2 Chapter 2 Reserve Problems

RP2.1 The drawing (Figure RP2.1) shows an exploded view of an 1800-rpm motor, a gear box, and a 6000-rpm blower. The gear box weighs 20 lb, with center of gravity midway between the two mountings. All shafts rotate counterclockwise, viewed from the blower. Neglecting friction losses, determine all loads acting on the gear box when the motor output is 1 hp. Sketch the gear box as a free body in equilibrium.

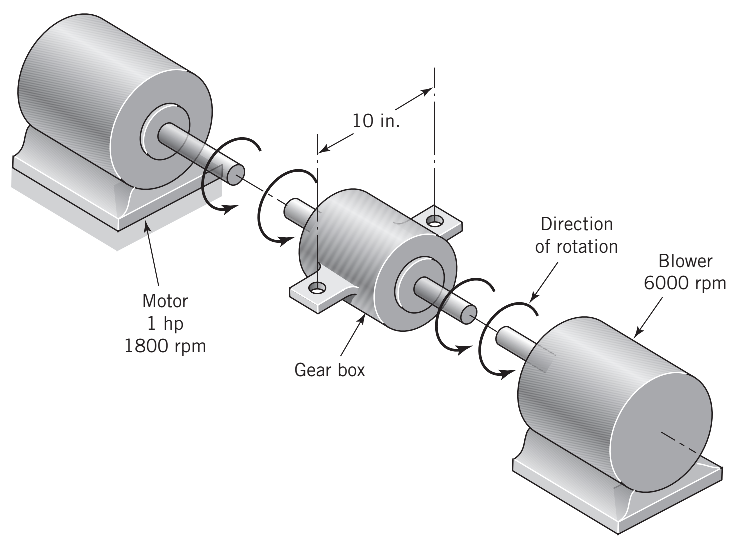

FIGURE RP2.1

RP2.2 The drawing (Figure RP2.2) shows an electric fan supported by mountings at A and B. The motor delivers a torque of 2 N·m to the fan blades. They, in turn, push the air forward with a force of 20 N. Neglecting gravity forces, determine all loads acting on the fan (complete assembly). Sketch it as a free body in equilibrium.

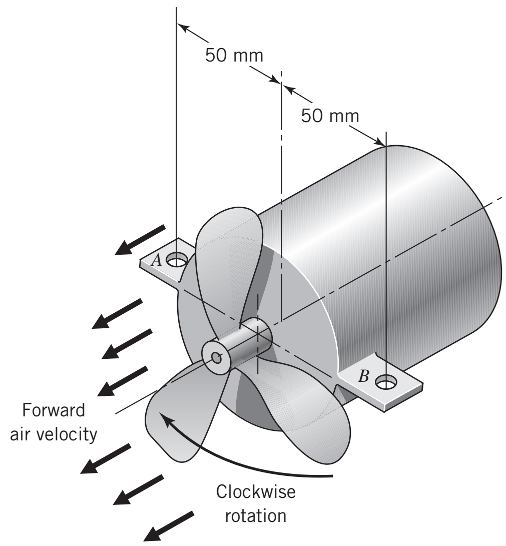

FIGURE RP2.2

RP2.3 Figure RP2.3 shows an exploded view of an airplane engine, reduction gear, and propeller. The engine and propeller rotate clockwise, viewed from the propeller end. The reduction gear housing is bolted to the engine housing through the bolt holes shown. Neglect friction losses in the reduction gear. When the engine develops 150 hp at 3600 rpm,

(a) What is the direction and magnitude of the torque applied *to* the engine housing *by* the reduction gear housing?

(b) What is the magnitude and direction of the torque reaction tending to rotate (roll) the aircraft?

(c) What is an advantage of using opposite-rotating engines with twin-engine, propeller-driven aircraft?

[Ans.: (a) 109 lb·ft ccw, (b) 328 lb·ft ccw]

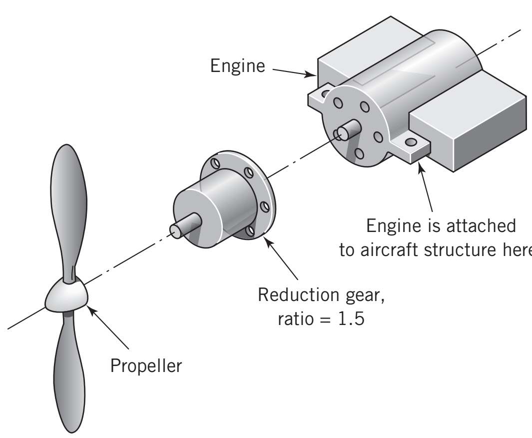

FIGURE RP2.3

RP2.4 The drawing (Figure RP2.4) represents a bicycle with an 800-N rider applying full weight to one pedal. Treat this as a two-dimensional problem, with all components in the plane of the paper. Draw as free bodies in equilibrium

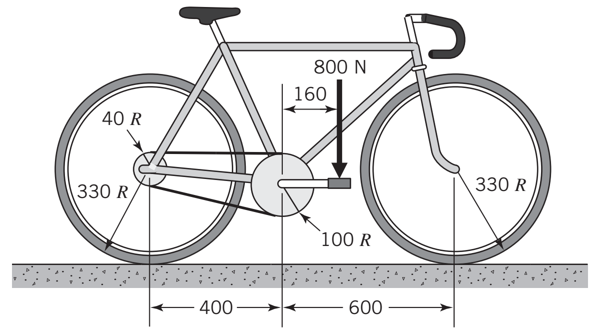

FIGURE RP2.4

(a) The pedal, crank, and pedal sprocket assembly.

(b) The rear wheel and sprocket assembly.

(c) The front wheel.

(d) The entire bicycle and rider assembly.

RP2.5 The drawings (Figure RP2.5) pertain to a spur gear reducer. A motor applies a torque of 200 lb·ft to the pinion shaft, as shown. The gear shaft drives the output load. Both shafts are connected with flexible couplings (which transmit only torque). The gears are mounted on their shafts midway between the bearings. The reducer is supported by four identical mountings on the side of the housing, symmetrically spaced on 6-in. and 8-in. centers, as shown. For simplicity, neglect gravity

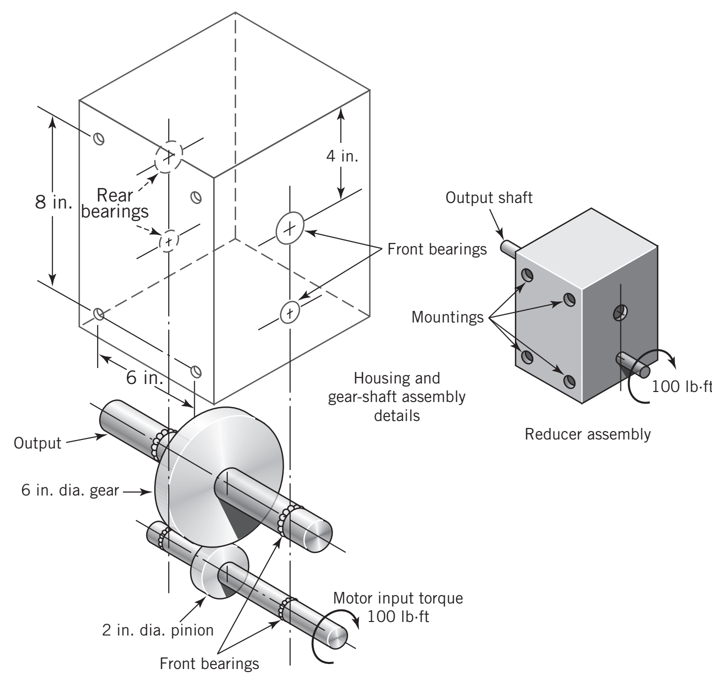

FIGURE RP2.5

and assume that forces between the gears (i.e., between gear and pinion) act tangentially. Sketch, as free bodies in equilibrium,

(a) The pinion and shaft assembly.

(b) The gear and shaft assembly.

(c) The housing.

(d) The entire reducer assembly.

RP2.6 With reference to Figure RP2.6

(a) Draw a free-body diagram of the structure supporting the pulley.

(b) Draw shear and bending moment diagrams for both the vertical and horizontal portions of the structure.

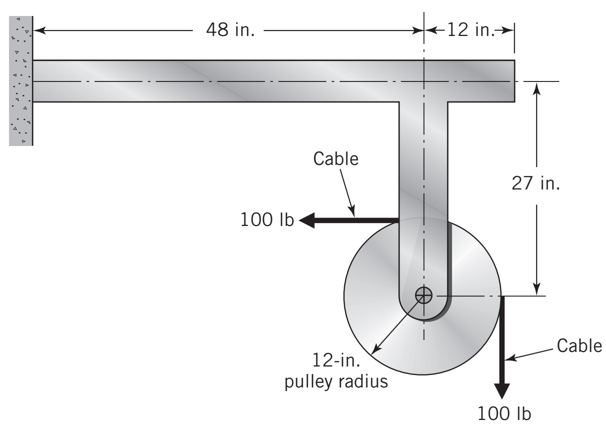

FIGURE RP2.6

RP2.7 The drawing (Figure RP2.7) shows a bevel gear attached to a shaft supported by self-aligning bearings at A and B and driven by a motor. Axial and radial components of the gear force are shown. The tangential or torque-producing component is perpendicular to the plane of the paper and has a magnitude of 2000 N. Bearing A takes thrust; B does not. Dimensions are in millimeters.

(a) Draw (to scale) axial load, shear, bending moment, and shaft torque diagrams.

(b) To what values of axial load and torque is the shaft subjected, and what portion(s) of the shaft experience these loads?

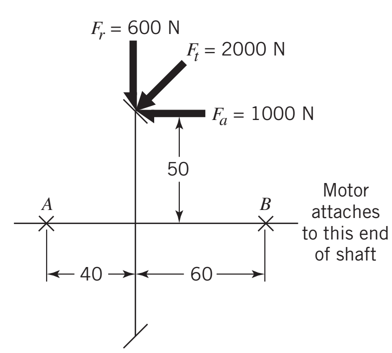

FIGURE RP2.7

RP2.8 Figure RP2.8 shows a screw with a square thread transmitting axial force F through a nut with n threads engaged (the drawing illustrates $n = 2$). Making appropriate simplifying assumptions, identify the stresses in the threaded portion of the screw and write an equation for each.* State the assumptions made, and discuss briefly their effect.

*The first five sections of Chapter 4 review simple stress equations.

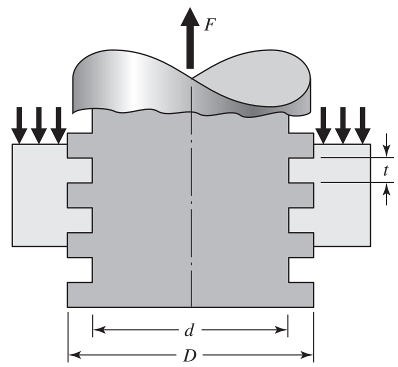

FIGURE RP2.8

RP2.9 Figure RP2.9 shows force P applied to an engine crankshaft by a connecting rod. The shaft is supported by main bearings A and B. Torque is transmitted to an external load through flange F.

(a) Draw the shaft, and show all loads necessary to place it in equilibrium as a free body.

(b) Starting with P and following the force paths through the shaft to the flange, identify the locations of potentially critical stresses.

(c) Making appropriate simplifying assumptions, write an equation for each.* State the assumptions made.

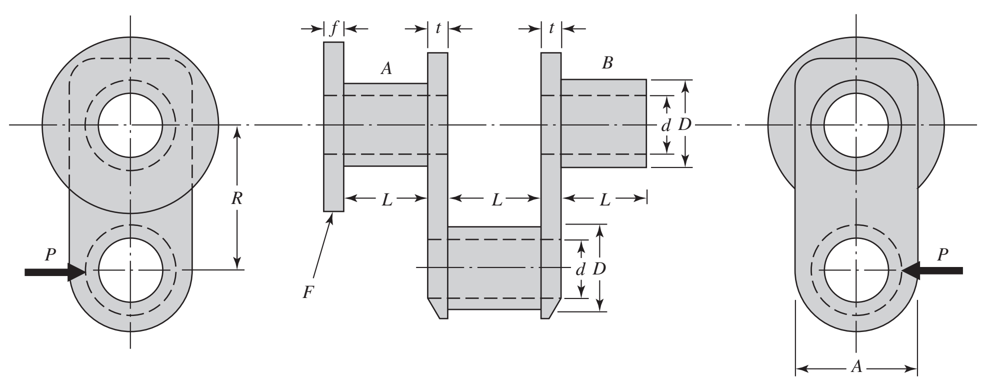

FIGURE RP2.9

RP2.10 A very stiff horizontal bar, supported by four identical springs, as shown in Figure RP2.10, is subjected to a center load of 100 N. What load is applied to each spring?

[Ans.: lower springs, 40 N; upper springs, 20 N]

*The first five sections of Chapter 4 review simple stress equations.

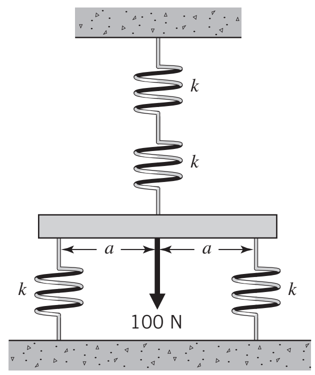

FIGURE RP2.10

RP2.11 Figure RP2.11 shows two plates joined with straps and a single row of rivets (or bolts). Plates, straps, and rivets are all made of ductile steel having yield strengths in tension, compression, and shear of 284, 284, and 160 MPa, respectively. Neglect frictional forces between the plates and straps.

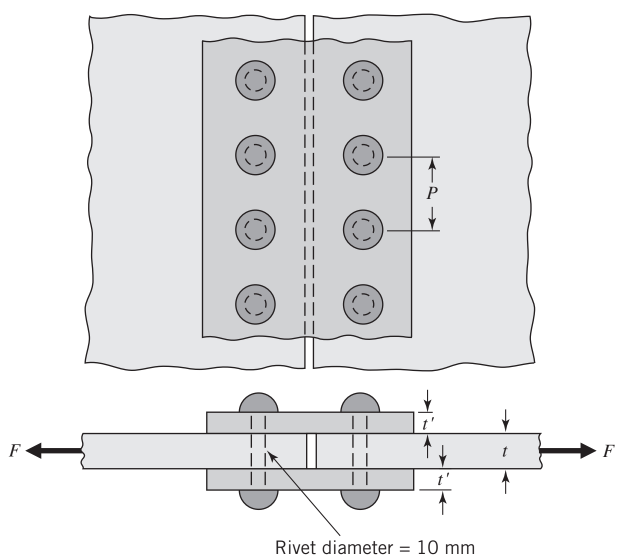

FIGURE RP2.11

(a) What force F can be transmitted across the joint per pitch, P, of joint width, based on rivet shear strength?

(b) Determine minimum values of t, t', and P that will permit the total joint to transmit this same force (thus giving a "balanced" design).

(c) Using these values, what is the "efficiency" of the joint (ratio of joint strength to strength of a continuous plate)?