HENSCHKE
Physics Educational Tools

Dr. Martin Henschke Gerätebau
Dieselstr. 8, 50374 Erftstadt, Germany
www.henschke-geraetebau.de/english/

Instruction Sheet
Variable Gap Magnet

Martin Henschke, 2004-05-09

art. no.: 650269

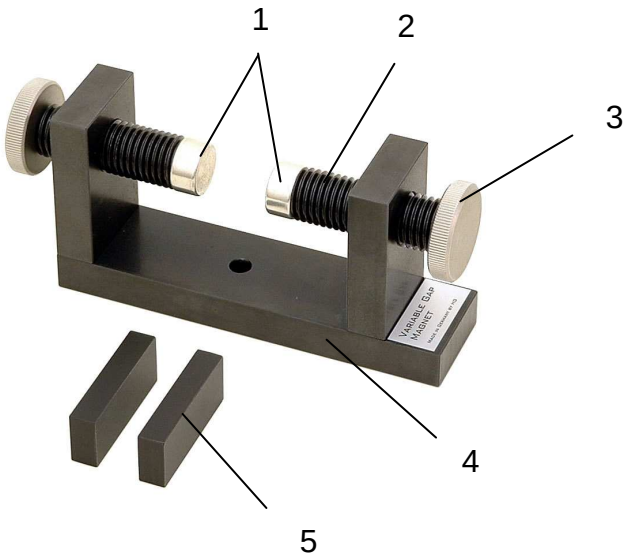

Fig. 1: Components

1 Neodymium magnets, each 20 mm in diameter and 10 mm in length
2 Threaded bolt made of black finished iron
3 Hand wheel made of stainless steel
4 Base apparatus made of black finished iron
5 Pole pieces made of black finished iron
6 Knurled-head screw M8 (not shown)

1. Safety instructions

Magnets have considerable forces of attraction and repulsion, through which they harbor injury hazards through squashing or sharp metal slivers attaching to the magnet. For that reason magnets may not be removed from the threaded bolts or subjected to mechanical modification.

Certain magetic materials are toxic and/or slightly soluble and thus not completely safe. Performance degradation, material damage and decay can result from, for example, corrosion (keep in dry storage), chemical effects, opposing magnetic fields, high temperatures etc.. Allergic reactions may be triggered by direct contact with magnetic material (e.g. against zinc and nickel).

Permanent magnets may not be exposed to radioactiveradiation.

When permanent magnets are in motion or when current-carrying materials are moved through the magnetic field this can lead to the formation of eddy currents and thus to considerable heat build up in the material – risk of burns.

Bear in mind that magnetic fields can delete data stored on data media and can adversely affect or destroy electronic as well as mechanical components, e.g. cardiac pacemakers. It is imperative that required safety distances be strictly adhered to.

A dangerous cargo certificate is needed for air freight transportation.

In spite of all these instructions the author is unaware of any negative influences for humans stemming from the magnetic fields of permanent magnets.

2. Description, technical data

The magnet with variable pole distance can be used together with the electromagnetic experiment apparatus #650270 for experiments on diamagnetism and paramagnetism to determine the force being exerted on current carrying conductors as well as in the demonstration of eddy currents.

Together with the Lorentz motor armature #650277 a motor can be assembled without needing an iron core in the motor winding and which rotates only on the basis of the Lorentz force. Here the rotation direction – unlike standard DC motors with twopole armatures – is dependent on the current direction.

To fasten down the magnets within experiment setups there is a bore hole with 8 mm diameter in the lower carrier plate and an M5 threaded hole arranged perpendicular to this. As such it is possible to either attach the magnets on a stand rod with 8 mm diameter or lock it in place with an M5 knurled screw or to screw it directly onto, e.g. the electromagnetic experiment apparatus using a knurled screw M8.

The air gap between the Neodymium magnets is adjustable from 2 mm up to 80 mm. The field intensity B which settles in along the imaginary center axis between the two magnets can be calculated as a function of the air gap width x as follows[1]:

[1] IBS-Magnet, brochure, www.ibsmagnet.de

$$B(x) = Br\left(\frac{2L + x}{\sqrt{D^2 + (2L + x)^2}} - \frac{x}{\sqrt{D^2 + x^2}}\right)$$

Here *L* stands for the total length of the magnets (2 x 10 mm = 20 mm) and *D* for the diameter (20 mm). Basically the magnetic remanence *Br* can only be determined via measurement because the manfacturing tolerances can be significant. The value for the magnets used here should be around 1000 - 1300 mT. Assuming that the remanence amounts to *Br* = 1230 mT, then according to the Equation above for an air gap width of *x* = 5 mm we obtain a field intensity of *B* = 826 mT.

3. Operation

The magnet can be used in 4 positions:

- standing upright, as in Fig. 1
- lying on one side
- standing on its head
- standing on its longer side (for experiments in the vertical magnetic field)

By using the pole pieces included with the delivery the dimension of the magnetic field can be increased. When attaching or removing the pole pieces proceed very carefully to avoid crimping or squashing your fingers.

The measurement of the air gap width should be carried out using a plastic ruler or a vernier caliper made of plastic, in order to avoid any undesired magnetisation of the measuring instrument. If the air gap width was determined for a certain position of the hand wheels, then the air gap width can continue to be determined on the basis of the number of turns made on the hand wheels for the rest of experiments since one full turn corresponds to a distance of 2.5 mm.

4. Maintenance and storage

If necessary, the iron components can be wiped clean using an oily rag. Solvents like aceton or petroleum ether can be used to clean the equipment. However, here you must make sure that the adhesive foil on the underside does not come off by accident. After cleaning with solvents the iron components should be prepared with a thin layer of anti-corrosion oil. This device should be stored in a dry location.

Any iron shavings adhering to the magnets can be removed with adhesive tape.