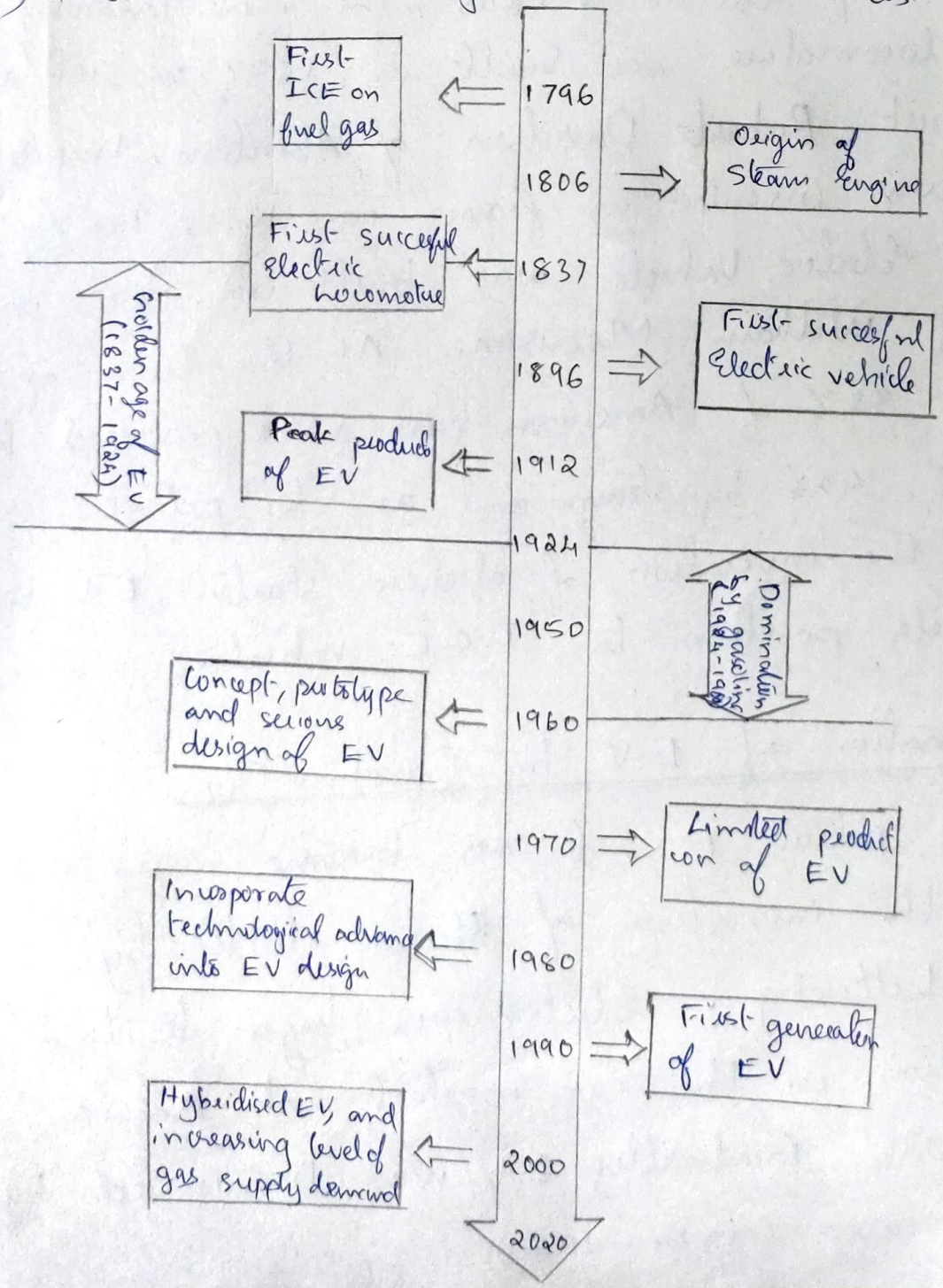
Assignment 1: Electric Vehicle Powertrains

1) Explain the journey of Automotive with the help of flow chart from the beginning of 18th century to the 21st century and give description on the following milestones in the Automotive journey.

a) Invention of Electric Motor b) Golden Era of EV

c) Domination of EV by Gasoline cars d) Coming of new era in EV

e) Introduction to Hybrid Electric vehicles.



a) Invention of Electric Motor

In 1828, the Hungarian inventor Anyos Jedlik, invented the World's first Electric Motor, and created a First small model car powered by his Electric motor.

b) Golden Era of E.V

The period from 1837 to 1924 is learned as the golden era of Electric Vehicles. The first known electric locomotive was built in 1837. in scotland by chemist Robert Davidson of Aberdeen. Improved battery was invented in France in 1881. The first successful Electric Vehicle was built in 1896 in the U.S by William Morrison. At the turn of the century 38% of American cars were powered by electricity, 40% by steam and 22% by petrol. Due to the invention of electric starter E.V began to lose its position to I.C.E vehicles.

c) Domination of E.V by Gasoline Cars.

In 1912, petrol powered cars became easier to drive due to the invention of Electric starter by Charles Kettering. Electric cars began to lose its position on the car market at America in 1920. Gradually E.V was Dominated by Gasoline cars. (1924 - 1960)

d) Coming of New Era in EV

The energy crisis in 21 century led to renewed interest in electric cars. A lot of small companies started to design and advertise electric cars to the public. Toyota offered its RAV-4 EVS in the year 2022 on 22nd of November.

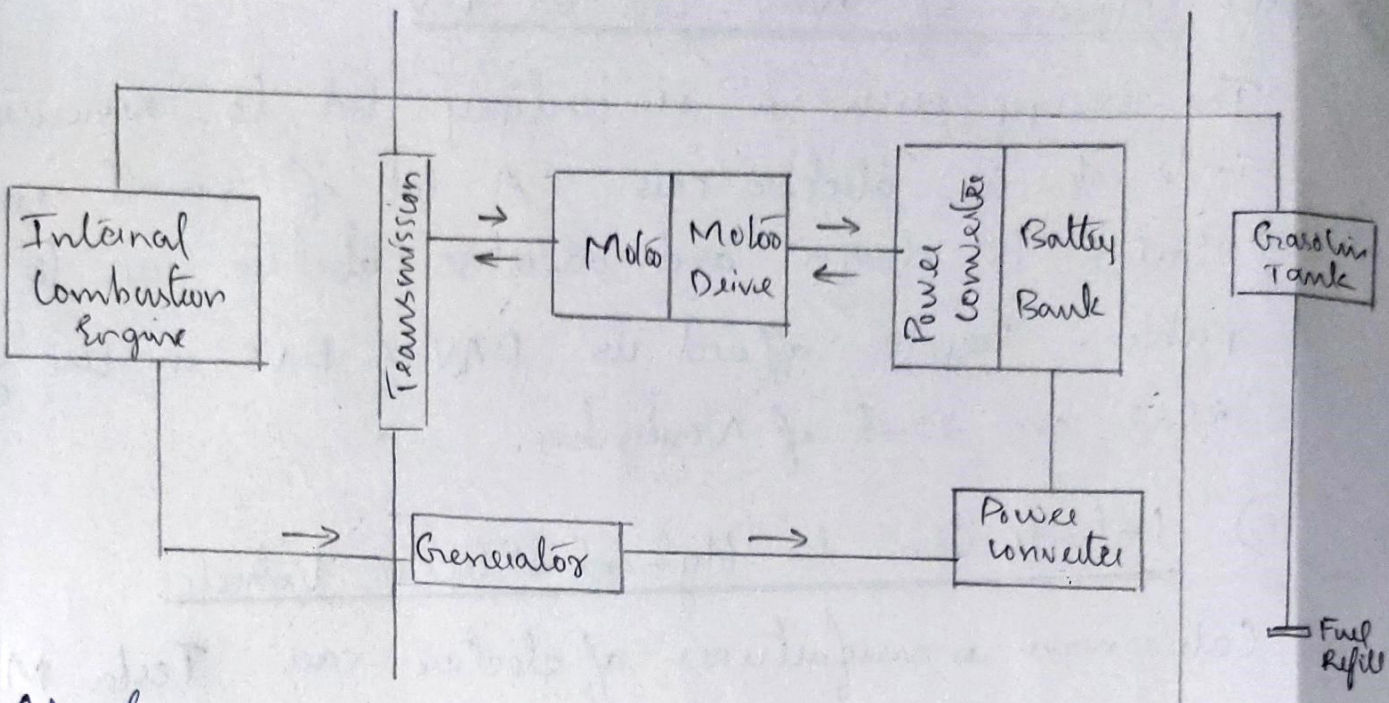
e) Introduction to Hybrid Electric Vehicles

Californian manufacturer of electric cars, Tesla Motors in 2004 started development of the Tesla Roadster model, which was first delivered to customers in 2008. Many MNC companies have taken the green initiative of making Hybrid Electric, Fully electric as well as Fuel Cell Electric vehicles.

2.) Explain and Draw the Layout of following HEV's with their two advantages, disadvantages and industrial application in automotive segment.

a) Series Hybrid Electric vehicles

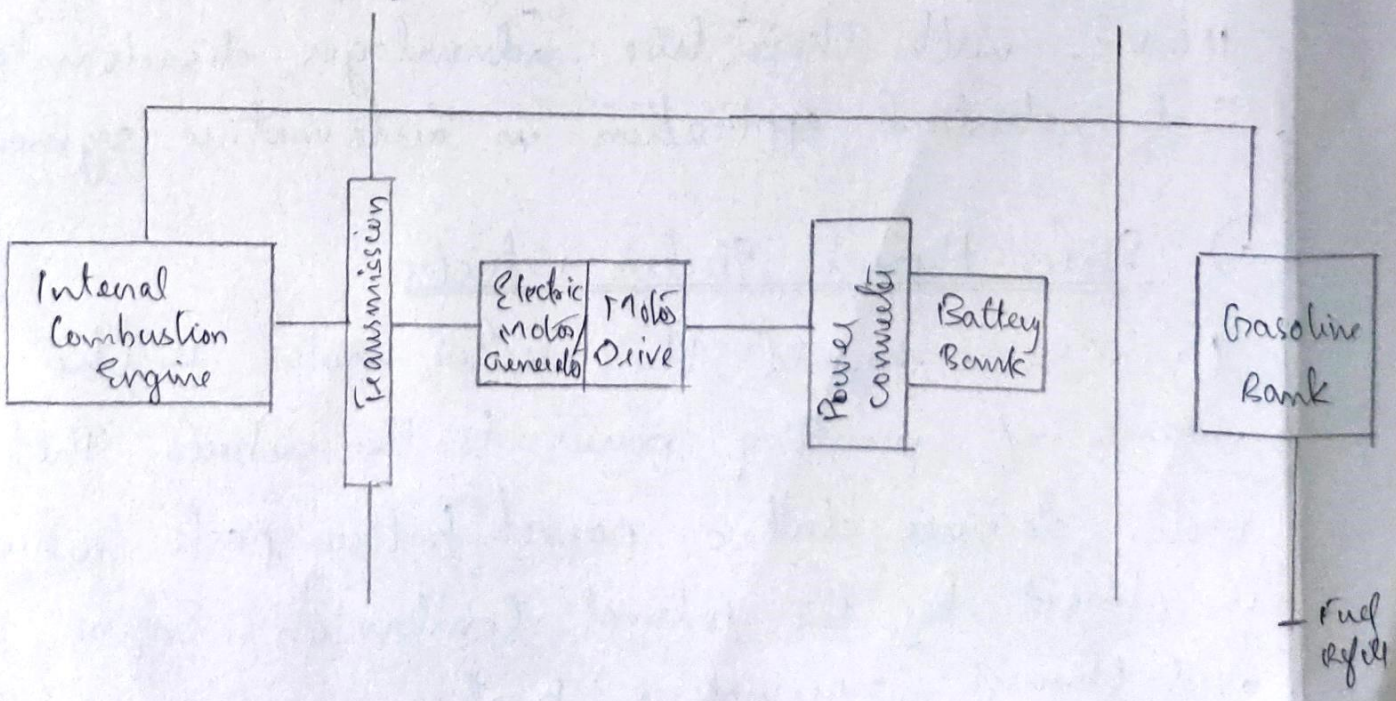
In a series hybrid, the electric motor is the only means of providing power to the wheels. The motor receives electric power from battery pack which is charged by the Internal Combustion Engine and through regenerative breaking.



Advantages : ① Mechanical decoupling between the ICE and and driven wheels allows the IC engine operating at its very narrow optimal region

② Nearly ideal torque-speed characteristics of electric make multi-gear transmission.

b) Parallel Hybrid Electric Vehicles



A parallel hybrid is propelled by both an Internal Combustion Engine (ICE) and an Electric motor connected to a mechanical transmission.

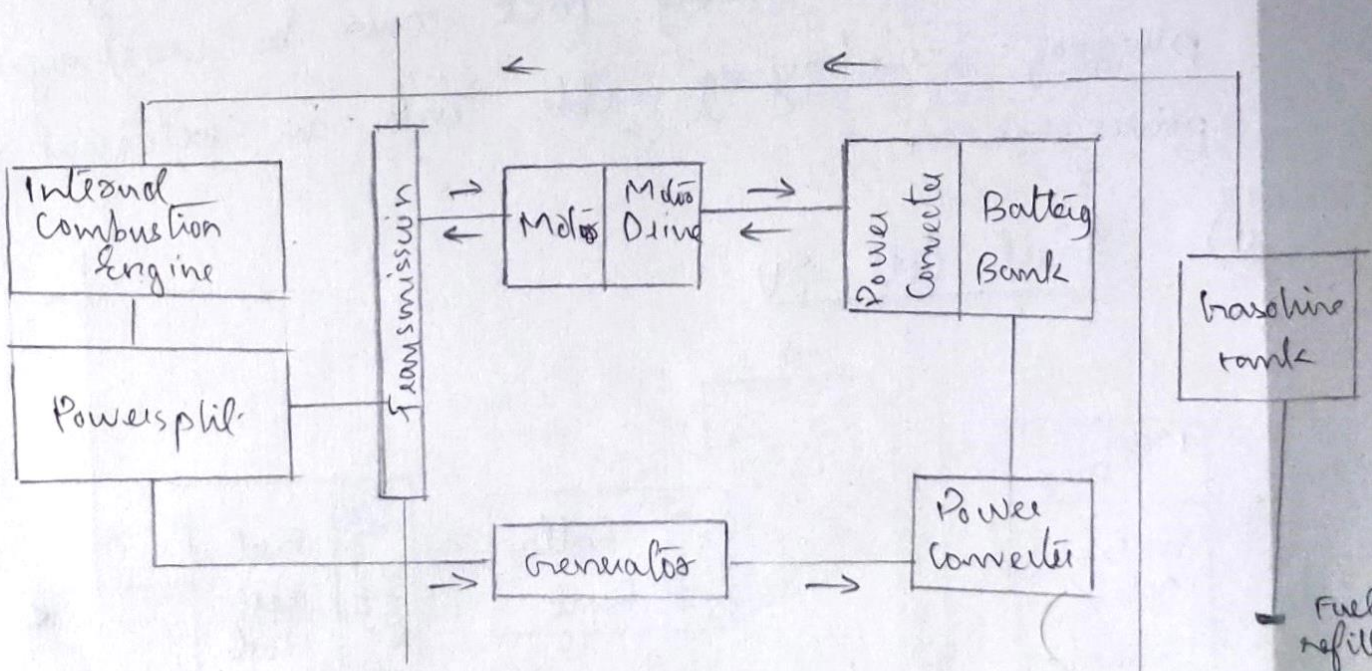
Advantages: ① Both engine and electric motor supply torques to the driven wheels, hence energy loss is less.

② Compactness due to no need of the generator and smaller traction motor.

Disadvantages ① The engine operating points cannot be fixed in a narrow speed region.

② The mechanical configuration and the control strategy are complex.

c) Series Parallel Hybrid vehicle

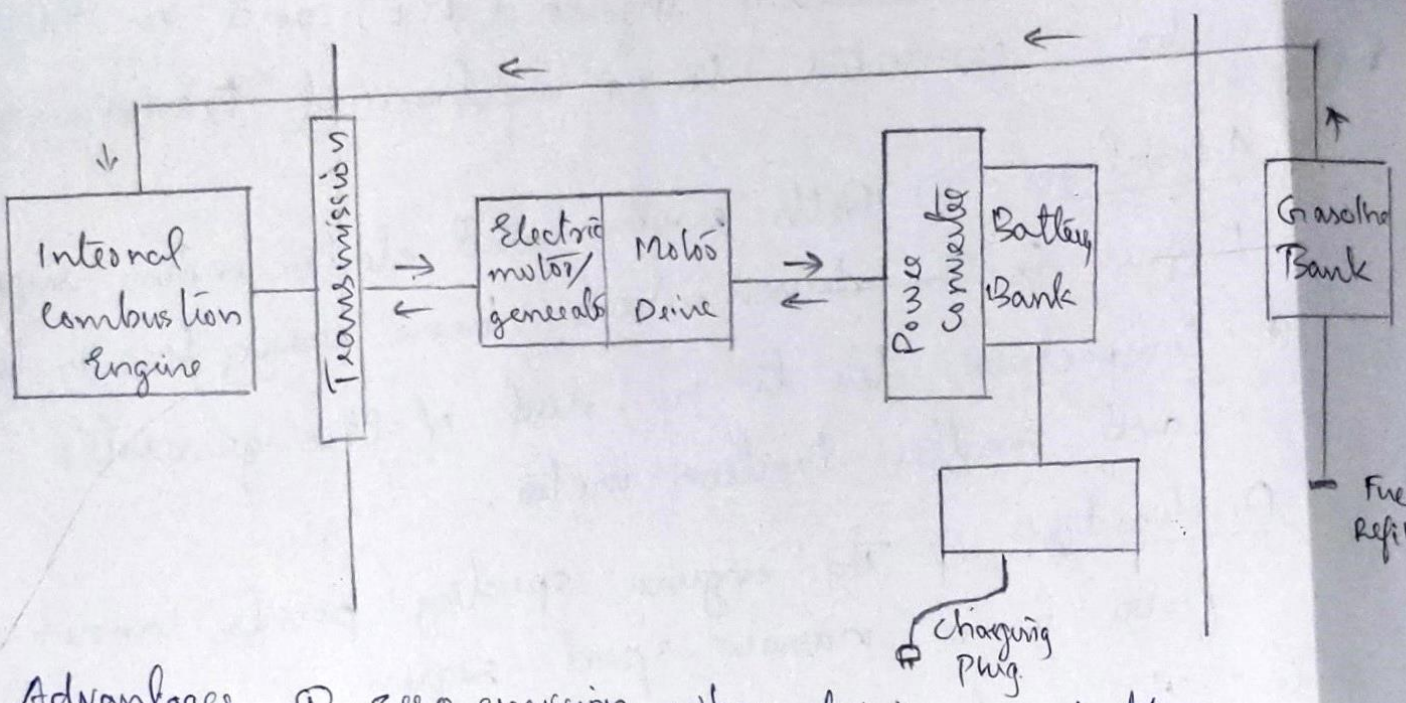


Advantages ① Have features of both series and parallel hybrid

② Many different modes of driving are possible.

Disadvantages ① Larger battery and motor with engine makes it costly and heavy.

d) Plug-in Hybrid Vehicle

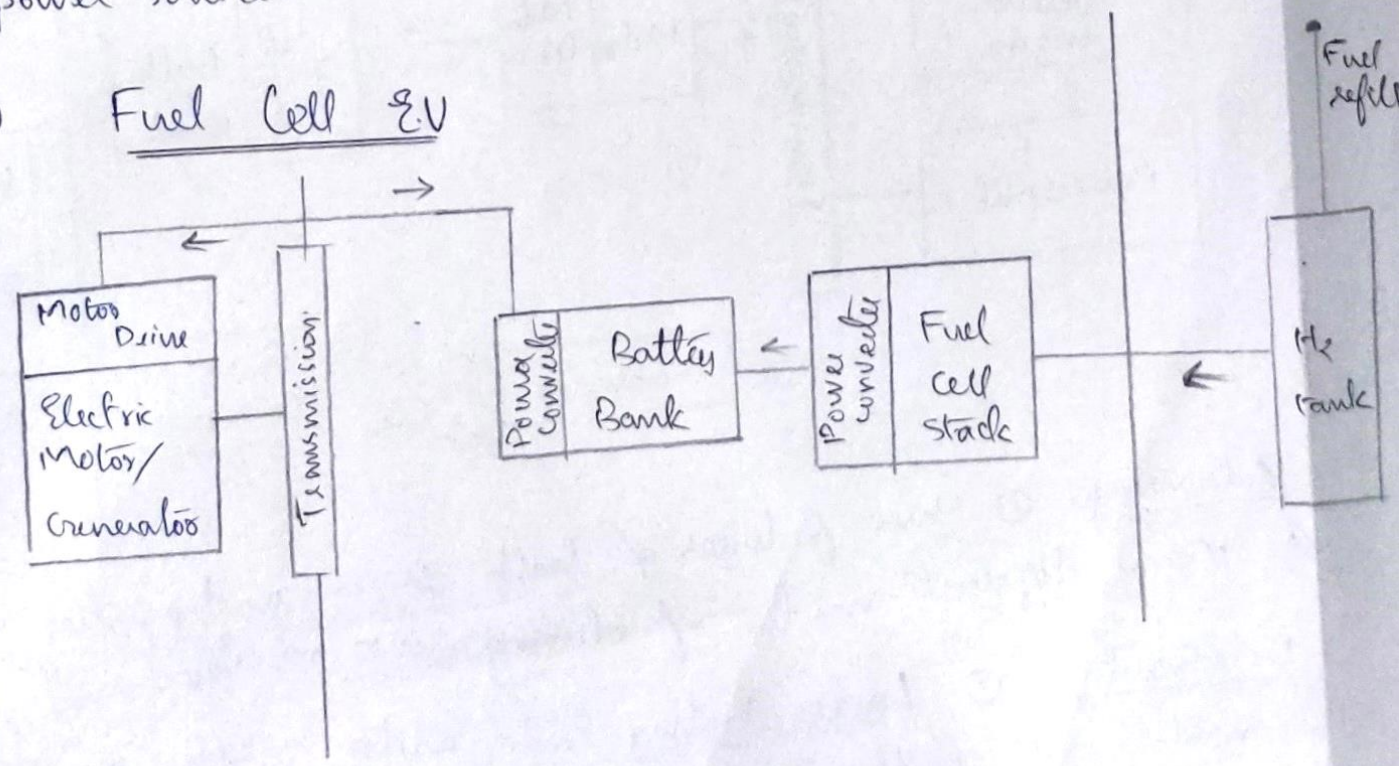


Advantages ① zero emission when driving on batteries ② Fuel efficient ③ Easy drivability

Disadvantages ① Relatively expensive, ② Battery life concerns.

Plug in hybrid electric vehicle is a hybrid electric vehicle whose battery pack can be recharged by plugging a charging cable into an external electric power source.

e) Fuel Cell E.V



Fuel Cell vehicle is an electric vehicle that uses a fuel cell, sometimes in combination with a small battery or super capacitor.

Advantages ① More efficient than conventional I.C engine vehicles

② No tailpipe emissions.

Disadvantages ① Hydrogen extraction ② Overall cost

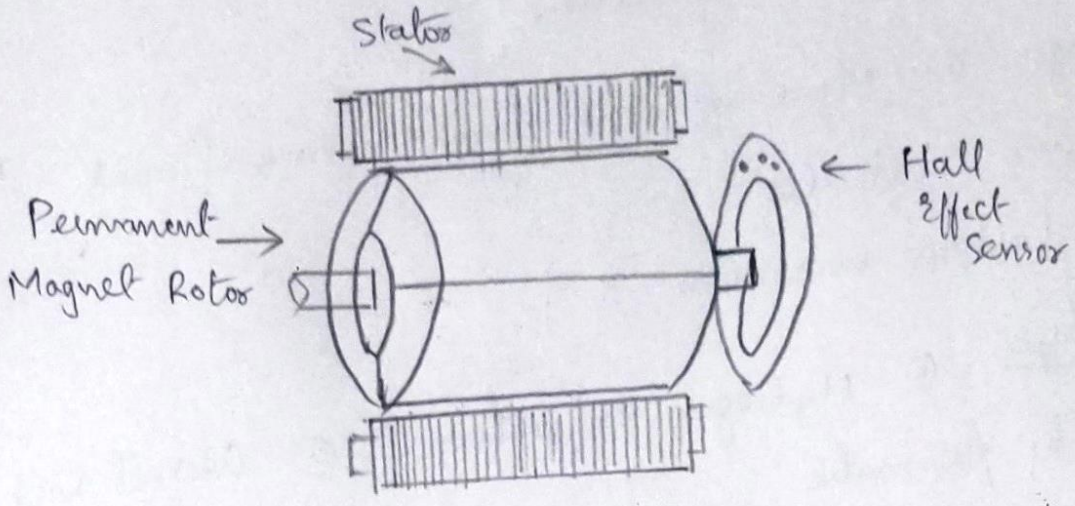
③ Highly flammable

3.) Explain with Diagram the Construction and Working principle of Brushless Motor BLDC.

Brushless DC motor (BLDC)

A brushless DC motor is a permanent magnet synchronous electric motor which is driven by direct current electricity and it accomplishes electronically controlled commutation system instead of a mechanically commutation system. BLDC motors are also refered as trapezoidal permanent magnet motors.

Construction of BLDC motor



Stator of a BLDC motor is made up of stacked steel laminations to carry the windings. These windings are placed in slots which are axially cut along the inner periphery of the stator. These windings can be arranged in either star or delta.

Each winding is constructed with numerous interconnected coils, where one or more coils are placed in each slot. In order to form an even number of poles, each of these windings are distributed over the stator periphery.

Rotor : BLDC motor incorporates a permanent magnet in the rotor. The number of poles in the rotor can vary from 2 to 8 pole pairs depending the application requirement.

Hall Sensors : Hall Sensor provides the information to synchronize stator armature excitation with rotor position.

Working Principle of BLDC Motor

BLDC motor works on the principle similar to that of a conventional DC motor, ie the Lorentz force law which states that 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. In case BLDC motor, the current carrying conductor is stationary while the permanent magnet moves.

When the stator coils are electrically switched by a supply source, it becomes electromagnet and starts producing the uniform field in the air gap. Though the source of supply is DC, switching makes to generate an AC voltage waveform with trapezoidal shape. Due to the force of interaction between electromagnet stator and permanent magnet rotor, the rotor continues to rotate.