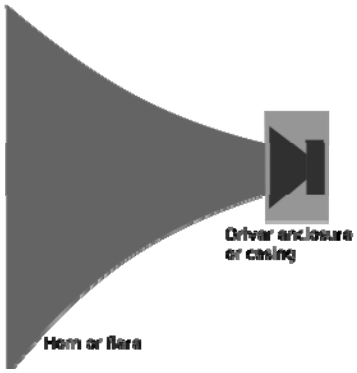
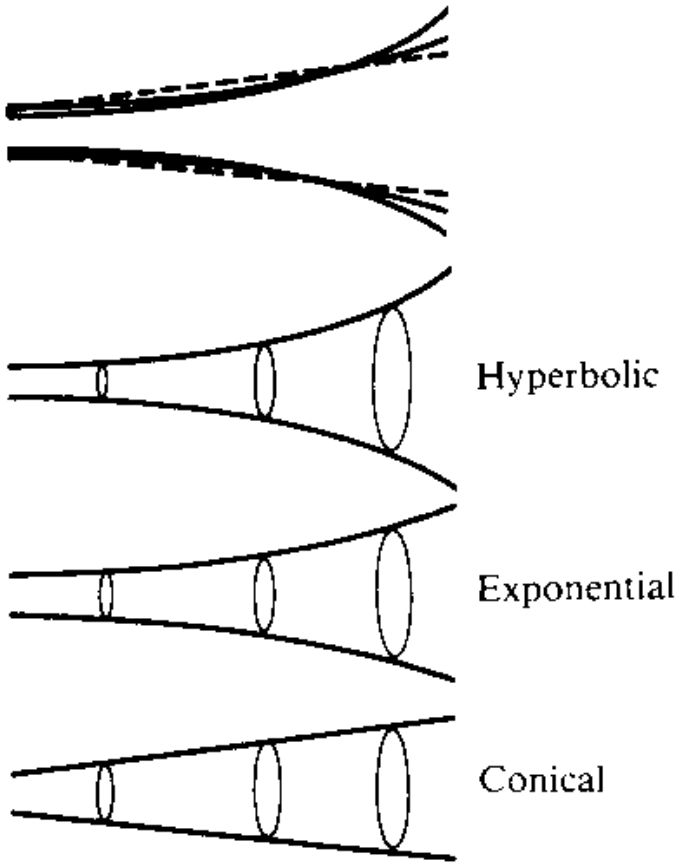
(c) Horn-type loudspeakers, as shown in the figure on the right, are intrinsically more efficient than cone-speakers in converting electrical energy into acoustical energy, because the design of the so-called compression driver for the horn, is simpler and more compact than that for a cone loudspeaker. The horn radiator acts as a sound transformer, adiabatically converting the high pressure sound field at the compression driver at the throat of the horn to that of low pressure at the bell of the horn.



Horns can also be designed to have greater directivity factors Q than cone-type loudspeakers, however they can also be designed to have constant directivity, independent of frequency. Their main disadvantage is size. For example, in order to achieive a smooth response down to $f \sim 100$ Hz, a horn needs to have a surface area of at least $\sim 8\ ft^2$. Thus, large horns are not often used for low frequencies; most of the time smaller ones are *e.g.* used in 2-, 3- or 4-way speaker systems, where *e.g.* a passive cross-over network is used to route the amplifier's signal in the low, medium and high frequency bands to the woofer, midrange horn and tweeter, respectively in a 3-way loudspeaker system.



Horns are named conical, exponential, hyperbolic, Bessel, *etc*. according to the way in which their area expands with distance from the compression driver, as shown in the figure on the right. Note that such horn shapes also appear in the classic wind instruments – *e.g.* trumpet, French horn, clarinet, saxophone, *etc*!

The two horn designs that are in common use today are the multi-cellular horn and the radial / sectoral horn. The radial/sectoral horn uniformly controls the sound projection angle, and has straight sides on two boundaries and curved sides on the other boundaries, as shown in figure (a) below. The multi-cellular horn consists of several exponential horns with axis passing through a common point, as shown in figure (b) below. At lower frequencies, the multi-cellular horn radiates as a single unit, whereas at higher frequencies, each cell of the multi-cellular horn radiates its own narrow beam, its angular width decreasing with increasing frequency.