DC/AC MOTORS
TYPES & APPLICATIONS

Presented By:
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Text Book: Electrical Machinery Fundamental by Chapman, 4^{th} Edition, McGraw Hill Education

Lecture contents

1. Types of motors (AC & DC Machines)
2. Synchronous motor SM (3φ SM is not Self start motor)
3. Single phase (1φ) Induction Motors IM (1φ IM is not Self Start)
4. Types of Single phase Induction motor
5. Universal Motor (Series DC motor operated on both AC & DC)
6. Switched Reluctance (SR) motors,
7. Hysteresis motors
8. Stepper motors
9. Brushless DC motors (BLDC).

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What to learn in this part of course ?

- ***Energy Conversion*** schemes are the key ideas (Electromechanically Energy conversion)
- Energy conversation are mainly Electrical Energy to Mechanical or Mechanical Energy to electrical energy.

- Electric energy to electric energy to certain voltage level
  - Transformer (Only AC voltage level is changed)
- Electric energy to mechanical energy
  - Motor
- Mechanical energy to electric energy
  - Generator
- Magnetic energy is essential !
  - Main quantity of electromechanical conversion variable
- Electrical Machinery fundamental part is discussed

The key points in magnetic field theory

1. A current carrying wire produces a magnetic field in the area around it.

2. A time changing magnetic field induces a voltage in a coil of wire if it passes through that coil. (This is the basis of Transformer action)

3. A current carrying wire in the presence of a magnetic field has a force induced on it. (This is the basis of motor action)

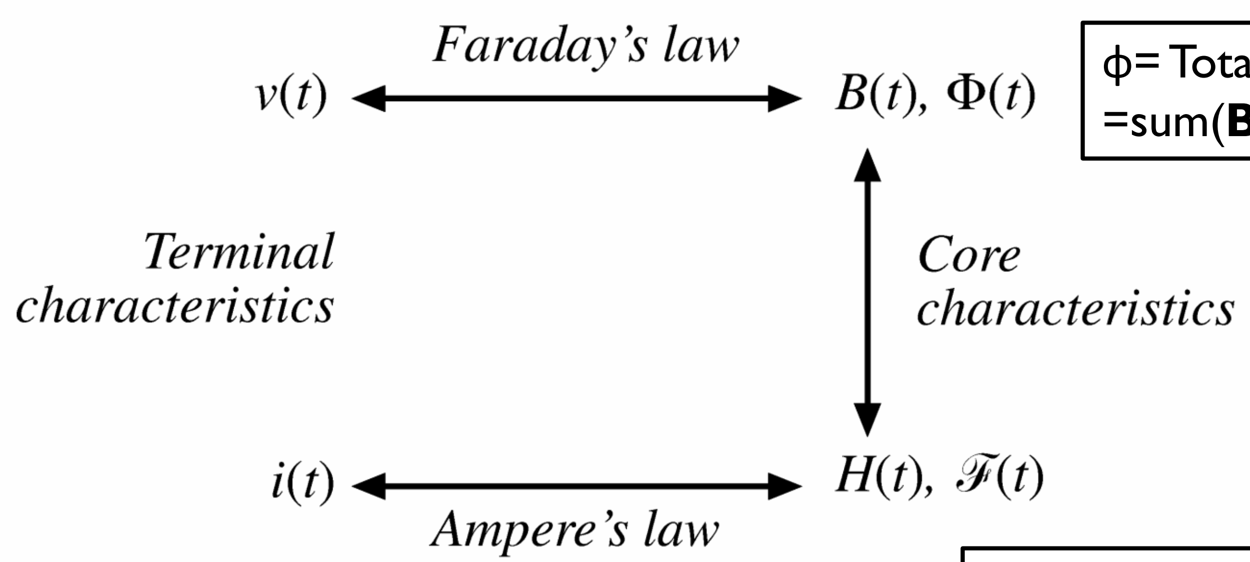
4. A moving wire in the presence of a magnetic field has a voltage induced in it. (This is the basis of Generator action)

Overview of relative electromagnetic theories

- Magnetic field: Ampere’s law
- Magnetic flux: magnetic material, hysteresis characteristics
- Transformer: Faraday’s law, Len’s law

B= Magnetic Flux density

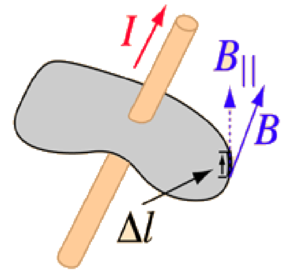
ϕ= Total electrical flux =sum(**B**.**A**) (Tesla)



H= Magnetic field intensity

F= Magnetic Motive force

Ampere's Law



Ampere's Law

$$\sum B_{||} \Delta l = \mu_0 I$$

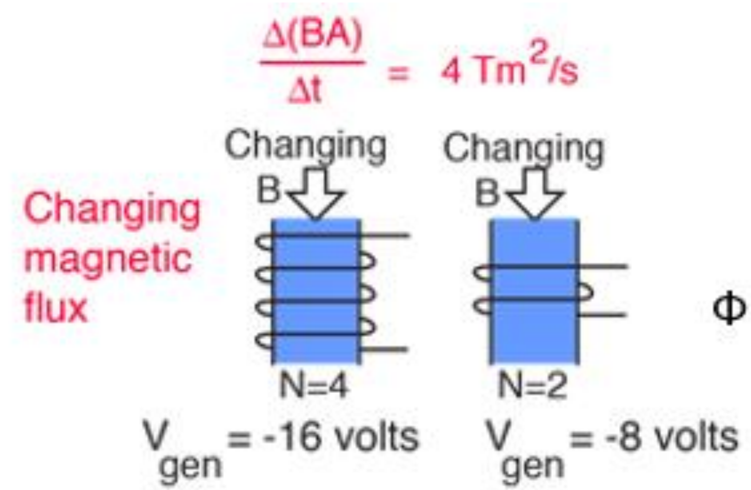
- The magnetic field in space around an electric current is proportional to the electric current which serves as its source.
- Ampere's Law states that for any closed loop path, the sum of the length elements times the magnetic field in the direction of the length element is equal to the permeability times the electric current enclosed in the loop.

Faraday's Law

- Electromagnetic or magnetic induction is the production of an electromotive force across an electrical conductor in a changing magnetic field.
- The induced emf in coil is proportional to rate of change of magnetic flux.

$$\text{Induced } emf = (emf)_{\text{induced}} = -N\frac{\mathrm{d}\Phi}{dt}$$

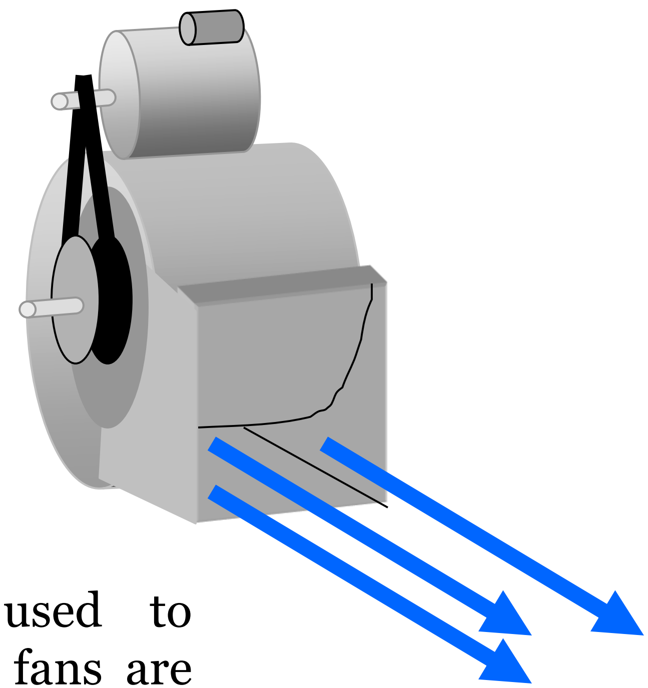
- Where N= Number of loops, Φis magnetic flux



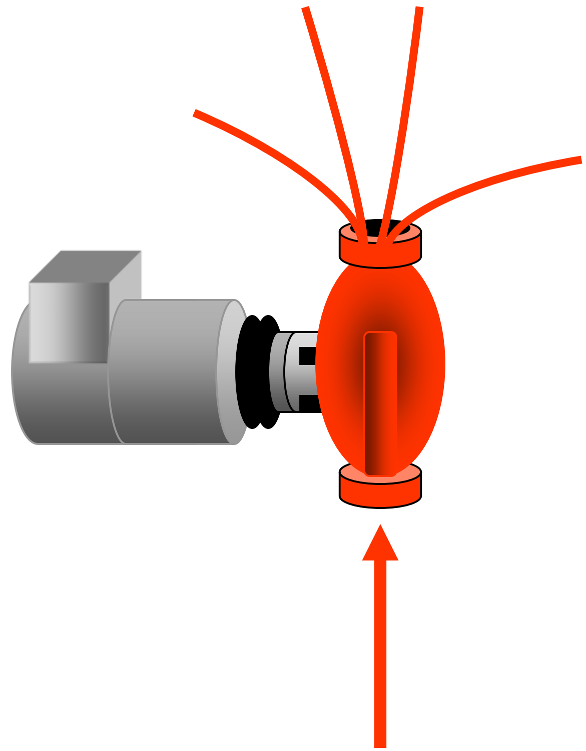
Faraday's Law

Example - Application of Electrical Motors

- Motors are used to convert electrical Energy to Mechanical Energy

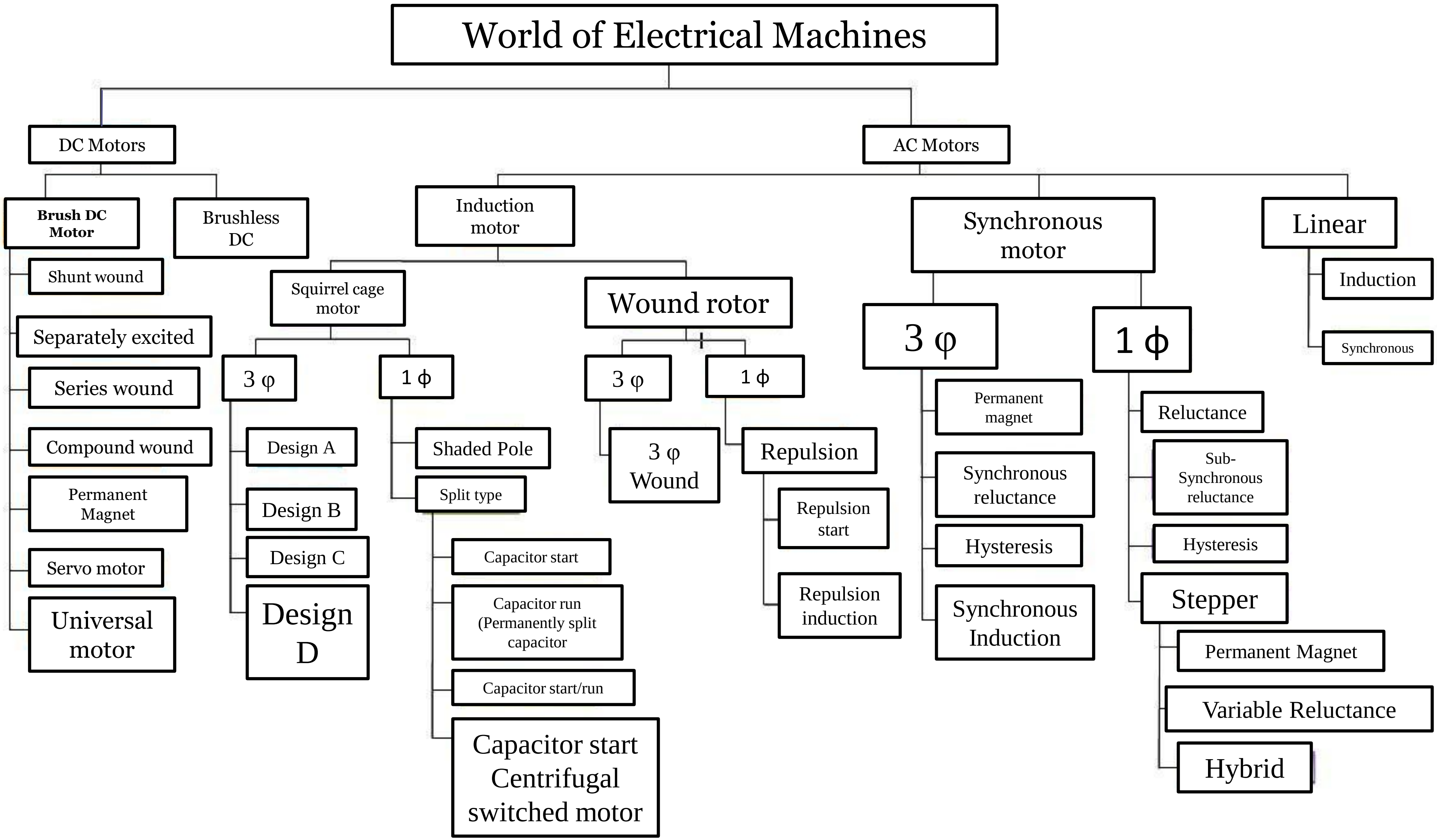


Fans are used to move air & fans are operated on Electric power supply



Pumps are used to move liquids & pumps are definitely operated on Electric Power Supply.

Classification of Electrical Motors



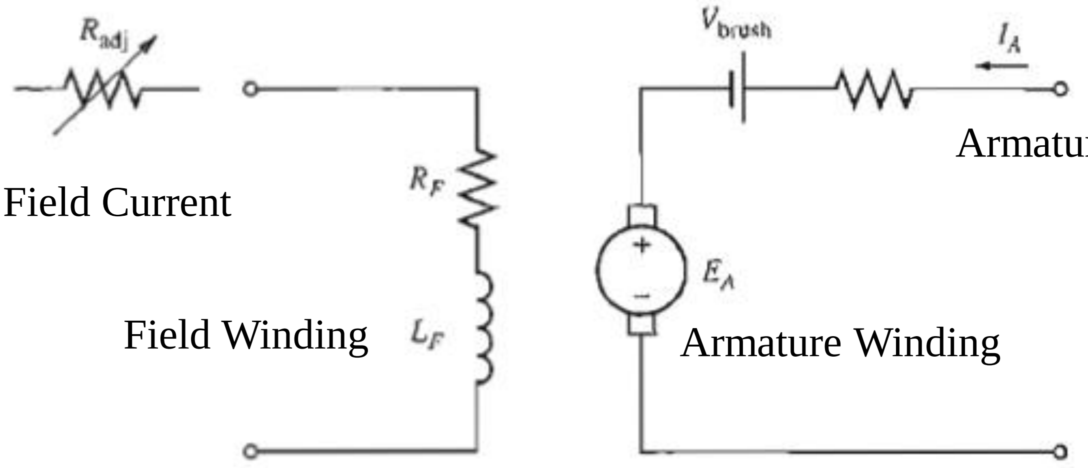
Overview of Direct Current (DC) Machines

- Direct-current (DC) machines are operated on DC Power Supply i.e., 220V DC, 480V DC, 2.2 kV DC.
- DC machines are mainly divided into DC generators and DC motors.
- Most DC machines are similar to AC machines: i.e. May be they have AC voltages and current within them.
- DC machines have DC outputs just because they have a mechanism converting of induced AC voltages inside the coil to DC voltages at their terminals.
- This mechanism is called a commutation (I.e., conversion from internally generated AC to output DC) ; therefore, DC machines are also called commutating machines.
- While dc motors are widely used, such as in automobile, aircraft, and portable electronics, in speed control applications…

Simple DC Motor

Adjustable Voltage Drop Across Field Winding

Brush Drop



Field Current

Field Winding

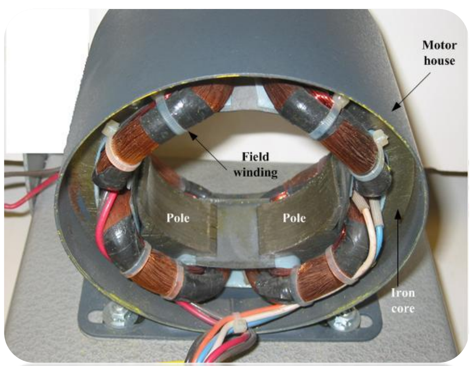
Armature Current

Armature Winding

(a)

Stator
(Stator is stationary part)

Rotor
(Rotor is rotating part)



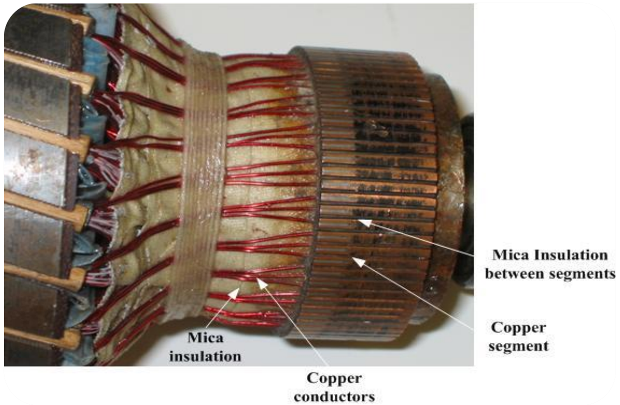
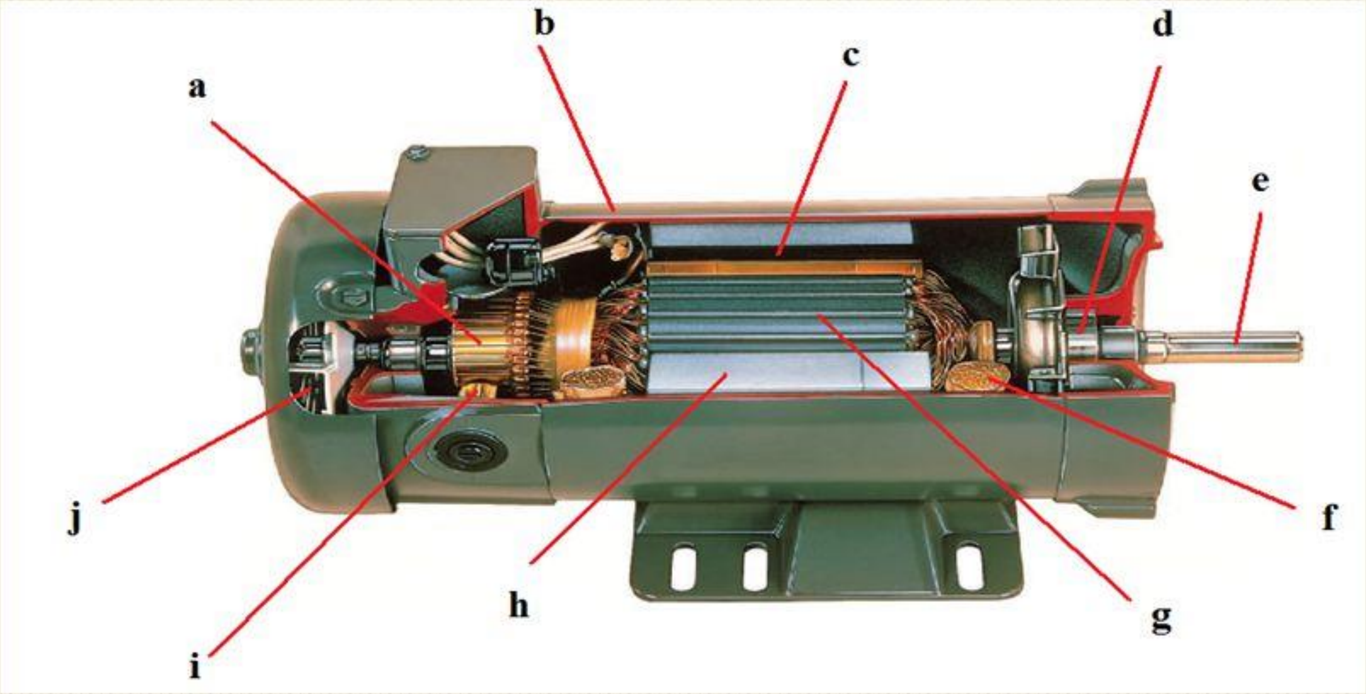


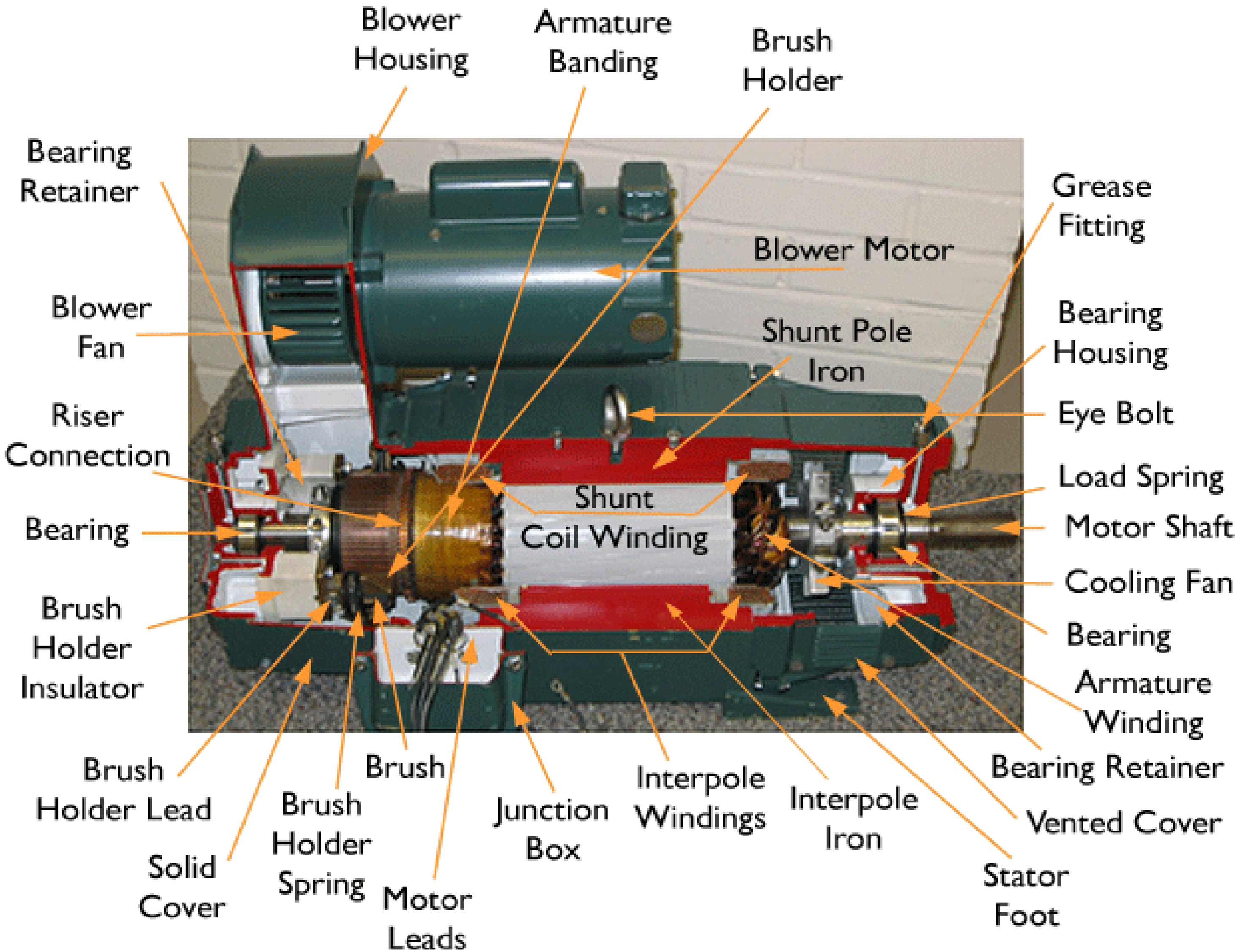
Figure (a) The equivalent circuit of a dc motor with R adj with field winding. Filed winding Portion and armature portions are shown here for convenience

DC MOTOR



a. Commutator	e. Shaft	i. Carbon Brush
b. Frame	f. Stator Winding	j. Fan
c. Field Pole	g. Armature	
d. Ball Bearings	h. Terminal Box	

DC Motor Cutaway



Armature of a DC Motor

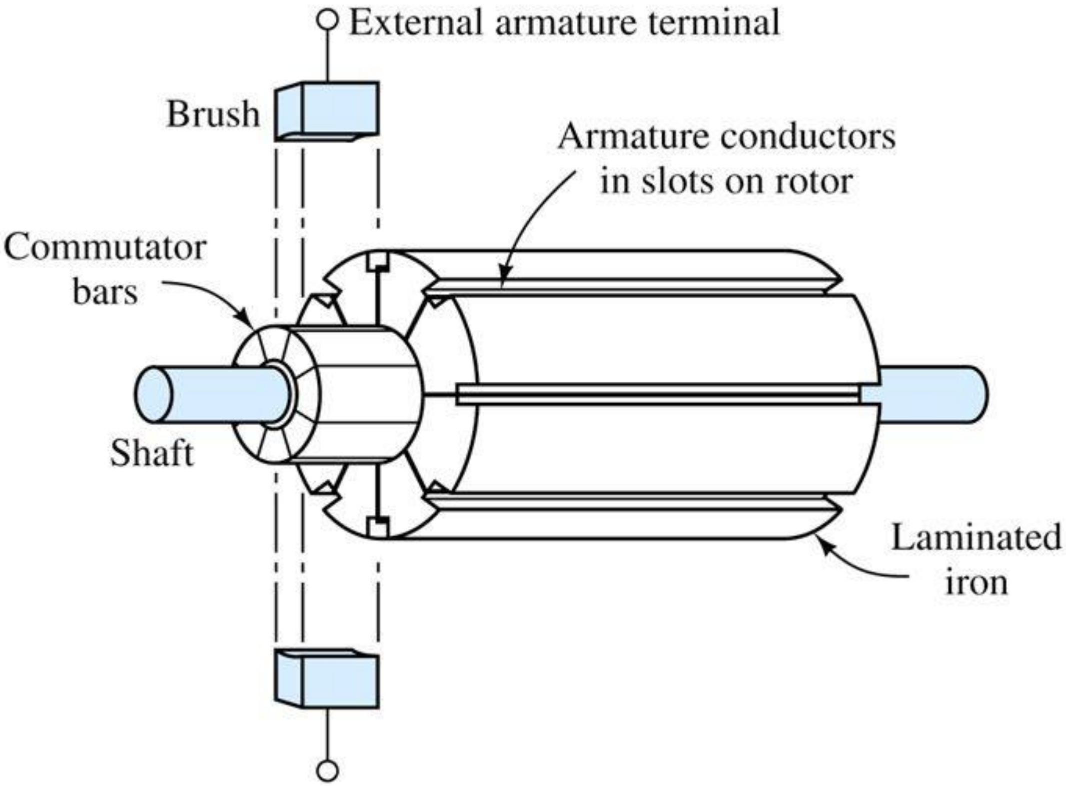
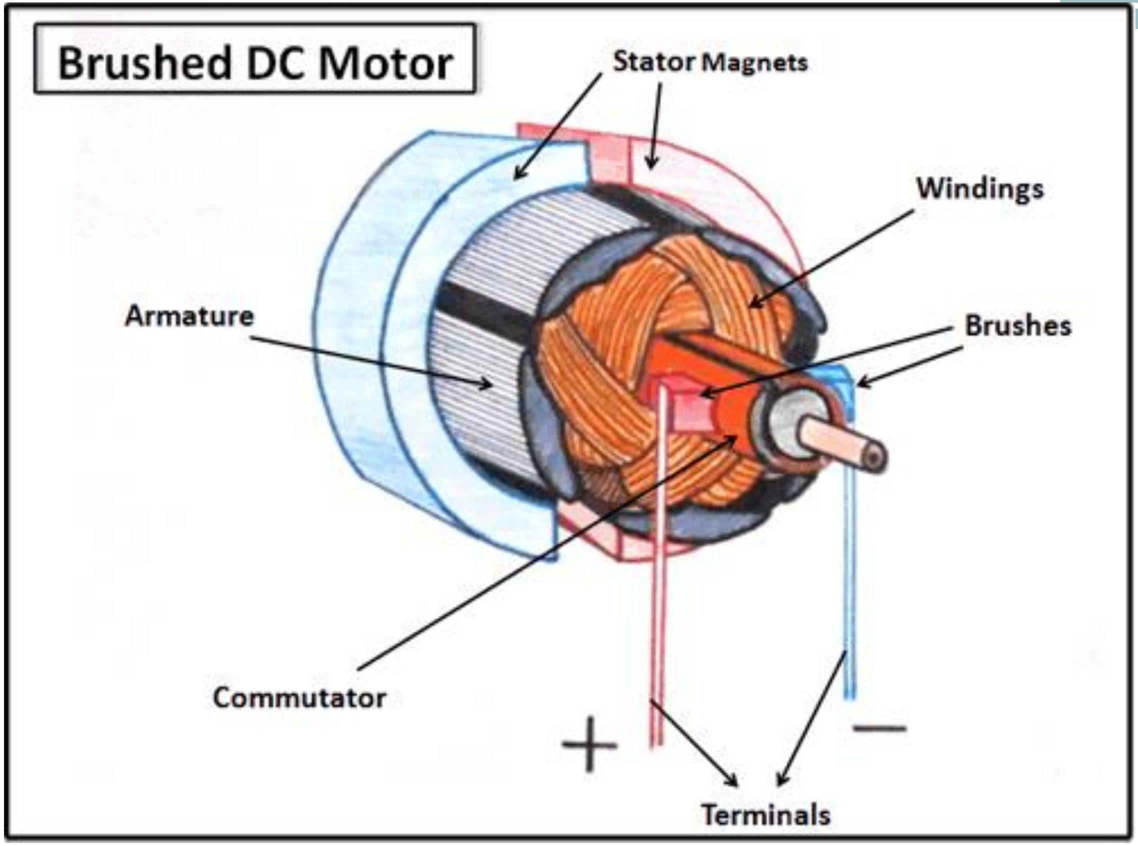


Fig: Rotor assembly of a dc machine.



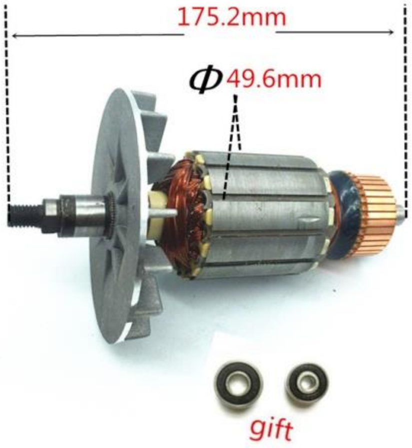


Fig: Armature Part
With fan

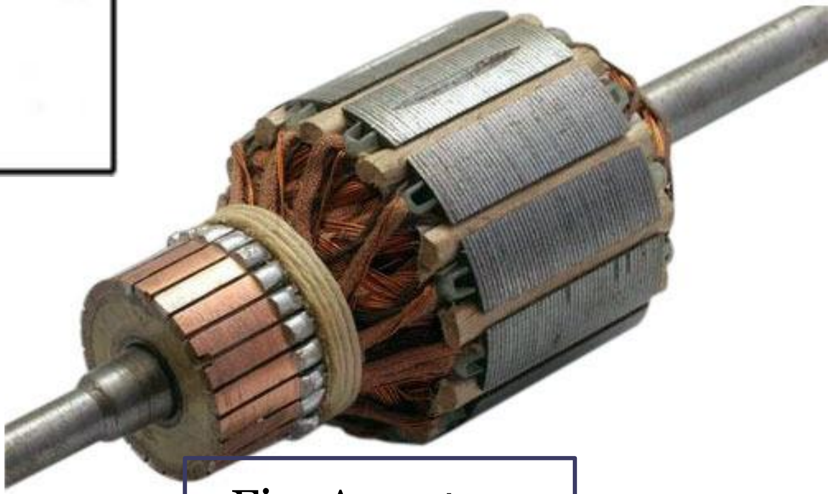


Fig: Armature Part

YOKE

MATERIAL:-

It is made of galvanised iron(G.I.) with rolled heat treatment.

FUNCTION:-

1. It carries magnetic flux from one pole to another pole.
2. It acts as protective cover to other parts. Viz field pole, field winding, armature core etc.
3. It provides space for field pole housing by rivetting.

Fig: Yoke Part

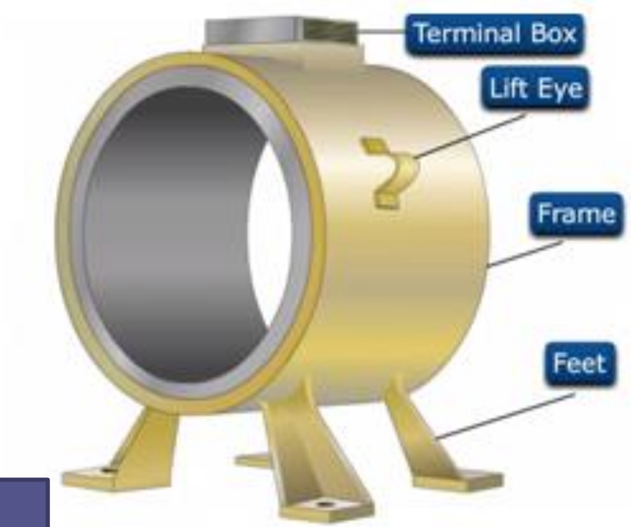


Fig: Yoke Part

Armature Core And Armature Winding

1. The power producing components of dc generator
2. The armature can be on either the rotor or the stator
3. The winding are placed in slots on the surface of the armature core
4. It consist of steel or soft iron to provide a good magnetic path, and laminate to reduce eddy currents.

Core Material: It is made up of very thin laminations of silicon steel.(S.S.)
Function:-
1)It provides slots for housing of armature winding.
2)It cut's the magnetic field developed by field circuit.

Armature Winding:-
Material:-it is made up of copper(cu) with suitable gauge.
Function:-it develop emf for producing necessary torque due to which armature

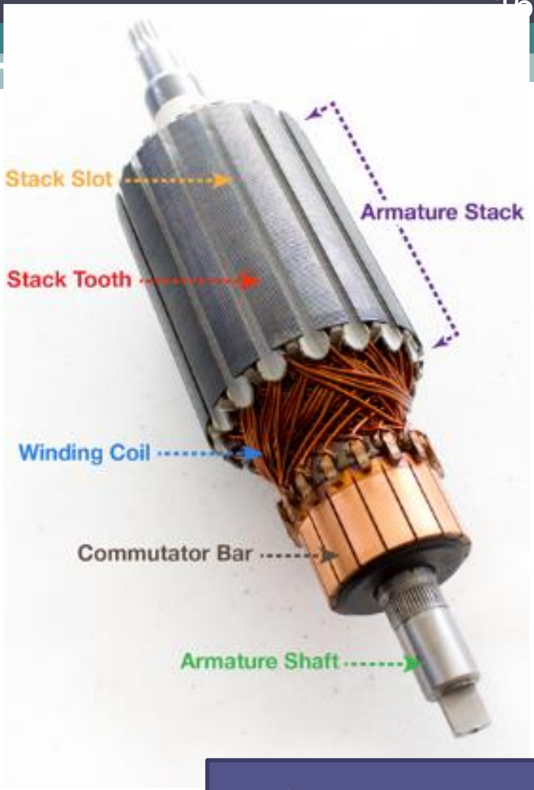
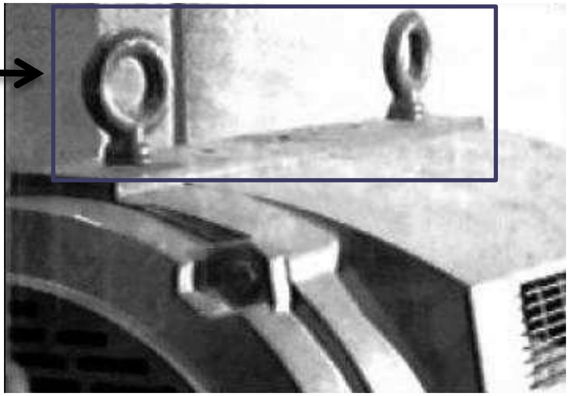


Fig: Armature Part

Eye Bolt



1. MATERIAL:- It is made of hot rolled grain oriented (HRGO) mild steel (M.S.).
2. FUNCTION:- It helps for shifting of machine from one place to other place OR for level change.

DC Motor

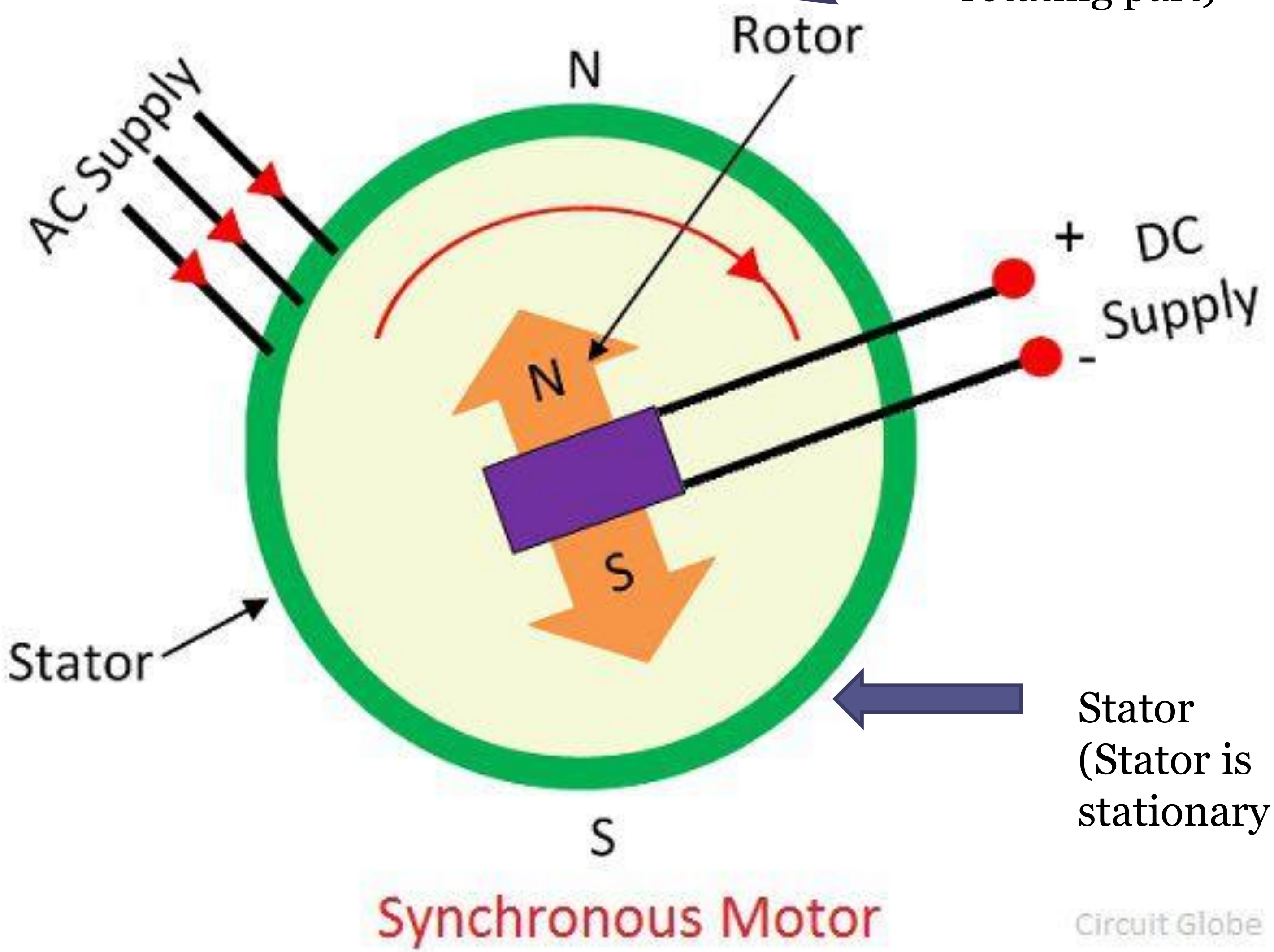
- The direct current (dc) machine can be used as a motor or as a generator.
- DC Machine is most often used for a motor.
- The major advantages of dc machines are the easy speed and torque regulation.
- However, their application is limited to mills, mines and trains. As examples, trolleys and underground subway cars may use dc motors.
- In the past, automobiles were equipped with dc dynamos to charge their batteries.
- Even today the starter is a series dc motor
- However, the recent development of power electronics has reduced the use of dc motors and generators.
- The electronically controlled ac drives are gradually replacing the dc motor drives in factories.
- Nevertheless, a large number of dc motors are still used by industry and several thousand are sold annually.

Synchronous motors (SM) (AC Motor)

- They are constant speed motor
- Used on Both three phase and single phase power supply
- Three phase Synchronous motor are not self start. To make it self start, an external mechanism is required to start. External mechanism may be
  - ✓ external source of rotational power
  - ✓ Damper Induction motor start winding

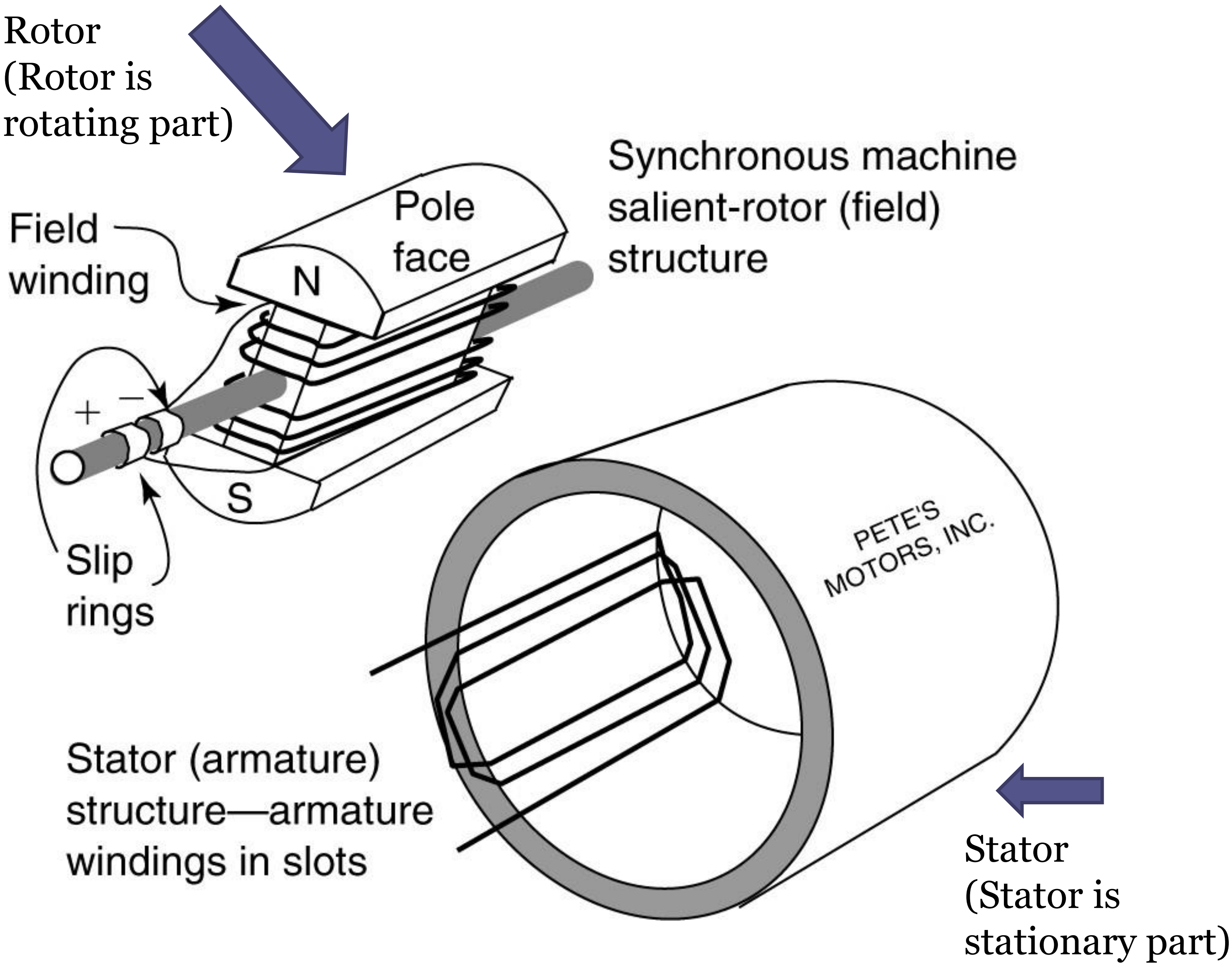
Synchronous motors (SM)

Rotor
(Rotor is
rotating part)



Stator
(Stator is
stationary part)

Synchronous motors (SM)



Synchronous motors (SM)

- 3 phase SM AC motor is operated on three phase ac supply.
- DC excitation of rotor through two slip rings and three phase AC supply on stator is necessary to run this motor.
- Synchronous machine can be used as **SM or synchronous ac generator (alternator or three phase generator)**
- **Three phase motors** use three sets of stator coils
    - The rotating magnetic field drags the rotor around with it
- **Three phase SM is not self start and hence** require some starting mechanism
- Torque is only produced when the rotor is in sync with the rotating magnetic field
- **Not self-starting -** may be configured as an induction motor with cage conducting bar on rotor until it gets up to speed, then DC excitation on rotor becomes a synchronous motor to make it a self start. This type of typical design is called **Synchronous run induction start motor**.
- SM can be operated on lagging and leading power factor

Synchronous motors (SM)

- 3-phase Synchronous motors are most commonly used in very large industrial applications or where exact speed is required
- So called because rotor tries to line up with the rotating magnetic field in the stator. It has the stator of an induction motor, and the rotor of a dc motor.
- Rotor rotation per minute is synchronized with stator magnetic field movement.
- N_{stator}=120 f/p=N_{rotor}

Three phase Induction motor (IM)

- These motors are operated on principle of electro magnetic induction phenomena.
- These motors are also called Generalized Transformers
- They are operated with variable speed operation
- They motor speed is calculated by using the formula $\mathrm{N}_S = \frac{120\, f}{p}$

Induction Motors

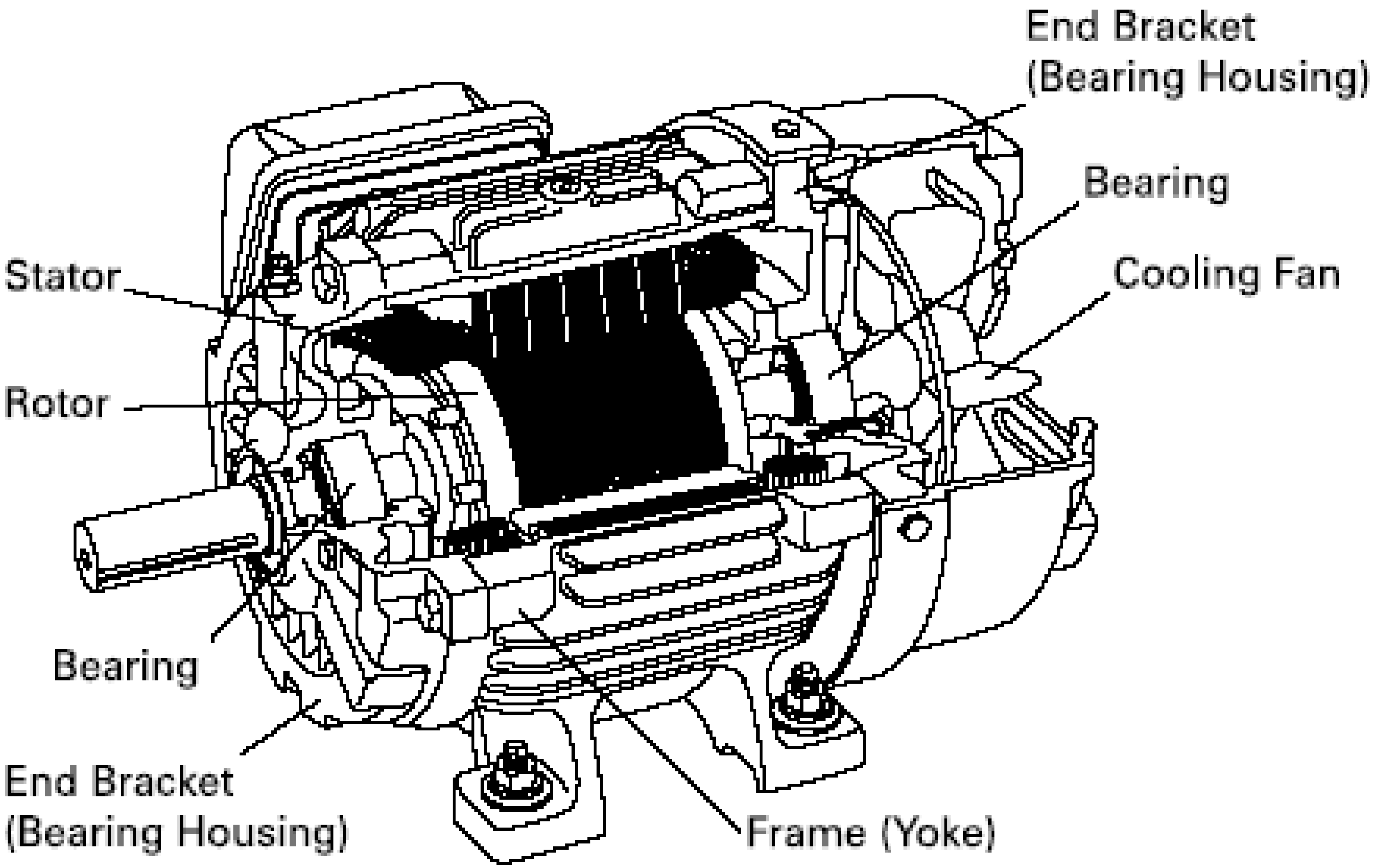


Fig: Induction Motor Stator and
Cage Rotor

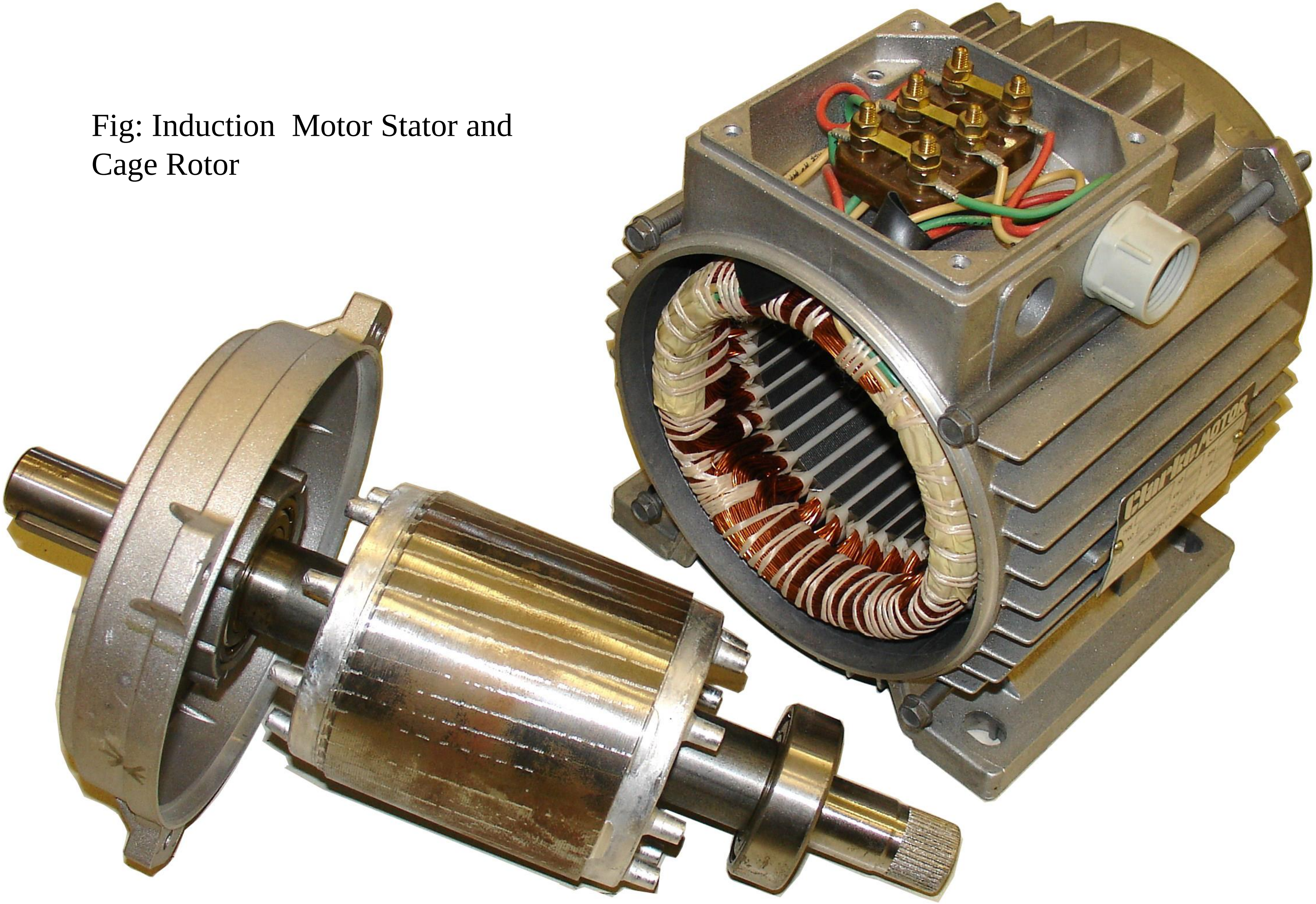


Figure: Induction motor stator winding

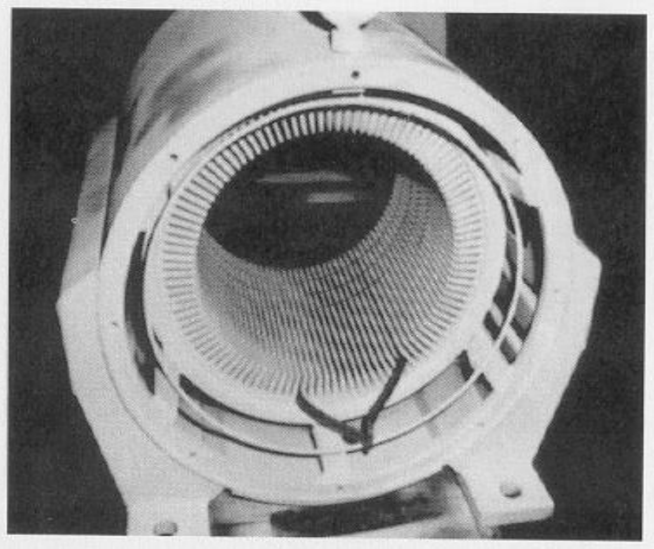
Three phase Induction motor Types (IM)

- AC motors include 3-phase and single phase types.

  3-phase AC induction motors are the most widely used motors in industrial and commercial applications. They are divided into two sub-categories:

1. Squirrel cage motors (Short Circuited Rotor bars)
2. Slip ring rotor or Wound rotor motors (Rotor winding are brought out of rotor with 3 or 4 slip rings on shaft.

Induction Motor Components

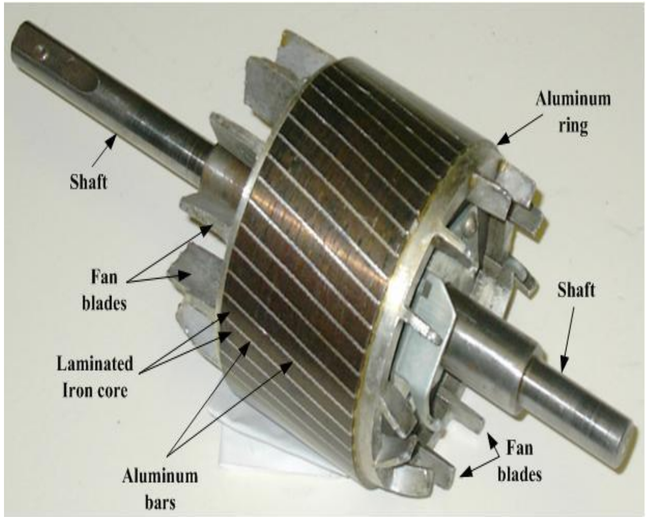


1) **<u>Stator</u>**: Consisting of a steel frame that supports a hollow, cylindrical core of stacked laminations. Slots on the internal circumference of the stator house the stator winding

2) **<u>Rotor</u>**: There are two different types of induction motor rotor:

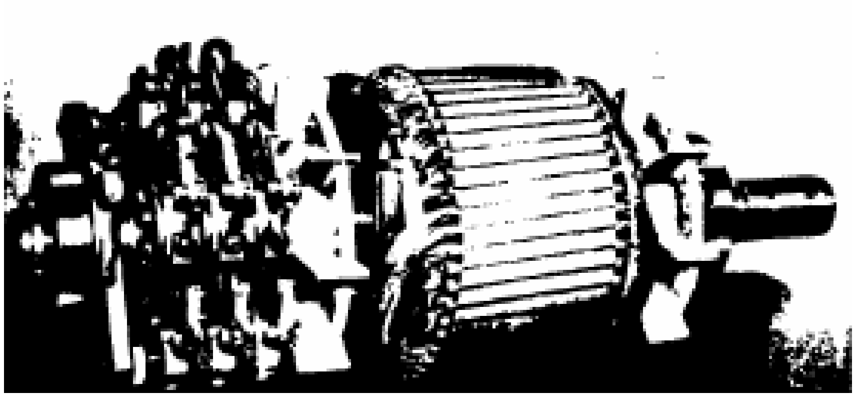
<u>Squirrel cage rotor (Cage rotor):</u>

Consists of series of conducting bars laid into slots carved in the face of rotor and shorted at either end by large shorting rings.

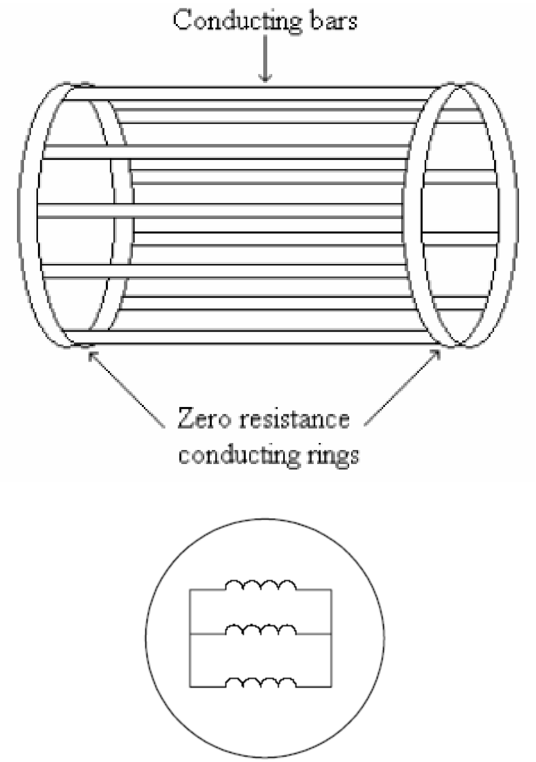


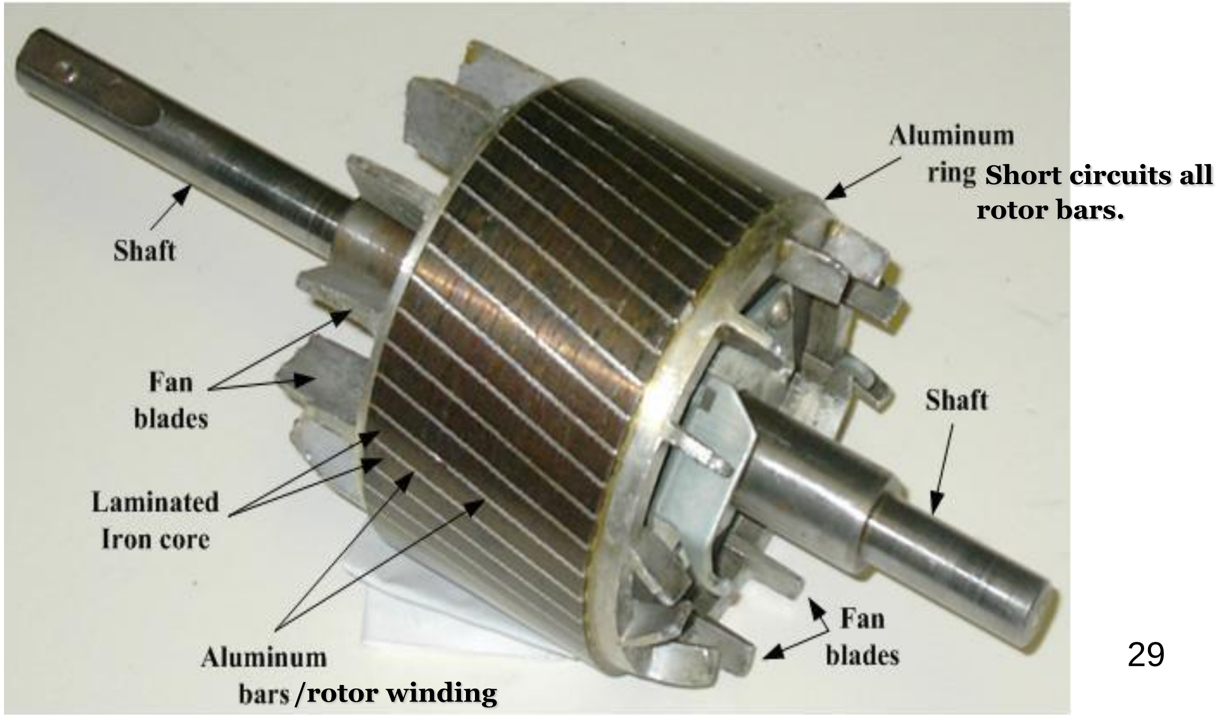
Construction (Rotor construction)

Wound Rotor



Squirrel-Cage Rotor





- There are 4 types of 3 phase Induction motors.
  - Design A
  - Design B
  - Design C
  - Design D
- These classifications are according to speed torque characteristics

Design Type of IM	Starting Torque (Nm)	Starting current (A)	Breakdown Torque (Nm)	Full Load Slip	Typical Application
A (Seldom Used Type)	Normal	High	High	<5%	Machine Tools
B	Normal	Normal	Normal	<5%	Same As A
C	High	Normal	Low	<5%	Compressors, crushers, conveyers
D	Very high	Low	Not applicable	>5%	Punch pressers, high inertial loads, elevators

Wound Rotor Induction Motor

- The wound rotor induction motor operates on the same principles as the squirrel cage motor, but differs in the construction of the rotor.
- Instead of shorted bars, the rotor is made up of **windings which terminate at slip rings on the shaft.**
- This type of motor is used in special applications where a **high starting torque** is required.
- Connection of external resistance to the rotor circuit via the slip rings permits variation of motor torque-speed characteristics
- **After starting, the slip rings are shorted together.**
- Shorting the external connection results in operation similar to squirrel cage motors.

- **Speed range variation** of about 5:1 can be achieved by adding **external resistance** to the rotor circuit; however, this is at the expense of **electrical efficiency** unless a slip energy recovery circuit is used.

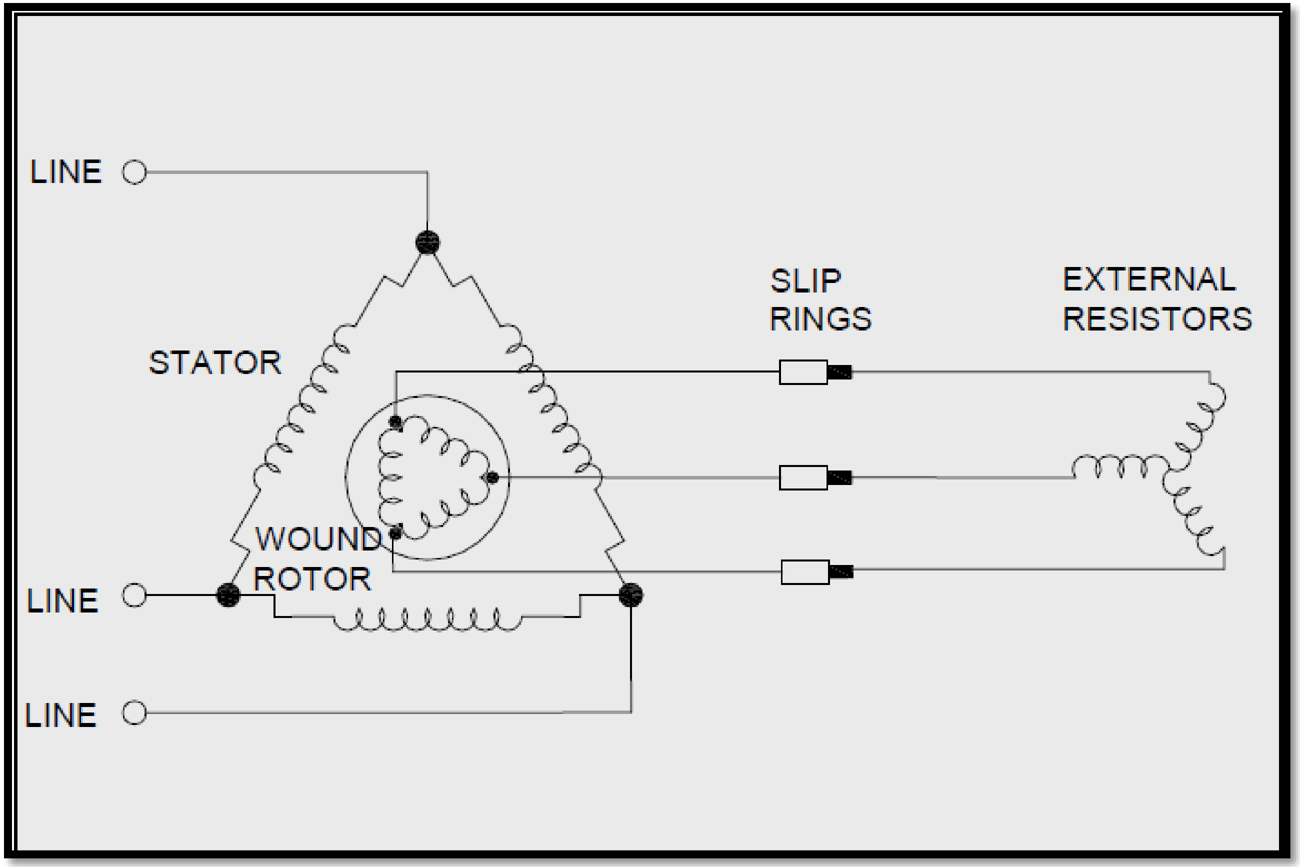


Figure: Wound Rotor Induction Motor

Starting circuits

- What is starting?

Starting is a process in which motor rotor is brought from zero to rated speed

- Speed of rotor is given by

speed=120f/p

- Starting torque proportional to applied voltage
- Starting circuits used to reduce the starting high current taken by the motor. Normally 5 to 7 times of Rated current is drawn at the start.

Types of Starting :

1. DOL starter (Direct online start)
2. Primary resistance starter
3. Autotransformer starter
4. Star delta starter
5. Rotor resistance starter in case of Wound / slip ring motor

Speed control of induction motor

- They are as follows;

1. Stator side control
   - Stator voltage control
     - Using autotransformer
     - Primary resistors in series with stator winding
   - Stator frequency control
   - V/f control
   - Pole changing method (Dual speed motor with neutral shifting setup on stator pole winding)
2. Rotor side control
   - Cascade control
   - Adding external resistance and centrifugal switch.

Differences between squirrel cage and slip ring induction motor

Sr. no	**Squirrel cage induction motor**	**Slip ring induction motor**
1	Low starting torque	Much higher
2	Higher efficiency	Lower efficiency
3	No speed control	Speed control
4	High starting current	Low starting current
5	Needs a starter	Can be started directly
6	Minimum maintenance	High maintenance
7	Rugged construction	Not as rugged
8	Cheaper	Higher cost

Comparison table for Synchronous motor and Induction motor		
Sr.	Synchronous Motor (Three phase)	Induction motor (3 phase)
1	Construction is complicated	Construction is simpler, particularly in case of cage rotor
2	Not self start	Self starting
3	Separate dc source is required for motor excitation	Rotor gets excited by the induced emf . So separate source is not necessary
4	Speed is always synchronous irrespective of load	The speed is always less than synchronous but never synchronous
5	Speed control is not possible	Speed control possible though difficult
6	As load increases, load angle increases, keeping speed constant as synchronous	As load increase, the speed keeps on decreasing
7	By changing the excitation, the motor power factor can be changed from lagging and leading	It always operate on lagging pf and pf control is not possible
8	It can be used as synchronous condenser (dominating capacitor load) for p.f. improvements	It can not be used as synchronous condenser
9	Motor is sensitive to sudden load change and hunting results	Phenomenon of hunting is absent
10	Motor is costly and require frequent maintenance	Motor is cheap specially cage motor are maintenance free

Single phase induction motors

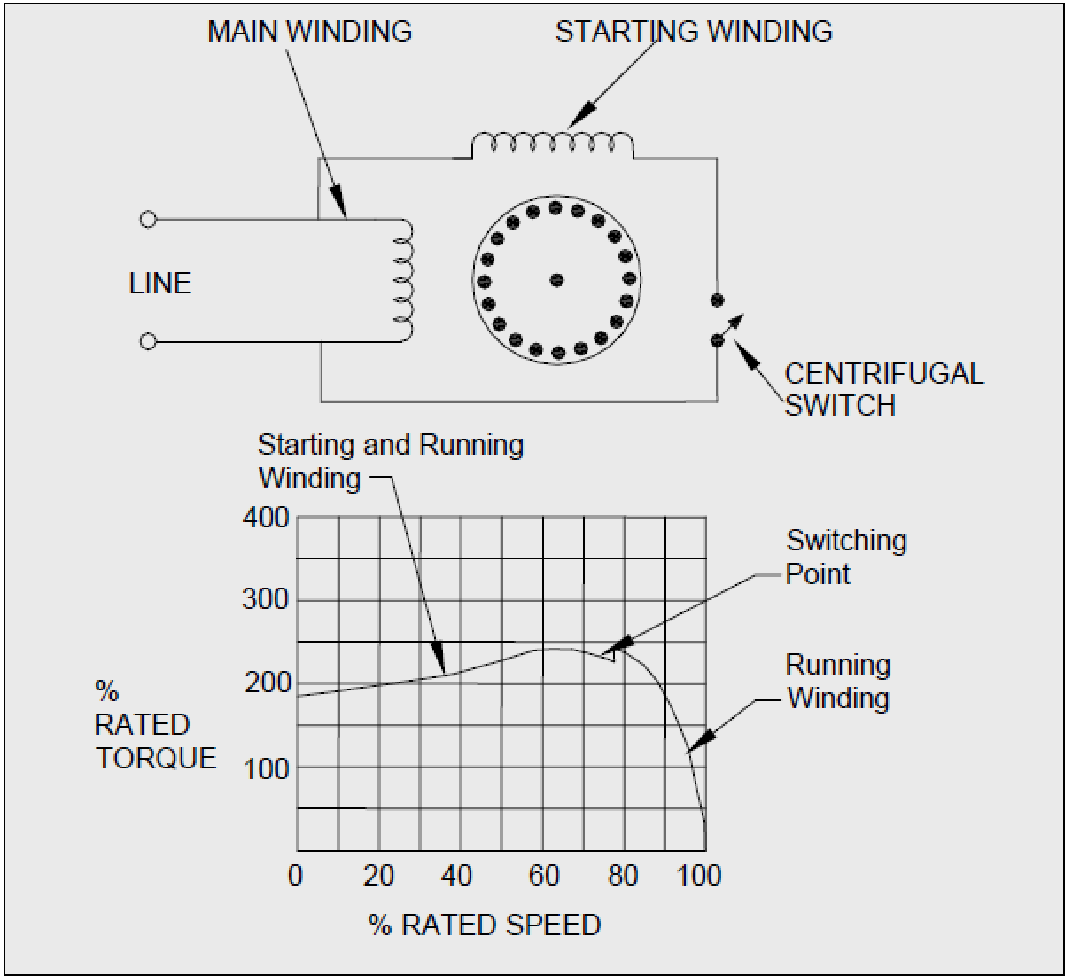
- Single phase induction motors are used where three phase power is not available; typically in residential, commercial and agricultural applications. They are also used in applications with power requirements below 1 horsepower (HP).
- The main sub-categories include:

1. Split phase (Arbitrary 2nd phase is added to make it self start)
2. Capacitor run
3. Capacitor start induction run with Centrifugal switch
4. Capacitor start – capacitor run
5. Shaded pole

- Such motors are inexpensive and are widely used in domestic applications
- Split-phase motors use two separate windings to create the necessary rotating magnetic field. These windings are named the start winding and the run winding.

Split phase

- Split phase motors use a starting winding with a **different resistance/reactance ratio than that of the main stator winding** to produce the phase difference required for starting.
- The phase difference is not the desired 90º, and the magnetic fields are not equal. This results in a **lower starting torque** than other motor designs
- Different X/R ratio for starting winding



Split phase

- Two separate motor windings
- Good running efficiency
- Medium amount of starting torque
- Speed typically ranges from 1500 – 3000 rpm (for 50 Hz Power Supply)
- Motor speed is determined by the number of poles
- Slip is the difference between the calculated N_s and actual motor speed N_r

Applications

- Split phase motor starting torque, however, is sufficient for many applications such as **refrigerated display case circulation fans and some power tools** (e.g. drill press).
- This type of motor is cheap to produce and is therefore a favorite in OEM (Original equipment manufacturer) products. Normally rating with 0.5 HP (Horse power)

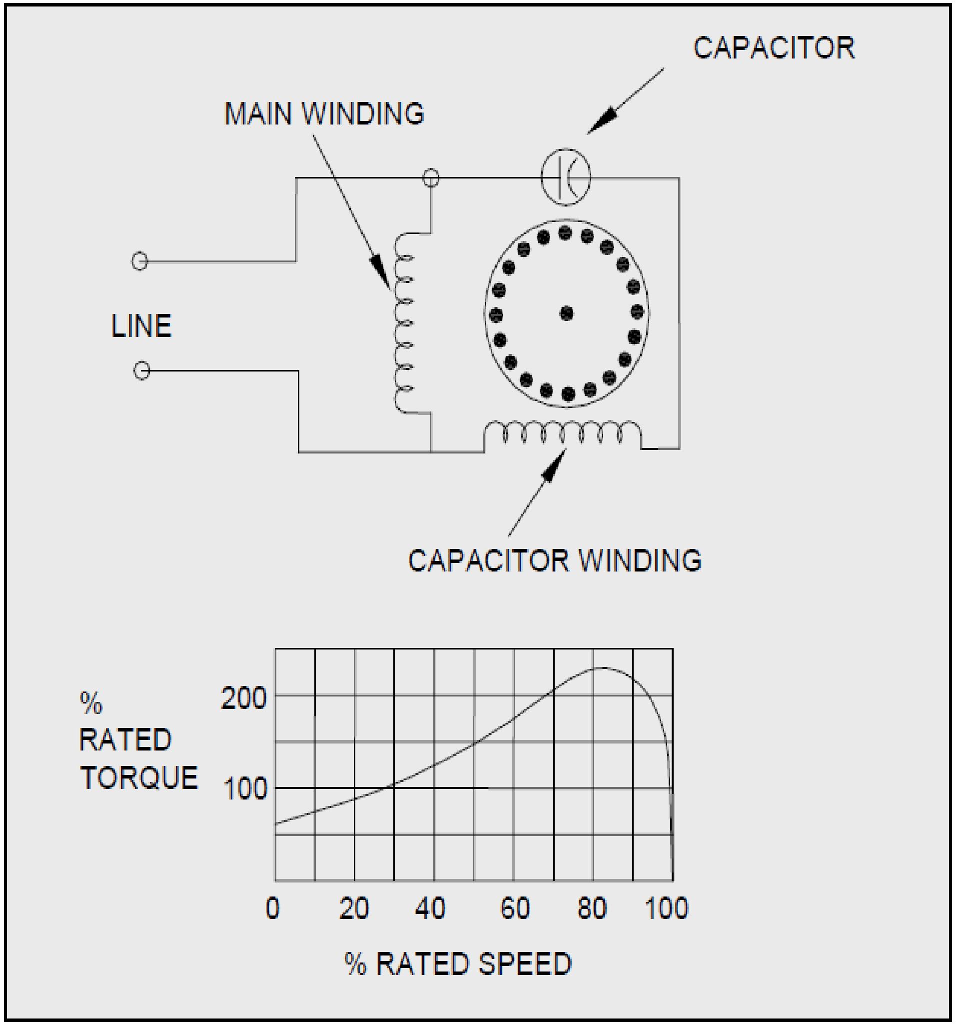
Capacitor Motors

- Many single phase motors use a capacitor in series with one of the stator windings to optimize the field phase difference for starting.
- Capacitive current leads voltage by 90º. Adding capacitance causes a phase shift in one winding relative to the other.
- The result is a higher starting torque than a split phase motor can produce.
- **Applications** Capacitor motors are used in high starting torque applications such as compressors and air conditioners and ceiling fans. Typical sizes range up to about 10 HP.

- **Types**
  - Capacitor run
  - Capacitor start

Capacitor run motors

- Capacitor run motors use a capacitor **permanently connected in series with one of the start windings**, to achieve a compromise between good starting torque and good running characteristics .
- This design is lower in cost than other capacitor motors that incorporate capacitor switching systems.
- These are sometimes called permanent split capacitor (PSC) motors.
- **Application** New furnace fan motors sometimes use capacitor run motors.

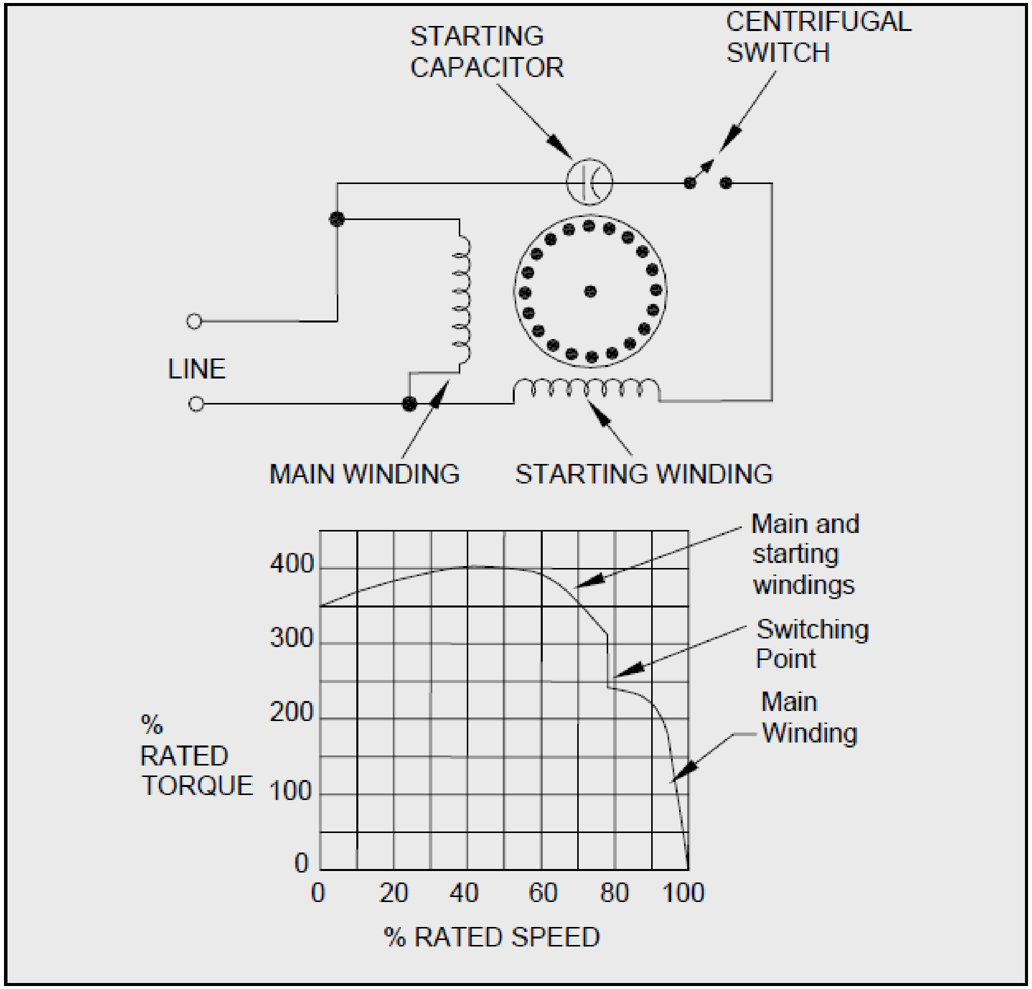


Capacitor start motor

In capacitor start motors, a capacitor connected in series with the starting winding is **sized to maximize starting torque.**

The starting winding is removed from the circuit by a **centrifugal switch or electronic relay when the motor reaches running speed.**

- Starting torque is higher than for capacitor run motors, with **running performance similar to a split phase motor**.



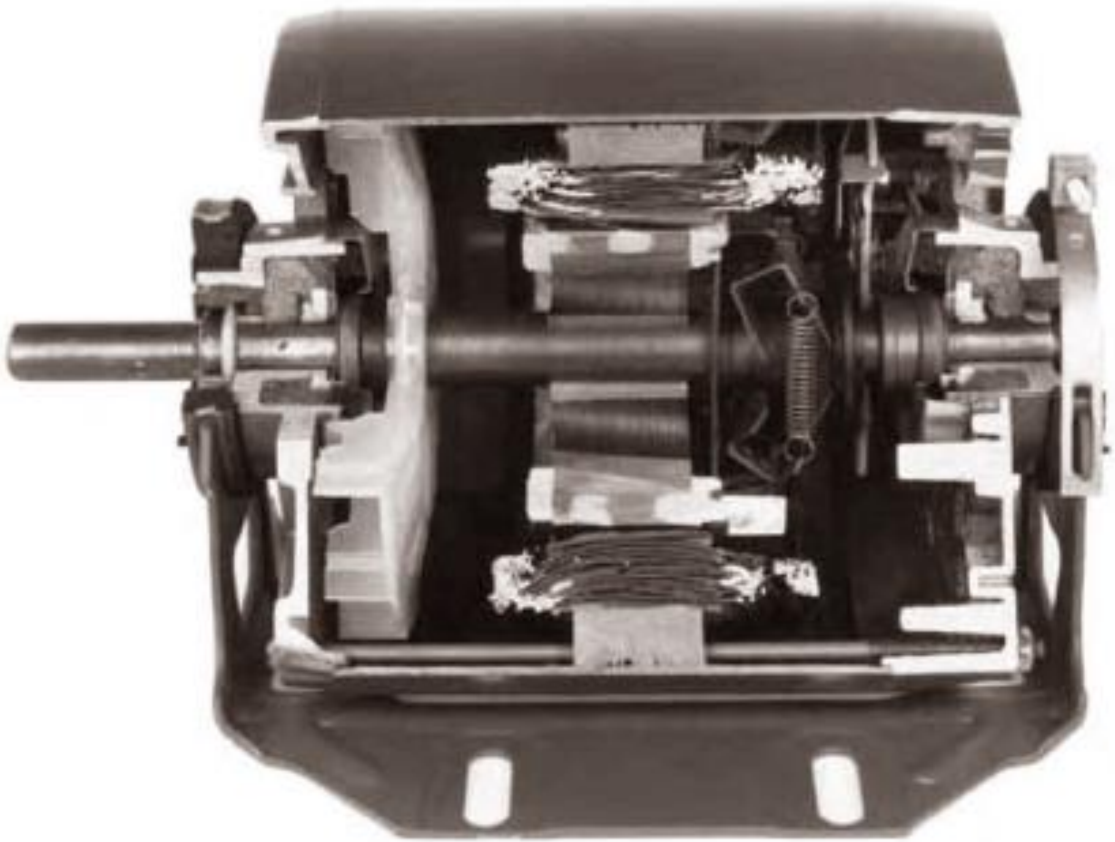
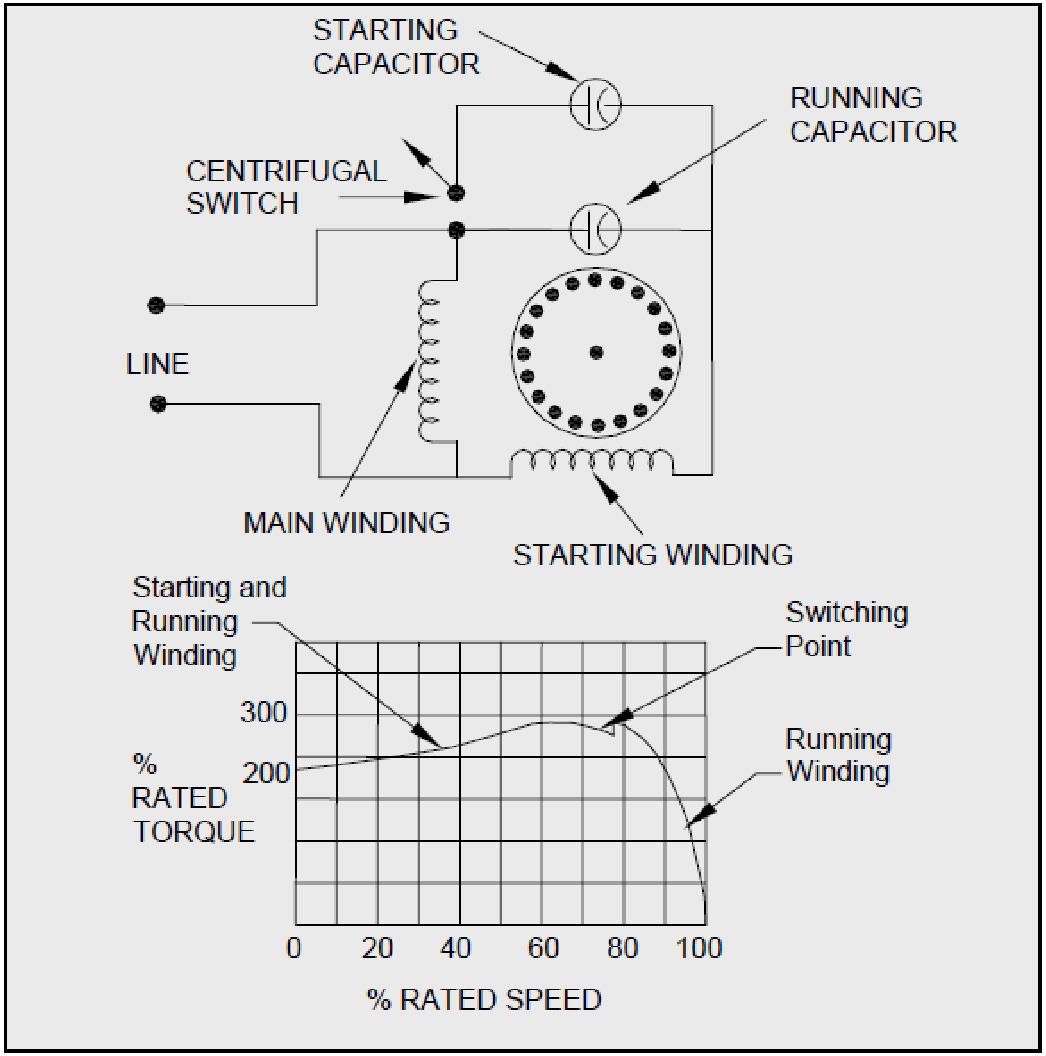


Fig:
Cutaway view of a split-phase motor. showing the main and auxiliary windings and the centrifugal switch. *(Courtesy of Westinghouse Electric Corporation.)*

Capacitor Start – Capacitor Run Motors

- This design uses a capacitor optimized for running characteristics in series with the main stator winding

- A second capacitor in series with the starting winding optimizes starting torque. The starting capacitor is switched out of the circuit at running speed.
- Both starting torque and running characteristics are optimized
- A centrifugal switch disconnects the start winding when the motor attains 75% of the rated speed



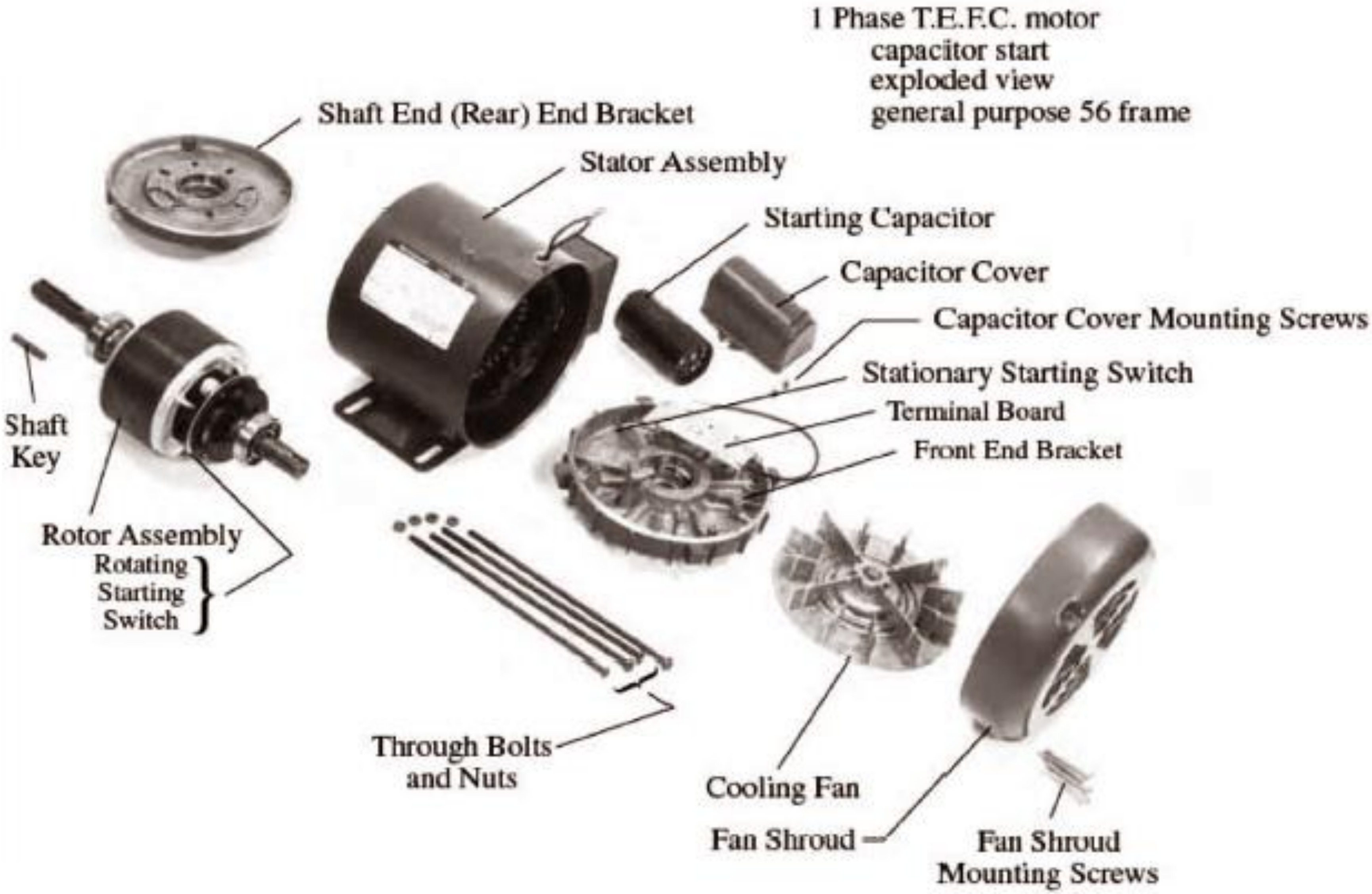


Fig: Exploded view of a capacitor-start induction motor. *(Courtesy of Westinghouse Electric Corporation.)*

Shaded Pole Motors

- A shaded pole motor is the **simplest form of a single phase motor** and is very low in cost .
- It develops a rotating field by delaying the build up of magnetic flux through part of the pole structure.
- The **shaded portion of the pole** is isolated from the rest of the pole by a **copper conductor** that forms a single turn around it.
- The magnetic flux in the unshaded portion increases with the current through its winding. Magnetic flux increases in the shaded portion; however, it is **delayed by the current induced in the copper field.**
- The magnetic field sweeps across the pole face from the unshaded portion to the shaded portion, developing a torque in the squirrel cage.
- To maximize torque, the rotor is made with relatively high resistance.
- **Applications** Shaded pole motors are used where low torque is acceptable

(such as fans) and are usually less than 1/4 HP. Due to their very low efficiency, shaded pole motors should only be used in applications where the motor is either very small or operates for very short periods of time (e.g. shower fan motor).

SHADED-POLE MOTOR

1. Very low starting torque
2. Not as efficient as the PSC motor
3. A portion of the run winding is shaded to provide the imbalance in magnetic field that allows the motor to start
4. Heavy copper wire or bands are used to shade the run winding
5. Manufactured in the fractional horsepower range

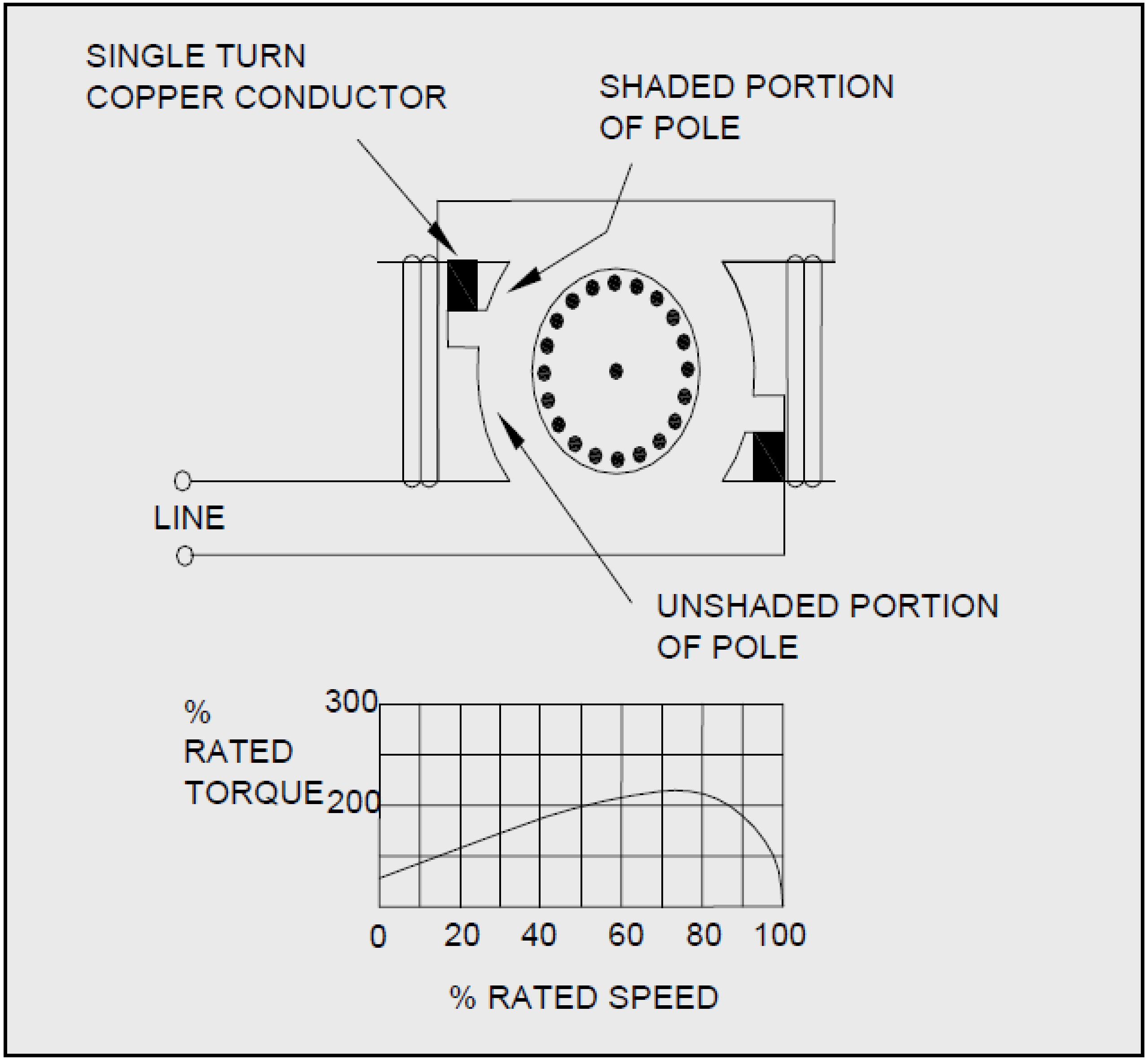
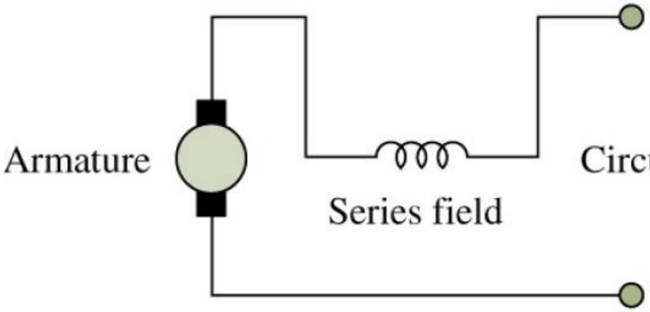


Figure: Shaded Pole Motors

Motor type	Starting torque	Efficiency	Typical Application
Shaded Pole	Low	Low	Direct drive fans
Split phase	Low	Low	Direct drive fans, centrifugal pumps, air and refrigeration compressors
	Medium	Medium	Belted fans, air and refrigeration compressors, major applications
Capacitor start	Medium	Medium	Belted fans, compressors, centrifugal pumps, commercial and business application
	High	Medium	Positive displacement pumps, air and refrigeration compressors,
Capacitor start /run	Medium	high	Belted fans, centrifugal pumps
	High	High	Positive displacement pumps, air and refrigeration compressors, industrial fans, commercial appliances, business equipments
Permanent split capacitor	low	High	Direct drive fans, refrigeration compressors, business equipments

Universal Motors (UMs)

- It is actually a DC Series motor and operated on DC and single phase AC power supply
- Universal motors are **series wound**, with rotor circuitry similar to DC motors
- The term universal results from their ability to operate on either DC or AC power.
- The operation and construction of these motors closely resemble DC motors, with **components designed for efficiency on AC up to the line frequency** .
- Operating speeds typically range from **3,000 to 15,000 RPM**.
- The speed will drop with increasing load.
- A high horsepower to size ratio is characteristic of this design.



Circuit diagram

Universal motors

- Maintenance requirements per hour of operation are higher than other designs due to the brush / commutator setup.
- Universal motors are mostly operated on AC power, but they can operate on either AC or DC. Tools and appliances with UMs are among the most frequent applications.
- A universal motor has both a wound field (on the stator) and a wound armature (on the rotor). It cannot use a permanent magnet to create the stator field because it needs to reverse its magnetic polarity every half cycle of the mains. The voltage being fed to the commutator brushes is also changing polarity every half cycle, and in fact is simply in series with the field winding.
- This motor only has two poles, and so does not have a lot of starting torque. That's why you sometimes need to turn the big wheel on the end of the sewing machine to get it started.
- Common uses of these motors include low duty cycle applications such as **power saws, drills, vacuum cleaners and lawn mowers.** Sizes up to about 2 HP are common.

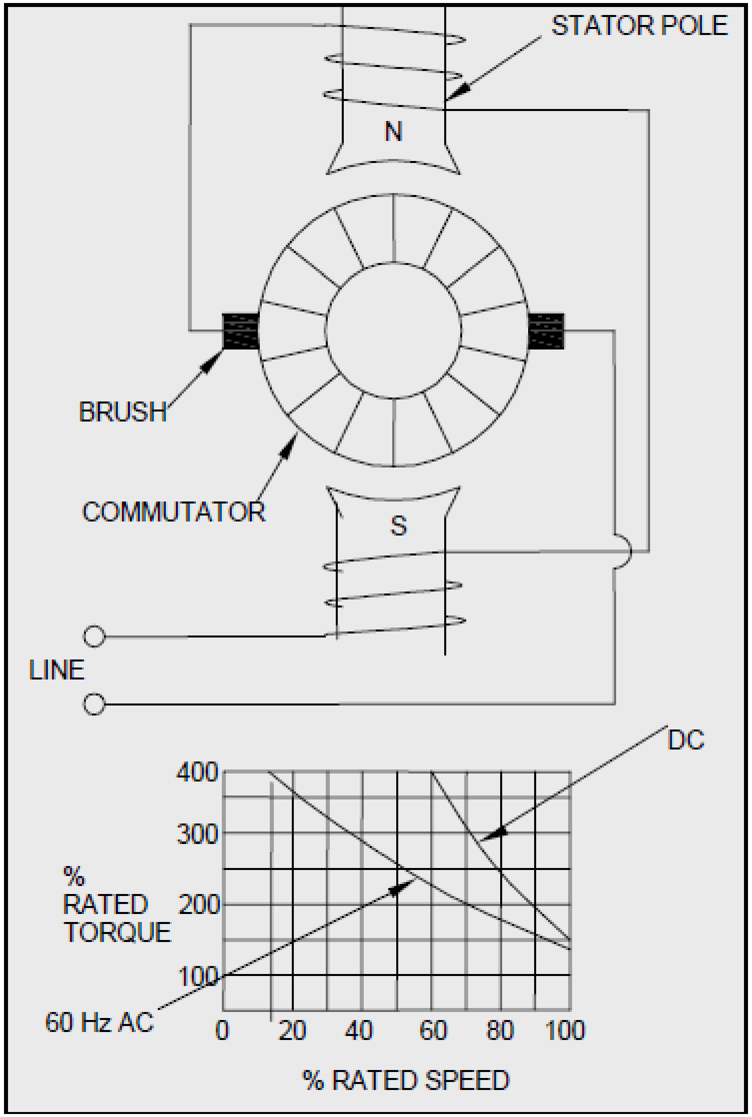


Fig: Universal Motor schematic, Characteristics curve and rotor

Universal Motors

- While most motors operate from either AC or DC, some can operate from either
- These are **universal motors** and resemble series-wound DC motors, but are designed for both AC and DC operation
  - typically operate at high speed (usually > 10,000 rpm)
  - offer high power-to-weight ratio
  - ideal for portable equipment such as hand drills and vacuum cleaners

Torque Speed Characteristics

- Some important points found on a torque-speed graph include:
- (a) **Starting torque** – the torque produced at zero speed.

  If the motor is to turn a load that is difficult to start (a high inertia load) one would choose a motor with high starting torque.
- (b) **Pull-up torque** – the minimum torque produced during acceleration from standstill to operating speed.

  This may be critical for an application that needs power to go through some temporary barriers before achieving the working level output.
- (c) **Breakdown torque** – the maximum torque that the motor can produce before stalling.
- (d) **Full load torque** (also braking torque) – the torque produced at full load speed that gives the rated output of the motor. At this point the torque times the speed equals the nameplate horsepower rating.

Reluctance motor: A synchronous-induction Motor

1. A reluctance motor is a motor which depends on reluctance torque for its operation.
2. Reluctance torque is the torque induced in an iron object (such as a pin) in the presence of an external magnetic field, which causes the object to line up with the external magnetic field.
3. This torque occurs because the external field induces an internal magnetic field in the iron of the object, and a torque appears between the two fields, twisting the object around to line up with the external field.
4. In order for a reluctance torque to be produced in an object, it must be elongated along axes at angles corresponding to the angles between adjacent poles of the external magnetic field.

Reluctance motor: A synchronous-induction Motor

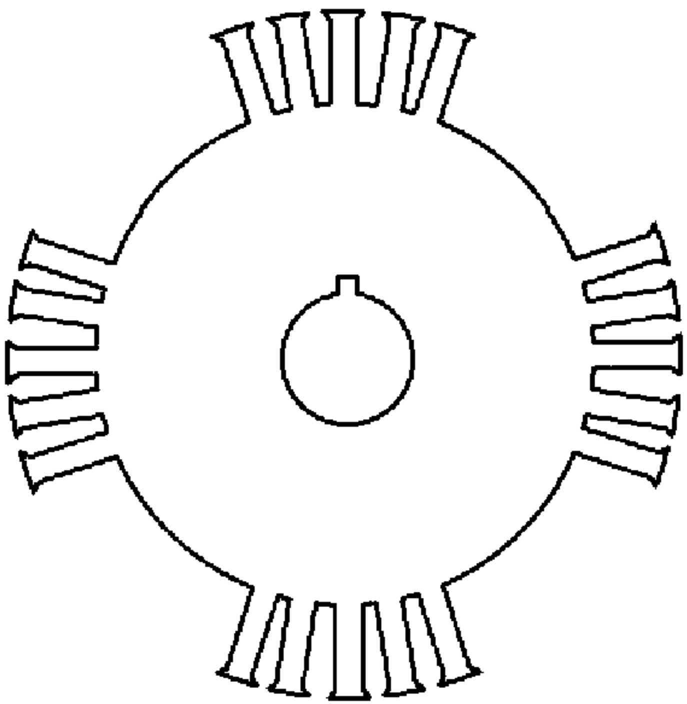


Fig: The rotor design of a "synchronous induction" or self-starting reluctance motor.

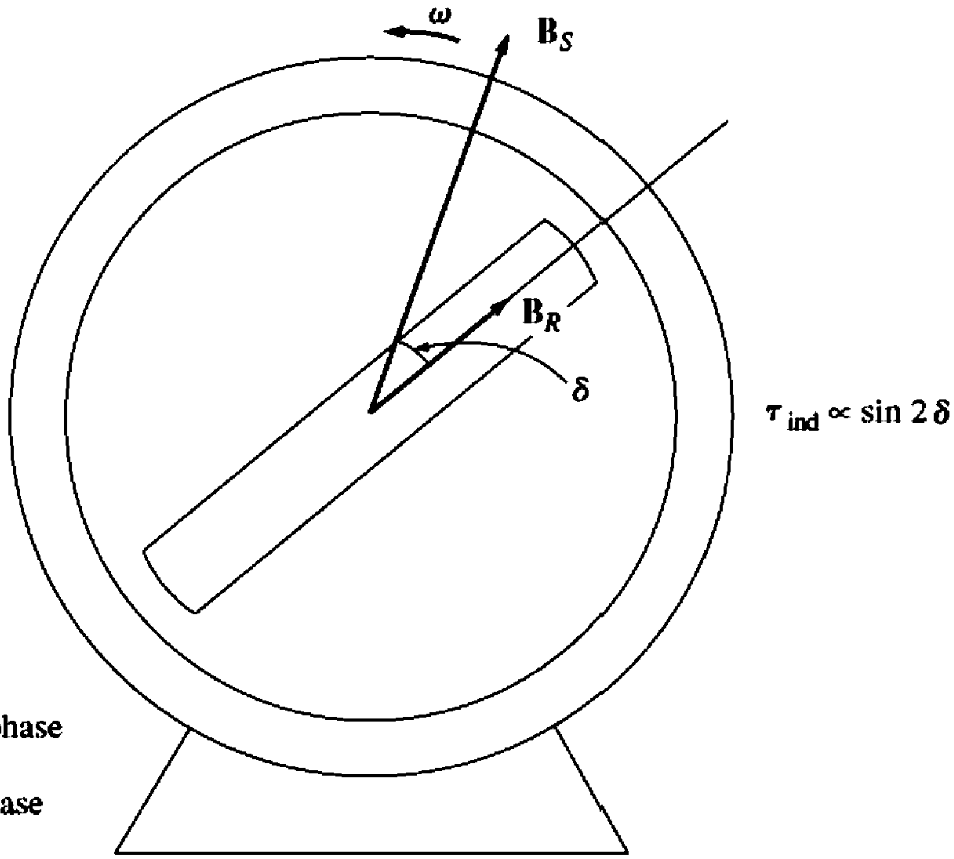


Fig: The basic concept of a reluctance motor.

Reluctance motor: A synchronous-induction Motor

1. The rotor has salient poles and a cage so that it starts like an induction motor, and runs like a synchronous motor.
2. Uses soft magnet rotor that is magnetized by the application of current in the stator coils
3. The magnet is spun by a 3 phase AC motor with no rotor voltage
4. The gear teeth are designed to increase the magnetic flux driving the rotor while providing asymmetry that gives it the rotational acceleration
5. Permeability of the rotor provides a significant increase in inductive power
6. It is full solution of Faraday's law with time and velocity dependence.

Stepper Motor (A special type of synchronous motor

- Used for measured rotation
- Can be held at a particular position of the shaft
- Ideal for many autonomous robots requiring higher precision
- Designed to rotate a specific number of degrees for every electric pulse received by its control unit.
- Typical steps are 7.5^0 or 15^0 per pulse.
- It can rotate in both directions, move in
- precise angular increments, sustain a holding torque at zero
- speed, and be controlled with digital circuits.
- It moves in accurate angular increments known as steps, in response to the application of digital pulses to the electric drive circuit.
- Generally, such motors are manufactured with steps per revolution.
- Step motors are either bipolar, requiring two power sources or unipolar requiring only one power source.

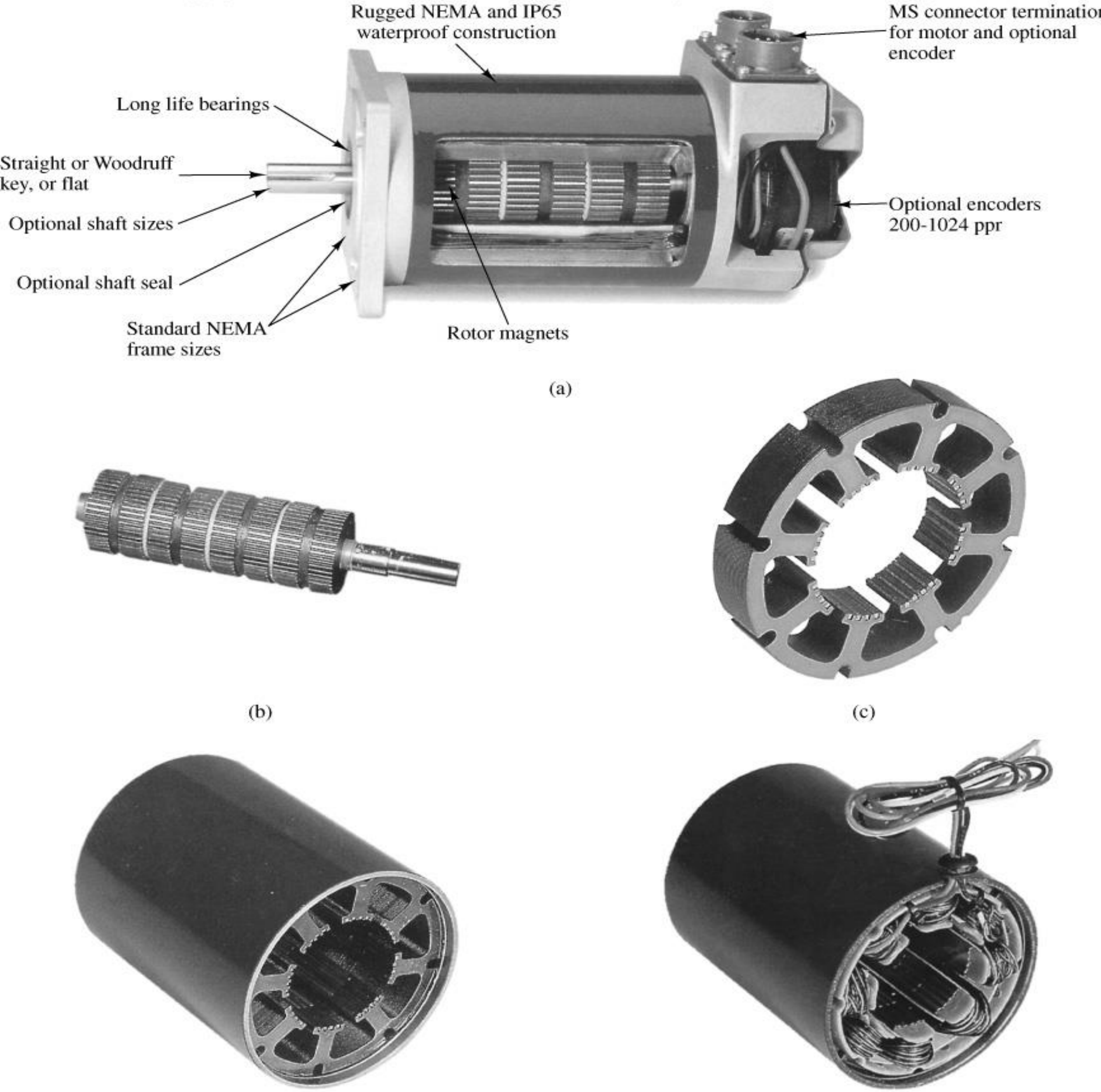
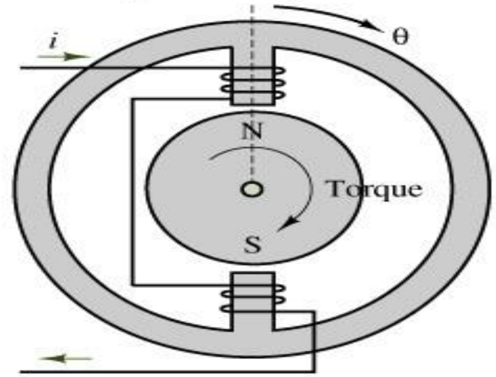
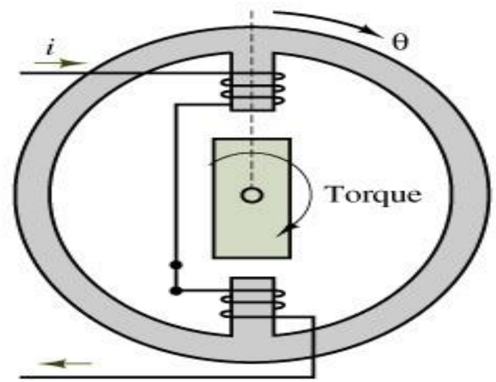


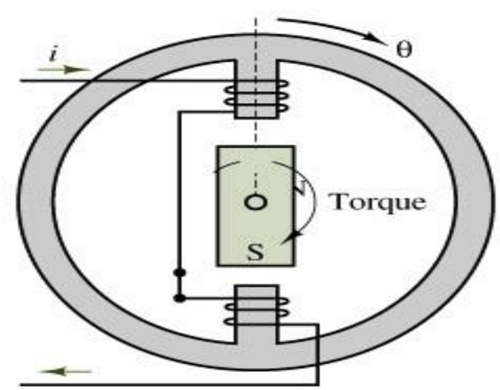
Fig: Stepper Motor



(a) Permanent-magnet stepping motor

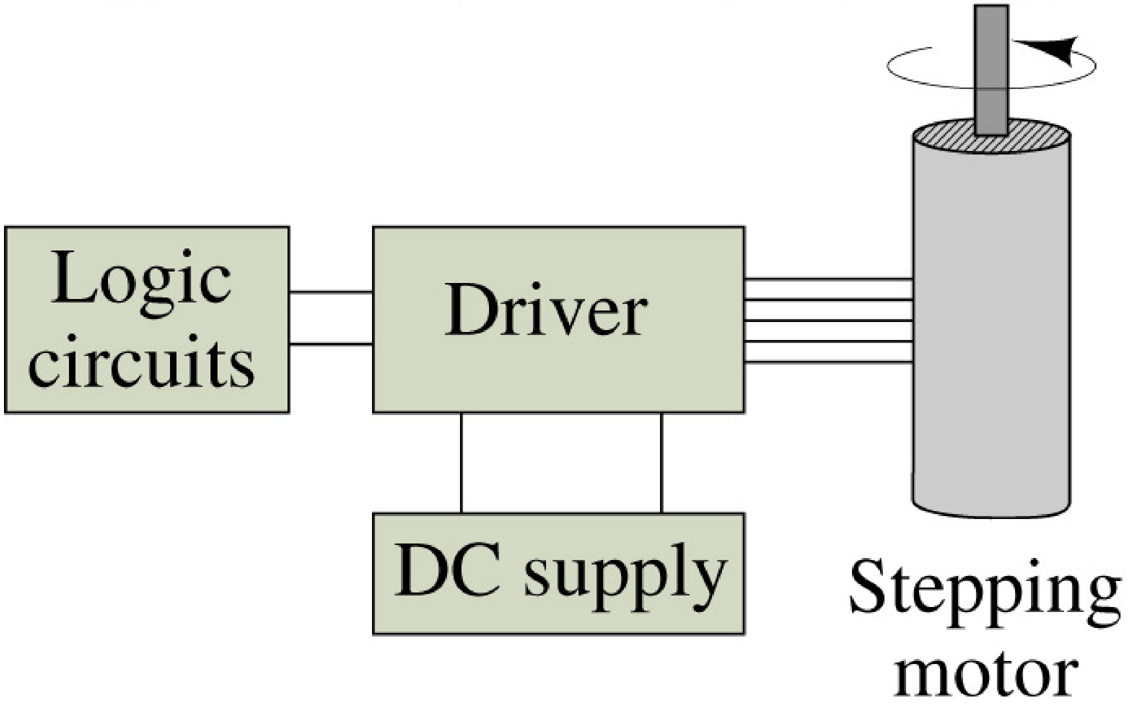


(b) Variable-reluctance stepping motor



(c) Hybrid stepping motor

Variable Reactance (VR) Stepper Motor
(a) Complete Motor Assembly; (b) PM Rotor; (c) Stator Cross Section; (d) Fully Assembled Stator; (e) Stator with Windings.



Servo Motor

- Used in closed loop control systems in which work is the control variable.
- An integral feedback device (resolver) or devices (encoder and tachometer) are either incorporated within the servo motor or are remotely mounted, often on the load itself.
- A servo motor is a DC, AC, or brushless DC motor combined with a position sensing device (digital decoder). Servos are extremely useful in robotics.
- The motors are small and are extremely powerful for the size.
- Brushless DC motor is not a DC motor but a permanent-magnet synchronous machine. The name is actually due to the fact that its operating characteristics resemble those of shunt DC motor with constant field current.

Key Points (electrical Power Supply)

- Residences are furnished with single-phase power
- Houses can be supplied power from the transformer
- Power feeds into circuit breaker panel or fuse box
- Circuit breakers protect each individual circuit
- Power is distributed throughout the house
- Typical residential panels provide 115 and 230 volts
- Commercial and industrial facilities require three-phase power

Key Points (Summery)

- Power generation is dominated by AC machines
  - range from automotive alternators to the synchronous generators used in power stations
  - efficiency increases with size (up to 98%)
- Both DC and AC motors are used
  - high-power motors are usually AC, three-phase
  - domestic applications often use single-phase induction motors
  - DC motors are useful in control applications
- Electrical machines include both generators and motors
- Three phase Synchronous generator (Alternator) is used for power generation
- Motors can usually function as generators, and vice versa
- Electrical machines can be divided into AC and DC forms
- The rotation of a coil in a uniform magnetic field produces a sinusoidal e.m.f. This is the basis of an AC generator
- A commutator can be used to produce a DC generator
- The magnetic field in an electrical machine is normally produced electrically using field coils
- DC motors are often similar in form to DC generators
- Some forms of AC generator can also be used as motors
- The most widely used form of AC motor is the induction motor
- Synchronous motors are used for constant speed operation.

Motor Selection Criteria

- ✓ Available power (DC or AC)
- ✓ Operating condition.
- ✓ Starting characteristics (torque and current)
- ✓ Operating speed.
- ✓ Forward/reverse operation.
- ✓ Acceleration characteristics (depending on load)
- ✓ Efficiency at rated load.
- ✓ Overload capability.
- ✓ Electrical and thermal safety.
- ✓ Life span and maintenance.
- ✓ Mechanical aspects (size, weight, noise level, environment).
- ✓ EMC and EMI
- ✓ Control complexity and Cost.

Thank you