

UNIT-III

Fundamentals of Electrical Machines



Lecture 21

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INDUCTION MOTORS

An induction motor or asynchronous motor is an AC electric motor in which the electric current in the rotor needed to produce torque is obtained by electromagnetic induction from the magnetic field of the stator winding

Depending on the rotor construction, induction motor can be classified into two categories:

- Squirrel-cage induction motor.
- Slip-ring induction motor or wound rotor induction motor.

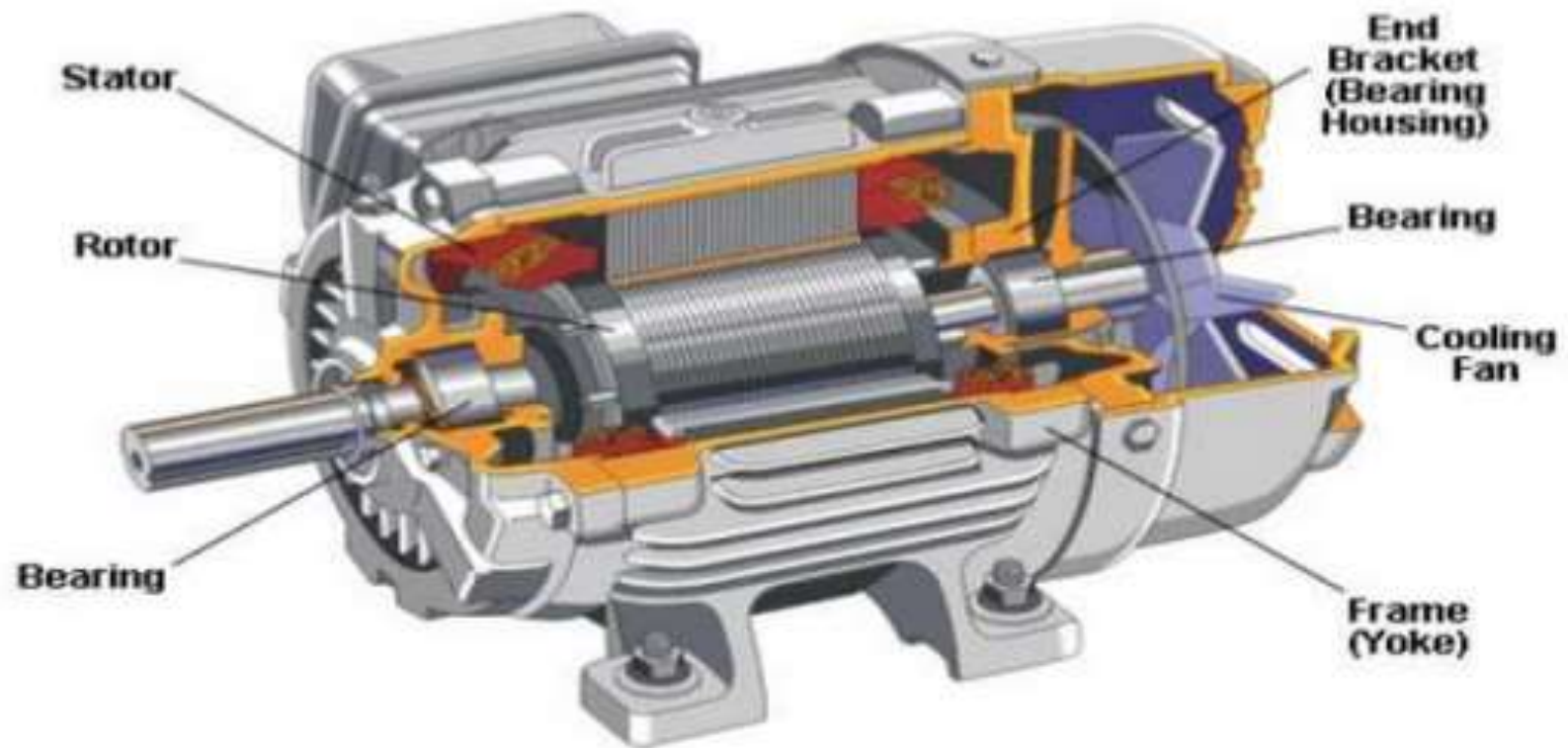
Depending on the number of phases it can be classified as:

- Single-phase induction motor
- Three-phase induction motor

Single Phase Induction Motor

- The single-phase induction machine is the most frequently used motor for refrigerators, washing machines, clocks, drills, compressors, pumps, and so forth.
- The single-phase motor stator has a laminated iron core with two windings arranged perpendicularly.
 - One is the main and
 - The other is the auxiliary winding or *starting winding*

Parts of AC Motor



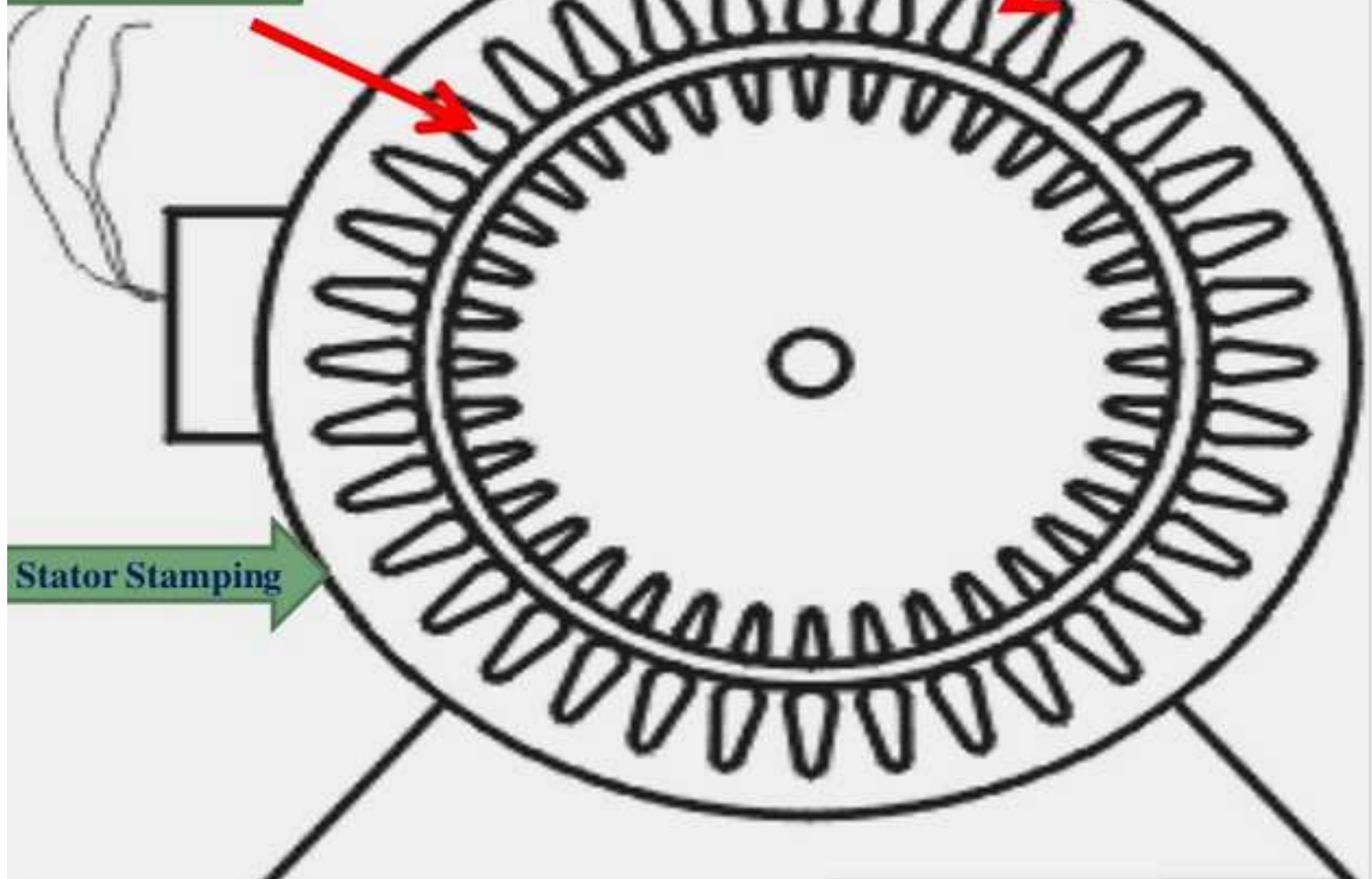
► It consists of two parts:

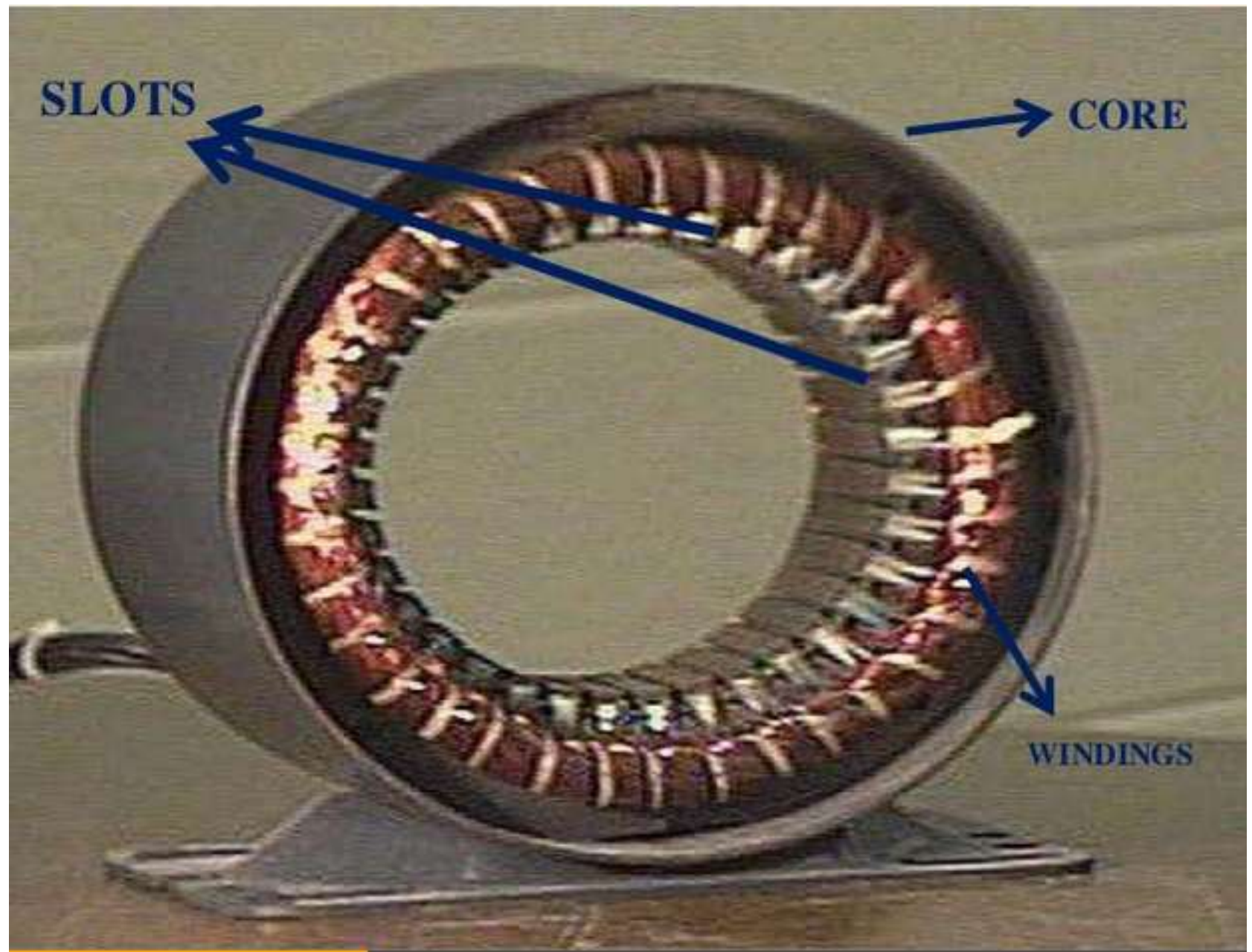
1. **Stator** - It is the stationary part of the motor.
2. **Rotor** - It is the rotating part of the motor.

STATOR

Slots

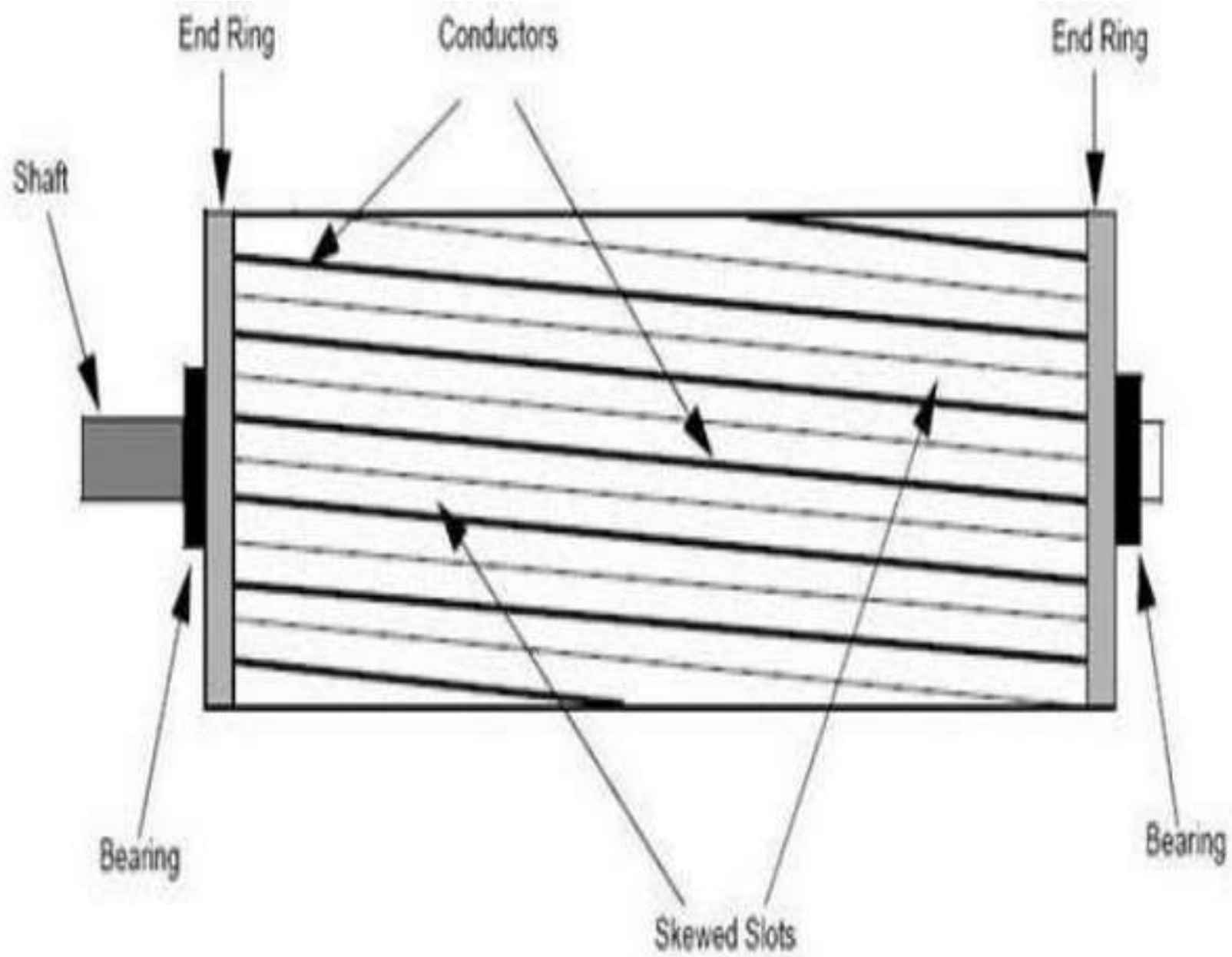
Tooth



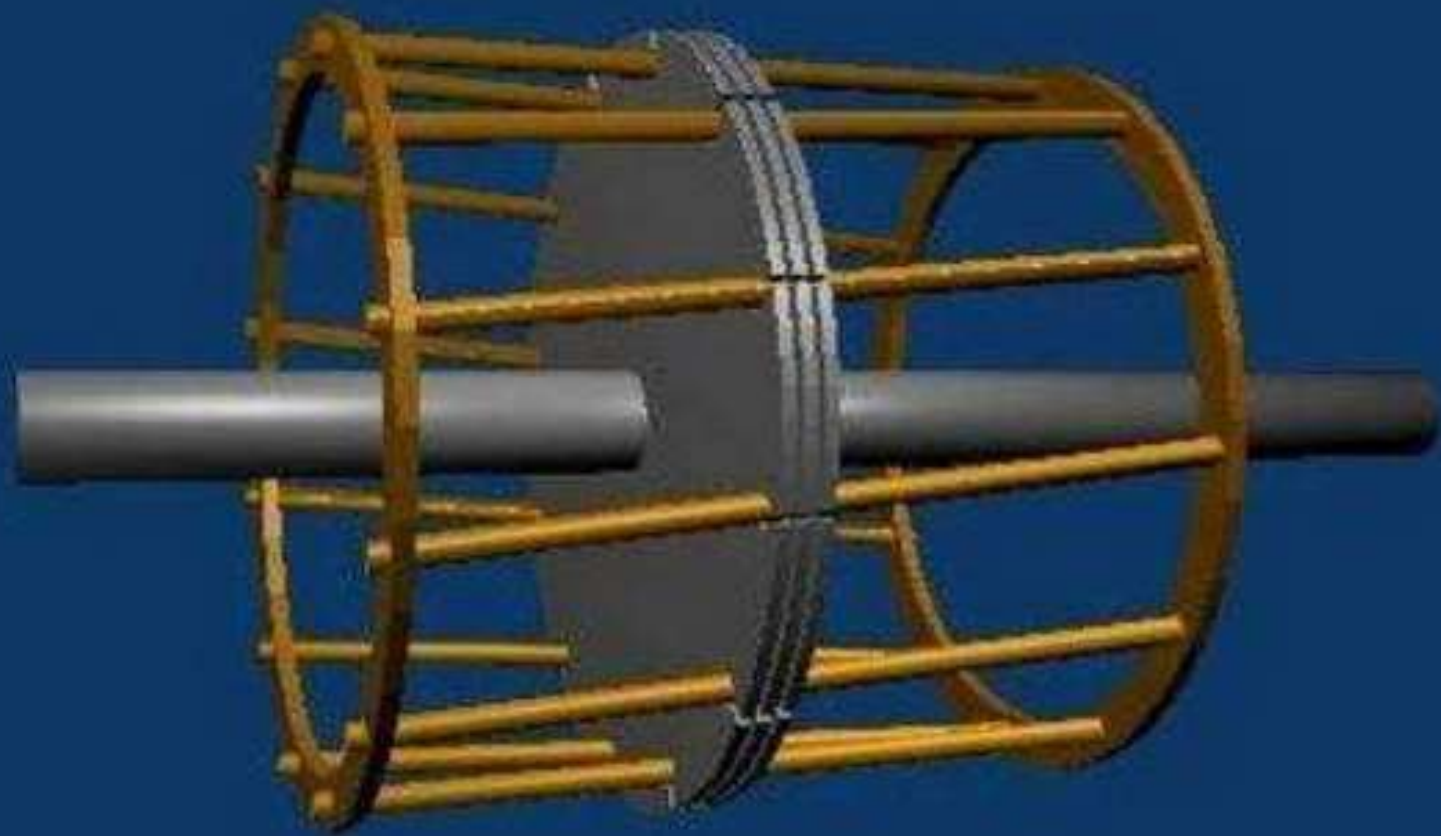


ROTOR

SQUIRREL CAGE ROTOR



- ▶ It consists of a laminated cylindrical core having semi closed circular slots at the outer periphery.
- ▶ Copper or aluminum bar conductors are placed in these slots and short circuited at each end by copper or aluminum rings called short circuiting rings.
- ▶ The rotor winding is permanently short circuited and it is not possible to add any external resistance.



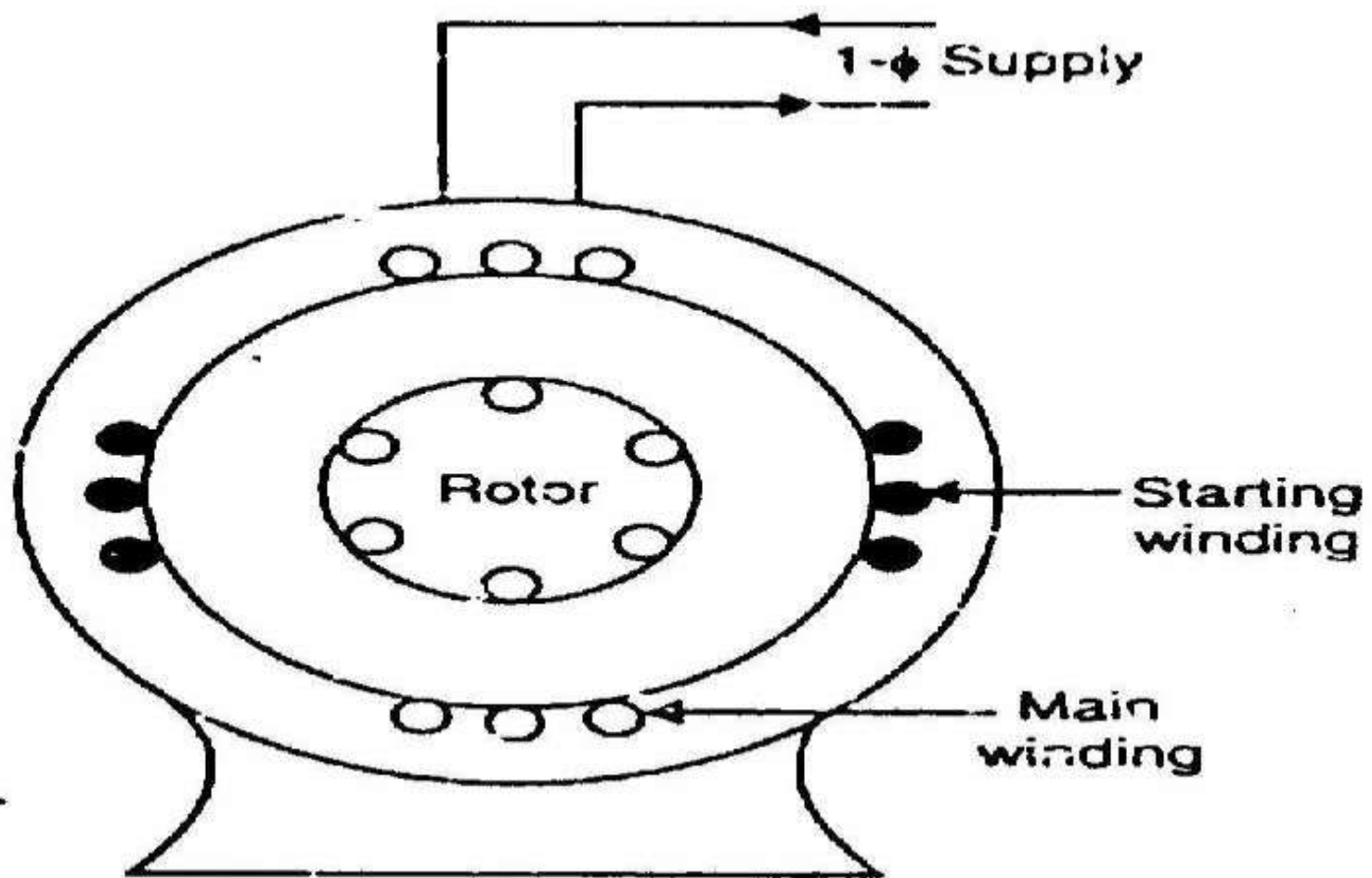
PHASE WOUND ROTOR

- ▶ It is also called ***SLIP RING ROTOR***
- ▶ Consists of a laminated core having semi closed slots at the outer periphery and carries a 3-phase insulated winding.
- ▶ The rotor is wound for the same number of poles as that of stator.
- ▶ The three finish terminals are connected together forming a star point and the three star terminals are connected to three slip rings fixed on the shaft.



Making Single-Phase Induction Motor Self-Starting

- The single-phase induction motor is not self starting and it is undesirable to resort to mechanical spinning of the shaft or pulling a belt to start it.
- To make a single-phase induction motor self-starting, we should somehow produce a revolving stator magnetic field. This may be achieved by converting a single-phase supply into two-phase supply through the use of an additional winding.
- When the motor attains sufficient speed, the starting means (i.e., additional winding) may be removed depending upon the type of the motor.



Quick Quiz (Poll 1)

- The torque developed by a single-phase motor at starting is
 - a) less than the rated torque
 - b) More than the rated torque
 - c) zero
 - d) None of the above

Single Phase Induction Motor

- The single-phase induction motor operation can be described by two methods:
 - Double revolving field theory; and
 - Cross-field theory.
- Double revolving theory is perhaps the easier of the two explanations to understand
- Learn the double revolving theory only

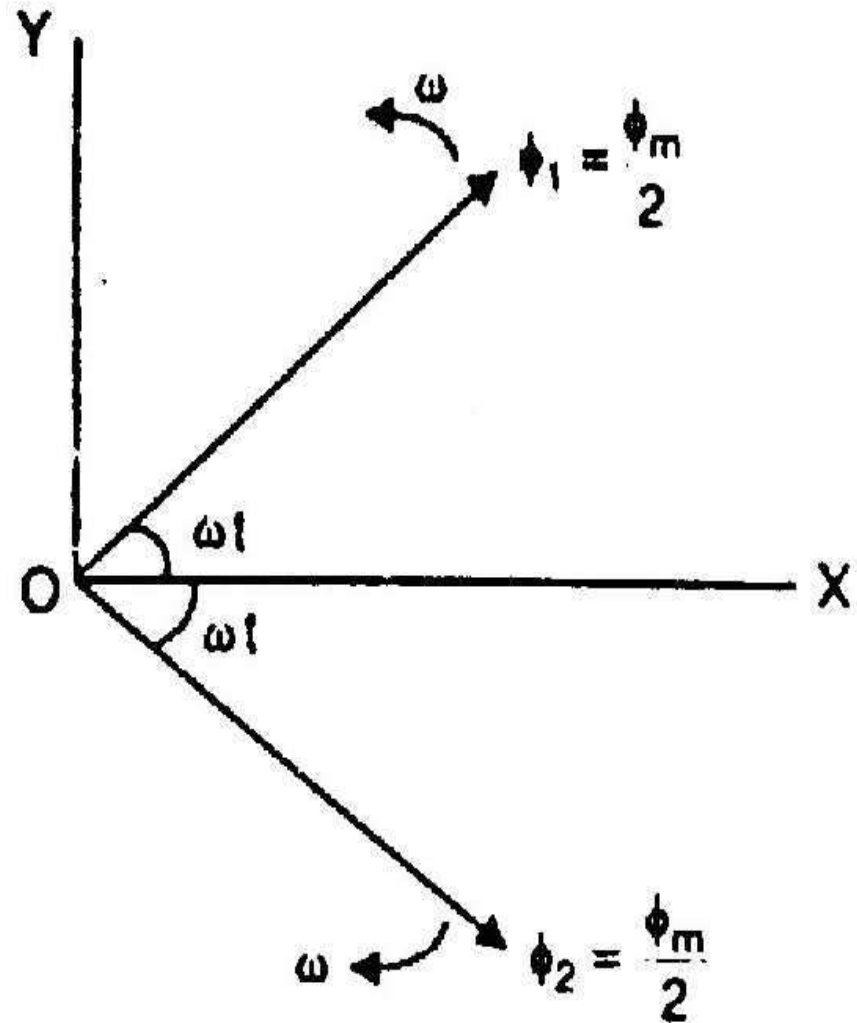
Single Phase Induction Motor

Double revolving field theory

- A single-phase ac current supplies the main winding that produces a pulsating magnetic field.
- Mathematically, the pulsating field could be divided into two fields, which are rotating in opposite directions.
- The interaction between the fields and the current induced in the rotor bars generates opposing torque

Single Phase Induction Motor

- Under these conditions, with only the main field energized the motor will not start
- However, if an external torque moves the motor in any direction, the motor will begin to rotate.
- Single-phase motor main winding generates two rotating fields, which oppose and counter-balance one another.



Applications

- Fans
- Hair driers
- Washing machines
- Vacuum Cleaners
- Mixers
- Refrigerators
- Food Processors

Quick Quiz (Poll 2)

- If any two phases for an induction motor are interchanged
 - A. The motor will run in the reverse direction
 - B. The motor will continue to run in the same direction
 - C. The motor will stop
 - D. The motor will Burn

Quick Quiz (Poll 3)

A centrifugal switch is used to disconnect starting winding when motor has

- a) Picked up 10% speed
- b) Picked up 20% speed
- c) Picked up 5 – 10% speed
- d) Picked up 50 – 70% speed