COR.—When $V^2 = 2gh$, we have, from (3),

$$\text{efficiency} = 0.5.$$

When $V^2 = 4gh$, we have, from (3),

$$\text{efficiency} = \frac{1}{2(2 - \sqrt{2})} = .85.$$

When $V^2 = 6gh$, we have, from (3),

$$\text{efficiency} = 0.9.$$

Hence, theoretically, *the centrifugal pump has a considerable efficiency when the velocity of rotation exceeds the velocity due to twice the height of the column of water raised.*

SCH.—Centrifugal pumps work to the best advantage only at the particular lift for which they are designed. When employed for variable lifts, as is constantly the case in practice, their efficiency is much reduced, and does not exceed .5, and is often much less.

The earliest idea of a centrifugal pump was to employ an inverted Barker's Mill, consisting of a central pipe dipping into water, connected with rotating arms placed at the level at which water is to be delivered. The first pump of this kind which attracted notice was one exhibited by Mr. Appold in 1851, and the special features of this pump have been retained in the best pumps since constructed. The experiments conducted at the Great Exhibition on Appold's Centrifugal Pump with curved arms, gave the maximum efficiency 0.68. But when the arms were straight and radial, the efficiency was as low as .24, showing the great advantage of having the curved form of the arms, which causes the water to be projected in a tangential direction.

**160. Turbines.**—A reaction wheel is defective in principle, because the water after delivery has a rotatory velocity, in consequence of which a large part of the head is