Chapter 11, Problem 10

The gears shown in Figure P11.10 have a diametral pitch of 5 teeth/in. and 25° pressure angle. Determine, and indicate on free-body diagrams,

(*a*) The tangential and radial forces on gears 2 and 3.

(*b*) The reactions on shaft *C*.

Design Decision: Driving gear 1 transmits 10 hp at 1500 rpm through idler pair mounted on shaft *B* to gear 4.

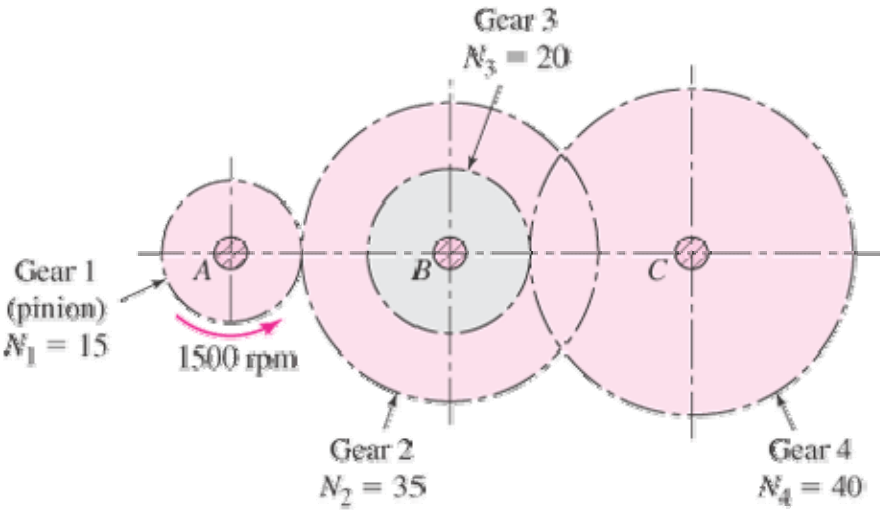


Figure P11.10

Chapter 11, Solution 10

Equation (11.2):

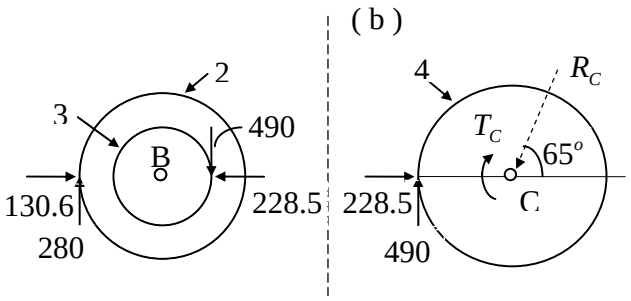
$$d_1 = \frac{N_1}{P} = \frac{15}{5} = 3\ in., \quad d_2 = \frac{35}{5} = 7\ in., \quad d_3 = \frac{20}{5} = 4\ in., \quad d_4 = \frac{40}{5} = 8\ in.$$

$$\text{(a)}\ T_1 = \frac{63000hp}{n} = \frac{63000(10)}{1500} = 420\ lb \cdot in.$$

$$F_{t1} = \frac{420}{1.5} = 280\ lb = F_{t2}, \qquad F_{r1} = 280\tan 25^o = 130.6\ lb = F_{r2}$$

$$T_2 = 280(\tfrac{7}{2}) = 980\ lb \cdot in.$$

$$F_{t3} = \frac{980}{2} = 490\ lb, \qquad F_{r3} = 490\tan 25^o = 228.5\ lb$$



$$T_C = 490(4)$$
$$= 1960\ lb \cdot in.$$
$$R_C = \sqrt{228.5^2 + 490^2}$$
$$= 540.7\ lb$$

Chapter 11, Problem 13

The gears shown in Figure P11.10 have a module of 5 mm, tooth width of 15 mm, and a 20° pressure angle. Determine

(*a*) The allowable bending load, applying the Lewis equation and K_f = 1.5, for the tooth of gear 3.

(*b*) The allowable load for wear, using the Buckingham equation, for gears 3 and 4.

(*c*) The maximum tangential load that gear 3 can transmit.

Design Decisions: All gears are made of cast steel (0.20% C WQ&T, Table 11.3); gears 2 and 3 are mounted on shaft *B*.

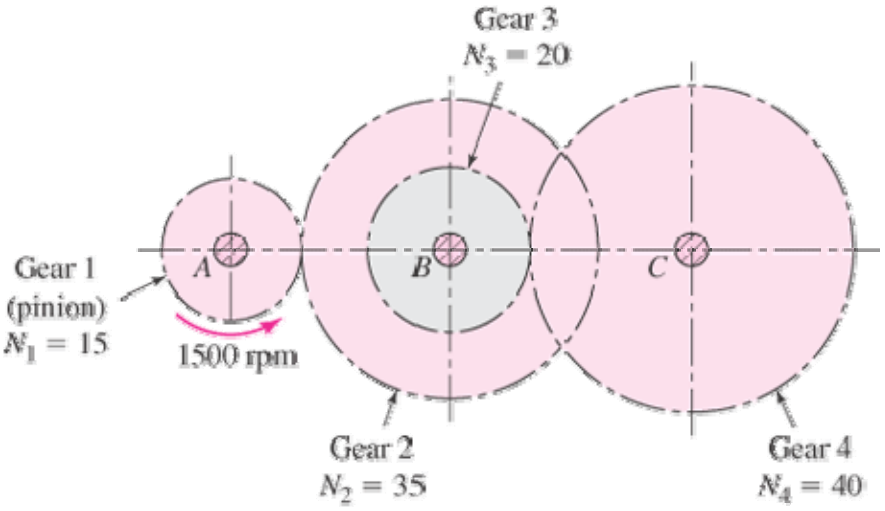


Figure P11.10

Chapter 11, Solution 13

Equations (11.4) and (11.8):

$$d_3 = mN_3 = 5(20) = 100\ mm, \quad n_3 = n_1 \tfrac{N_1}{N_3} = 1500(\tfrac{3}{4}) = 1125\ rpm$$

$$V_3 = \tfrac{\pi dn}{60} = \pi(0.1)(\tfrac{1125}{60}) = 5.89\ \ m/s$$

(a) Table 11.2: $Y = 0.320,$ Table 11.3: $\sigma_0 = 172\ MPa$ and 250 Bhn

$$F_b = \tfrac{\sigma_0 bYm}{K_f} = \tfrac{1}{1.5}(172)(15)(0.320)(5) = 2.75\ kN \qquad \text{(Eq.11.27)}$$

(b) Table 11.9: $K = 0.903,$ $Q = \tfrac{2N_4}{N_3+N_4} = \tfrac{2(40)}{20+40} = \tfrac{4}{3}$ (Eq.11.34)

$$F_w = d_3 bQK = 100(15)(\tfrac{4}{3})(0.903) = 1.81\ kN \qquad \text{(Eq.11.32)}$$

(c) $F_d = \tfrac{3.05+5.89}{3.05} F_t = 2.931 F_t$ (Eq.11.18a, with $600/196.8 = 3.05\ m/s$)

Thus $2.75 \times 10^3 = 2.931 F_t, \quad F_t = 938\ N$

and $1.81 \times 10^3 = 2.931 F_t, \quad F_t = 617.5\ N$