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Loudspeaker System Providing Improved Off Axis Frequency and Power Response to Achieve Superior Soundfield

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Abstract- Attempts to achieve a more natural sound field through complicated electronics means have generally been less than successful. The present invention is a new loudspeaker design that produces better music intelligibility by minimizing beaming and creating a wide dispersion of sound by extending the MTM configuration through improved uniform off-axis and power response.

Summary- At their best, conventional designs typically have horizontal and vertical beamwidth of about 60 degrees. However, even within this beamwidth we usually find that the off-axis frequency response does not have the same uniformity as the on-axis response and therefore has a non- constant power response. These response anomalies can create audible distortion, thereby corrupting the soundfield and reducing music intelligibility. Moreover, this occurrence is enhanced by asymmetrical and non-coincident response irregularities in conventional designs.

For many considerations, an ideal speaker would radiate spherical soundwaves, similar to a pulsating sphere, a sphere that would vary in size with amplitude -- a true point source. Many attempts to achieve this goal have failed either by the complexity of the design or complecations in driver array. Creating such a radiator requires the consideration of certain parameters, the major two being a frequency response that is nearly flat, and a uniform response with a constant power generating energy in all directions.

When sound waves hit a surface, the sound waves tend to propagate in random directions depending on the surface purity, smoothness, and the angle. The original and radiated waves would almost be identical if the integrity of such sound waves is maintained, such as when light is reflected from a mirror.

Objectives

The present configuration is a new approach to obtaining wide dispersion in both vertical and horizontal planes across the full frequency bandwidth from at least 200 Hz to 20 KHz uniformly as a function of frequency. This design achieves a natural sound field and enhanced music intelligibility with instrument articulation. Due to their limited off-axis and drooping in the off-axis power response at high frequencies, conventional front firing speakers cannot sonically recreate the sound fields of musical instruments that propagate sound in all directions.

A true omni directional speaker causes us to hear sound in all axial planes, greatly improving the average summed response. The cue for instrument localization seems to be present and intact when

the angular dispersion pattern and power response in all directions are identical, or at least similar. The spatial characteristic and ambient sound field of the concert hall and recorded reverbs gives the

perception of live sound coming from the speakers. Phantom images become vivid and transparent, similar to a live performance. In contrast, the total average response of forward firing speakers is further polluted by the off-axis anomalies with room interaction.

Technology

The new design essentially takes an MTM configuration a step further to achieve the above objectives by a unique driver topology and design approach. This is done by tilting an MTM's two midranges or two full range radiators about 90 degrees to project sound waves toward one another. This results in an omni-directional radiation pattern radiating in phase to about 240 degrees. Additionally, for a smooth transition, a diffractive/ reflective object unique in geometry is placed medially between the two radiators to further smooth the off-axis response (Fig 1-1). Consequently it creates a configuration that has a more uniform frequency response without lobing. The radiation pattern is similar to a true point source (Fig 2-1, Fig 2-2) with a perfect symmetry and acoustic center.

The vertical listening window is enormously increased, and this way, the tweeter will no longer have to be at the ear level (Fig 3). Frequencies above the driver's physical dimension are no longer directional at any particular point; therefore, beaming is reduced due to the dispersion pattern.

In order to add flexibility to the design for various applications, such as directivity, a high frequency radiator can be placed between the two drivers. Measurements of such configuration have showed us that multi-lobing is virtually non-existent in vertical direction as a function of frequency. Constant power response is also maintained about the vertical axis due to its coincident configuration as well as in the horizontal axis. Combination of such configurations can be applied in line arrays for different applications. A vertical array of two or more drivers will beam energy in a series of vertical lobes, over a portion of the frequency band. The present configuration readily allows line arrays without such lobings. Poor power and frequency response in vertical off-axis adds distortion in the average axis response. In order to form and benefit from a line array, a stack of two, four, or eight can be configured in the vertical array without multi lobing (Fig 1-2). This has been pragmatic with conventional designs.

Manufacturing

Finally fabrication of such designs is possible with readily available drivers. For THX applications the vertical angle can be limited to a desirable angle. For rear surround sound speaker applications they can be substituted for dipoles due to their improved off-axis response in the vertical and horizontal planes.

Single Array and Line Array for Wide Dispersion

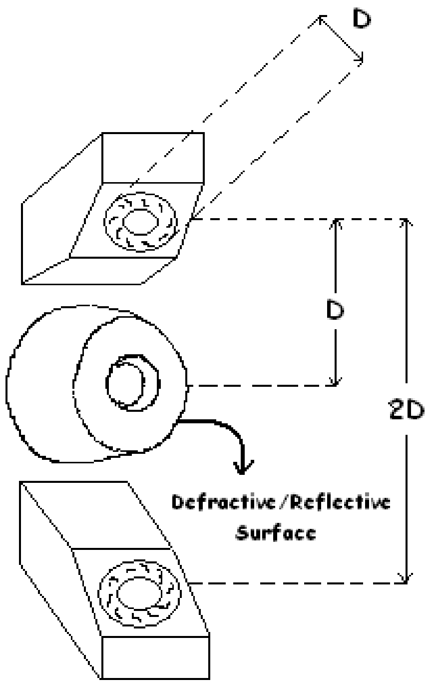

Fig 1-1

Wide Dispersion Array

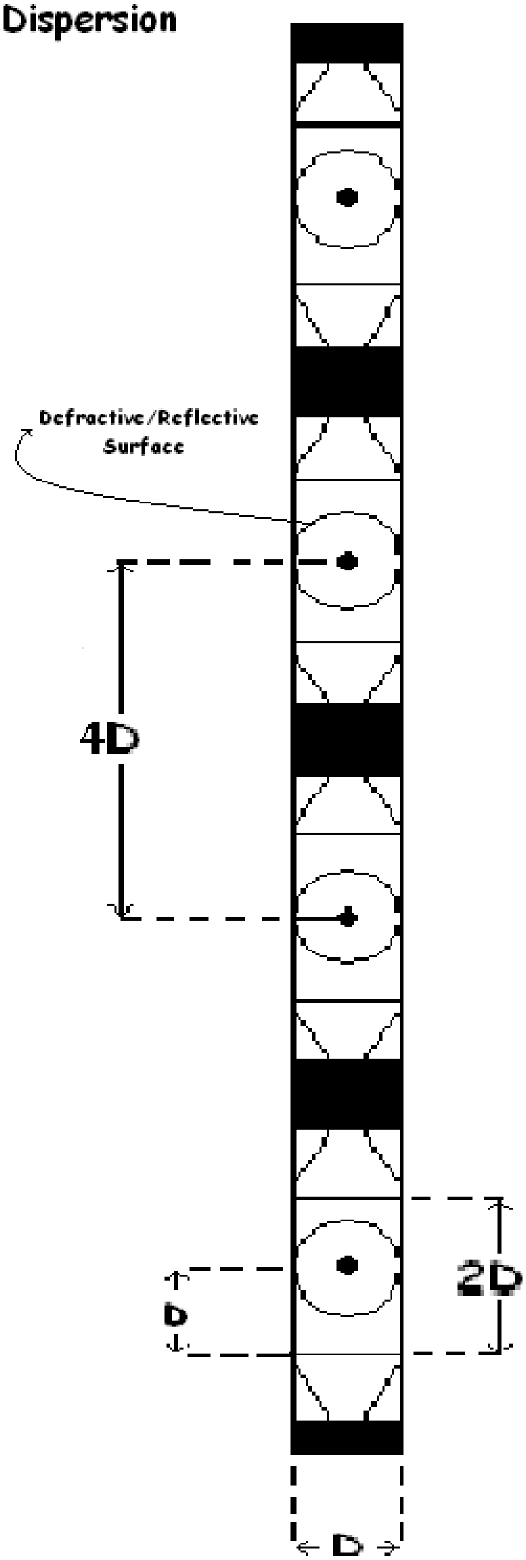

Fig 1-2

Line Array

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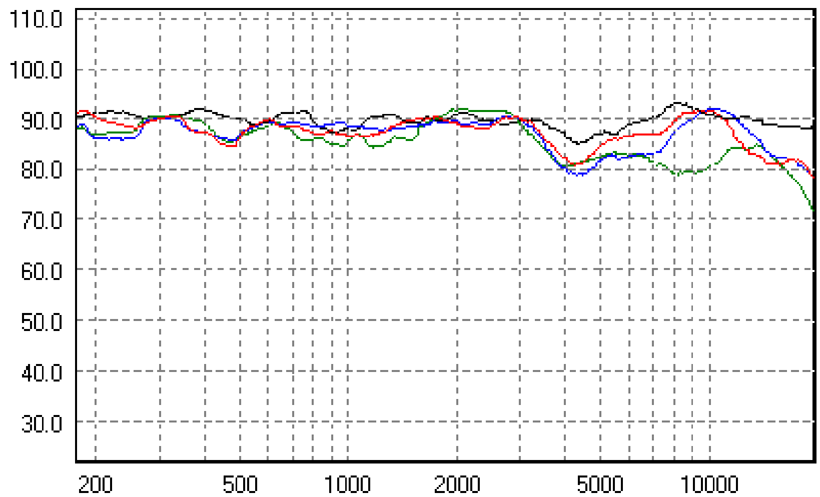

Fig 2-1

Horizontal Measurements- Black 0 deg, Red 45 deg, Blue 90 deg, Green 135 deg

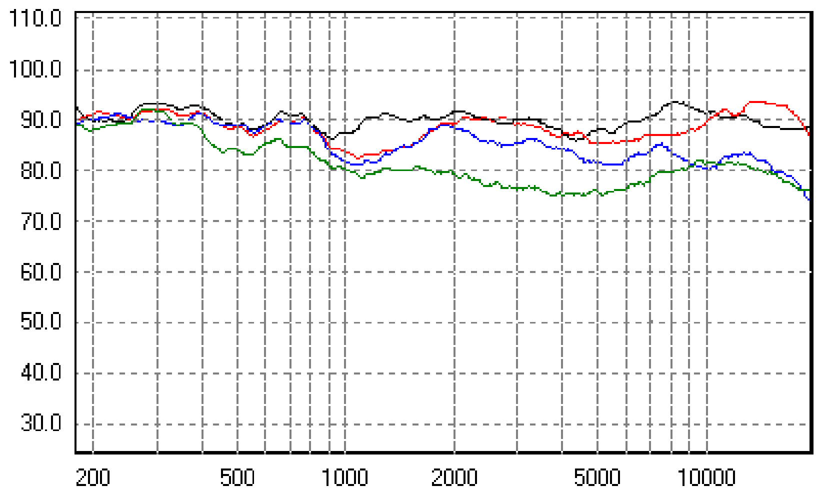

Fig 2-2

Vertical Measurements- Black 0 deg, Red 45 deg, Blue 90 deg, Green 135 deg

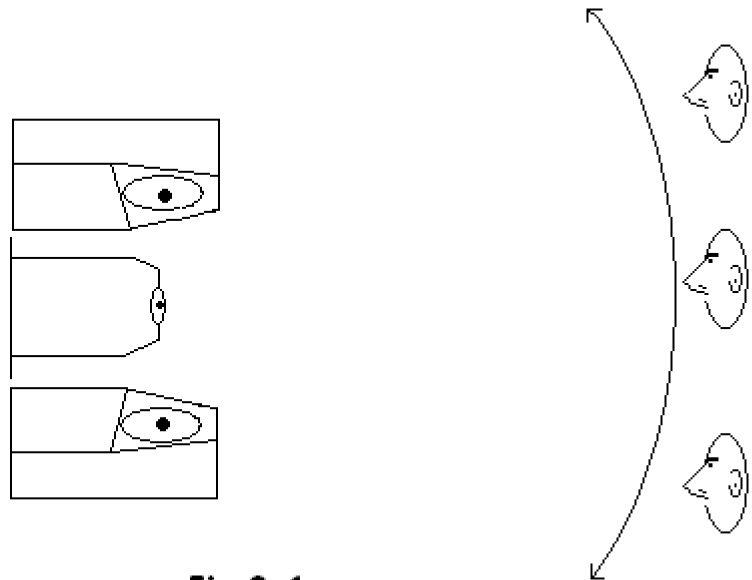

Fig 3-1

Vertical Symetry due to Coincident Array

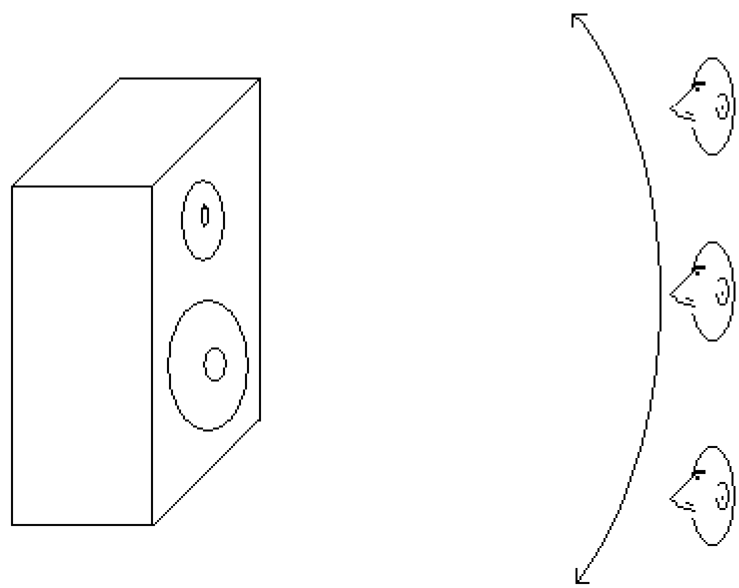

Fig 3-2

Asymetrical in the Vertical Plane

Fig 3