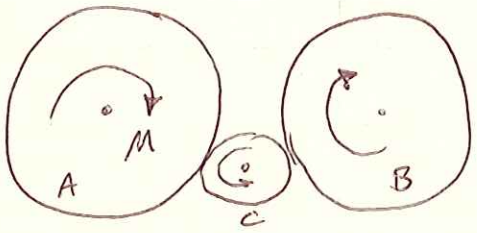
PROB. 16-36



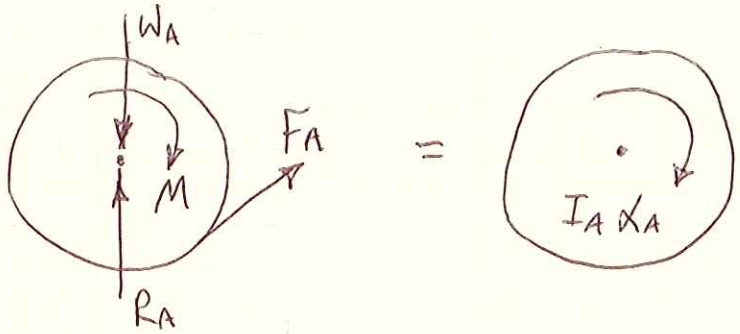
$W_A = W_B = 20^{LB}$, $W_C = 5^{LB}$

$K_A = K_B = 7.5^{IN}$, $K_C = 3^{IN}$

$r_A = r_B = 10^{IN}$, $r_C = 4^{IN}$

$M = 50^{IN\cdot LB}$, FIND α_A, F_E ON GEAR A

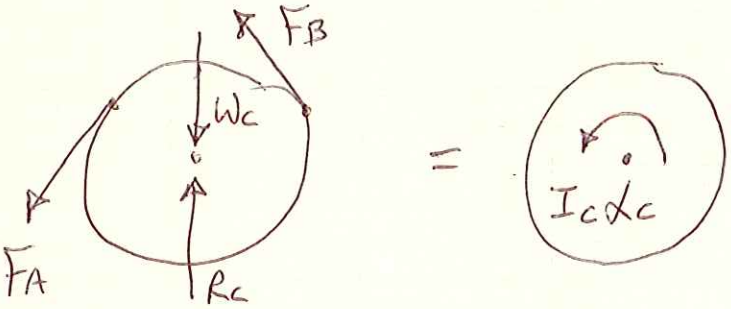
GEAR A:



$$\Sigma \vec{M}_G = \Sigma (\vec{M}_G)_{EFF} : \quad -M + r_A F_A = -I_A \alpha_A$$

$$r_A F_A + I_A \alpha_A = M$$

GEAR C:

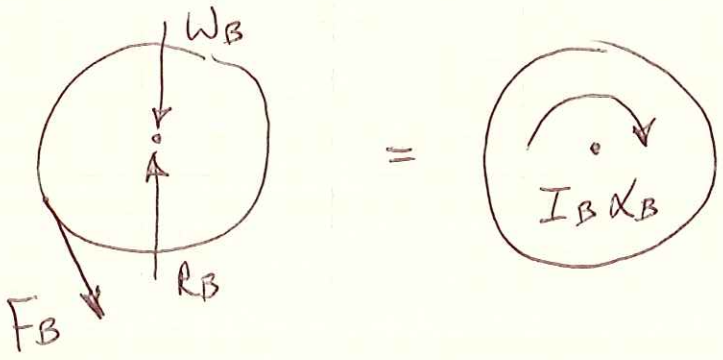


$$\Sigma \vec{M}_G = \Sigma (\vec{M}_G)_{EFF} : \quad r_C F_A + r_C F_B = I_C \alpha_C$$

$$F_A = -F_B + \frac{I_C \alpha_C}{r_C} \qquad [F_A \neq F_B]$$

PROB. 16-36 CONT.

GEAR B:



$$\Sigma \vec{M}_G = \Sigma (\vec{M}_G)_{EFF} : \quad r_B F_B = -I_B \alpha_B$$

$$F_B = -\frac{I_B \alpha_B}{r_B}$$

$$F_A = -\left(-\frac{I_B \alpha_B}{r_B}\right) + \frac{I_C \alpha_C}{r_C} = \frac{I_B \alpha_B}{r_B} + \frac{I_C \alpha_C}{r_C}$$

$$r_A \left(\frac{I_B \alpha_B}{r_B} + \frac{I_C \alpha_C}{r_C}\right) + I_A \alpha_A = M$$

$$I_A = \left(\frac{W_A}{g}\right) K_A^2, \quad I_B = \left(\frac{W_B}{g}\right) K_B^2, \quad I_C = \left(\frac{W_C}{g}\right) K_C^2$$

$r_A = r_B$

$$\left(\frac{r_A}{r_B}\right)\left(\frac{W_B}{g}\right) K_B^2 \cdot \alpha_B + \left(\frac{r_A}{r_C}\right)\left(\frac{W_C}{g}\right) K_C^2 \cdot \alpha_C + \left(\frac{W_A}{g}\right) K_A^2 \cdot \alpha_A = M$$

TANGENTIAL ACCELERATION: $a_t = r_A \alpha_A = r_C \alpha_C$

$$\boxed{\alpha_C = \left(\frac{r_A}{r_C}\right) \alpha_A}$$

$$r_C \alpha_C = r_B \alpha_B, \quad \alpha_B = \left(\frac{r_C}{r_B}\right) \alpha_C = \left(\frac{r_C}{r_B}\right)\left(\frac{r_A}{r_C}\right) \alpha_A \boxed{= \alpha_A}$$

$$W_B K_B^2 \alpha_A + \left(\frac{r_A}{r_C}\right) W_C K_C^2 \left(\frac{r_A}{r_C}\right) \alpha_A + W_A K_A^2 \alpha_A = Mg$$

PROB. 16-36 CONT.

$$\alpha_A\left[W_B K_B^2 + \left(\frac{r_A}{r_C}\right)^2 W_C K_C^2 + W_A K_A^2\right] = Mg$$

$$\alpha_A = \frac{Mg}{\left[W_B K_B^2 + \left(\frac{r_A}{r_C}\right)^2 W_C K_C^2 + W_A K_A^2\right]}$$

$$\alpha_A = \frac{(50^{IN\cdot LB})\left(32.2\ \frac{ft}{s^2}\right)}{\left[(20^{LB})(7.5^{IN})^2 + \left(\frac{10}{4}\right)^2(5^{LB})(3^{IN})^2 + (20^{LB})(7.5^{IN})^2\right]} \cdot \left(\frac{12\ IN}{ft}\right)$$

$$\boxed{\alpha_A = 7.632\ \frac{RAD}{s^2}}$$

$$F_A = \frac{1}{r_A}\left(M - I_A \alpha_A\right) = \frac{1}{r_A}\left[M - \left(\frac{W_A}{g}\right)K_A^2 \cdot \alpha_A\right]$$

$$F_A = \frac{1}{(10^{IN})} \cdot \left[(50^{IN\cdot LB}) - \left(\frac{20^{LB}}{32.2\ \frac{ft}{s^2}}\right) \cdot (7.5^{IN})^2 \left(7.632\ \frac{RAD}{s^2}\right)\left(\frac{ft}{12^{IN}}\right)\right]$$

$$\boxed{F_A = 2.778^{LB}}$$