GRIFFIN & GEORGE LTD.
CURRENT BALANCE

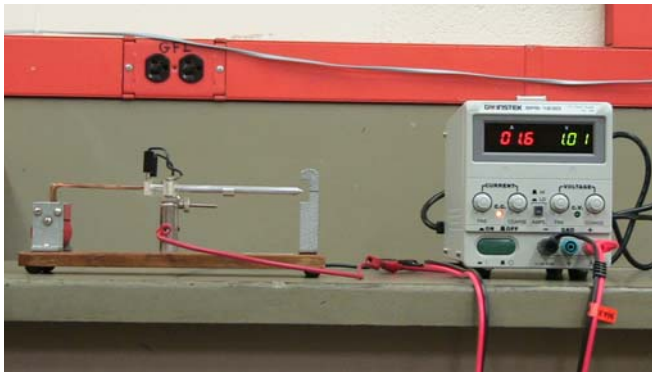


Figure 1: Experimental Set-up

The Griffin & George current balance uses the torque produced by a weight on one end to balance a torque created by a magnetic field and a current. The length of coil immersed in the magnetic field experiences a force proportional to the current in the wire and the strength of the magnetic field. In MKS units the magnetic field is measured in Tesla, the current in amperes and the force in Newtons (see equation 2).

The movable mass represents an equivalent mass placed at the end of the coil. So, for example, when the mass is moved to 0.20(0), it represents 0.20(0) grams at the far end of the coil from the pivot. The force is the mass times the acceleration due to gravity, 9.80 m/s^2.

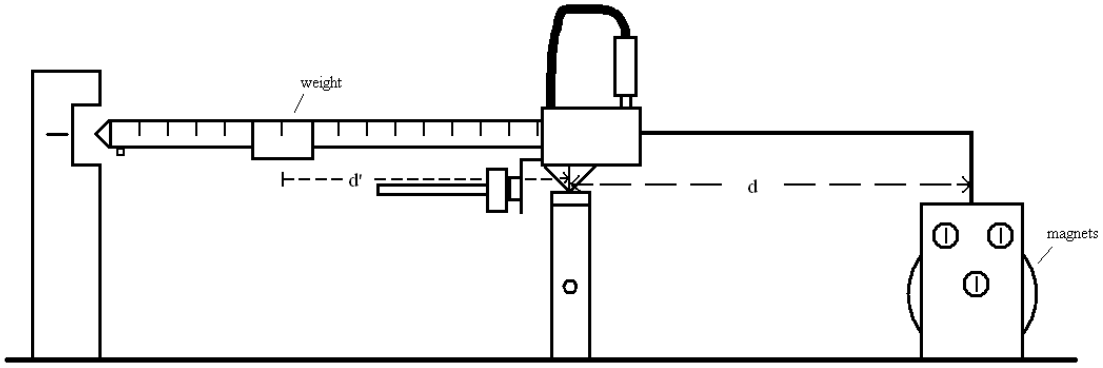
If i is the current passing through a loop of a conductor, B is the magnetic field produced by the horseshoe magnet assembly, and dl an infinitesimal section of the wire then the force exerted on the current wire loop is given by:

$$d\vec{F} = id\vec{l} \times \vec{B} \quad . \qquad (1)$$

Since the magnetic field is approximately constant and perpendicular to the length of wire L in between the magnets, equation 1 can be integrated and simplified. This will leave the following equation to be solved for the magnetic field:

$$F = iBL \, . \qquad (2)$$

The experimental setup is similar to a double pan balance, the torque produced by the magnetic force ($iBLd$) on the right side must be equal and opposite to the torque produced by a counter weight on the left side (mgd') where d and d' are the distances measured from the pivot point of the balance (See figure 2).The scale is calibrated so that the reading on the lever arm equals an equivalent weight (in grams) placed on the opposite end of the balance. You should immediately convince yourself that equation 1 is qualitatively correct. Note that the direction of the magnetic field in between the horseshoe magnets is defined from north to south where the red end of the magnet is the north pole and the black end is the south pole, the direction of the current flow is defined for positive current flow from the positive terminal of the power supply to negative terminal. With these sign conventions and the correct use of the right hand rule you should be able to show that equation 1 is qualitatively correct.



Side View of Current Balance

Figure 2: Side view of Current Balance

Procedure

1. Place device in the center of the mount and align the coil in the center of the magnets and the weighted end in the center of the notch.
2. Move the mass to zero and make sure that it is balanced properly. Use the fine and coarse adjustments under the balance to zero the balance, in order to collect accurate data.
3. The two wires on top of the balance can be moved around to change the width, *L*, of the coil. Record this value (**Note make sure the power supply is turned off before connecting/disconnecting any wires**).
4. Connect a power supply to the center posts using patch cords. A certain polarity is needed, in order to create the correct torques. When a current is applied, the current loop portion of the balance should move downward.
5. Adjust the weight. Record the measurement to the nearest 0.005 of a gram.
6. Turn on the Instek power supply and set the unit in the current control mode. The power supply will then adjust its voltage to supply a constant current .Then slowly increase the current. It is sometimes necessary to give the weighted arm a nudge. Be careful not to alter the weight or position of the balance. Adjust the current to align the balance with the dash. Record the current. The Instek power supply will display the current reading to 0.1 amps, if you desire more current resolution you will have to put an ammeter in series with the power supply.
7. Repeat the measurements by adjusting the weight, and the wires to alter the coil length.
8. The same result can also be seen in providing a current and adjusting the mass to create the balance.

9. Check your data to make sure that you get similar values for the magnetic field. NOTE: The earth's magnetic field is approximately 52.7 microteslas, μT, or 0.527 gauss. For this experiment, the effect of the earth's magnetic field is small compared to the magnetic field of the magnets. The magnetic field in the center of the horseshoe magnet assembly is roughly 800 gauss, this was measured with a magnetic field Hall probe (1 Tesla = 10,000 gauss).
10. Plot Force versus current for each wire length configuration l .The slope of your graph will then be Bl . Do your experimental values from your current balance measurements of the B field agree with the Hall probe measurement?

References

Current Balance Model EM-8623. Roseville, CA: PASCO, 1990. Print.

Amrani,D. "Use of a current balance to calibrate an ammeter and to determine the magnetic permeability of space" Eur. J. Phys 26 (2005) 273-278.

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