The preliminary design of a unit for automatically reducing the speed of a freely rotating assembly is shown. Initially, the unit is rotating freely about a vertical axis through O at a speed of 600 rev/min with the arms secured in the positions shown by AB. When the arms are released, they swing outward and become latched in the dashed positions shown. The disk has a mass of 30 kg with a radius of gyration of 90 mm about O. Each arm has a length of 160 mm and a mass of 0.84 kg and may be treated as a uniform slender rod. Determine the new speed \( N \) of rotation and calculate the loss \( |\Delta E| \) of energy of the system. Would the results be affected by either the direction of rotation or the sequence of release of the rods?

**Ans.** \( N = 504 \text{ rev/min} \), \( |\Delta E| = 98.1 \text{ J} \)

\[
\begin{align*}
\omega_1 &= 600 \text{ rpm} = 62.83 \text{ rad/s} \\
M_D &= 30 \text{ kg} \\
K_D &= 0.09 \text{ m} \\
I_a &= 0.16 \text{ m} \\
M_a &= 0.84 \text{ kg} \\
I_D &= K_D m = (0.09)(30) = 0.27 \text{ kg m}^2 \\
\overline{I_a} &= \frac{1}{12} m l_e^2 = \frac{1}{12} (0.84)(0.16)^2 = 0.001792 \text{ kg m}^2
\end{align*}
\]

\[
\begin{align*}
H_0 &= \overline{I_a} \omega_1^2 = \frac{1}{12} (0.84)(62.83)^2 = 8.546 \text{ J} \\
H_{a1} &= \overline{I_a} \omega_1 + m_a v_a d_a \\
&= \text{we need } v_a \text{ and } d_a
\end{align*}
\]

\[
\begin{align*}
0.08 \text{ m} \\
0.11 \text{ m}
\end{align*}
\]

\[
\begin{align*}
d_a &= \sqrt{0.11^2 + 0.08^2} = 0.136 \text{ m} \\
v_a &= d_a \omega_1 = (0.136)(62.83) = 8.546 \text{ rad/s}
\end{align*}
\]

\[
\begin{align*}
H_{a1} &= \overline{I_a} \omega_1 + m_a v_a d_a \\
H_{a1} &= (0.001792)(62.83) + (0.84)(8.546)(0.136) = 1.089 \\
(H_0)_{sys} &= H_0 + 4 H_{a1} \\
&= 15.27 + 4(1.089) = 19.63 \text{ rad}^2/s^2
\end{align*}
\]

\[
\begin{align*}
\omega_2 &= 52.84 \text{ rad/s} \\
\omega_2 &= 504.6 \text{ rpm}
\end{align*}
\]