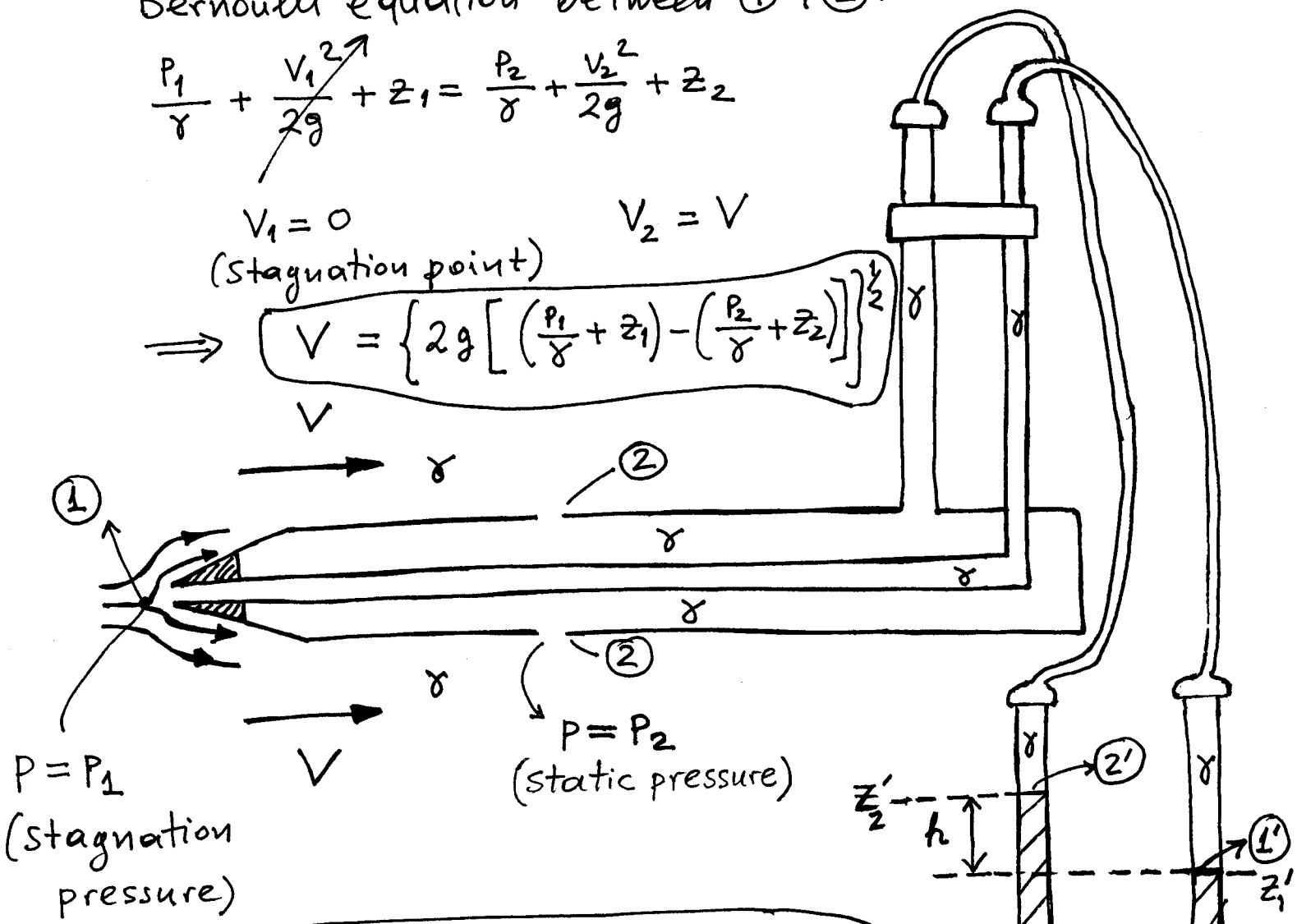
Pitot tube:

Bernoulli equation between ① + ②:

$$\frac{P_1}{\gamma} + \cancel{\frac{V_1^2}{2g}} + z_1 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + z_2$$

$V_1 = 0$ (stagnation point) $\qquad V_2 = V$

$$\Longrightarrow \boxed{V = \left\{2g\left[\left(\frac{P_1}{\gamma} + z_1\right) - \left(\frac{P_2}{\gamma} + z_2\right)\right]\right\}^{1/2}}$$



To determine flow velocity V we must determine:

$$\left(\frac{P_1}{\gamma} + z_1\right) - \left(\frac{P_2}{\gamma} + z_2\right) \quad \text{or} \quad (P_1 - P_2)$$

Since z_1, z_2, and γ are known

To do that we connect the Pitot tube to the shown U-manometer with fluid of γ_{Ma}

From hydrostatics of manometer:

$$p_1' - p_2' = \gamma_{Ma} \cdot h \qquad (1)$$

Hydrostatic Law between ① and ①' gives:

$$\frac{p_1}{\gamma} + z_1 = \frac{p_1'}{\gamma} + z_1' \qquad (2)$$

and between ② and ②':

$$\frac{p_2}{\gamma} + z_2 = \frac{p_2'}{\gamma} + z_2' \qquad (3)$$

$$(2) - (3) \Rightarrow \left(\frac{p_1}{\gamma} + z_1\right) - \left(\frac{p_2}{\gamma} + z_2\right) =$$

$$= \left(\frac{p_1'}{\gamma} + z_1'\right) - \left(\frac{p_2'}{\gamma} + z_2'\right) =$$

$$= \frac{p_1' - p_2'}{\gamma} + \underbrace{(z_1' - z_2')}_{-h} = \frac{\gamma_{Ma} \cdot h}{\gamma} - h =$$

$$= \left(\frac{\gamma_{Ma}}{\gamma} - 1\right) h$$

Thus: $\boxed{V = \sqrt{2gh\left[\frac{\gamma_{Ma}}{\gamma} - 1\right]}}$