

entire structure with it. This may be regarded as trading a heavy bearing, heavy supports, a precision rotor against some crude piping plus pumping installation.

References

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DISCUSSION

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While the fundamental principles of mechanics predict the behavior of gyroscopic action, it remains as one of the more elusive concepts for the engineer. Gyroscopic moment can be calculated for normal cases, but they are not intuitive, at least not for me. The present paper discusses an even more academically obscure aspect of gyroscopic action. The paper derives a very simple yet useful formula for determining the gyroscopic moment. At the same time, it provides another way of grappling with the concept.

Equation (15), derived within the framework of the assumptions, gives what appears to be a simple and useful area rule for determining the gyroscopic moment for flow through an arbitrarily shaped loop. The moment developed is proportional to the quantity of flow, the precessional velocity, and the sums of the loop area projected onto two planes. Like the simple equation developed for the gyroscopic moment of a precessed rotating disk, this equation looks disarmingly simple.

I am not certain about the intent or the meaning of the authors' comments concerning the effects of friction in the loop, which does

not appear in the paragraph after equation (14).

The description of a simple basement-shop type of experiment to prove the essence of the theory is clever and interesting. While it is not exactly stated, I assume that the electromagnetic pump has no moving parts to affect the derived equations. In addition, the picture in Figs. 3-5 look as though they are turned on their side with respect to the test schematically represented in Fig. 2.

I would hope that a few more tests could be run on the apparatus, one to include an elongated rectangular shape along the precessional axis, another to show an equal rectangular area elongated essentially 90 deg with respect to the first, and the final one in which the loop does not lie entirely in a single plane.

Authors' Closure

The authors appreciate the complimentary observations made by Professor Curreri, who raised some interesting points. The first one concerned "obviousness" of the device. Granted that gyroscopic behavior is not obvious, but using a conventional gyroscope to extrapolate from, a circular torus indicates other possible geometric shapes by way of natural extrapolation. Obviousness of the device should be interpreted in this context.

The effect of fluid friction has been raised for two reasons: (a) if we assume the existence of a slug-flow, then in a closed circuit of the kind described, friction, per se, does not seem to have any effect; (b) a slug flow is however only an approximation and with real fluids friction is bound to give rise to secondary flow, the effects of which remain to be explored for the present problem.

The third point raised pertained to the "electromagnetic pump." The one used here had no moving parts, in fact it was the stator of a linear electric motor, the armature of which was the mercury.

Hopefully, some further experiments will be carried out with the rig we have, when the experiments suggested by Professor Curreri would have high priority.

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