SNS COLLEGE OF ENGINEERING

Kurumbapalayam (Po), Coimbatore – 641 107

An Autonomous Institution

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Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE NAME : 19EE401 SYNCHRONOUS AND INDUCTION MACHINES

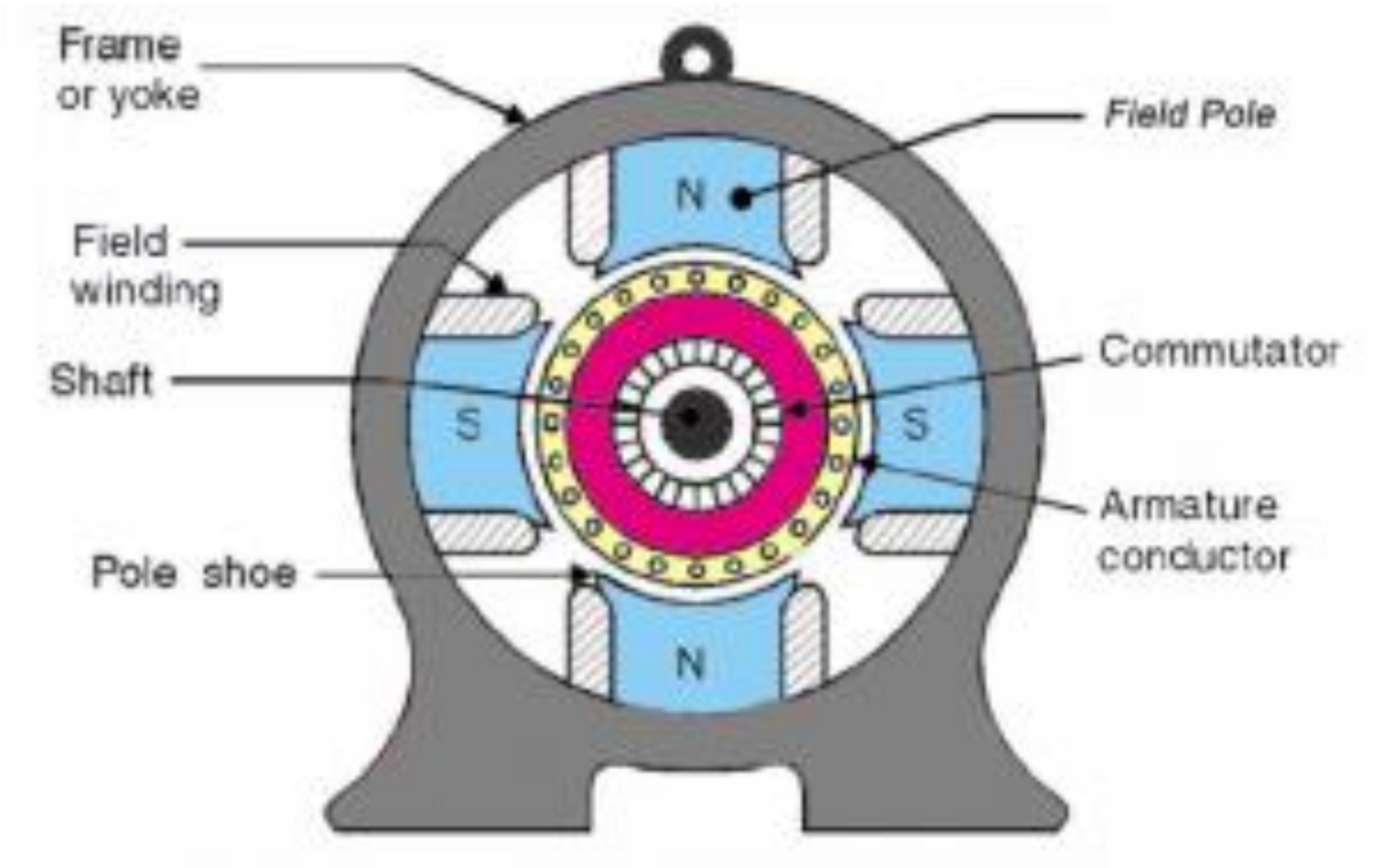
II YEAR /IV SEMESTER

UNIT – I SYNCHRONOUS GENERATOR

TOPICS TO BE COVERED IN THE UNIT

Types - Constructional features – EMF equation – Armature reaction – Voltage regulation – Predetermination of regulation by Synchronous Impedance, Ampere Turn and Potier reactance method – Parallel operation – Synchronizing Current and Synchronizing power – Effect of Change of Excitation – Alternator on infinite Bus bar.

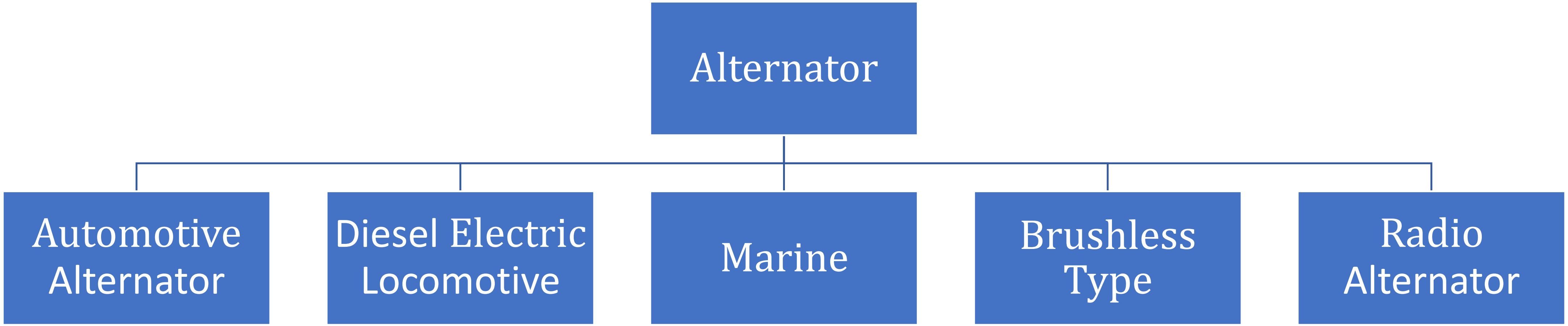
RECAP – DC GENERATOR



Drawbacks of DC Generator

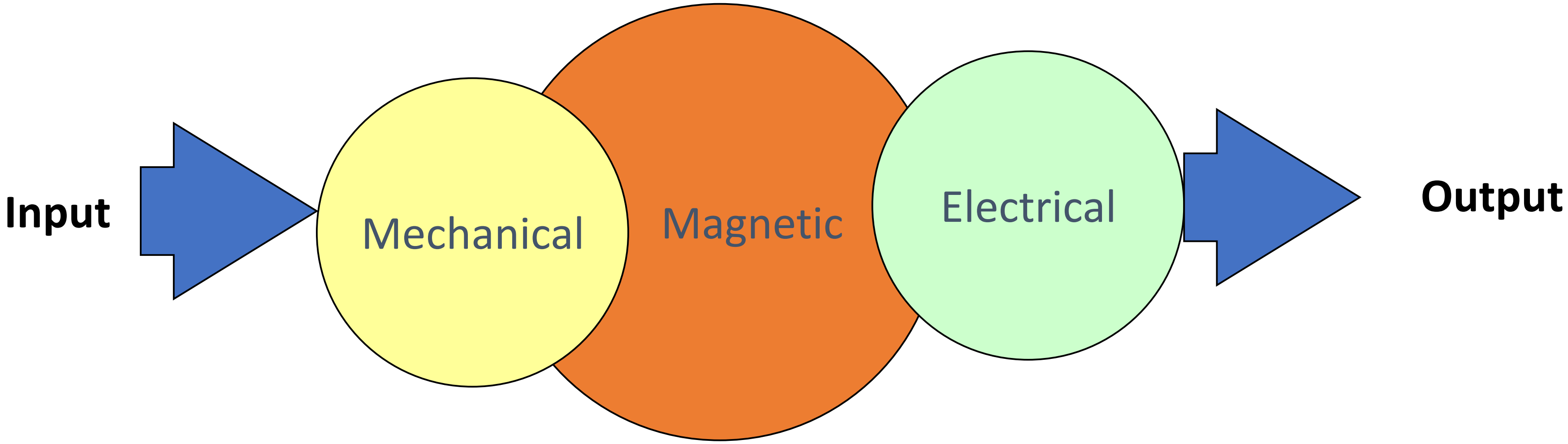
- It is incompatible with a transformer. Therefore, it is not suitable for a Power system operation as the power grid is AC in nature.
- The current flowing in the generator experiences high core loss, copper losses, mechanical losses and others. Therefore, the efficiency of a DC generator is very low.
- Unsuitable for providing stable voltage over great distances.

ALTERNATOR OR SYNCHRONOUS GENERATOR



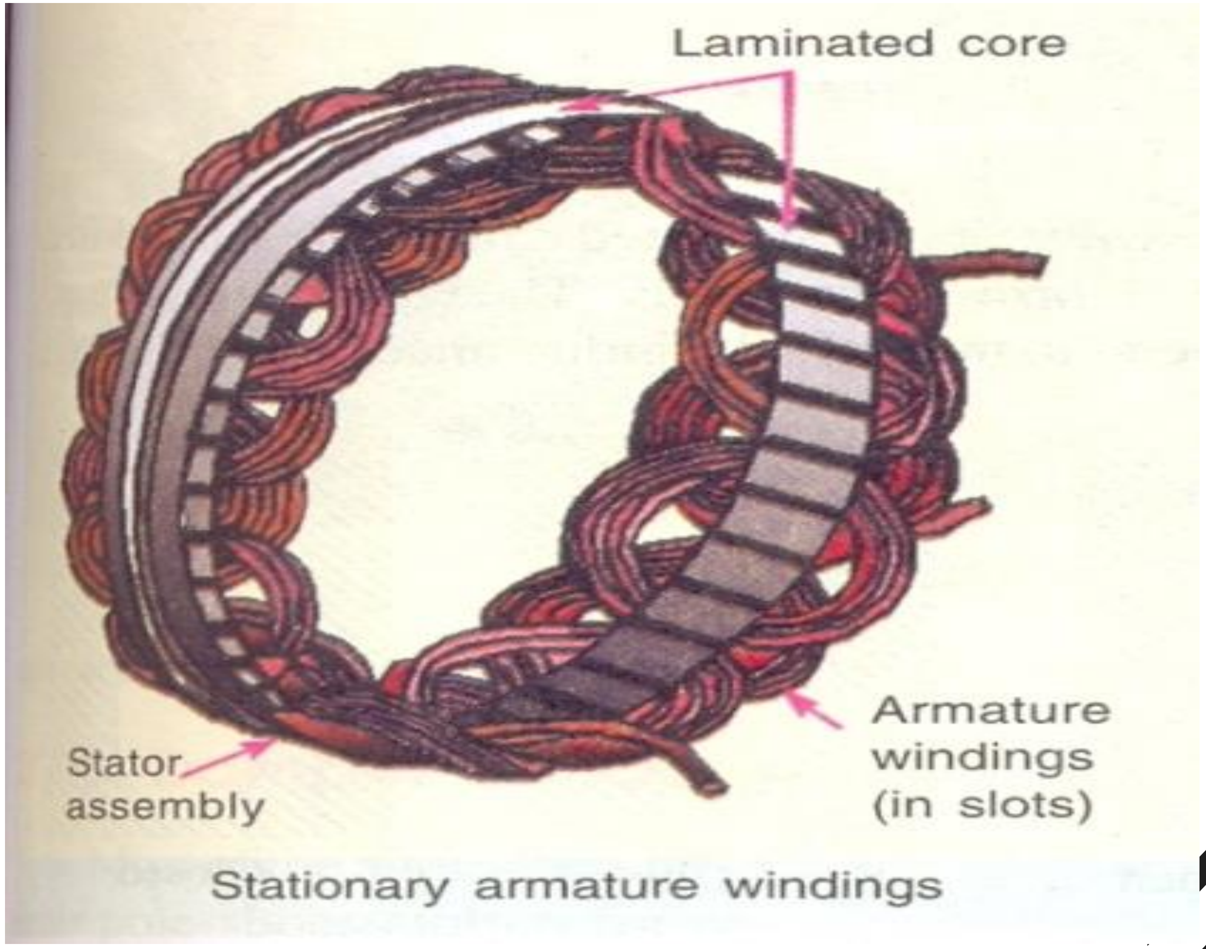
SYNCHRONOUS GENERATOR

- The machine which produces 3-phase power from mechanical power is called an alternator or synchronous generator.
- Generator converts mechanical power into electrical power.
- Synchronous generators are constant speed generators.
- The conversion of mechanical power into electrical power is done through a coupling field (magnetic field).



SYNCHRONOUS GENERATOR

In case of Alternators, it is possible to have, *(i)* the rotating armature and stationery field, *(ii)* the rotating field and stationery armature.



SYNCHRONOUS GENERATOR

The various advantages of rotating field type can be stated as

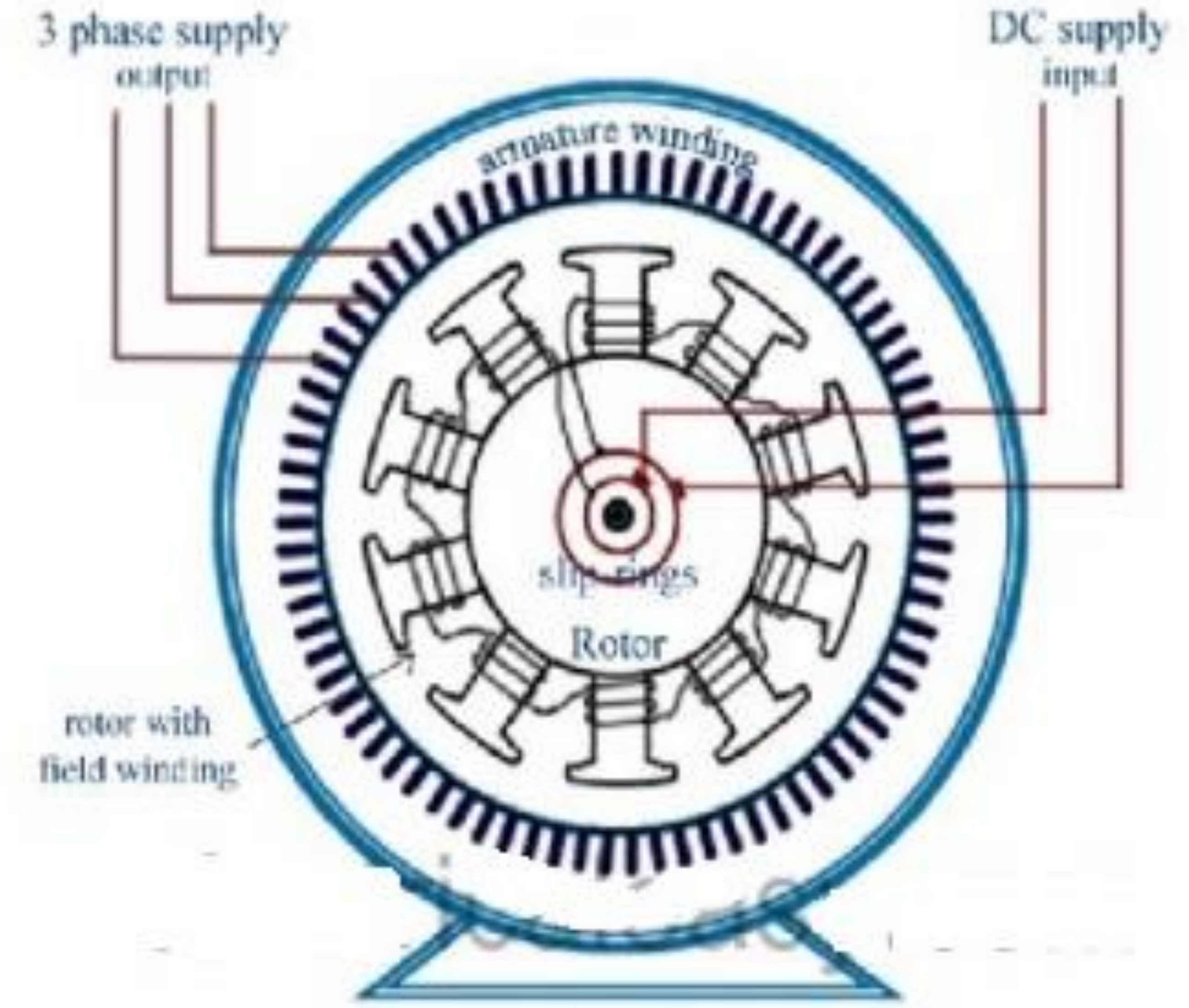
1. The output current can be led directly from fixed terminals on the stator to the load circuit, without having to pass it through brush-contacts.

2. It is easier to insulate stationary armature winding for high a.c voltages, which may have as high a value as 30kV or more.

3. The field circuit (slip rings) low power d.c which can, therefore, be easily insulated.

4. Rotating field makes the overall construction very simple. With simple, robust mechanical construction and low inertia of rotor, it can be driven at high speed. So greater output can be obtained from an alternator of given size.

SYNCHRONOUS GENERATOR



SYNCHRONOUS GENERATOR

- Armature winding mounted on a stationery element called Stator
- Field windings on a rotating element called Rotor.
- When the rotor rotates, the stator conductors are cut by the magnetic flux, hence they have induced e.m.f produced in them. Because the magnetic poles are alternatively N and S, they induce an e.m.f and hence current in armature conductors , which first flows in one direction and then in the other.
- An alternating e.m.f is produced in the stator conductors

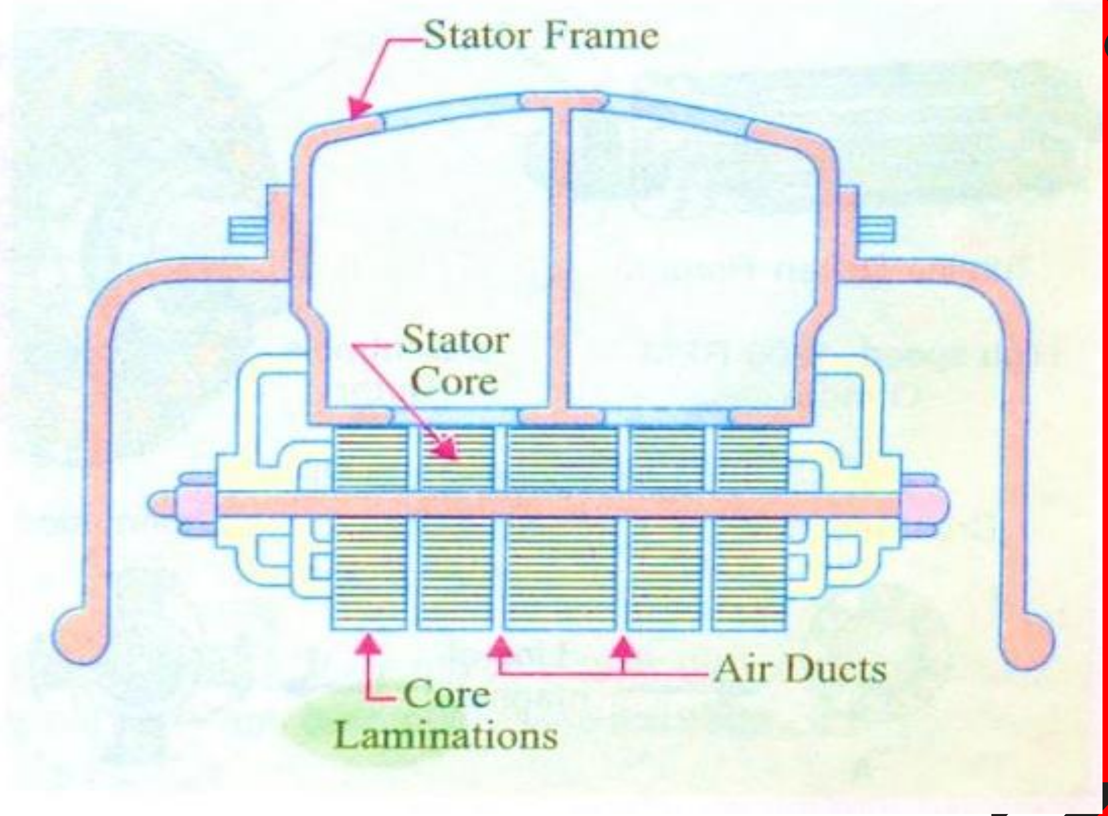
(*i*) Whose frequency depends on the number of N and S poles moving past a conductor in one second

(*ii*) Whose direction is given by Flemings Right-hand rule.

SYNCHRONOUS GENERATOR

Stator

- It is the stationary part of the machine and is built up of sheet-steel laminations having slots on its inner periphery.
- A 3-phase winding is placed in these slots and serves as the armature winding of the alternator.
- The armature winding is always connected in star and the neutral is connected to ground.



SYNCHRONOUS GENERATOR

Rotor

- The rotor carries a field winding which is supplied with direct current through two slip rings by a separate d.c. source. This d.c. source (called exciter) is generally a small d.c. shunt or compound generator mounted on the shaft of the alternator. Rotor construction is of two types, namely;

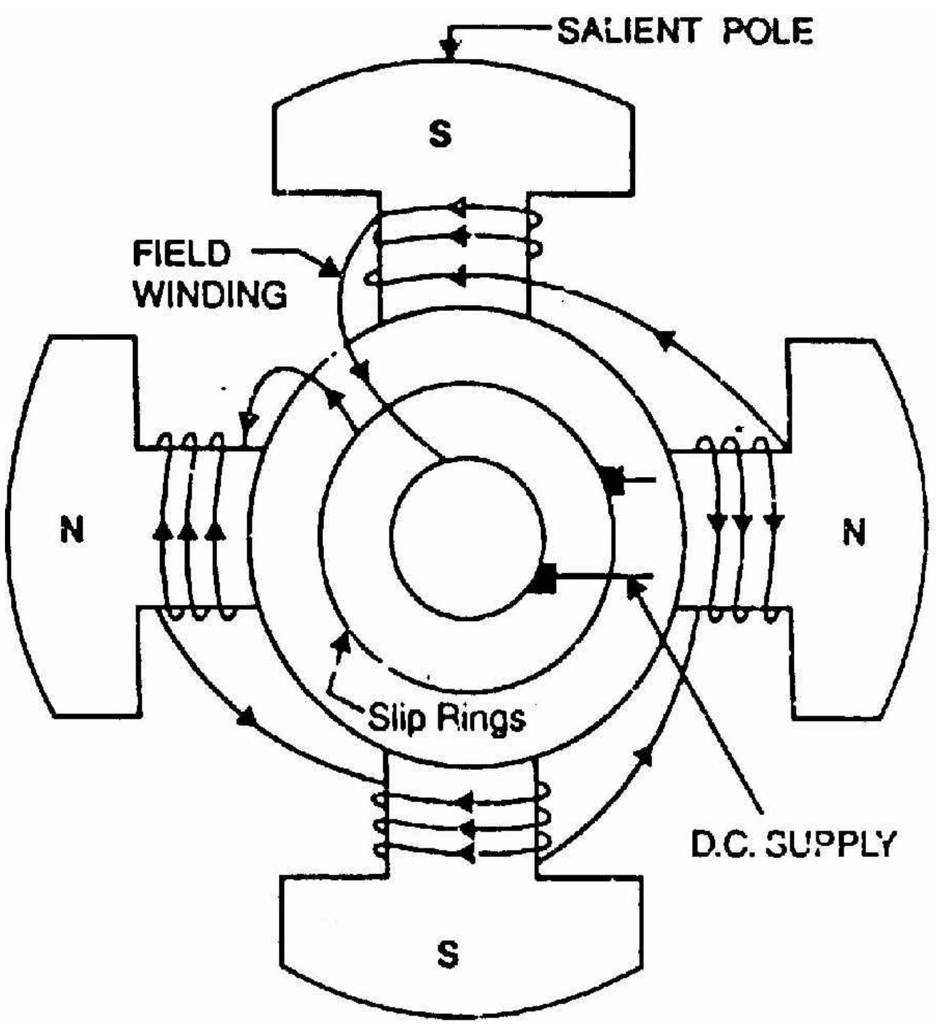
  (i) Salient (or projecting) pole type

  (ii) Non-salient (or cylindrical) pole type

SYNCHRONOUS GENERATOR

Salient pole type

- In this type, salient or projecting poles are mounted on a large circular steel frame which is fixed to the shaft of the alternator. The individual field pole windings are connected in series in such a way that when the field winding is energized by the DC exciter, adjacent poles have opposite polarities.



SYNCHRONOUS GENERATOR

- Low and medium-speed alternators (120-400 r.p.m.) such as those driven by diesel engines or water turbines have salient pole type rotors due to the following reasons:

(a) The salient field poles would cause .an excessive windage loss if driven at high speed and would tend to produce noise.

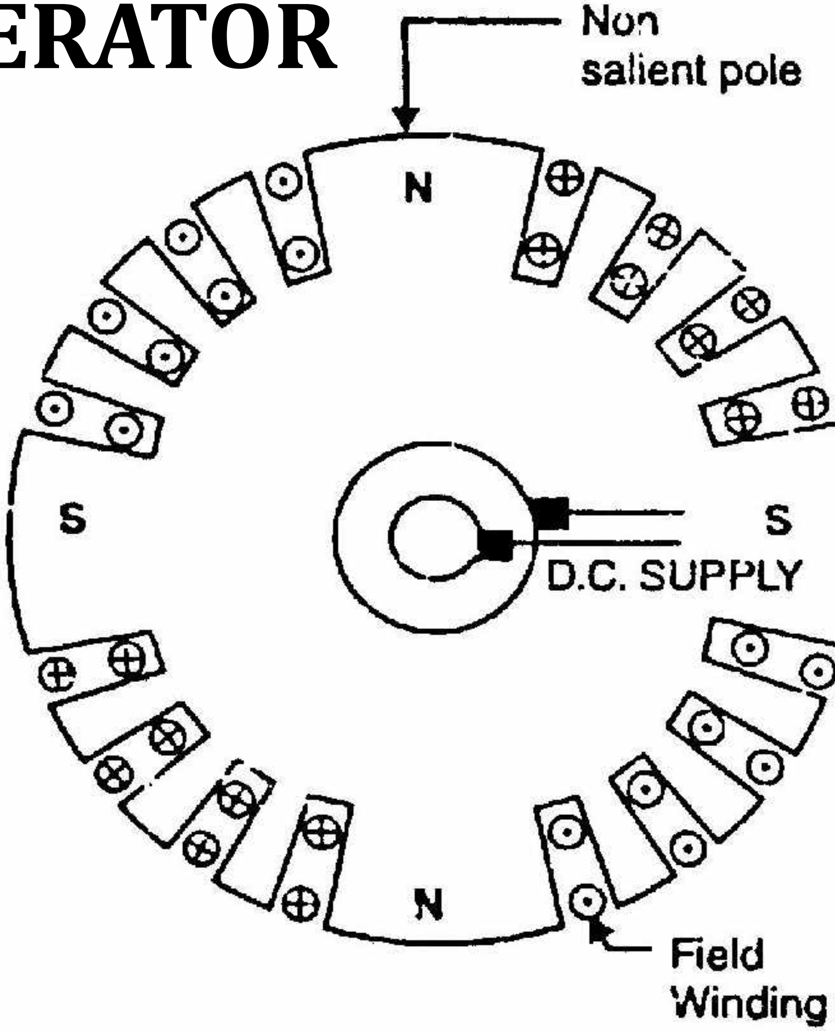
(b) Salient-pole construction cannot be made strong enough to withstand the mechanical stresses to which they may be subjected at higher speeds.

- Since a frequency of 50 Hz is required, we must use a large number of poles on the rotor of slow-speed alternators.
- Low-speed rotors always possess a large diameter to provide the necessary spate for the poles.
- Consequently, salient-pole type rotors have large diameters and short axial lengths.

SYNCHRONOUS GENERATOR

Non-salient pole type

- In this type, the rotor is made of smooth solid forged-steel radial cylinder having a number of slots along the outer periphery.
- The field windings are embedded in these slots and are connected in series to the slip rings through which they are energized by the d.c. exciter.
- The regions forming the poles are usually left un slotted as shown in Fig.
- It is clear that the poles formed are non-salient i.e., they do not project out from the rotor surface.



SYNCHRONOUS GENERATOR

- High-speed alternators (1500 or 3000 r.p.m.) are driven by steam turbines and use non-salient type rotors due to the following reasons:

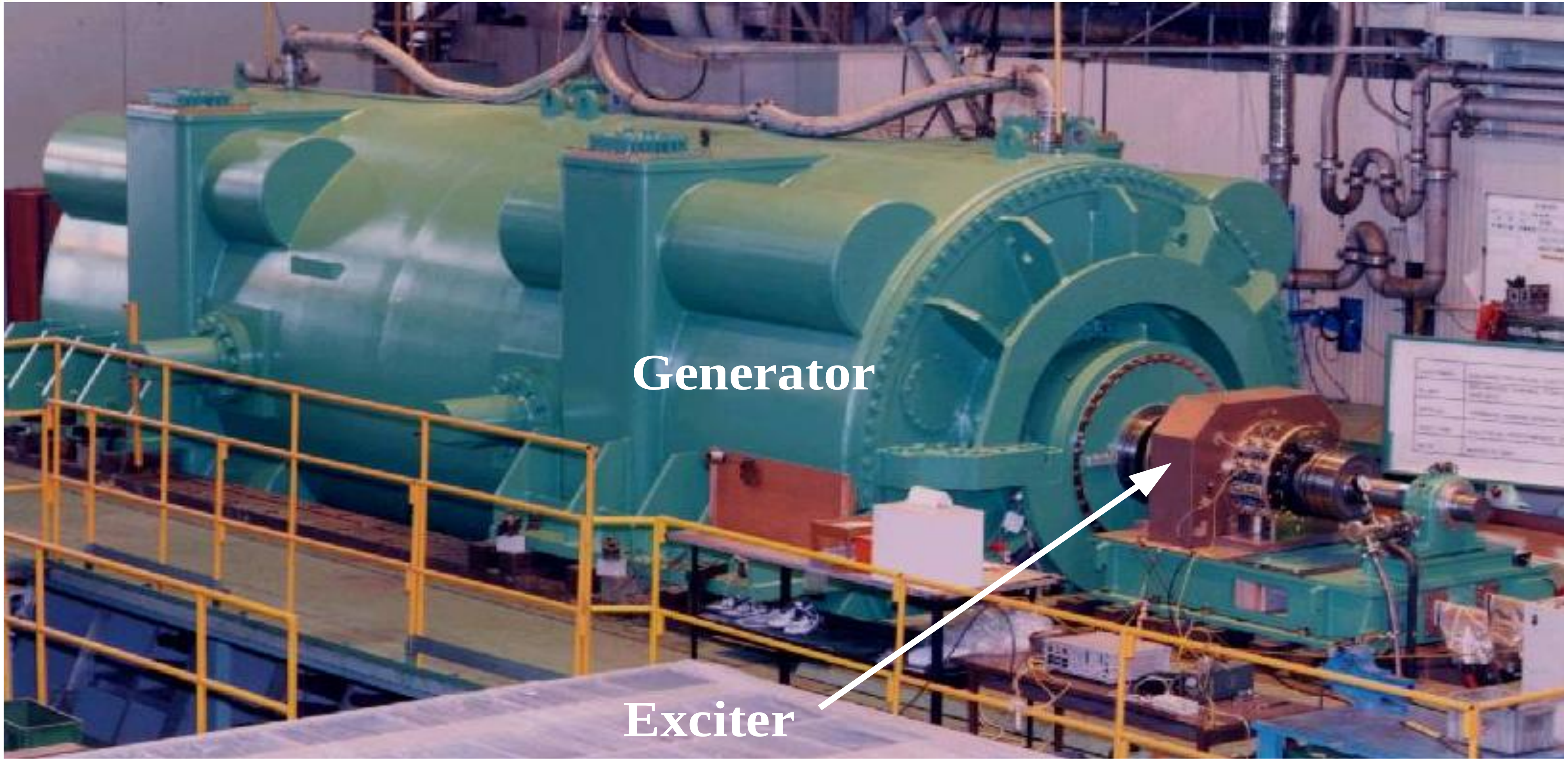
(a) This type of construction has mechanical robustness and gives noiseless operation at high speeds.

(b) The flux distribution around the periphery is nearly a sine wave and hence a better e.m.f. waveform is obtained than in the case of salient-pole type.

Since steam turbines run at high speed and a frequency of 50 Hz is required, we need a small number of poles on the rotor of high-speed alternators (also called turboalternators).

Consequently, turboalternators possess 2 or 4 poles and have small diameters and very long axial lengths.

Synchronous Generator



View of a two-pole round rotor generator and exciter(Westinghouse)

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THANK YOU