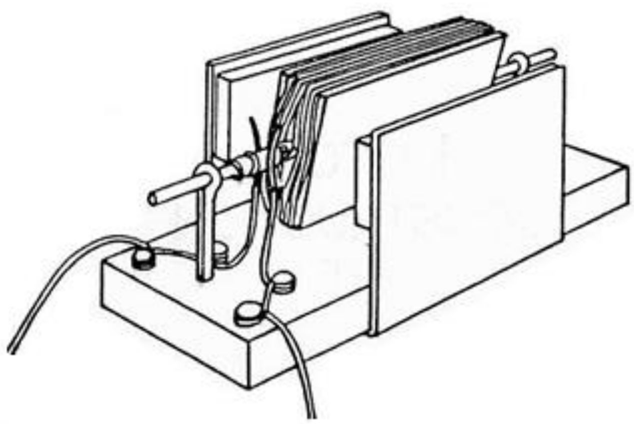
H30506 **Motor Construction Kit** **NFU 454**

Purpose

This construction kit contains selected items from the full Westminster Electromagnetic Kit (H26357). Students can build a simple working model of a DC electric motor and gain a practical understanding of the principles.
A power supply capable of providing 1 volt DC at up to 8 amps is required.



Contents

This kit includes all the parts required to build 6 model motors, as in the Westminster Electromagnetic Kit.

- 12 x Magnadur magnets
- 6 x armatures with aluminium tube through the centre
- 6 x mild steel yokes
- 6 x support bases
- 6 x knitting needle shafts
- 24 x rivets
- 12 x split pins
- 1 x reel of 26 swg PVC covered tinned copper wire
- 1 x 30 cm valve rubber

Some spares are available from local sources, but for specialised items check availability in our catalogue.

Safety advice

There are no specific hazards in using this kit. The power supplies used should have an electronic or thermal “trip” so that short circuits do not overheat the motor windings. This advice is not a replacement for a formal risk assessment, which should be carried out according to your school or LEA policy.

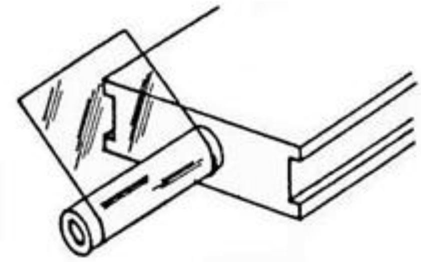
Activities

1 Building the motor – as standard and with an alternative commutator
2 Testing the motor
3 Using the motor to do some work
4 Estimating the efficiency of the motor
5 Improving the motor’s efficiency

Useful words

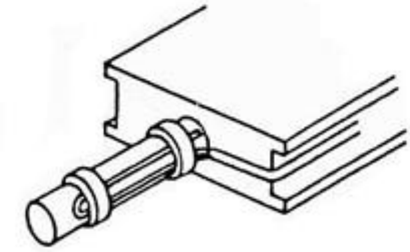
Armature = moving/spinning part of a motor containing a coil of wire
Commutator = a rotating contact that allows current to flow through the armature
Brushes = electrical contacts that "brush" against the commutator as it rotates
Field = a magnetic field, provided by magnets in simple motors

1. Building the motor - standard

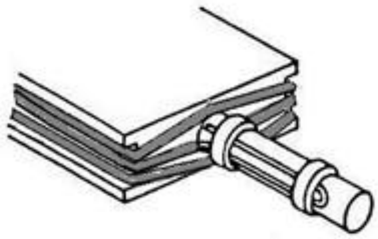


First insulate one end of the aluminium tube with Sellotape.

Then cut two slices off the bicycle valve rubber tube to make two small rubber bands, which are fitted over the end of the insulated tube. Strip an end of the PVC wire and form a loop which is fixed to the insulated aluminium tube with the rubber bands, as shown here. This is one side of the **commutator**.



Wind about 10 turns around the **armature** and cut off, leaving enough to strip and loop to make the other side of the commutator. For clarity, only three turns are shown in the illustration.

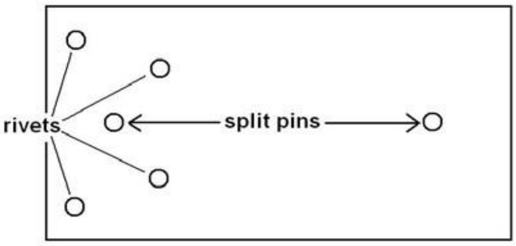


Carefully slide the rubber bands off and place the second stripped loop on the opposite side of the aluminium tube from the first.

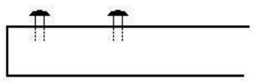
Finally, replace the rubber bands to hold the commutator in position. It is possible that one rubber band could hold the tips of the looped ends.

The looped ends are not strictly necessary – a single stripped end would suffice – but the loop provides greater contact with the **brushes** during each revolution. This gives some increase in power – see activity 4.

Prepare the base by fitting one split pin and four of the rivets at one end, and a second split pin at the opposite end.

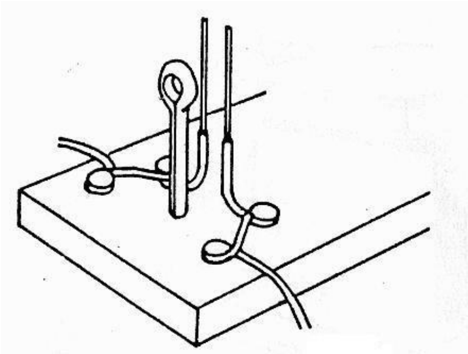


Do not push the rivets fully into the holes.



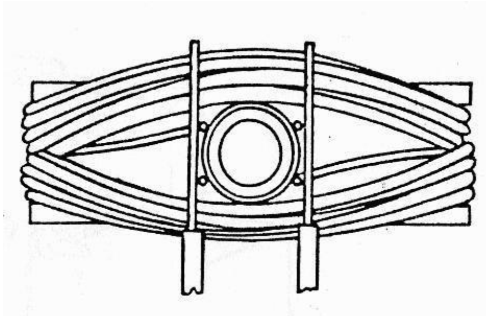
The **brushes** are two lengths of wire, which also act as connections to the power supply.

The ends are stripped. The wires are wrapped around rivets pushed into holes in the base, and firmly held in place by pressing the rivet heads down. The wires should be bent vertical, parallel and almost touching so they will press against the commutator.



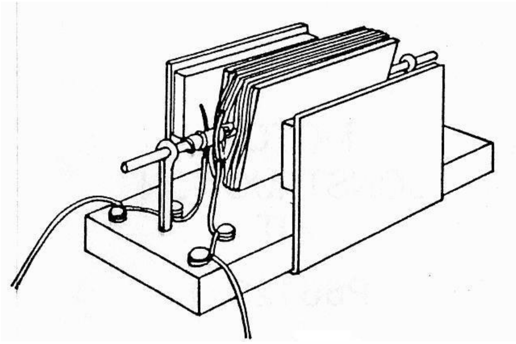
The commutator part of the armature can be eased gently between them, pushing them slightly apart.

Finally, hold the armature level with the "eyes" of the split pins. Insert the knitting needle through one split pin, through the aluminium tube then through the second split pin, to make the axle of the motor.



Apart from the slight friction of the brushes, the armature should spin freely when twisted with the fingers.

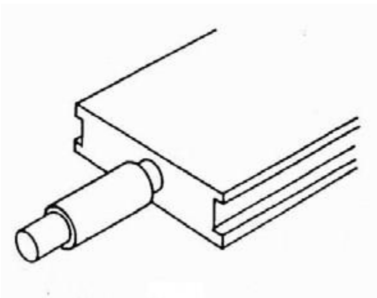
Check the contact between the **brushes** and the **commutator** when the coil is in the horizontal position. Adjust by gently bending the brushes.



The **field** is provided by two Magnadur magnets and the mild steel yoke arranged as in Figure 1. Take care to place the magnets with opposite poles facing one another.

When the 1 volt supply is connected, a slight twist of the armature should start the motor, which then spins at high speed.

1a Building the motor - with an alternative commutator

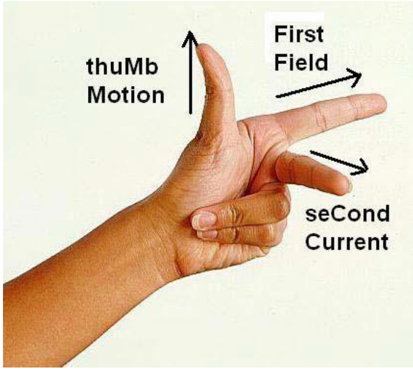


The alternative commutator may be easier for some students. However, the larger diameter gives greater friction, making the motor less efficient.

Instead of the Sellotape, narrow rubber tube is fitted over the aluminium tube to provide insulation. Larger rubber bands are required to secure the stripped wire loops but otherwise proceed as for the standard version.

2. Testing the motor

Once built, the motor can be used to test the predictions of Fleming's Left Hand Rule.



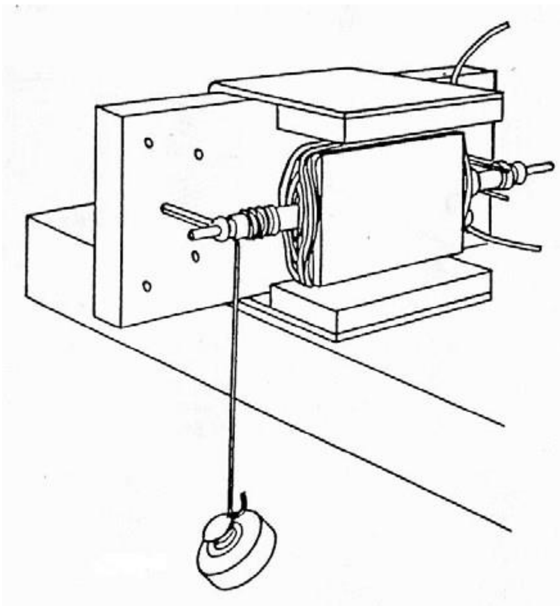
The direction of the magnetic **F**ield is conventionally from North to South.
The direction of the **C**urrent is from positive (+) to negative (-).
The **M**otion produced is predicted by aligning your first and second fingers with the Field and Current.

These magnets are unmarked, so you may need to identify their North face using a magnet whose North pole *is* marked.

Reversing the current or reversing the two magnets should have predictable effects on the direction of rotation of the motor.
Q. Which way does the current go on the opposite side of the armature?
Q. Why is it best to start the motor with the armature horizontal?

3. Using the motor to do some work

The motor will raise a 5g weight (or a lump of Plasticine) tied to the aluminium tube by a cotton thread. The cotton can be secured to the tube using a piece of Sellotape.



In one example, a 5g load (0.05N) was raised by 1 metre in about 5 seconds.

$$\text{power (W)} = \frac{\text{force (N)} \times \text{distance (m)}}{\text{time (s)}}$$

The motor's **power output** was about 0.01 watts.

4. Estimating the efficiency of the motor

Connect an ammeter in series with the motor and a voltmeter across the power supply. Read the values when the motor is raising the load. Multiply the current and voltage, the result is the **power input** in watts (W).

$$\text{efficiency (\%)} = \frac{\text{power output (W)} \times 100}{\text{power input (W)}}$$

5. Improving the motor's efficiency

If you have time, the motor can be re-built with some changes.
Use two pairs of magnets, the extra pair will have to be on the *outside* of the yoke.
Increase the number of turns of wire on the armature.
Test each modification by measuring the power input and output again.

Warranty, repairs and spare parts

The motor construction kit is guaranteed for a period of one year from the date of delivery to the customer. This warranty does not apply to defects resulting from the action of a user such as misuse, improper wiring, any operations outside of its specification, improper maintenance or repair, or unauthorized modification.

Our liability is limited to repair or replacement of the product. Any failure during the warranty period should be referred to Customer Services.

In the event of a fault, apart from replacing the instrument fuse in the IEC socket, the power supply should be referred to the Philip Harris recommended repair agent.

Please contact Customer Services or techsupport@philipharris.co.uk for advice

Supplier details

Philip Harris Education, 2 Gregory Street, Hyde, Cheshire SK14 4RH

Orders and Information	Tel: 0845 120 4521
	Fax: 0800 138 8881
Repairs	Tel: 0845 120 3211

E-mail: techsupport@philipharris.co.uk

Website: www.philipharris.co.uk