N=4 case

$$
\begin{aligned}
\mathbf{r}_1 &= \mathbf{R} + \frac{3}{4}\boldsymbol{\xi}_2 \\
\mathbf{r}_2 &= \mathbf{R} - \frac{1}{4}\boldsymbol{\xi}_2 + \frac{2}{3}\boldsymbol{\xi}_3 \\
\mathbf{r}_3 &= \mathbf{R} - \frac{1}{4}\boldsymbol{\xi}_2 - \frac{1}{3}\boldsymbol{\xi}_3 + \frac{1}{2}\boldsymbol{\xi}_4 \\
\mathbf{r}_4 &= \mathbf{R} - \frac{1}{4}\boldsymbol{\xi}_2 - \frac{1}{3}\boldsymbol{\xi}_3 - \frac{1}{2}\boldsymbol{\xi}_4
\end{aligned}
$$

The above transformations allow one to easily find the canonical momentum $\mathbf{p}_{\xi_i}$ correponding to any internal coordinate $\boldsymbol{\xi}_i$ or to express a particle momentum $\mathbf{p}_i$ in terms of canonical internal momenta. Thus, from the above N=4 example, we have

$$
\begin{aligned}
\mathbf{p}_1 &= \frac{1}{4}\mathbf{P} + \mathbf{p}_{\xi_2} \\
\mathbf{p}_2 &= \frac{1}{4}\mathbf{P} - \frac{1}{3}\mathbf{p}_{\xi_2} + \mathbf{p}_{\xi_3} \\
\mathbf{p}_3 &= \frac{1}{4}\mathbf{P} - \frac{1}{3}\mathbf{p}_{\xi_2} - \frac{1}{2}\mathbf{p}_{\xi_3} + \mathbf{p}_{\xi_4} \\
\mathbf{p}_4 &= \frac{1}{4}\mathbf{P} - \frac{1}{3}\mathbf{p}_{\xi_2} - \frac{1}{2}\mathbf{p}_{\xi_3} - \mathbf{p}_{\xi_4}
\end{aligned}
$$