A Demonstration Condenser Microphone
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Professional studio recording typically employs large diaphragm condenser microphones for their ability to accurately translate an acoustic pressure wave into a potential. Although the engineering involved in such a microphone is elegant and results in a costly product, the underlying principle is simply that a change in capacitance will result in a corresponding change in voltage.

Capacitance is defined as

\[ C = \frac{q}{V} \]

where \( C \) is capacitance, \( q \) is charge on the plates, and \( V \) is the potential measured across the plates. For a simple parallel plate capacitor,

\[ C = \frac{\varepsilon_0 \kappa A}{d} \]

where \( A \) is the area of the plates and \( d \) is the distance between plates. \( \varepsilon_0 \) and \( \kappa \) are the permittivity of free space and dielectric constant, respectively. For a constant charge, rearranging these equations results in

\[ V = \frac{qd}{\varepsilon_0 \kappa A} \]

where the voltage across the plates is directly proportional to the plate separation. Therefore, if a constant charge can be placed on the plates, and the plate separation can respond to a pressure wave, that change in separation should result in a change in potential that can be amplified. A demonstration of this phenomenon can be made with aluminum foil, a sheet of acetate and an embroidery hoop.

Begin by trapping a sheet of aluminum foil between embroidery hoops. Try to make the foil as smooth as possible. This will be the top element of the microphone. Place a second sheet of foil on an insulated surface and upon that, tape down a sheet of acetate. Both of these items should be larger than the embroidery hoop (fig. 1). The acetate will become the polarized element that will induce a charge on the foil. Tribocharging the acetate with fur yields acceptable results, although much better performance can be obtained if the acetate is charged with a high voltage power supply (see video http://goo.gl/l7nkI). Support the top element over the acetate with 1 to 2 mm spacers. The top element’s foil must be in close proximity to the acetate and be able to flex in response to the sound pressure wave.

Once the setup is complete, connect the lower foil sheet and the foil in the top element to an oscilloscope or microphone amplifier; the voltage output should respond to sound.

fig. 1 The assembled microphone elements. Note that the acetate has been tinted for illustration purposes.