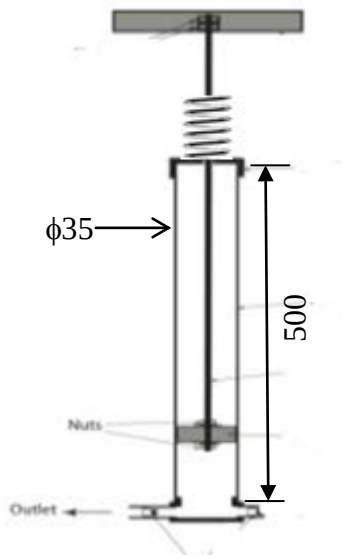
January 18, 2018

ME-351A
Design Tutorial 01

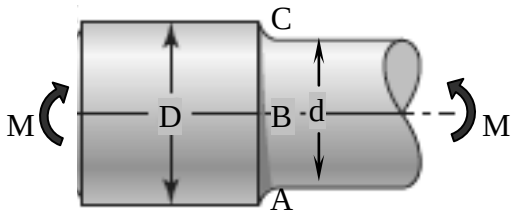
1. A bi-cycle pump (see fig) has an ID of 35 mm. The length of the cylinder is 500 mm. The piston rod is 600 mm in length. Take atmospheric pressure as 0.1 MPa. Assume the compression to be a polytropic process with an index of 1.3 and there is no leakage of air past the piston. Determine the diameter of the piston rod so that it will not buckle during operation. The rod is made of steel with E=200 GPa and yield strength S_y of 200 MPa. The maximum tire tube pressure for which this pump can be used is 0.3 MPa (gauge).



Considerations in deciding design factor:

- When the force is applied on the handle by a person, the resultant force may not be along the centroidal axis of the rod.
- Commercially available rods may not be straight
- If at all the rod buckles what are the consequences
- Cycle pumps cost no more than Rs. 200/- and weigh less than one kg.

2. The stepped cylindrical member shown in figure is subjected to a bending moment (M) of 50 N.m, an axial tensile load of 8 kN and a torque of 40 N.m. Determine the factor of safety at points A, B and C using the Modified Mohr theory. The material is a brittle material with S_{ut} of 170 MPa and S_{uc} of 680 MPa. For each case (A, B & C), clearly indicate the stress states in the σ_1-σ_2 plane along with the failure envelope. D=26 mm and d=20 mm.



P. Venkitanarayanan, S. Basu, P. Wahi and C. Chindam