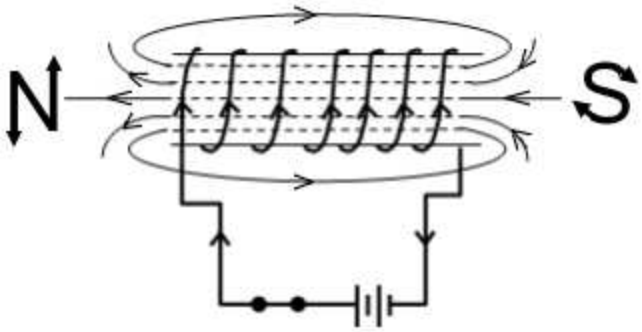


Determining the polarity of the magnetic field

Method I

If on looking at the end of the solenoid, the current is flowing in the clock wi**S**e direction, that end will be a south pole.

If current is flowing in the a**N**ti-clock wise direction that end will be a North Pole.

Method II

The polarity can be given by the right hand grip rule. It states that if the fingers of the right hand grip the solenoid in the direction of the current; the thumb points to the North Pole.

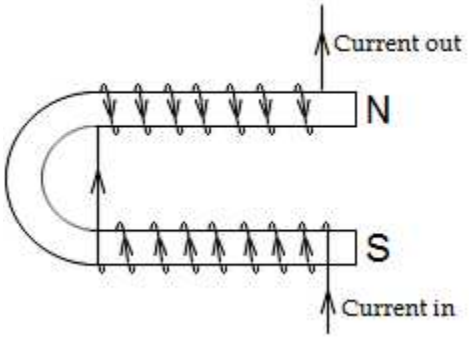
Note: The strength of the magnetic field inside the solenoid can be increased by:-

(i) Having a large number of turns wound on the core

(ii) Increasing the current flowing through the coil

ELECTROMAGNET

An electromagnet is made by winding a copper wire oppositely on a U – shaped soft iron core to form two solenoids as shown below. The soft iron core is magnetised only when current flows through the surrounding coil. An electromagnet is a temporary magnet which can be switched on and off.



Soft iron core is used in making electromagnets because;

(i) It can easily be magnetized and demagnetized

(ii) It is strongly magnetized.

The strength of an electromagnet can be increased by:-

(i) Increasing the current flowing through the coils.

(ii) Increasing the number of turns on the coil.

(iii) Making the poles close to each other.

Practical applications of electromagnets

Electromagnets have a number of practical applications among which includes;-

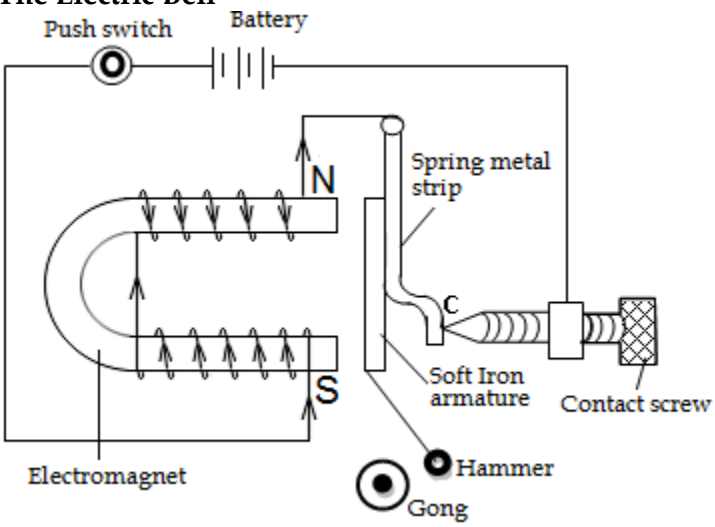
(i) Electric bell

(ii) Telephone receiver

(iii) Magnetic relay

(iv) Lifting magnets used in scrap yards and steel industries

The Electric Bell



How an Electric Bell Works

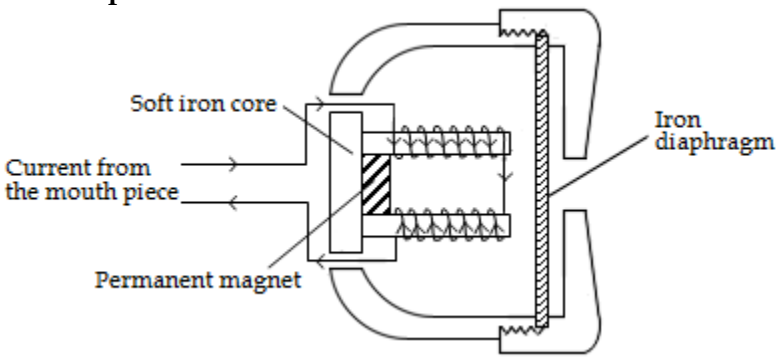
- When the switch is pushed, current flows through the coils magnetizing the iron core which attracts the soft iron armature.
- The soft iron armature moves along with the hammer which hits the gong producing sound.
- The attraction of the armature breaks the contact at C opening the circuit. The magnetism in the soft iron core is lost and the armature is returned to its position by the spring metal strip.
- When the armature is in its original position, contact at C is remade and the cycle is repeated producing continuous sound.

Note:

(i) An electric bell is a device which converts electrical energy to sound

(ii)The energy changes that take place in an electric bell: electrical energy to magnetic energy to kinetic energy and to sound energy

The telephone receiver

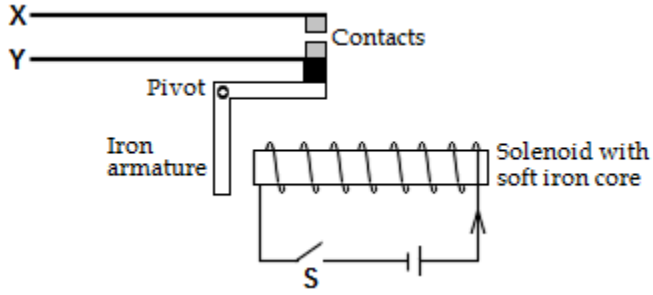


How a Telephone Receiver Works

- When a person speaks into a microphone at the other end of the line, a varying electric current is setup having the same frequency as the sound waves.
- The varying electric current passes through the coils in the receiver (earpiece), and magnetises the electromagnet.
- The varying electromagnetic strength makes the diaphragm to vibrate at the frequency of the original sound and the sound is reproduced.

Note: A telephone receiver changes electrical energy to sound energy.

Magnetic relay

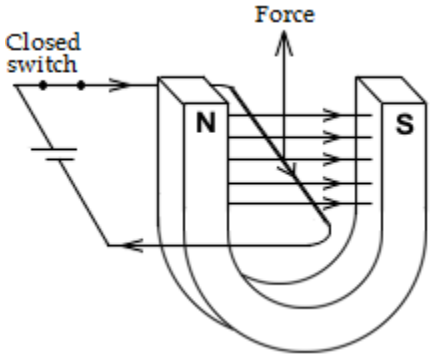


A Relay is an electrical device in which large current circuit can be operated by a low current dc circuit. From the diagram, when the switch S is closed, the iron core inside the solenoid becomes magnetised. It attracts the iron armature, which is pivoted. The upper limb of the armature causes the contacts in the secondary circuit XY to close, thus activating the large circuit.

Force on a Current Carrying Conductor Placed in a Magnetic Field

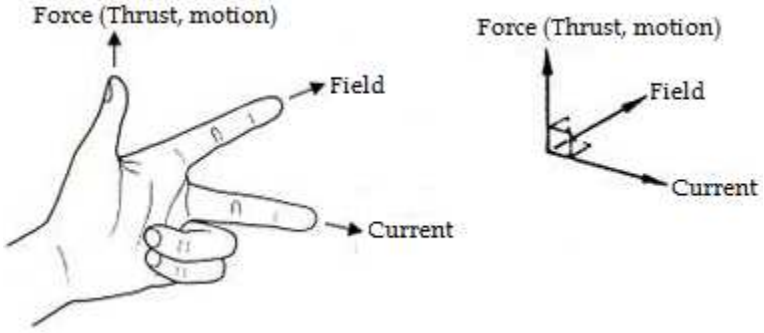
When a current carrying conductor is placed at right angles to the magnetic field produced by a permanent magnet, it experiences a force which pushes it in a direction which is perpendicular to that of both the field and current.

Experiment to demonstrate the Force on a Current Carrying Conductor placed in a magnetic field



- A strip of copper connected to a battery is placed at right angles to the magnetic field of a U–shaped magnet as shown above.
- When the switch is closed the copper strip is seen to move upwards. This is because of the upward force that acts on it.
- If either the direction of the current or that of the magnetic field is reversed, the copper strip moves downwards.

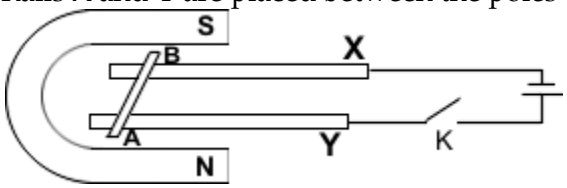
Note: The direction of the force on a current carrying conductor is given by **Flemings Left Hand Rule. It states;** that when the thumb, the first finger and the second finger of the left hand are held at right angles to each other with the first finger pointing in the direction of the field and the second finger pointing in the direction of the current, then the thumb points in the direction force (thrust).ie the direction in which the conductor moves.



The magnitude of the force on the current carrying conductor placed in a magnetic field is increased by;
(i) Increasing the current flowing in the conductor.
(ii) Using a stronger magnetic field
(iii) Increasing the length of the conductor lying in the magnetic field.

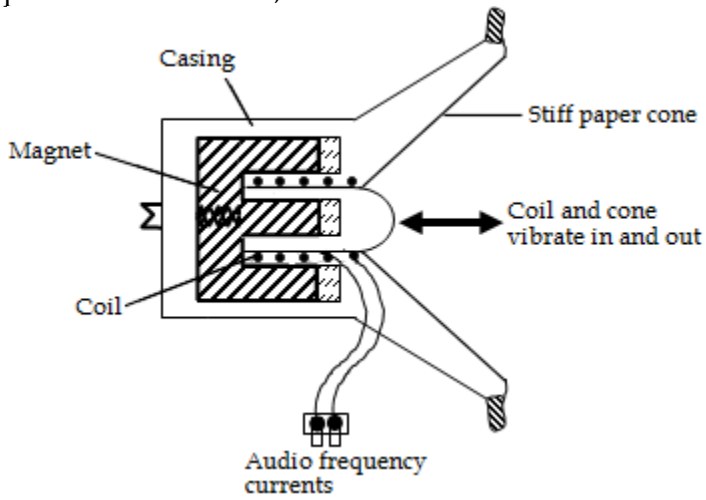
Applications of Force on a Current Carrying Conductor in Magnetic Field
(i) Moving coil loud speaker
(ii) Direct current motor (D.C motor)
(iii) Moving coil galvanometer

Question
A bare copper wire AB lies horizontally over fixed rails X and Y connected to a battery as shown in the diagram.
Rails X and Y are placed between the poles of a U-shaped magnet.



(a) Explain what happens to AB,
(i) When switch K is closed.
(ii) if two cells are used instead of one.
(b) Name the instruments which use the effect above.

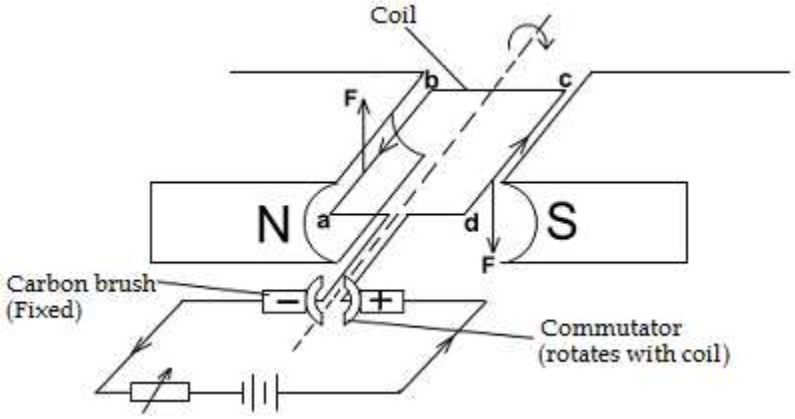
The Moving Coil Loud Speaker
This is a device which changes electrical energy into sound energy. It consists of a short coil whose turns are at right angles to the magnetic field of a magnet with a central pole and a surrounding ring pole as shown below;-



How a Loud Speaker Works (action)
- When a varying audio frequency current enters the coil placed in a radial magnetic field, a force acts on the coil which according to Fleming's left hand rule makes it move in and out (vibrate).
- A paper cone attached to the coil vibrates along with it and sets up sound waves in the surrounding air with the same frequency as the original sound that entered the amplifier.

The Direct Current Motor (D.C motor)

This is a device which converts electrical energy to mechanical energy (kinetic energy). It consists of a rectangular coil **abcd** of insulated copper wire which can rotate in a uniform magnetic field. The two ends of the coil are connected to a split ring commutator. It has two carbon brushes which press lightly on the commutator.



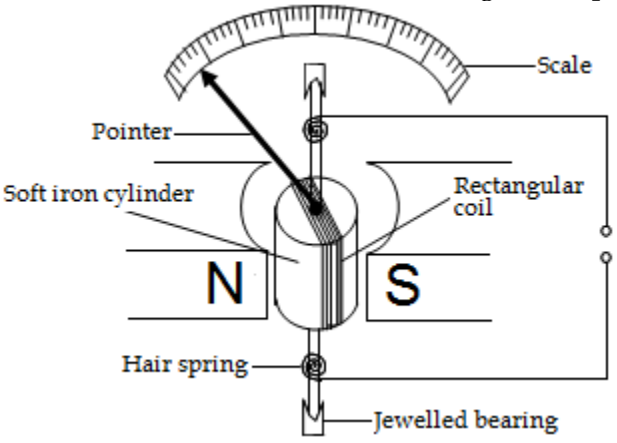
Mode of action (How it works)

- When current flows in the coil, according to Fleming's left hand rule side **ab** experiences an upward force while side **cd** experiences a downward force.
- The two equal but opposite forces on the sides make up a couple, which rotates the coil in the clockwise direction.
- When the coil reaches the vertical position, the carbon brushes loose contact with the commutator and current is cut off but the coil continues to rotate by its own inertia.
- Beyond the vertical position, the commutator exchanges contact with the carbon brushes and the direction of current in the coil is reversed. Therefore side **ab** now **downwards** while side **cd** moves **upwards**. Hence the coil continues to rotate in the clockwise direction

The Moving Coil Galvanometer

A moving coil galvanometer is an instrument which is used to detect and measure small currents or small p.ds in order of milliamperes (mA) millivolts (mV). It consists of rectangular coil of fine insulated copper wire pivoted on jewelled bearings between two concave poles of a permanent magnet.

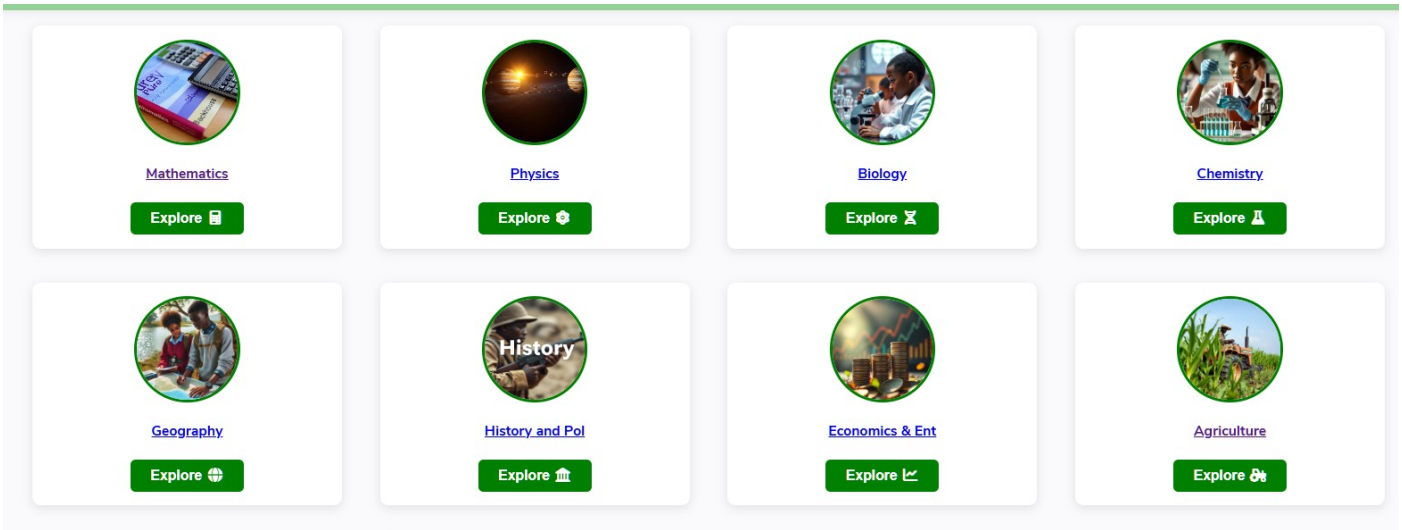
Current is connected to the coil through hair springs wound oppositely to provide a control couple.



Mode of action (How it Works)

- When current to be measured is passed through the coil, equal but opposite forces act on the vertical sides of the coil.

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