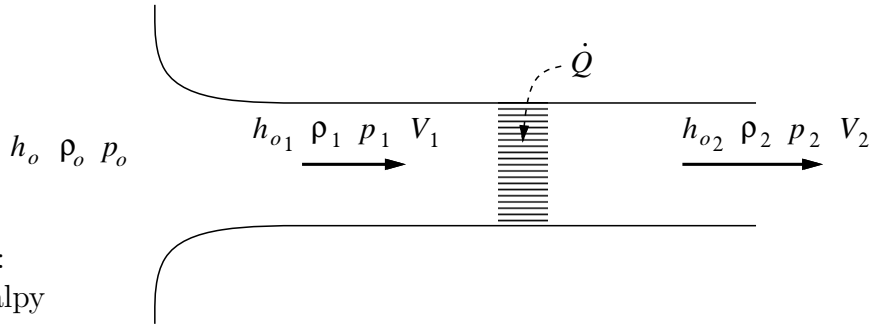
F11+12. Air is drawn at high speed out of a large reservoir through a duct of constant area A, which contains a radiator delivering a known $\dot{Q}$ to the flow (in Watts). The heating and friction of the duct walls are negligible.



The known flow quantities are:
$h_o = h_{o_1}$ reservoir total enthalpy
ρ_o reservoir total density
p_o reservoir total pressure
p_2 outlet pressure (drives the flow)

The remaining six unknown quantities inside the duct are:
h_{o_2} outlet total enthalpy
V_1 inlet velocity
V_2 outlet velocity
ρ_1 inlet density
ρ_2 outlet density
p_1 inlet pressure

A total of six equations are needed to solve for the six unknowns. One of these equations is the isentropic relation between the reservoir and station 1,

$$\frac{p_1}{p_o} = \left(\frac{h_{o_1} - \frac{1}{2}V_1^2}{h_o} \right)^{\gamma/(\gamma-1)}$$

and two additional ones are the state equations at stations 1 and 2.

$$p_1 = \frac{\gamma - 1}{\gamma} \rho_1 \left(h_{o_1} - \frac{1}{2}V_1^2 \right)$$
$$p_2 = \frac{\gamma - 1}{\gamma} \rho_2 \left(h_{o_2} - \frac{1}{2}V_2^2 \right)$$

Write down the remaining three equations by constructing a suitable control volume and applying the integral mass, momentum, energy equations. (Do not try to solve the six equations — it gets very messy!)