(*Reprinted from* NATURE, *Vol.* 140, *page* 30, *July* 3, 1937.)

Frictional Torque of an Axial Magnetic Suspension

A VERTICAL needle of iron suspended *in vacuo* by the co-axial field of a solenoid theoretically may have infinitesimal frictional torque against axial rotation. The purpose of the present note is to report an observed value of this frictional torque.

The arrangement used is a modification of that previously reported by one of us[1]. A solenoid carrying a steady direct current produces a magnetic field sufficiently strong to support a large fraction of the weight of the needle. A vane mounted on the needle controls the amount of light striking a photo-cell. The current from this cell is amplified and fed to a second lifting solenoid. Thus the needle is automatically maintained at a pre-determined height. Vertical oscillations about this position were damped out by using a large resistance in, and capacitance across, the power supply for the amplifier output tube[2].

For this experiment the vane was a solid aluminum alloy disk, 15 mm. in diameter and 5 mm. thick, mounted co-axially with the needle. The entire unit had a mass and moment of inertia of about 6 gm. and 0·8 gm. cm.^{2} respectively. It was spun *in vacuo* by the action of the field of a small bar magnet mounted horizontally on an air-driven turbine[3] spinning below the disk at about 1,500 rev./sec.

The rotor was speeded up to about 1,200 rev./sec. Its action was such as to indicate that small or large rotors probably can be taken up to their bursting speeds with macroscopic stability, and that many types of drive may be used.

Damping observations were carried out at speeds in the neighbourhood of 600 rev./sec. with the driving magnet removed. Under these conditions, one encounters a frictional torque due to residual gases, and three torques of electromagnetic origin due to misalignment and the earth's magnetic field. In this preliminary work the residual gas pressure was estimated to be of the order of magnitude of 10^{-5} mm. mercury, alignment was done roughly, and no attempt was made to neutralize the earth's field. However, the observed deceleration at the above speed was about 2×10^{-3} rev./sec.^{2}, corresponding to a frictional torque of about 10^{-2} dyne cm.

It is believed that this device offers possibilities in experiments in which it is necessary to suspend rotatable systems under a variety of conditions. The low frictional torque exhibited suggests its use in experiments in which this property is useful directly, or indirectly as in the attainment of relatively constant rotational speeds for use in velocity of light determinations, etc.

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May 12.

[1] Holmes, F. T., *Phys. Rev.*, **51**, 689 (1937).

[2] Reported by F. T. Holmes at meeting of the Va. Acad. Sci., May 7, 1937.

[3] Beams, J. W., Weed, A. J., and Pickels, E. G., *Science*, **78**, 338 (1933).

Printed in Great Britain by Fisher, Knight & Co., Ltd., St. Albans