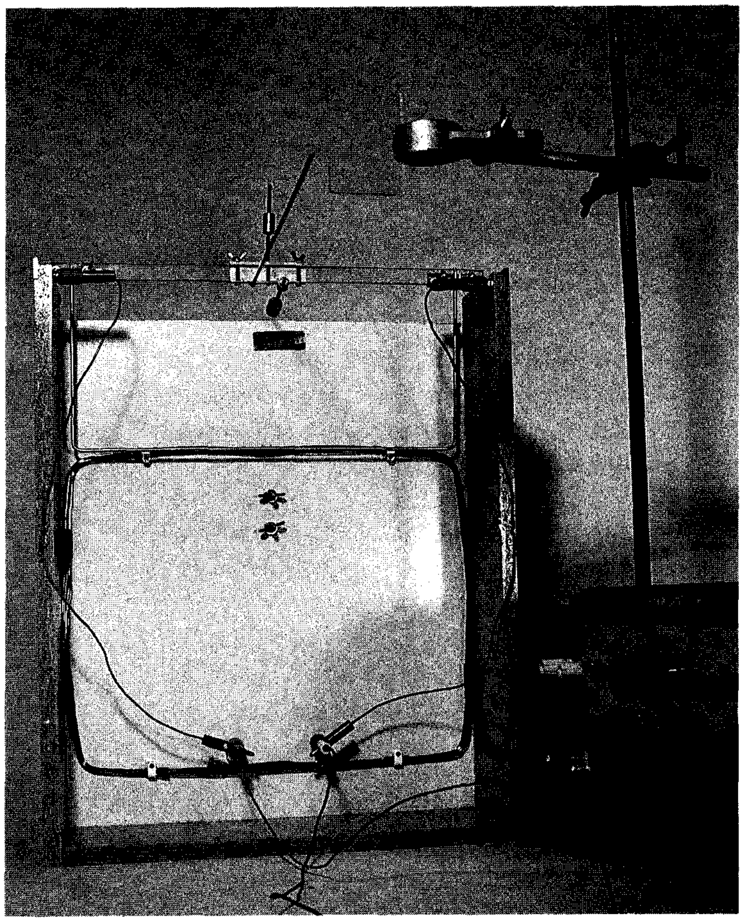
CURRENT BALANCE

The current balance is used effectively to investigate the magnetic force between 2 current-carrying wires. It consists of a wooden structure holding a fixed square loop of wire and a balancing armature to hold another loop of wire at varying distances from the fixed one. When these two loops are connected in two separate circuits and the current in each circuit turned on, the armature including the single loop is caused to move. The distance moved is a measure of the magnetic force between the loops.



SAFETY PRECAUTIONS

Take care when handling the perspex armature as it is easily broken about the central point.

SETTING UP AND USING THE CURRENT BALANCE

C **It is worth checking the following items before an experiment is set up**

- Ensure that the wire loops have straight sides.
- Since this equipment is a sensitive balance, choose a solid base on which to set it up and shield it from a draught.

X **Extra equipment for the suggested learning experiences includes:**

- 2 power packs
- Retort stand, bosshead and clamp
- 4 red leads and 4 yellow leads
- vernier callipers
- wire cutters
- 2 rheostats
- 2 DC ammeters (0-5 Amps)
- thin wire to make a small counter balance
- a ruler

S **Setting up the Current Balance**

- Using figures 1 and 2 assemble the armature fittings as follows:
  Loosen the wingnuts (N) under the centre of the armature and insert the pointer(P) into one of the slots so that the first notch (zero mark) is aligned with the knife edges. Insert the counter mass (M) into the other slot so that it protrudes on the opposite side of the beam from the pointer. Tighten the wingnuts. Insert the sensitivity adjustment rod with masses (A) into the hole in the centre of the beam balance.

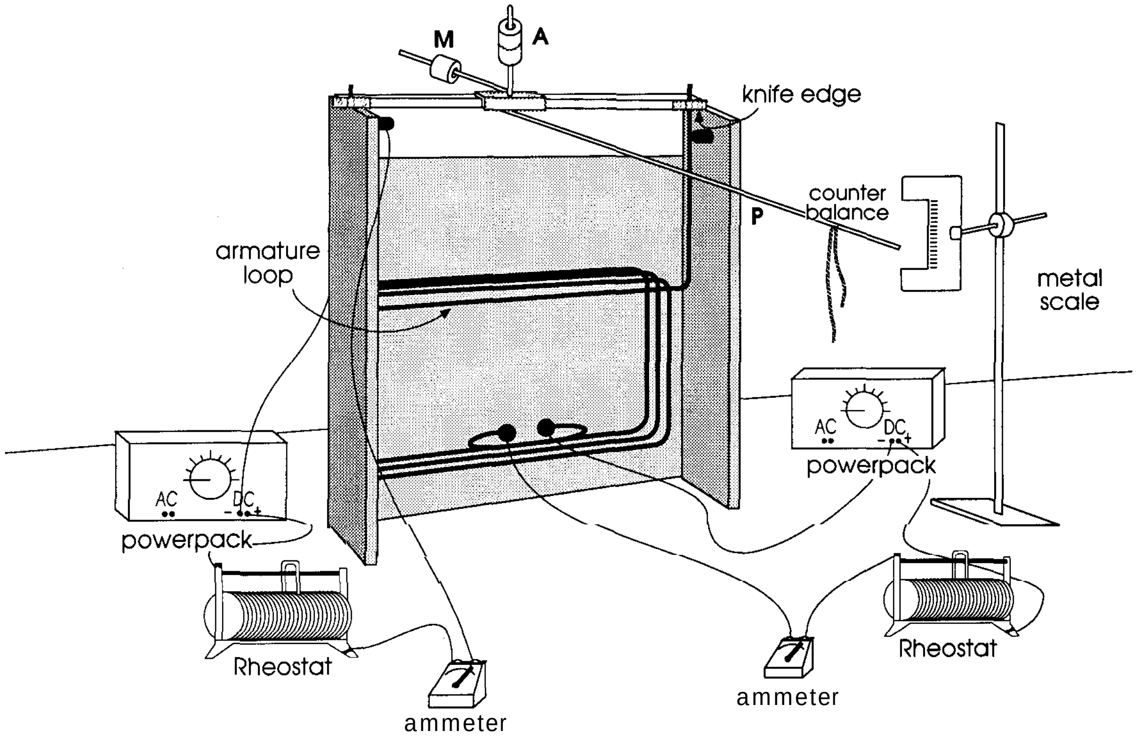


figure 1

Loosen the wingnuts (S) on either side of the armature and insert the longest loop into the slots near the wingnuts. Allow 2 mm of each end of the loop to protrude above the beam. Tighten the wingnuts.

- Place the beam so that the knife edges are located in the 2 'V' slots outermost from the fixed loop.
- Fix the zero marker in a clamp mounted on a retort stand and position it so that the pointer can oscillate only between the inner faces of the zero marker.
- Check that the pointer is free to oscillate.
- Adjust the balance using the following steps:
  1. Lower the sensitivity mass A and the counter mass M until the suspended wire is exactly vertically balanced. To ensure this, measure the distances between the tops of the fixed and movable loops and the bottoms of the fixed and moveable loops. If these distances are equal, the loop is vertical.
  2. Set the zero marker, by moving it up or down on the retort stand, so that the pointer is exactly at zero. To avoid parallax error, the small metal ruler may be used as a mirror to line up the pointer and its image.
- Connect the 2 separate circuits as indicated in figure 3.
- To help clarify the complicated setup, use a set of different coloured wires for each circuit.

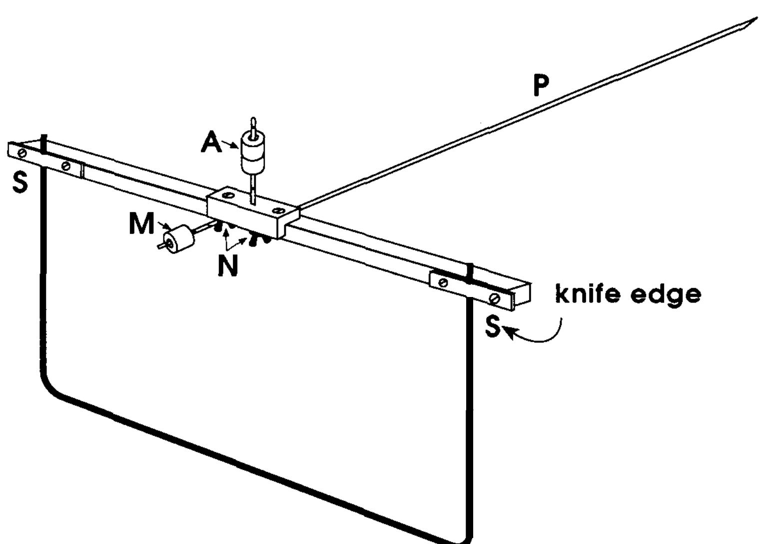


figure 2

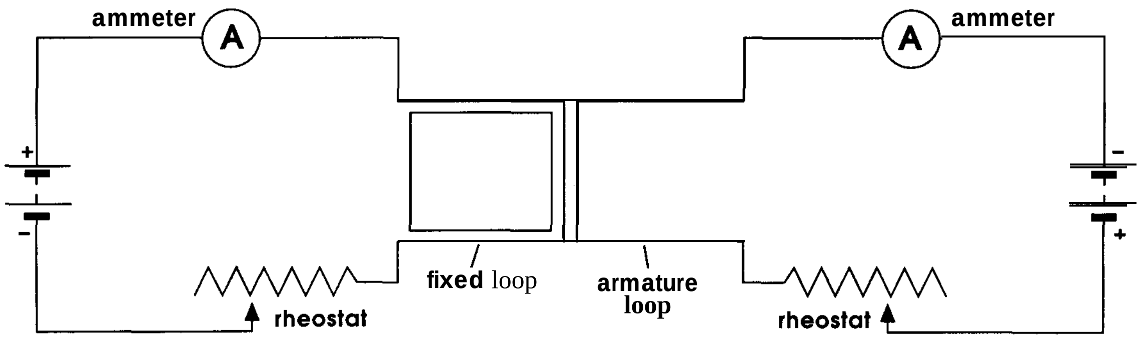


figure 3

HANDY HINT

If you no longer have the small counter balance, use 15 mm of a paper clip bent into an 's' shape to hang on the pointer.

SUGGESTED LEARNING EXPERIENCES

This equipment shows very clearly the phenomenon of the magnetic force between two current-carrying wires. It can be used to demonstrate *qualitatively* the dependence of the force on the direction and magnitude of the currents, the distance between the wires and common length of the wires. To obtain *quantitative* verification of the relationship takes patience as the armature must be balanced each time. However the results obtained are generally good.

The following is an outline of the general procedure required to balance the loop, in order to take measurements of the force between the wires:

- Set up the balance as described above, adjusting the balance to read zero on the scale with no current flowing in the circuits.
- Adjust the current flowing in the wires, using the rheostats so that *at least 4 amps* is flowing in each circuit. ***(If you cannot adjust the current using the rheostats, see note on connecting rheostats in the section on Hundy Hints on puge 22).***
- Balance the armature by suspending a small counter-balancing mass (see ***Handy Hint above***) in one of the slots on the pointer. Measure the distance from the pivoting point to the counter-balancing mass. This distance **(d)** is proportional to the force **(F)** between the wires,

as $F \propto mgd$ where **m**=mass of the counter balance (kg), **g**=9.8 ms^{-2}.

1. **Qualitative investigation of attractive and repulsive forces between current-carrying wires.**

2. **Verify the dependence of the force between the wires and the current in each wire,** as given by the expression $F \propto I_1 I_2$ In this case, it is physically easier to place the counter-balancing mass at regular intervals, say 2 cm apart, and adjust the current in the loop to balance the pointer. (See ***Yeur 12 Senior Physics Pruc manual for details)***

3. **Verify the relationship between the magnitude of the force on the wires and the distance between them,** given by the expression $F \propto 1/d$. Adjust the distance between the wires by placing the armature in different positions on the knife edges. (See ***Yeur 12 Senior Physics Pruc manual for details***)

4. **Verify that the force between two current-carrying wires depends on the length of wire common to both,** given by the expression $F \propto l$, **by** using loops of different sizes provided in the kit. (See ***Yeur 12 Senior Physics Pruc manual for details***) Note: this investigation is particularly time consuming and difficult to perform, quantitatively.