and difference between each harmonic of the speech and 1123 Hz. Thus, the spectral component that was the fundamental of the speech sound is output at both 1023 Hz and 1223 Hz, the former second harmonic (originally at 200 Hz) appears at 923 Hz and 1323 Hz, and so on. The formerly harmonic speech now sounds inharmonic and may not be intelligible.

Ring modulation may be realized without oscillators just by multiplying two signals together. Thus, the multiplier shown in figure 4.17 is a general-purpose ring modulator. Two signals are often combined in this way for the purpose of frequency alteration. Suppose that two sine waves, with amplitudes $A_1$ and $A_2$ and frequencies $f_1$ and $f_2$, respectively, are multiplied together. The resulting spectrum will contain frequencies of $f_1 - f_2$ and $f_1 + f_2$, and the amplitude of each component will be $A_1 A_2 / 2$. Observe that if either signal has an amplitude of 0, there will be no output from the modulator. Composers such as Jean-Claude Risset (see section 4.12) and James Dashow have used this form of ring modulation for the creation of chordal structures.

The multiplication of two complex sounds produces a spectrum containing frequencies that are the sum and difference between the frequencies of each component in the