3.114 The 3-arm lawn sprinkler of Fig. P3.114 receives 20°C water through the center at 2.7 m^3/hr. If collar friction is neglected, what is the steady rotation rate in rev/min for (a) $\theta = 0°$; (b) $\theta = 40°$?

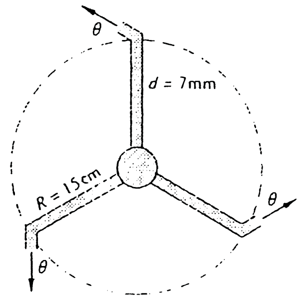

Fig. P3.114

Solution: The velocity exiting each arm is

$$V_o = \frac{Q/3}{(\pi/4)d^2} = \frac{2.7/[(3600)(3)]}{(\pi/4)(0.007)^2} = 6.50\ \frac{m}{s}$$

With negligible air drag and bearing friction, the steady rotation rate (Example 3.15) is

$$\omega_{\text{final}} = \frac{V_o \cos\theta}{R} \quad \text{(a) } \theta = 0°: \quad \omega = \frac{(6.50)\cos 0°}{0.15\text{ m}} = 43.3\ \frac{\text{rad}}{\text{s}} = \mathbf{414\ \frac{rev}{min}} \quad \textit{Ans. (a)}$$

$$\text{(b) } \theta = 40°: \quad \omega = \omega_o \cos\theta = (414)\cos 40° = \mathbf{317\ \frac{rev}{min}} \quad \textit{Ans. (b)}$$

3.115 Water at 20°C flows at 30 gal/min through the 0.75-in-diameter double pipe bend of Fig. P3.115. The pressures are p_1 = 30 lbf/in^2 and p_2 = 24 lbf/in^2. Compute the torque *T* at point *B* necessary to keep the pipe from rotating.

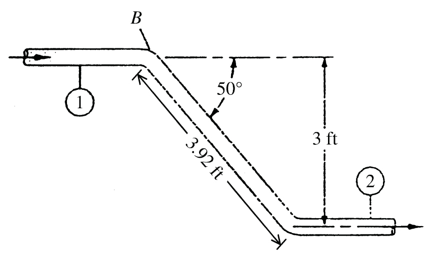

Fig. P3.115

Solution: This is similar to Example 3.13, of the text. The volume flow Q = 30 gal/min = 0.0668 ft^3/s, and ρ = 1.94 slug/ft^3. Thus the mass flow ρQ = 0.130 slug/s. The velocity in the pipe is

$$V_1 = V_2 = Q/A = \frac{0.0668}{(\pi/4)(0.75/12)^2} = 21.8\ \frac{ft}{s}$$

If we take torques about point B, then the distance "h_1," from p. 143, = 0, and h_2 = 3 ft. The final torque at point B, from "Ans. (a)" on p. 143 of the text, is

$$T_B = h_2(p_2A_2 + \dot{m}V_2) = (3\text{ ft})[(24\text{ psi})\frac{\pi}{4}(0.75\text{ in})^2 + (0.130)(21.8)] \approx \mathbf{40\ ft \cdot lbf} \quad \textit{Ans.}$$
