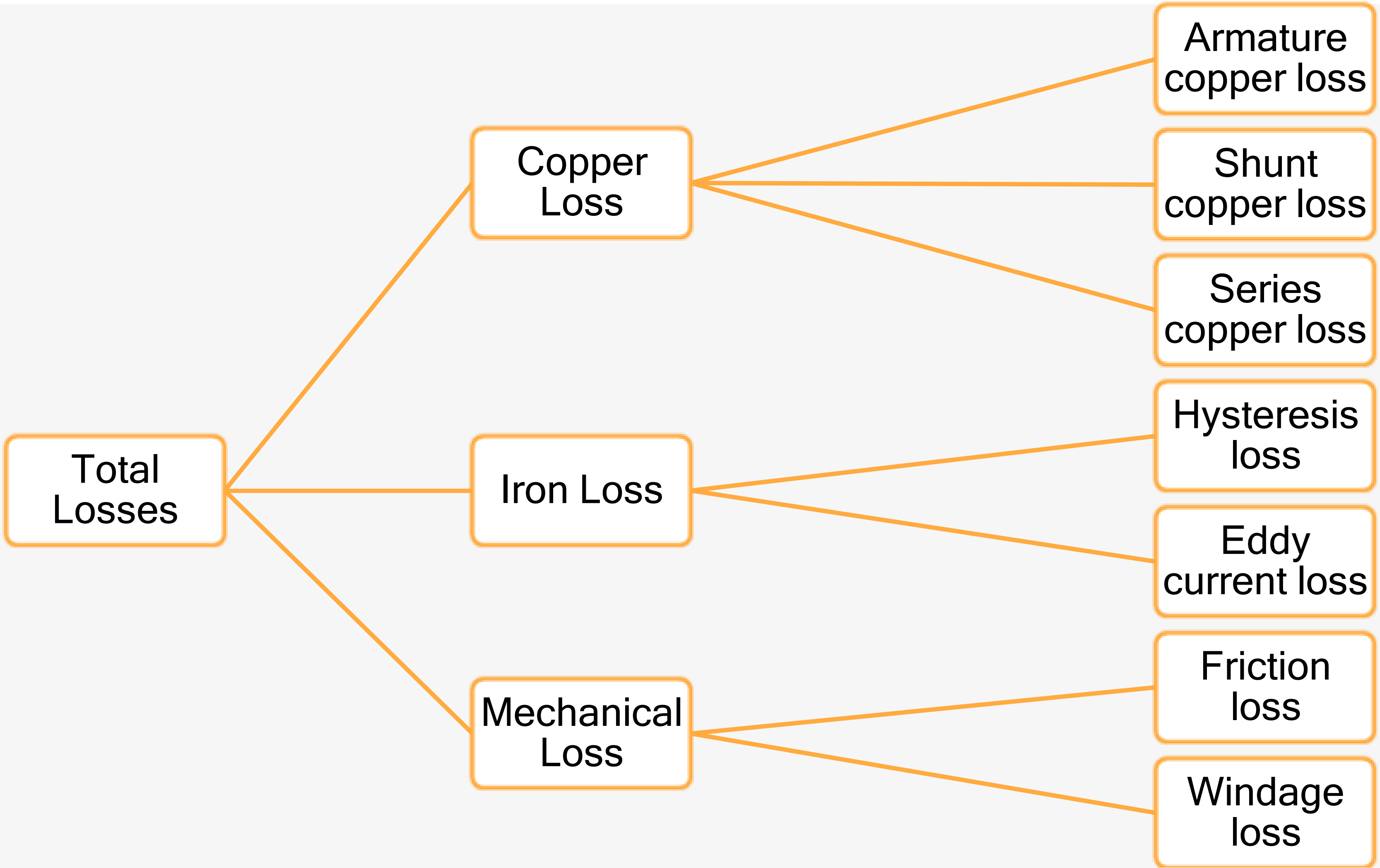
DC GENERATOR

Part 4 Note

Losses


Total Losses
Copper Loss
Iron Loss
Mechanical Loss
Armature copper loss
Shunt copper loss
Series copper loss
Hysteresis loss
Eddy current loss
Friction loss
Windage loss

Copper losses

Armature copper loss

- About 30 to 40% of full load loss

Field copper loss

- 20 to 30 % of full load loss

Loss due to brush contact resistance

Iron loss

- Losses at core
- Also known as core losses or magnetic losses
- 20 to 30 % of full load loss

Classified into two

- Hysteresis loss
- Eddy current loss

ENTRI

Hysteresis loss

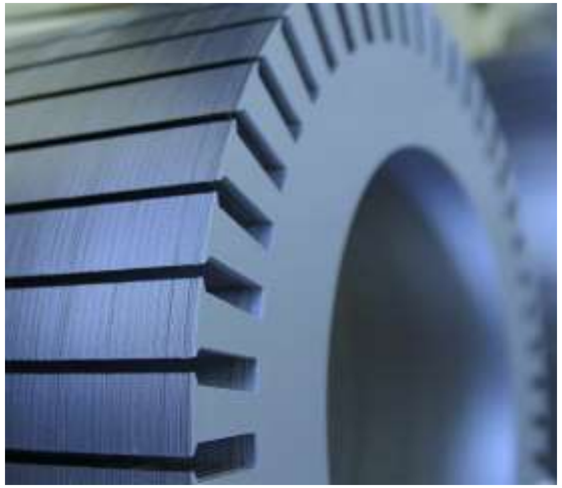
- This loss is due to the reversal of magnetization of the armature core.
- Energy wasted in the form of heat
- To reduce hysteresis loss, we are using silicon steel. silicon 3-4 %
- Losses calculated by Steinmetz formula.

$$W_h = \eta \, B_{max}^{1.6} \, f \, V \text{ watts}$$

- η = Steinmetz hysteresis constant , unit = joule/m^2
- B_{max} = maximum flux density
- V = Volume of the core in m^3
- f = frequency
- Silicon steel = 191 joule/m^2 cast iron = 2700-4000 joule/m^2

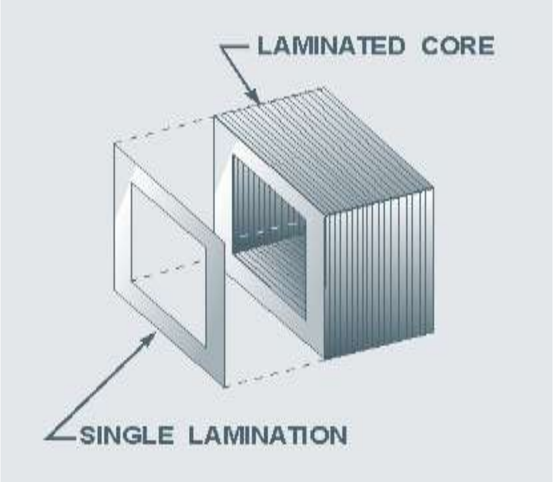
ENTRI

Eddy current loss



- Armature cuts the magnetic flux and an emf will induce on it.
- Power loss due to flow of current through the armature core.
- By using laminated silicon steel , eddy current loss will reduce
- Power loss in the form of heat

$$W_e = K\ Bmax^2\ f^2\ t^2\ v^2 \text{ watts}$$



- K= eddy current constant
- B_{max} = maximum flux density
- V = Volume of the core in m^3
- f = frequency of magnetic reversal
- t = thickness of each lamination

- Magnetic losses are practically constant for shunt and compound generator.
    - Because field current approximately constant.

Mechanical losses

Friction loss

- At bearing and commutator

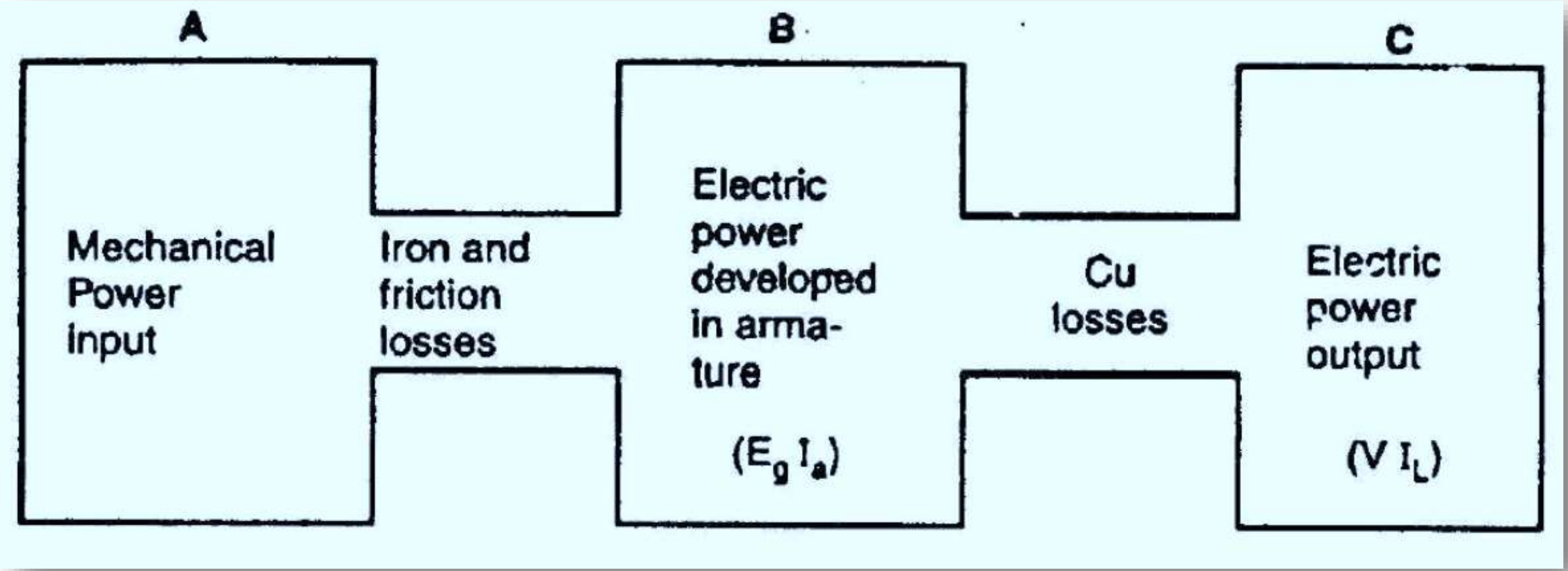
Windage loss

- Windage loss of rotating armature
- 10 to 20 % of full load loss

Stray losses

- Sum of magnetic and mechanical losses
- Also called rotational losses

Power stages of DC Generator



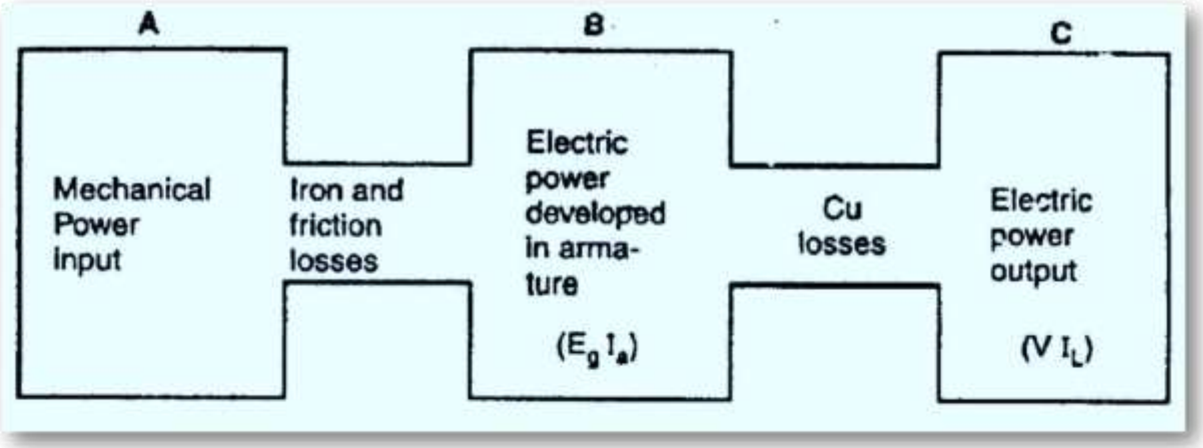
Generator Efficiency

- Mechanical efficiency

$$\eta = \frac{total\ watt\ generated\ in\ armature}{mechanical\ power\ supplied} = \frac{E_g I_a}{output\ of\ driving\ engine}$$

- Electrical efficiency

$$\eta = \frac{watts\ available\ in\ load\ circuit}{total\ watts\ generated} = \frac{VI}{E_g I_a}$$



- Overall efficiency

$$\eta = \frac{watts\ available\ in\ load\ circuit}{mechanical\ power\ supplied}$$

Condition for maximum efficiency

- Copper loss = core loss
- $I^2 R_a = W_c$
- $I = \sqrt{\frac{W_c}{R_a}}$