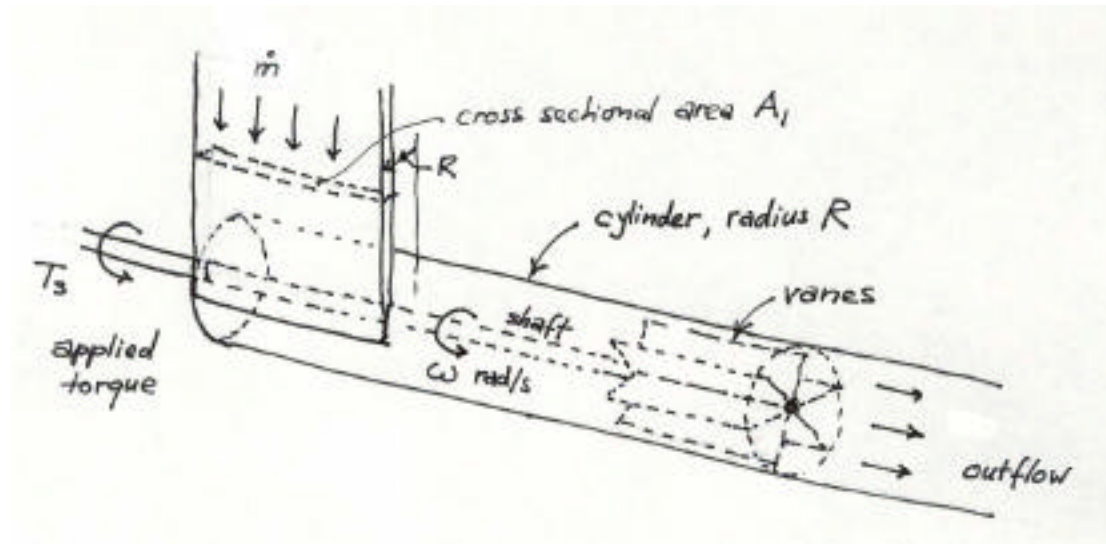


Problem 5.24

Mass flow from torque



The figure shows a device that, an inventor claims, provides a direct measurement of mass flow rate. The flow to be measured is routed tangentially into the cylindrical tube (radius R) as shown, flows axially along the tube until it passes over a set of straight vanes mounted on a shaft that can be rotated either freely or by applying a torque to the shaft, and then exits from the system.

The inventor claims he can determine mass flow directly by two methods: (1) from the angular rate of rotation of the vanes, ω (rad/s), when the shaft is allowed to rotate freely, and (2) from the torque T_s required to hold the shaft stationary.

Derive a theory for how this might be done.

ANSWER