# Additional Information

## Baffles and Cabinets

A baffle is an older term referring to the type of box and air vents constructed around the speaker, while the cabinet refers to the box itself. The cabinet functions as a resonance cavity and alters the sound in different ways based upon which baffle design is used. There are four principle baffle designs: flat, open, closed and bass reflex.

A speaker that is not mounted at all is said to have a flat baffle, which provides no increase in quality.

An open baffle is one where the speaker is mounted in a box and has an open back. This provides some minor increase in sound quality, but much of the pressure exits through the wide back of the speaker instead of out through the front. This design was used in early speakers to provide air convection cooling for the components in the back which would frequently overheat.

The third type of baffle, the closed baffle, dramatically increases the sound quality because any enclosure possesses natural internal resonant frequencies. The closed baffle also keeps the sound focused towards the front. **Figure 1** and **figure 2** show a closed baffle speaker made from a cardboard box and a Styrofoam plate.

Figure 1

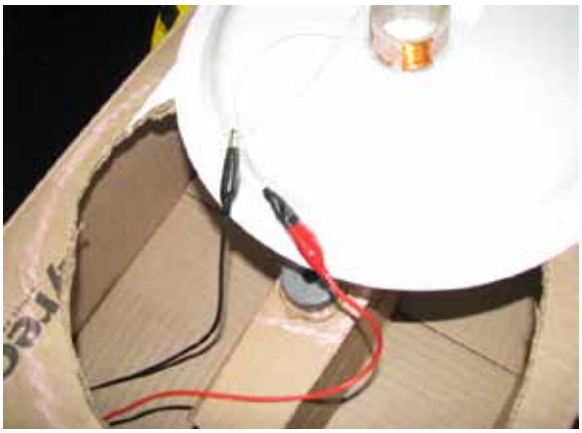

Figure 2

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The fourth kind of baffle is the bass reflex baffle. This specific baffle is used almost exclusively with low-frequency speakers for several different reasons. First, this type of baffle enhances the response of the driver (the magnet and coil) and can reduce the amount of distortion around the central range (in terms of pitch) of that speaker. This improves the quality of the sound. Second, it can extend the frequency response of the driver, allowing the speaker to produce deeper bass sounds than it could if mounted in a closed baffle.

Bass reflex baffles are quite useful, but there are major limitations preventing them from being used to mount drivers that produce higher-frequency sounds. Most importantly, resonant systems by nature cannot start and stop instantly. For there to be resonance to enhance the sound, it must echo very slightly before the augmented sound is heard. This is less of a problem in subwoofers because the lowest channel of music has the fewest distinct notes playing at any given moment. If the bass reflex baffle were applied to a tweeter, the echo would become noticeable and the music would sound slurred and distorted.

As a further activity, try to mount the Styrofoam plate speaker in a box using an open or closed baffle. If feeling extremely adventurous, try mounting the speaker in a bass-reflex sysem, but be warned: the bass reflex baffle uses constructive resonance to enhance the sound. This constructive resonance is achieved through incredibly precise calculations factoring in the volume of the box, the strength of the driver, the diameter of the diaphragm and several other pieces of data. To achieve this constructive resonance, the port must be very precisely placed. Try making different holes in different spots on different boxes and see which one produces the clearest bass with the speaker mounted. **Figure 3 and figure 4** indicate a rough design of a bass-reflex baffle with the port in the best location.

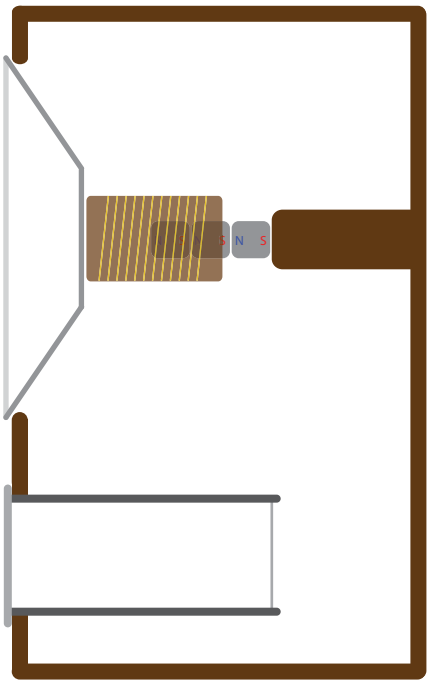


Figure 3

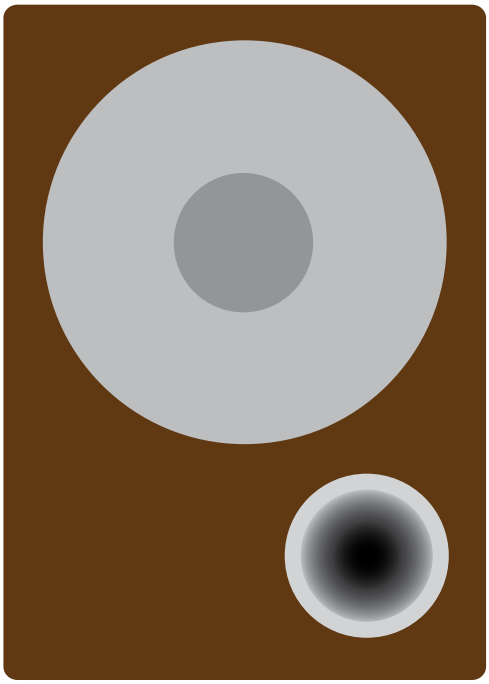

Figure 4

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## Sound

Sound travels through matter as a longitudinal wave. Longitudinal waves consist of areas where the wave is compressed together and other areas where it is expanded. Molecules of the medium carrying the sound do not travel with the wave. They move slightly in the direction of the sound wave to bump the neighbouring molecules, causing a chain reaction of short range motion before they return to their original positions.

## Ampère's Law

Loudspeakers work by using Ampère's Law, which describes the relationship between electrical currents and magnetic fields. An electric current flowing through a wire produces a magnetic field that circles the wire. When a wire carrying a current is coiled, creating a structure called a solenoid, a magnetic field is produced inside and aligns with the solenoid's axis (**Figure 5**). Therefore, a solenoid functions exactly like a bar magnet. If the direction of the current is reversed, the poles of the magnetic field are flipped. A permanent magnet is placed inside the solenoid. When the two magnetic fields are pointed in the same direction, they repel, pushing the coil and diaphragm away from the stationary magnet, and when the fields are pointed in opposite directions, they attract, pulling the coil and diaphragm towards the stationary magnet. Thus, by alternating the direction of the electrical current in the coil at a specific frequency, the diaphragm will vibrate at that frequency, creating a longitudinal wave in the air.

Ampère's Law not only describes the directional relationship between electrical currents and magnetic fields, it also gives us information about their magnitudes. The greater the current, the stronger the magnetic field. The strength of the solenoid's magnetic fields is directly proportional to the displacement of the Styrofoam plate. Therefore, the amplitude of the longitudinal sound wave is controlled by the strength of the current flowing into the coil.

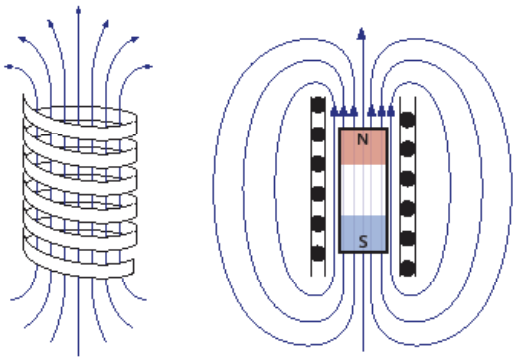


Figure 5. (left) Magnetic field alignment inside the coil of a speaker. (right) Cross-section showing magnet in field.