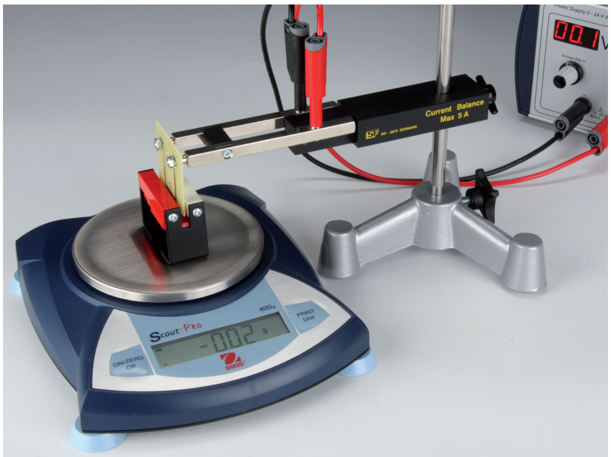
Current Balance 4565.00

2014.12.01

4565.00 AE



Description of the equipment:
This equipment is designed to measure the force-acting upon an electric conductor, placed in a magnetic field. When an electric conductor with length L, is within a magnetic field B, and a current I is running through the conductor, this will be acted upon by a force, which can be calculated by the following formula (also known as Laplace's law):

$$F = B \cdot I \cdot L$$

This formula presupposes that the magnetic field is perpendicular to the conductor.

The equipment consists of a holder with 6 interchangeable magnets, a holder for wire frames, and 6 wire frames with conductors of different length.

With this equipment the different parameters in the formula above can be variated one by one. The force is measured indirectly. The magnet holder is placed on a balance which you tare. The force is found by applying Newton's third law. In this situation it means that the force acting upon the conductor from the magnetic field is equal in magnitude, but opposite in direction, to the force acting upon the magnetic field from the current in the conductor. If the force acting on the conductor is directed upwards, the force acting on the magnetic holder will be directed downwards which results in an apparent increase of the weight of the magnet holder. Since the force is proportional to the weight ($F = m \cdot g$), the force can easily be calculated.

The equipment contains 6 wire frames with conductors of different length, so it is easy to make an experiment where one changes the length of the conductor. Even more easy is it to change the current through a certain conductor, this can be done on the power supply. As the magnets in the magnet holder cannot be relied upon to have exactly the same strength, one cannot use the amount of magnet as a measure of the magnetic field strength, but it is possible to disassemble the magnet holder, and remove one or more magnets. The strength of the magnetic field can be measured by means of a teslameter.

For a more detailed description of the experiment, please refer to the experimantal section.

Necessary accessories:

Powersupply with stabilized DC, 3630.00 or 3640.00

Ammeter 3810.70 or
Digital multimeter type 386215 - or the like

Laboratory Balance with 10 mg resolution and at least 200 g capacity

Base triphod 0006.00

Rod 0008.50

Test cables

Teslameter 4060.50

Operation:
See experimental section in the end of the manual.

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Spare parts:
4565.02 U-magnet for Current balance, 1 pcs.
4565.03 Holder with 6 U-magnets
4565,0090 Wire frame SF 37
4565,0091 Wire frame SF 38
4565,0092 Wire frame SF 39
4565,0093 Wire frame SF 40
4565,0094 Wire frame SF 41
4565,0095 Wire frame SF 42
4565,0096 Wire frame SF 43

Laboratory Exercise

Purpose

The current balance is used to perform measurements which verify Laplace's Law. This law relates the force on a conductor to the conductor length, the magnitude of the current through the conductor, the magnetic field strength and the angle between the direction of current flow and the magnetic field:

$$F = I \cdot L \cdot B \cdot \mathrm{Sin}V$$

F: Force on the wire due to the magnetic field (newton).

B: Magnetic field strength (tesla).

I: Current (ampere).

L: Length of wire (meter).

V: Angle (degrees) between the B-field and the direction of the current.

PROCEDURE

The experimental procedure can be described as follows in that the equation parameters are changed one at a time:

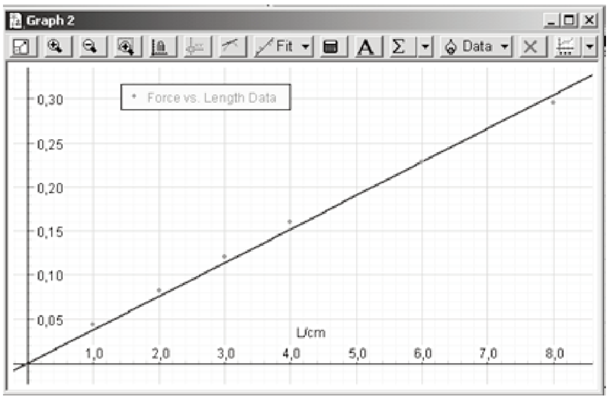
- the force is proportional to the length of the conductor
- the force is proportional to the current
- the force varies as the sine of the angle V between the current and the B-field
- the force is proportional to the strength of the B-field (qualitative)

Force vs. length:

Set up the equipment so that the magnet assembly rests upon a sensitive balance, and the arm of the current weight is positioned to support conductors of various lengths completely within the region of uniform magnetic field. Begin with the L=1 cm conductor in position, set the current to zero (e.g. by breaking the circuit), and zero the balance if possible (press the tara button).

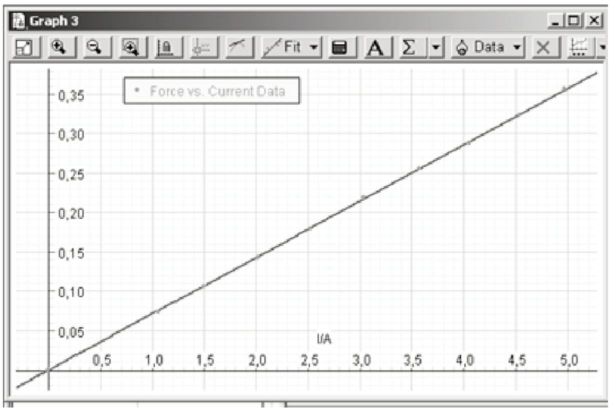
Now set the current to a constant value, e.g. 4,0 amperes, and take a reading from the balance. Repeat this process for various conductor lengths. Note that the values observed may be positive or negative depending upon the orientation of the B-field. Change the direction of current flow if required to obtain positive values, if that is preferred.

Values in grams may be converted to a true force by using Newton's second law: F = m · g. For example, a value of "5 grams" corresponds to a force of 0,005 kg * 9,82 m/s² =0,0491 N.



Force vs. current:

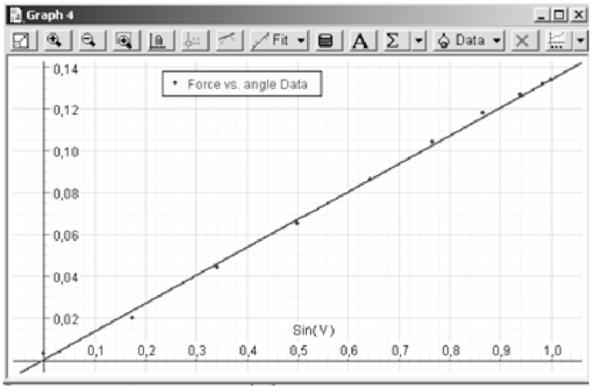
Again the equipment should be set up so that the magnet assembly rests on the sensitive balance, and the arm of the current weight is positioned to support a conductor. Now use the longest conductor length e.g. L = 8 cm. Set the current to zero by breaking the circuit, and zero the balance as before. Keeping the conductor length constant, change the current through the circuit and read off corresponding values from the balance.



Force vs. angle:

The equipment is prepared as before, however with the introduction of the goniometer assembly with the coil instead of the single conductor accessory. Be careful to adjust the goniometer so that the moveable angle indicator reads zero, when the horizontal (bottommost) conductors of the coil are parallel to the magnetic field. Zero the sensitive balance with no current flowing. Now supply a constant current of e.g. 4 amperes, and adjust the angle between the conductors and the magnetic field in 10 degree increments. Read off corresponding “force” values from the balance.

Note that magnetic forces also act on the vertical segments of the coil but in opposite directions and parallel to the surface of the sensitive balance. These small forces tend to twist the coil (as in a motor) but have no effect upon the vertical force component which we measure.



Force vs. magnetic field:

The final parameter in Laplace’s law is the strength B of the magnetic field. It can not be assumed that the field strength is directly proportional to the number of magnets. However, a general impression can be formed by changing the number of magnets and observing the magnitude of the magnetic force as before. The direct proportionality of force with field strength can be confirmed using a Hall detector to measure corresponding values of the actual field strength and the “force” recorded by the sensitive balance. Note that this experiment requires that the set up be carefully adjusted and zeroed again after each measurement with different numbers of magnets.

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