SNS COLLEGE OF ENGINEERING

Kurumbapalayam (Po), Coimbatore – 641 107

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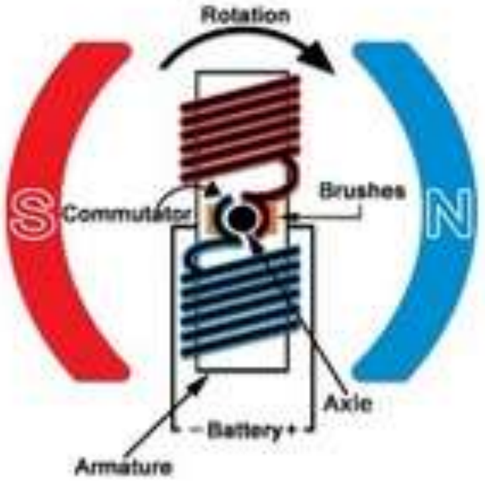
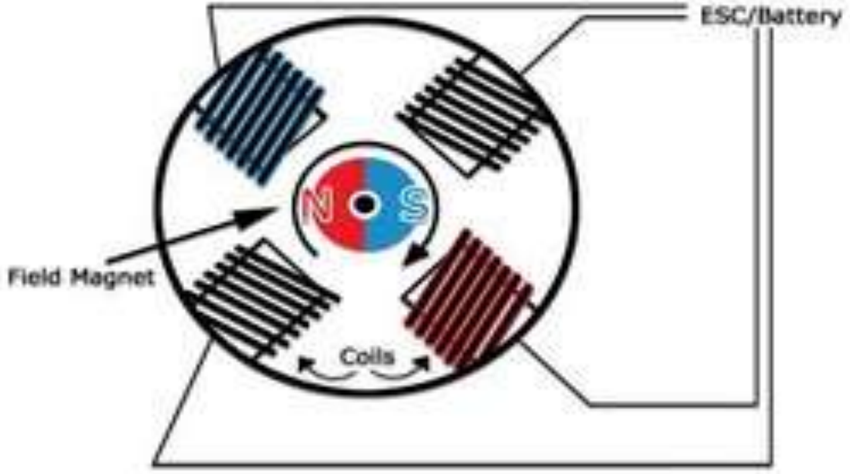
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

19EE504 - SPECIAL ELECTRICAL MACHINES
UNIT – 1
PERMANENT MAGNET BRUSHLESS DC MOTOR

Brushed DC Motor VS Brushless DC Motor





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- Construction of PMBLDC
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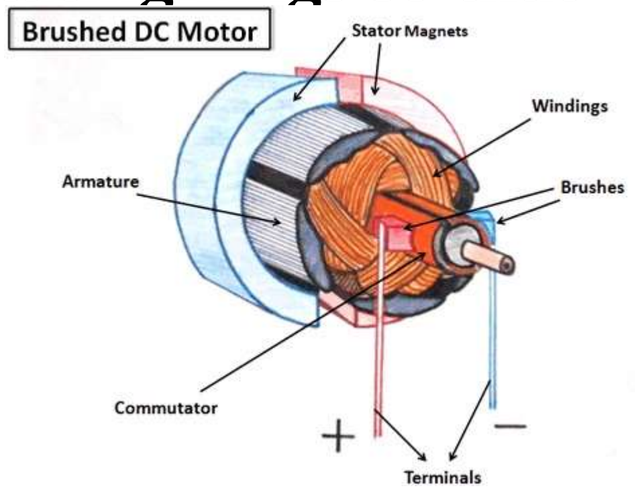
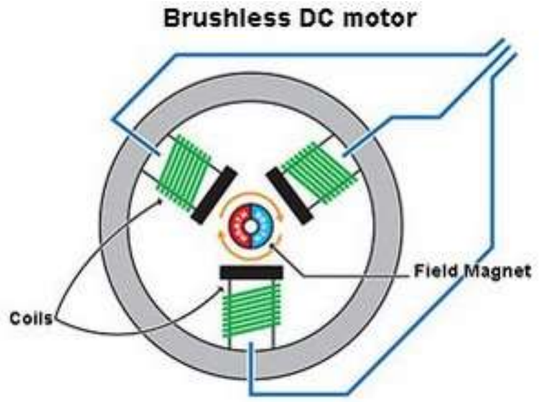
What is a Brush in a DC Motor?

- Invented by William Sturgeon in 1886.
- Brushes in an electric motor are mainly used to **transfer power between the rotating armature coils and stationary wires** to the rotor.
- It also helps to make a **contact with the rotating rings so that current can be supplied to the coil**.

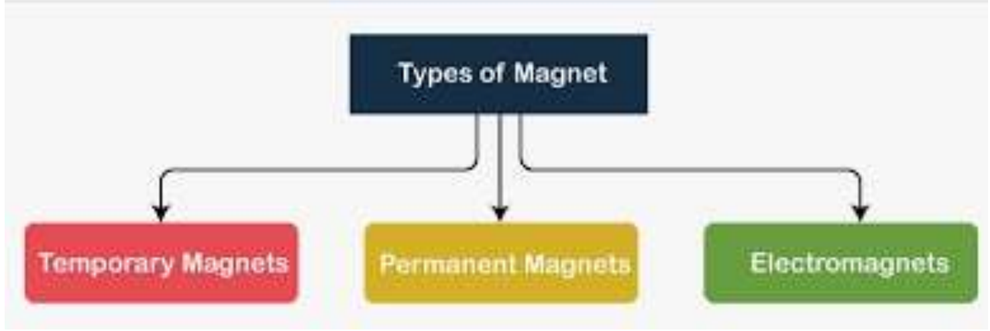


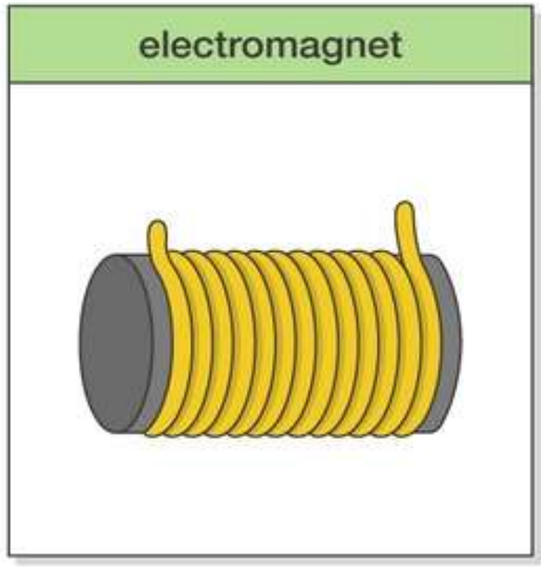
History of Brushless DC Motor

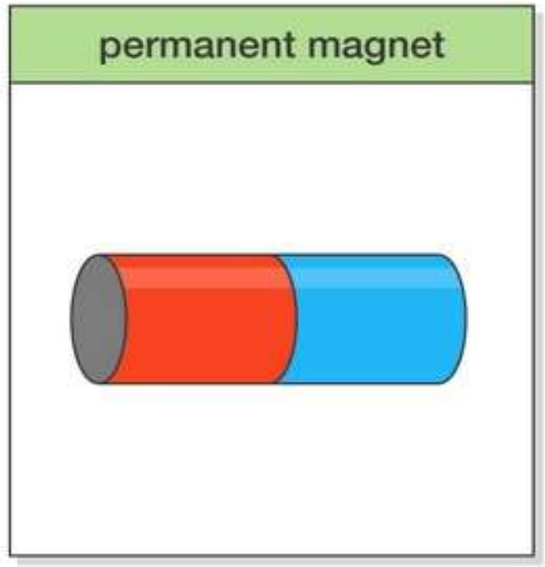
- Invented by **T.G.Wilson** and **P.H.Trickey** in 1962.
- Brushless DC motors operate on the same principle of magnetic attraction and repulsion as brush motors, but they are constructed somewhat differently.
- Instead of a mechanical commutator and brushes, the magnetic field of the stator is rotated by using **electronic commutation**.



Fundamentals of Magnets







Permanent Magnet vs. Electro Magnet

- Permanent magnet is always magnetic
- Retains properties even when it is not close to other magnets
- Strength cannot be changed

- Electromagnets can be turned on and off
- Produced by the electric current and magnetized core
- Strength can be hundreds or thousands of times larger than a permanent magnet and can be adjusted

Conventional DC Motor vs PMBLDC Motor

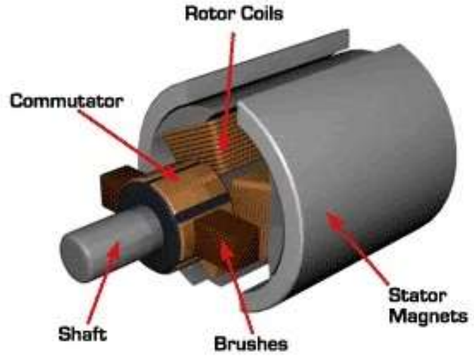
FEATURES	CONVENTIONAL DC MOTOR	PMBLDC MOTOR
Maintenance	High	low
Commutation method	Mechanical contact between brushes & commutator.	Electronic switching using power semiconductor devices ie, transistor,MOSFET
Detecting method	Automatically detected by brushes	Rotor position can be detected by using sensor ie, Hall sensor, optical sensor
controllable	Speed controllable is difficult	Speed can be easily controllable, so that it is possible to have very high speed

Construction of Permanent Magnet Brushless DC Motor

- Consists of two main parts Stator & Rotor.
- Stator is made of silicon steel stampings with slots.
- The slots are accommodated with armature windings.
- Windings are wound with specified number of poles (even number).
- This winding is connected with a dc supply through power electronic switching circuits.
- Rotor accommodates Permanent Magnet
- The rotor shaft carries rotor position sensor.
- Sensor provides information about the position of the shaft.
- The shaft position signal is send to electronic commutator.

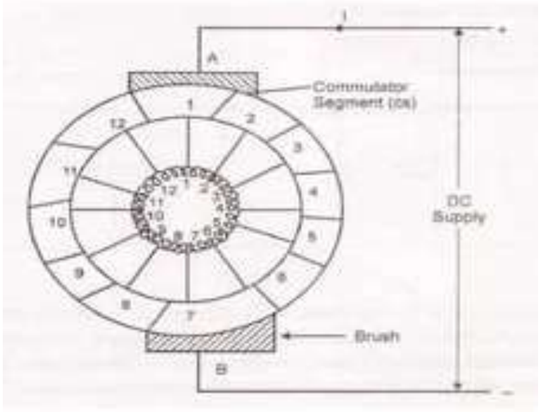
Commutation in DC motor

- The process of switching between the phases is called commutation.
- Two types
  - Mechanical Commutator
  - Electronic Commutator



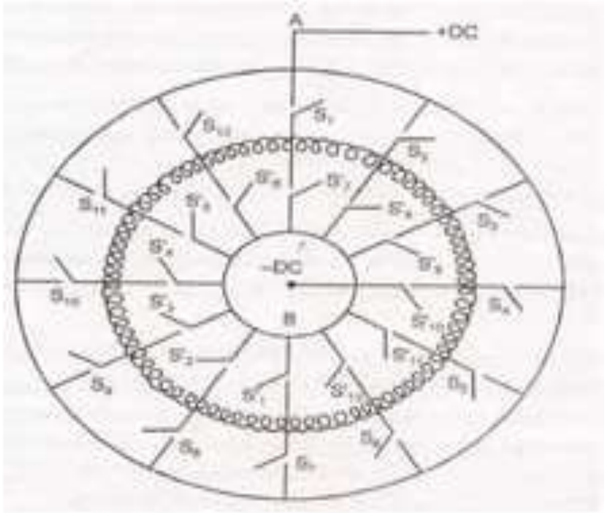
Mechanical Commutator

- It consists of 2 poles and 12 commutator segments.
- Carbon brush A contacts with CS1 and brush B contacts with CS7.
- When DC supply is connected across A&B.
- Current passes through 1-2-3-4-5-6-7 and
- 1-12-11-10-9-8-7



Electronic Commutator

- S1 & S1’ are closed and other switches are open, current have two parallel paths in the armature winding.
- Path 1 = 1-2-3-4-5-6-7
- Path 2 = 1-12-11-10-9-8-7
- Thus operating switches in the sequential manner magnetic field.



Mechanical Commutator vs Electronic Commutator

Mechanical commutator	Electronic commutator
Commutator is made up of commutator segments and mica insulation. brushes are made up of carbon.	Power electronics switching devices are used in the commutator.
Shaft position sensing is inherent in the arrangements.	It requires a separate rotor position sensor.
Commutator arrangement is located in the rotor	Commutator arrangement is located in the stator.
Sliding contact between commutator and brushes.	No sliding contacts.
Sparking takes place.	There is no sparking.
It requires a regular maintenance.	It requires less maintenance.
Number of commutator segments are very high.	Number of switching devices is limited to 6.
Difficult to control the voltage available across tapping	Voltage available across armature tappings can be controlled by PWM techniques.
Highly reliable	Reliability depends on the switching devices.

Principle of PMBLDC motor

"Whenever a current carrying conductor placed in a magnetic field it experiences a force"

"As a consequence of reaction force, the magnet will experience an equal and opposite force"

Operation of PMBLDC motor

STARTING

- When DC supply is given – the armature winding draws current.
- The current distribution with in the stator winding depends upon the rotor position.
- The perpendicular mmf is set .
- Then the armature conductors experience a force .
- The force develops a torque in the rotor.
- If this torque is more than the opposing frictional and load torque then motor starts.
- It is a self starting motor.

Operation of PMBLDC motor

- As the motor picks up speed , there exists a relative angular velocity between the permanent magnetic field and the armature conductors.
- An emf is dynamically induced.
- This back emf opposes the current and it is reduced.
- As a result the developed torque reduces .
- The rotor will attain a steady speed when developed torque is exactly equal to the opposing frictional torque.
- Thus the motor attains the steady state condition.

Video Links

- https://www.youtube.com/watch?v=WV2gul2SQNc
- https://www.youtube.com/watch?v=bCEiOnuODac

Thank you