7 The notch sensitivity of the material is found from either equation 6.13 (p. 345) or Figure 6-36 (pp. 344–345) and for bending is $q = 0.50$, and for torsion is $q = 0.57$, both for an assumed notch radius of 0.01 in.

8 The bending-fatigue stress-concentration factor is found from equation 6.11*b* (p. 343) using the assumed geometric stress-concentration factor.

For bending stress in the keyway:

$$K_f = 1 + q(K_t - 1) = 1 + 0.50(3.0 - 1) = 2.00 \tag{h}$$

For torsional stress in the keyway:

$$K_f = 1 + q(K_t - 1) = 1 + 0.57(3.0 - 1) = 2.15 \tag{i}$$

9 From equation 6.17 (p. 364) we find that in this case, the same factor should be used on the mean stress components:

$$\begin{aligned} K_{fm} &= K_f = 2.00 \\ K_{fsm} &= K_{fs} = 2.15 \end{aligned} \tag{j}$$

10 The shaft diameter can now be found from equation 10.8 (p. 560) using an assumed safety factor of 3 to account for the uncertainties in this preliminary design. Note that the ASME equation (10.6) on p. 558 cannot be safely used in this case since it assumes constant torque. The more general, modified-Goodman line approach of equation 10.8 must be used.

$$d_{output} = \left\{ \frac{32 N_{sf}}{\pi} \left[\frac{\sqrt{(K_f M_a)^2 + \frac{3}{4}(K_{fs} T_a)^2}}{S_f} + \frac{\sqrt{(K_{fm} M_m)^2 + \frac{3}{4}(K_{fsm} T_m)^2}}{S_{ut}} \right] \right\}^{\frac{1}{3}}$$

$$= \left\{ \frac{32(3)}{\pi} \left[\frac{\sqrt{[2.00(80.9)]^2 + \frac{3}{4}[2.15(380)]^2}}{27\,000} + \frac{\sqrt{[2.00(43.6)]^2 + \frac{3}{4}[2.15(205)]^2}}{64\,000} \right] \right\}^{\frac{1}{3}}$$

$$d_{output} = 1.00 \text{ in} \tag{k}$$

So a 1-in nominal shaft diameter seems acceptable for the output shaft.

11 The input shaft has the same mean and alternating bending moments as the output shaft, but its torque is only 40% of the output shaft's. The mean and alternating torques on it are 82 and 152 lb-in. When these are put in equation 10.8 with all other factors the same, a smaller shaft diameter results.

$$d_{input} = \left\{ \frac{32(3)}{\pi} \left[\frac{\sqrt{[2.00(80.9)]^2 + \frac{3}{4}[2.15(152)]^2}}{27\,000} + \frac{\sqrt{[2.00(43.6)]^2 + \frac{3}{4}[2.15(82)]^2}}{64\,000} \right] \right\}^{\frac{1}{3}}$$

$$d_{input} = 0.768 \text{ in} \tag{l}$$

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