VENTED LOUDSPEAKER ENCLOSURE CONSTRUCTION AND OPERATION

Vented or "bass-reflex" enclosures require special construction due to the large forces that can be developed by the drivers installed inside that act on them. This is particularly true of large subwoofer enclosures. It is important for cabinet builders to be aware of construction techniques that are peculiar to loudspeaker enclosures in order to build an extremely rigid and secure enclosure that will not detract from the potential of the drivers installed in it. Some background on how vented speaker enclosures work will help you understand what construction requirements are unique to this type of cabinet.

Vented loudspeaker enclosures have two primary functions: the separation of vibrations from the front and rear of the loudspeakers, and the containment of air so that the air can act as a resonating elastic medium inside the enclosure. Vented enclosure operation is analogous to the way a bottle will behave as a whistle. You will note when blowing air across the top of a bottleneck that a certain pitch is generated in the air resonating inside the bottle. This effect was among the subjects of a scholarly scientific paper published by German scientist Hermann Helmholtz in 1859, and has long since come to be known as the "helmholtz frequency" or the "helmholtz resonator." If you add water inside the bottle displacing air, (make the inside volume smaller) the pitch goes up. If you cut off part of the bottleneck (the duct) the pitch goes up. If you increase the diameter of the bottleneck the pitch goes up. If you pour out water or make the neck longer or decrease the neck's diameter, the pitch goes down. You can thus tune the bottle (enclosure) higher or lower by adjusting the ratio of vent volume and enclosure interior volume. The particular pitch obtained depends on the ratio of the the mass of the air in the enclosure and the mass of the air in the much smaller vent.

In a tuned system it's important to avoid air leaks, since the vent produces most of the sound at the frequency of resonance (helmholtz frequency) and the pressure inside the enclosure can be substantial. Air leaks in the enclosure's seams or walls can cause the tuning of the system to shift in frequency, producing other undesirable effects as well.

In a very large bottle--for example, several cubic feet--there is space on the wall or on the end of the bottle to install a loudspeaker. Instead of having to blow air across the duct to produce resonance, the resonance can be stimulated by excitation from the loudspeaker within. The duct can also be turned around and pointed inside the bottle and the bottle's outside surfaces can be flattened to form a conventional box-shaped loudspeaker enclosure. This, then, is the typical nature of a vented loudspeaker enclosure.

The material used for enclosure walls should be solid and dense and should be free of voids or warps. The ideal speaker enclosure would have no wall resonances at frequencies that fall within the frequency range of loudspeakers mounted in it. 25 mm (1") solid lead plate would make an excellent loudspeaker enclosure.

19 mm (3/4") Finland or Baltic birch type plywood is recommended where enclosures will be transported frequently, while high-density particle board (not chip board) can be used for permanently installed use. Corners must be strong and air tight and should not have any air leaks or openings. Glued joints should be properly filled with glue that will not crack under high stress or impact. If the integrity of the glue seal can't be determined, hot glue or RTV caulking should be used to

seal all seams. Bracing made of 2x4's or 75 mm (3") pieces of the birch ply should be liberally applied either inside or outside the cabinet, depending on whether the cabinet is to be permanently installed or portable. The braces should be liberally glued and screwed down on edge. Edge-wise drilled and countersunk holes through the braces can be used for #10-2 flathead wood screws to avoid the use of more expensive lag bolts. The glue on the braces accomplishes all the stiffening needed so screws may be removed once the glue is dry if there is any doubt about them coming loose from vibration. If butt-joint cabinet edges are used, care should be taken to apply cleats inside the corner edges to pull the edges tight with wood screws, assuring air-tight corners and edge joints.

Although the sound waves in the subwoofer's frequency range are very long, typically longer than 4.3 m (14') 1/4-wavelength increments in interior cabinet dimensions should be the size limit; in other words, if you will be using an 80 Hz crossover frequency, let 1.07 m (42") or about a 1/4-wavelength of the 80 Hz sound wave, be the maximum dimension of any single loudspeaker compartment within your enclosure. If enclosure volumes require larger sizes, then use an interior dividing wall to separate the volume into equal smaller compartments. Chances are if your enclosure is that large, you need the extra enclosure stiffening this will provide. Once the enclosure has been divided, each compartment should be treated as an individual enclosure in both bracing and porting. For example, a 1133 l (40 ft^3) enclosure designed to house four 2245H subwoofer drivers should be divided so that two compartments each contain two drivers. Each compartment is then braced and vented as if it were a separate 566 l (20 ft^3) enclosure.