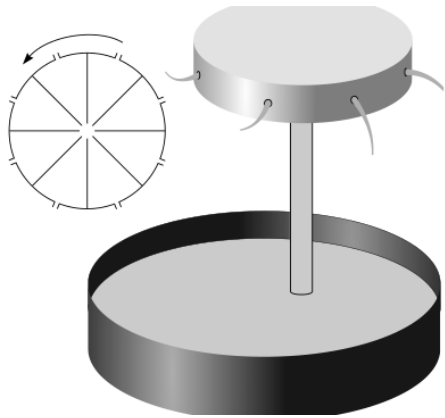
4. Water pump (10 p)

Consider the following construction of a water pump. A vertical tube of cross-sectional area S_1 leads from an open water reservoir to a cylindric rotating tank of radius r. All the vessels are filled with water; there are holes of net cross-sectional area S_2 along the perimeter of the tank, which are open for the operating regime of the pump. The height of the tank from the free water surface of the reservoir is h (the height of the tank itself is small). An electric engine keeps the vessel rotating at the angular velocity ω. The water density is ρ, the air pressure — p_0, and the saturated vapour pressure — p_k. Assume the water flow to be laminar (neglect the energy of vortices) and neglect the friction. Inside the tank, there are metal blades, which make the water rotating together with the tank.



1) Calculate the pressure p_2 at the perimeter of the tank, when all the holes are closed (2 p).

2) From now on, all the holes are open. Find the velocity v_2 of the water jets with respect to the ground (2 p).

3) If the tank rotates too fast, the pump efficiency drops due to cavitation: the water starts "boiling" in some parts of the pump. Find the highest cavitation-free angular speed $\omega_{\max}$ (3 pts).

4) If the power of the electric engine is P, what is the theoretical upper limit of the volume productivity of the pump $\mu_{\max}$ (volume of the pumped water per unit time)?