Tutorial # 7 : Gears #2

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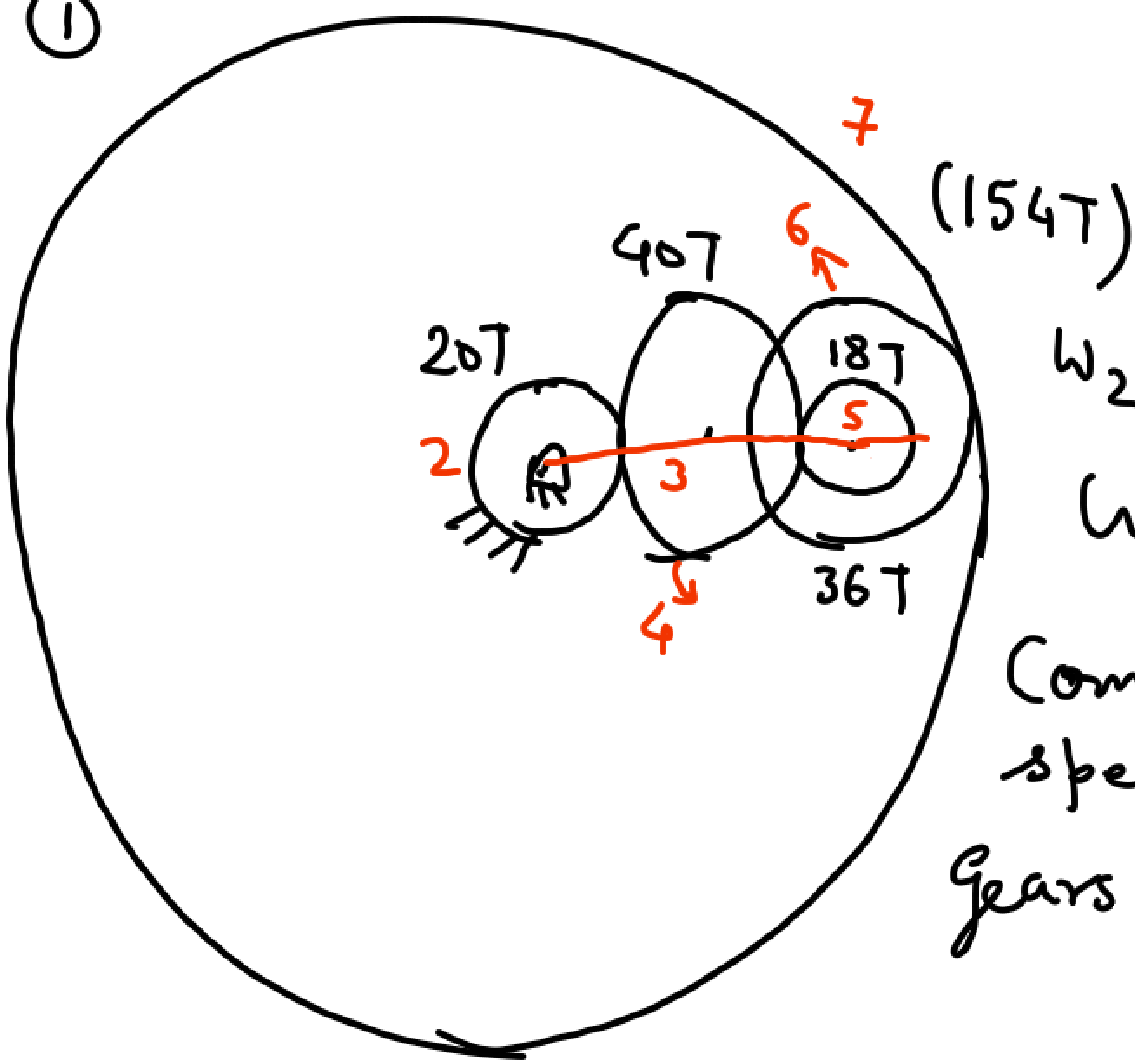


$\omega_2 = 0$

$\omega_3 = 300\,rpm$

Compute speeds of gears 7

3 : Arm

Gears 2 and 7 rotating about fixed axis.

Solve using both

(a) Relative velocity equation

(b) Tabular approach

Method (a) :

$$\frac{(\omega_7 - \omega_3)}{(\omega_2 - \omega_3)} = \frac{(\omega_7 - \omega_3)}{(\omega_6 - \omega_3)} \frac{(\omega_6 - \omega_3)}{(\omega_5 - \omega_3)} \frac{(\omega_5 - \omega_3)}{(\omega_4 - \omega_3)} \left(\frac{\omega_4 - \omega_3}{\omega_2 - \omega_3}\right)$$

1 (∵ Same shaft)

$$\frac{(\omega_7 - 300)}{(0 - 300)} =$$

$\omega_7 = \frac{17100}{77}\,rpm$

$= 222.08\,rpm$

(b) Tabular approach

Gear	2	3 (Arm)	4	5	6	7
(i) Gear train is locked and rotates as 1 rigid body along with Arm (300 ↺)	300	300	300	300	300	300
(ii) Arm is fixed and gear 2 is rotated by 300 in CW	-300	0	___	___	___	___
(iii) Total	0	300	___	___	___	___

Use the gear tooth nos.

$$\omega_4 = 450 \text{ rpm}$$

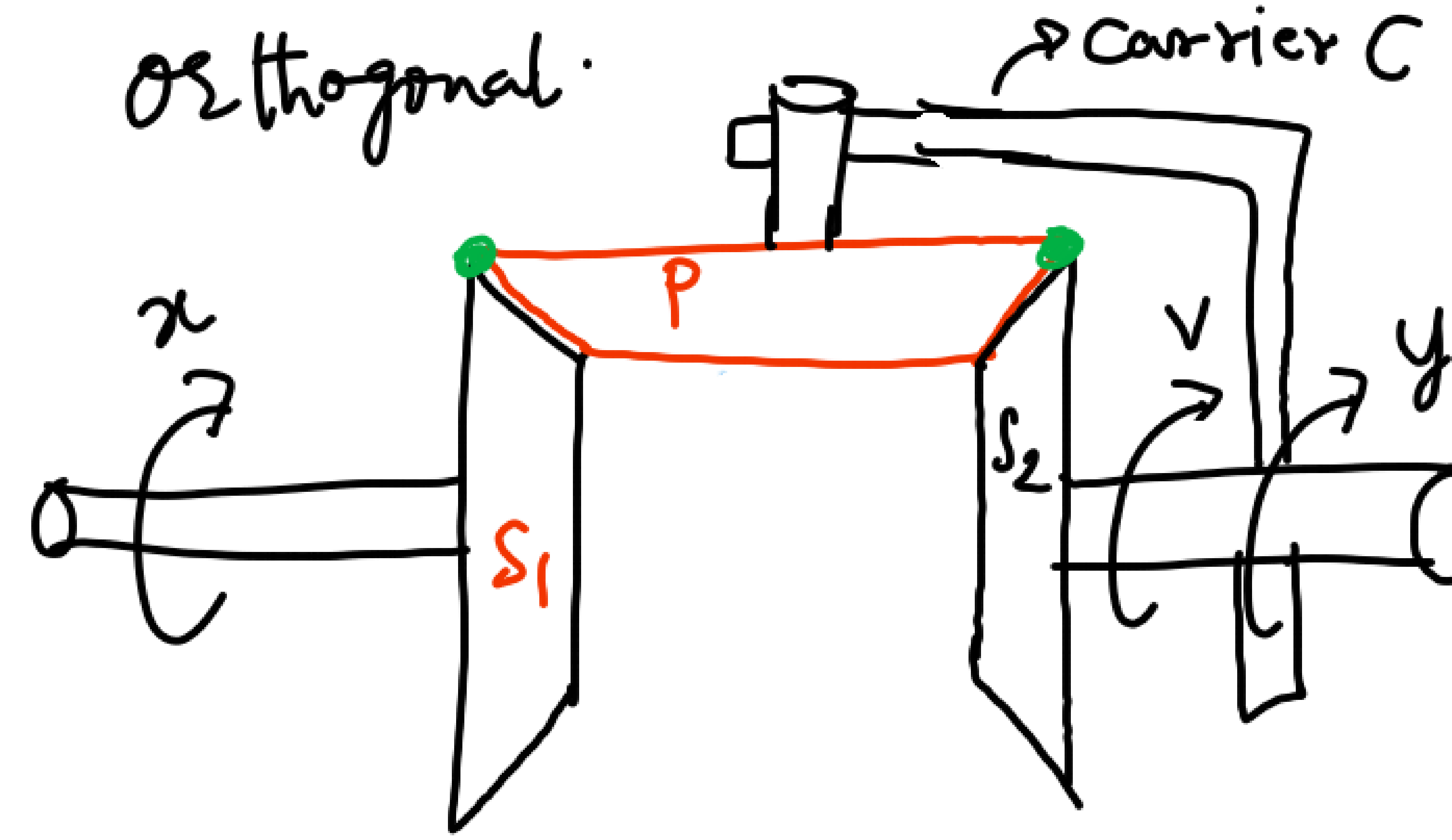
$$\omega_5 = \omega_6 = -\frac{100}{3} \text{ rpm}$$

$$\omega_7 = \frac{17100}{77} \text{ rpm}$$

Q2: Bevel gear differential

Bevel gears are used to transmit power bet'n non-parallel shafts.

In the given examples, axes are orthogonal.



v : Speed of Carrier

x : Speed of S_1

y : Speed of S_2

Calculation of speed ratio for bevel gears is exactly same as straight gear

i.e. $\left|\frac{\omega_{s_1}}{\omega_p}\right| = \frac{N_p}{N_{s_1}}$

But here we are only calculating the ratio of magnitude of speed. To get the direction, we should look at the velocity of pitch point. So identifying direction should be done separately

Tabular approach

Gears	S_1	S_2	C
Gear train is locked and arm is given speed "v"	v	v	v
Hold the carrier and give speed "w"	w	$\underline{-w}$	0
Total	v+w	v−w	v

$\boxed{\text{Given } N_{s_1} = N_{s_2}}$

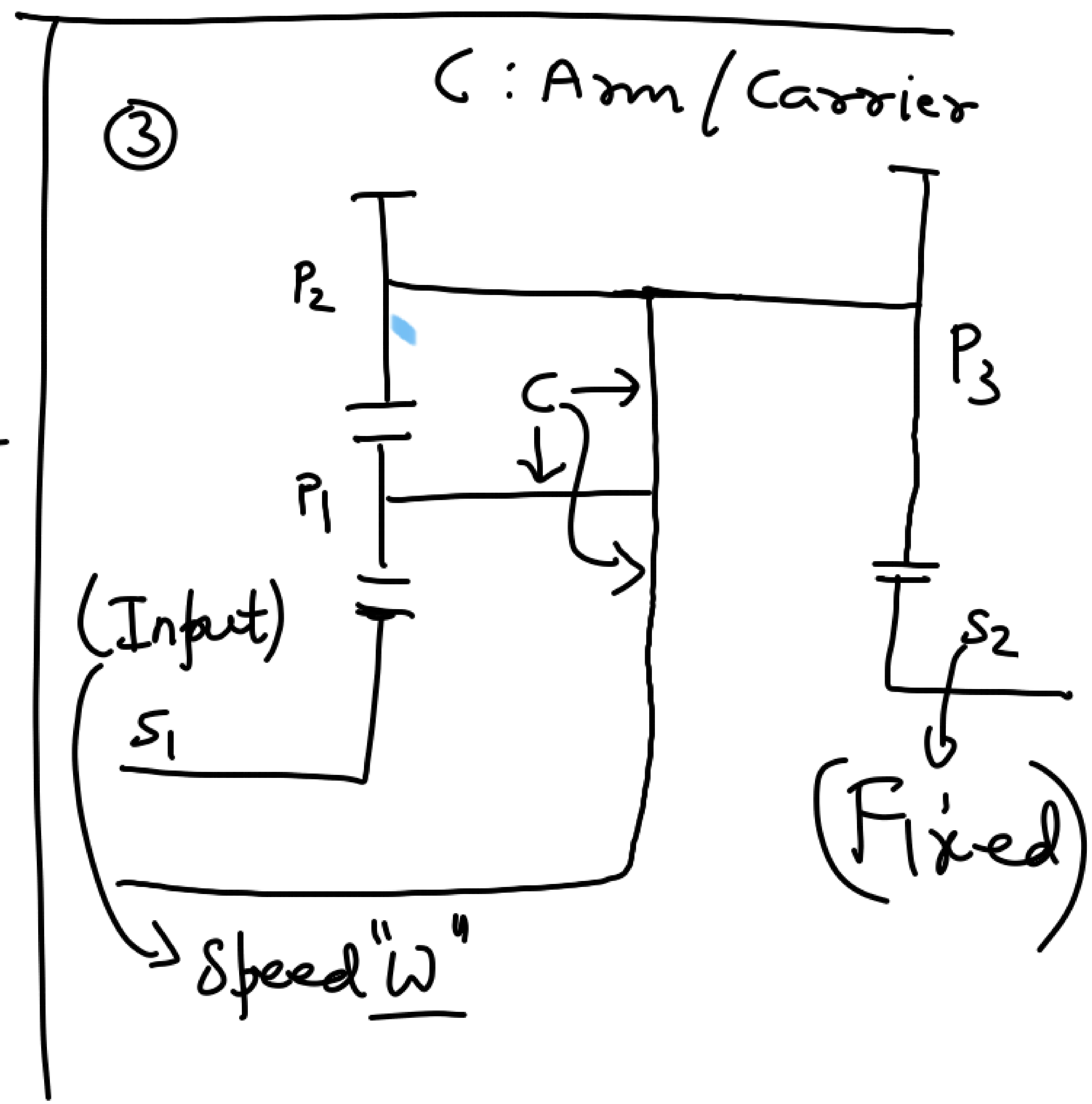
$$\frac{|\omega_p|}{|\omega_{s_1}|} = \frac{N_{s_1}}{N_p}$$

$$\frac{|\omega_{s_2}|}{|\omega_p|} = \frac{N_p}{N_{s_2}}$$

$$\frac{|\omega_{s_2}|}{|\omega_{s_1}|} = \frac{N_{s_1}}{N_{s_2}} = 1$$

$$x = v + w$$
$$y = v - w$$
or $$v = \frac{x+y}{2}$$
$$w = \frac{x-y}{2}$$

$$\frac{\omega_{s_1} - \omega_p}{\omega_{s_2} - \omega_p} = -1$$



Tabular approach

Gear	S_1	P_1	P_2	C	P_3	S_2
Gear train is locked and arm is rotated	ω_c	ω_c	ω_c	ω_c	ω_c	ω_c
S_2 given rotation in the opposite dir'n. C is fixed	—	—	—	0	—	$-\omega_c$
Total	—	—	—	ω_c	—	0

$$\boxed{\omega_c = \frac{\omega}{\left(1 + \frac{N_{s_2} N_{p_2}}{N_{p_3} N_{s_1}}\right)}}$$

$N_{p_2} = N_{p_3} =$

$N_{p_1} =$

No need to simplify expressions

$$\frac{\omega_{p_3}}{\omega_{s_2}} = \frac{-N_{s_2}}{N_{p_3}}$$

$$\omega_{p_3} = \frac{-N_{s_2}(-\omega_c)}{N_{p_3}}$$

$$= \frac{\omega_c N_{s_2}}{N_{p_3}}$$

$$\omega_{p_2} = \omega_{p_3}$$

$$\frac{\omega_{p_1}}{\omega_{p_2}} = \frac{-N_{p_2}}{N_{p_1}}$$

$$\omega_{p_1} = \left(\frac{-N_{p_2}}{N_{p_1}}\right)\left(\frac{\omega_c N_{s_2}}{N_{p_3}}\right)$$

$$\frac{\omega_{s_1}}{\omega_{p_1}} = \frac{-N_{p_1}}{N_{s_1}}$$