Microphone Taxonomy
b.r.koball – 30 March 2020

Transducer Technology

There are two common types of transducer technology used in microphones: dynamic and condenser (there are a few less common transducers which I'll ignore).

Dynamic mics generally use a diaphragm (flexible membrane) attached to a coil of wire moving in a magnetic field. The sound pressure waves vibrate the diaphragm, generating a variable voltage on the coil (ribbon mics are a special case of dynamic mic; a thin ribbon of conductor suspended in a magnetic field).

Condenser mics also use a flexible diaphragm, but here the diaphragm is conductive and forms one plate of a capacitor (an electronic component consisting of two conductive plates separated by an insulator, in this case air) with the other fixed plate mounted very close to the diaphragm. Internal circuitry applies a polarizing voltage to across the two plates and when the sound pressure waves impinge on the diaphragm a signal is generated as the flexible diaphragm moves closer to and further away from the fixed plate. Since this signal is very weak, condenser mics almost always have internal circuitry to boost it. (NB. "condenser" is an archaic name for a capacitor).

Because condenser mic diaphragms are much lower mass than dynamic mic diaphragms, condenser mics usually have a much wider frequency response. And because they usually need electronic circuitry to polarize the plate and to boost the signal, condensor mics are usually more expensive that dynamic mics.

Polar Pattern

A microphone's "polar pattern" (sensitivity to the direction from which the sound arrives at the mic) is determined by the physical construction of the mic. Either transducer technology (dynamic or condenser) can be configured to yield an omnidirectional or a unidirectional polar pattern.

Omnidirectional mics fall in a class called pressure microphones; they respond strictly to the sound pressure waves impinging on the front of the mic diaphragm. Ideally they respond equally to sound pressure waves from any direction but in practice most omni mics do exhibit some directionality as the sound frequency increases, mainly because of interference cancellation near the diaphragm.

Unidirectional mics are a class of mics called pressure gradient mics; they respond to the difference in sound pressure (i.e., the pressure gradient) at two locations in space, usually the front of the mic diaphragm and the rear of the diaphragm. How the physical paths to the front of diaphragm and the rear of the diaphragm are configured determines the mic's directional response (e.g., waves from the rear cancel waves from the front). There are several varieties of polar patterns in unidirectional mics (e.g.,wide cardioid, cardioid, hyper-cardoid, and super-cardoid) named for mathematical functions describing the shape of the polar pattern. Some high-end condenser mics have switchable polar patterns.

There is also a figure-8 pattern where both sides of the diaphragm are open to the sound field.

Proximity Effect

One unique feature of most pressure gradient (i.e. unidirectional) mics is something call the “proximity effect.” Simply put, this is a variation in the frequency response of the mic depending on how close it is to the sound source; if the sound source is very close to the mic the low frequency response is increased. This is often used by performers as an effect, but it can also exacerbate “plosives” , i.e., popping or thumping when a low frequency sound pressure wave hits the mic. The RCA 44BX ribbon mic was famous for its proximity effect, with singers and announcers virtually “eating” the mic to get the resonant, bass-heavy sound. Omnidirectional mics do not have proximity effect and therefore are mostly immune to plosives. There are some unidirectional mics that have been designed to eliminate the proximity effect (e.g., ElectroVoice RE20).

Mic Address Direction

This refers to the orientation of the mic’s diaphragm and thus the direction of the 0 degree axis of the mic’s polar pattern. A common microphone design is a cylinder (similar shape with one dimension longer that the other). A cylindrical mic with a diaphragm perpendicular to the long axis of the mic is called an “end address” mic, i.e., you talk into the “end” of the mic. A cylindrical mic with a diaphragm parallel to the long axis of the mic is called an “side address” mic; A Shure SM57 is an end address mic; a Neumann U87 is a side address mic.