CHENEY INNOVATIONS...

Dear Audiophile:

The technical information contained herein is intended to be the basis for a superwoofer system designed by the user to fit individual needs, circumstances and resources. Because of the numerous variables involved and the nature of this top of the line design, it is not feasible to present plans for one specific enclosure that would be applicable to every user's needs.

If constructed with no design compromises, this type of enclosure has greater dynamic range and lower distortion at maximum sound pressure level than any other type of enclosure. It should be noted that the size of this enclosure - as is the case with all enclosure designs - is one of the primary dictators of its efficiency, although even in its reduced versions results are certainly very impressive.

We at CHENEY INNOVATIONS are currently working on a computer-aided revolutionary design that will dramatically reduce the size of the megawoofer enclosure while still retaining its unparallelled efficiency. For having shown a sincere interest in state of the art acoustics, I will personally see to it that you have the first opportunity to gain access to this new development - BEFORE the public.

Thank you for your interest in CHENEY INNOVATIONS INDUSTRIES.

Sincerely,

Steven A. Cheney

Steven A. Cheney
President

Enc.

The megawoofer consists of a horn enclosure of the exponential type designed for use in the bass region of the audio spectrum. A horn is an enclosure designed with a flare such that its cross-sectional area increases from a small value at one end (designated the throat) to a larger value at the other end (designated the mouth). The horn is an acoustic transformer that allows maximum energy transfer from the cone of the driver to the room air. It is a boundry for the sound waves and ideally does not vibrate itself. Although many different types of flare rates exist (conical, hyperbolic, parabolic, etc.), the exponential flare is a good engineering compromise because it keeps pressure and distortion acceptably low yet has a cutoff frequency three times lower than the hyperbolic flare.

The horn accomplishes its task by presenting to the driver a very high but consistent impedance while transforming the high pressure, low velocity wave from the surface of the driver into a low pressure, high velocity wave of low impedance at the mouth of the horn. By horn-loading a driver, an increase in output of up to 15db can be achieved over a conventional acoustic suspension type enclosure. The significance of this becomes very apparent when the 15db change is converted to its corresponding power ratio (31.6:1). What this means is that the user of a properly designed and constructed horn-loaded driver can expect to achieve the same sound pressure level as a conventional speaker with only 1/30th of the input power. For example, an average speaker would have to be driven with approximately 3000 watts (if it could handle that much power) to sound as loud as the horn-loaded driver with only 100 watts of input power! From this, the advantage of horn-loading is clearly seen.

The exponential horn is defined by the equation:

$$\frac{A_x}{A_T} = e^{kx}$$

where,

- A_x is the cross-sectional area at distance x from the throat, in square inches,
- A_T is the cross-sectional area of the throat, in square inches,
- e is the natural logarithm base, 2.718,
- k is the flare constant of the horn, in inverse inches,
- x is the distance from the throat, in inches.

Following is a step by step procedure designed for obtaining the horn dimensions and related data in a logical and easily understandable format. From the data obtained during these calculations, a horn enclosure can be designed. An example is also presented for your convenience.

1) Decide upon the desired low frequency cutoff of the horn.

2) Calculate the wavelength of the chosen cutoff frequency:

$$w = \frac{V}{f_c}$$

where,
- w is the wavelength of the desired cutoff frequency,
- V is the velocity of sound in air, 13,500 inches per second,
- f_c is the chosen low frequency cutoff of the horn.

3) Calculate the corresponding flare constant:

$$k = \frac{4\pi f_c}{V}$$

where,
- k is the flare constant of the horn,
- π is the physical constant, 3.1416
- V is the velocity of sound in air,
- f_c is the low frequency cutoff.

The flare constant determines how long a horn with a given mouth-throat area ratio will be. It is directly dependent upon the cutoff frequency of the horn.

4) Calculate mouth area of the horn.

The consistent high impedance at the throat of the horn can be maintained only if the mouth of the horn is a minimum of 1/3 wavelength of the cutoff frequency in diameter. If this is not the case, the horn does not properly load the diaphragm at the throat to the air impedance at the mouth and loss of efficiency results. The cross-sectional area can be calculated as follows:

$$MA = \frac{\pi w^2}{36}$$

where,
- MA is the mouth area in square inches,
- w is the wavelength of the low frequency cutoff.

5) Determine throat area of the horn.

The throat area of the horn should be closely equal to the area of the drivers used. If this is not the case, energy is lost in the transfer of acoustic energy from the diaphragm to the horn.

Although a single 15 inch driver can be used as an acoustic source, we highly recommend the employment of two, side by side mounted, 15 inch drivers of top quality. This has a twofold benefit- 1) The acoustic energy potential obtainable from the horn is doubled, and 2) The employment of a larger throat effectively reduces the required length of the horn enclosure. With a rectangular horn matched to two 15 inch drivers, the throat area would be 28" by 13" or 364 square inches.

6) Calculate length of horn.

With the information calculated thus far and the use of the exponential horn defining equation given previously, the length of the horn can now be calculated as follows:

$$x = \frac{NL \frac{MA}{TA}}{k}$$

where,
- x is the horn length in inches,
- NL means to take the natural log of MA/TA,
- MA is the mouth area in square inches,
- TA is the throat area in square inches,
- k is the flare constant of the horn.

7) Calculate flare

A common and convenient method of specifying horn flare rates is to specify the distance along the axis over which the cross-sectional area doubles. This is most easily obtained from:

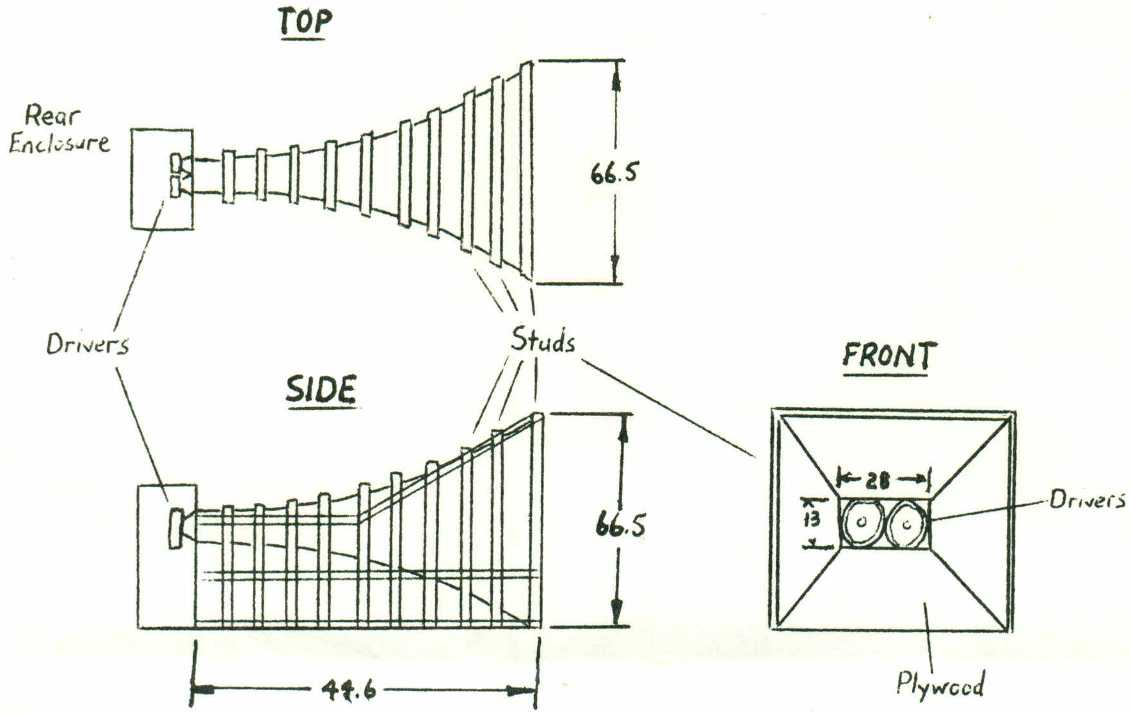
$$e^{ky} = 2 \quad \text{or} \quad y = \frac{.6932}{k}$$

where,
- y is the flare,
- k is the flare constant.

After having calculated the horn specifications from the above data, the actual dimensions of the horn can be plotted on paper. As long as the calculated areas remain the same, the actual dimensions can be any convenient measure and are often rectangular in shape to accomodate room dimensions.

The horn can be constructed of 2x2 studs and 1/4 inch plywood. Although many construction methods are feasible, one possibility is illustrated in the diagram on the next page.

The plywood is attached to a framework made up of studs and assembled to correspond to the dimensions calculated in the preceding data. The studs should be closely spaced to provide rigidity of the structure. This is to ensure that the horn does not vibrate. The rear air chamber should be of a volume recommended by the manufacturer of the drivers in use. A low crossover frequency - on the order of 300 Hz - should be chosen to minimize harmonic distortion in the horn. The dimensions presented are for a horn designed with a cutoff frequency of 60 Hz. This is sufficient in most cases, as there are very few recordings that contain information below this frequency. Most of what is perceived as deep bass is actually in the region from 60 Hz - 120 Hz.



Cutoff Frequency = 60Hz
Wavelength (w) = 225 inches
Flare Constant (k) = .0559
Mouth Area = 4417 square inches
Throat Area = 364 square inches
Length = 44.6 inches
Flare (y) = 12.4 inches

Horn dimensions at 12.4 inches from throat = 27×27 (728 in^2)
" " 24.8 " " = 38×38 (1456 in^2)
" " 37.2 " " = 54×54 (2912 in^2)
" " 44.6 " " = 66.5×66.5 (4417 in^2)