NASA TECH BRIEF

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Suspension of Objects in Magnetic and Electric Fields

The problem:

Certain objects can be suspended in air by use of magnetic or electric fields. This phenomenon has some interesting applications, one of which is the development of low-friction mass transportation vehicles. Until recently, however, all attempts to design devices using this technique have been unsatisfactory.

The solution:

Suspension efficiency has been greatly improved with a device which simulates the characteristics of diamagnetic materials. This pseudodiamagnetic device was used to suspend a magnet in a magnetic field at a rate of 232 kg/W. By analogy this approach can be extended to electric fields.

How it's done:

Suspension in a magnetic field can be produced in two ways: the magnetic source can be stationary and the pseudodiamagnetic device suspended or vice versa. Experiments were performed with the magnetic source suspended.

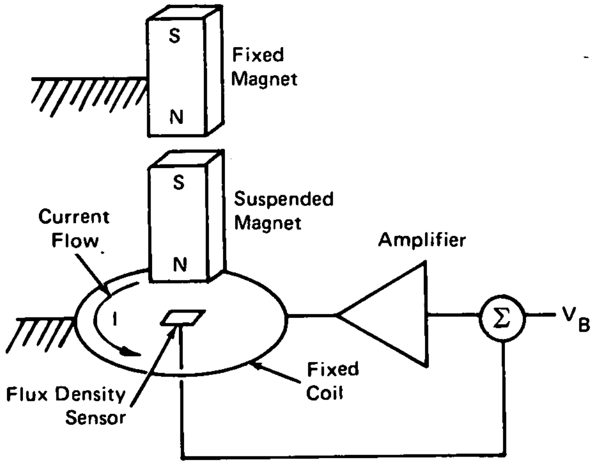

Figure 1. Suspended Magnet Configuration

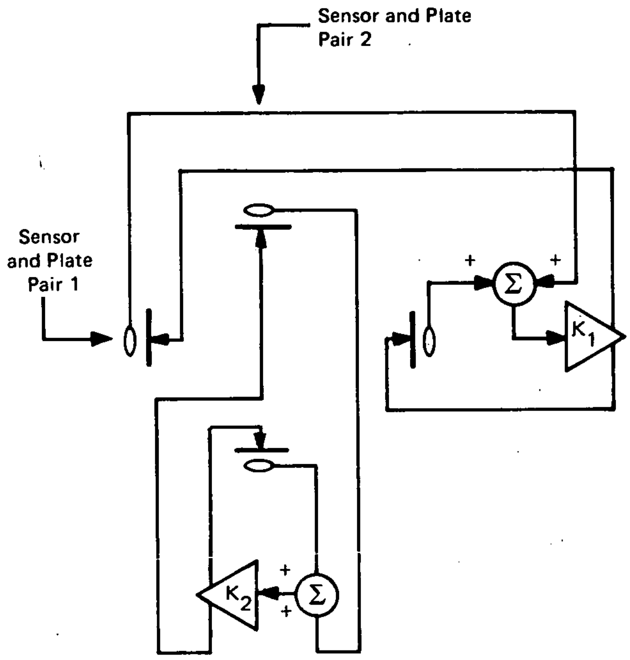

Figure 2. Pseudodiadielectric Configuration.
Note: Sensor and Plate Pair 3 not shown.

As shown in Figure 1, a magnet is suspended between the pseudodiamagnetic device (coil) and a fixed magnet. In this configuration, the device provides a stabilizing force in the vertical direction. When the suspended magnet is in equilibrium, no steady supporting force is required from the pseudodiamagnetic device. Thus the average current through the coil can be reduced to zero by summing in a bias voltage (V_B) to the amplifier. In essence, power consumption in the coil is related to any forces disturbing the suspended magnet, and, in their absence, consumption is due only to the quiescent operation of the electronics.

An experiment was performed in which the fixed magnet was a cylinder 2.54 cm in diameter and 10 cm long; the suspended magnet was a cylinder 1.3 cm in diameter, 8.9 cm long, and weighing 83.6 g; both were

(continued overleaf)

Alnico V magnets. The coil with an inside diameter of 1.9 cm had 10^4 turns and a resistance of 40 ohms. The amplifier-sensor gain was 10 amperes per turn. The initial operation provided suspension, but with dynamic oscillation of the suspended magnet. This dynamic oscillation was easily corrected by the addition of a velocity sensing coil of 200 turns placed around the fixed magnet and appropriately summed into the amplifier.

In particular, the coil current could be reduced to less than 3 mA in the laboratory environment. In other words, stable suspension was provided at the rate of 232 kg/W (exclusive of sensor-amplifier quiescent power).

By a similar approach, it is possible to suspend objects in an electric field. Although no known dielectric material has a property (permittivity less than that of vacuum) analogous to diamagnetic material, it is still possible to construct a pseudodiadielectric device, as shown in Figure 2.

In this device, each axis of an orthogonal set consists of a pair of parallel plates whose voltage difference is proportional to the voltage sum of two electric field sensors positioned symmetrically on axis outside the plates. The sensors are located outside the plate to avoid shielding effects and they provide a voltage proportional to the axial component of the electric field.

As the sensors are displaced further away from the plates, they are less sensitive to the field arising from the plates. Hence the total electric field near the outside surface of the plates can be driven to the opposite polarity of the externally applied field.

Patent status:

Title to this invention has been waived under the provisions of the National Aeronautics and Space Act [42 U.S.C. 2457 (f)], to the Massachusetts Institute of Technology, Cambridge, Massachusetts 02139.

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