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Basics of induction Motors

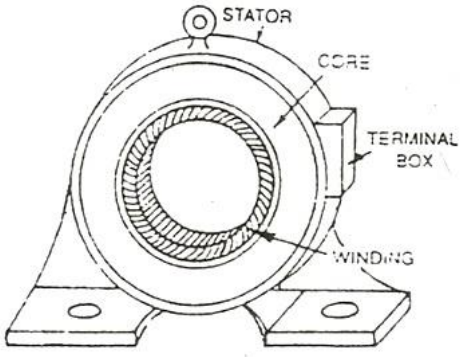
Different parts and construction of induction motor Part 1

Stator: The stator frame consists of laminations of silicon steel, usually with a thickness of about 0.5 millimeter. Lamination is necessary since a voltage is induced along the axial length of the steel as well as in the stator conductors. The laminations are insulated from each other usually by a varnish layer. This breaks up the conducting path in the steel and limits the losses (known as eddy current losses) in the steel.

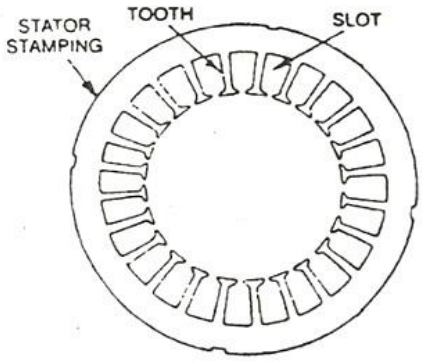
The stator coils are normally made of copper round conductors of many turns per coil are used for small motors, and rectangular bars of fewer turns are employed for larger machines. The coils are electrically insulated. It is common practice to bring only three leads out to a terminal block whether the winding is connected in wye or in delta.

Construction of Stator: The stator is built up of high-grade alloy steel laminations to reduce eddy current losses. It has three main parts, namely outer frame, the stator core and a stator winding.

Outer frame: It is the outer body of the motor. Its main function is to support the stator core and to protect the inner parts of the machine. For small machines, the outer frame is casted, but for the large machine, it is fabricated. The figure below shows the stator construction.



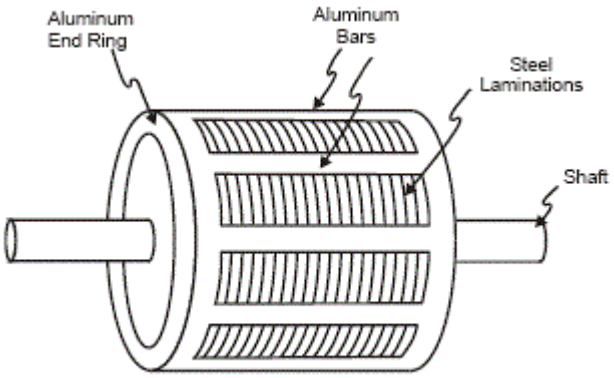
Stator Core: The stator core is built of high-grade silicon steel stampings. Its main function is to carry the alternating magnetic field which produces hysteresis and eddy current losses. The stampings are fixed to the stator frame. Each stamping is insulated from the other with a thin varnish layer. The thickness of the stamping usually varies from 0.3 to 0.5 mm. Slots are punched on the inner side of the stampings as shown in the figure below.



Stator windings: The core of the stator carries three phase windings which are usually supplied from a three-phase supply system. The six terminals of the windings (two of each phase) are connected in the terminal box of the machine. The stator of the motor is wound for a definite number of poles, depending on the speed of the motor. If the number of poles is greater, the speed of the motor will be less and if the number of poles is less than the speed will be high.

Rotor: The rotor is a rotating part of induction motor. The rotor is connected to the mechanical load through the shaft. The rotors of the three phase induction motor are further classified as

A. Squirrel cage rotor.

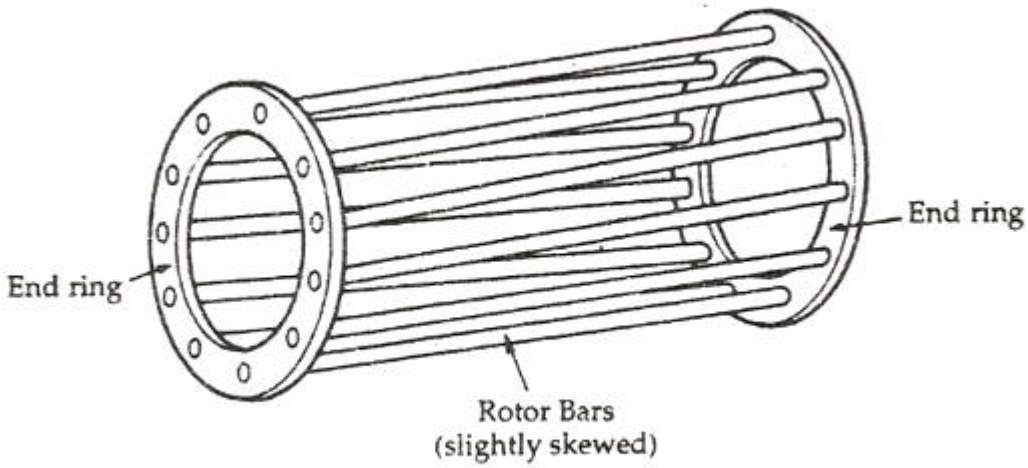


The magnetic part of the rotor is also made of steel laminations, mainly to facilitate stamping conductor slots of the desired shape and size. In most induction motors, the rotor winding is of the squirrel-cage type where solid conductors in the slots are shorted together at each end of the rotor iron by conducting end rings. In such machines there is no need to insulate the conductors from the iron. For motors up to about 300 kilowatts, the squirrel cage often consists of an aluminum casting incorporating the conductors, the end rings, and a cooling fan. For larger motors, the squirrel cage is made of copper, aluminum, or brass bars welded or brazed to end rings of a similar material. In any case, the rotor is very rugged and is also economical to produce in contrast to rotors requiring electrically insulated windings.

The rotor slots need not be rectangular. The shape of the slots can be designed to provide a variety of torque-speed characteristics.

Construction of Rotor: The rotor is also built of thin laminations of the same material as the stator. The laminated cylindrical core is mounted directly on the shaft. These laminations are slotted on the outer side to receive the conductors.

Squirrel Cage Rotor: A squirrel cage rotor consists of a laminated cylindrical core. The circular slots at the outer periphery are semi-closed. Each slot contains uninsulated bar conductor of aluminum or copper. At the end of the rotor the conductors the short-circuited by a heavy ring of copper or aluminum. The diagram of the cage rotor is shown below.



The rotor slots are usually not parallel to the shaft but are skewed. The skewing of the rotor conductors has the following advantages given below

It reduces humming and provide smooth and noise free operation. It results in a uniform torque curve for different positions of the rotor.

- The locking tendency of the rotor is reduced. As the teeth of the rotor and the stator attract each other and lock.
- It increases the rotor resistance due to the increased length of the rotor bar conductors.

Advantages of Squirrel Cage Rotor:

The following advantages of the cage rotor are given below.

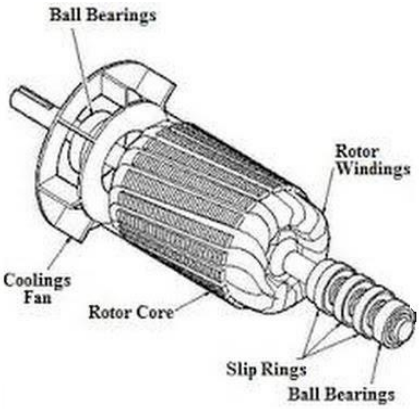
- The cage rotor is cheaper, and the construction is robust.
- The absence of the brushes reduces the risk of sparking.
- Its Maintenance is less.
- The power factor is higher
- The efficiency of the cage rotor is higher.

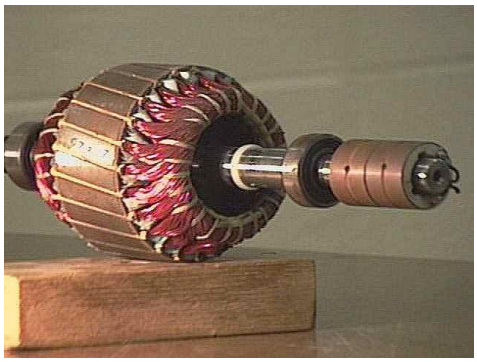
B. Slip Ring or Wound rotor

Some special induction motors are constructed with insulated coils in the rotor like those in the stator winding. The rotor windings are usually of a three-phase type with three connections made to insulated conducting rings (known as slip rings) mounted on an internal part of the rotor shaft. Carbon brushes provide for external electric connections.

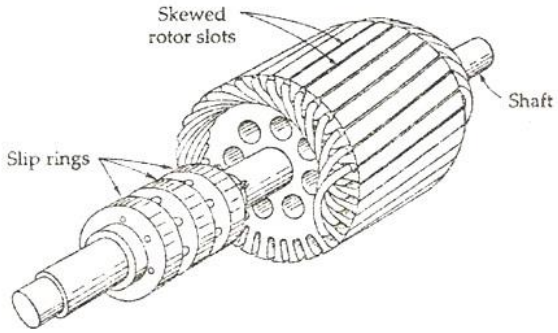
A wound-rotor motor with three resistors connected to its slip rings can provide a high starting torque without excessive starting current. By varying the resistance, a degree of speed control can be provided for some types of mechanical load. The efficiency of such drives is, however, low unless the speed is reasonably close to the synchronous value because of the high losses in the rotor circuit resistances. As an alternative, an electronic rectifier-inverter system can be connected to the rotor

slip rings to extract power and feed it back to the electric supply system. This arrangement, normally called a slip recovery system, provides speed control with acceptable efficiency.





A wound rotor induction motor has a stator like the squirrel cage induction motor, but a rotor with insulated windings brought out via slip rings and brushes. However, no power is applied to the slip rings. Their sole purpose is to allow resistance to be placed in series with the rotor windings while starting. This resistance is shorted out once the motor is started to make the rotor look electrically like the squirrel cage counterpart.



The slip rings are mounted on the shaft with brushes resting on them. The brushes are connected to the variable resistor. The function of the slip rings and the brushes is to provide a means of connecting external resistors in the rotor circuit. The resistor enables the variation of each rotor phase resistance to serve the following purposes given below.

- It increases the starting torque and decreases the starting current.
- It is used to control the speed of the motor.

In this type also, the rotor is skewed. A mild steel shaft is passed through the center of the rotor and is fixed to it. The purpose of the shaft is to transfer mechanical power.

Advantages of Phase Wound Rotor:

Following are the advantages of the Phase Wound Rotor.

- High starting torque and low starting current.
- For controlling the speed of the motor, an external resistance can be added in the circuit.