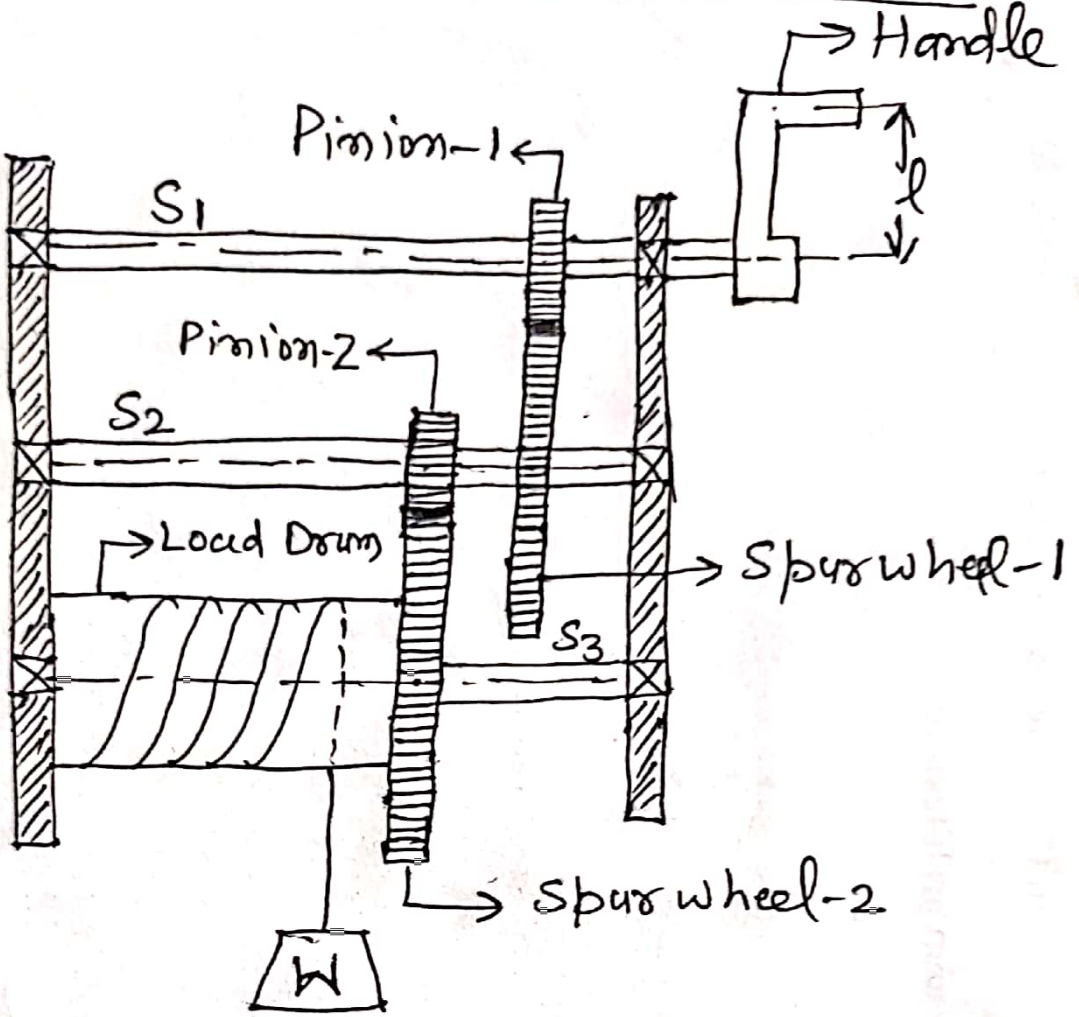
Double Purchase Winch Crab ①



* In this machine velocity ratio is gained in two stages.
* It has three parallel spindles, S_1, S_2 and S_3.

⇒ Pinion-1 is attached to spindle S_1. Spur wheel-1 and pinion-2 are attached to spindle S_2.

* Spur wheel-2 and load drum are attached to spindle S_3.
* A string is wound round the load drum, At the end of

string, load (W) is suspended.

⇒ Effort (P) is applied at the handle to lift the load.

Let, T_1 = No. of teeth on pinion-1

T_2 = No. of teeth on spur wheel-1

T_3 = No. of teeth on pinion-2

T_4 = No. of teeth on spur wheel-2

d = diameter of load drum.

Now, for one revolution of handle

Distance moved by effort = $2\pi l$

Number of revolutions made by pinion-1 with teeth T_1 = 1

No. of revolutions made by spur wheel-1 with teeth T_2 = $\frac{T_1}{T_2}$ ✓

No. of revolution made by pinion-2 with teeth T_3 = $\frac{T_1}{T_2}$ ✓

Number of revolutions made by spur wheel-2 with teeth-$T_4 = \frac{T_1}{T_2} \times \frac{T_3}{T_4}$.

$\therefore$ Distance moved by load $= \pi d \times \frac{T_1}{T_2} \times \frac{T_3}{T_4}$

πd = circumference of load drum.

Now, $V.R. = \frac{\text{Distance moved by effor}}{\text{Distance moved by load}}$

$$= \frac{2\pi l}{\pi d \times \frac{T_1}{T_2} \times \frac{T_3}{T_4}}$$

$$\boxed{V.R. = \frac{2l}{d}\left(\frac{T_2}{T_1} \times \frac{T_4}{T_3}\right)}$$

Mechanical Advantage $= \frac{\text{Load}}{\text{Effor}}$

or $\boxed{M.A. = \frac{W}{P}}$

Efficiency, $\boxed{\eta = \frac{MA}{V.R}}$

Problem:- In a double purchase winch crab, teeth of pinions are 20 and 25 and that of spur wheels are 50 and 60. Length of handle is 1.75 m and diameter of load drum is 0.5 m. Find efficiency of the crab, if an effort of 30N is required to lift a load of 900N.

Solution:- Given, $T_1 = 20$, $T_3 = 25$

$T_2 = 50$, $T_4 = 60$,

$l = 1.75\ m$, $d = 0.5\ m$.

$P = 30N$, $W = 900N$

$$M.A. = \frac{W}{P} = \frac{900}{30} = 30 \checkmark$$

$$V.R. = \frac{2l}{d}\left(\frac{T_2}{T_1} \times \frac{T_4}{T_3}\right)$$

$$= \frac{2 \times 1.75}{0.5}\left(\frac{50}{20} \times \frac{60}{25}\right)$$

$$= 42. \checkmark$$

Efficiency, $\eta = \frac{MA}{VR} = \frac{30}{42} \times 100$

$$\boxed{\eta = 71.43\%} \checkmark$$