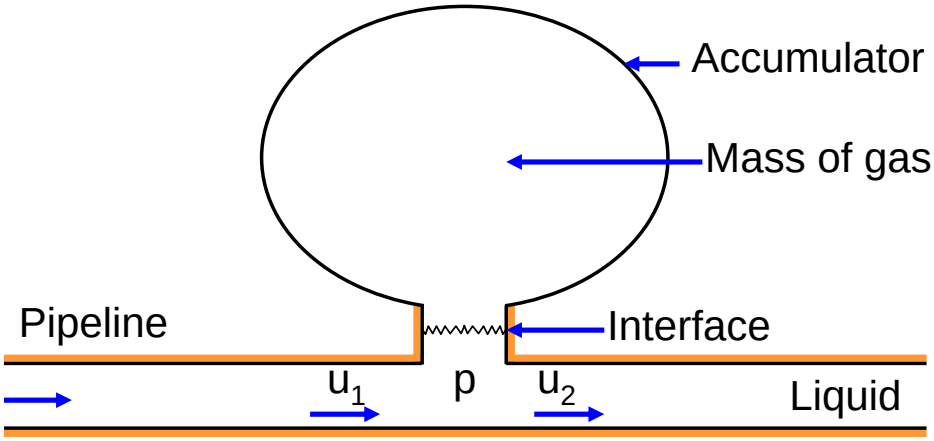
Problem 113B

An accumulator is a device which is often installed in a pipeline in order to change the propagation of pressure waves and unsteady flows in the pipeline. The basic elements of the accumulator are shown below:



Find the characteristic of the accumulator defined as the relation (differential equation) connecting the instantaneous pipeline velocity just upstream of the accumulator, u_1, the instantaneous pipeline velocity just downstream of the accumulator, u_2, the instantaneous pressure, p, at the mouth of the accumulator and time, t. Assume that

- The liquid in the pipeline is incompressible.
- The cross-section area of the pipeline is A.
- The accumulator contains a fixed mass of gas which behaves isentropically. In other words the pressure p and the volume of gas, V, in the accumulator are related by $pV^\gamma = constant$ where γ is the ratio of specific heats and the constant is known because the mass of gas occupies a volume V_0 at a pressure p_0.

The answer also contains A, γ, V_0 and p_0.