coefficients for any free-rotor gyroscope. The accuracy of these predictions will be consistent with the knowledge of the absolute value of the bearing parameters.

DISCUSSION

C. L. Strodtman[2]

The author is to be congratulated on the excellence of his paper and in particular on the good agreement between theory and measurements.

Since reference [1] is not available in the open literature it could not be checked, but this paper seems to indicate that Cogan considered only the effect of viscous torques and that the present paper is an extension in that the pressure gradient torque is now included. Can the author give some figures on the relative sizes of the two error torques? In other words, can either or both the B or E coefficients be separated into components due to viscosity and due to pressure gradient?

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Because the total acceleration sensitivity rates are so high it is obvious that they must be compensated in a precision system. This brings up the questions, "How consistent are these rates in a given gyroscope," and "What parameters in a gyroscope must be controlled?" With an analysis of the caliber presented here, it should be possible to vary, say h_0 or ω, to get the approximate partial derivative of B or E with respect to the varied parameter. Has the author run such a sensitivity analysis?

Author's Closure

The author wishes to thank Mr. Strodtman for his interest in this paper. The B and E coefficients are separated into pressure gradient and viscous components in the text. Specifically, the first terms in equations (19) and (20) are pressure gradient terms. The relative magnitude of the terms can be obtained from the numerical example.

	Pressure Gradient	Viscous	Total
B	0.6546	2.6665	3.321
E	0.2668	1.3295	1.596

Although properly the subject of another paper, some comments can be made concerning the sensitivities of the B and E coefficients. If we look at the viscous portion of these coefficients, theory tells us that they have the following functional form:

$$B \; \alpha \; \frac{h_0^3}{\mu\omega^2}$$

$$E \; \alpha \; \frac{h_0}{P_a\omega}$$

From a production point of view, we see that h_0 is the most sensitive parameter. From a stability point, the ambient pressure and gas viscosity will be dominate.