6.541J Handout   2/12/04

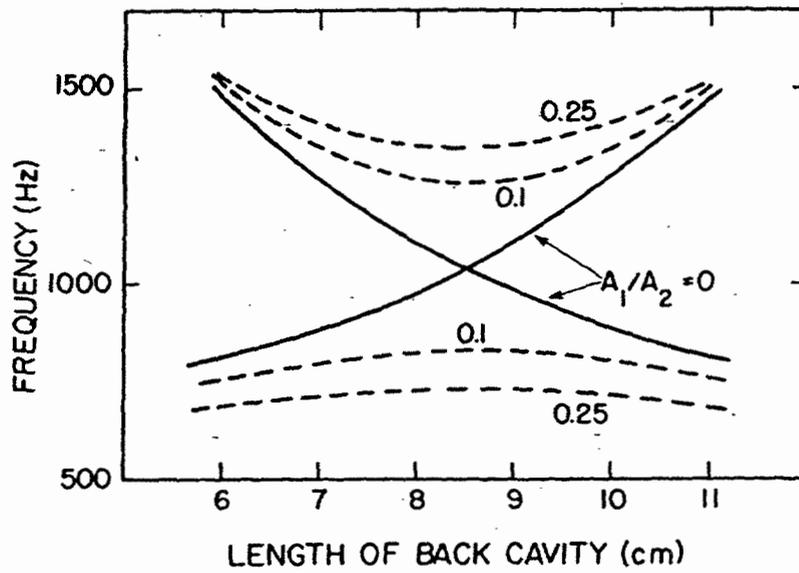**Figure 3.13** Two-tube configuration used to illustrate coupling of resonators.

LENGTH OF BACK CAVITY (cm)

Figure 3.14 First two natural frequencies of the two-tube resonator in figure 3.13 as a function of the back-cavity length ℓ_1, for various area ratios A_1/A_2. Area ratio $A_1/A_2 = 0$ corresponds to no acoustic coupling between the tubes. The total length $\ell_1 + \ell_2$ is fixed at 17 cm.
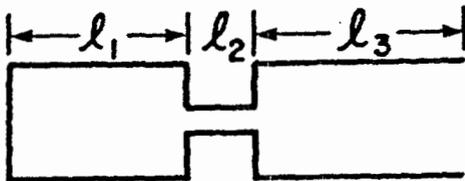

Figure 3.15 Uniform tube with a narrow constriction, used to approximate area functions for consonants.
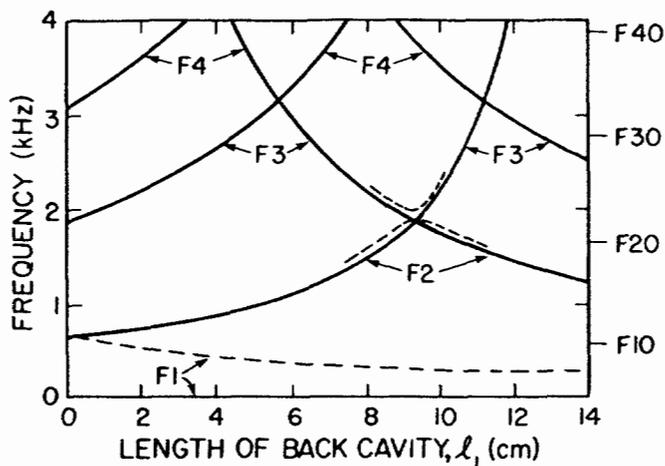
Figure 3.16 Relations between natural frequencies and the position of the constriction for the configuration shown in figure 3.15. The overall length of the tube is 16 cm and the length of the constriction is 2 cm. The lines sloping up to the right represent the resonances of the front cavity (anterior to the constriction); the lines sloping down to the right represent the resonances of the back cavity. The solid lines are the resonances if there is no coupling between front and back cavities. The dashed lines near the point of coincidence of two resonances at $\ell_1 = 9.3$ cm illustrate the shift in the resonant frequencies for the case where there is a small amount of coupling between front and back cavities. When the area of the constriction is very small, $F1 = 0$ as shown. When the constriction is larger, $F1$ increases as shown by the dashed line. The resonances of a 16-cm tube with no constriction are shown by the labeled marks at the right. The curves are labeled with the appropriate formant numbers.
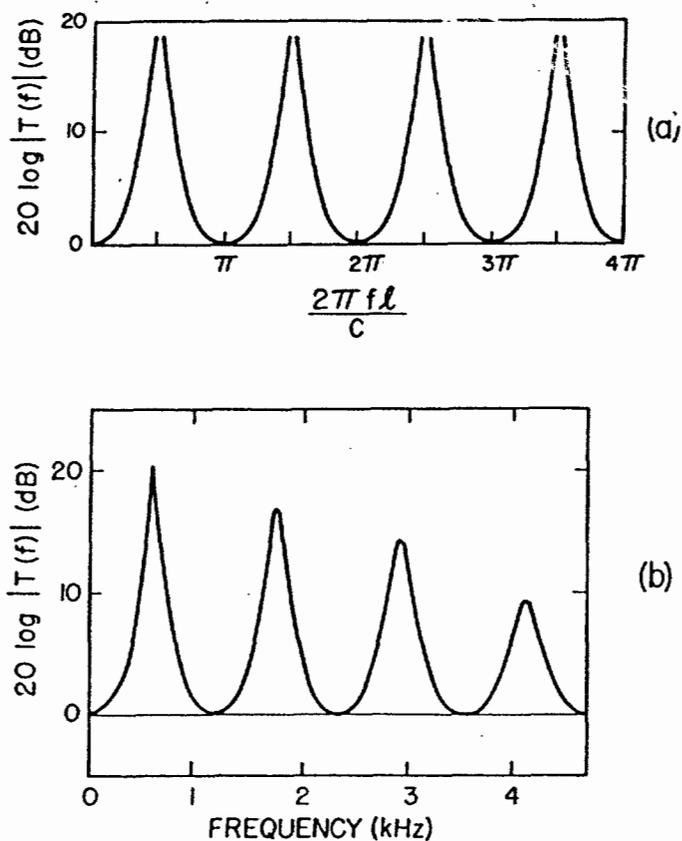

Figure 3.31 (a) Plot of magnitude of transfer function $T(f) = U_o/U_s$, expressed in decibels for an ideal uniform, lossless acoustic tube, shown in figure 3.8. (b) Magnitude of transfer function $T(f)$ for an ideal uniform tube of length 15 cm with losses similar to those occurring in the vocal tract.