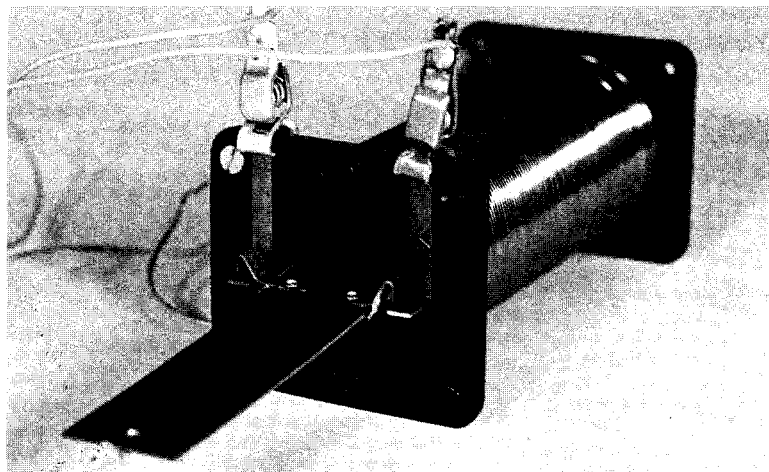


CURRENT BALANCE KIT

The current balance kit is used to demonstrate the effect of a magnetic force on a current-carrying wire and to use this effect to measure the strength of the magnetic field at the centre of a solenoid.

The kit consists of a loop of wire mounted on one end of a rectangular armature. The armature is balanced on pivotal contacts at one end of a solenoid so that the loop of wire sits inside it.

When a current of electricity flows through the solenoid and also through the loop of wire, *the armature moves*, revealing a force between them.



SAFETY PRECAUTION

Do not use a current of over 5 amps in the solenoid, as this will damage the contacts.

SETTING UP AND USING THE CURRENT BALANCE KIT

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

- 1 Although there are several models of this apparatus, these differ mainly in the type of contacts used as the pivot. It is important to check how the contact is made to ensure the free movement of the armature and maximum flow of current.
- 2 Clean the contacts with 200 wet/dry sandpaper, glass paper or an emery board.

X Extra equipment for the suggested learning experiences includes:

- 2 ammeters
- 8 leads
- 2 rheostats
- 1 balance to measure the mass of the string

Setting up the Current Balance Kit

- 1 Attach the metal strips/contacts to one end of the plastic cheek of the solenoid using the alligator clips. The contacts should slide into ready-made grooves in the outside of the cheek with the clips protruding from either side of the hole in the solenoid for the pivot points of the armature to swing freely on them (*see figure 1*) Put the armature in place, balancing on its pivoting points.

Set up the rest of the circuit following the circuit diagram in *figure 2*.
NOTE: The balance should move when both circuits are turned on and the current is adjusted to approximately 4 amps, using the rheostats.

If the readings on the ammeters are fluctuating clean the contacts again.

If the currents cannot be varied, then see the Handy Hints section below on connecting the rheostats.

With **NO** current flowing in the circuit, balance the armature to the horizontal by adjusting the screw on the end of the armature which is outside the solenoid.

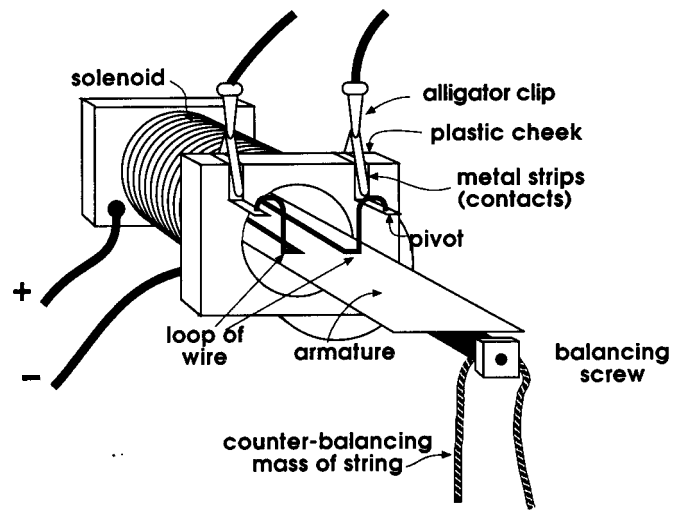


figure 1

HANDY HINTS

For models where the armature has a printed circuit with a loop of conducting material each side of the central pivoting points, you will need to determine which end of the armature will complete the circuit. This is easily achieved by locating small breaks in the circuit on one side of the pivot points. As this loop is broken, it will not complete the circuit. It is only present to balance the armature. The *other* side consists of the unbroken circuit loop through which the current will flow. Place *unbroken* circuit inside the centre of the solenoid, balancing the pivot points on the metal contacts.

To connect a rheostat into a circuit correctly, you must connect one lead to the thick top bar and the other lead to the bottom coil at the other end of the rheostat (see *figure 3*). The current will then flow from the bottom contact, through the coil to the sliding connector and across the thick bar at the top of the rheostat. The current flowing through the circuit can be adjusted by moving the sliding connector.

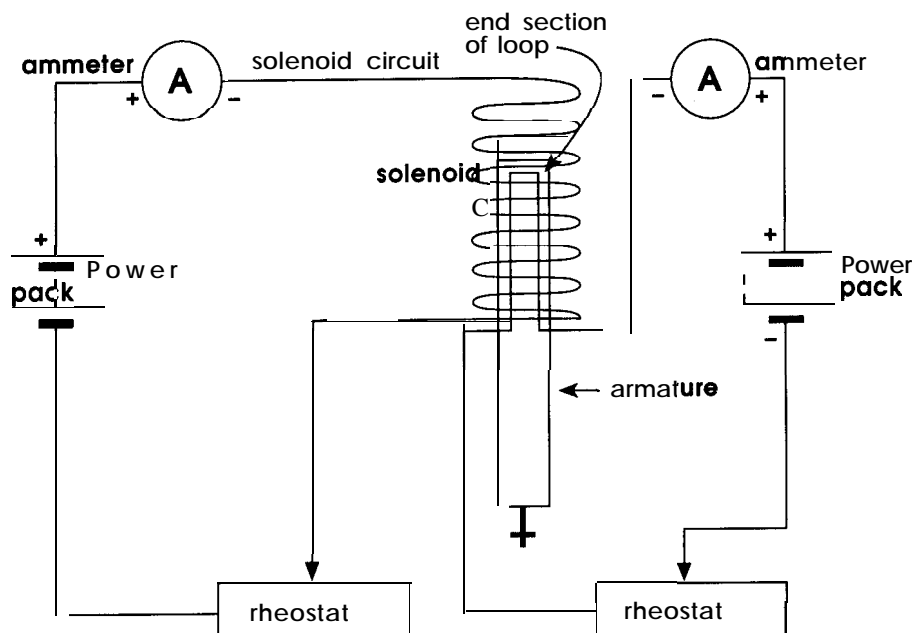
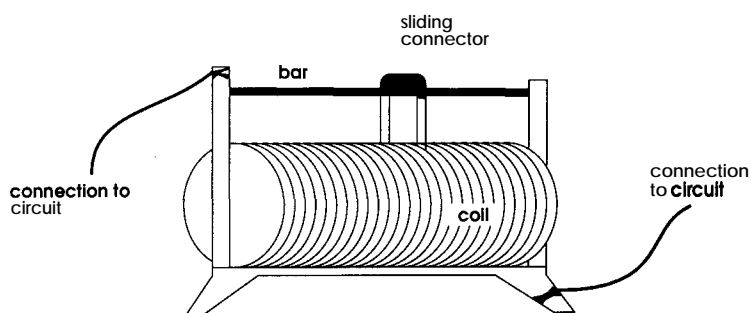


figure 2

SUGGESTED LEARNING EXPERIENCES

1. **Discover qualitatively the force exerted on a current-carrying wire in a magnetic field.** Set up the balance and compare the effect of varying the current in the solenoid from a minimum to a maximum. Vary the current in the loop and compare the effects on the armature. Ask the students to form some general statements explaining what they have experienced.



Rheostat

figure 3

2. **Calculate the magnetic field intensity (B) at the centre of the solenoid,** by measuring the force exerted on the end of a rectangular current-carrying loop of wire. (The small piece of wire across the very end of the armature, positioned in the solenoid, is the only part of the loop which is actually affected by the magnetic field as it is at right-angles to the field. The other two sides of the loop are parallel to the magnetic field, inside the solenoid, and will not be affected).
 - Use the equation $F = B I l \sin\theta$ where $\theta = 90^\circ$ and $l \cong 3\text{cm}$ (the length of the wire across the end of the armature).
 - Turn on the power and observe the internal section of the armature pushed down by the magnetic force between the loop and the solenoid.
 - Measure this magnetic force (F) by placing short lengths of string as counter-balancing weights on the other end of the armature until it is balanced in the horizontal position.
 - Make sure that the string is placed at an equal distance from the pivoting points when compared with the end section of the loop affected by the magnetic field inside the solenoid.
 - The mass of the string is measured on a balance. Alternatively, measure the mass of a known length of string and calculate its mass/cm. Then, measure the length of string required to balance the armature and calculate its mass.
 - To give the force (F) in newtons, multiply the mass in kilograms by 9.8
 - Set the current in the solenoid to 4 amps and calculate the force (F) required to balance different values of current (I) in the loop.
 - Vary I using the rheostat and plot a graph of F against I . (The gradient of the graph will be a measure of $B.I$). Hence calculate B . See *the PSSC Manual p77 for further details*.
3. **The solenoid from the current balance kit is used in conjunction with the Mass of the Electron apparatus - see page 36.**