AC & DC generators

Magnetism and electromagnetism

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Introduction

In this sub-topic we are going to discuss the working of **ac** and **dc** generators as an application of electromagnetism:

- Definition of a generator, motor, ac, and dc.
- Working of an ac generator.
- Working of a dc generator.
- Working of a dc motor.
- Summary
- Quiz

Generators

- A generator is an electrical device that converts mechanical energy into electrical energy.
- In a generator, the mechanical energy is usually provided by **steam turbines**, **gas turbines**, and **wind turbines**.
- We can group generators into two types, namely:
  - **AC** generator
  - **DC** generator
- **Note:** Generators are commonly called **electric** generators.

How a generator work

- In simple terms we can say that a generator works by rotating a coil of wire within the magnetic field of permanent magnets, thereby inducing electromotive force (voltage) in the coil by **electromagnetic induction**.
- The induced voltage is then carried to an external circuit.
- Modern day generators nearly provide all the power that is required for electric power grids.

DC Generators

- **DC** stands for **Direct Current**.
- This is a type of electrical current in which the **flow** of electric charge is **in one direction only**.
- In this type of electrical current, the charge **does not** reverse its direction of flow.
- Below are parts of a DC generator:
  a. Annular magnet
  b. Coil
  c. Commutator (Split-ring)
  d. Soft spring
  e. Carbon brush
- **Figure 1** shows an illustration of a DC generator.

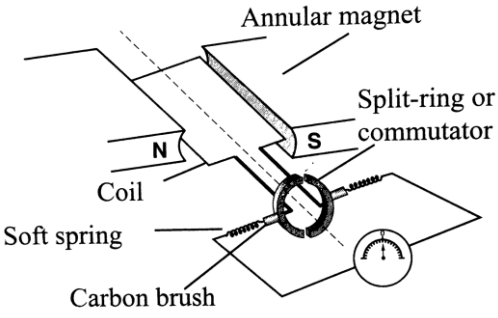

***Figure 1**: DC generator*

DC generator

- It is made up of a rectangular coil whose ends are connected to the two halves of split ring (commutator). The split ring makes contact with carbon brushes which connect to the external circuit.
- The carbon brushes are supported by two light springs respectively, making sure that the carbon brushes press lightly on the split ring.
- The magnets in a DC generator have annular shaped poles in order to concentrate the magnetic field lines on the coil.
- **Note:** a DC generator is also called a **dynamo**.

How a DC generator works

- As the coil rotates about its axis, it cuts across the magnetic field lines of the annular shaped permanent magnet, as such current is induced in the coil and it is indicated by the deflection of the connected galvanometer. (**Figure 1**)
- When the coil passes through its vertical position, the **two halves of the split ring change from one brush to another**, making sure that the flow of current in one (same) direction is maintained.

AC Generators

- AC stands for Alternating Current.
- This is a type of electrical current in which the flow of electric charge **periodically reverses its direction**.
- Below are parts of an AC generator.
  a. Annular magnets
  b. Two slip rings
  c. Coil
  d. Carbon brushes
  e. Soft springs
- **Figure 2** shows an illustration of an AC generator.

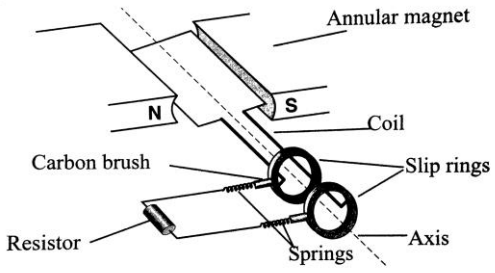

Figure 2: *AC generator.*

AC generator

- It is a modification of a DC generator, the only difference is the commutator.
- In this generator, the split rings are replaced by two separate slip rings attached to each end of the coil. (see **Figure 2**)
- An AC generator is also called an **alternator**.
- An AC generator is used in vehicles to produce the majority of the vehicle's electricity.
- **Figure 3** is a diagram of a real alternator.

How a AC generator works

- As the coil rotates about its axis, it cuts across the magnetic field lines of the annular shaped permanent magnet, as such current is induced in the coil.
- The direction of the current in the coil changes after every half rotation because each carbon brush remains on the same ring when the coil is rotating without changing positions.
- Below are links to video animation on how ac and dc generators:

https://www.youtube.com/watch?v=sAO9gYaMZkg

DC motor

- A motor is an electrical device that converts **electrical energy** into **mechanical energy**.
- The **input** electrical energy is **direct current**, hence the name DC motor.
- This direct current is transformed into **mechanical rotation** by motor.
- A DC motor has the same parts as a DC generator.
- **Figure 4** shows an illustration of a DC motor.

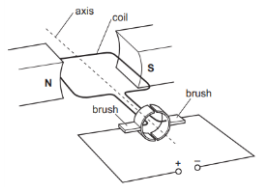

Figure 4: *DC motor*

How a DC motor works

- When current flows through the coil within the magnetic field of the motor's magnets, it creates a force called **motor effect**, causing the coil to start rotating, hence converting electrical energy into mechanical rotation.

Summary

AC Generator: Produces alternating current by rotating a coil of wire within a magnetic field, based on electromagnetic induction. Uses two separate spli-rings (commutators).

DC Generator: Generates direct current by rotating a coil of wire within a magnetic field and converting the induced alternating current to direct current using a commutator (split ring) and brushes.

DC Motor: Converts electrical energy into mechanical energy by creating a magnetic field as current flows through a the coil, that interacts with the magnetic field of the rotor, causing rotation of the coil. The direction and speed of the coil is controlled by regulating the magnitude of the current flowing in the conductor.

Quiz

1. What is an electric motor?**(1)**
2. Describe how a DC generator works. **(4)**
3. Give any difference between an AC generator and DC generator.**(2)**
4. Name any **two** uses of an AC generator . **(2)**
5. **Figure 0** below shows an illustration of a generator. Use it to answer questions that follow

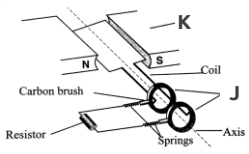

Figure 0

   a. Name the marked **J**. **(1)**
   b. Explain why part labelled K is shaped in such a way. **(2)**