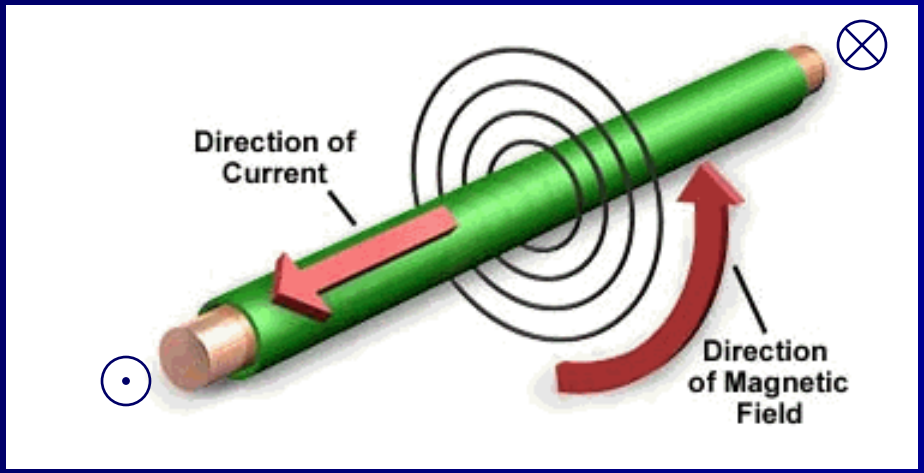
Three Phase AC Induction Motors

Motors

Motors convert Electrical energy into Mechanical energy

Magnetic Fields

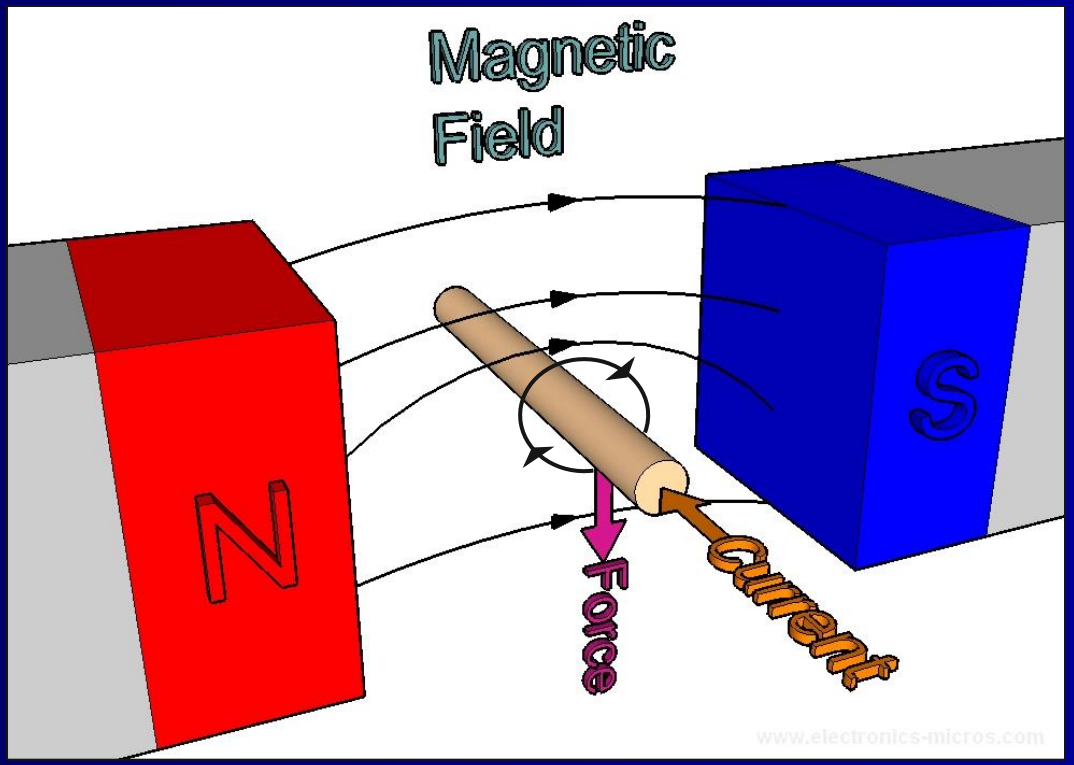
When current flows in a conductor it produces a magnetic field about it - as shown below



Using the corkscrew rule we can see that the field is moving in an anticlockwise direction as we look at it.

Motion

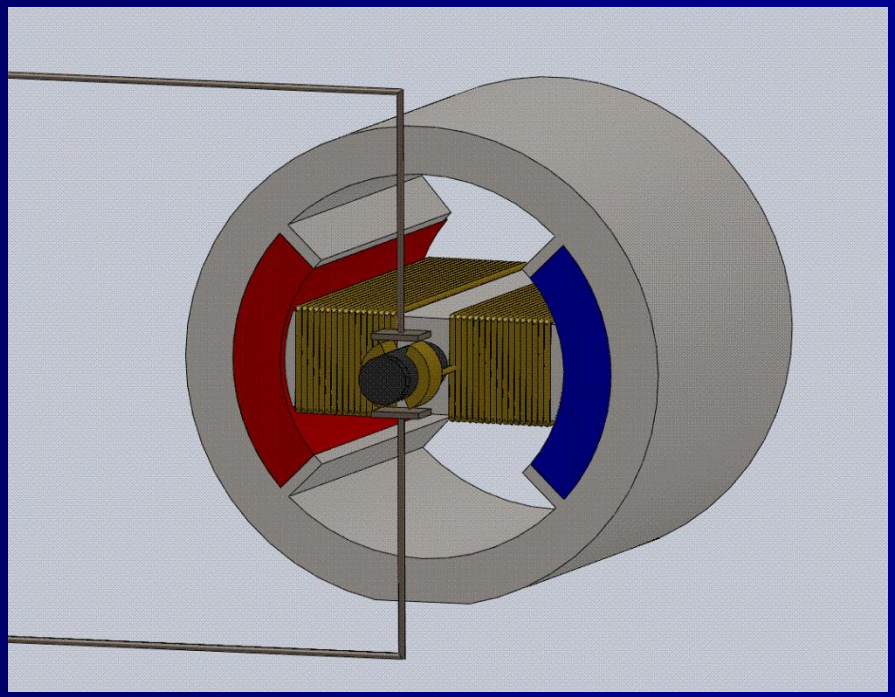
When the current-carrying conductor is placed within an external magnetic field, the two fields interact and a force is exerted on the conductor



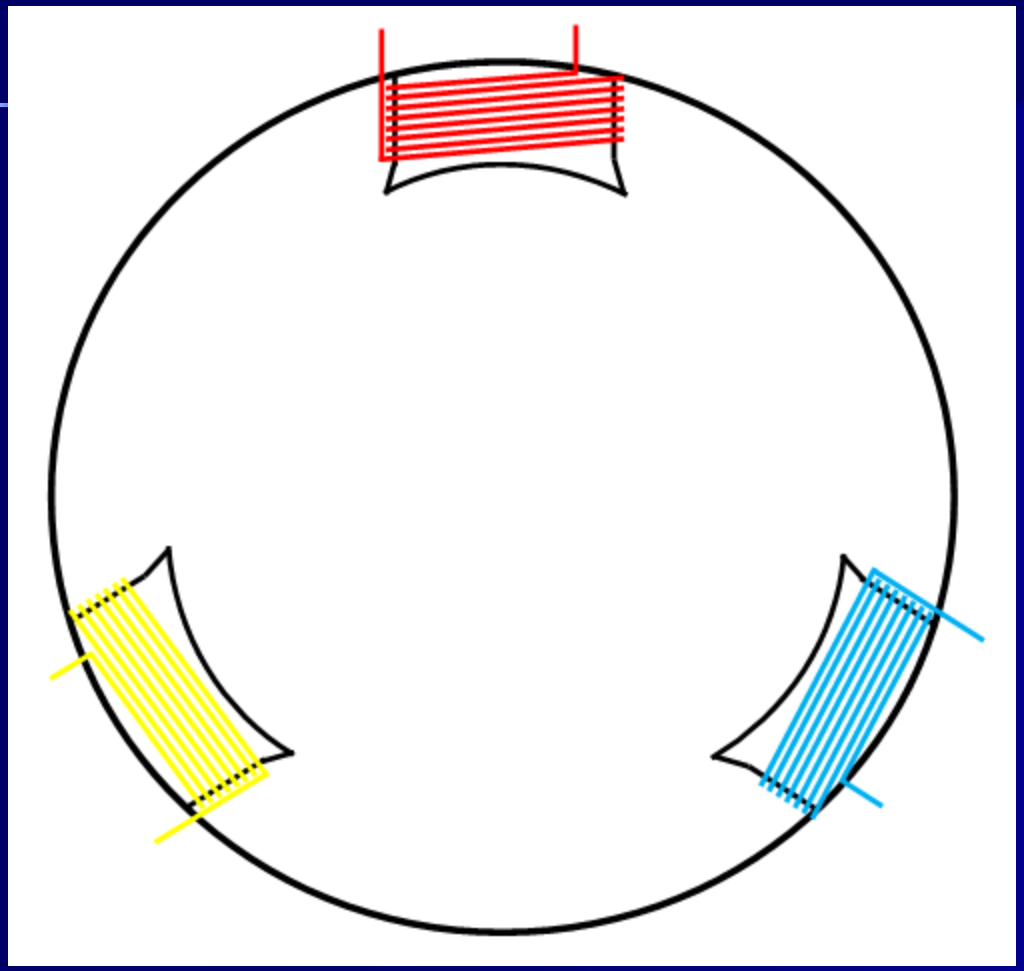
(Flemings Left Hand Rule)

Basic DC Motor

If the current-carrying conductor is placed within an external magnetic field and coiled in a loop the conductor field can be increased in strength, the fields interact on both sides of the loop and a force is exerted on the conductors to make them rotate

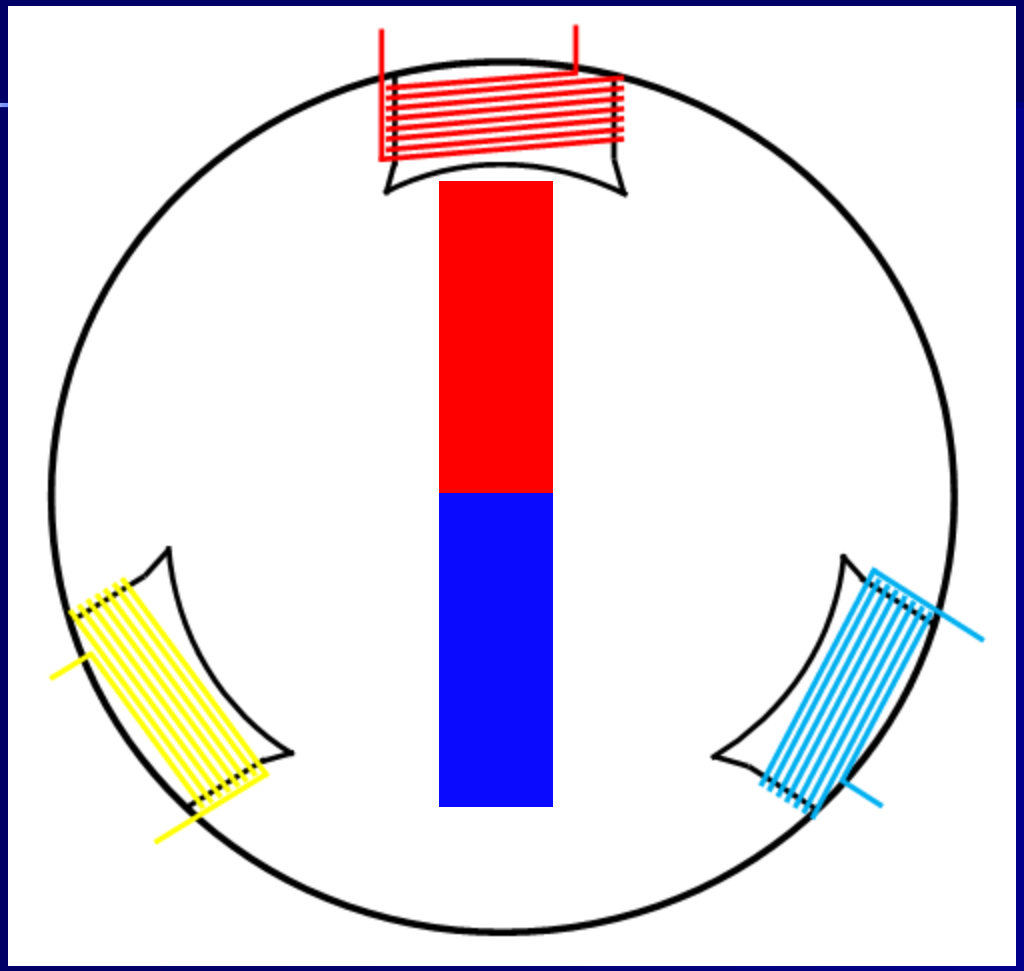


Three Phase AC Winding



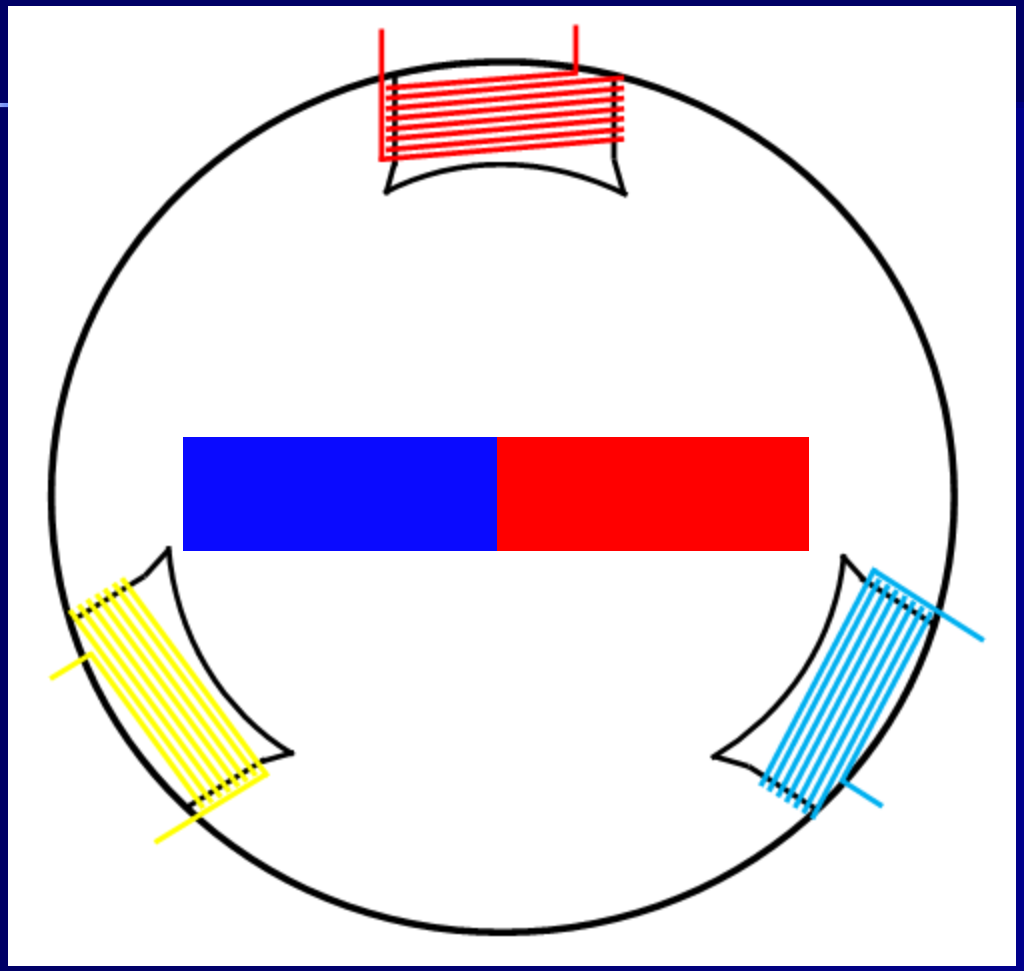
With three windings we can position them 120^0 apart to give us 3 pole faces

Three Phase AC Winding

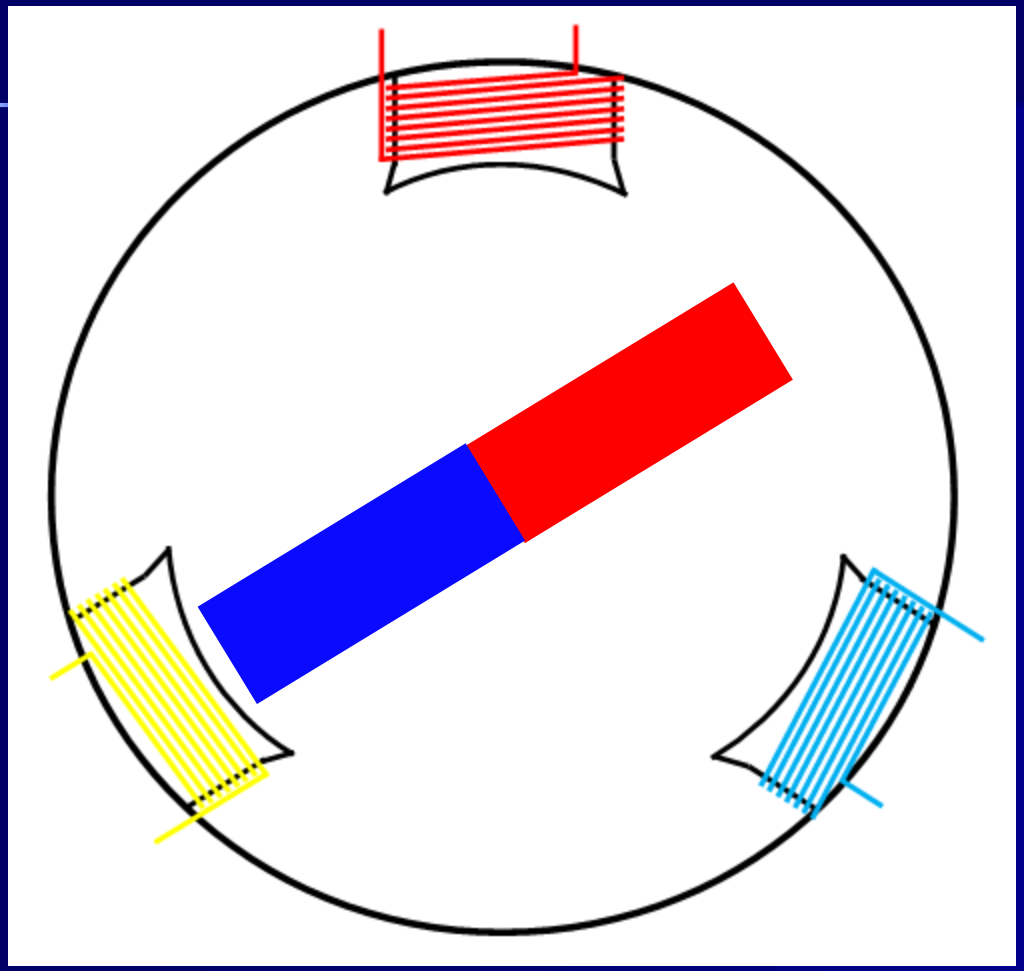


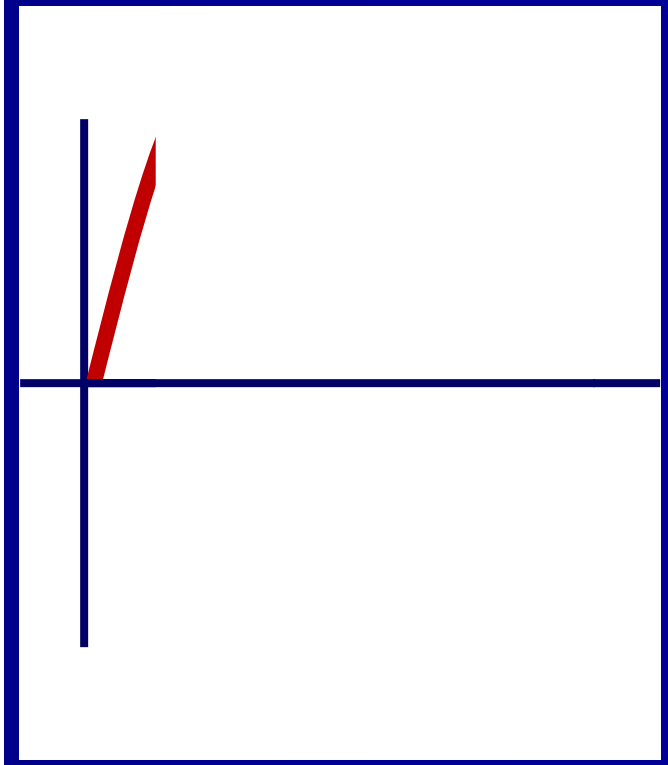
This is how a Generator would be configured

Three Phase AC Winding

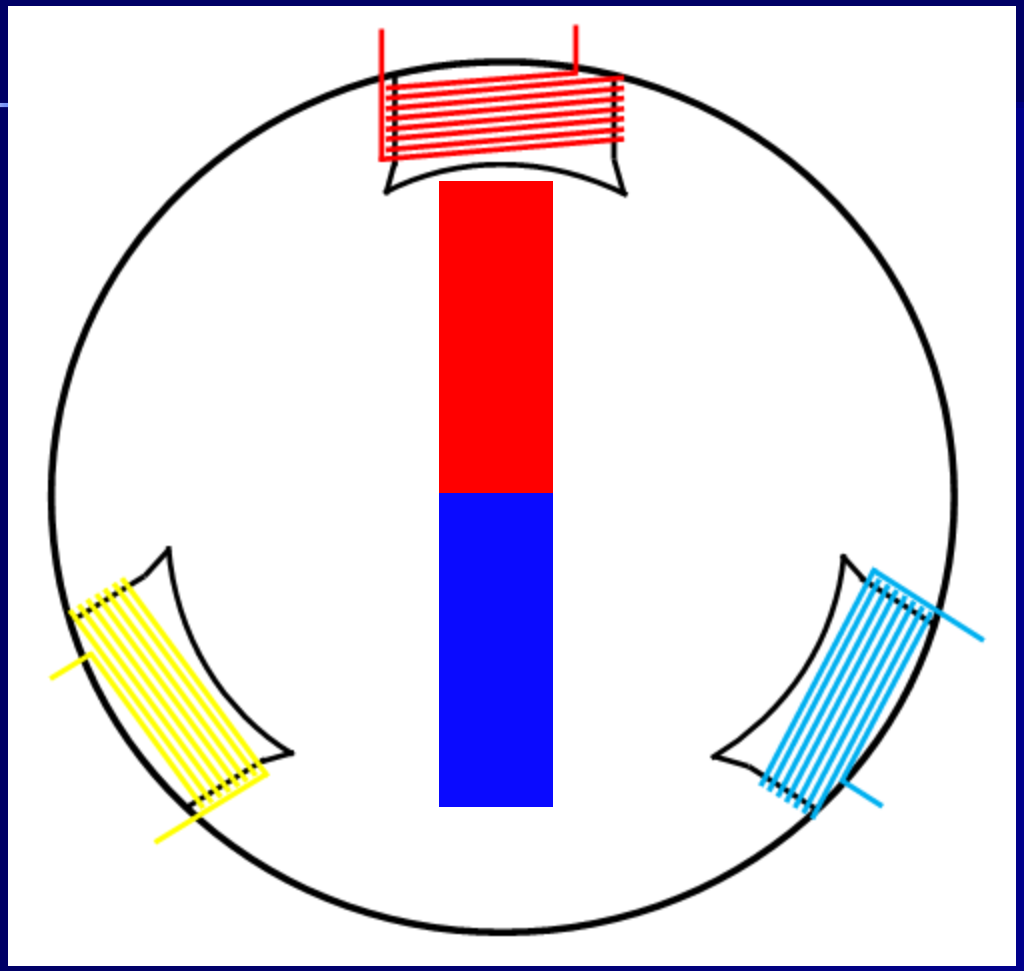


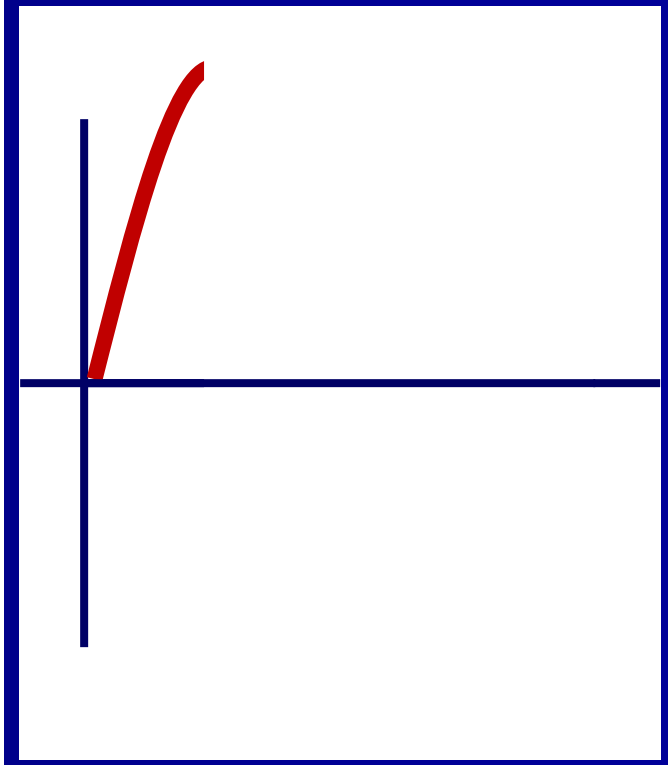
Three Phase AC Winding



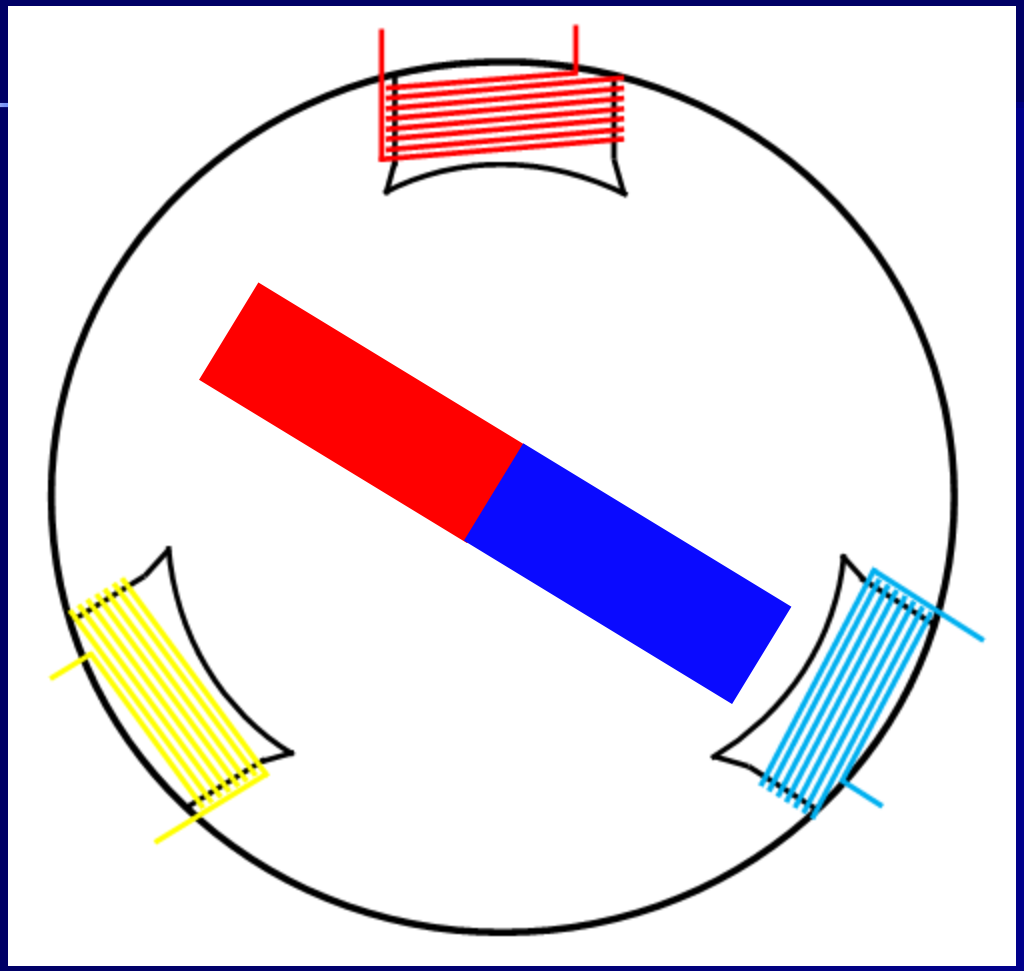


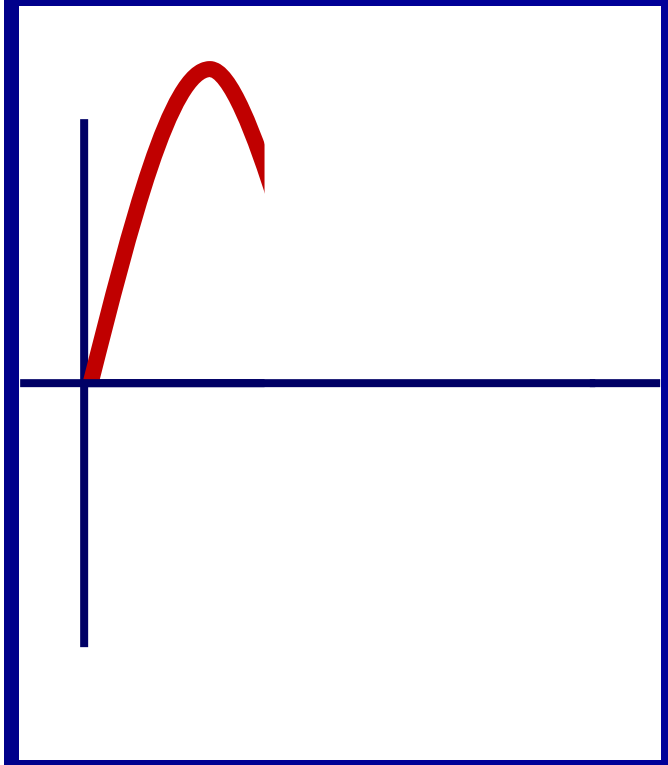
Three Phase AC Winding



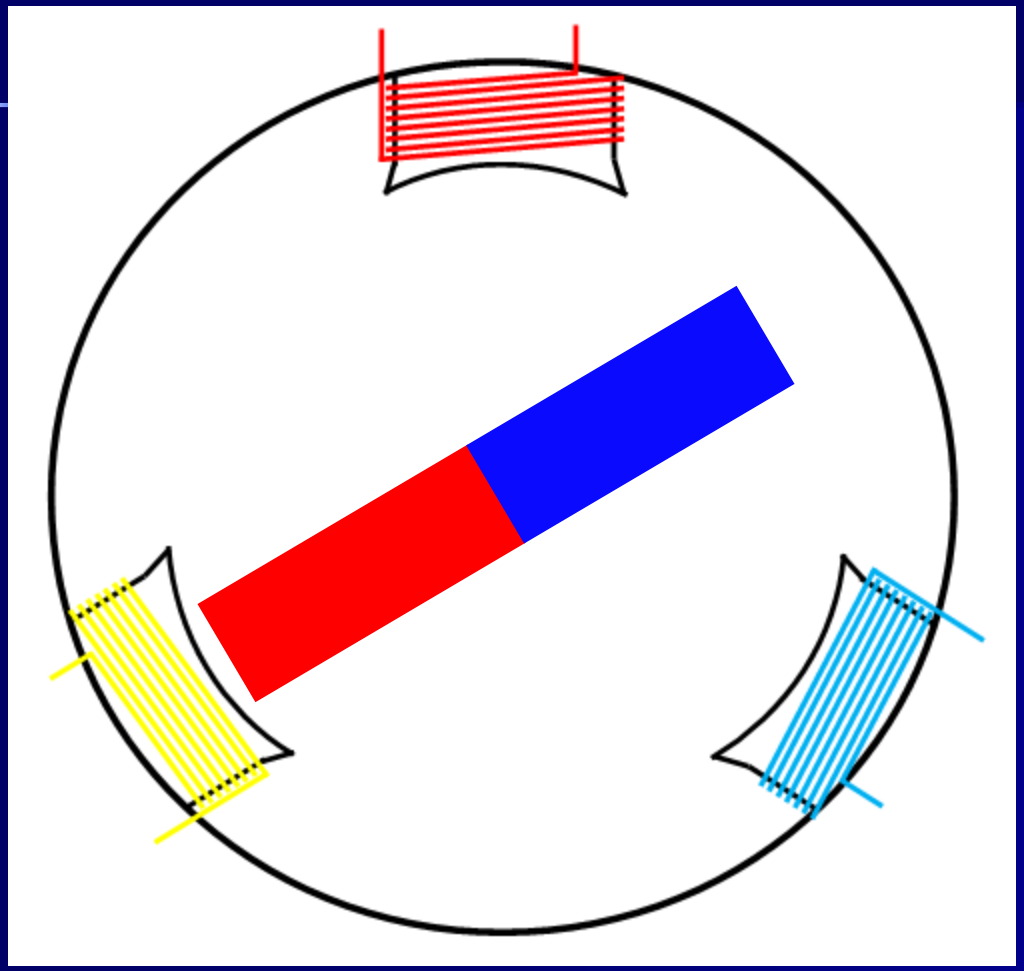


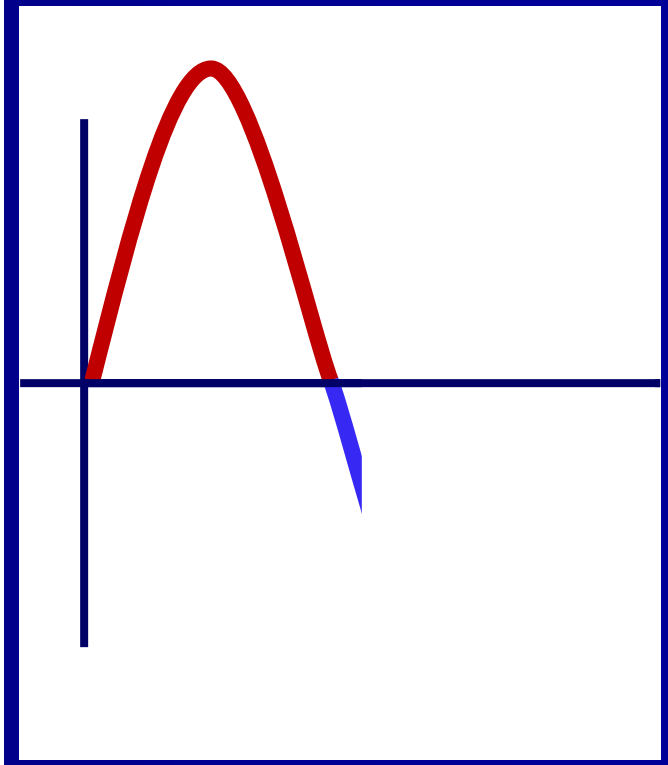
Three Phase AC Winding



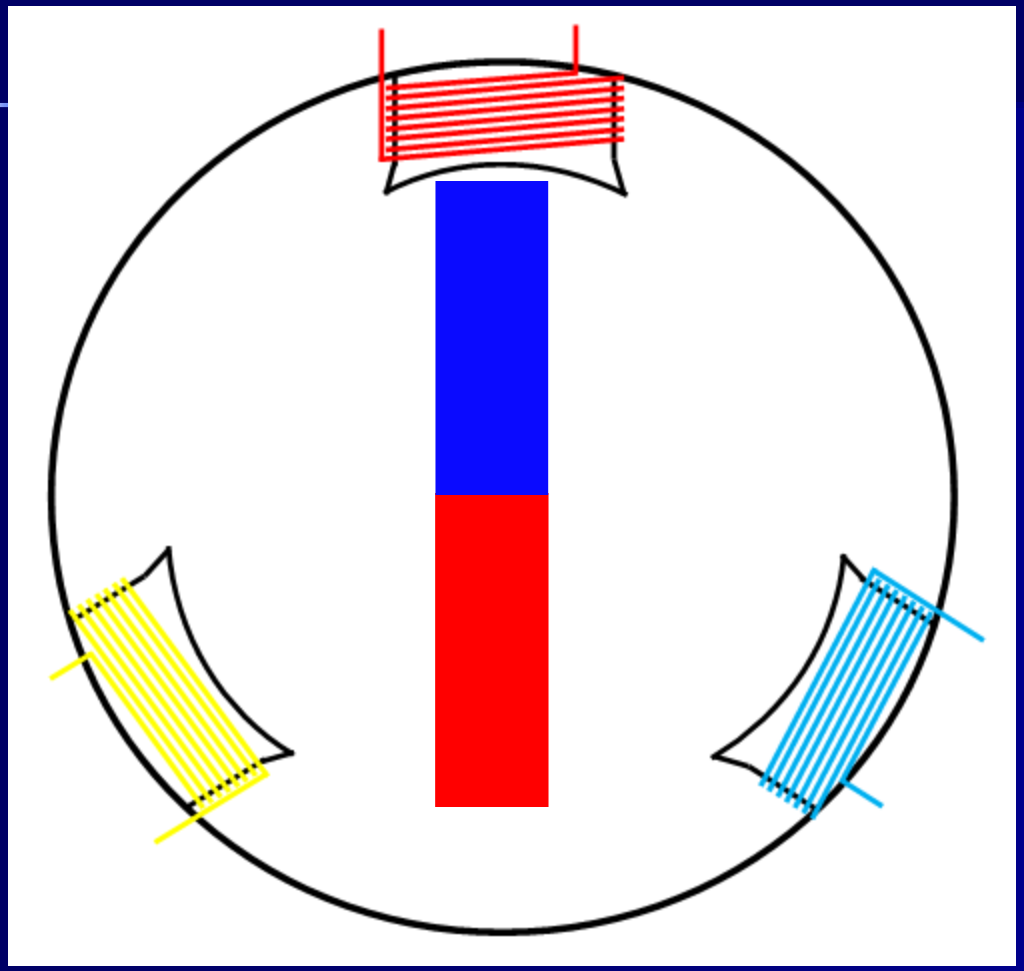


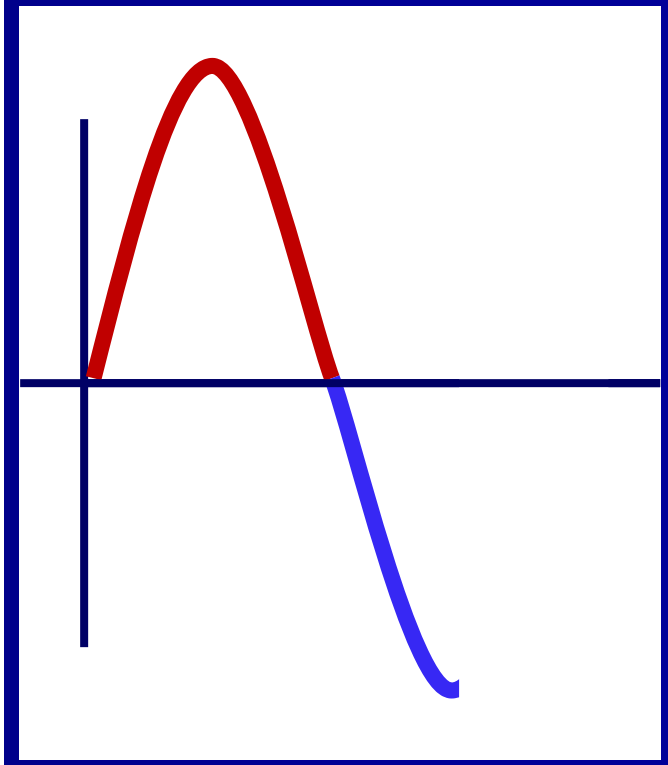
Three Phase AC Winding



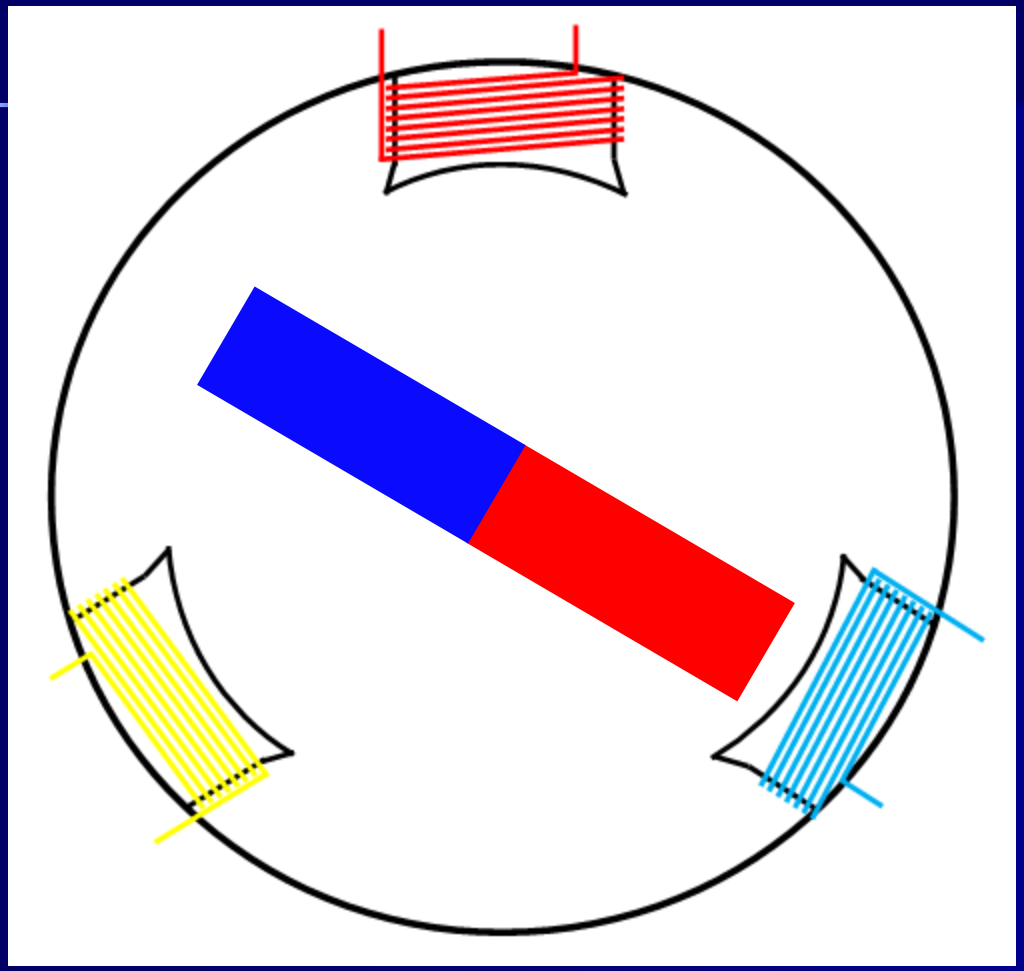


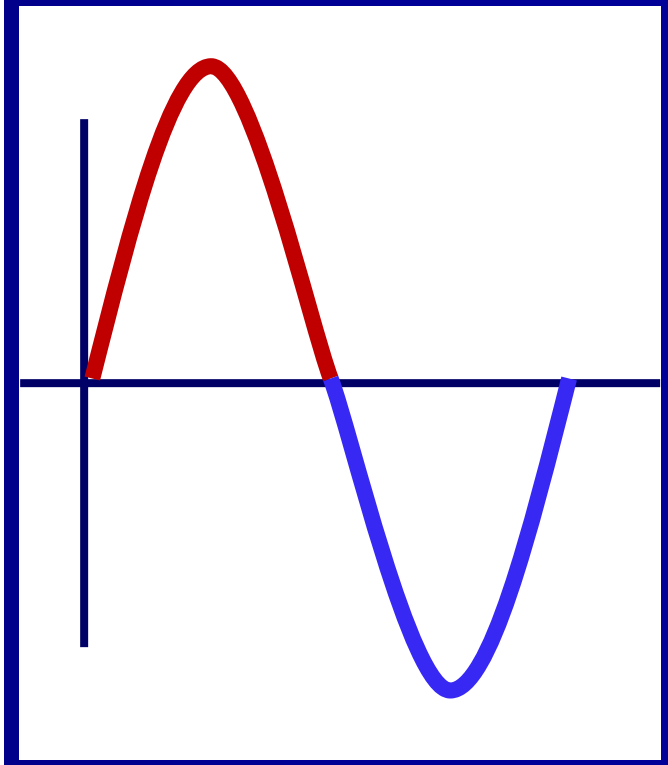
Three Phase AC Winding



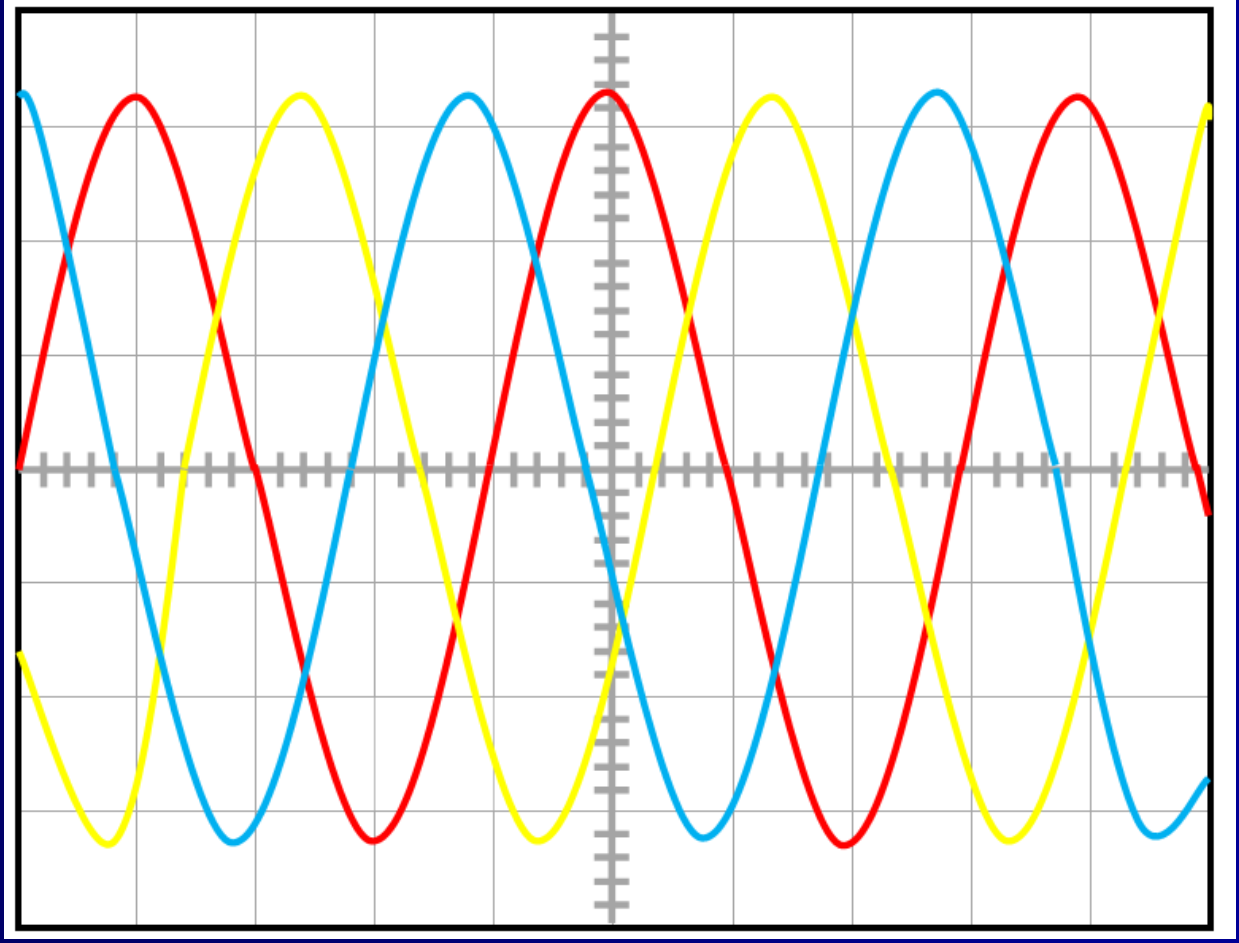


Three Phase AC Winding

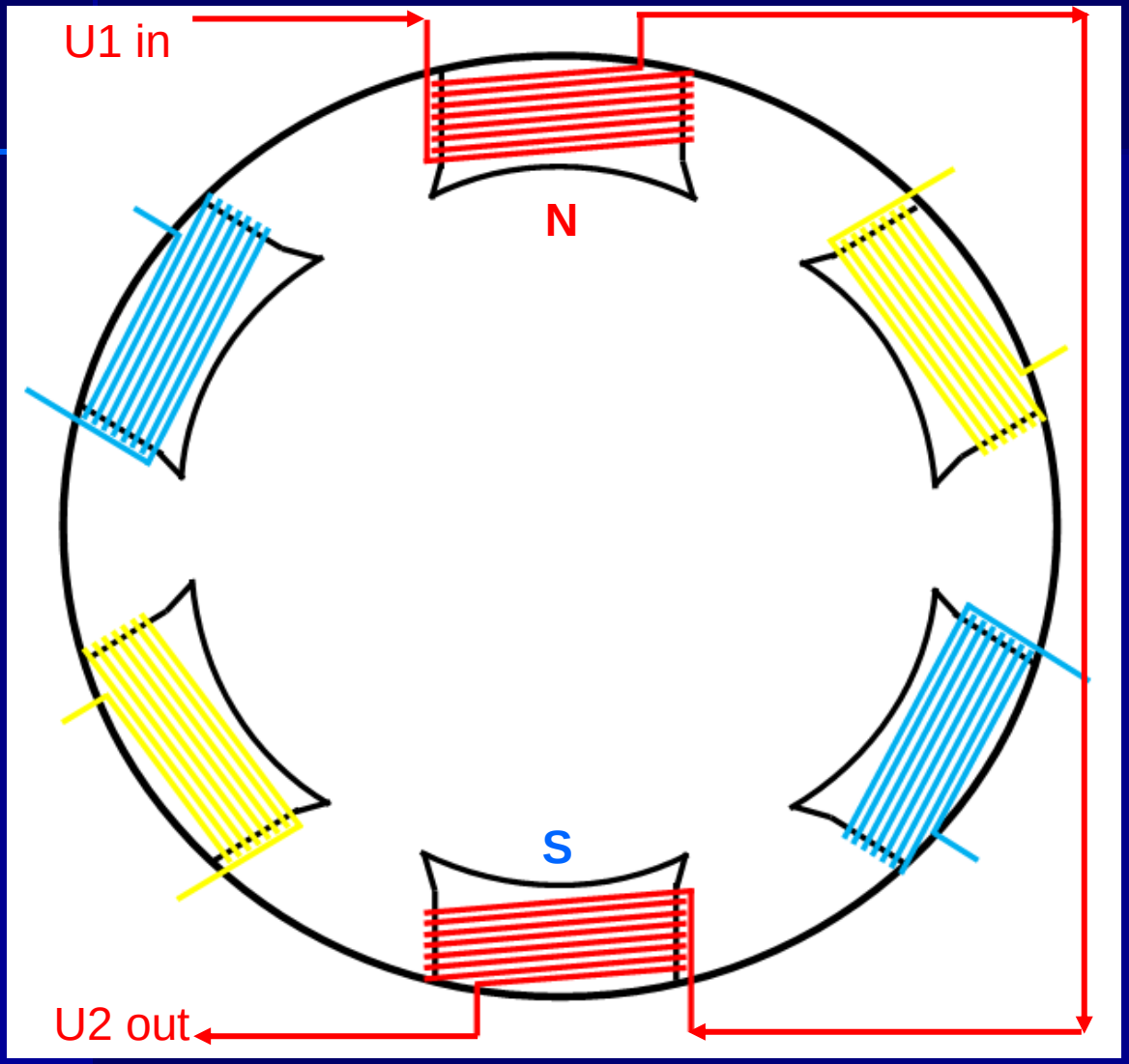




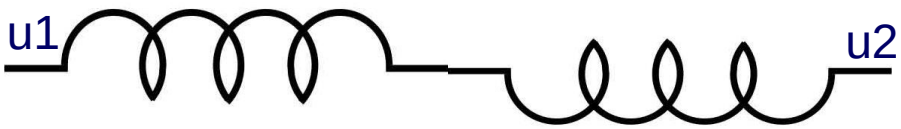
Three Phase Supply Rotation

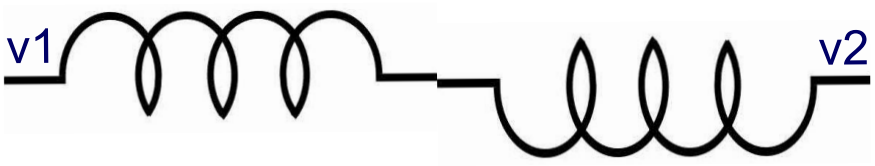


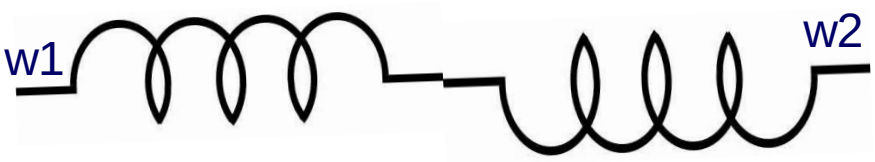
Stator Windings



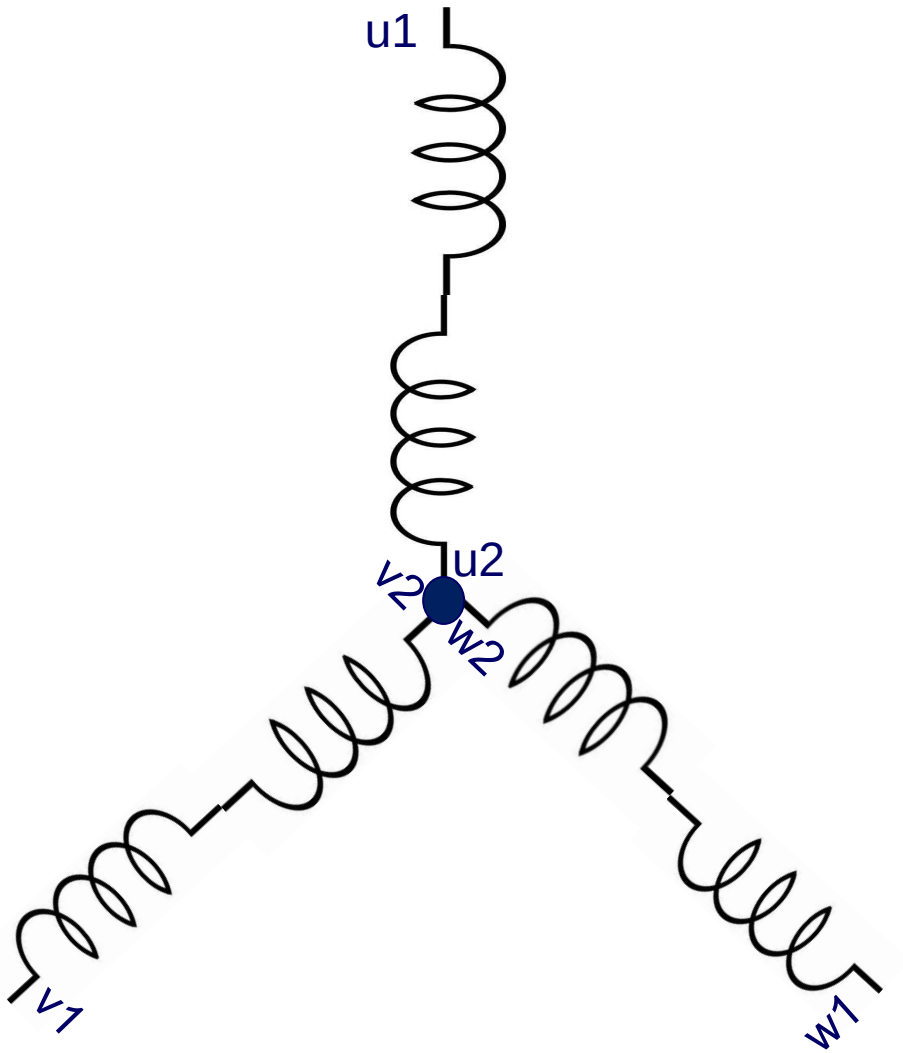
3Φ AC induction motors are wound to give us pole pairs, North & South for opposite pole faces. Here we have a 2-pole motor i.e., 2 poles per phase or 1 pole pair per phase


u1
u2

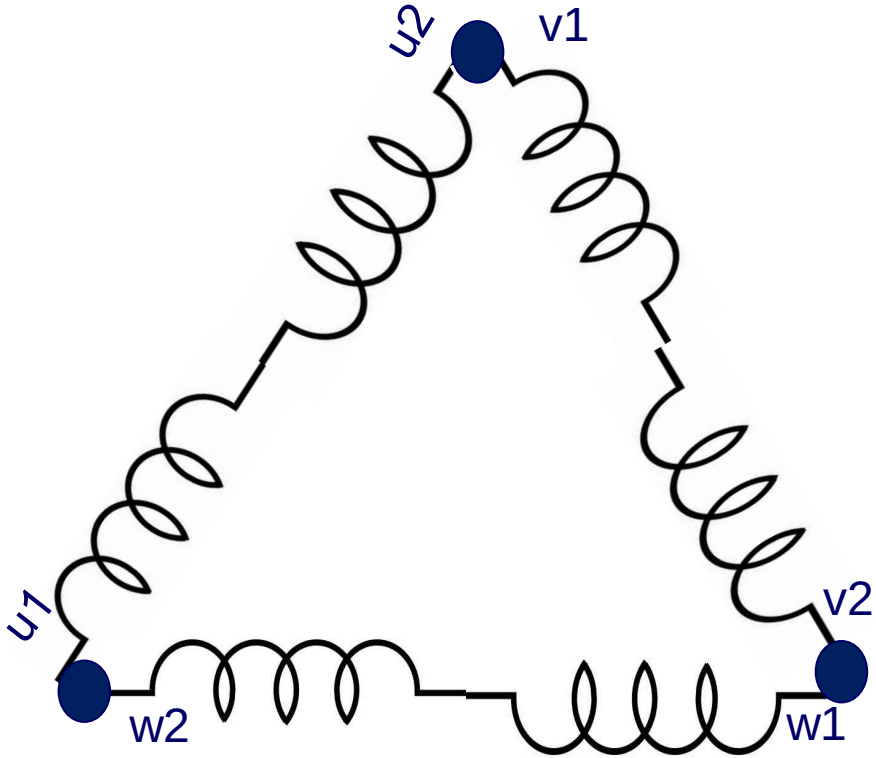

v1
v2


w1
w2

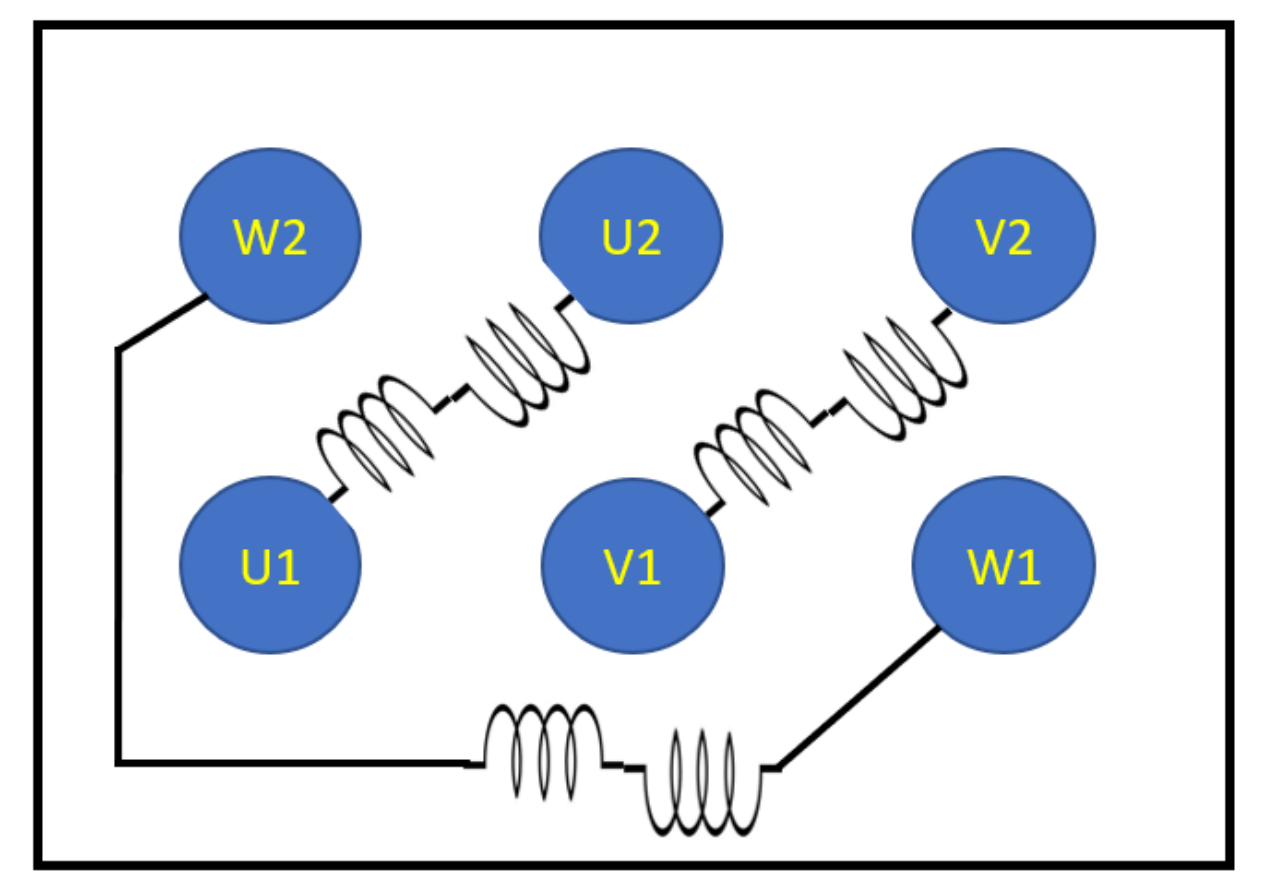
STAR CONNECTED



DELTA CONNECTED

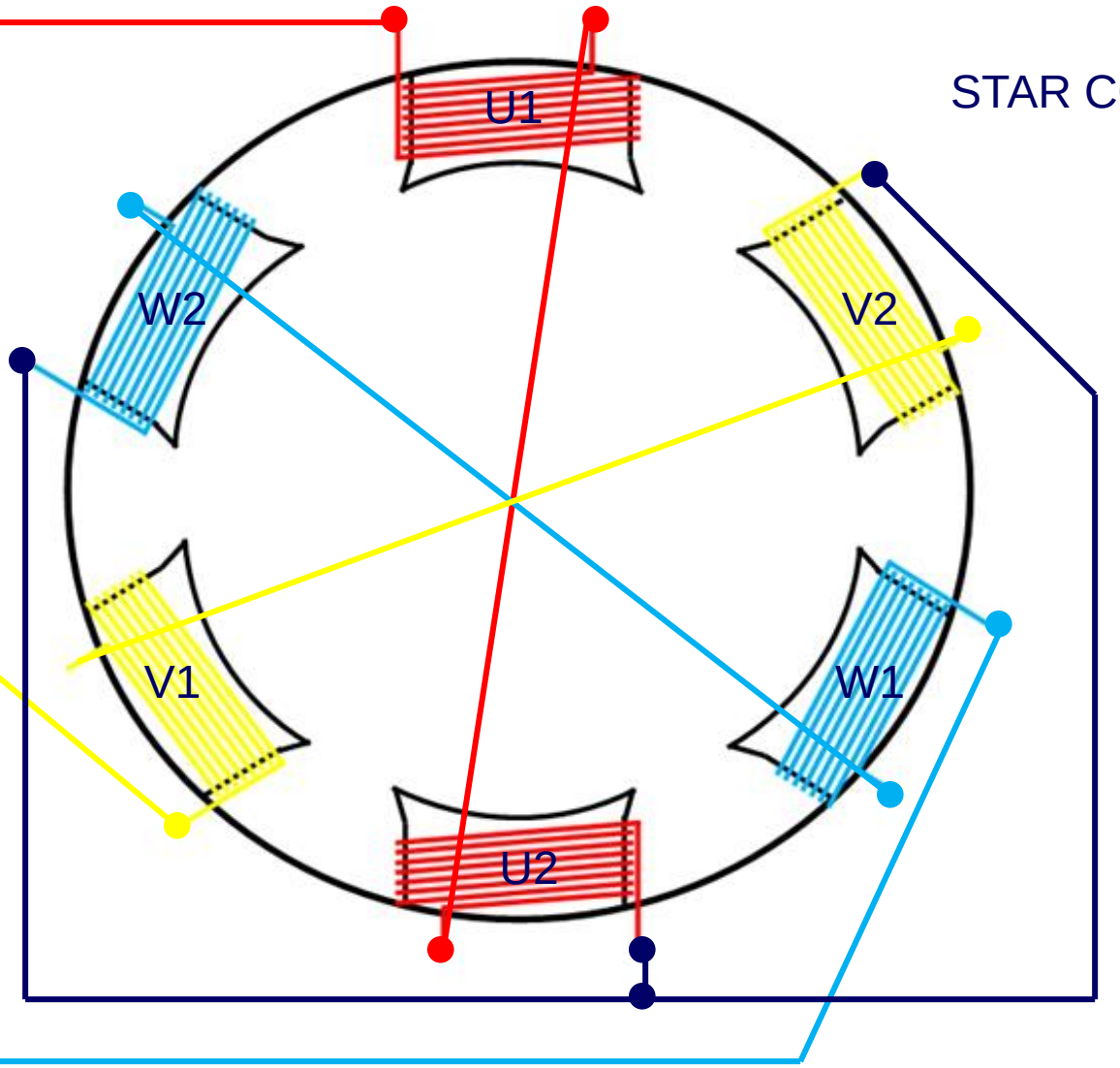


Terminal Box Configuration

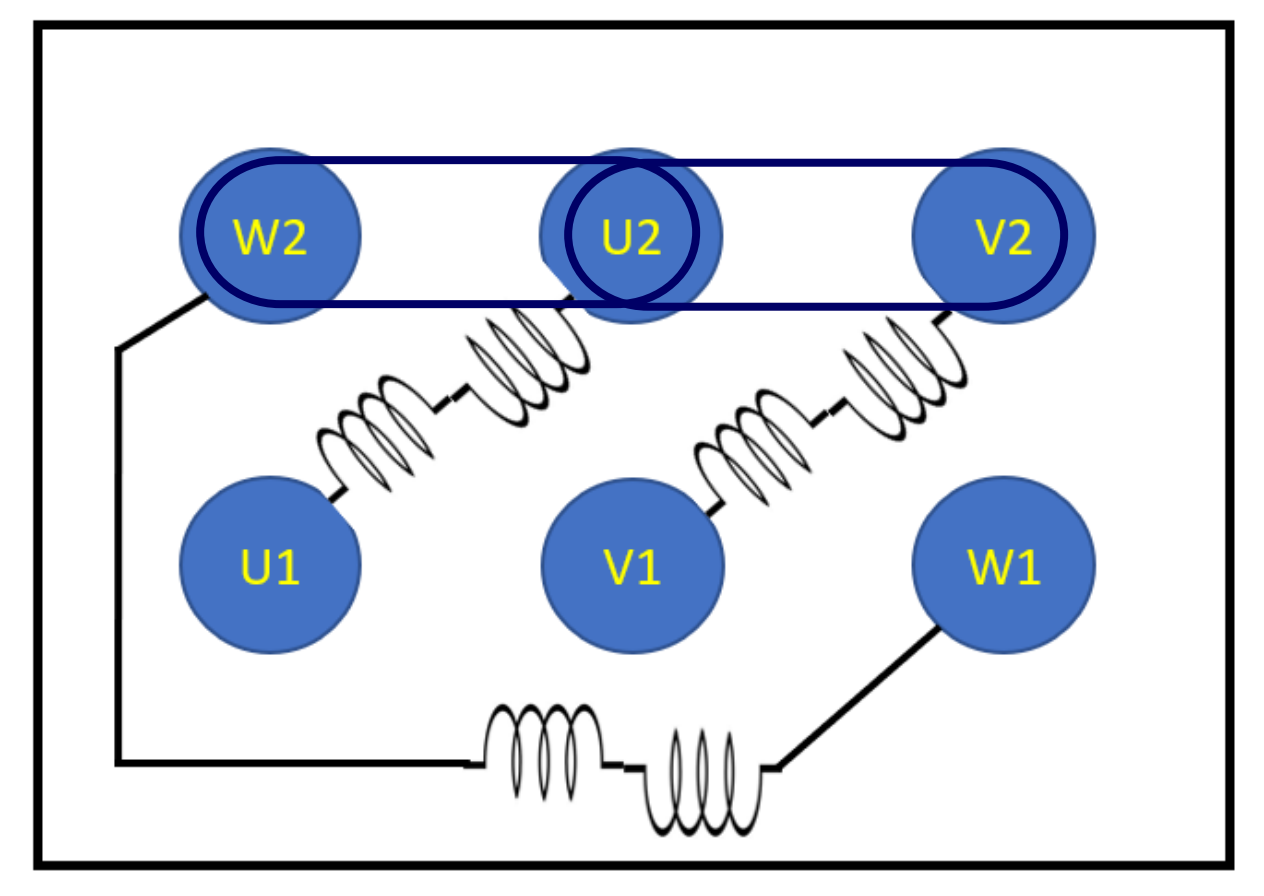


3 phase
supply
400V
50Hz

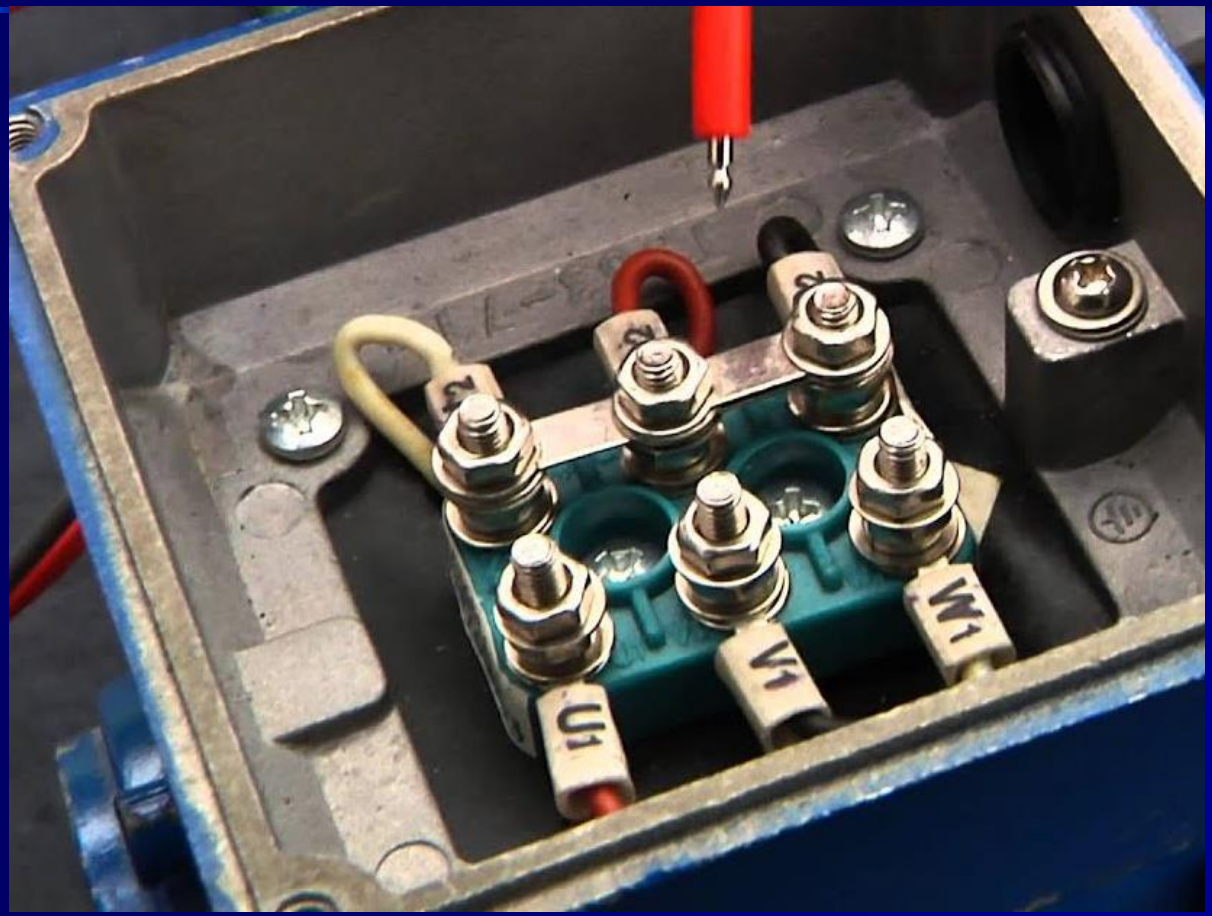
STAR CONNECTED



Terminal Box Star linked for Star

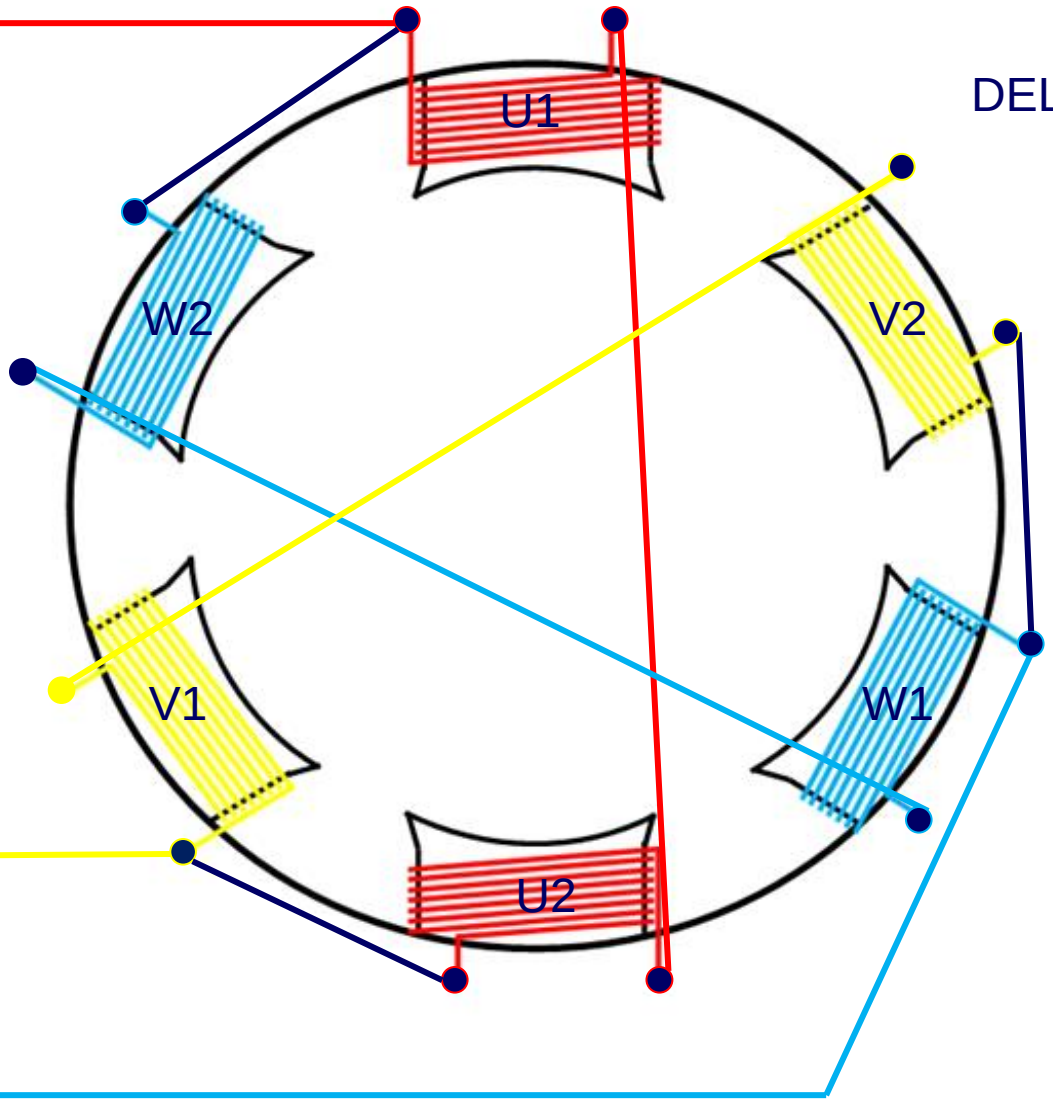


Motor Links



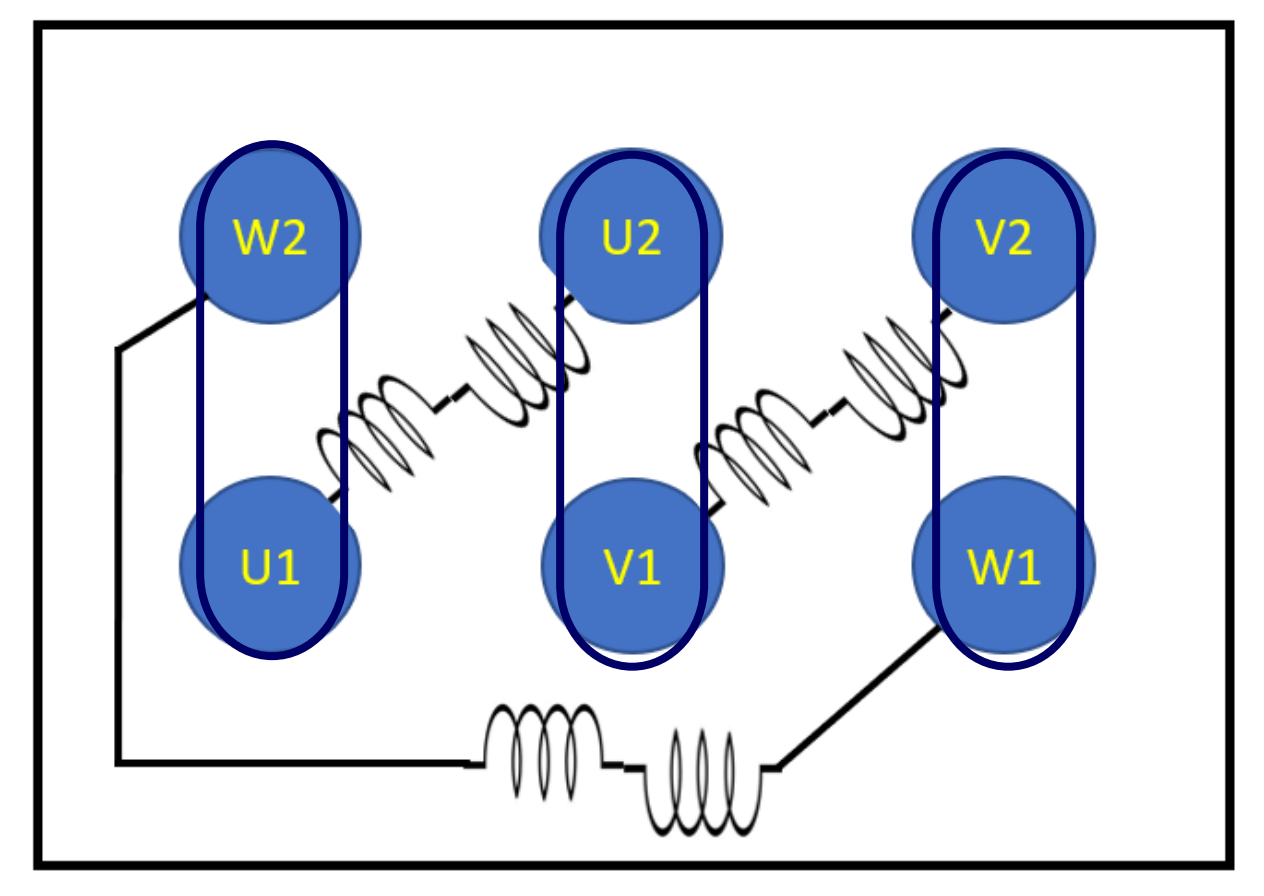
STAR CONNECTED

3 phase
supply
400V
50Hz

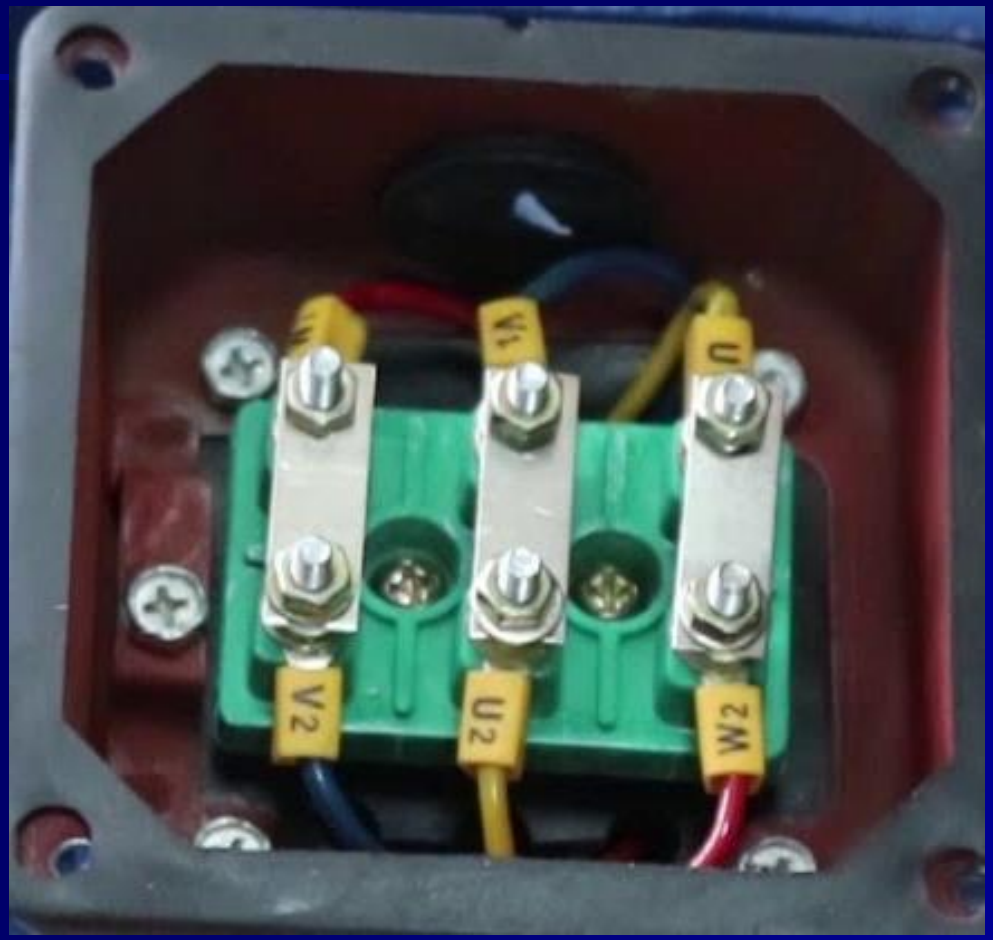


DELTA CONNECTED

Terminal Box linked for Delta

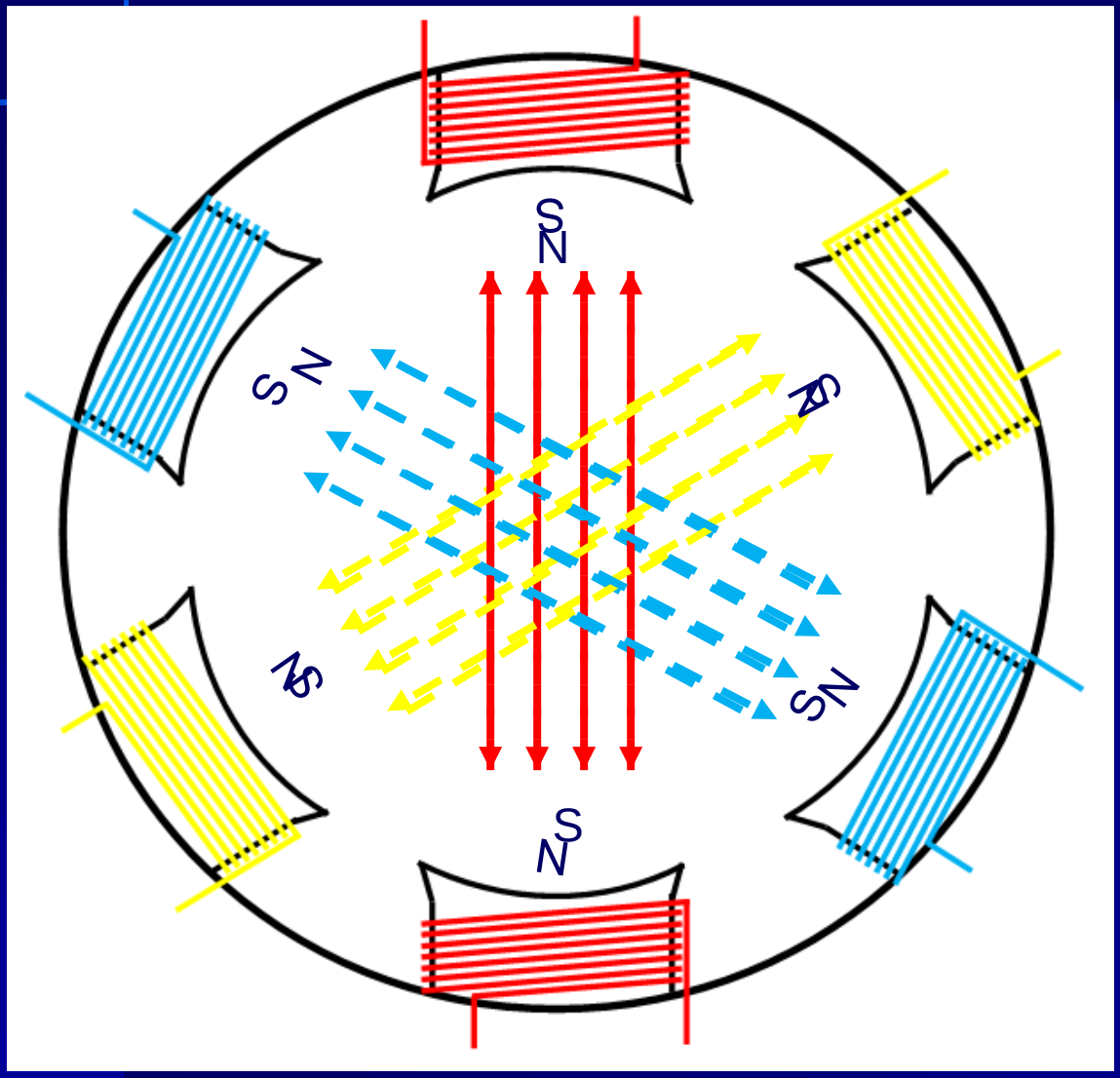


Motor Links



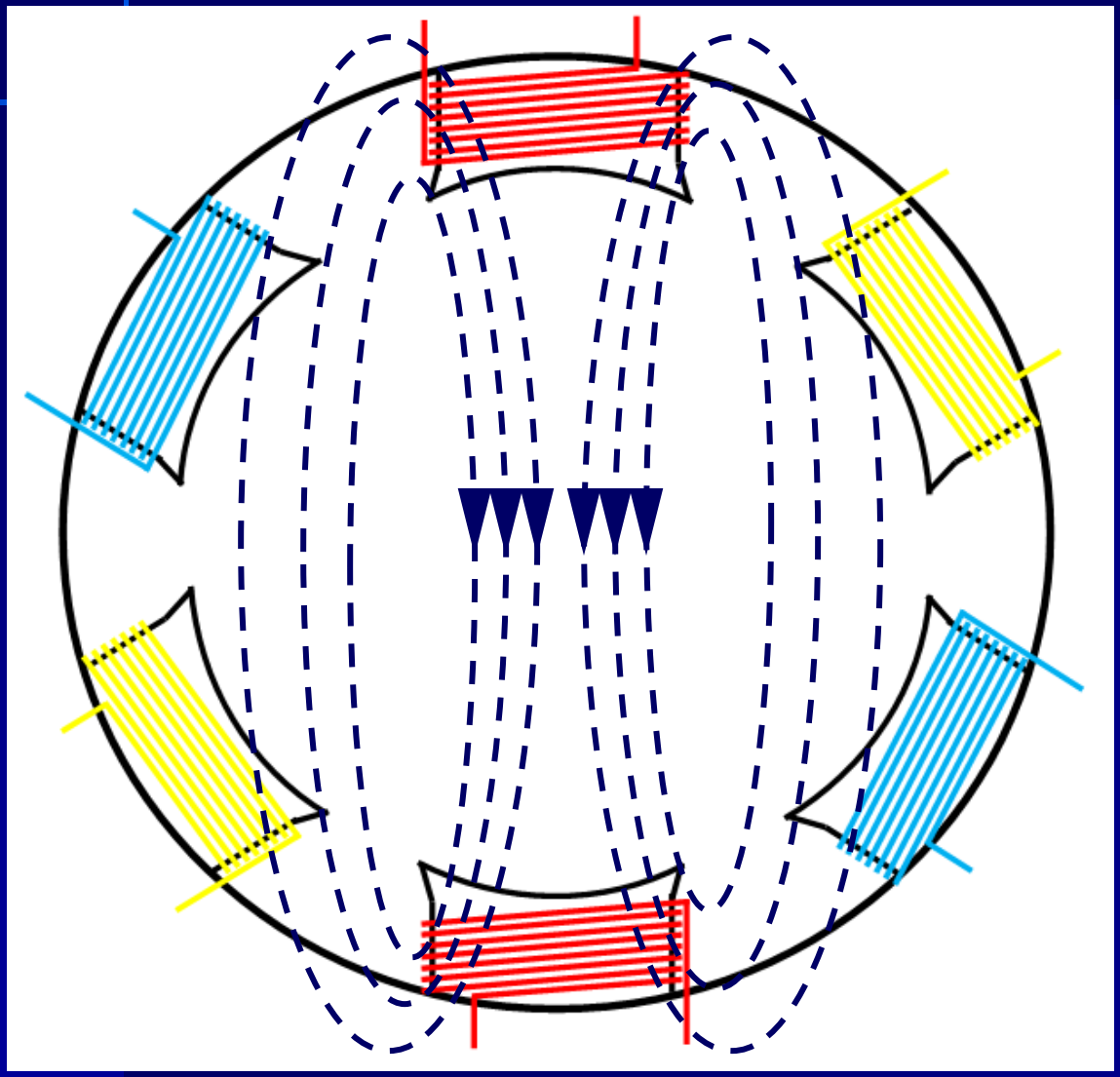
DELTA CONNECTED

Three Phase Stator Windings



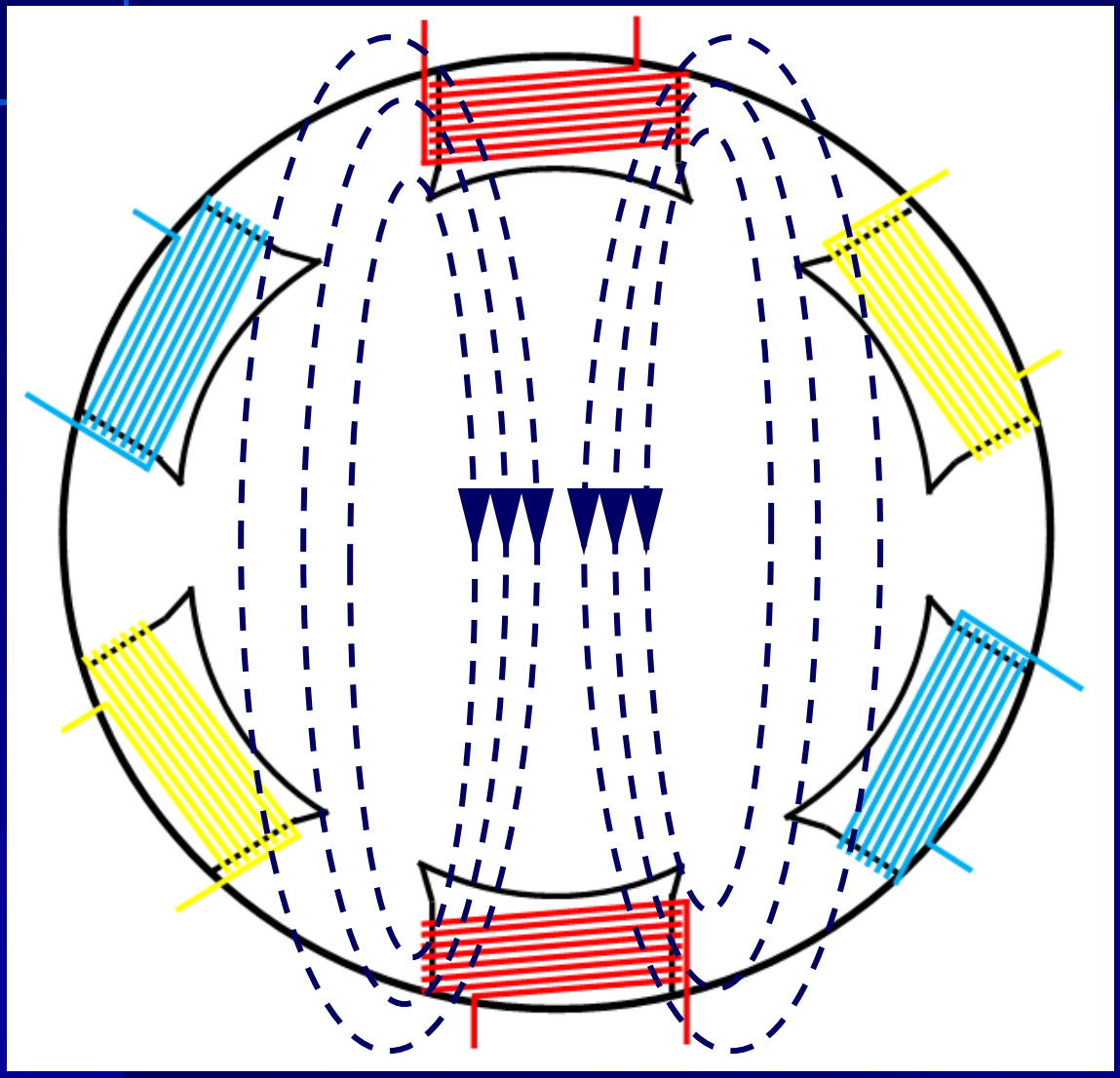
With the three windings now configured for STAR or DELTA we can create pole faces that concentrate the magnetic fields as each phase peaks

Three Phase Stator Windings



The magnetic field will adopt the standard pattern created by a coil and due to phase rotation it will appear to rotate

Three Phase Stator Windings



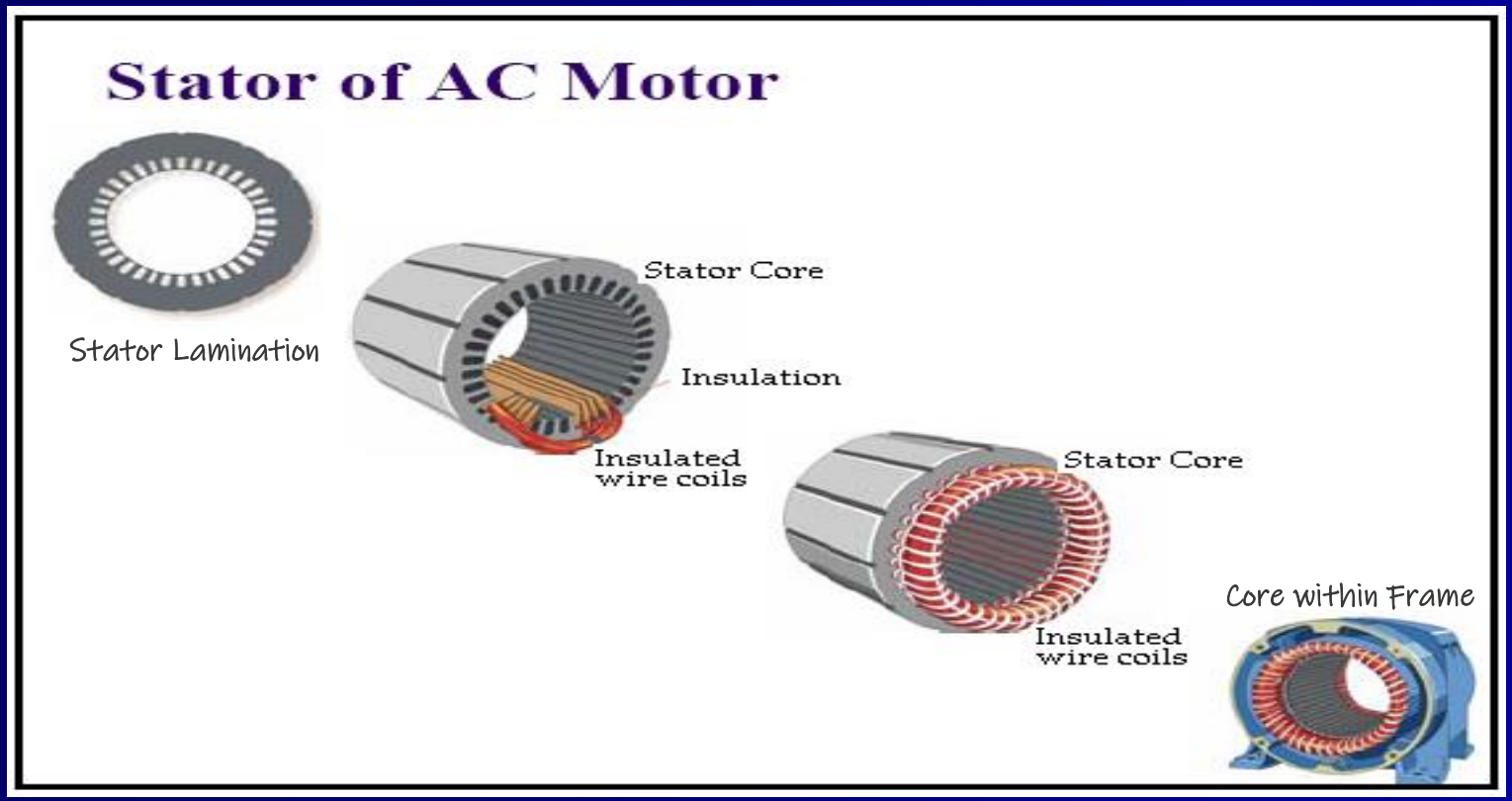
The magnetic field will adopt the standard pattern created by a solenoid and due to phase rotation it will appear to rotate

UK once every 20 milliseconds (50Hz)

AC Cage Induction Motor

This machine uses the same basic principles of motors but also utilises some of the technology of generators and is essentially consisting of two main parts.

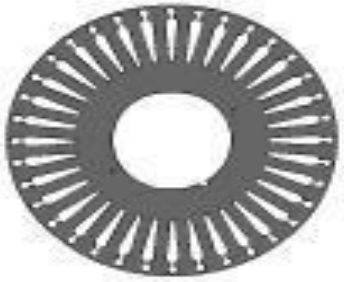
Stator



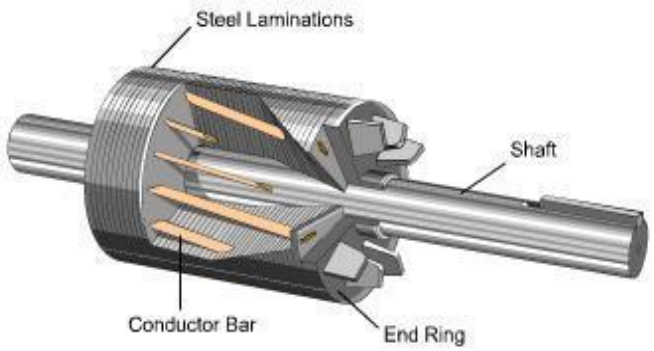
AC Cage Induction Motor

Cage Rotor

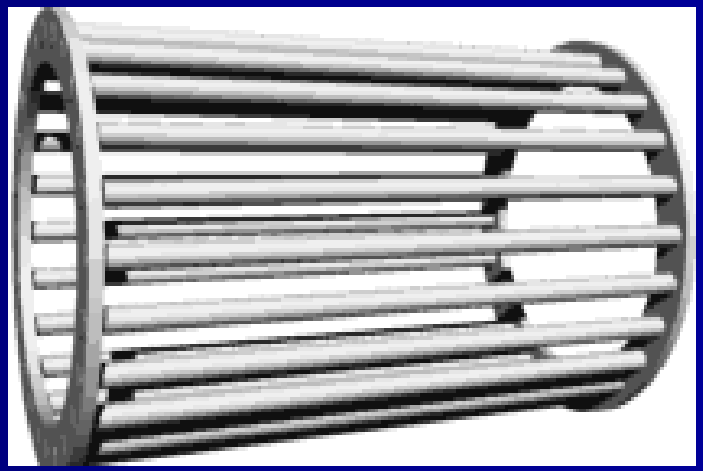
Rotor



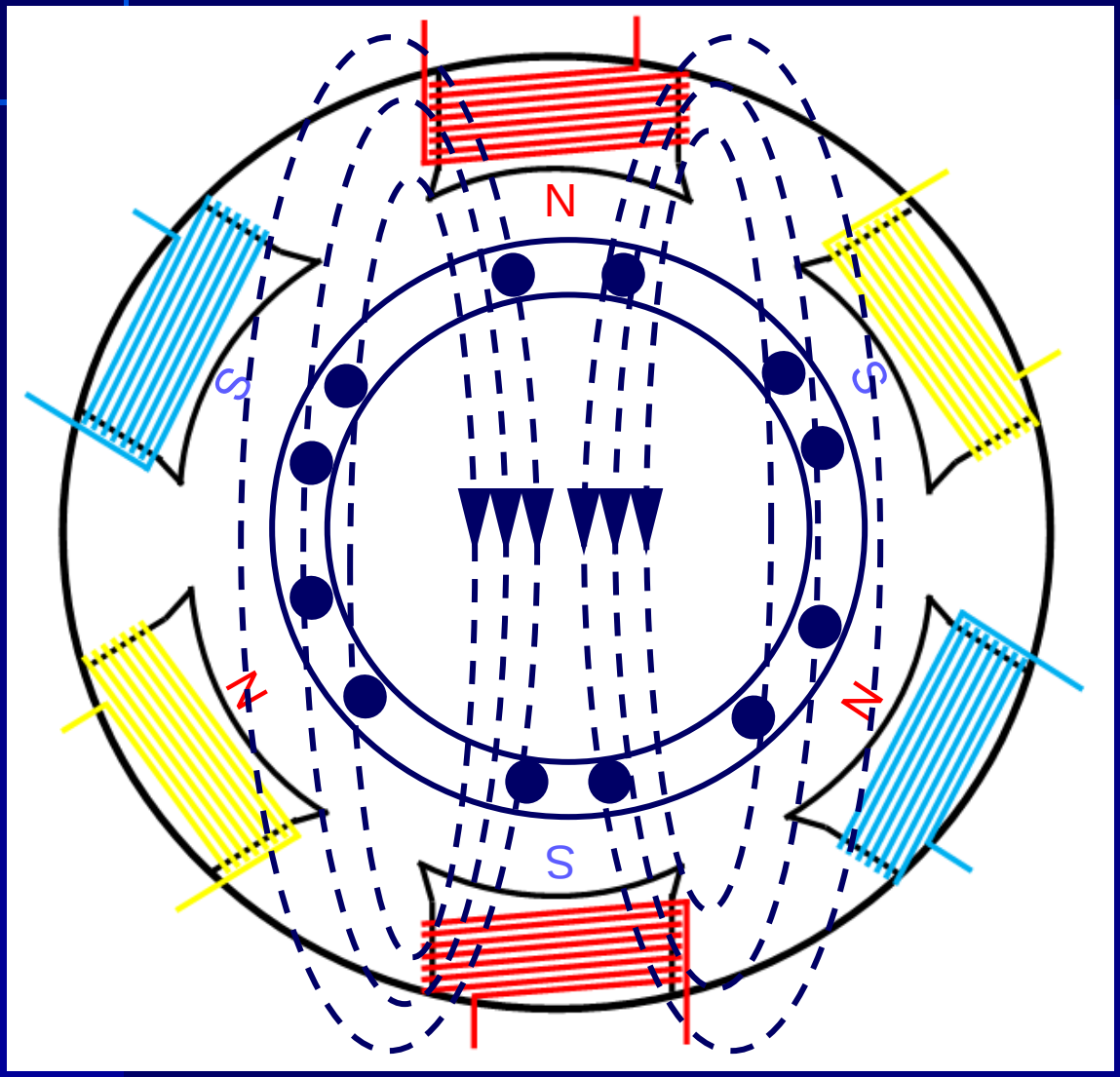
Rotor Lamination



Cutaway View of Rotor

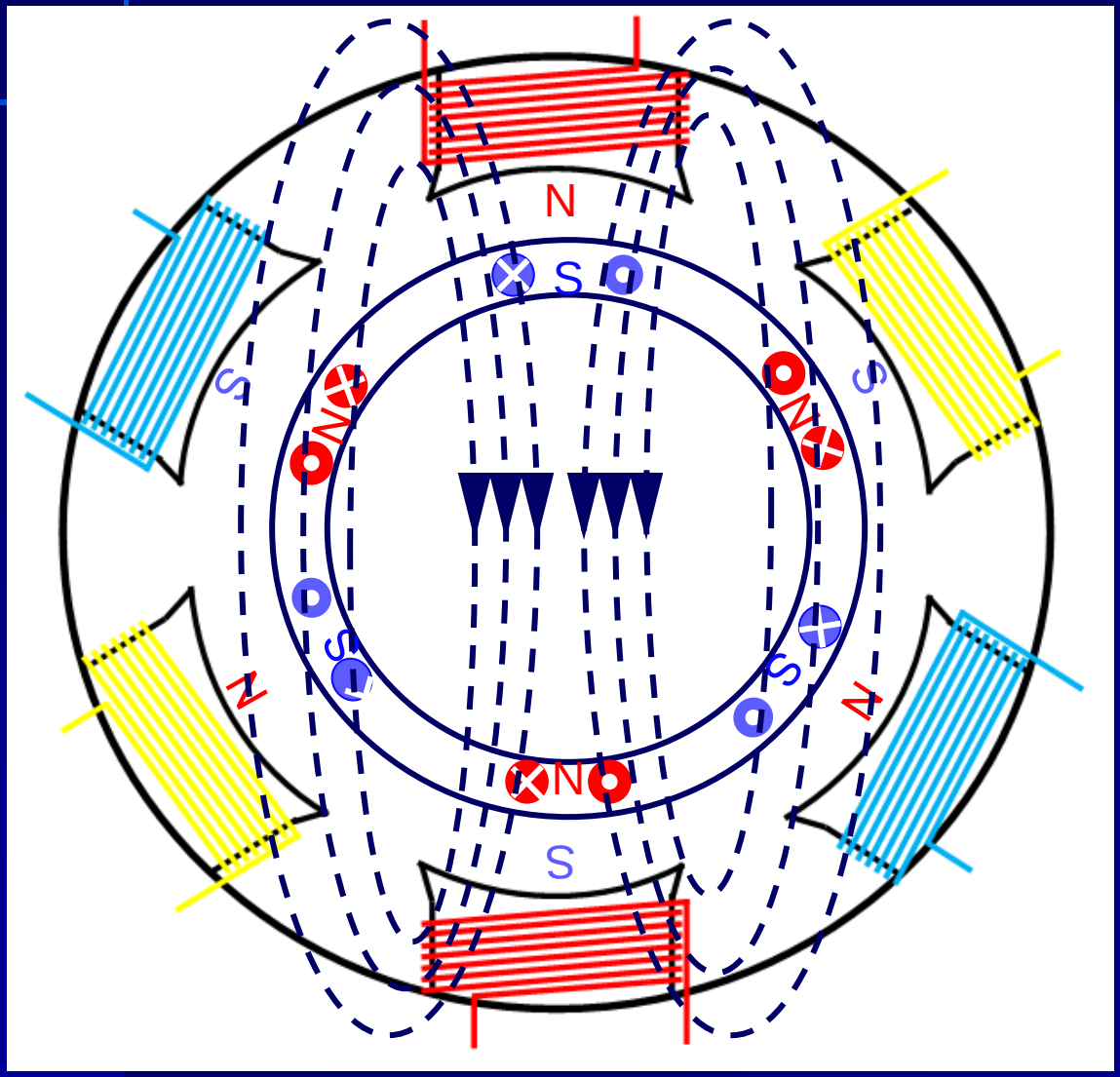


Induction into Rotor



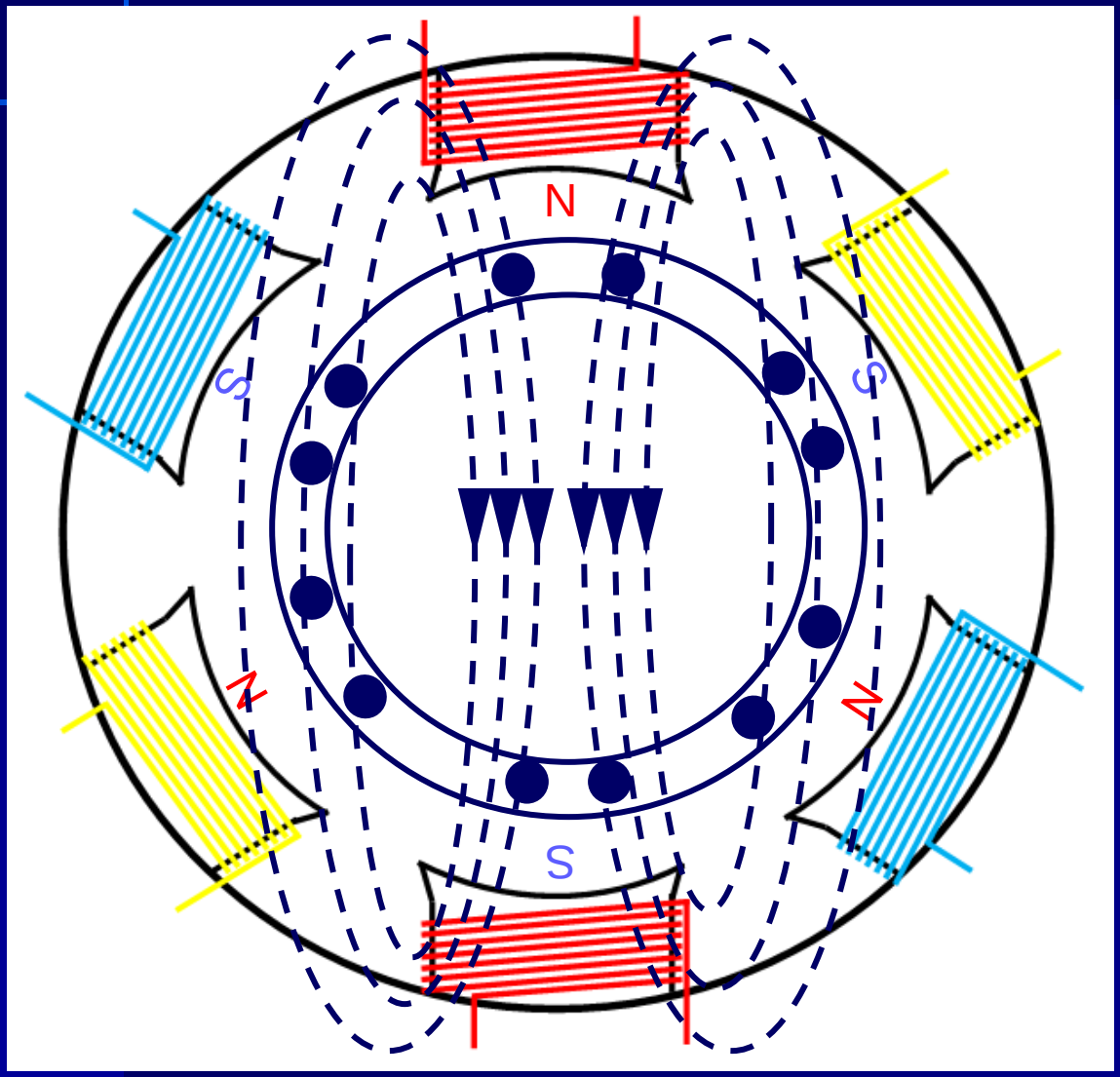
If we now place the cage rotor inside the rotating field of the stator that rotating field will induce a current into the bars of the cage as they are closed loops

Induction into Rotor



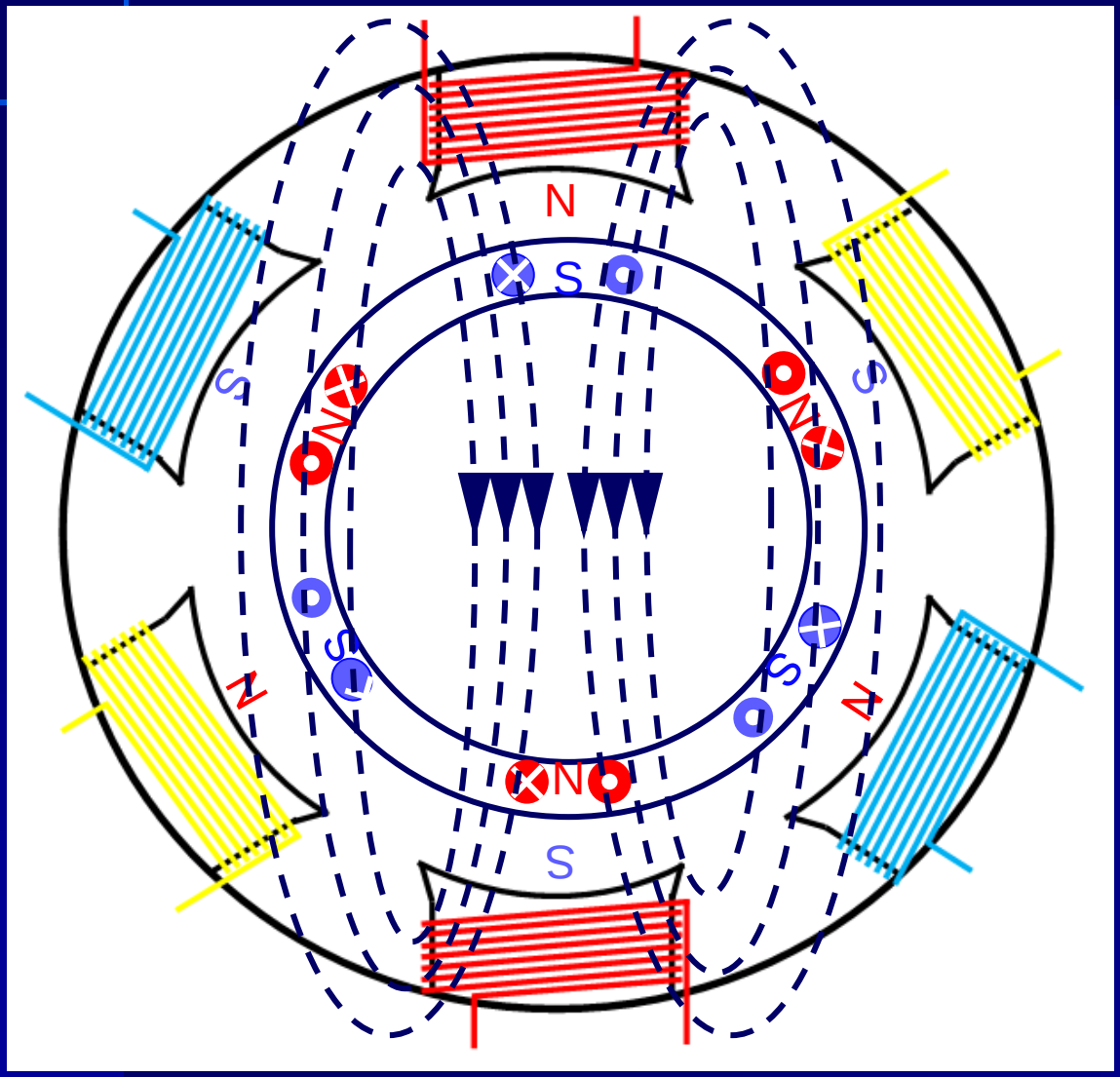
These individual loop currents will create their own fields which will try to lock on to the rotating stator field therefore the rotor will rotate in the direction of the rotating field

Induction into Rotor



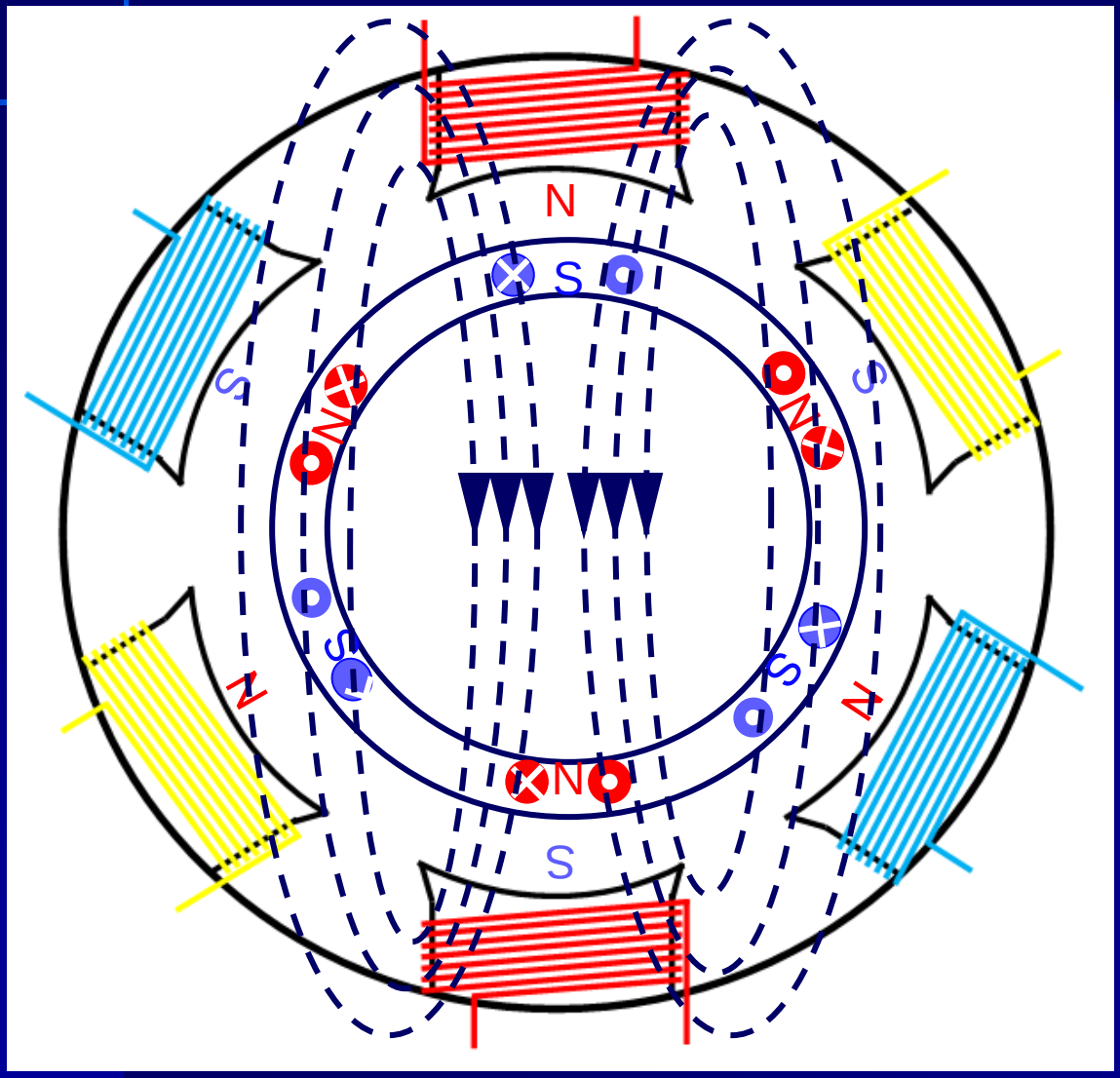
If the rotor catches up to the stator they will become synchronous and no current will be induced into the rotor bars and it will slow down

Induction into Rotor



The slowing down of the Rotor speed to less than the Stator field speed re induces current into the Rotor bars and the motor would speed up again

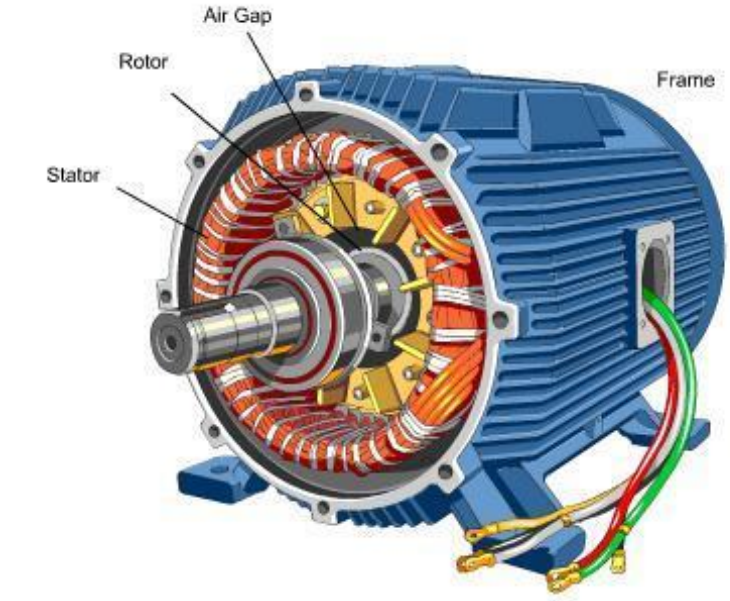
Induction into Rotor



We clearly don't want the motor speeding up and slowing down so the Rotor is designed to run at slip speed (asynchronous) so there is always interaction between the Rotor and the Stator

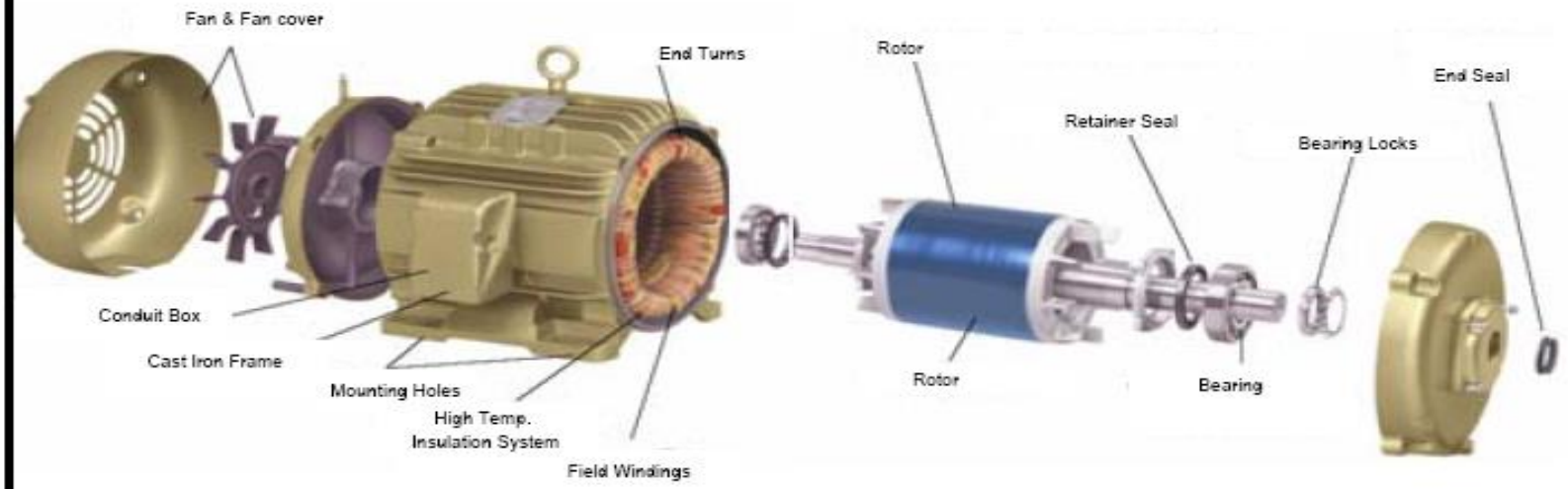
Three Phase AC Motor

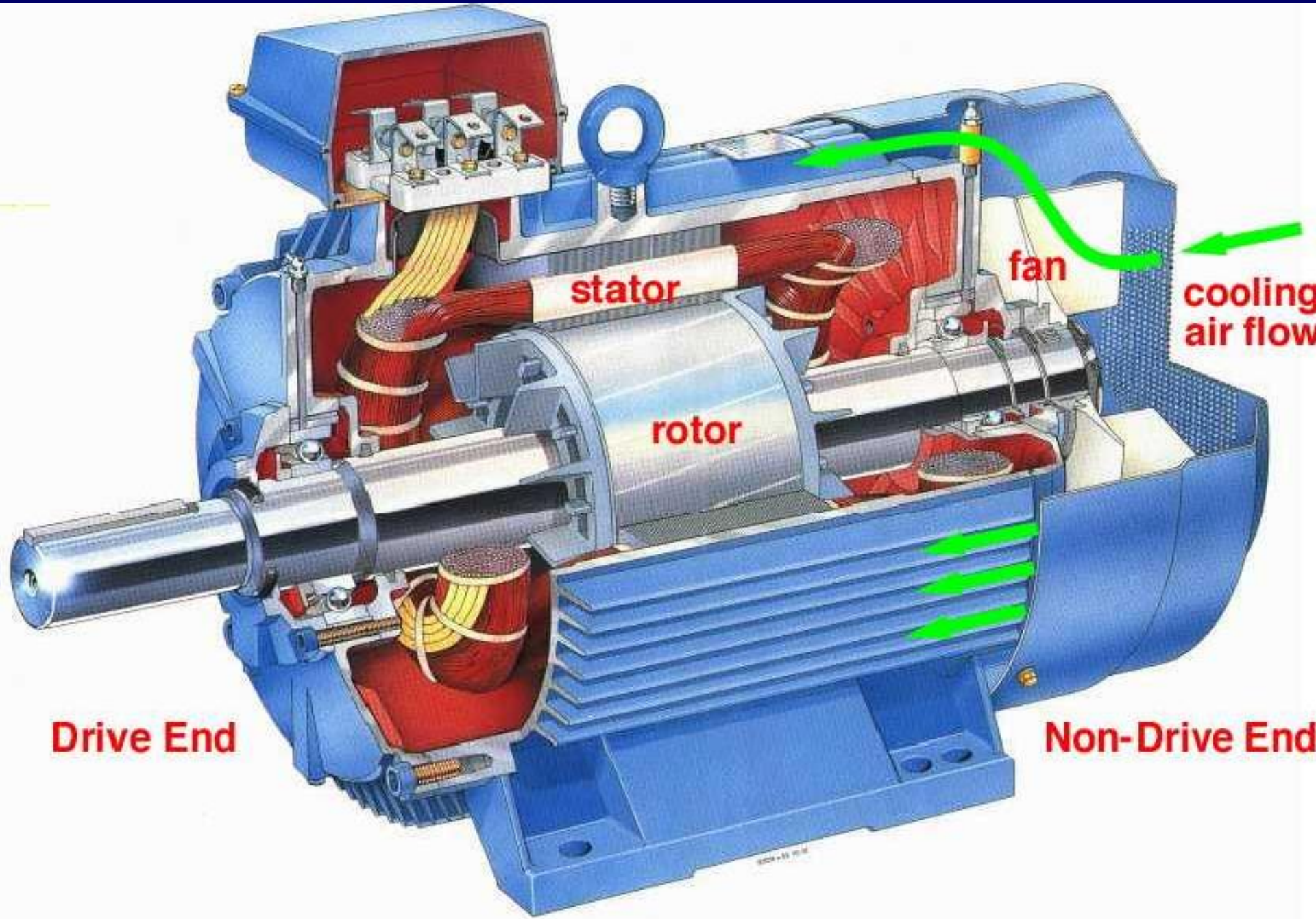
- It has three pairs of electromagnets, connected to one of the three phases of the power supply.
- It provides a lot higher power that a single phase motor can deliver.



Partially Assembled Motor

Parts of AC Motor





AC Motor Data Plate

Each motor has a plate mounted on its frame, with electrical and mechanical information.