4.3 A Second-Order Multiple-Feedback Band-Pass Filter

Another circuit which realizes the second-order band-pass filter is the multiple-feedback network [21] shown in Fig. 4.4. Analysis shows that it realizes Eq. (4.1) for the values

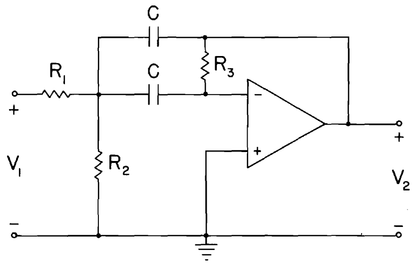

Fig. 4.4. A multiple-feedback second-order band-pass filter.

$$B = \frac{2}{R_3 C}$$
$$\omega_0^2 = \frac{1}{R_3 C^2}\left(\frac{1}{R_1} + \frac{1}{R_2}\right) \tag{4.4}$$

The constant K in Eq. (4.1) is given by $-1/R_1C$, and hence the circuit yields an inverting gain (negative) with magnitude $R_3/2R_1$. This may be converted to a noninverting gain, if one wishes, by cascading Fig. 4.4 with an inverting amplifier.

For high Q, the network of Fig. 4.4 has a wide spread of element values and large Q sensitivities. For this reason it should probably be restricted to values of $Q \leq 10$. The network has the nice feature that one may specify f_0, Q, and the gain. Practical values of the capacitances and resistances may be obtained using the procedure described in the summary at the end of the chapter.

As an example, let $f_0 = 1000$ Hz, $Q = 10$, and gain $= 10$. From Fig. 4.11*b*, we have a K parameter of 10, and from Fig. 4.31, we have $R_1 = 15.9$ kΩ, $R_2 = 840$ Ω, $R_3 = 318$ kΩ, for a C of 0.01 μF. Using an SU536 op-amp and resistances of 16 kΩ, 820 Ω, and 330 kΩ respectively, we obtain the response shown in Fig. 4.5, having $f_0 = 1024$ Hz, $Q = 9.3$ ($B = 110$ Hz), and a gain of 8.8. The response is shown with a scale of 250 Hz/division.