Additionally, all the blocks in the perturbation are scaled so that their infinity norms are bounded by 1:

$$\|\Delta_1\|_\infty \leq 1; \|\Delta_2\|_\infty \leq 1; \ldots; \|\Delta_n\|_\infty \leq 1.$$  \hspace{1cm} (5.14b)

Note that the bounds in (5.14b) imply the bound in (5.14a). The perturbation is normalized by incorporating the actual bound (which may be frequency-dependent) into the plant, as discussed in Section 5.4.1. The subset of $\Delta$ that satisfies the bounds in (5.14) is termed the set of admissible perturbations.

**Example 5.8**

Consider the following transfer function:

$$G(s) = \frac{1}{(s + p_1)(s + p_2)}.$$

The two poles are uncertain, as given by

$$p_1 \in [0.9, 1.1]; \quad p_2 \in [3, 5].$$

These poles can be modeled as a nominal value plus a perturbation:

$$p_1 = 1 + \delta_1; \quad p_2 = 4 + \delta_2,$$

where $\delta_1$ ranges from $-0.1$ to $0.1$ and $\delta_2$ ranges from $-1$ to $1$. These perturbations can be placed in a feedback loop around the nominal plant, as shown in Figure 5.15. Figure 5.15a shows the basic block diagram of this system. The perturbations are isolated in separate feedback loops in Figure 5.15b. The result is put in standard form, as shown in Figure 5.15c, by normalizing the perturbations. The resulting perturbation has the property that

$$\|\Delta_1\|_\infty \leq 1; \|\Delta_2\|_\infty \leq 1; \|\Delta\|_\infty \leq 1,$$

where both $\Delta_1(s)$ and $\Delta_2(s)$ are real perturbations. The transfer function $N(s)$ is

$$N(s) = \begin{bmatrix}
\frac{N_{ydw}(s)}{N_{yw}(s)} & \frac{N_{ydw}(s)}{N_{yw}(s)}
\end{bmatrix} = \begin{bmatrix}
-0.1 & 0 & \frac{0.1}{(s + 1)} \\
\frac{-1}{(s + 1)(s + 4)} & \frac{-1}{(s + 1)(s + 4)} & \frac{1}{(s + 1)(s + 4)} \\
\frac{-1}{(s + 1)(s + 4)} & \frac{-1}{(s + 1)(s + 4)} & \frac{1}{(s + 1)(s + 4)}
\end{bmatrix}.$$