Using the expressions for F_1 and F_3 as a function of $\dot{L}_1$ and $\dot{L}_2$, one finds for $a_1 = a_2 = a_3 = a$

$$\begin{aligned}
\mathcal{P} &= 4\pi\mu a \left[1 + \frac{a}{L_1} - \frac{1}{2}\frac{a}{L_2} + \frac{a}{L_1 + L_2}\right] \dot{L}_1^2 + \\
&\quad 4\pi\mu a \left[1 - \frac{1}{2}\frac{a}{L_1} + \frac{a}{L_2} + \frac{a}{L_1 + L_2}\right] \dot{L}_2^2 + \\
&\quad 4\pi\mu a \left[1 - \frac{1}{2}\frac{a}{L_1} - \frac{1}{2}\frac{a}{L_2} + \frac{5}{2}\frac{a}{L_1 + L_2}\right] \dot{L}_1 \dot{L}_2. \qquad (5.47)
\end{aligned}$$