UNIT-1

PERMANENT MAGNET BRUSHLESS DC MOTOR

INTRODUCTION:

BLDC motors are one of the motors gaining more popularity. These motors are used in industries such as

* Automotive
* Aerospace
* Medical
* Industrial automation equipment
* Instrumentation

BLDC motors do not use Brushes for commutation instead they are electronically commutated.

BLDC motors have many advantages over brushed DC motors and AC motors They are

* Better speed torque characteristics
* High efficiency
* High dynamic response
* Long operating life
* Noiseless operation
* High speed ranges.

Fundamentals of Permanent Magnet Motors

Motors using permanent magnets can be broadly classified as follows.

1) Conventional dc PM motors:

Whose armature, commutator and brushes are the same as that of a normal dc motor except that the field winding in the stator is replaced by PM.

2) PM BLDC Motors:

The construction is similar to a synchronous motor with armature windings in stator but whose field windings in the rotor is replaced by PM and the commutation of currents in the stator is carried out electronically.

PM materials used in these m/c's are:

* Different grades of Alnico (an alloy of aluminium), nickel, cobalt, iron.
  - ↳ Depending on the quality, they are graded as Alnico 5, Alnico 7, Alnico 9
  - ↳ The higher the number, the better the grade.

ie higher energy density $(BH)_{max}$ product.

* Ceramic (or) ferrite magnets:

↳ These have lower B_r but higher H_c.

↳ They are cheaper.

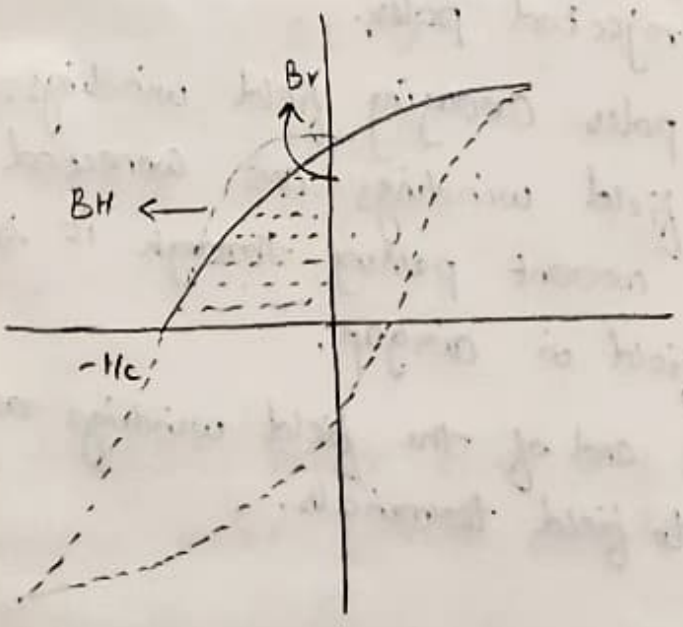
* Sumarium Cobalt (SmCo):

↳ These are high energy density magnets with large B_r and also high coercive force H_c.

* NdFeB magnets are alloy of Neodymium iron and Boron.

↳ These have so far the highest $(BH)_{max}$ product.

Magnetic characteristics.



Where B_r - flux density

H_c - Coercive magnetic force.

Evolution of PMBLDC Motor :-

Conventional dc Motor

↓

Permanent Magnet dc Motor

↓

Permanent Magnet brushless Dc Motor.

CONVENTIONAL DC MOTOR

It is an electro magnetic and electro dynamic equipment.

Stator

* Stator is made of forud steel with inward projected poles.
* The poles carrying field windings.
* The field windings are connected such that the current passing through it set up magnetic field in airgap.
* The end of the field windings are connected to field terminals.

Rotor.

* It is made up of silicon stampings with slots.

* The slots are accomodating the closed armature windings wound for same number of poles as the stator.

* Brushes are connected to terminals of armature.

PERMANENT MAGNET DC MOTOR.

The construction is similar to the conventional DC motor.

Difference: Stator poles are replaced by suitable permanent magnets.

* No need to have field windings.

Advantages.

↳ ∴ There is no field winding and so there is no field copper loss.

↳ Efficiency is higher.

↳ Size is small.

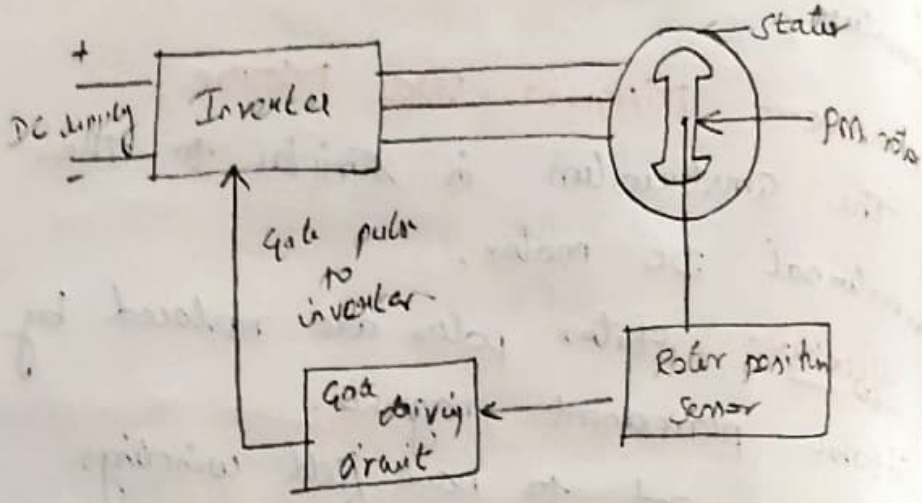
PERMANENT MAGNET BRUSHLESS DC MOTOR.

Introduction :-

* A BLDC motor is a poly phase synchronous motor with a permanent magnet rotor.

* This motor cannot operate without its electronic controller (or) electronic commutator.

* ∴ BLDC motor drive system that combined into one unit an AC motor, solid state inverter & rotor position sensor.



The inverter uses transistors, MOSFET for low power drives and thyristors for high power drives.

The RPS (rotor position sensor) monitors the shaft position and sends control signals for turning ON the control switches of the inverter in an appropriate sequence.

Stator

+ The construction is opposite to conventional DC motor.

* The stator is made up of silicon steel stampings with slots its inner surface.

* These slots are accommodated either in closed or open distributed armature winding.

* These windings are wound for a specified number of poles (even numbers).

* This winding is suitable connected to DC supply through a solid state inverter circuit.

Rotor:

* Rotor accomodates a permanent Magnet.

* The number of poles of rotor is same as that of stator.

* The rotor shaft carries a rotor position sensor. (RPS).

* This position sensor provides information about the position of the shaft to the Controller which sends signals to the electronic Commutator.

Advantages.

* No mechanical Commutator & Brushes
* It has longer life.
* Problems related to electromagnetic interface are minimized.
* It can run at higher speed.
* It is more efficient

Disadvantages

* Power Rating is restricted because of the maximum available size of PM.
* It requires a rotor position sensor.
* It requires power switching circuit

Applications

Textile industries

Computer & Robotics.

CONSTRUCTION OF COMMUTATOR.

* Commutator is made of specially designed commutator segments, made of Copper
* These segments are insulated from each other by a thin layer of mica.
* It forms a cylindrical shape.

Commutator & Brush Arrangements

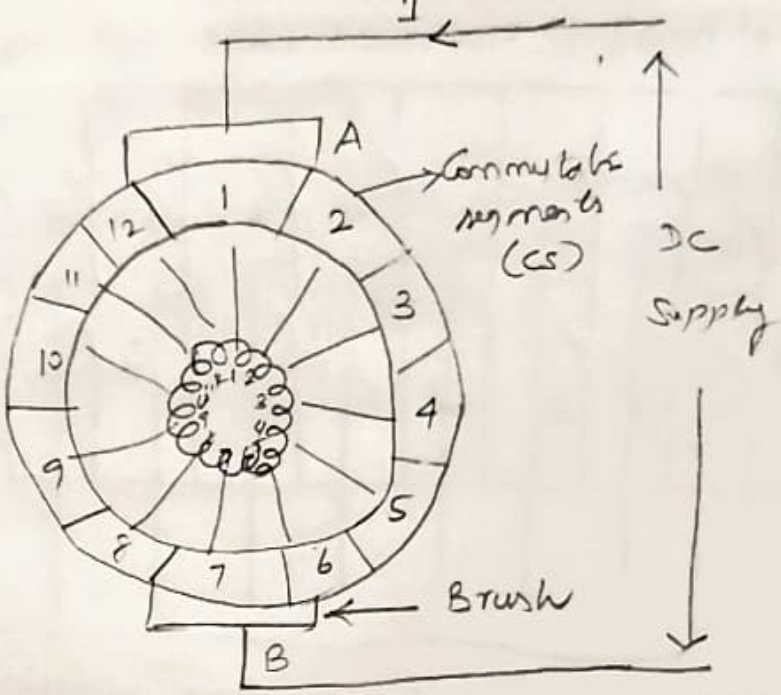
Two types of commutator.

↳ Mechanical commutator

↳ Electronic commutator.

Mechanical Commutator

Let us consider 2 pole machine with 12 commutator segments.

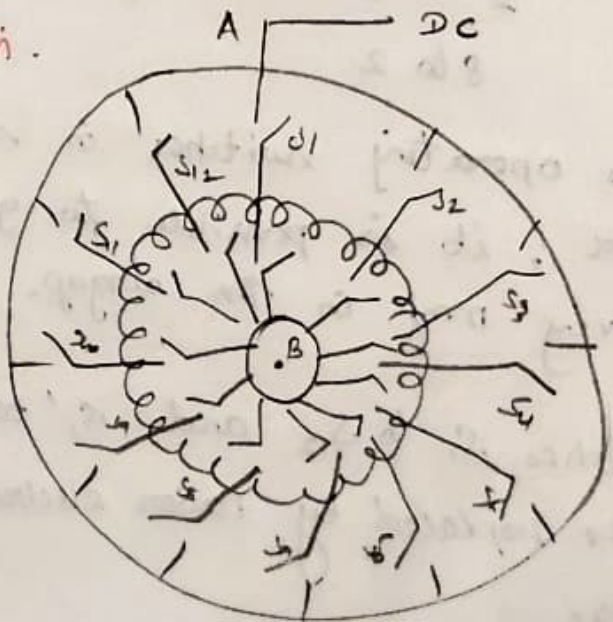


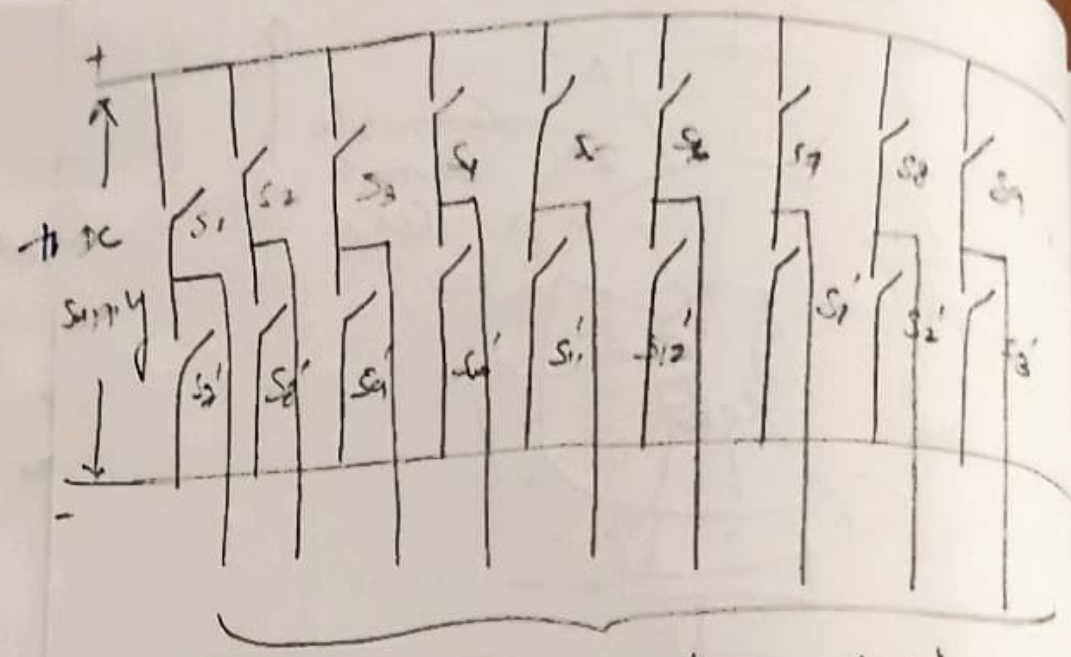
Let us consider, carbon brush 'A' Contacts with CS1 and brush B with CS7.

When dc supply is connected across A & B, a dc current passes through A CS1, tapping 1, tapping 7, CS7 & through B

Electronic Commutator

The function of Commutation is achieved through "Power semiconductor switching circuits" is known as Electronic Commutation.





→ When S_1 & S_1' are closed and others are in open position, the dc supply is given to tappings 1 and 7.

→ Now the current has two parallel paths 1, 2, 3, 4, 5, 6, 7 and 1, 12, 11, 10, 9, 8, 7

→ When S_2 & S_2' are closed:

2 to 8. sets up an mmf & 8 to 2.

→ Thus operating switches in sequence manner, it is possible to get a revolving mmf in the airgap.

→ Switches S_1 to S_{12} and S_1' to S_{12}' can be replaced by power electronic switches

→ Devices like SCR, MOSFET, IGBT's are used for switching.

→ The power semiconductor switches can be ON & OFF by information get in from Rotor position signals.