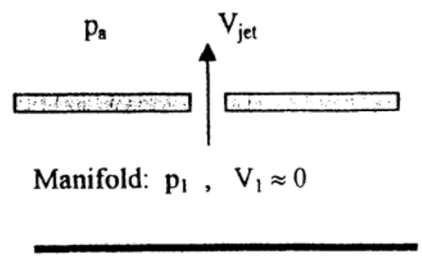
3.162 Suppose you are designing a 3 × 6-ft air-hockey table, with 1/16-inch-diameter holes spaced every inch in a rectangular pattern (2592 holes total), the required jet speed from each hole is 50 ft/s. You must select an appropriate blower. Estimate the volumetric flow rate (in ft^3/min) and pressure rise (in psi) required. *Hint*: Assume the air is stagnant in the large manifold under the table surface, and neglect frictional losses.



Solution: Assume an air density of about sea-level, **0.00235 slug/ft³**. Apply Bernoulli's equation through any single hole, as in the figure:

$$p_1 + \frac{\rho}{2}V_1^2 = p_a + \frac{\rho}{2}V_{jet}^2, \quad or:$$

$$\Delta p_{required} = p_1 - p_a = \frac{\rho}{2}V_{jet}^2 = \frac{0.00235}{2}(50)^2 = 2.94\ \frac{lbf}{ft^2} = \mathbf{0.0204\ \frac{lbf}{in^2}} \quad Ans.$$

The total volume flow required is

$$Q = VA_{1-hole}(\#\ of\ holes) = \left(50\ \frac{ft}{s}\right)\frac{\pi}{4}\left(\frac{1/16}{12}\ ft\right)^2 (2592\ holes)$$

$$= 2.76\ \frac{ft^3}{s} = \mathbf{166\ \frac{ft^3}{min}} \quad Ans.$$

It wasn't asked, but the power required would be $P = Q\Delta p = (2.76\ ft^3/s)(2.94\ lbf/ft^2) =$ 8.1 ft·lbf/s, or about 11 watts.