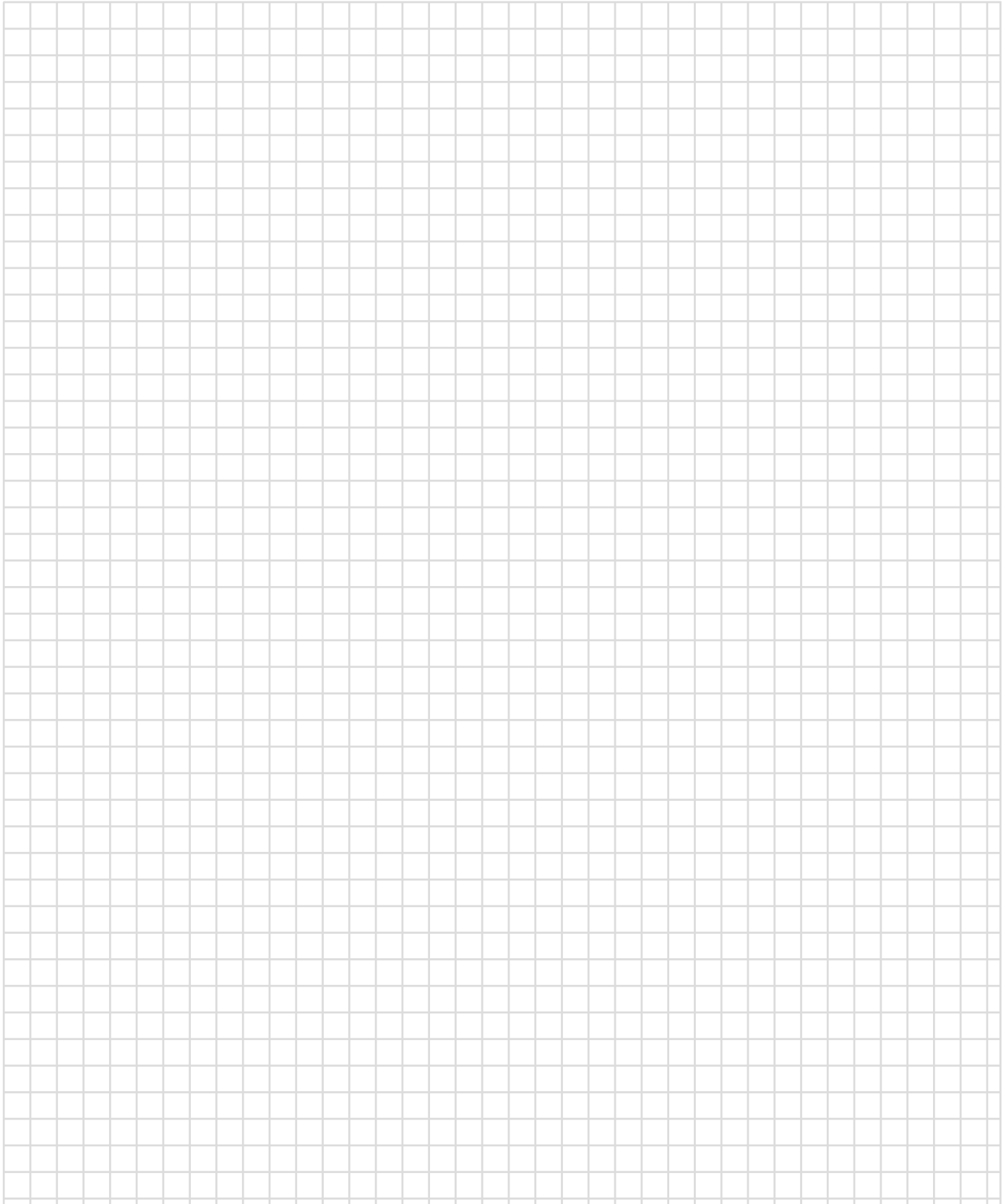


## Chapter 9 - Problems

**Note: All SI Unit Problems changed to US Customary Units**

9-1

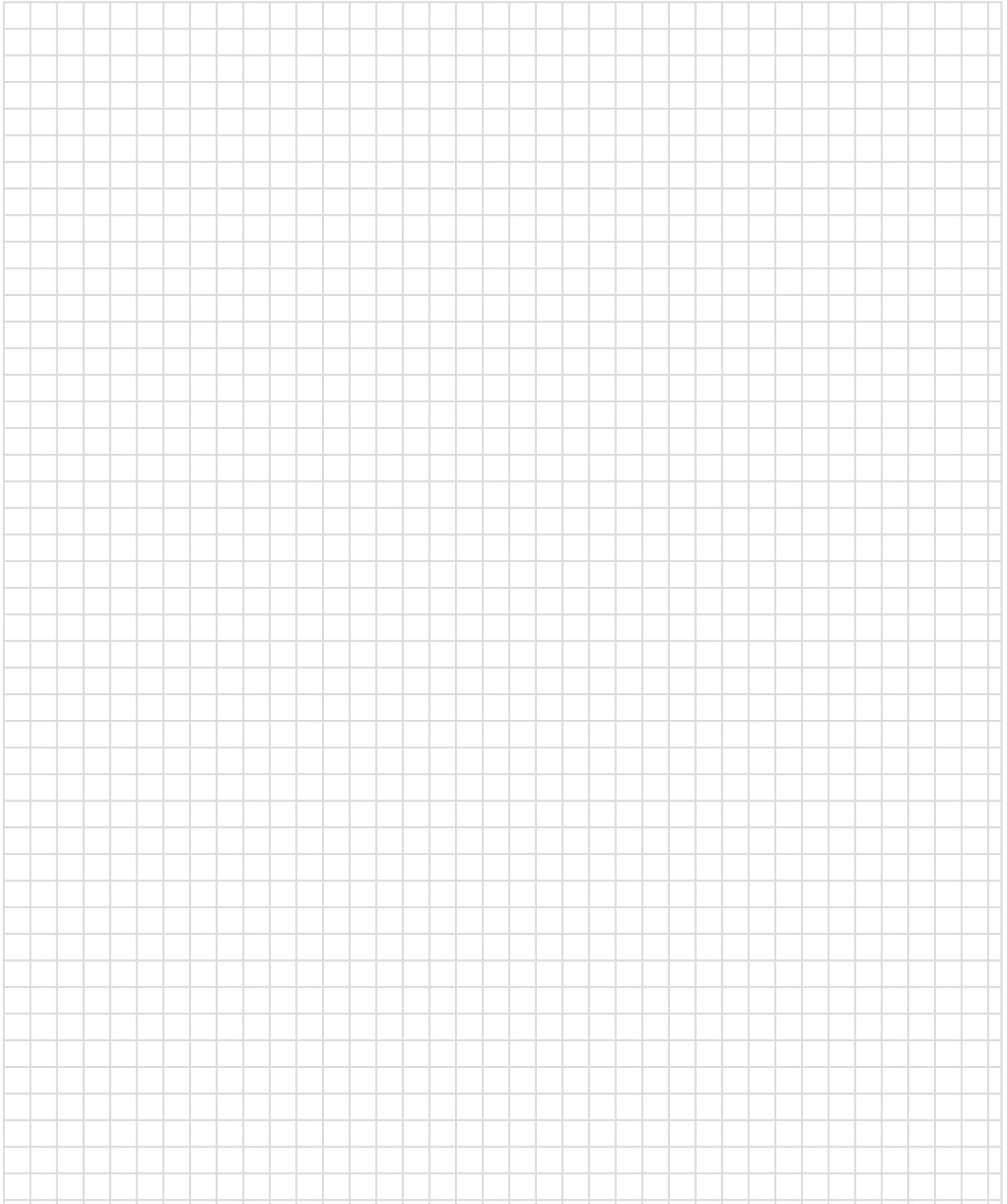
A 1.5-ton crate is hoisted by three steel wires. Each wire is  $\frac{3}{4}$  in. in diameter and each carries one-third of the load. Determine the stress in the wires.



9-2

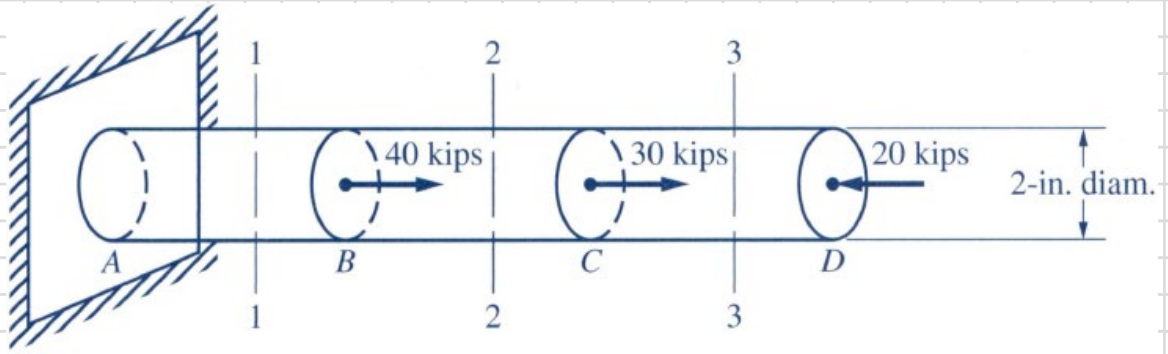
An 17,985 lb hopper is supported by three steel wires. Each wire is 0.6 in. in diameter and each carries one-third of the load. Determine the stress in the wires.

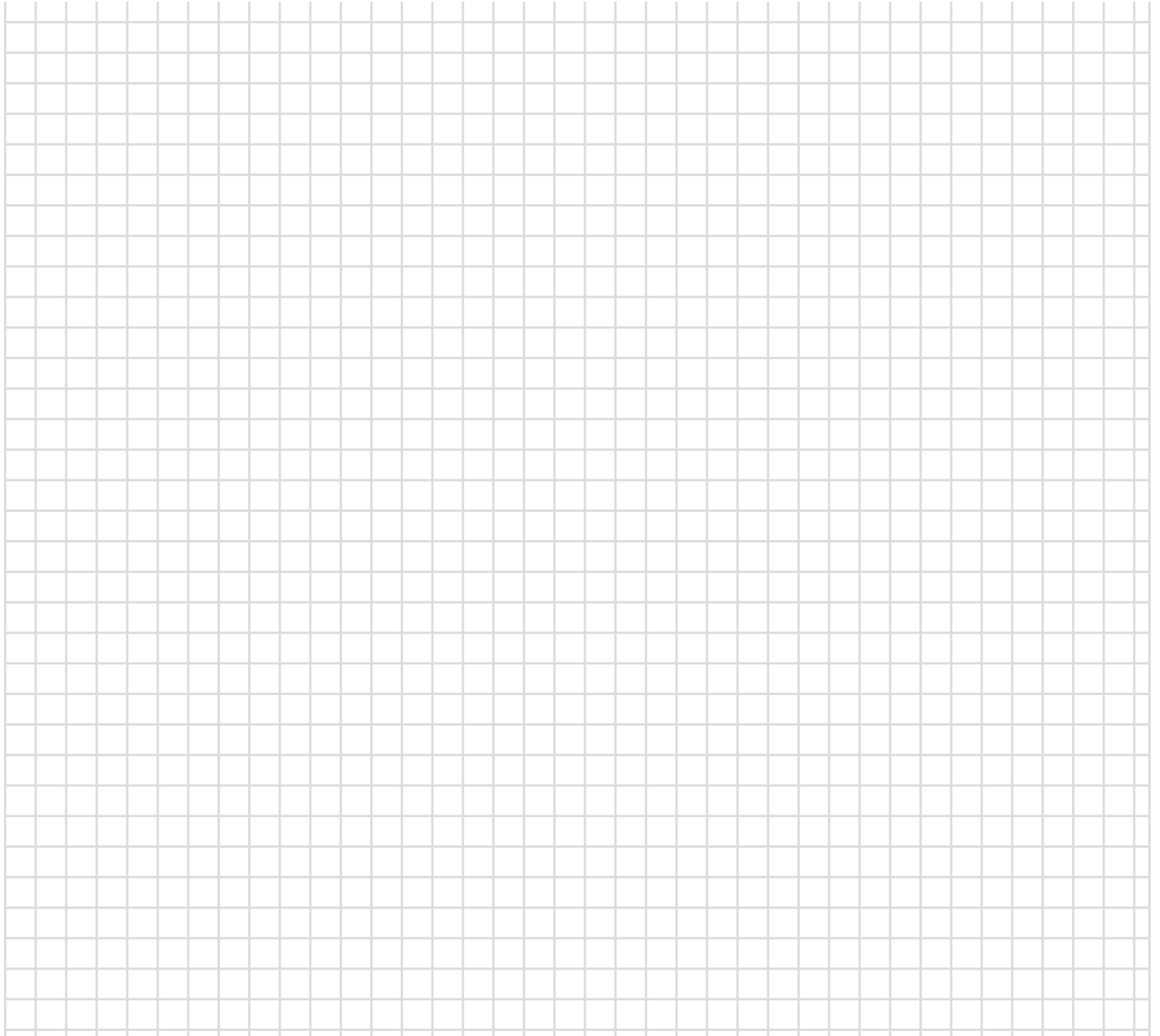
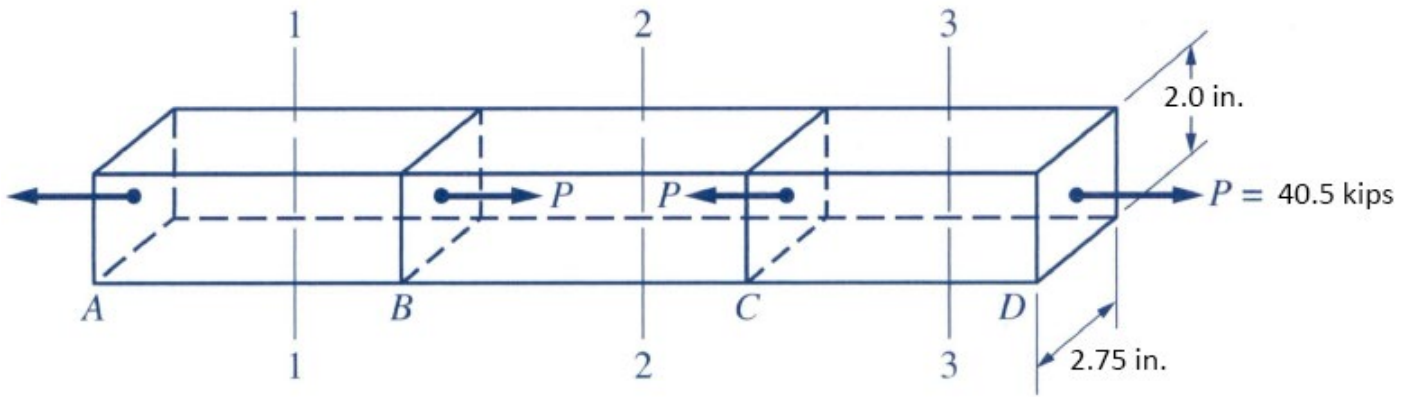
Solution.



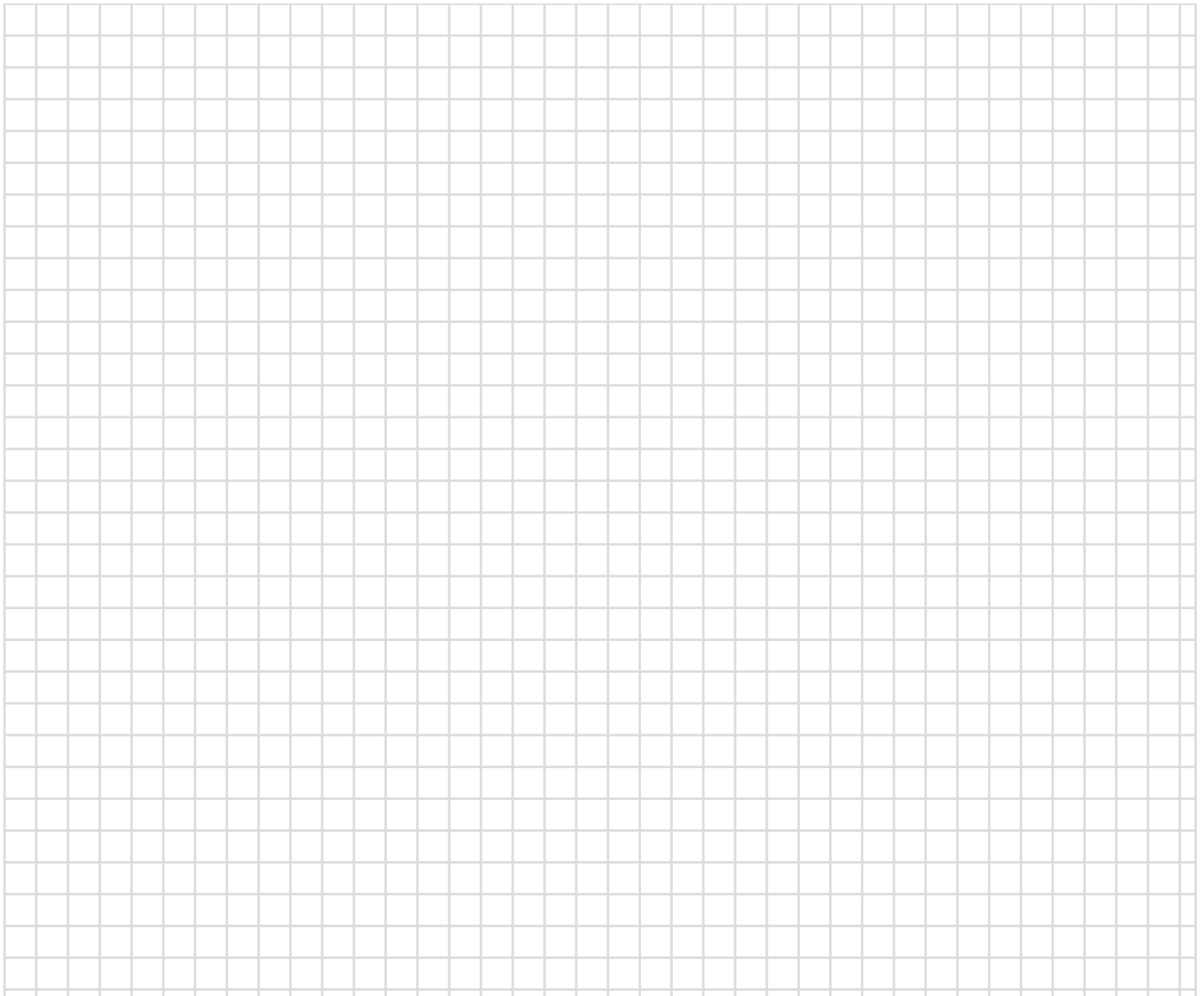
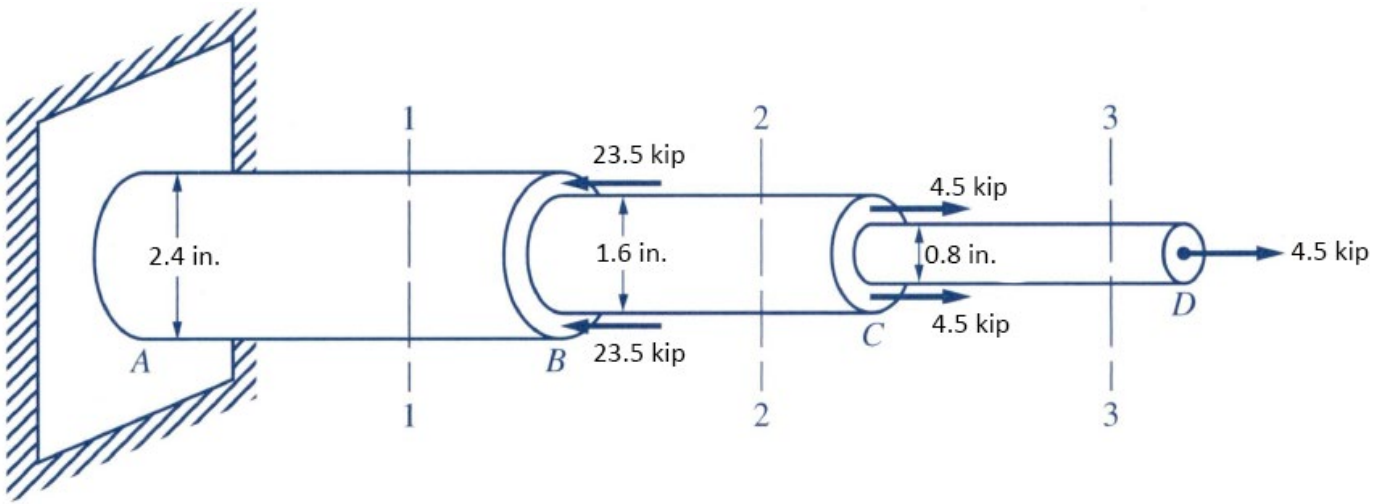
Refer to Figs. P9-3 to P9-5. Plot the internal axial force diagram and determine the normal stresses in segments AB, BC, and CD of each member due to the axial loads shown.

9-3



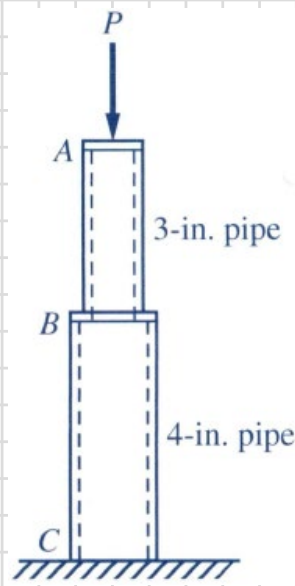


9-5



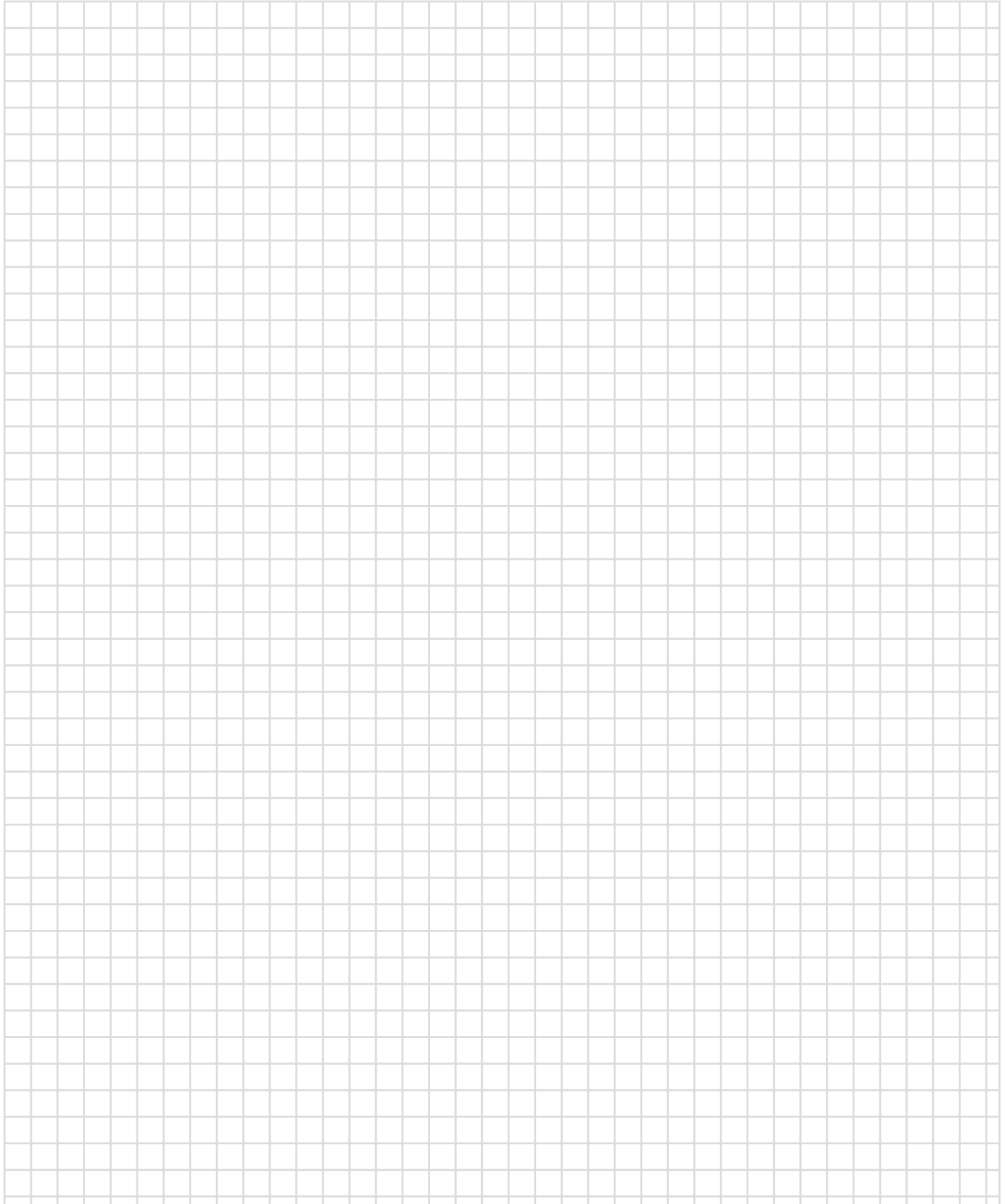
9-6

A short column composed of two standard steel pipes is subjected to a load  $P = 20$  kips, as shown in Fig. P9-6. Determine the compressive stress in each pipe. Neglect the weight of the pipes.



9-7

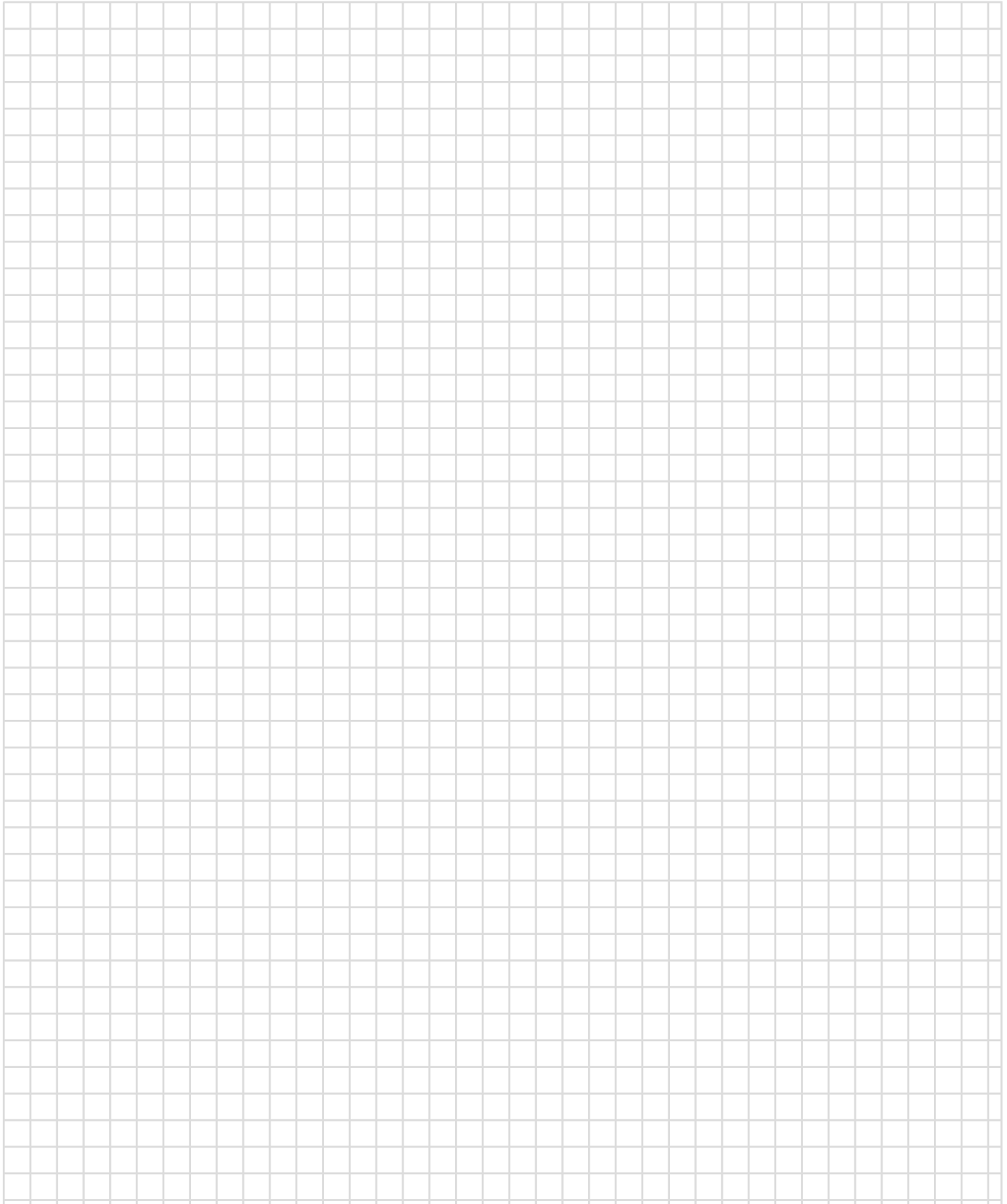
Determine the size steel rod, to the nearest sixteenth of an inch, needed to support a tensile load of 40 kips if the allowable tensile stress of steel is 22 ksi.



9-8

Determine the size of steel rod, to the nearest in., needed to support a tensile load of 45 kip if the allowable tensile stress of steel is 22 ksi.

Solution.

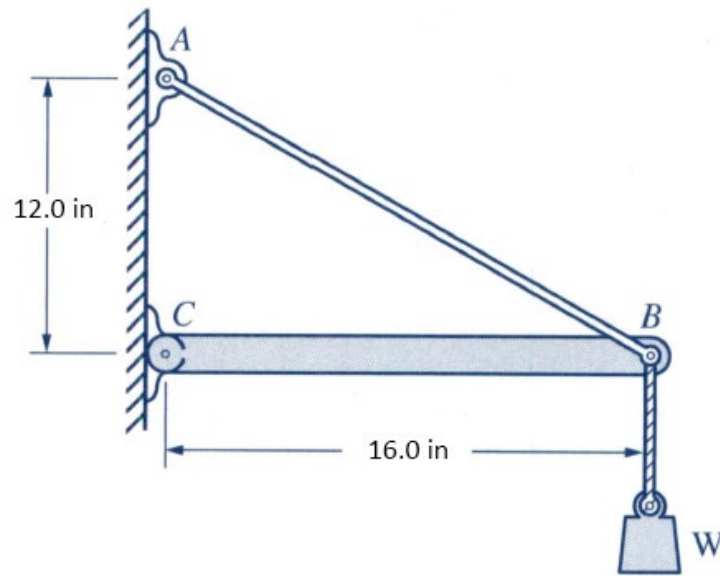




9-9

If rod AB in Fig. P9-9 has a diameter of 0.4 in., determine the normal stress in the rod due to a weight  $W = 3.4$  kip.

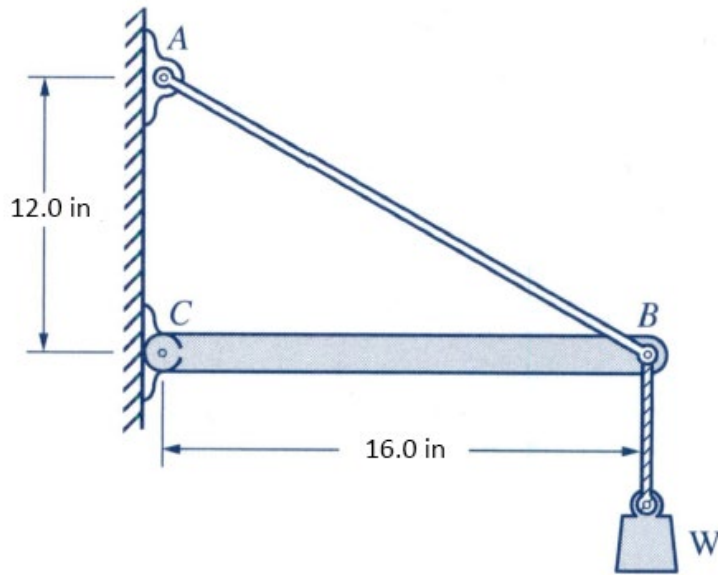
Solution.



9-10

Refer to Fig. P9-9. Determine the diameter of the rod AB, to the nearest in., needed to support a weight  $w = 6.7$  kip and the allowable tensile stress is 22 ksi.

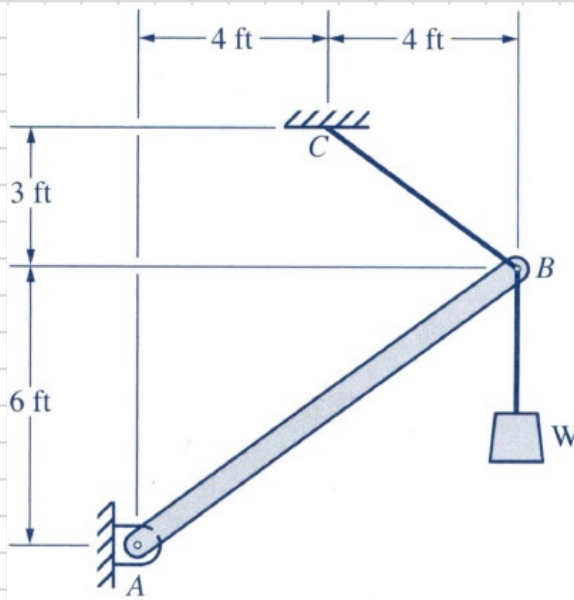
Solution.



9-11

A 600-lb weight  $W$  is supported as shown in Fig. p9-11. Determine the normal stresses in cable  $BC$  and rod  $AB$  if their cross-sectional areas are  $0.025 \text{ in.}^2$  and  $0.5 \text{ in.}^2$ , respectively.

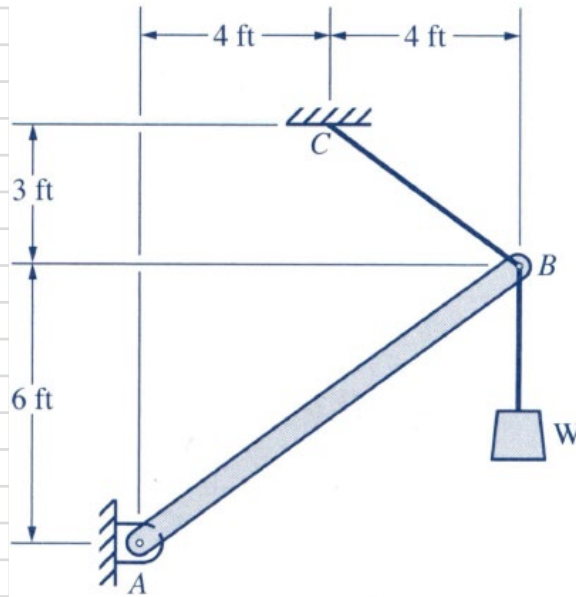
Solution.



9-12

Refer to Fig. P9-11. Determine the cross-sectional area required for rod AB to support a weight of  $W = 1000$  lb if the allowable compressive stress for the member is 1200 psi.

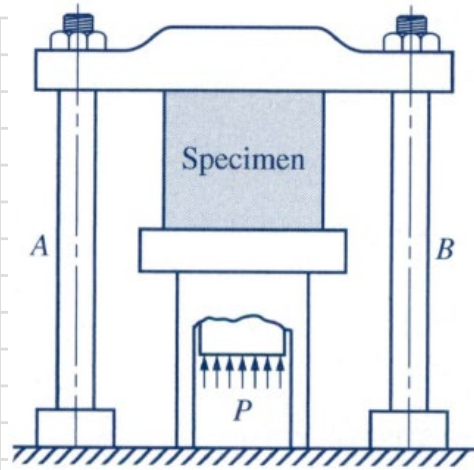
Solution.



9-13

Determine the maximum hydraulic compression, in lb, that can be applied to the testing machine in Fig. P9-13. Each of the two posts, A and B, has a diameter  $d = 3$  in. and an allowable tensile stress of 29 ksi.

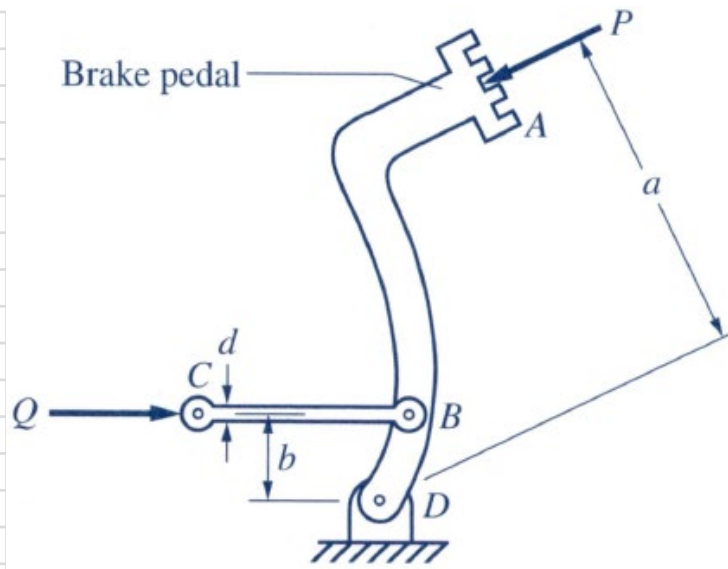
Solution.



9-14

The force applied to the brake pedal of a car is transmitted by lever AD and connecting rod BC, as shown in Fig. P9-14. If  $P = 20$  lb,  $a = 10$  in.,  $b = 2$  in. and  $d = \frac{1}{4}$  in., determine the normal stress in rod BC.

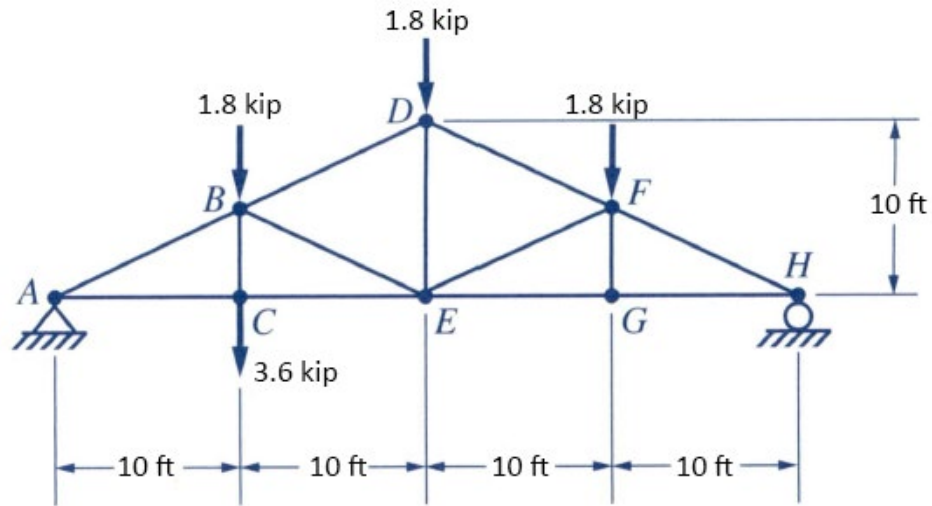
Solution.



9-15

Refer to Fig. P9-15. Determine the required cross-sectional area in  $\text{in}^2$  of members BD, BE, and CE of the truss subjected to the forces shown. The allowable stresses are 20 ksi in tension and 10 ksi in compression.

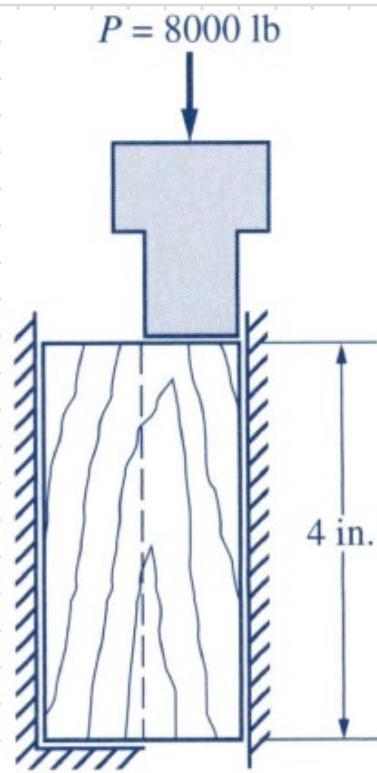
Solution.



9-16

A schematic diagram of the apparatus for determining the ultimate shear strength (failure shear stress) of wood is sketched in Fig. P9-16. The test specimen is 4 in. high, 2 in. wide, and 2 in. deep. If the load required to shear the specimen into two pieces is 8000 lb, determine the ultimate shear strength of the specimen.

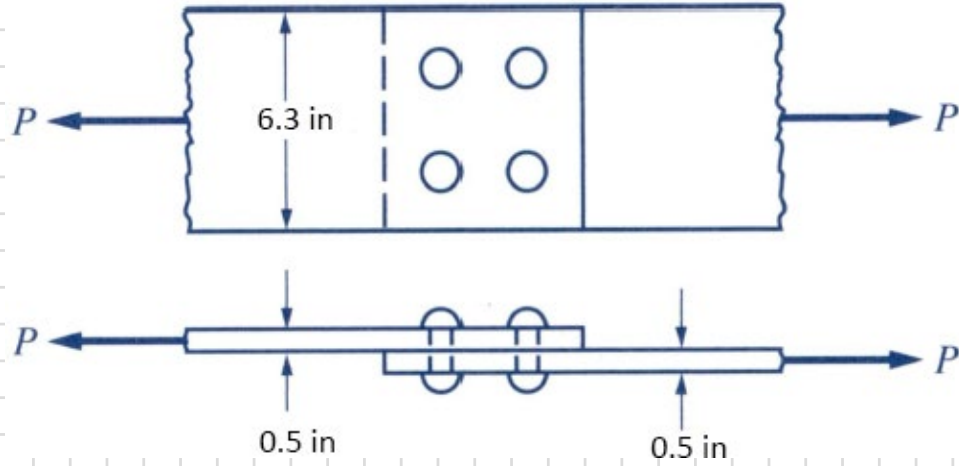
Solution.





9-17

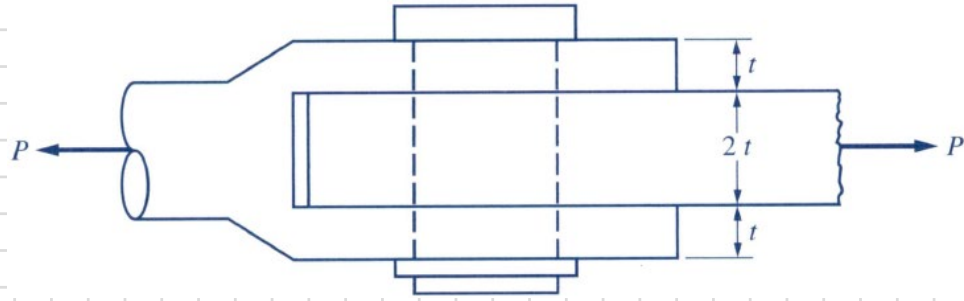
The lap joint shown in Fig. P9-17 is connected by four 0.8 in-diameter rivets. Determine (a) the shear stress in the rivets and (b) the bearing stress between the rivets and the plates. Assume that the load  $P = 27$  kip carried equally by the four rivets.



9-18

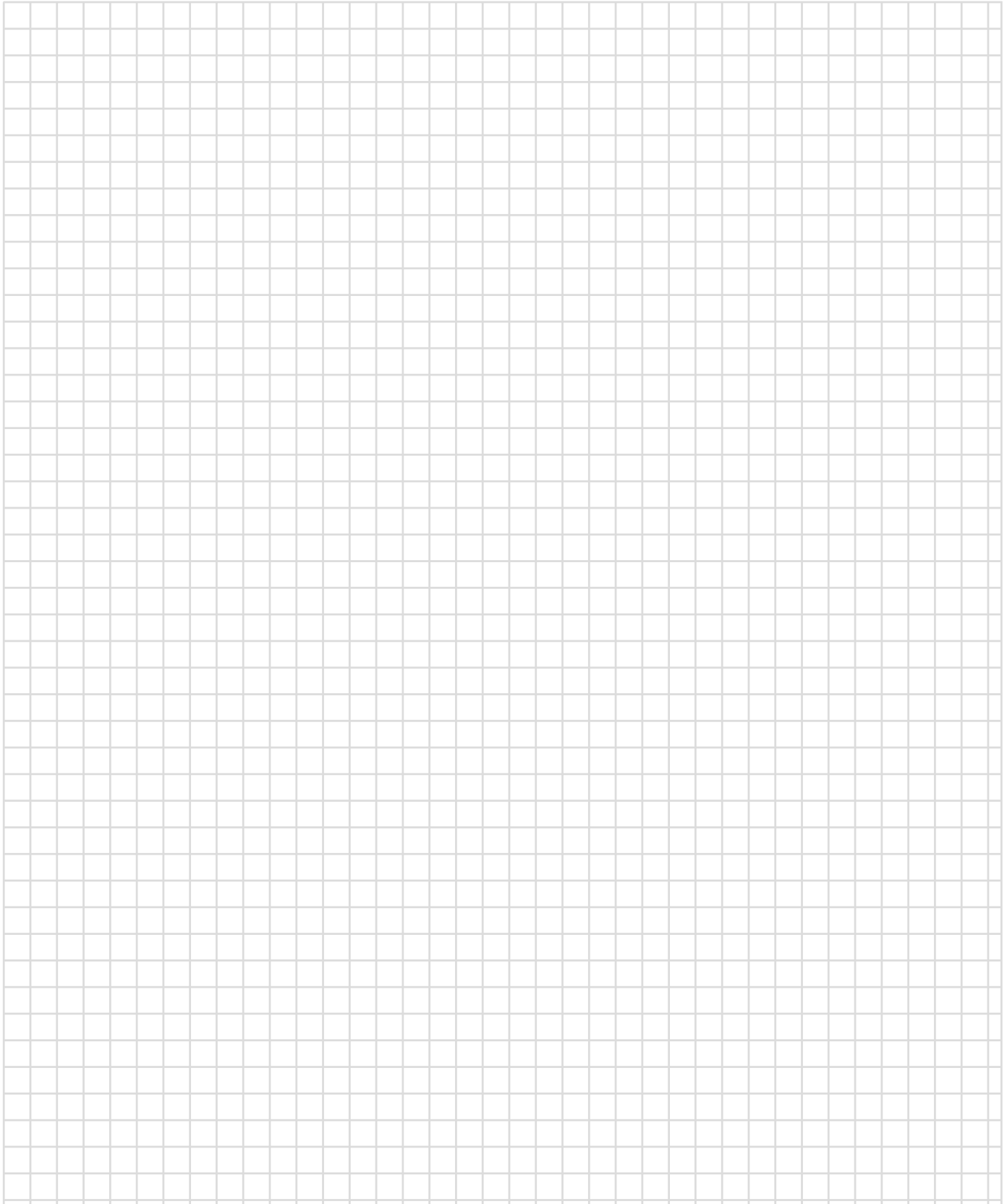
The clevis shown in Fig. P9-18 is connected by a pin of  $\frac{3}{4}$ -in. diameter. Determine the shear stress in the pin and the bearing stress between the pin and the plates if  $P = 10$  kips and  $t = \frac{1}{4}$  in.

Solution.



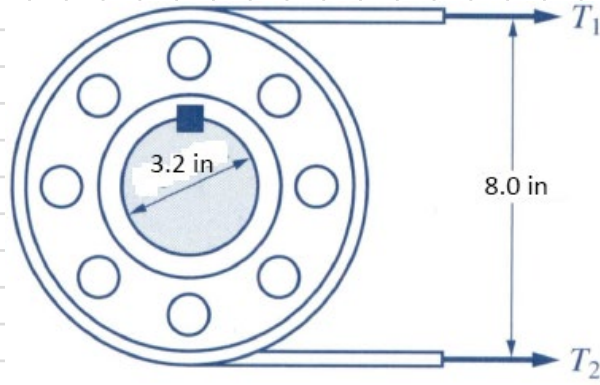
9-19

A 1.4 in-diameter shaft transmits a torque of 700 lb ft by means of a chain drive. The chain sprocket is fastened to the shaft by means of an 0.3 in x 0.3 in square key 2.0 in long. Determine (a) the shear stress in the key and (b) the bearing stress between the key and the shaft.



9-20

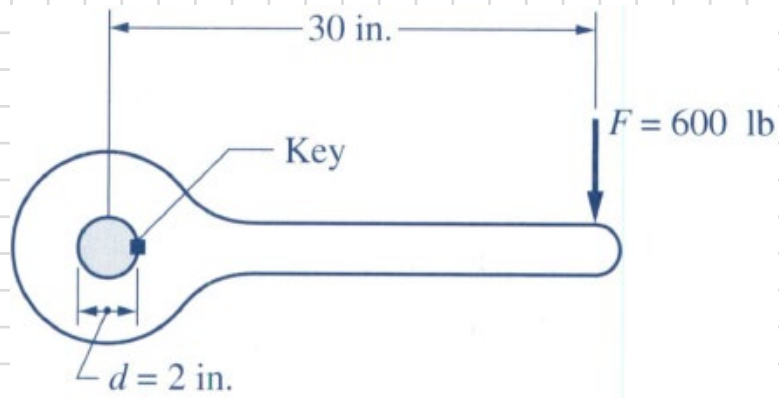
The pulley shown in Fig. P9-20 is connected to a 3.2 in-diameter shaft by a 0.8 in square key that is 4.0 in long. If the belt tensions are  $T_1 = 9$  kip and  $T_2 = 27$  kip, determine (a) the shear stress in the key and (b) the bearing stress between the key and the shaft.



9-21

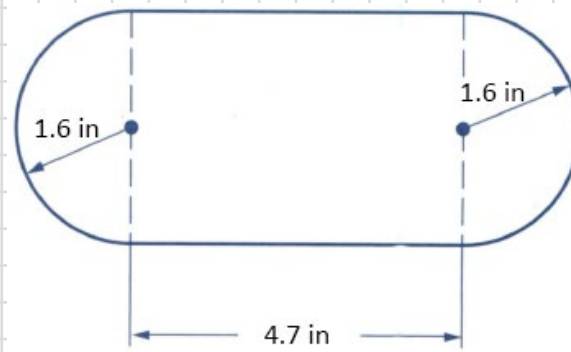
A force  $F = 600$  lb is applied to a crank and is transmitted to a shaft through a steel key, as shown in Fig. P9-21. The key is  $\frac{1}{2}$  in. square and  $2\frac{1}{2}$  in. long. Determine (a) the shear stress in the key and (b) the bearing stress between the key and the shaft.

Solution.



9-22

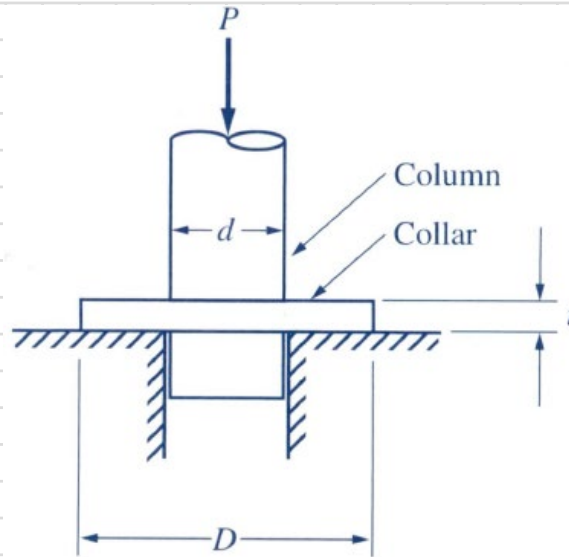
Determine the minimum force that must be exerted on a punch to shear a hole, having the shape shown in Fig. P9-22, through a steel plate 0.16 in thick. The plate has an ultimate shear strength (failure shear stress) of 44 ksi.



9-23

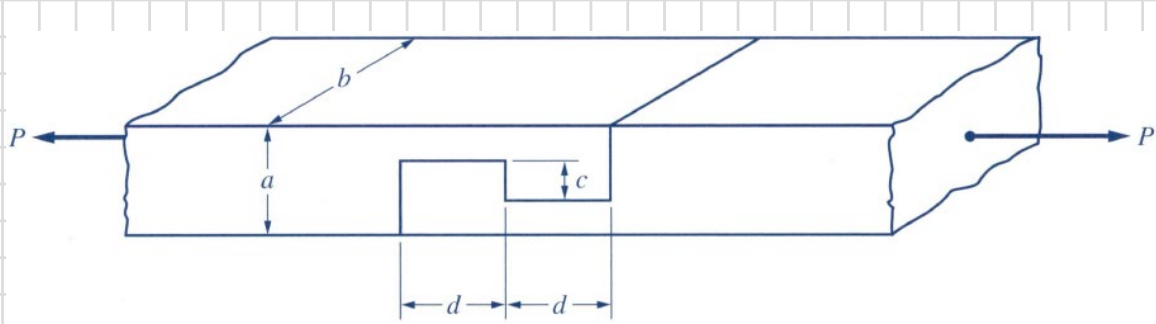
In the collar bearing shown in Fig. P9-23, the average bearing stress between the collar and the support is known to be 4000 psi. If  $d = 2$  in.,  $D = 4$  in., and  $t = \frac{1}{2}$  in., determine (a) the load  $P$  applied to the column and (b) the average shear stress on the area between the collar and the column.

Solution.



9-24

The dimensions in the wood joint shown in Fig. P9-24 are  $a = 4.0$  in,  $b = 6.0$  in,  $c = 1.6$  in, and  $d = 3.5$  in. Determine the shear stress and the bearing stress in the joint if  $P = 11.2$  kip.

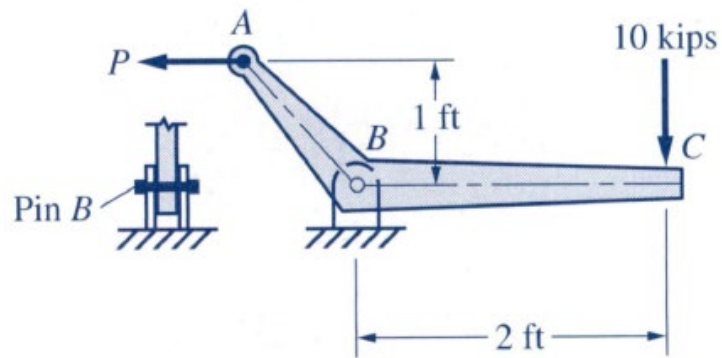




9-25

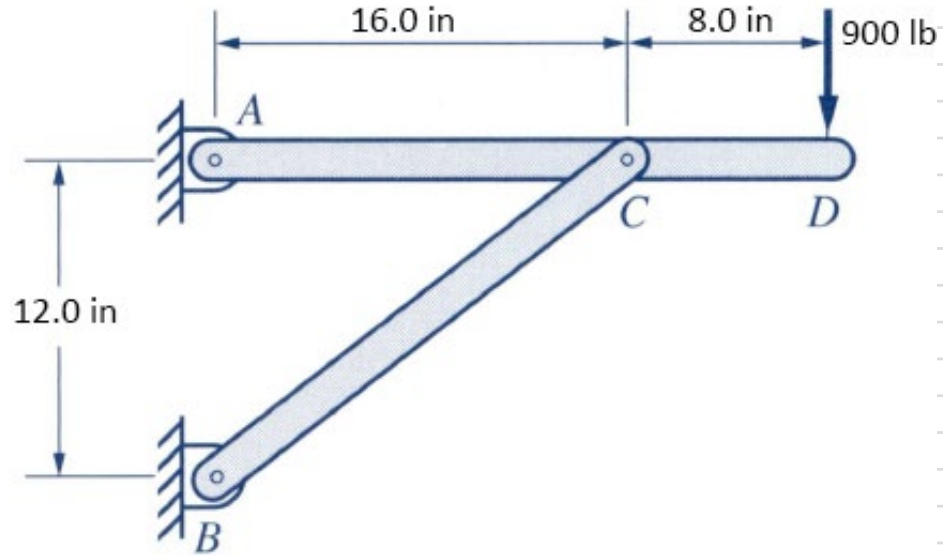
The bell crank mechanism in Fig. P9-25 is subjected to a vertical force of 10 kips applied at C. The force is resisted by a horizontal force  $P$  at A and a reaction at B. If the mechanism is in equilibrium and the allowable shear stress of the pin is 15 ksi, select the size of the pin at B.

Solution.



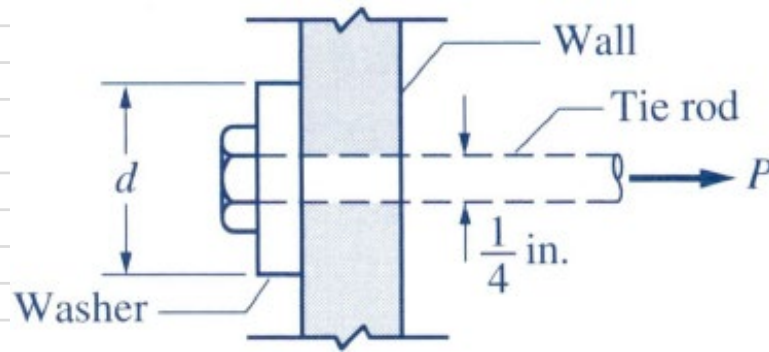
9-26

The structure shown in Fig. P9-26 is fastened to the support by bolts at A and B. The bolts are in double shear. If the allowable shear stress in the bolts is 17.4 ksi select the sizes of the bolts at A and B.



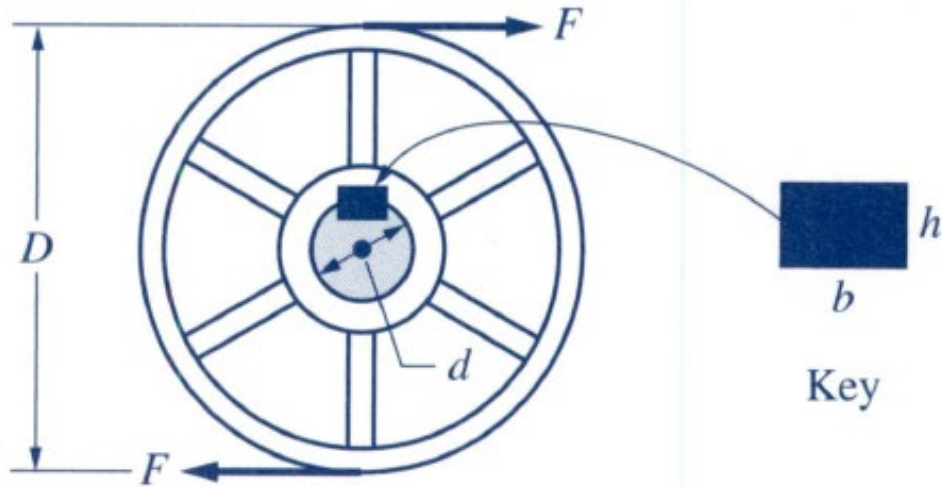
9-27

See Fig. P9-27. A tie rod of  $\frac{1}{4}$ -in. diameter is used to hold a plaster wall in place. The tensile stress in the rod caused by  $P$  is 20 ksi. Find the diameter  $d$  of the washer that keeps the bearing stress between the plaster and the washer from exceeding 300 psi.



9-28

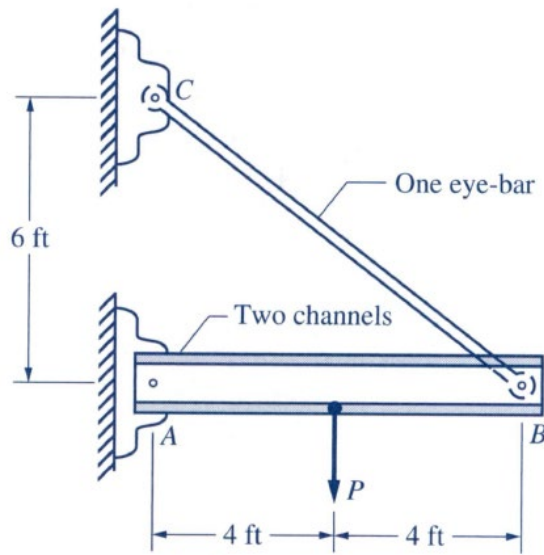
The control gate in Fig. P9-28 is operated by a wheel and shaft connected by a flat key, as shown. The allowable stresses in the key are 8000 psi in shear and 20 000 psi in bearing. If  $d = 2\frac{1}{4}$  in.,  $D = 30$  in.,  $b = \frac{1}{2}$  in.,  $h = \frac{3}{8}$  in., and  $F = 450$  lb, determine the length of the key.



9-29

The wall bracket shown in Fig. P9-29 carries a load of  $P = 12$  kips. The allowable tensile stress in the eye bar is 20 ksi, and the allowable shear stress in the pins is 12 ksi. Select (a) the diameter of the eye bar and (b) the diameter of the pin at A, which is in double shear.

Solution.



9-30

In the collar bearing shown in Fig. P9-30, the thickness of the collar is  $\frac{1}{2}$  in. The load  $P$  is 50 kips. The allowable compressive stress in the column is 20 ksi, the allowable shear stress in the collar is 15 ksi, and the allowable bearing stress between the collar and the support is 5 ksi. Select the proper sizes for  $d$  and  $D$ .

Solution.

