Experiment (6)

MAGNETIC FORCE ON A CURRENT CARRYING CONDUCTOR

OBJECTIVE

To measure the force on a conductor carrying electric current placed in a magnetic field. The force is measured as the current and the length of the conductor are varied. The effect of the magnetic field strength on the resulting force is also studied.

EQUIPMENT REQUIRED

1. Balance.
2. Wire loop, L=50 *mm*.
3. Wire loop. L=25 *mm*.
4. Wire loop. L=12.5 *mm*.
5. Power supply.
6. Ammeters (two).
7. 900-turn coils (two).
8. Pole pieces (two).
9. Iron core, *U*-shape.
10. Distributor.
11. Right angle clamp.
12. Bridge rectifier.
13. Teslameter with a tangential probe.
14. Multimeter.

INTRODUCTION

Consider a straight conductor of length L and carrying current I placed in a region of a uniform magnetic field $\boldsymbol{B}$, where the magnetic field is perpendicular to the conductor. The magnetic force on the conductor is given by:

$$F = IBL \quad \text{.......... (1)}$$

The direction of the force is given by:

$$a_F = a_I \times a_B \quad \text{.......... (2)}$$

PROCEDURE

The experimental set up is shown in Figure 1. The *AC* current out of the power supply is rectified (call it I_F) and passed through the 900-turn coils to produce a constant magnetic field between the pole pieces. The *DC* current out of the power supply is passed through the conductor (call it I_L).

<u>PART A: Force vs. conductor current</u>

1. Attach the 50 *mm* wire loop (N=1) to the balance.
2. Set the *AC* output voltage of the power supply to the 12 *V* setting.
3. Adjust the balance to the horizontal position when the switch is off (I_F = 0). Record the reading or the balance dial.
4. Turn the switch on and adjust I_L to 0.5 *A*. Readjust the balance again to the horizontal position. Record the reading of the balance dial.

5. The difference in the balance readings of steps (3) and (4) is the force in grams exerted on the wire. To obtain the force in mille-Newton (*m N*), multiply the force in grams by 9.81.
6. Measure the magnetic field between the pole pieces using the Teslameter and the tangential probe. This value of the magnetic field will be used in the theoretical calculations. (*Remember to calibrate the Teslameter. After calibration, push the DC button and choose the 300mT setting*).
7. Repeat steps (3)-(6) for a range of conductor current between 0.5 and 5 A.

PART B: Force vs. conductor length

Repeat the steps of *PART A* for different conductor lengths (N=1) with $I_L = 5.0\ A$ only.

PART C: Force vs. magnetic field

1. Attach the 50 *mm* (N=1) wire loop to the balance.
2. Fix I_L to 5 A.
3. Measure the force as the current I_F is varied. (This is done by choosing different voltage settings on the power supply).
4. Measure the corresponding magnetic field.

QUESTIONS FOR DISCUSSION

1. Plot the experimental and the theoretical relations between the force on the conductor and the conductor current, the conductor length and the magnetic field.
2. Why did we ignore the effect of the magnetic field of the surroundings?
3. Why did we ignore the effect of the vertical portions of the conductor loop?
4. Plot and explain the relation between the magnetic field and I_F. (Use the results of *PART C*).

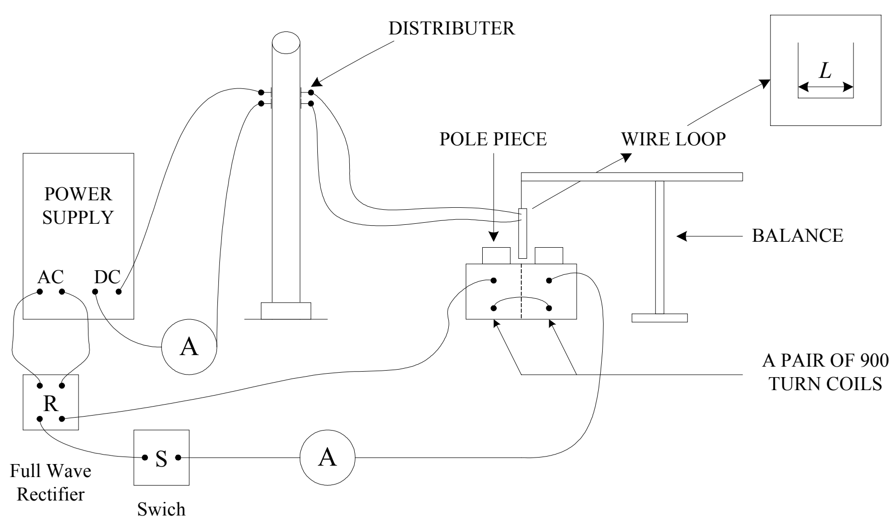

Figure 1: Experimental set-up

