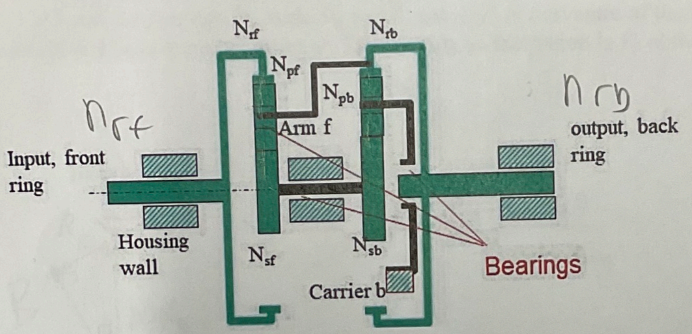
4. This is the reading example of the Simpson planetary gearing system. The input is through the shaft of the front ring gear, aligned with the axis of the common suns. The output is by the shaft of the back ring gear. All the sun gears, ring gears, and the rotation axes of the carriers are co-axial. For the forward 1 mode, the back carrier, b, is fixed with no rotation allowed, and the front carrier (the arm) and back ring gear are connected as shown. Knowing N_{sf}, N_{pf}, N_{rf}, N_{sb}, N_{pb}, N_{rb},

(a) Determine the ratio of the input-output speeds, n_{rf}/n_{rb}, where n_{rf} is the rotation speed (rpm) of the front ring gear, and n_{rb} is that of the back ring gear.

(b) What is the number of teeth of the from ring gear in terms of those of the front sun and planet gears?



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a) $i = \frac{n_{rf} - n_a}{n_{rb} - n_a} = 1 - \frac{n_{rf}}{n_a} = \frac{\cancel{N_{rf}} N_{sf} \cancel{N_{pb}} N_{rb}}{N_{rf} \cancel{N_{pf}} N_{sb} \cancel{N_{pb}}}$ one more ?

$$\boxed{\frac{n_{rf}}{n_{rb}} = \frac{N_{sf} N_{rb}}{N_{rf} N_{sb}} + 1}$$ X

$n_a = n_{rb}$ Wrong

-3

b) $\frac{\cancel{m} N_{rf}}{2} = \cancel{m} N_{pf} + \frac{m N_{sf}}{2}$

$$\boxed{N_{rf} = 2N_{pf} + N_{sf}}$$ ✓

MAKE RB STATIONARY REFERENCE FRAME:

$$\frac{n_{SF}-n_{RB}}{n_{RF}-n_{RB}} = -\frac{N_{RF}}{N_{SF}}$$ ← FLIPS ONCE

$$n_{SF}-n_{RB} = -\frac{N_{RF}}{N_{SF}}\left(n_{RF}-n_{RB}\right) \quad (1)$$

RELATE SB TO SF AND RB:

$$\frac{n_{SB}}{n_{RB}} = -\frac{N_{RB}}{N_{SB}}$$ ← FLIPS ONCE

$$n_{SB} = n_{SF} = -n_{RB}\left(\frac{N_{RB}}{N_{SB}}\right) \quad (2)$$

USE EQ 1 AND 2:

$$-n_{RB}\left(\frac{N_{RB}}{N_{SB}}\right) - n_{RB} = -\frac{N_{RF}}{N_{SF}}\left(n_{RF}-n_{RB}\right)$$

SOLVE FOR $i = \frac{n_{RF}}{n_{RB}}$:

$$\frac{N_{RF}}{N_{SF}} n_{RF} = \frac{N_{RF}}{N_{SF}} n_{RB} + n_{RB}\left(\frac{N_{RB}}{N_{SB}}\right) + n_{RB}$$

$$= n_{RB}\left(\frac{N_{RF}}{N_{SF}} + \frac{N_{RB}}{N_{SB}} + 1\right)$$

$$\boxed{\Rightarrow i = \frac{n_{RF}}{n_{RB}} = \frac{\left(\frac{N_{RF}}{N_{SF}} + \frac{N_{RB}}{N_{SB}} + 1\right)}{\frac{N_{RF}}{N_{SF}}}}$$