

CHAPTER 4

SYNCHRONOUS MACHINE

11.1 INTRODUCTION

Synchronous machine are of two types

- (1) 3 phase synchronous motor (2) 3 phase synchronous generator

11.2 3 PHASE SYNCHRONOUS MOTOR

3 phase synchronous motor convert the 3 phase electrical energy into the mechanical energy.

Principle: 3 phase synchronous motor works on the principle of magnetic locking.

Construction: The constructions of 3 phase synchronous motor shown in fig. 11.1.

- (1) The stator of the synchronous motor consist a 3 phase winding.
 (2) The rotor of the synchronous motor is of salient pole type. It consist a winding.

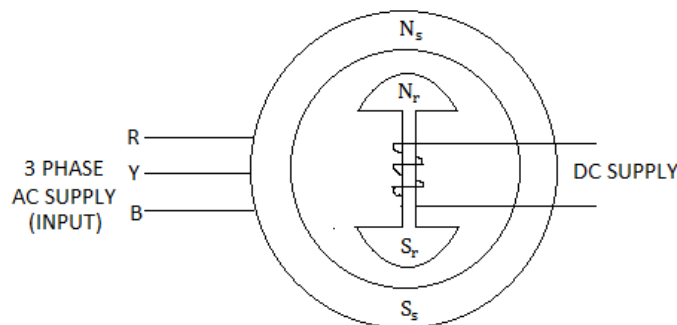


Fig. 11.1

Working: The working of the synchronous motor is as follow.

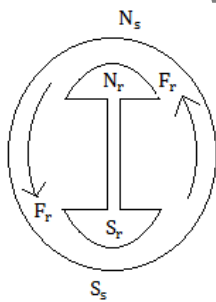


Fig. 11.2 (a)

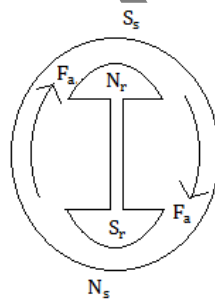


Fig. 11.2 (b)

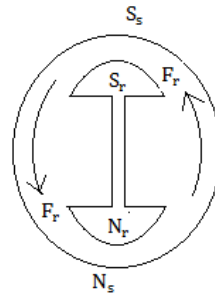


Fig. 11.2 (c)

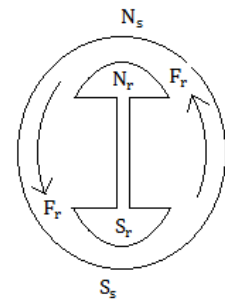


Fig. 11.2 (d)

- (1) A three phase supply given to the stator winding which produce a rotating magnetic field which is rotating by synchronous speed. The N_s and S_s are the North Pole and South Pole of the stator rotating magnetic field.
 (2) A DC supply is given to the rotor winding which produce a constant magnetic field. The N_r and S_r are the North Pole and South Pole of the rotor constant magnetic field.

- (3) At a particular time N_s coincides with N_r and S_s coincides with S_r as shown in fig. 11.2 (a). In this condition like poles of the stator and rotor coincides with each other. As we know like pole experience a repulsive force F_r . Assume the rotor start the rotate in the anti-clock wise direction.
- (4) After half cycle stator pole interchange their position as shown in fig. 11.2 (b). Now unlike pole coincides each other and rotor experience an attractive force F_a . Now the rotor will rotate in the clock wise direction.
- (5) As a result the torque in clock wise and anti clock wise direction are equal and opposite, so the resultant torque is zero. The rotor will not rotate. Hence a **3 phase synchronous motor is not a self starting motor.**
- (6) For make 3 phase synchronous motor self starting the rotor should rotated by some external means at a speed almost equal to the speed of the rotating magnetic field (synchronous speed).
- (7) At every instant the stator and rotor like poles will face each other as shown in fig. 11.2 (c) and fig. 11.2 (d), then due to strong force of repulsion, magnetic locking is established. The stator and rotor continuously maintain the same relative position.
- (8) Due to this, rotor experiences a unidirectional torque. Hence a 3 phase synchronous motor must run at synchronous speed. That is the reason this motor is called the synchronous motor.

Application: The application of the 3 phase synchronous motor is as follow.

- (1) Cement industries
- (2) Machine tools
- (3) Timing devices

11.3 3 PHASE SYNCHRONOUS GENERATOR (ALTERNATOR)

3 phase synchronous generator (alternator) convert the mechanical energy into the 3 phase electrical energy.

Principle: 3 phase synchronous motor works on the principle of faraday law of Electro Magnetic Induction (EMI) According to this law "If there is the rate of change in the flux link with the winding then EMF will induced in the winding".

Construction: The fig. 11.3 shows as salient pole type 3 phase synchronous generator.

- (1) The stator of the synchronous generator consist a 3 phase winding.
- (2) The rotor of the synchronous generator is either cylindrical or salient pole type. It consist a winding.

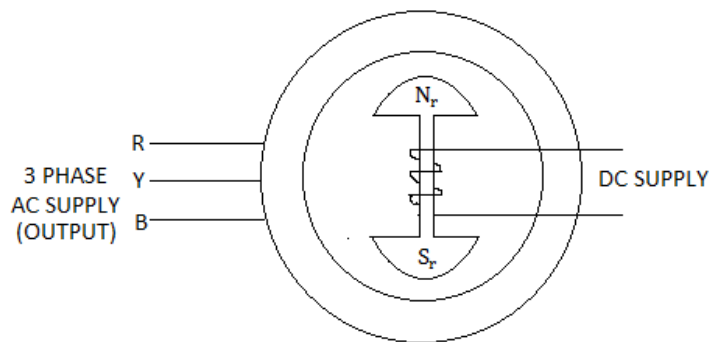


Fig. 11.3

Working: The working of the synchronous motor is as follow.

- (1) A DC supply is given to the rotor winding which produce a constant magnetic field. The N_r and S_r are the North Pole and South Pole of the rotor constant magnetic field.
- (2) A mechanical energy is provided to the rotor by which rotor will rotate.
- (3) The magnetic field produce by the rotor link with the stator 3 phase winding.
- (4) Due to the rotation in the rotor the magnetic field link with stator 3 phase winding is changing with time.
- (5) According to faraday law of Electro Magnetic Induction (EMI) an EMF is induced in all the 3 phases of the stator.
- (6) Finally a mechanical energy is converted in to 3 phase electrical energy.

Application: The application of the 3 phase synchronous generator is as follow.

- (1) Power plant