HYDROELECTRIC POWER PLANTS
HYDRAULIC TURBINES

By

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Hydraulic Turbine

- A mechanical device that converts Potential Energy stored in water at a height to useful shaft work.

Classification of Hydraulic Turbines

- **According to the water head**: Low Head Hydraulic Turbine (2-15m), Medium Head Hydraulic Turbine (16-70m), High Head Hydraulic Turbine (71-500m), Very High Head Hydraulic Turbine (> 500 m)

- **According to the placement of the turbine's shaft**: Horizontal Shaft & Vertical Shaft turbines.

Classification of Hydraulic Turbines

- **According to the turbine's Specific Speed**

$$N_s = \frac{N\sqrt{P}}{H^{5/4}}$$

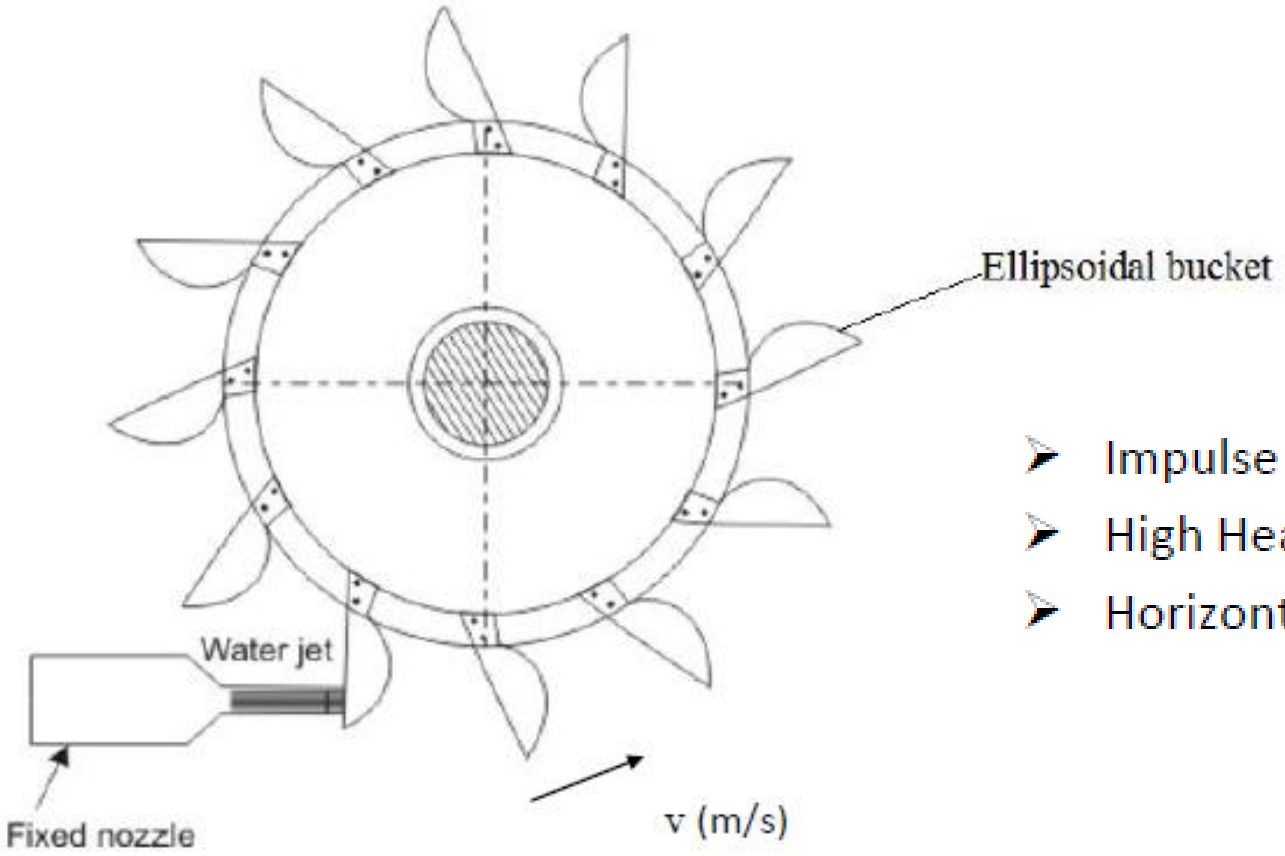
where N is the normal working speed of the turbine in rpm (rev/ min)
P is the power output of the turbine in kW
H is the net water head in m

Classification of Hydraulic Turbines

- **According to the name of the inventor/ patent holder of the turbine:** Kaplan Turbines & Francis Turbines are named after their inventors, namely, James. B. Francis and Dr. Victor Kaplan.

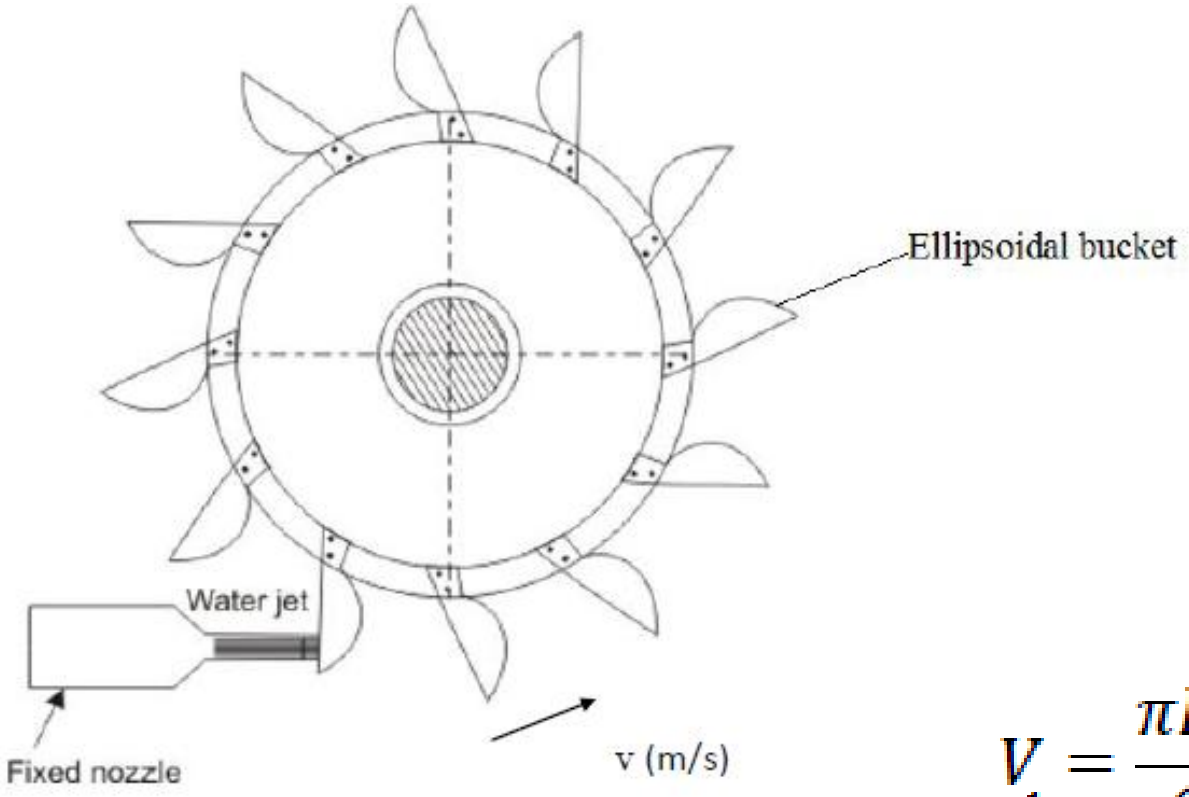
- **According to the nature of water jet acting on the turbine**: Based on this classification there are two types of turbines; Impulse Turbines & Reaction Turbines.

PELTON WHEEL



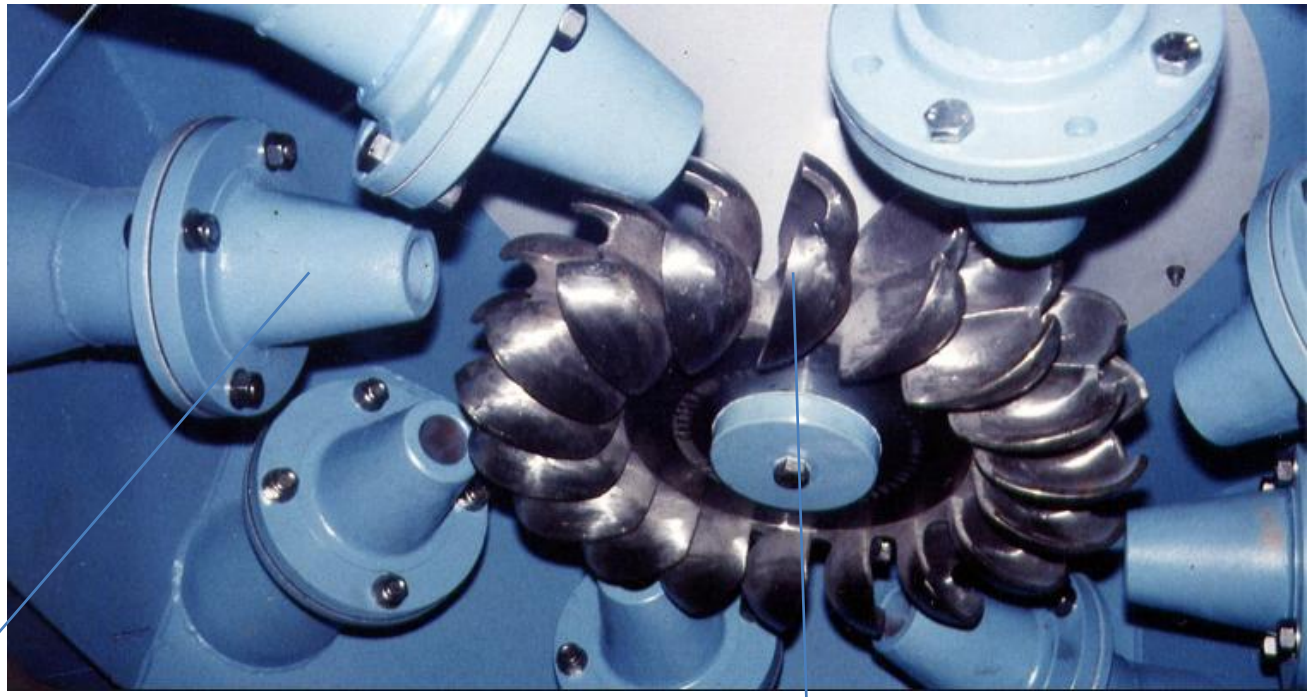
- Impulse Turbine
- High Head Turbine
- Horizontal Shaft Turbine

PELTON WHEEL



$$V_b = \frac{\pi DN}{60} \quad m/s$$

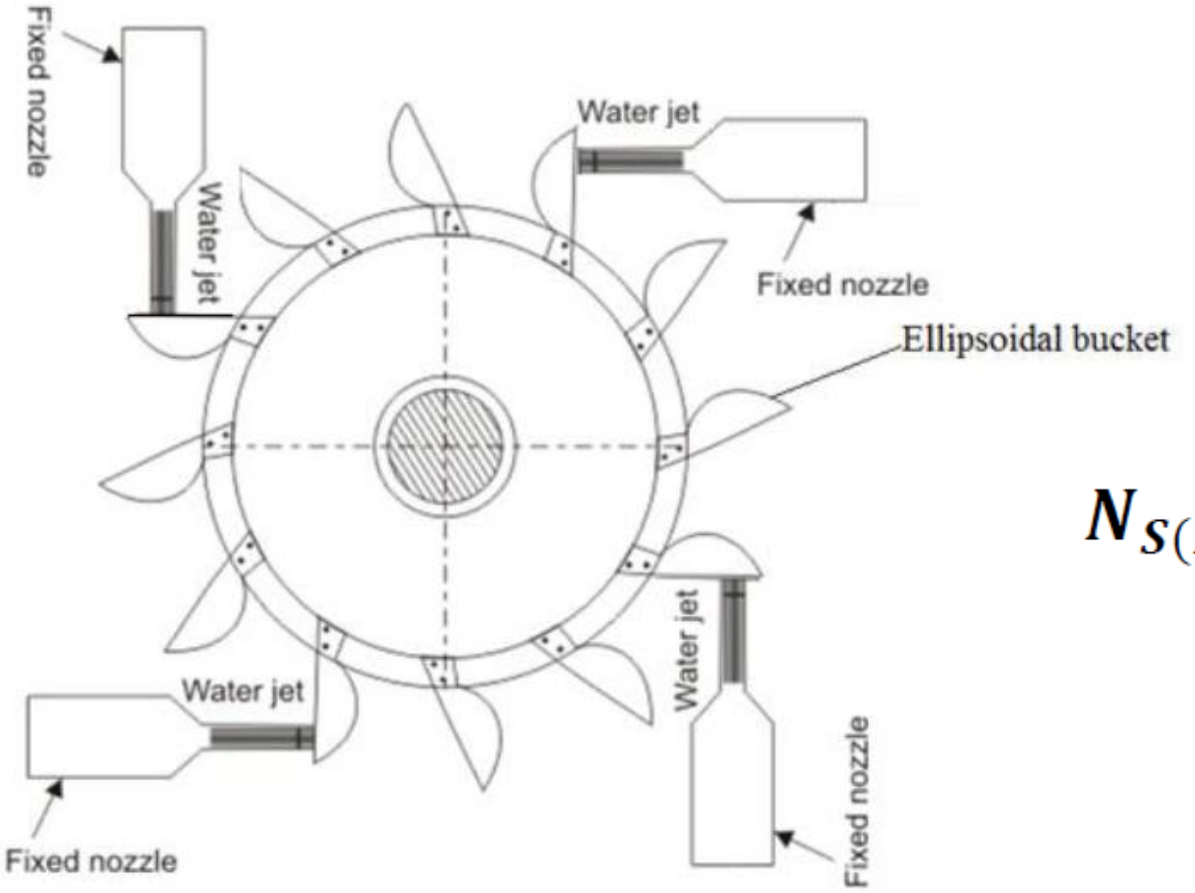
PELTON WHEEL



Nozzle

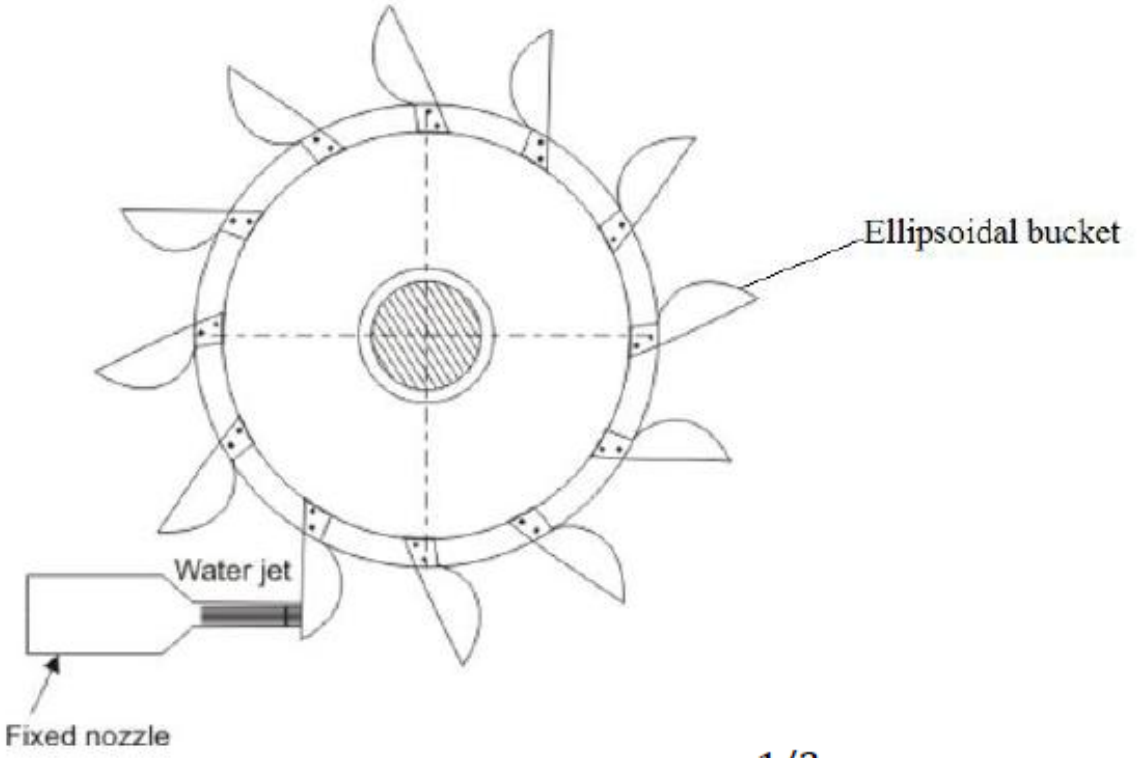
Bucket

Multi-jet PELTON WHEEL



$$N_{S(MJ)} = \sqrt{n}\ N_{S(SJ)}$$

Velocity of Water-jet



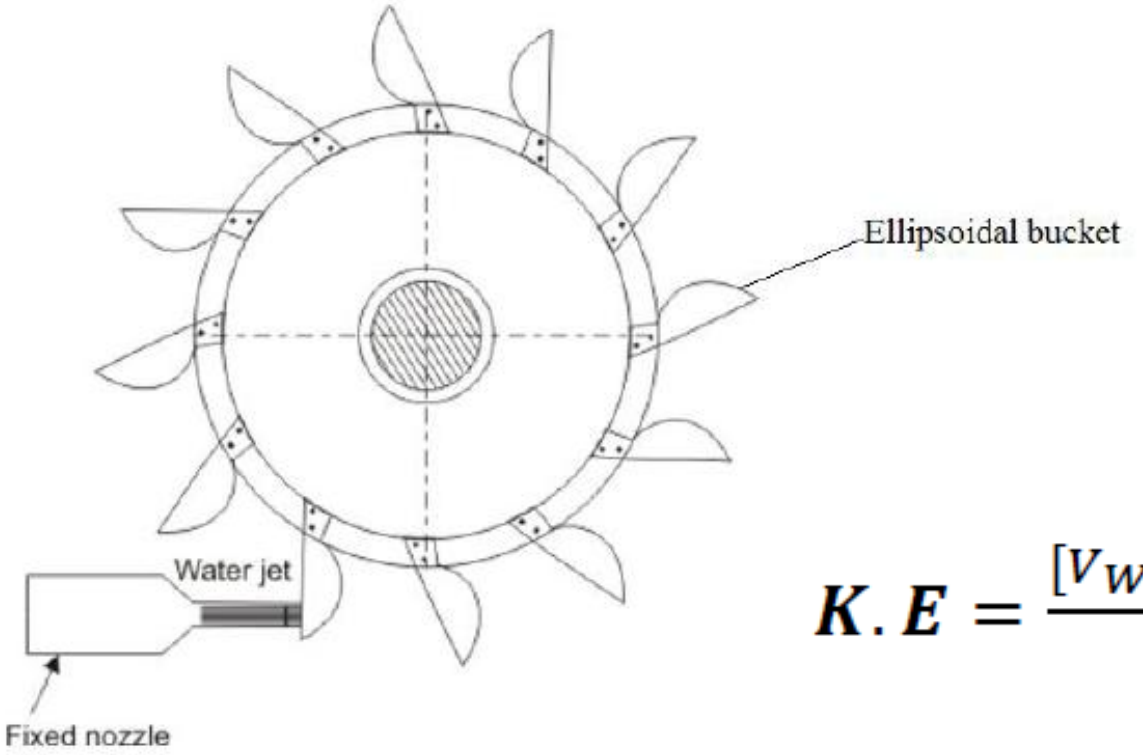
$$V_{Water-jet} = C_V[2gH]^{1/2}\ m/s$$

H is the water head in m

g is the acceleration due to gravity 9.81 m/s^2

C_V is the velocity coefficient (0.97 – 0.99)

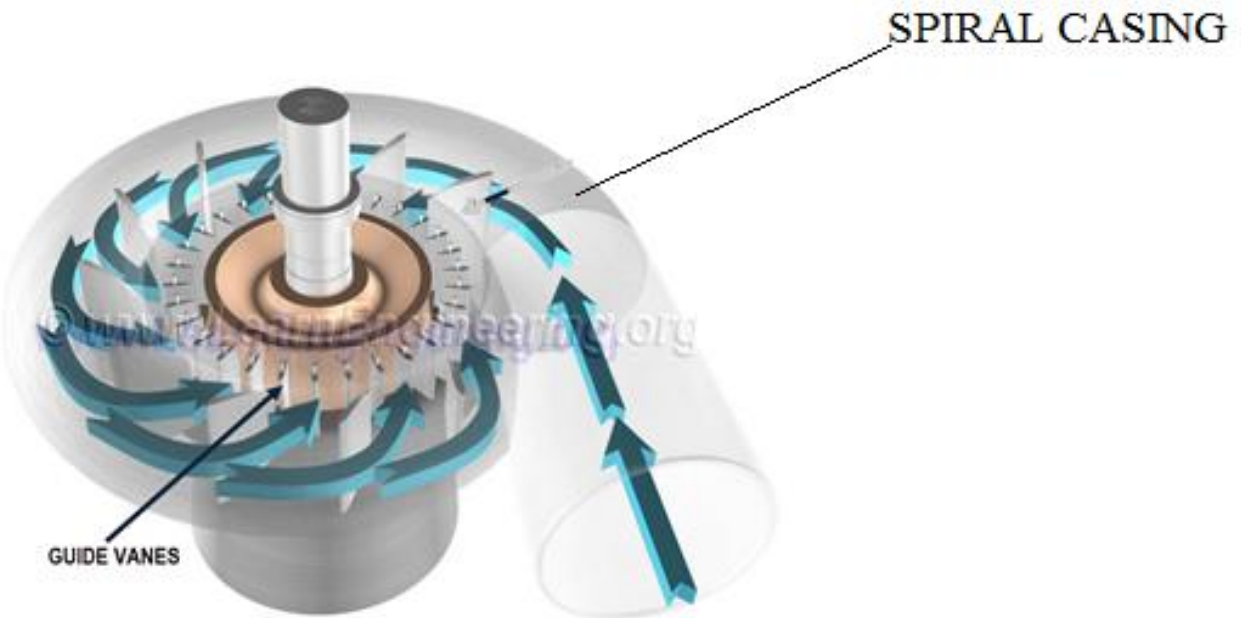
K.E of Water-jet



$$\boldsymbol{K.E} = \frac{[V_{water-jet}]^2}{2g} \; Joules$$

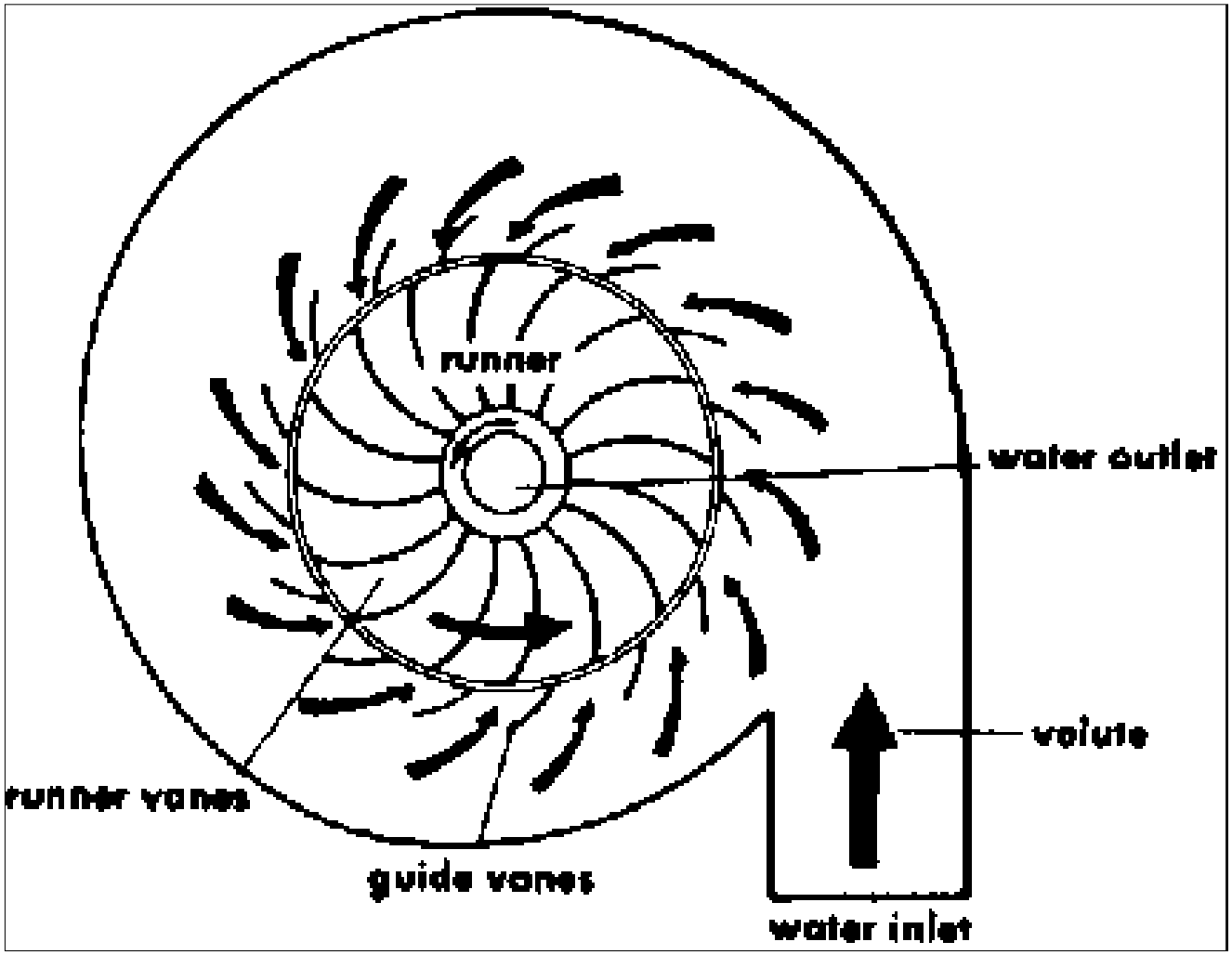
FRANCIS TURBINE

Reaction Turbine



A Francis Turbine

FRANCIS TURBINE



FRANCIS TURBINE Characteristics

- Reaction Turbine
- Vertical Shaft Turbine
- Water flows in a closed conduit

Example Problem

Q. In a hydroelectric power station, water is available at the flow rate of 175 meters cubed/ second under a head of 18 m. If the available turbines run at a speed of 150 rpm with overall efficiency of 82 percent, find the number of turbines required if

(a) Francis turbines with maximum specific speed of 460 are used.

(b) Pelton wheels with maximum specific speed of 350 are used.