Electric Traction & Control 3350907

Vishal D Devdhar

Lecturer,

Government Polytechnic,

Rajkot.

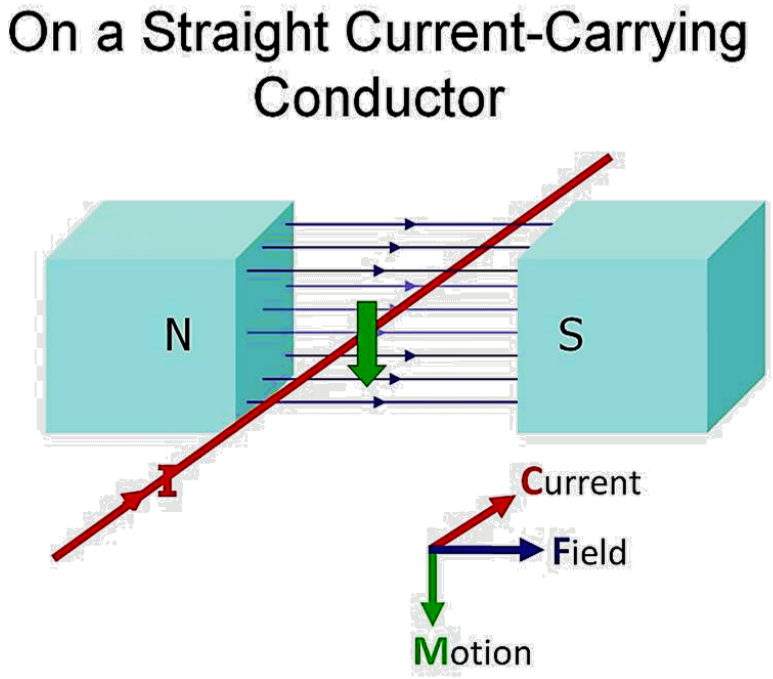
www.vishaldevdhar.org

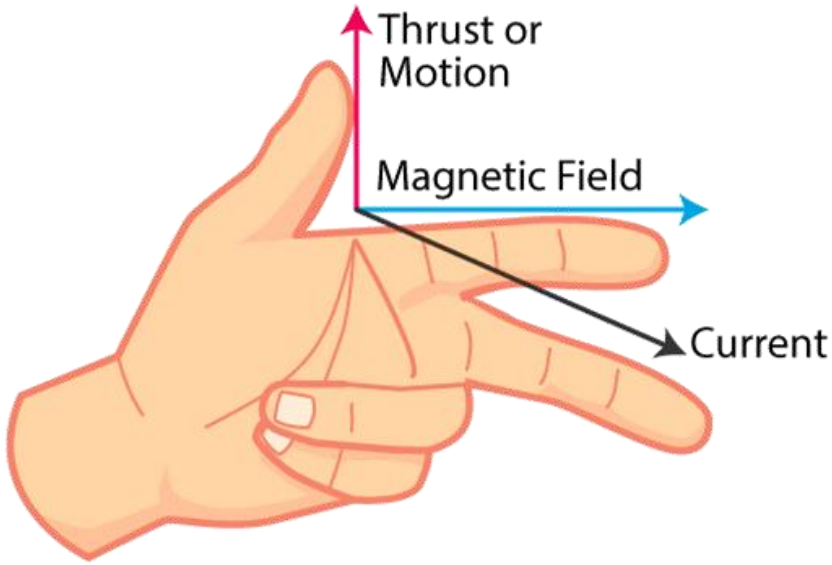
DC Motor

Motor converts Electrical Energy into Mechanical Energy

Fleming's Left Hand Rule

When a current-carrying conductor is placed in an external magnetic field, the conductor experiences a force perpendicular to both the field and to the direction of the current flow.

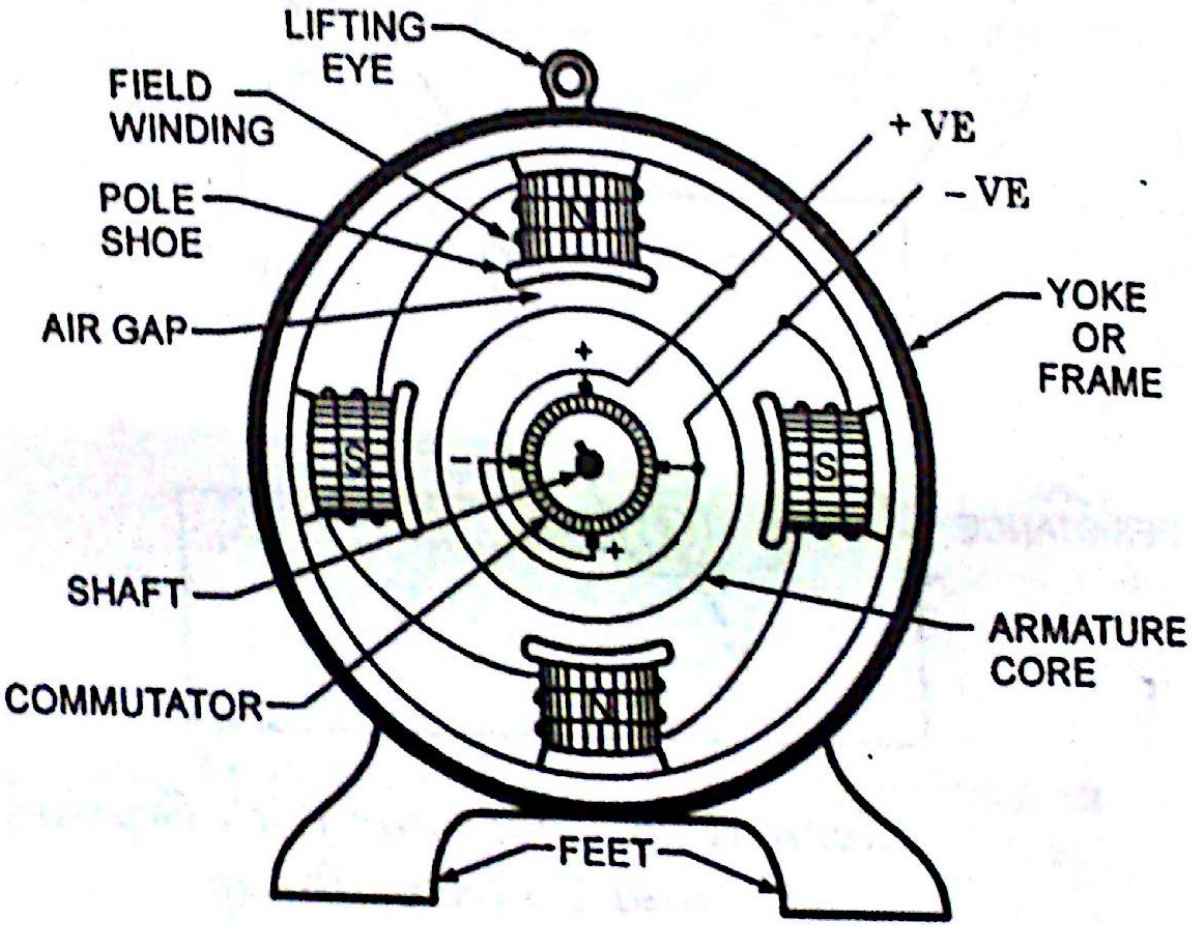




DC Machine Construction

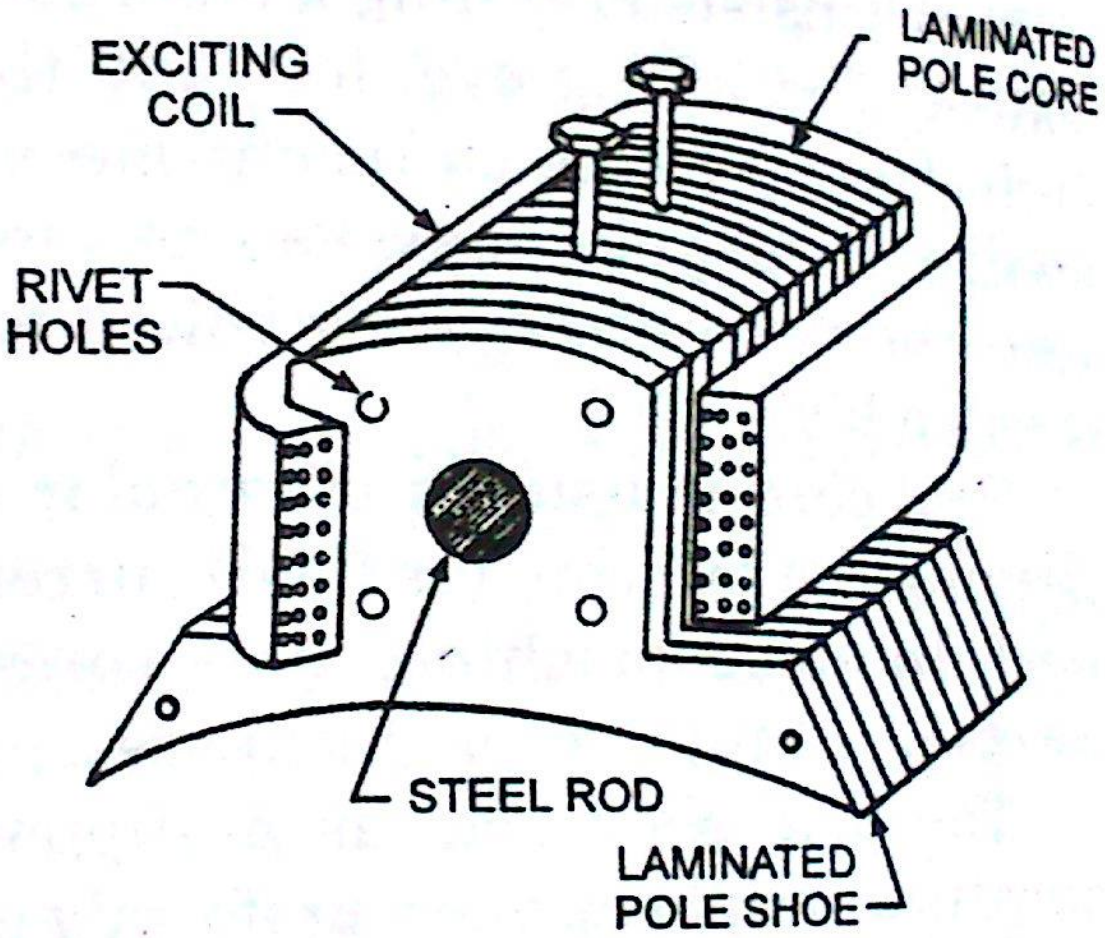
- Field System
  - Yoke/ Frame
  - Pole Core
  - Pole Shoes
  - Magnetizing Coils
- Armature
- Commutator
- Brushes
- Bearings
- Shaft

Yoke / Frame



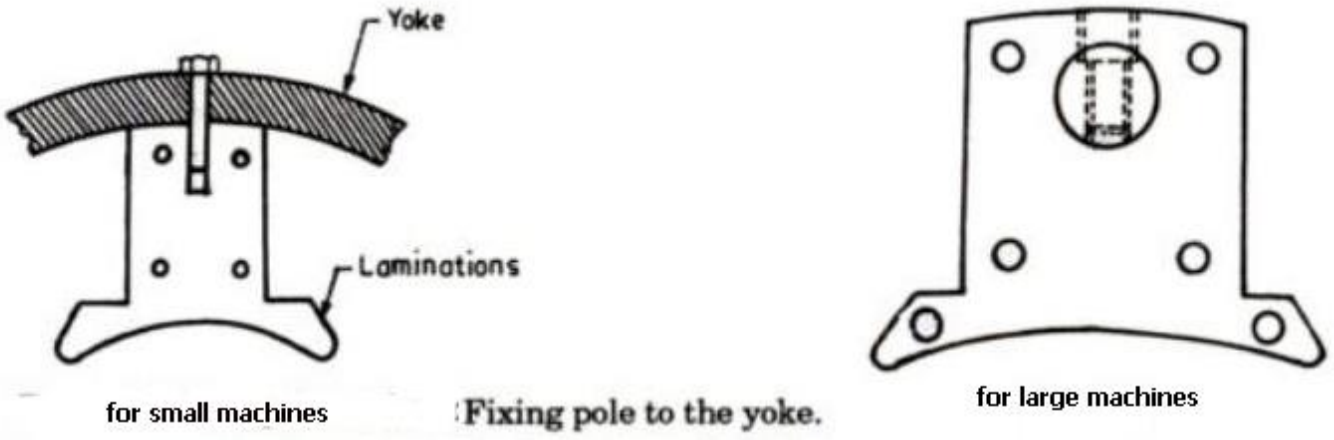
4-Pole DC Machine

Pole Core, Pole Shoes, Magnetizing Coils

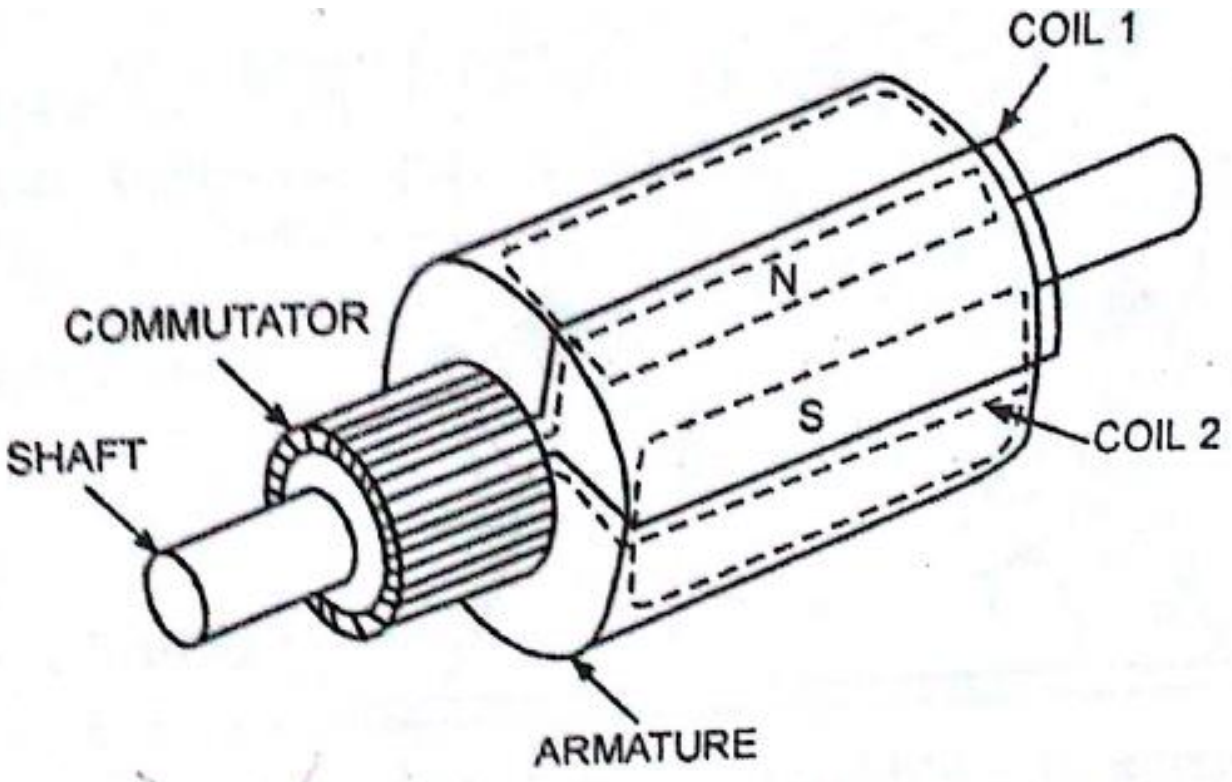


Laminated Pole Core and Pole Shoe

Pole Core, Pole Shoes, Magnetizing Coils



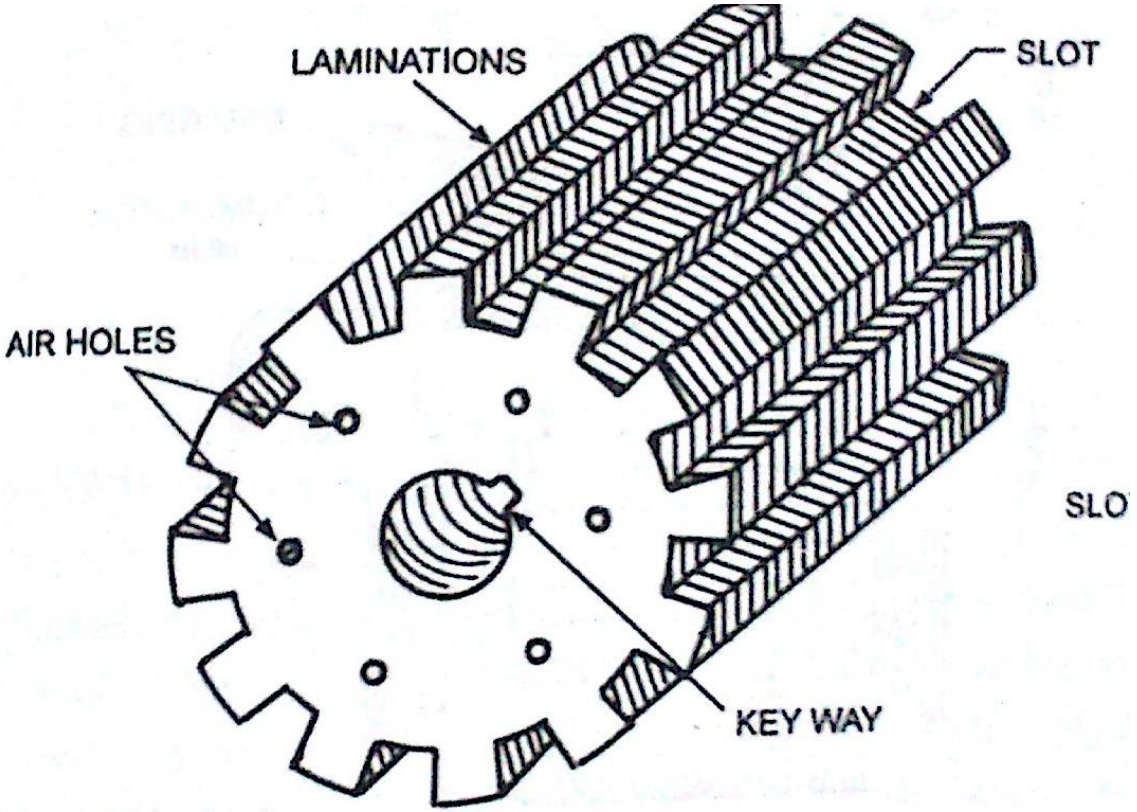
Armature



(a) Longitudinal View of Armature

Armature

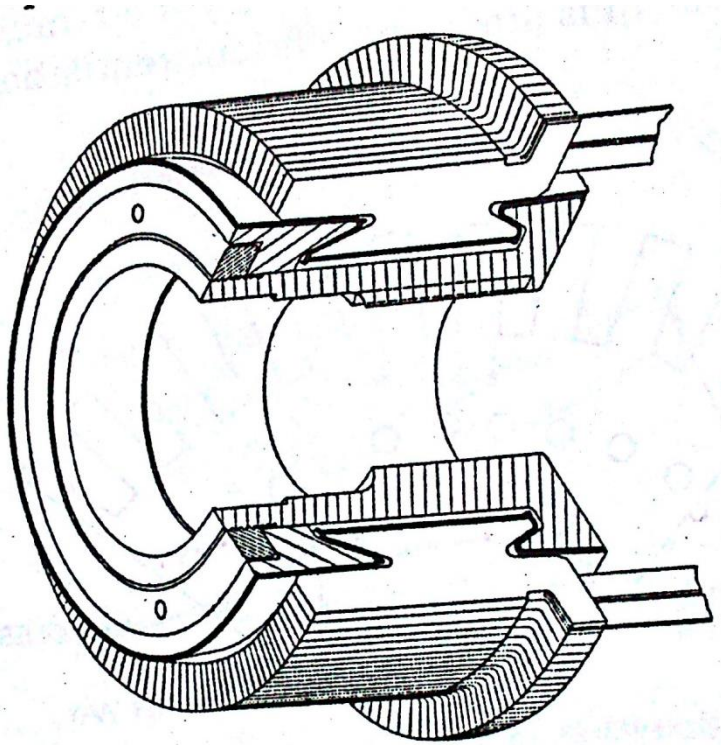
Armature Lamination

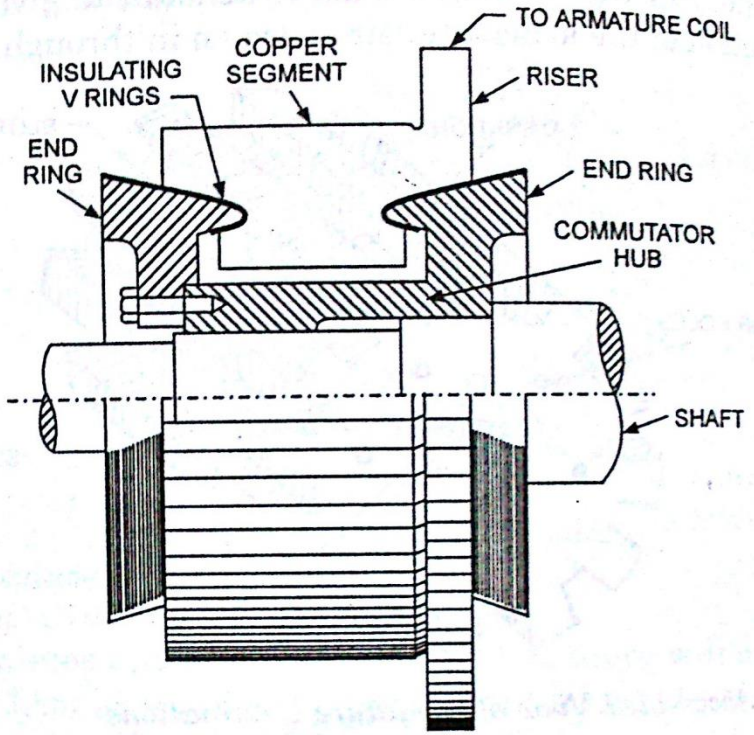


Assembled View of Armature Laminations

Armature

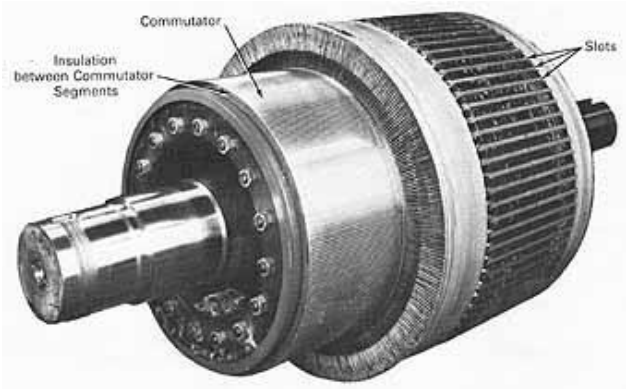
Commutator

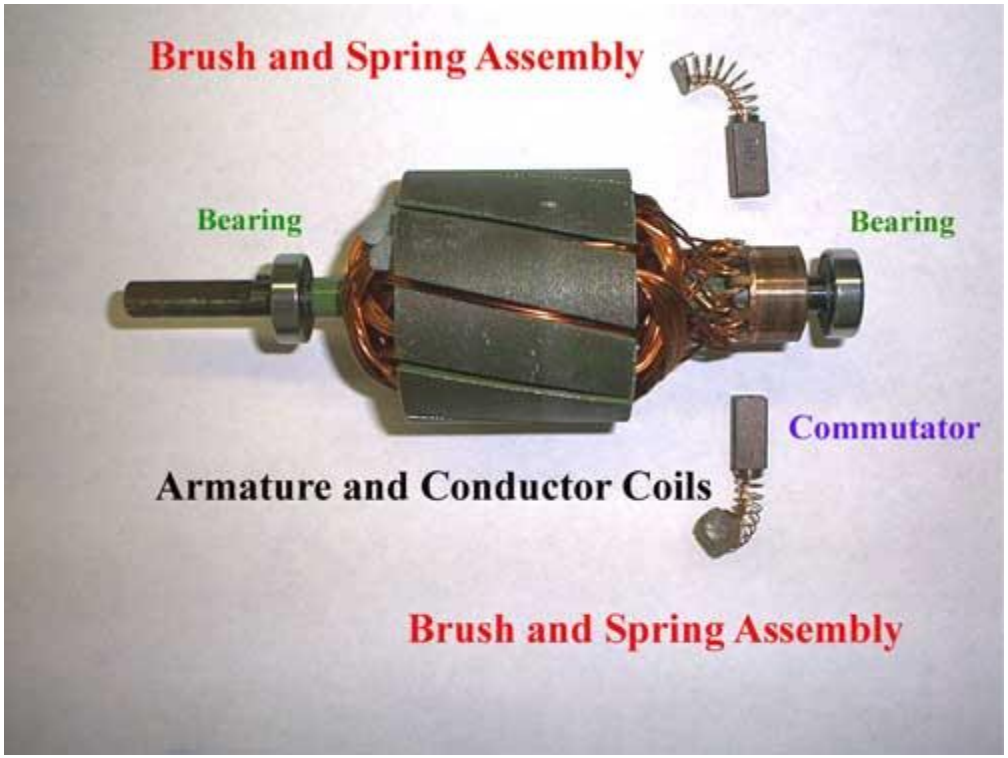




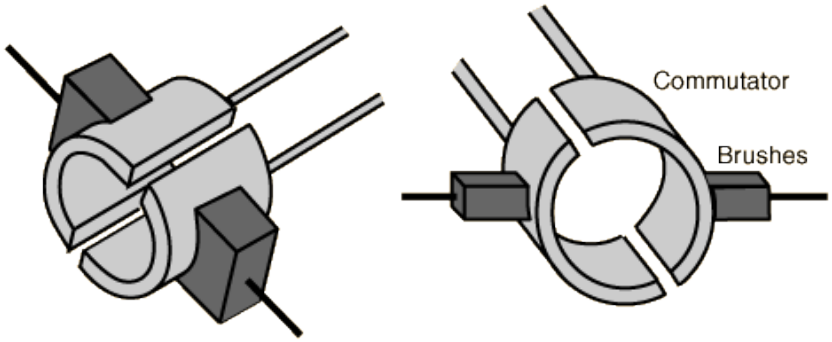
(b) Section View of Commutator Segments

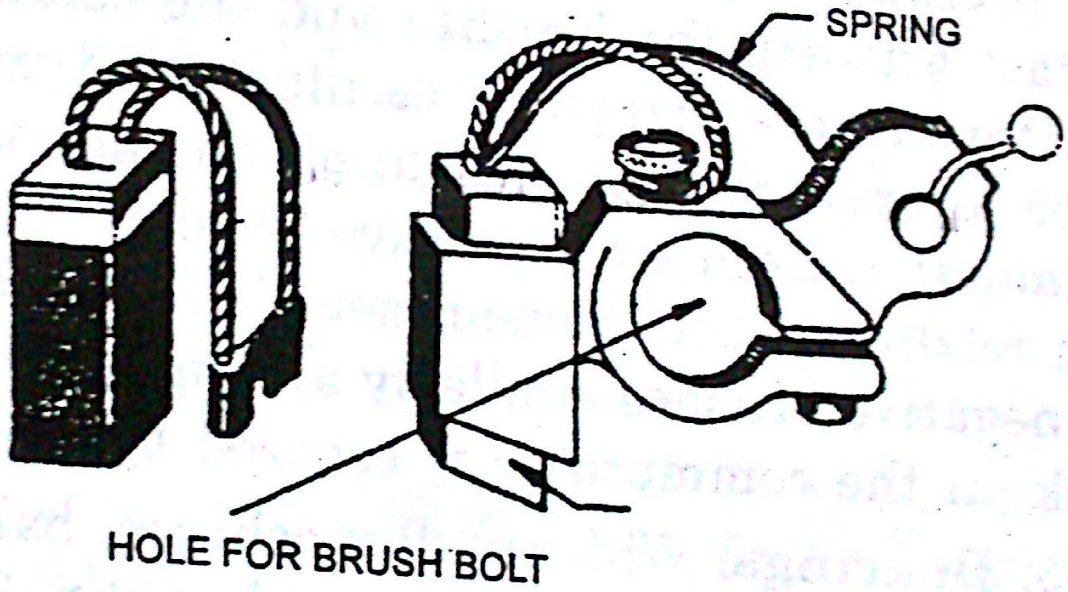
Armature & Commutator



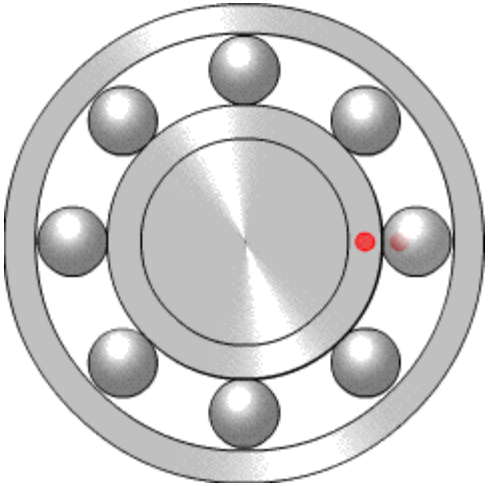


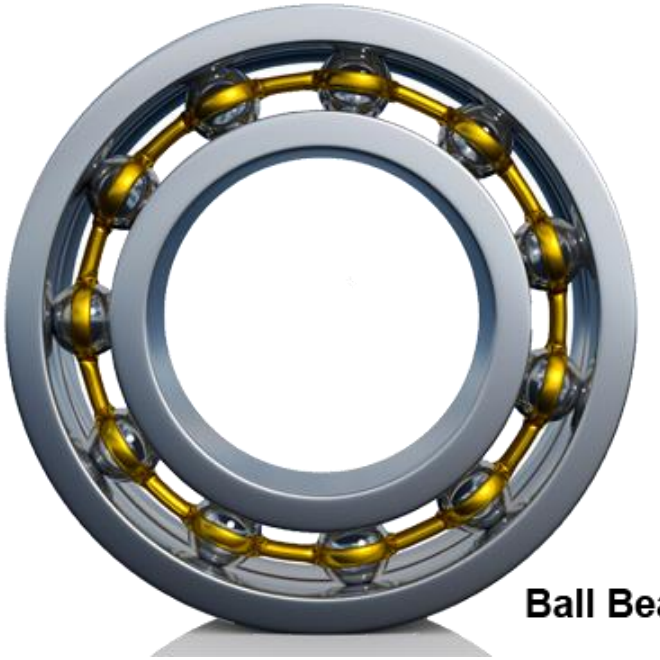
Brushes





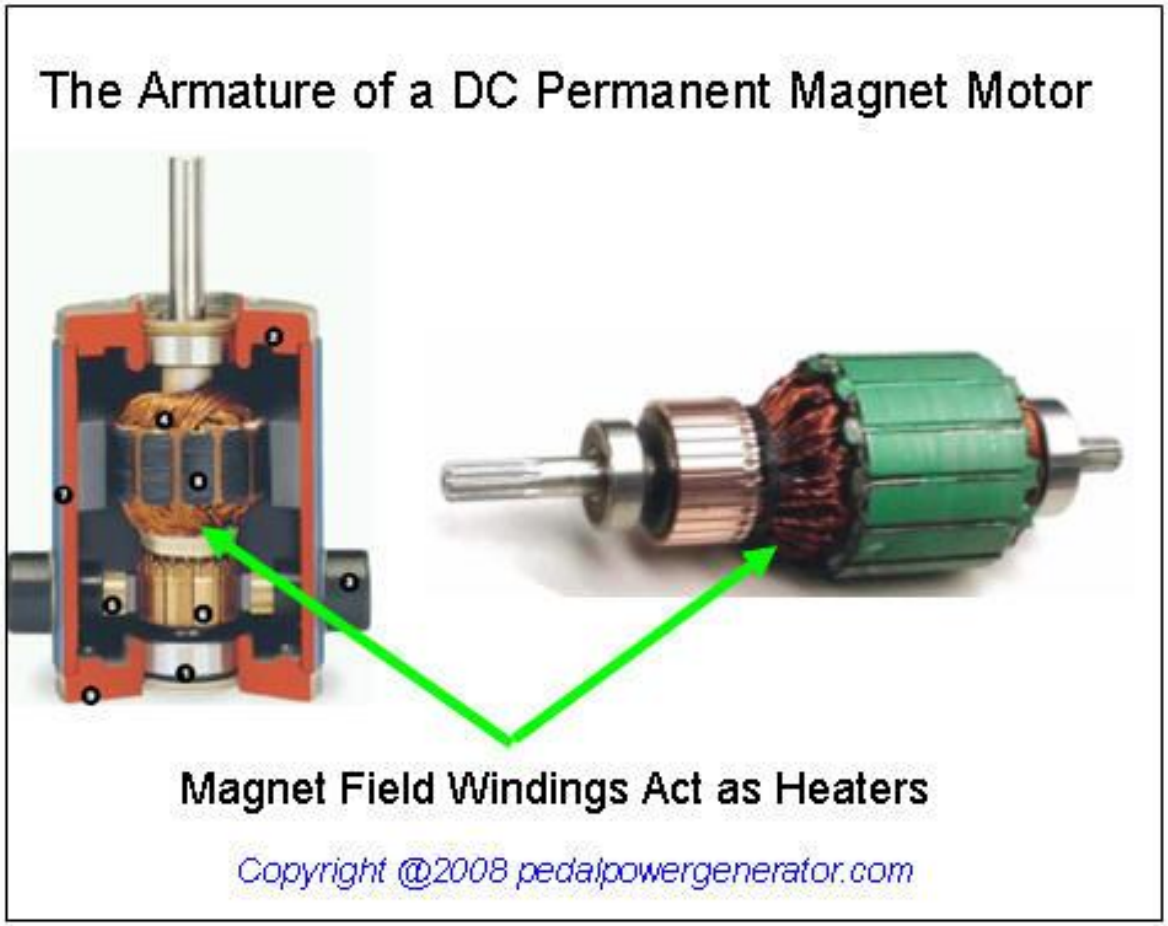
Bearings

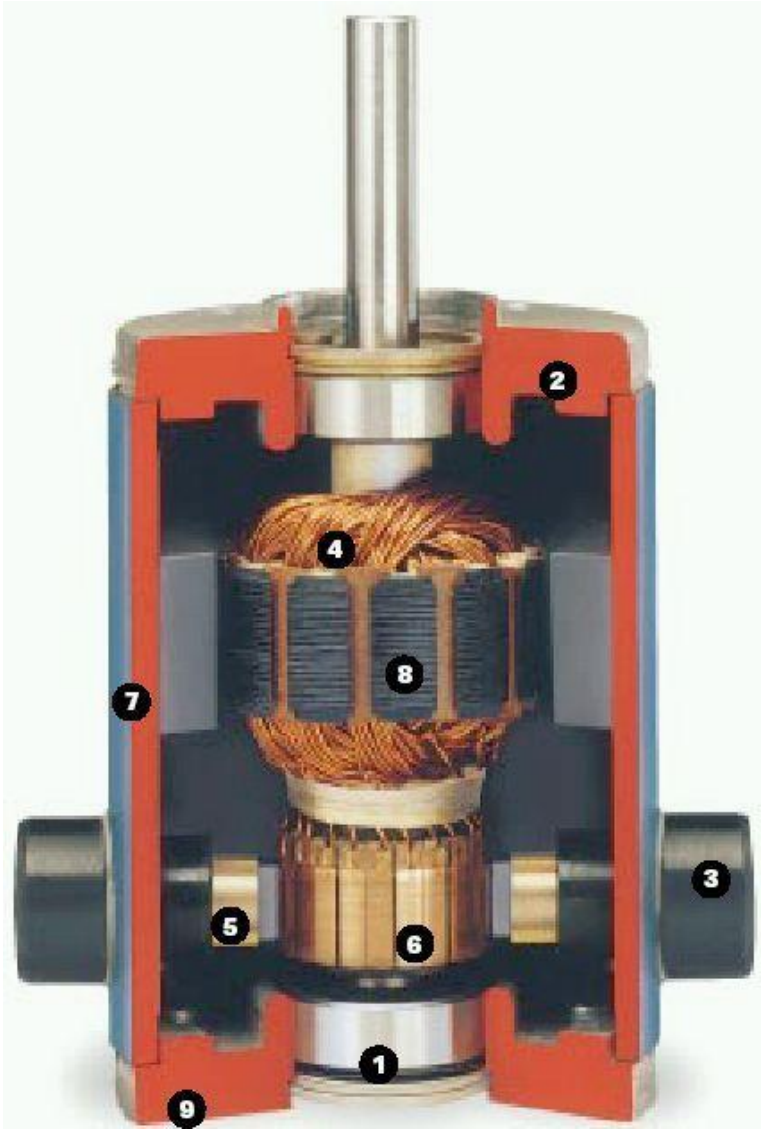




Ball Bearing

Shaft


The Armature of a DC Permanent Magnet Motor
Magnet Field Windings Act as Heaters
Copyright @2008 pedalpowergenerator.com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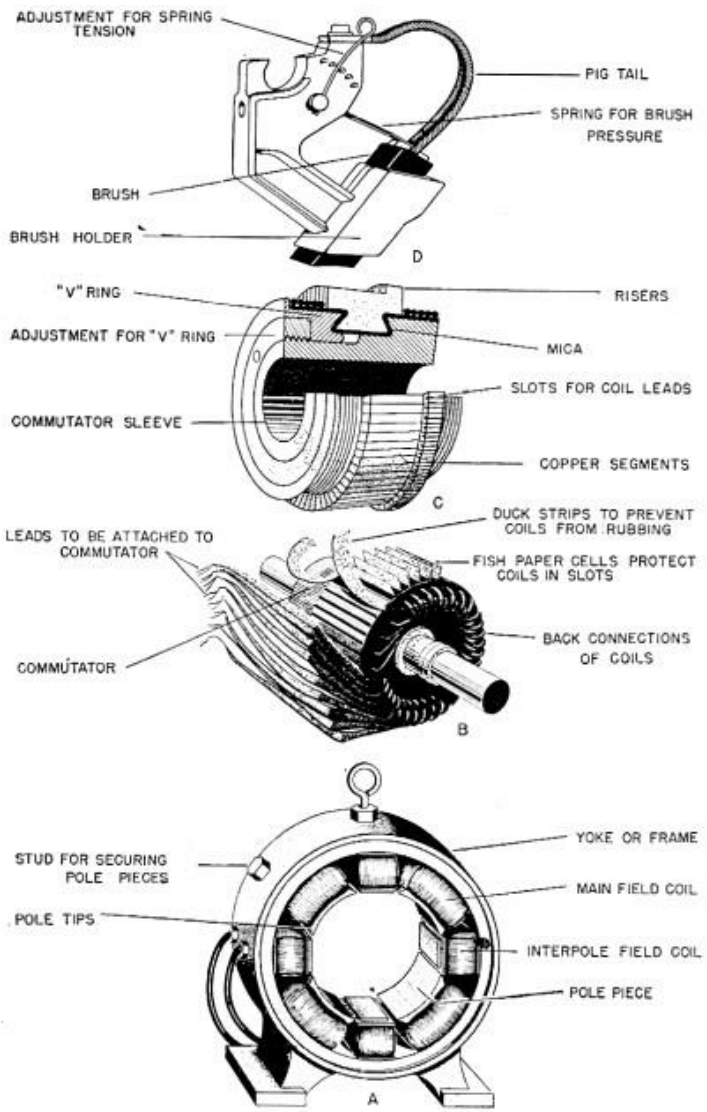
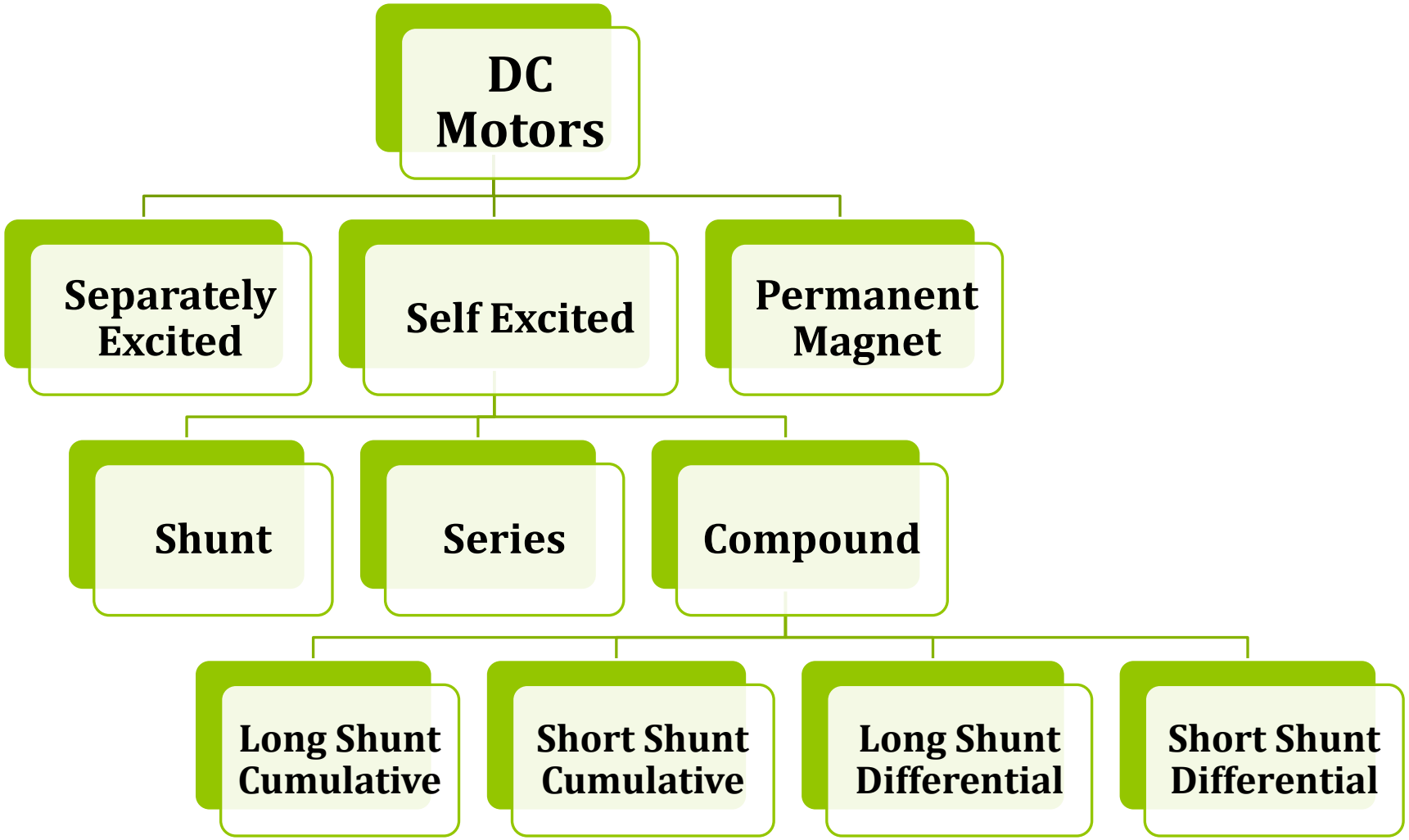

ADJUSTMENT FOR SPRING TENSION
PIG TAIL
SPRING FOR BRUSH PRESSURE
BRUSH
BRUSH HOLDER
D
"V" RING
RISERS
ADJUSTMENT FOR "V" RING
MICA
SLOTS FOR COIL LEADS
COMMUTATOR SLEEVE
COPPER SEGMENTS
C
DUCK STRIPS TO PREVENT COILS FROM RUBBING
LEADS TO BE ATTACHED TO COMMUTATOR
FISH PAPER CELLS PROTECT COILS IN SLOTS
BACK CONNECTIONS OF COILS
COMMUTATOR
B
YOKE OR FRAME
STUD FOR SECURING POLE PIECES
MAIN FIELD COIL
POLE TIPS
INTERPOLE FIELD COIL
POLE PIECE
A

Types of DC Motor



DC Motor Back EMF Equation

$$E_b = \frac{\varphi Z N P}{60 A}$$

When the conductor cuts the magnetic field, EMF induces in the conductor

$E_b = Back\ EMF, Volt$

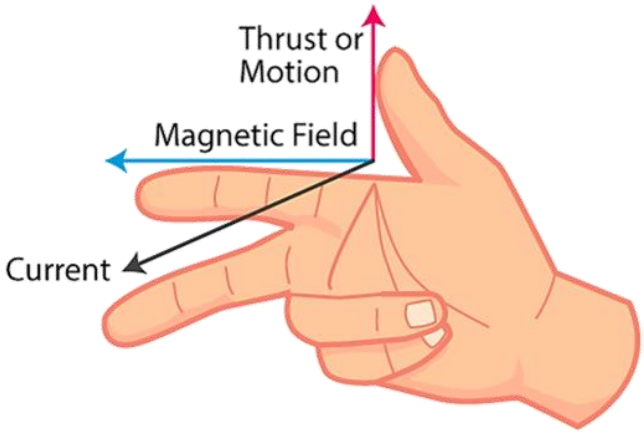
$\varphi = \frac{Flux}{Pole}$, Weber

$Z = No.of\ Armature\ Conductors$

$N = Speed, rpm$

$P = No.of\ Poles$

$A = No.of\ Parallel\ Paths$



DC Motor Starting Current

$$E_b = \frac{\varphi Z N P}{60 A}$$

$$E_b \propto \varphi N$$

At Starting,

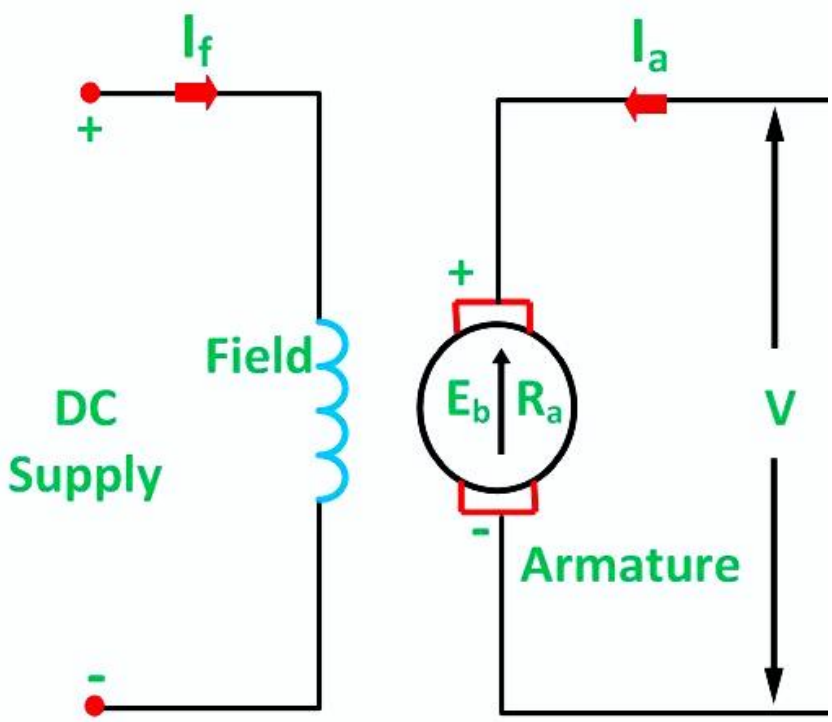
$$N = 0 \rightarrow E_b = 0$$

$$I_a = \frac{V - E_b}{R_a}$$

$$T \propto \varphi \cdot I_a$$

The back emf develops the armature current according to the need of the motor

Separately Excited Motor



$$V = E_b + R_a I_a$$

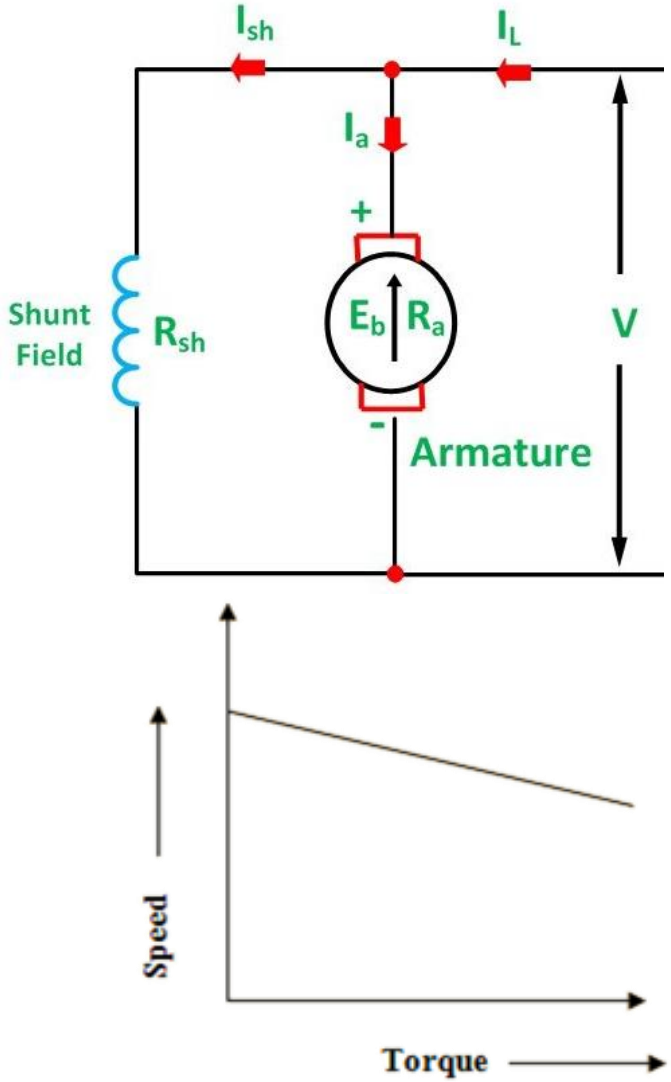
$$I = I_a$$

$$I_f = \frac{V_f}{R_f}$$

$$N \propto \frac{E_b}{\varphi}$$

$$T \propto \varphi \cdot I_a$$

DC Shunt Motor



$$V = E_b + R_a I_a$$

$$I_a = \frac{V - E_b}{R_a}$$

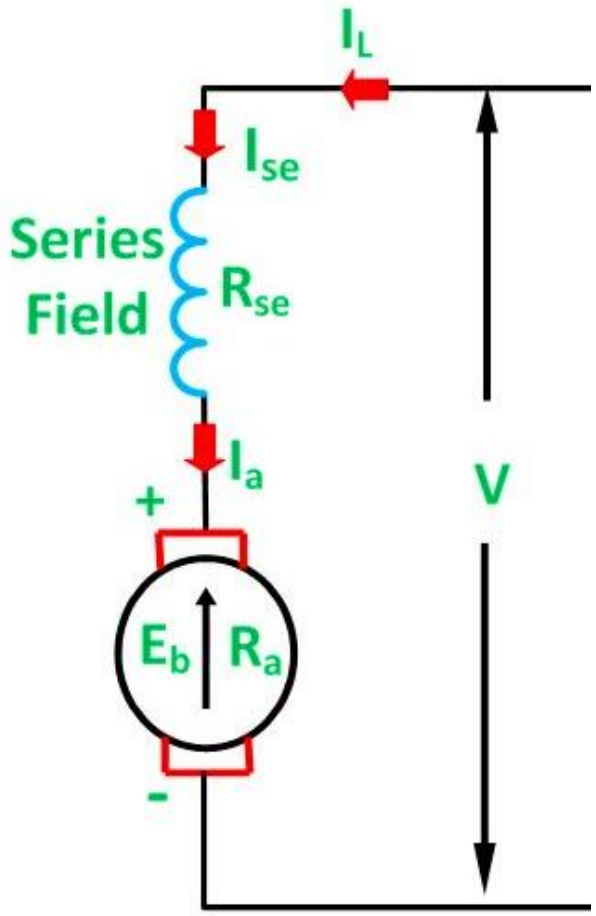
$$I = I_a + I_{sh}$$

$$I_{sh} = \frac{V}{R_{sh}} = Constant$$

$$N \propto \frac{E_b}{\varphi} = Constant$$

$$T \propto \varphi \cdot I_a$$

DC Series Motor



$$V = E_b + I_a(R_a + R_{se})$$

$$I_a = \frac{V - E_b}{(R_a + R_{se})}$$

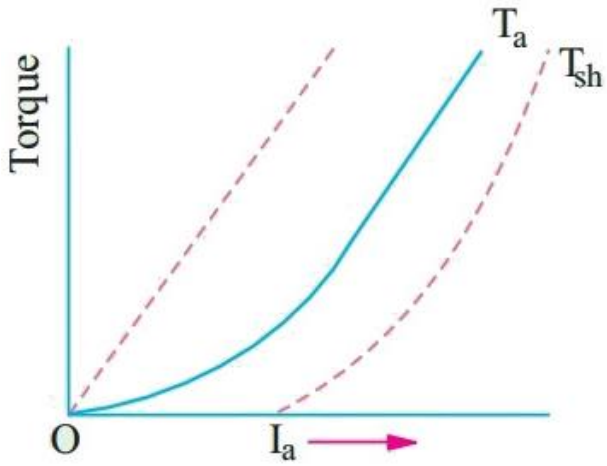
$$I = I_a = I_{se}$$

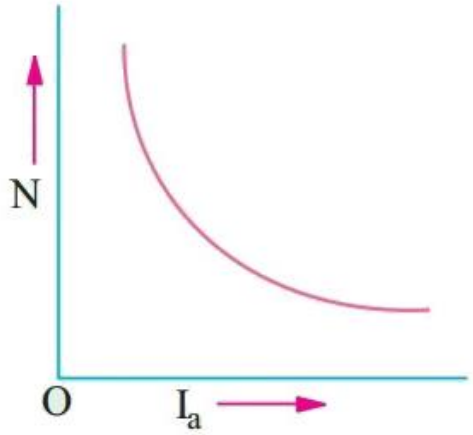
$$N \propto \frac{E_b}{\varphi}$$

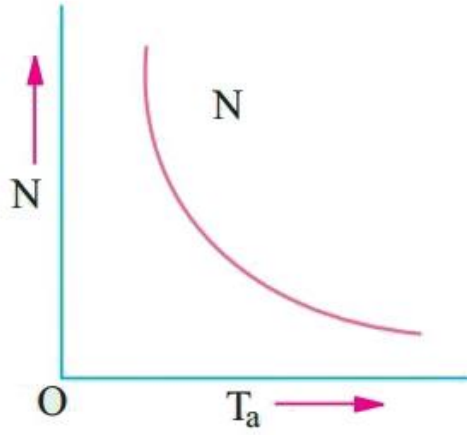
$$T \propto \varphi \cdot I_a$$

$$T \propto I_a^2$$

DC Series Motor

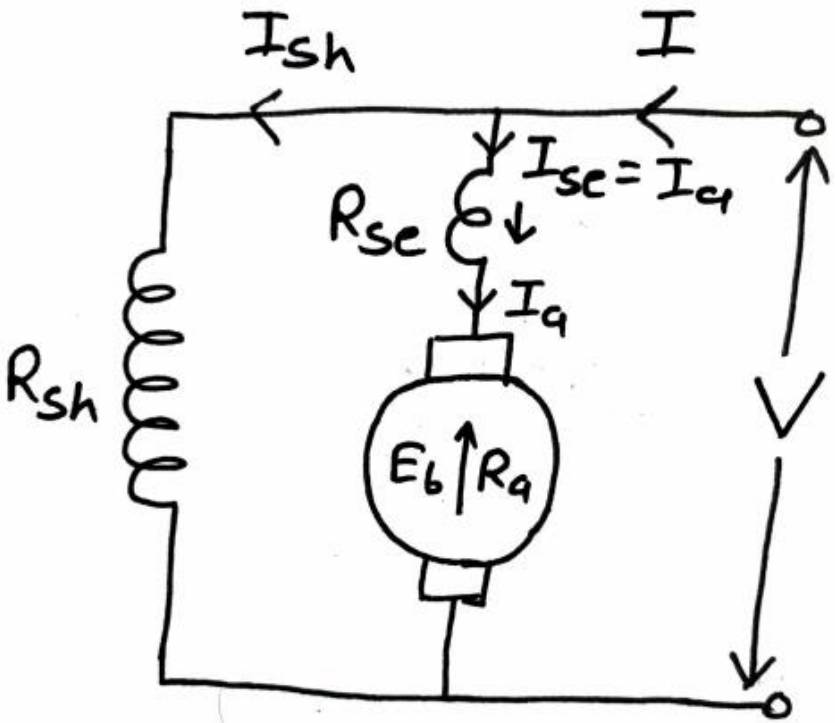






$$N \propto \frac{E_b}{\varphi} \qquad T \propto \varphi \cdot I_a \qquad T \propto I_a^2$$

DC Compound Motor

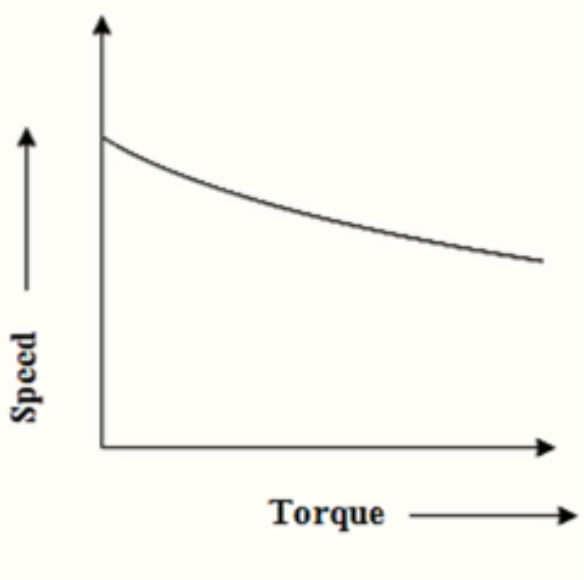


Long Shunt
Cumulative Compound

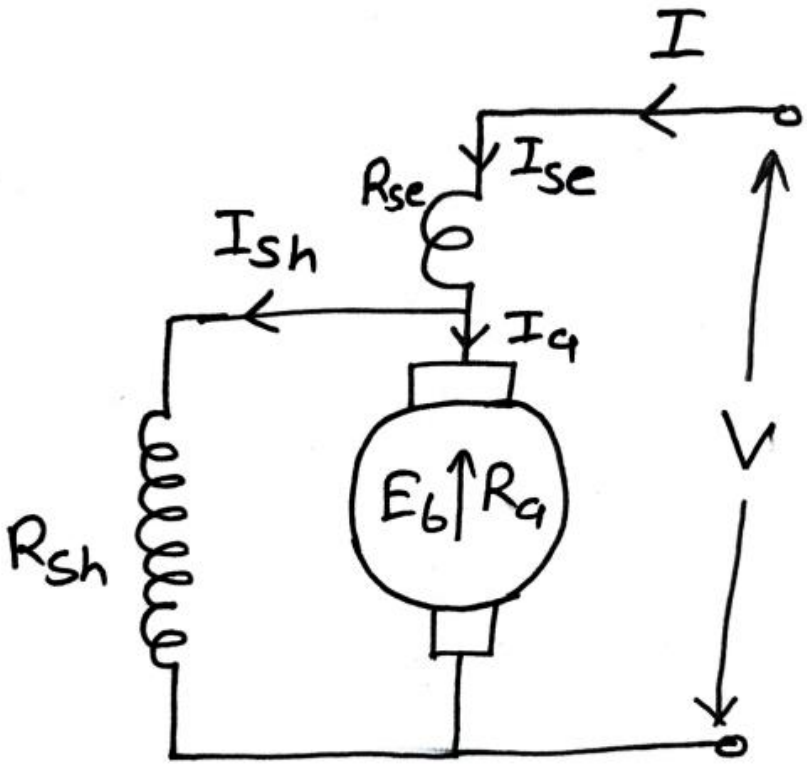
$$\varphi = \varphi_{sh} + \varphi_{se}$$

$$N \propto \frac{E_b}{\varphi}$$

$$T \propto \varphi \cdot I_a$$



DC Compound Motor

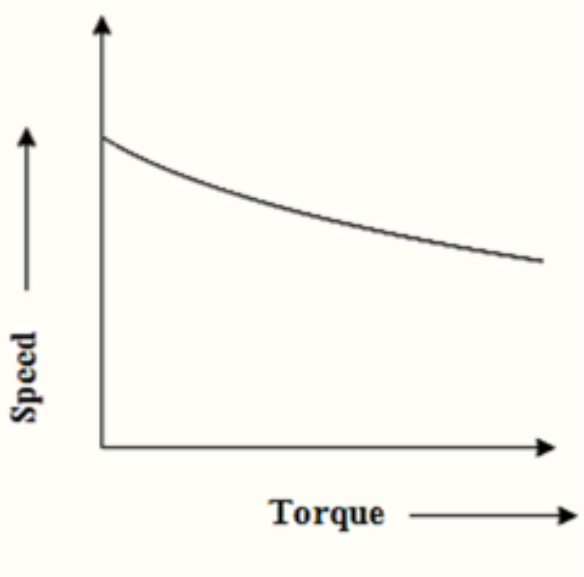


Short Shunt
Cumulative Compound

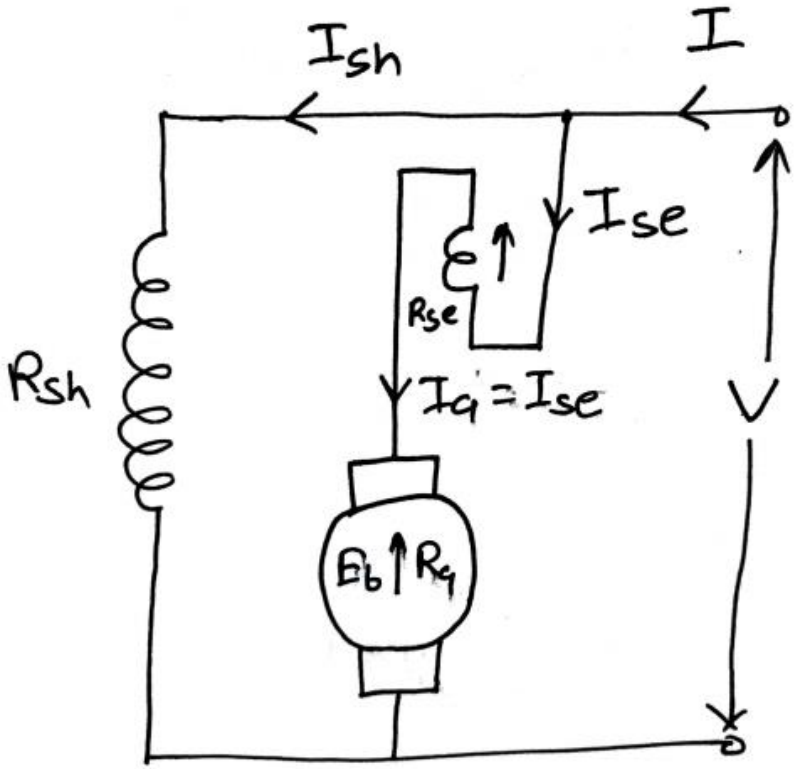
$$\varphi = \varphi_{sh} + \varphi_{se}$$

$$N \propto \frac{E_b}{\varphi}$$

$$T \propto \varphi \cdot I_a$$



DC Compound Motor

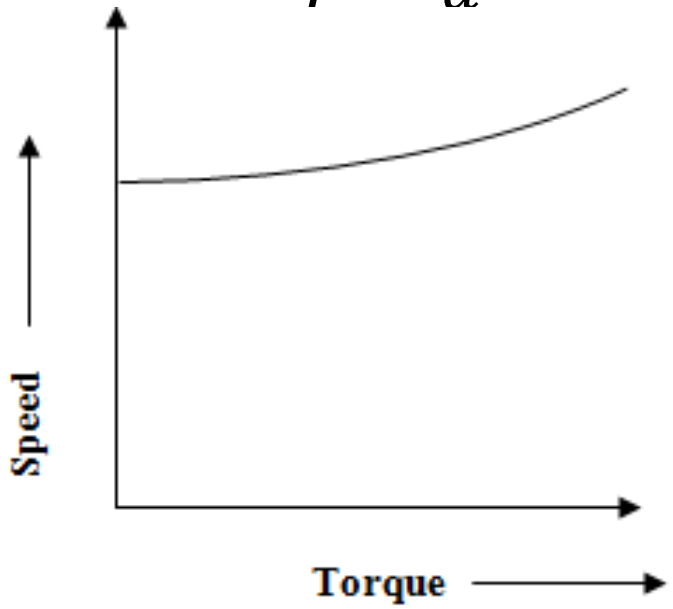


Long Shunt
Differential Compound

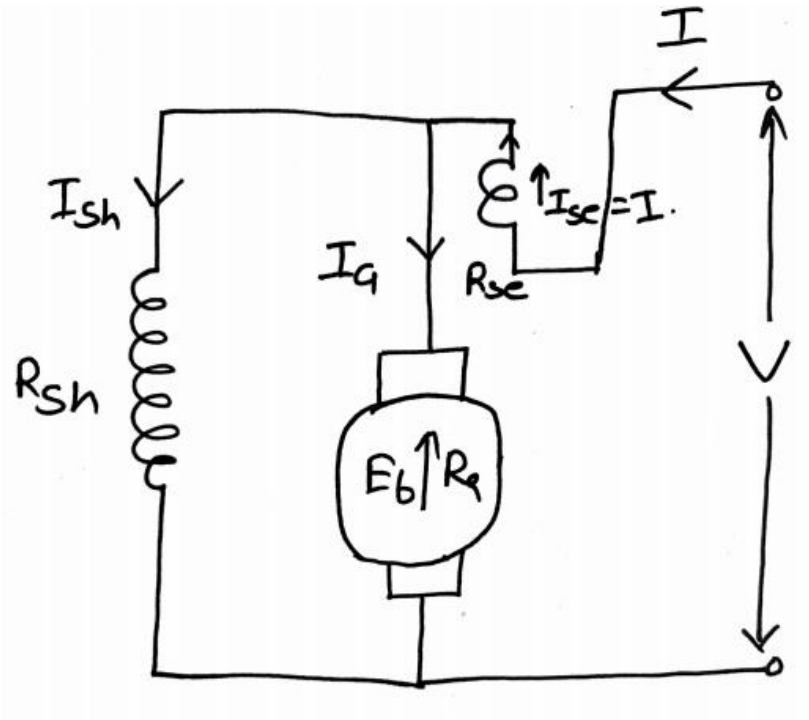
$$\varphi = \varphi_{sh} - \varphi_{se}$$

$$N \propto \frac{E_b}{\varphi}$$

$$T \propto \varphi \cdot I_a$$



DC Compound Motor

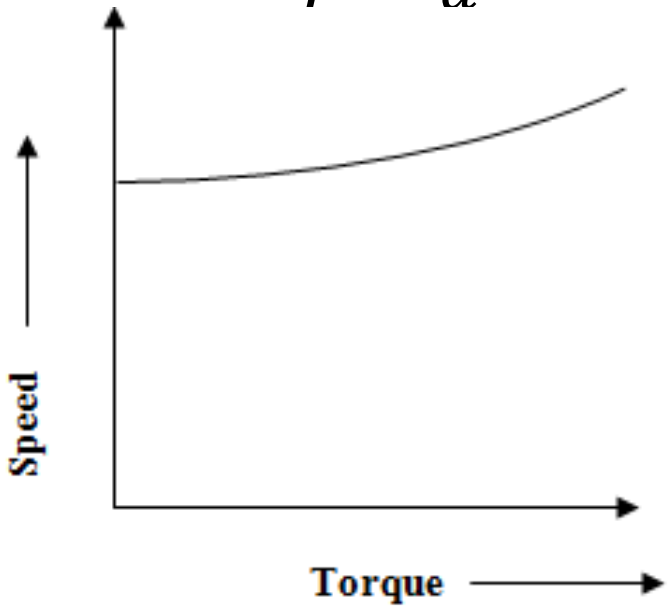


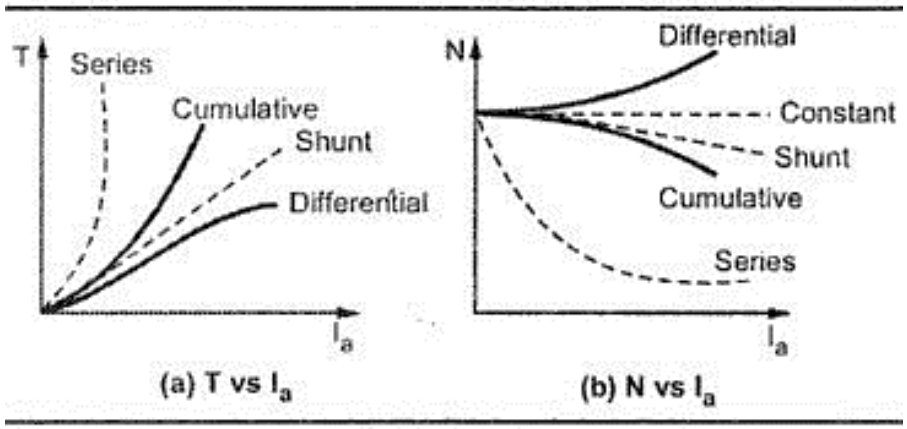
Short Shunt
Differential Compound

$$\varphi = \varphi_{sh} - \varphi_{se}$$

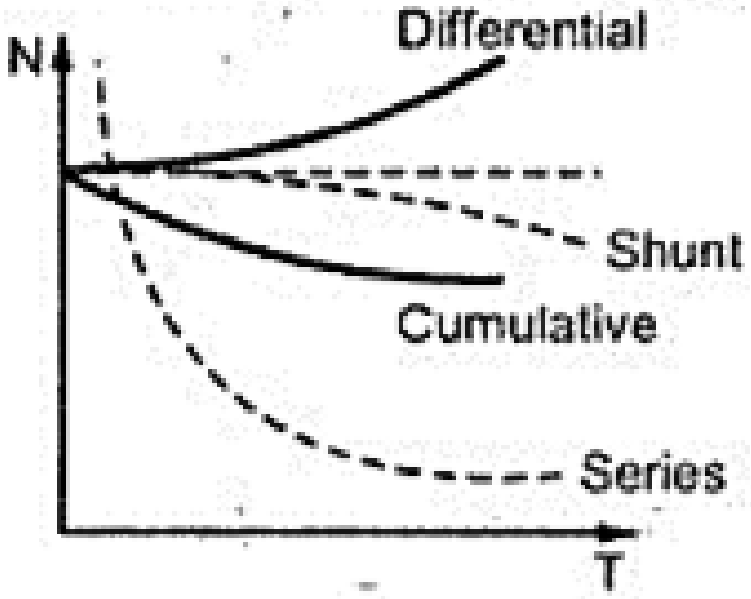
$$N \propto \frac{E_b}{\varphi}$$

$$T \propto \varphi \cdot I_a$$





(a) T vs I_a (b) N vs I_a



(c) N vs T

Summary of Applications

Type of motor	*Characteristics*	*Applications*
Shunt	Approximately constant speed Adjustable speed Medium starting torque (Up to 1.5 F.L. torque)	For driving constant speed line shafting Lathes Centrifugal pumps Machine tools Blowers and fans Reciprocating pumps
Series	Variable speed Adjustable variying speed High Starting torque	For traction work *i.e.* Electric locomotives Rapid transit systems Trolley, cars etc. Cranes and hoists Conveyors
Comulative Compound	Variable speed Adjustable varying speed High starting torque	For intermittent high torque loads For shears and punches Elevators Conveyors Heavy planers Heavy planers Rolling mills; Ice machines; Printing presses; Air compressors

Thank You

Vishal D Devdhar
Lecturer,
Government Polytechnic,
Rajkot.

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