AC Generators

Subject Name: Electrical Fundamentals

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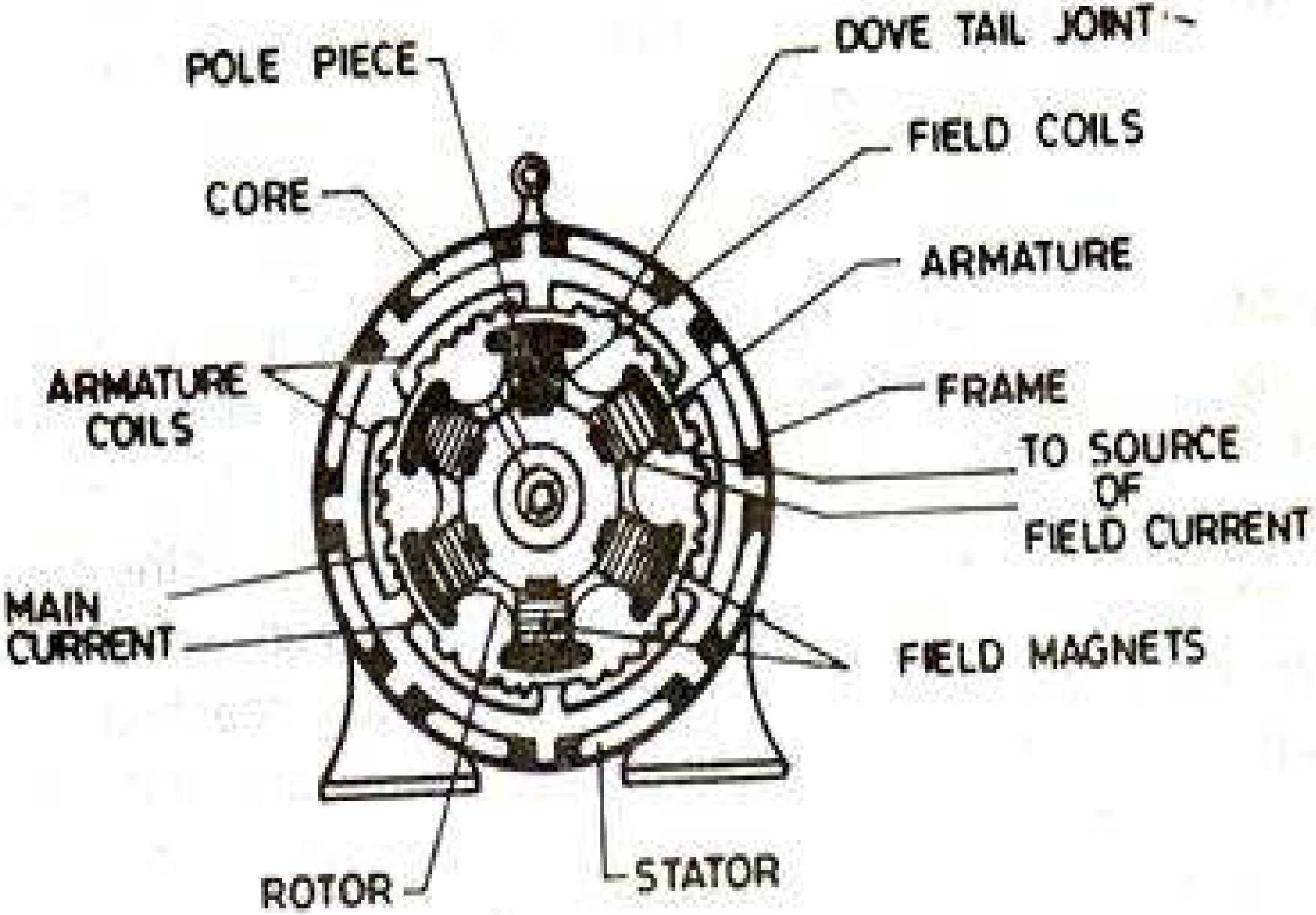
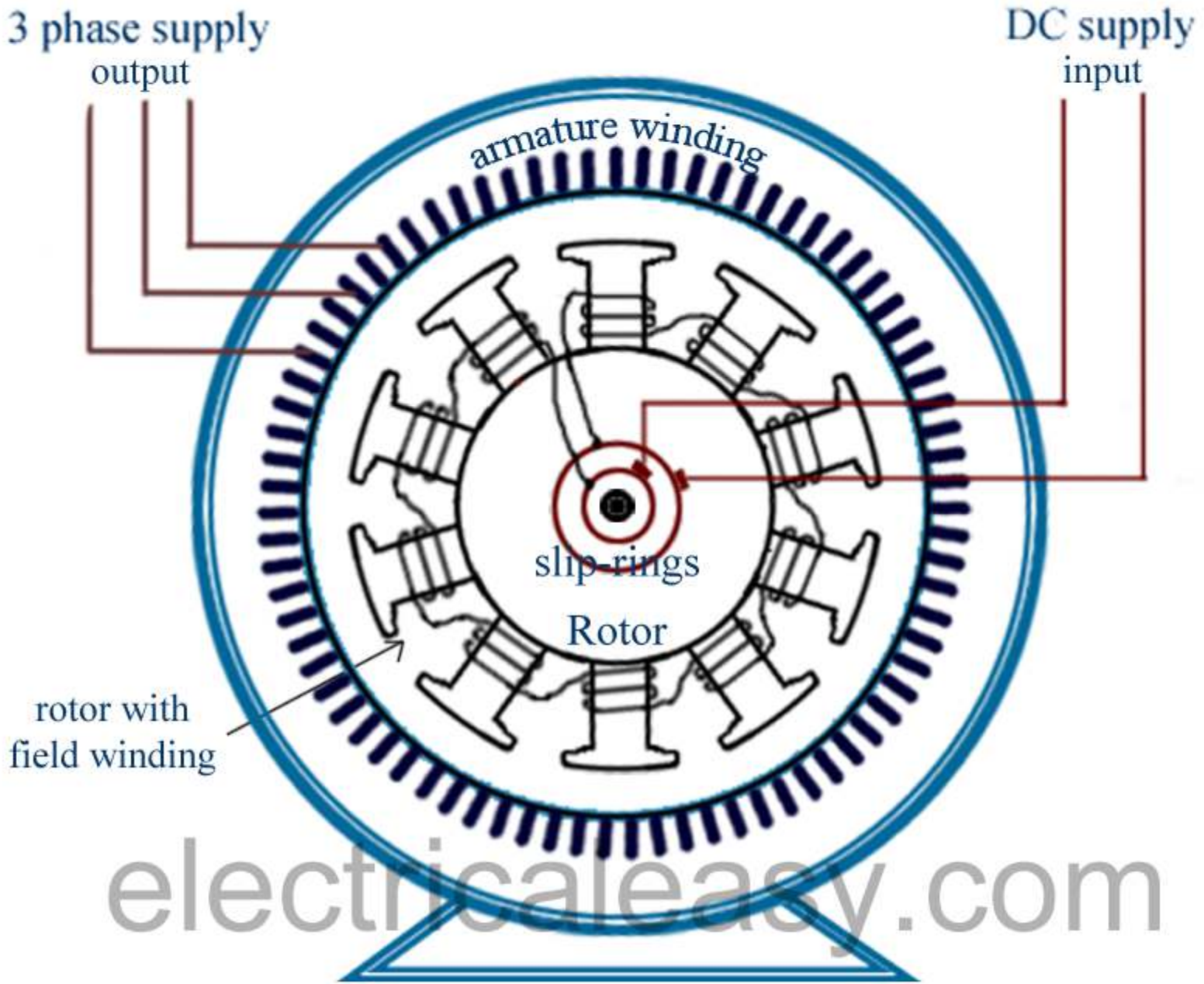
Construction

- Most of Alternator prefer rotating field type of construction.
- Winding terminology is slightly different than in case of d.c.generator
- Stationary winding➔ **Stator** ➔ Armature
- Rotating winding ➔ **Rotor** ➔ Field

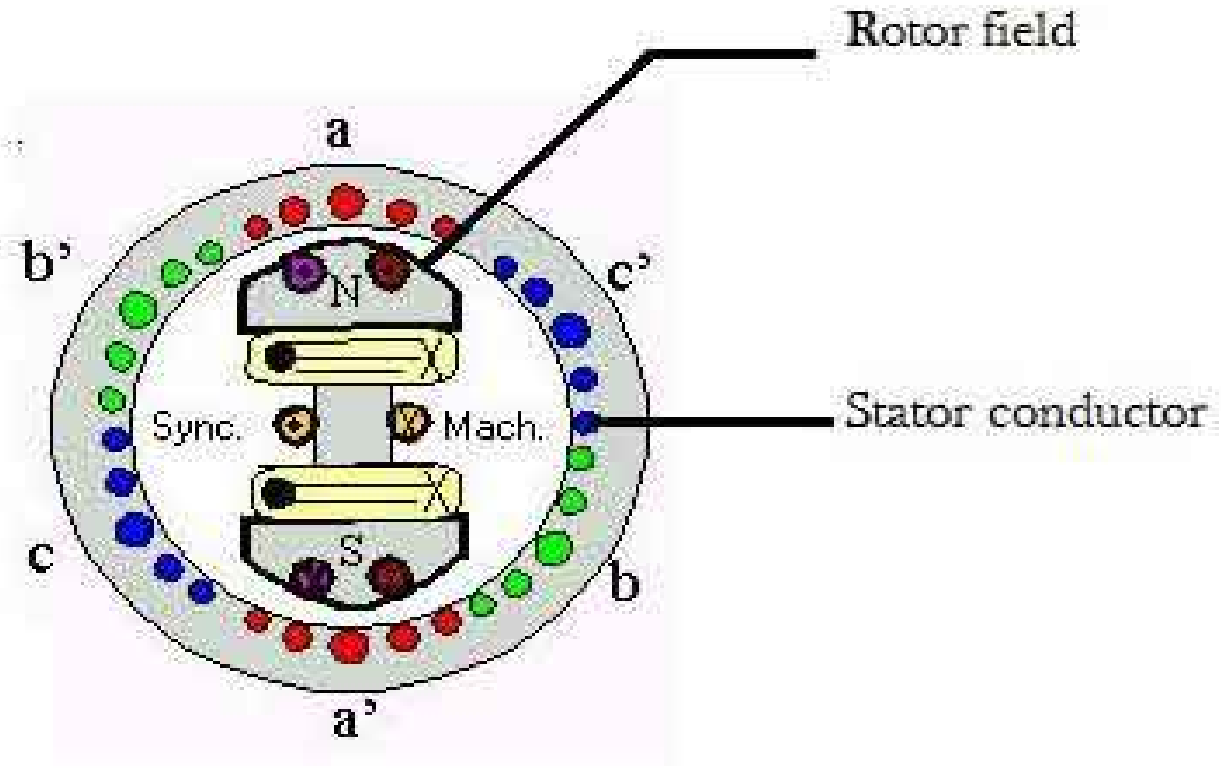
1. STATOR
2. ROTOR
   - Salient pole Type
   - Smooth Cylindrical Type.

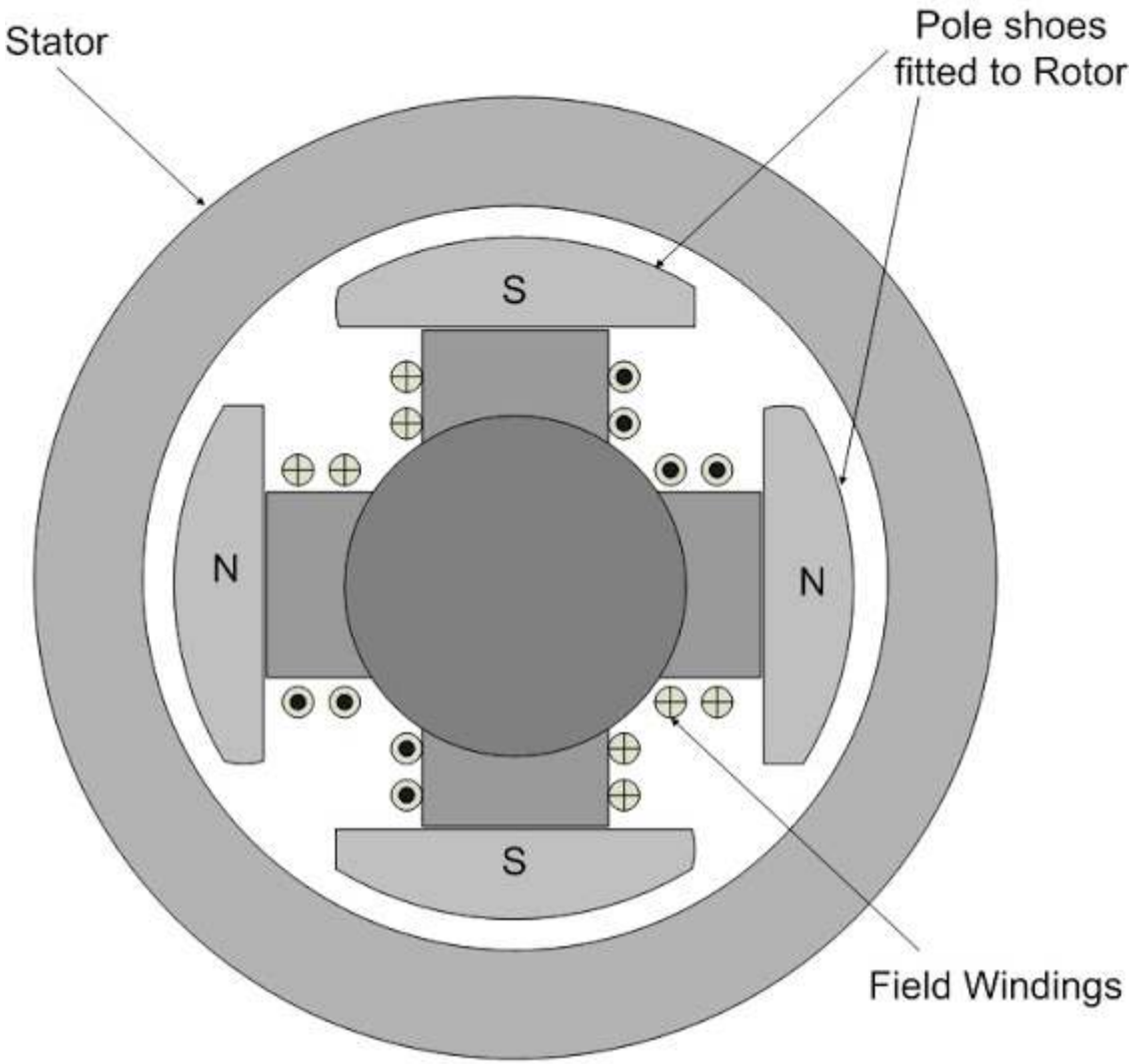

POLE PIECE
DOVE TAIL JOINT
FIELD COILS
CORE
ARMATURE
ARMATURE COILS
FRAME
TO SOURCE OF FIELD CURRENT
MAIN CURRENT
FIELD MAGNETS
ROTOR
STATOR



➢Construction wise, an alternator generally consists of field poles placed on the rotating fixture of the machine i.e. rotor as shown in the figure belove.

➢Once the rotor or the field poles are made to rotate in the presence of armature conductors housed on the stator, an alternating 3 φ voltage represented by aa' bb' cc' is induced in the armature conductors thus resulting in the generation of 3φ electrical power.





A salient 4-pole Generator. Carefully observe the location of North & South poles

There are mainly two types of rotor used in **construction of alternator**,

1. Salient pole type.
2. Cylindrical rotor type.

Salient Pole Type

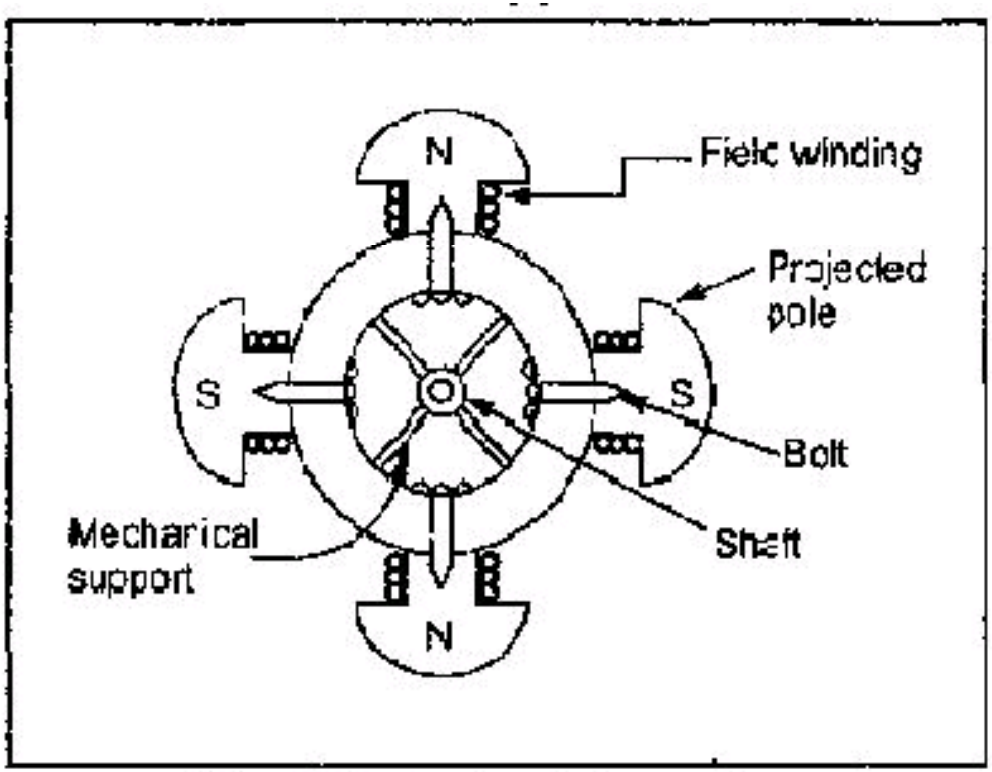


Fig. 6.3 Salient pole type rotor

➢The salient pole type of rotor is generally used for slow speed machines having large diameters and relatively small axial lengths

The salient features of pole field structure has the following special feature-

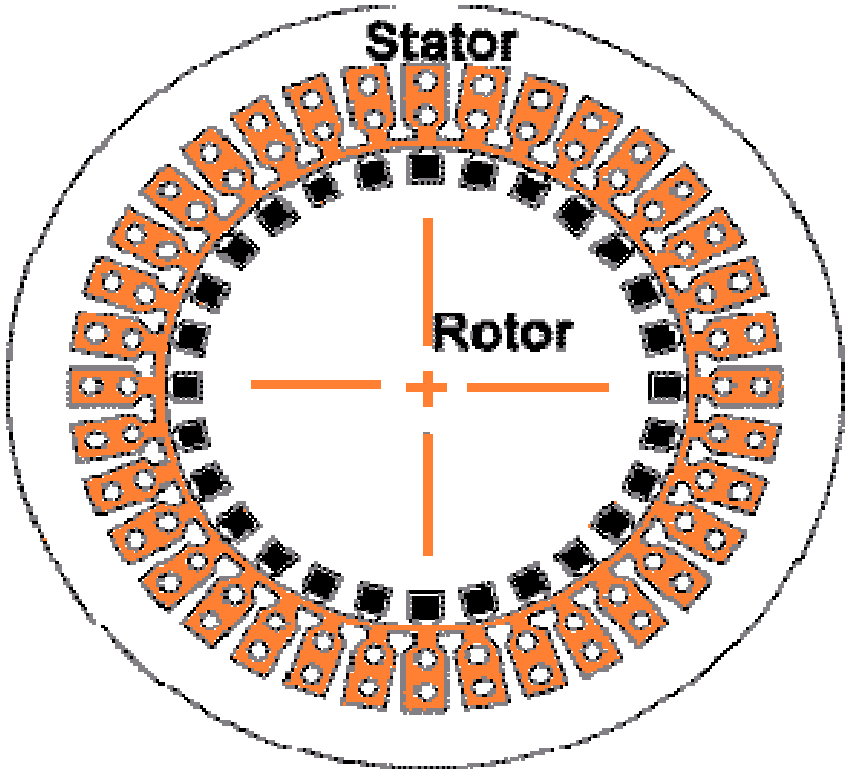
➢They have a large horizontal diameter compared to a shorter axial length.

➢The pole shoes covers only about $^{2}/_{3}$rd of pole pitch.

➢Poles are laminated to reduce eddy current loss.

➢The salient pole type motor is generally used for low speed operations of around 100 to 400 rpm, and they are used in power stations with hydraulic turbines or diesel engines.

Cylindrical Rotor Type



Cylindrical Rotor Alternator.

- The cylindrical rotor is generally used for very high speed operation and are employed in steam turbine driven alternators like turbo generators.
- The cylindrical rotor type machine has uniform length in all directions, giving a cylindrical shape to the rotor thus providing uniform flux cutting in all directions. The rotor in this case consists of a smooth solid steel cylinder, having a number of slots along its outer periphery for hosing the field coils.

Difference between Salient and Cylindrical Type Rotor

Salient Pole Type	Smooth Cylindrical Type
Pole are projecting out from the surface	Unslotted portion of the cylinder acts as poles hence poles are non uniforms
Air-gap is non uniform	Air gap is uniform due to smooth cylindrical periphery
Diameter is high and axial length is small	Small diameter and large axial length is feature.
Mechanically weak	Mechanically robust
Preferred for low speed alternators	For high speed alternator
Prime mover used are water turbine IC engines	Prime movers used are steam turbines, electric motor
For same size, the rating is smaller than cylindrical type	For same size, rating is higher than salient pole type.
Separate damper winding is provided	Separate damper winding is not necessary.

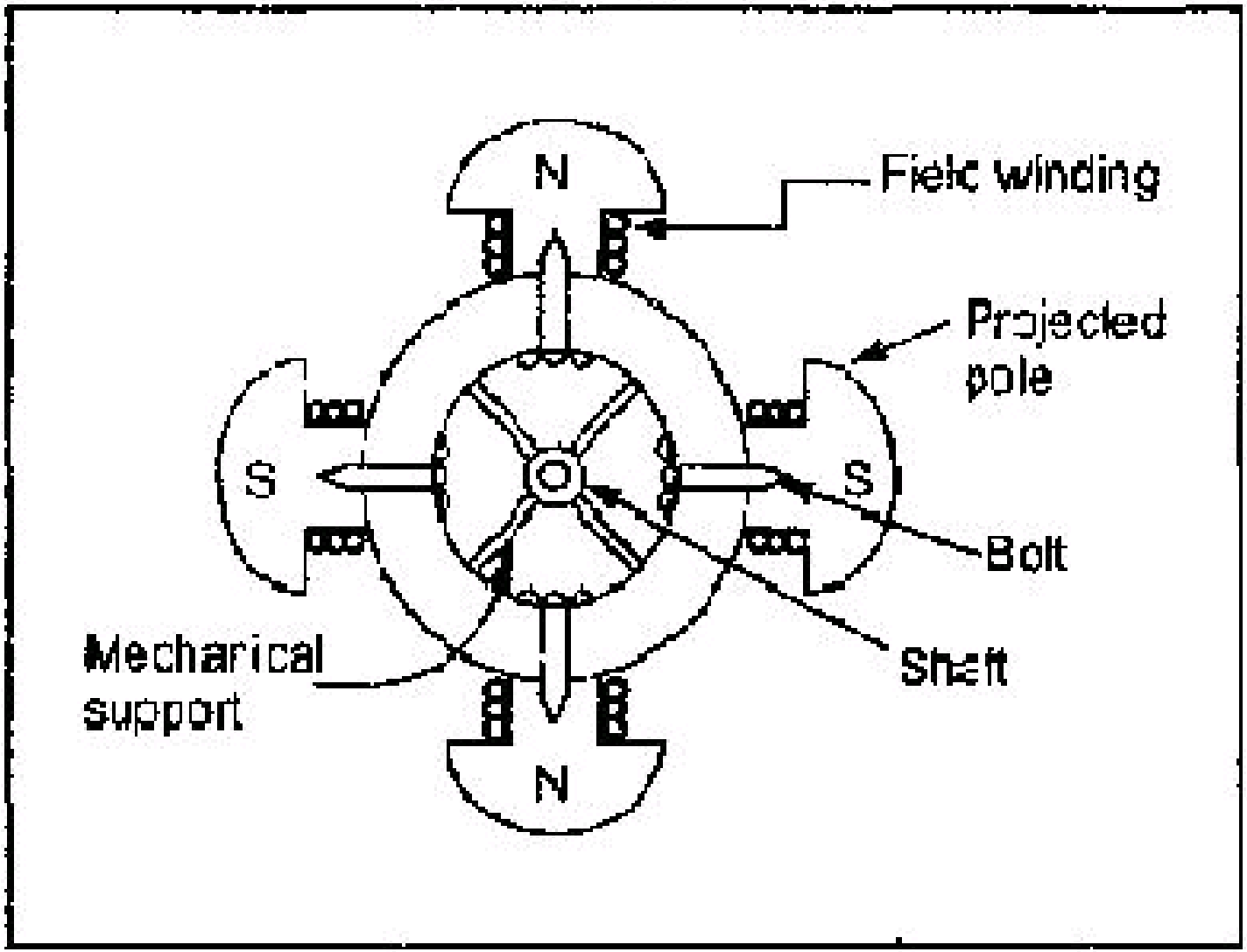
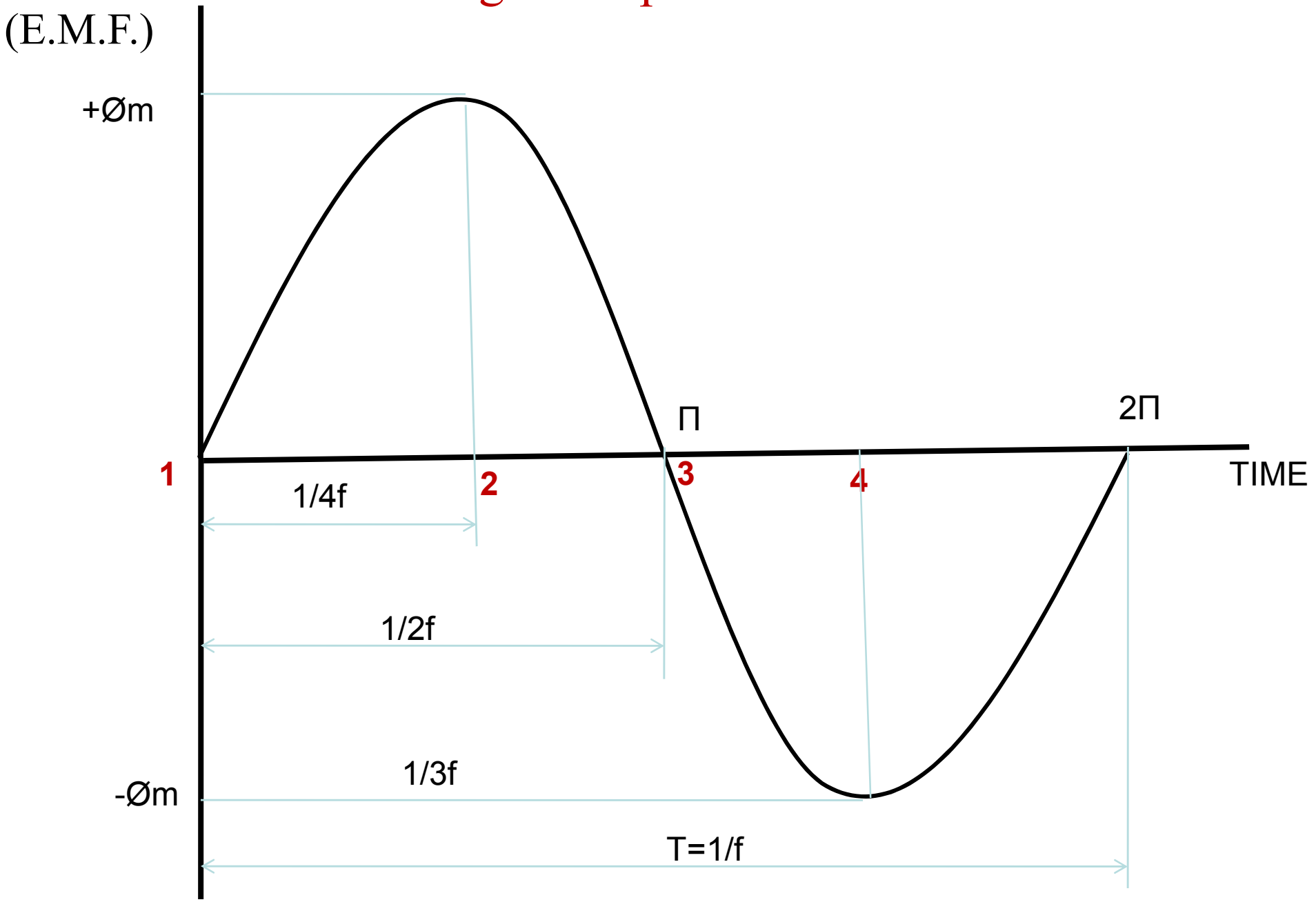


Fig. 6.3 Salient pole type rotor

Working Principle of Alternator



Frequency of Induced e.m.f.

$$f = \frac{PN}{120} \text{ Hz } (\text{Cycle per Sec.})$$

P = No. of Poles
N = Speed of the rotor in r.p.m.
F = Frequency of the induced e.m.f.

Synchronous Speed (Ns)

$$N_s = \frac{120 \times f}{P}$$

No. of Pole	2	4	8	12	24
Ns	3000	1500	750	500	250

Minimum no. of pole for an alternator can be two hence maximum value of synchronous speed possible.

Synchronization of Alternators

Necessary Condition for Synchronization

1. The terminal Voltage of the incoming machine must be same as that of bus bar Voltage.
2. The frequency must be same as that of the incoming machine as well as that of the bus bar. The necessitates that speed must be properly adjusted.

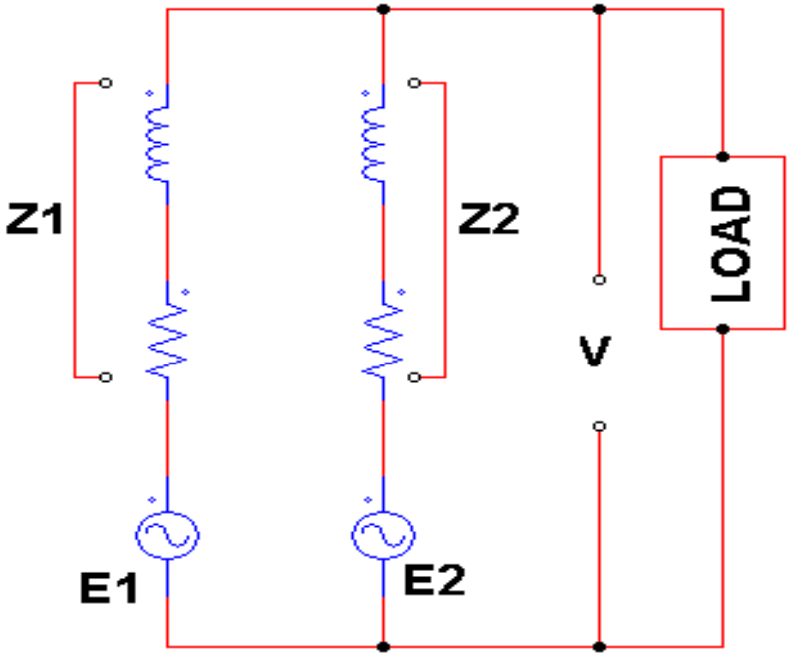
$$f = \frac{PN}{120} \text{Hz} \quad (\text{Cycle per Sec.})$$

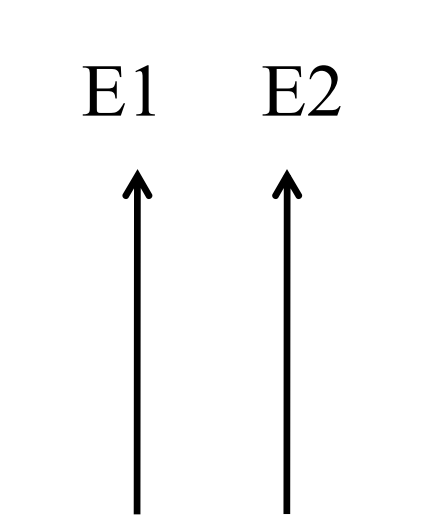
3. With respect to external load, the phase of alternator voltage must be identical with that of the bus bar voltage.

Alternator Phase sequence for the two voltages must be same

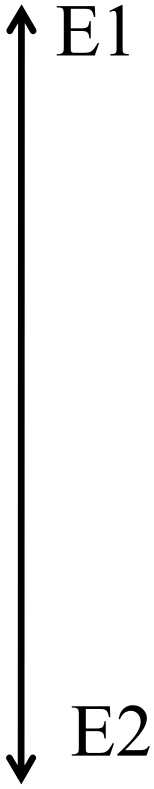
Above condition can be satisfied by using a Voltmeter, Synchronizing lamps or. Synchroscope.

Parallel operation of Alternators



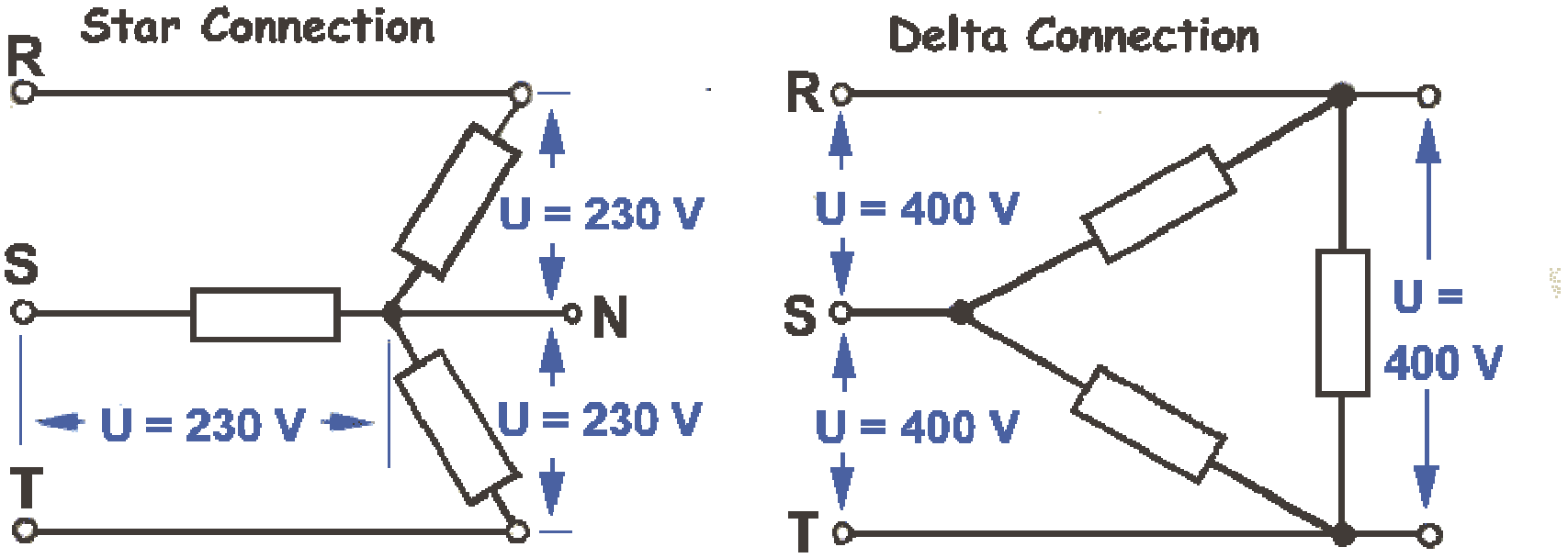


External Circuit



Load Circuit

Connecting a 3 Phase Generator to the Network



Permanent magnet type generator

- In a permanent magnet generator, the magnetic field of the rotor is produced by permanent magnets. Other types of generator use electromagnets to produce a magnetic field in a rotor winding. The direct current in the rotor field winding is fed through a slip-ring assembly or provided by a brushless exciter on the same shaft.

Permanent Generator