b) $\dot{Y} = 0 = \frac{q_{in} S}{S^2 - A^2} - \sqrt{\frac{A^2}{(S^2-A^2)^2} q_{in}^2 + \frac{2A^2 g}{S^2 - A^2} Y}$

$$\Rightarrow \left(\frac{q_{in} S}{S^2 - A^2}\right)^2 = \frac{A^2}{(S^2-A^2)^2} q_{in}^2 + \frac{2A^2 g}{S^2-A^2} Y$$

$$\Rightarrow \left[\frac{S^2}{(S^2-A^2)^2} - \frac{A^2}{(S^2-A^2)^2}\right] q_{in}^2 = \frac{2A^2 g}{S^2 - A^2} Y$$

$$\Rightarrow \frac{\cancel{S^2 - A^2}}{(S^2-A^2)^{\cancel{2}}} q_{in}^2 = \frac{2A^2 g}{S^2-A^2} Y$$

$$\Rightarrow \frac{1}{\cancel{S^2 - A^2}} q_{in}^2 = \frac{2A^2 g}{\cancel{S^2-A^2}} Y$$

$$\Rightarrow q_{in}^2 = 2A^2 g Y$$

$$\Rightarrow \cancel{g}\ \boxed{q_{in} = \sqrt{2A^2 g Y}}$$

The control variable q_{in} has <u>no</u> range to maintain a constant level Y for the whole working range of the level. Given $\dot{Y} = 0$, the relation between q_{in} and Y is parabolic in nature. for $q_{in} > 0$ and $Y > 0$, the relation $q_{in} = \sqrt{2A^2 g Y}$ has no range of q_{in} for which Y remains constant. The steady-state relation of Y and q_{in} is 1 to 1.