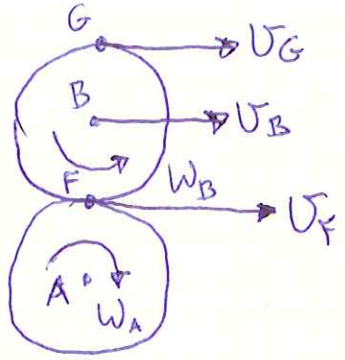
PROB. 15-48

$r_A = r_B = r_C = r_D = 3^{IN}$, $r_E = 9^{IN}$

$\omega_E = \left(120 \frac{REV}{MIN}\right)\left(\frac{MIN}{60s}\right)\left(\frac{2\pi}{REV}\right) = 12.57 \frac{RAD}{SEC}$ C.W.

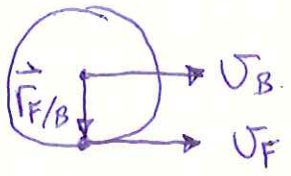
$\omega_A = 150\ RPM = 15.71 \frac{RAD}{SEC}$ C.W.

a) FIND $\omega_B = \omega_C = \omega_D$



$v_F = r_A \omega_A$, $v_G = r_E \omega_E$

$\vec{v}_F = \vec{v}_B + \vec{v}_{F/B} = \vec{v}_B + \omega_B \hat{k} \times \vec{r}_{F/B}$



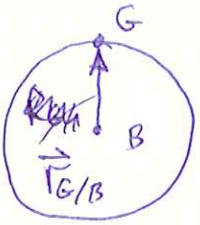
$\vec{r}_{F/B} = (-r_B)\hat{j}$

$(r_A \omega_A)\hat{i} = (v_B)\hat{i} + (\omega_B)\hat{k} \times (-r_B)\hat{j}$

$$(\omega_B)\hat{k} \times (-r_B)\hat{j} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & \omega_B \\ 0 & -r_B & 0 \end{vmatrix}$$

$= [0 - (\omega_B)(-r_B)]\hat{i} = (r_B \omega_B)\hat{i}$

$r_A \omega_A = v_B + r_B \omega_B \Rightarrow v_B = r_A \omega_A - r_B \omega_B$ EQN. 1



$\vec{v}_G = \vec{v}_B + \vec{v}_{G/B} = \vec{v}_B + \omega_B \hat{k} \times \vec{r}_{G/B}$

$(r_E \omega_E)\hat{i} = (v_B)\hat{i} + (\omega_B)\hat{k} \times (r_B)\hat{j}$

PROB. 15-48 CONT.

$$(\omega_B)\hat{k} \times (r_B)\hat{i} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & \omega_B \\ 0 & r_B & 0 \end{vmatrix}$$

$$= [0 - (\omega_B)(r_B)]\,\hat{i} = (-r_B\omega_B)\,\hat{i}$$

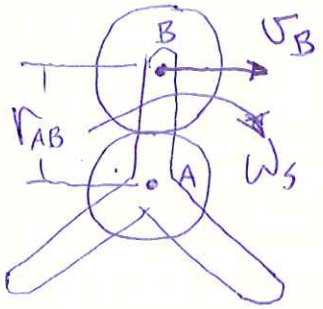
$$r_E\omega_E = v_B - r_B\omega_B \Rightarrow v_B = r_E\omega_E + r_B\omega_B \quad \text{EQN. 2}$$

$$r_A\omega_A - r_B\omega_B = r_E\omega_E + r_B\omega_B$$

$$\omega_B = \frac{r_A\omega_A - r_E\omega_E}{2r_B} = \frac{(3^{IN})(15.71\ \frac{RAD}{S}) - (9)(12.57)}{2(3^{IN})}$$

$$\omega_B = \left(-11.0\ \frac{RAD}{SEC}\right)\left(\frac{60}{2\pi}\right) = -105.0\ RPM\ \circlearrowleft$$

b) FIND ω_{SPIDER}



$$v_B = r_{AB} \cdot \omega_S, \quad \omega_S = \frac{v_B}{r}$$

$$v_B = r_A\omega_A - r_B\omega_B$$

$$v_B = (3^{IN})(15.71\ \tfrac{RAD}{SEC}) - (3)(-11.0) = 80.13\ \tfrac{IN}{SEC}$$

$$\omega_S = \frac{(80.18\ \frac{IN}{SEC})}{(6^{IN})} = \left(13.35\ \frac{RAD}{SEC}\right)\left(\frac{60}{2\pi}\right) = 127.5\ RPM\ \circlearrowright$$