7. Magnetic Effect of Electric Current

Let us assess

1. Question

Current is passed from south to north through a conductor placed below a freely pivoted magnetic needle.

a) To which direction will the north pole of the magnetic needle turn?

b) Which is the rule used to arrive at this inference?

c) State the rule.

d) If the current flows in the conductor in the east west direction, what do you guess about the magnetic needle? Explain.

Answer

(a) If current is passed from south to north through a conductor placed below a freely pivoted magnetic needle, then the north pole of the magnetic needle will turn towards the east.

(b) Fleming’s Left-Hand Rule

(c) According to **Fleming's left-hand rule**, if the thumb, fore-finger and middle finger of the left hand are stretched to be perpendicular to each other as shown in the illustration at left, and if the fore finger represents the direction of magnetic field, the middle finger represents the direction of current, then the thumb represents the direction of force.

(d) By applying Right hand thumb rule we get that, when current is flowing in east- west direction then the magnetic needle will be deflected towards north direction.

2. Question

How will you determine the polarity when current is passed through a solenoid? Suggest methods for increasing the strength of the magnetic field around a current carrying solenoid.

Answer

The polarity when current is passed through a solenoid can be determined by clock rule.

According to the clock rule, if we find that in a coil the current is flowing in anti-clock wise direction then the face of the coil will behave like the north pole while; if the current is flowing in clock wise direction then the face of the coil will behave like the south pole.

The strength of the field can be increased by:

a) Increasing the number of turns per meter of the solenoid

b) Increasing the current through it.

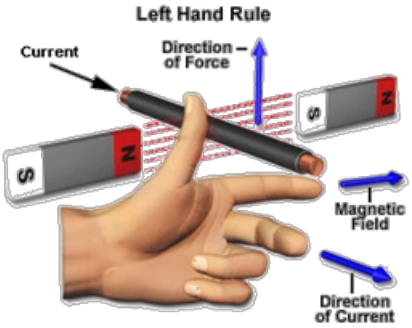
3. Question

State the Motor Rule. If the directions of current in the conductor and the magnetic field are the same, in which way will the conductor move?

Answer

The motor rule is also known as the **Fleming's left-hand rule.**

According to **Fleming's left-hand rule**, if the thumb, fore-finger and middle finger of the left hand are stretched to be perpendicular to each other as shown in the illustration at left, and if the fore finger represents the direction of magnetic field, the middle finger represents the direction of current, then the thumb represents the direction of force.

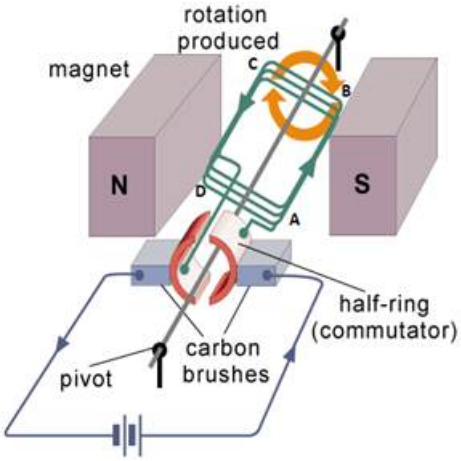


Extended activities

1. Question

Construct a simple DC motor and show its working.

Answer



Construction: A simple DC motor consists of:

•two magnets one having its north pole facing the south pole of other

•one armature coil (ABCD)

•two split rings (half rings)

•two carbon brushes

•dc supply.

1. The magnets are placed so to produce uniform magnetic field inside the region between them.

2. The two ends of the coil are connected to two split rings which are supported by carbon brushes as shown above.

3. The two carbon brushes are then connected to dc supply with connecting wires.

4. The setup including armature coil and split rings is pivoted onto a rotational axis.

Working:

1. Initially the rotating coil is in horizontal alignment and the magnetic field is always in direction N→S.

2. When the circuit is closed the current start flowing, taking positive charge in account, initially the current is flowing in direction A→B, B→C, C→D.

3. By applying Fleming's left-hand rule to arm AB where current is in perpendicular direction to present magnetic field, we get that AB experiences force downwards. Similarly arm CD suffers an upward force. So, the coil start rotating in clockwise direction.

4. At instant when the plane of coil is perpendicular to plane of magnetic field the slip rings changes their contact with carbon brush (Slip ring which was connected to left carbon brush get connected to right one and vice versa). Due to this current flows from A→B in arm AB and from D→C in arm CD.

5. Now, by Fleming’s left-hand rule AB suffers upward force and CD suffers downward force but, still coil rotating in clockwise direction.

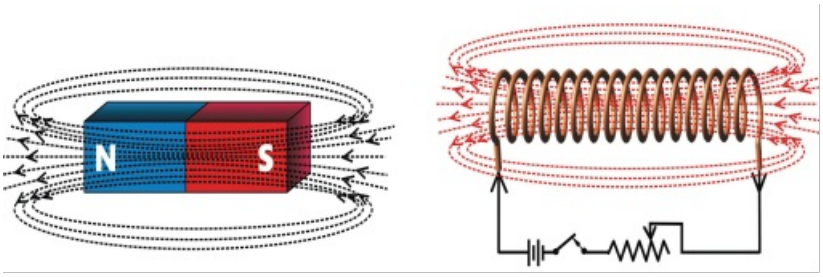
6. This happens for the next half cycle when again the plane of coil is perpendicular to the direction of magnetic field. The direction of current reverses.

7. The process continues and coil rotates continuously.

2. Question

Draw the lines of force around a solenoid and exhibit it.

Answer

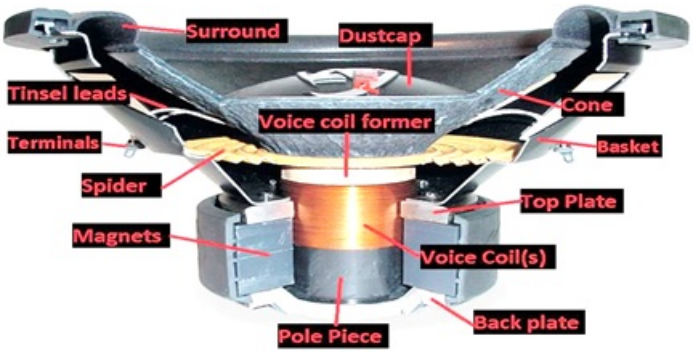


3. Question

Dismantle the parts of a loudspeaker that is defunct and arrange them on a sheet of paper one by one and exhibit. What is the reason for its voice coil being very thin?

Answer

The parts of loudspeaker are given below:



The reason for the voice coil being very thin is to accurately reproduce high-frequency sounds without being damped too much by inertia.

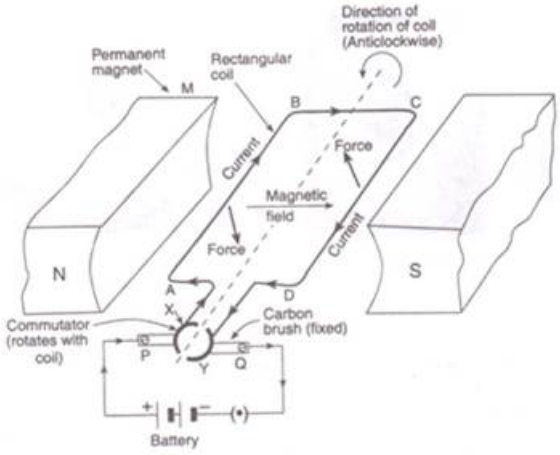
4. Question

Draw a diagram of the structure of an electric motor, mark its parts and exhibit.

Answer

When armature windings are connected to a DC supply, current sets up in the winding. Magnetic field may be provided by field winding (electromagnetism) or by using permanent magnets. In this case, current carrying armature conductors experience force due to the magnetic field, according to the principle stated above.

Commutator is made segmented to achieve unidirectional torque. Otherwise, the direction of force would have reversed every time when the direction of movement of conductor is reversed the magnetic field.


Direction of rotation of coil (Anticlockwise)
Permanent magnet
M
Rectangular coil
B
C
Current
Force
Magnetic field
Force
Current
N
S
A
D
X
Commutator (rotates with coil)
Carbon brush (fixed)
P
Y
Q
+
−
Battery