Subject: Constant directivity tweeter horns and waveguides
Posted by Wayne Parham on Wed, 02 Apr 2008 06:11:53 GMT
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Quadratic throat waveguides have conical flares with throats gradually curved to match the entry angle. Oblate spheroidal (OS) waveguides do too. So do prolate spheroidal (PS) waveguides, for that matter. Right now, it seems like more people talk about OS waveguides than do about PS waveguides or quadratic throats. Personally, I find the PS horn to be more useful than OS because OS is axisymmetric but PS can be made to radiate other patterns. In other words, you can have a 90x40 PS horn. It's the same principle though - a conical flare with throat curved to match entry angle. Each of these are nice shapes, in my opinion.
Quadratic Throat Waveguide
Prolate Spheroidal WaveguideThese days, most people talking about the OS shape with regards to waveguides are talking about Geddes waveguides. He has a couple other features that are important to his implementation, one that is easily realized and one that is not. The most important part - which unfortunately is also the one hardest to implement - is making the phase plug match the horn flare. This one isn't done yet, because he hasn't begun to machine throats or phase plugs for compression drivers. That makes the second feature more important to him. He puts open cell foam in the horn to partially absorb sound.

The reason these extra features are important to Geddes is they cut down on what he calls (HOM) high-order modes. Most sound traveling down the horn progresses along its axis. Wavefront propogation is mostly this way, with waves of equal pressure across the horn's cross-section. If the sound source was a perfect radiating sphere of acoustically small dimensions and the throat was conical and acoustically small, I think all wavefront progogation through the horn would be this way. Or if it generated perfect planar waves and the exit was a tube, either way. But real-world horns are not driven by point sources that radiate perfectly spherical wavefronts or planar waves nor are all their features acoustically small. The diaphragm and throat is acoustically small at low frequencies, but becomes large at high frequencies. That's why phase plugs are used, to try and correct this to some degree. Because of these things, some sound can be skewed within the horn, reflecting off the walls rather than propogating along its axis. This is something Geddes has focused his attention on. That's why he adds the foam. The idea is sound traveling along the horn axis will travel through less absorbent foam than sound bouncing off the walls, so the reflected sounds will be absorbed more.

To be honest, I'm not sure how audible HOM are. In fact, I'm not sure they've been measured yet, although it does stand to reason that they exist. Geddes claims night and day difference between a horn treated with foam to reduce HOM and one without, but I didn't hear any qualitative difference. I do like the horn shape, mostly for its absense of discontinuities from abrupt flare changes and for its constant directivity. I could do without the foam.

When you bolt a 1" compression driver onto a quadratic, oblate spheroidal, prolate spheroidal or pure conical flare, you get reasonably constant directivity within a band determined by the dimensions of the waveguide. At some low frequency point, it will lose pattern control. At high frequency, the 1" entrance becomes acoustically large, so the features within the compression driver are shaping wavefront propogation, not the waveguide. The waveguide has basically no influence at high frequencies if the throat is a gradually expanding shape. So the pattern narrows drastically in the top octave, since the exit flare angle of most 1" compression drivers is 5° to 10°. This abrupt beaming boosts on-axis sound in the top octave (right where some drivers exhibit breakup peaks) and may be more reason to put absorbent foam in a waveguide like this than anything else.