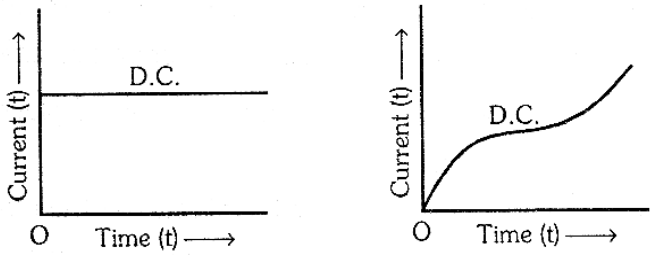
MAGNETIC EFFECT OF ELECTRIC CURRENT
Electric Current

DIRECT AND ALTERNATING CURRENT

DIRECT CURRENT (D.C.) :

A current which has a constant magnitude and same direction, is called a direct current

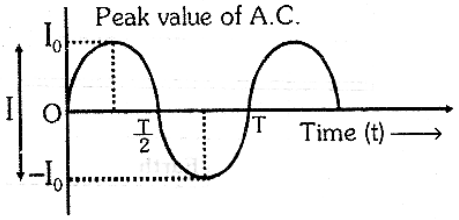
Current due to a cell or a battery is a direct current.



ALTERNATING CURRENT (A.C.) :

A current which changes in magnitude and direction at regular intervals of time is called an alternating current . The frequency of household supply of a.c. in India is 50 Hz. This means, a.c. completes 50 cycles in one second. Thus, a.c. changes direction after every $\frac{1}{100}$ second. In other words, a.c. used in India changes direction 100 times in one second.

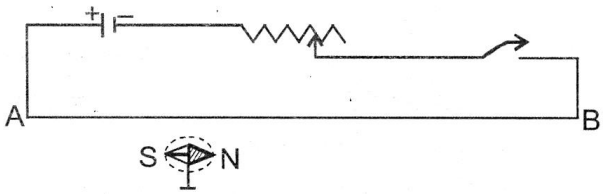
Current changes direction after each rotation of the coil.



MAGNETIC EFFECT OF CURRENT:

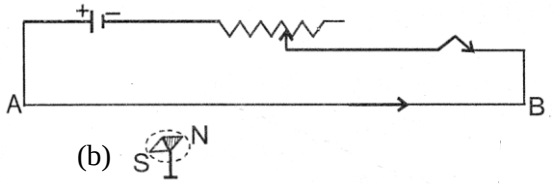
Hans Oersted, in 1820, first discovered that when an electric current is passed through a conducting wire, a magnetic field is produced around it. If a compass needle is kept in the vicinity of the current carrying wire, the needle is found to deflect in a definite direction. If the direction of current in the wire is reversed, Then the direction of deflection of the needle is reversed.

AB is a wire lying in the north-south direction and connected to a battery through a rheostat and a tapping key. A compass needle is kept just below the wire. When the key is open i.e. no current is passed through the wire, the needle shows no deflection and points in the N-S direction (i.e., remains parallel to the wire) as shown in figure(a).

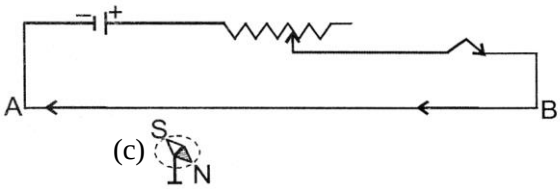


(a)

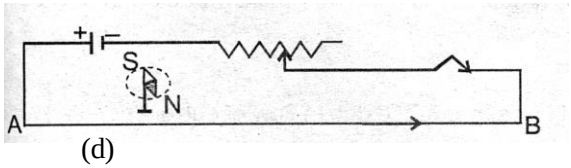
When the key is pressed and current passes in the wire in the direction A to B (i.e. from south to north and the north pole (**N**) of the needle deflects towards the west as figure (b). Thus a current (or moving charge) produces a magnetic field. When the direction of current in the wire is reversed by reversing the terminals of the batter, the north pole of the needle deflects towards the east as figure(c).



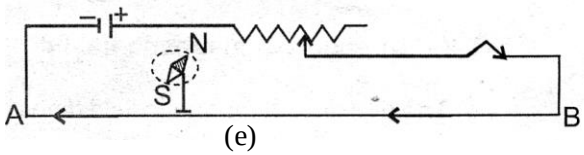
(b)



(c)



(d)



(e)

NOTE: If the compass needle is kept just above the wire, the deflection will be as shown in figure (d) and (e) for the direction (e) for the direction of current from A to B and from B to A respectively.

AC Generator or Dynamo :

When a coil (conductor) is rotated in a magnetic field, the magnetic flux linked with it changes and therefore an alternating e.m.f. is induced in the coil.

Construction: The main parts of dynamo are :-

(i) Field magnet : It is a strong horse shoe permanent magnet. An electromagnet run by a DC source can also be used for high power generators.

(ii) Armature: It is a soft iron core on which a coil ABCD having a large number of turns of insulated copper wire is wound. This armature (or coil) is rotated rapidly in the magnetic field between the poles of the magnet.

(iii) Slip rings : The ends of the armature (or the coil) are connected to two coaxial metallic slip rings S_1 and S_2 which rotate along with the coil.

(iv) Brushes : Two brushes B_1 and B_2 made of carbon, press against the slip rings S_1 and S_2 respectively. The external circuit (i.e. load) is connected between the other ends of brushed. The brushed B_1 and B_2 do not rotate along with the coil.

Working of an AC generator:

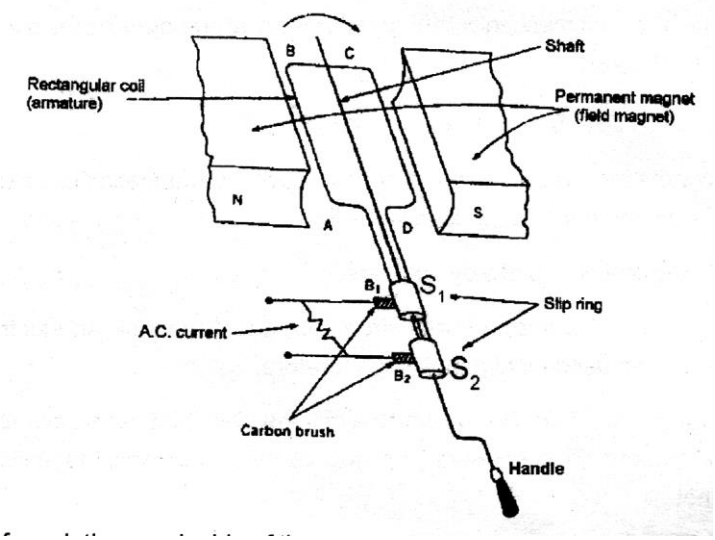
Suppose that the generator coil ABCD is initially in the horizontal position. Again suppose that the coil ABCD is being rotated in the anticlockwise direction between the poles N and S of a horse-shoe type magnet.

(i) As the coil rotates in the anticlockwise direction, the side AB of the coil moves down cutting the magnetic lines of force near the N- pole of the magnet and side CD moves up, cutting the lines of force near the S-pole of the magnet. Due to this induced current is produced in the side AB and DC of the coil. On applying Fleming's right-hand rule to the sides AB and DC of the coil, we find that the currents are in the directions B to A and D to C. Thus, the induced currents in the two sides of the coil are in the same direction and we get an effective induced current in the direction BADC.

(ii) After half revolution, the sides AB and DC of the coil will interchange their positions. The side AB will come on the right hand side and side DC will come on the left hand side. So, after half a revolution, side AB starts moving up and side DC starts moving down. As a result of this, the direction of induced current in each side of the coil is reversed after half revolution. Since the direction of induced current in the coil is reversed after half revolution so that polarity (positive and negative) of the two ends of the coil also changes after half revolution.

The end of coil which was positive in the first half of rotation becomes negative in the second half. And the end which was negative in the first-half revolution becomes positive in the second half of revolution. Thus, in 1 revolution of the coil, the current changes its direction 2 times.

The alternating current (**AC**) produced in India has a frequency of 50 Hz. That is, the coil is rotated at the rate of 50 revolutions per second. Since in 1 revolution of coil, the current changes its direction 2 times, so in 50 revolutions of coil, the current changes its direction $2 \times 50 = 100$ times. Thus, the AC supply in India changes its direction 100 times in 1 second. Another way of saying this is the alternating current produced in India changes its direction every 1/100 second. That is, each terminal of the coil is positive (+) for 1/100 of a second and negative (-) for the next 1/100 of a second.



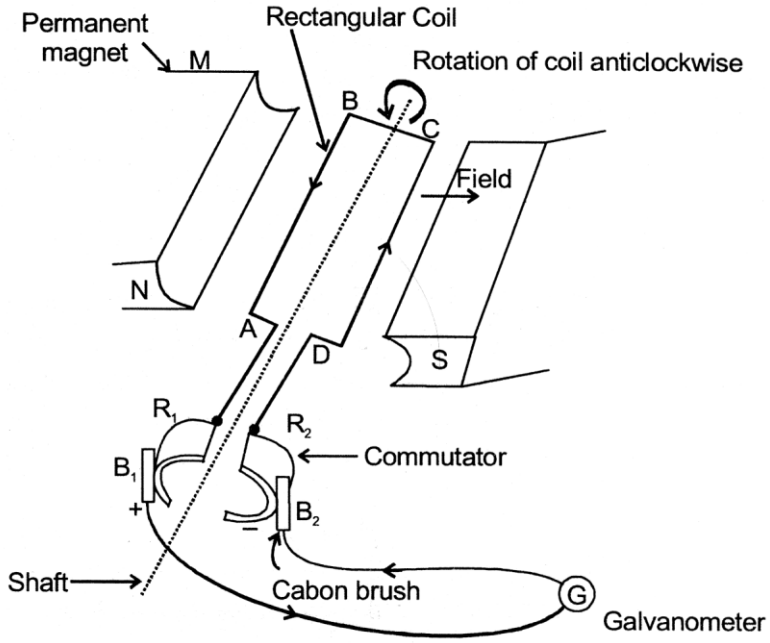
After every half revolution, each side of the generator coil starts moving in the opposite direction in the magnetic field. The side of the coil which was initially moving upwards, after half revolution, it starts moving downwards. Due to the change in the direction of motion of the two sided of the coil in the magnetic field every half revolution, the direction of current produced in them also changes after every half revolution.

(b) DC Generator (or DC Dynamo) :

"DC generator" means "Direction Current generator". That is, a DC generator produces direct current

Construction of a DC Generator:

A simple DC generator consists of a rectangular coil ABCD which can be rotated rapidly between the poles north and south of a strong horse-shoe type magnet M.
The generator coil is made of a large number of turns of insulated copper wire. The two ends of the coil are connected to the two copper half rings (or split rings) R_1 and R_2 commutator. There are two carbon brushes B_1 and B_2 which press lightly against the two half rings. When the coil is rotated, the two half rings R_1 and R_2 touch the two carbon brushes B_2 and B_2 one by one. So, the current produced in the rotating coil can be tapped out through the commulator half rings into the carbon brushes. From the carbon brusher B_1 and B_2. we can take the current into the various electrical appliances like radio, T.V., electric iron, bulbs, etc.



D.C. Genetator (or D.C. Dynamo)

Working of a DC generator:

Suppose that the generator coil ABCD is initial in the horizontal position. Again suppose that the coil ABCD is being rotated in the anticlockwise in the anticlockwise direction between the poles N and S of a horse-shoe type magnet.

(i) As the coil rotates in the anticlockwise direction, the side AB of the coil move down cutting the magnetic lines of force near the N-pole of the magnet and side DC moves up, cutting the lines of force near the S-pole of the magnet in figure. Due to this, induced current is produces in the sides AB and DC of the coil. On applying Fleming's right-hand rule to the sides AB and DC of the coil we find that the currents in them are in the directions B to A and to C respectively. Thus, we get an effective induced current in the direction BADC. Due to this the brush B_1 becomes a positive (+) pole and brush B_2 becomes negative (-) pole of the generator.

(ii) After half revolution the sides AB and DC of the coil will interchange their positions. The side AB will come on the right hand side and start moving up whereas side DC will come on the left-hand side and start moving down. But when sides of the coil interchange their position, then the two commutator half rings R_1 and R_2 automatically change their contacts from one carbon brush to the other. Due to this change, the current keeps flowing in the same direction in the circuit. Te brush B_1 will always remain positive terminal and brush B_2 will always remain negative terminal of the generator. Thus, a DC generator supplies a current in one direction by the use of a commutator consisting of two half-rings of copper.

Difference between a DC generator an AC generator:

In a DC generator we connect the two ends of the coil to a commutator consisting of two, half rings of copper. On the other hand, in an AC generator, we connect the two ends of the coil to two full rings of copper called slip rings.

Frequency: Frequency of A.C. is the number of cycles per second completed by the current.
One cycle is completed when the A.C. rises from zero to maximum positive then back to zero and then the maximum negative and zero again.

ADVANTAGES AND DISADVANTAGES OF A.C. OVER D.C.

A.C. has following merits (advantages) over D.C.:

1. A.C. can be transmitted over long distances without much loss of energy.
2. A.C. can be produced easily and cheaply than D.C.
3. A.C. voltage can be transformed to any desired value with the help of a transformer.
4. Transmission of A.C. at "high-voltage" and "low-current' reduces line losses.
5. A.C. motors or other A.C. appliances are easier to operate.
6. A.C. can easily by converted in D.C. when required.

A.C. has following demerits (disadvantages) over D.C.:

1. A.C. attracts a person who touches its line whereas D.C. gives a repelling shock.
2. A.C. gives a huge and sudden shock which becomes fatal.
3. A.C. is conducted over the surface of a conductor (skin effect).
   It increases effective resistance of the conductor.
4. Commercial generators do not produce pure A.C.
5. In certain applications like electroplating, battery charging etc. only D.C. is required.
6. A.C. is more dangers than D.C.

DOMESTIC ELECTRIC CIRCUITS

SUPPLY FROM POWER STATIONS: Electicity is generated at power station. In our homes, we receive the supply of electric power either supplied through overhead poles or underground cables using two thick aluminimum wires.

MAIN BOARD: It is provided outside the building under a covered poace (verandah or poarch). It contains the meter (energy-meter) and the main switch. (Fig.)
From the street electric pole, a thick rubber insulated cord reaches the main board. It constains two thick copper or aluminium wires, one covered with red and the other covered with black (or brown) poastic covering.

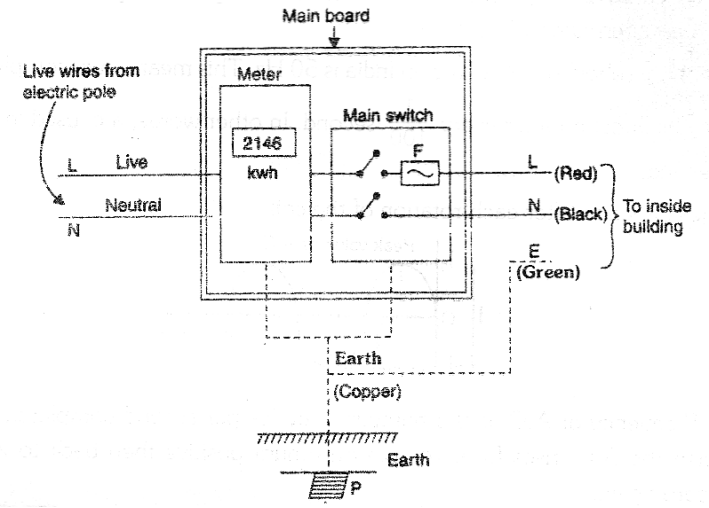


Fig . Main board outside the building

They form the liveline wire (L) and neutral line wire (N) respectively.
Live line wire has a potential or 220 V whereas the neutral wire has zero potential (with respect to the earth).
They enter the main board and are connected to the meter.
Wiring ahead is peocided by the house owner himself. These wires are also red black polastic covered.
From the meter the wires enter the main switch. In the main switch, a fuse F is provided in the path of live wire.
From outside the main switch, the wires become free to be used inside the building as required .
A third wire is a thick bare wire of copper. Called earth wire E. It is connected to an earth connection which consists of a thick copper plate P buried deep inside the moist earth.

INSIDE THE BUILDING: It is a well-known fact that inside the house, connections to all the devices are made in parallel, each having independent switch and fuse (if necessary). Thus, whenever some fault occurs in circuit of one particular device in one room, devices in other rooms do not suffer.

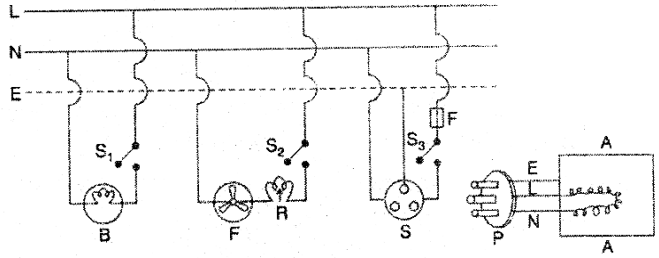


Fig. Circuit inside the building.

As shown in Fig., connection to low power devices like bulb B and fan F are made with lines N and L only, putting switch in line L. For devices of more power and with whom the body remains in contact (like electric press or refrigerator), we use connections through a 3 pin plug socket (shoe) system.

A three pin plug P and three pin socket S are shown in Fig. . The three points of the socket are connected to the three lines as shown in the diagram. A fuse F is also introduced to avoid damage to the appliance.

The three pin plug uses a three wire cord which has three plastic wires inside a single rubber insulating cover. The wires are colored : red, black (or brown) and green respectively to serve as an extension of live, neutral and earth wires for the appliance. The three wire are connected to there holes in the socket as shown in Fig. When the plug is inserted in the socket, proper lines get connected to the appliance.