United States Patent [19]

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[11] 3,818,138

[45] June 18, 1974

[54] **BARREL SHAPED SPEAKER ENCLOSURE**

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[22] Filed: **July 26, 1971**

[21] Appl. No.: **166,057**

[52] **U.S. Cl.** .... **179/1 E,** 181/31 B

[51] **Int. Cl.** **H04r 1/28**

[58] **Field of Search.** 179/1 E, 16 A, 1 G, 100.12 A; 181/31 B, 31 R; 325/352

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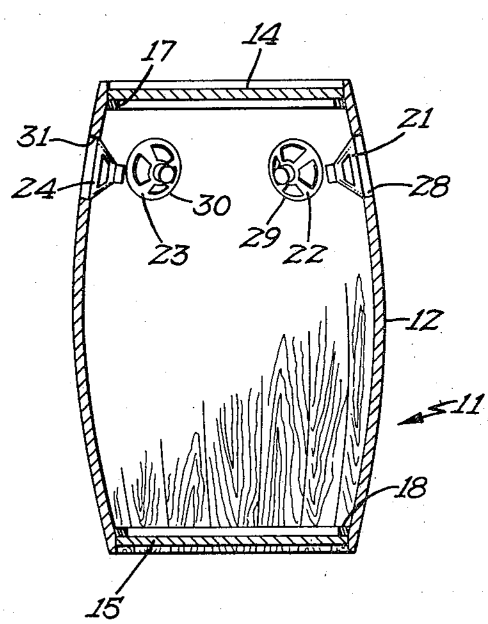
[57] **ABSTRACT**

Speaker enclosure having a general barrel-shaped profile containing a plurality of loudspeakers. Two embodiments are shown, one of which utilizes a plurality of full range loudspeakers, the second of which utilizes a plurality of high frequency loudspeakers in combination with a low frequency loudspeaker. The curved shape of the sidewall of the speaker enclosure provides substantial improvement in sound reproduction and, combined with the plurality of speakers, produces an omnidirectional sound source that projects breadth as well as depth to achieve true realism in phonetic reproduction. The speakers are so positioned in the barrel shaped enclosure that the sound emanating from the back of an individual speaker is reflected downwardly by the internal surface of the opposite sidewall to a point other than the back of the same speaker.

9 Claims, 5 Drawing Figures



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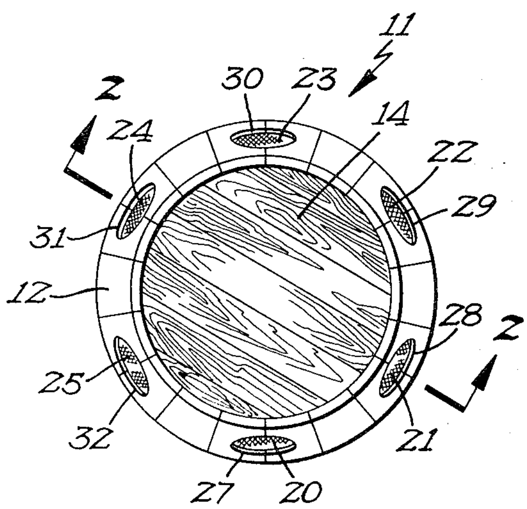

FIG 1

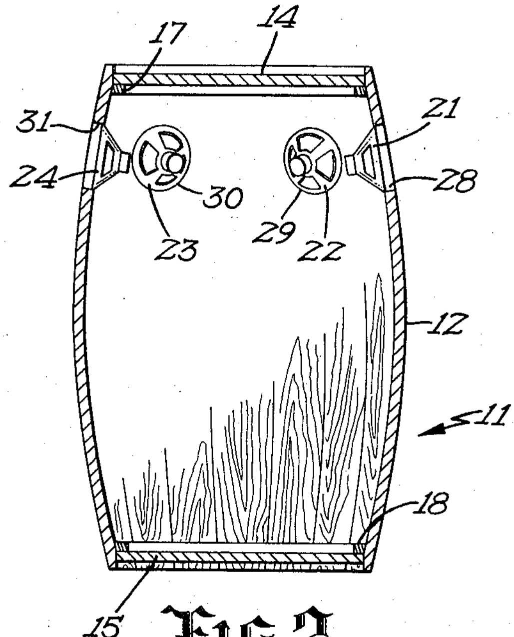

FIG 2

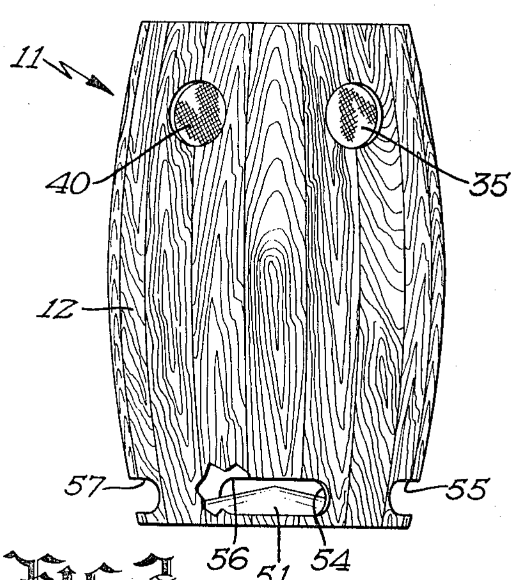

FIG 3

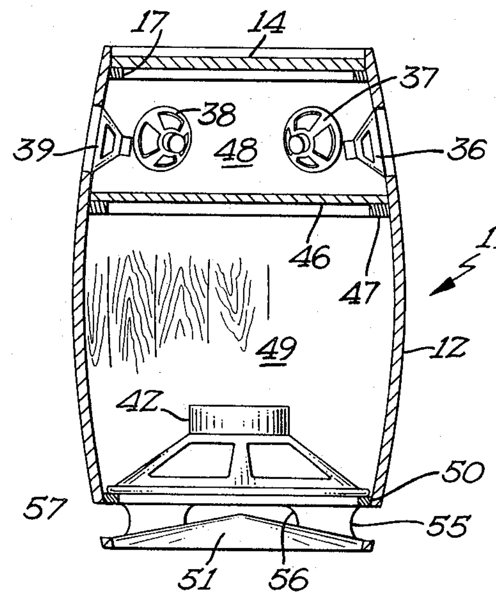

FIG 4

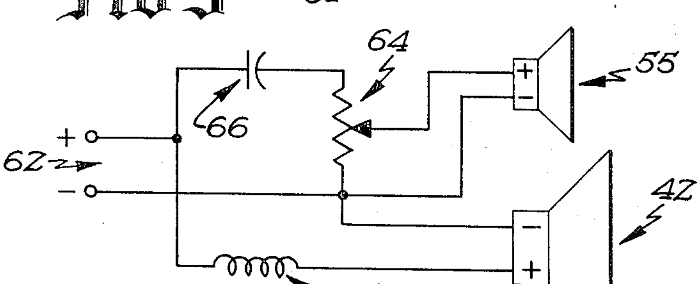

FIG 5

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BARREL SHAPED SPEAKER ENCLOSURE

BACKGROUND OF THE INVENTION

Speaker enclosures of the past have been generally constructed with rectangular planer sidewalls and have had a rectangular or hexagonal horizontal cross section. As the loudspeaker system contained therein moves to produce the sound, these structures are characterized by vibration and standing waves produced by the perpendicular planer walls as well as diffracted waves caused by sharp boundaries of the sidewalls of the enclosure which lessens the quality of the sound response. More recently, in an attempt to improve the sound response, speaker enclosures have assumed a generally cylindrical shape. However, as distinguished from the present invention, the generally cylindrical shape improves sound response in only one dimension. Since the cylindrical sidewall is still parallel to the loudspeaker face, standing waves continue to be produced and vibration continues to be caused by the generally perpendicular sidewall rescting to the movement of the speakers.

SUMMARY OF THE INVENTION

The present invention is concerned with a specific construction of a speaker enclosure having a generally circular cross section and a curvilinear sidewall. Such construction substantially increases the strength of a speaker enclosure and thereby reduces vibration. Since no planar sides are present or any structure which is perpendicular to the emitting source of the soundwaves, standing waves are also reduced. In addition, since the curvilinear design produces a geometrically smooth over-all shape, frequency response is improved due to the reduction in amplitude of diffracted waves.

By using a generally barrel-shape, rather than a spherical form, the speaker enclosure can be balanced and the speakers may be positioned at an optimum level and slightly tilted to effectively disburse the sound being reproduced. If the plurality of speakers are utilized, this allows true omnidirectional sound dispersion.

In addition, utilizing a plurality of speakers improves cone excursion, lowers the resonant frequency, and improves power capability and transient response.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a top view of my invention showing the equidistantly spaced speakers located in the upper half of the speaker enclosure;

FIG. 2 is a sectional front view of my invention taken along the line 2—2 of FIG. 1 showing the generally barrel-shaped profile and the internal positioning of the speaker elements;

FIG. 3 is a front view of a second embodiment of my invention showing similarly spaced high frequency speakers, and also showing apertures and a geometrically shaped member for dispersion of low frequency sound waves;

FIG. 4 is a sectional front view showing the chamber separation of high frequency and low frequency speakers as well as positioning of the speakers for optimum sound dispersion; and

FIG. 5 is a cross-over network which may be utilized with the second embodiment of my invention to effectively control the frequency response emitting from the speaker system.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A general understanding of my invention can be gained from FIGS. 1 and 2. The speaker enclosure **11** has a geometrically shaped sidewall **12** constructed of wood or any other suitable material. If constructed of wood, it may be shaped and glued together as commonly done in constructing a wooden barrel. Whatever material is utilized in the construction of the sidewall **12**, it is preferable that each piece extends the full length from the top to the bottom of the speaker enclosure **11**. As shown in the figures, the material should be shaped to produce a curvilinear, smooth sidewall having a general circular horizontal cross section with the greatest diameter approximately at the midpoint of the heighth of the enclosure and curving inwardly both upwardly and downwardly so that the smallest diameter cross section occurs at the top and the bottom of the speaker enclosure.

Conventional loudspeaker enclosures having planar sides will tend to vibrate. The vibrations are caused by a change in air pressure within the enclosure as the loudspeakers move. As the loudspeakers move inward, the enclosure moves outward, and as the loudspeaker moves outward, the enclosure moves inward. The enclosure vibration is, therefore, out of phase with the loudspeaker cone and thus, less speaker output can be delivered to a listener due to the power expended to vibrate the enclosure. In addition, the enclosure walls do not follow the exact movement of the cones, but instead create their own sound which is not present in the original material and represents distortion.

It has been found that the curvilinear sidewall **12** design represented in FIGS. 1 thru 4 has a much higher resistance to vibration. This is because when pressure or vacuum is applied, a portion of the forces are exerted along the surface of the material, and not perpendicular to the thickness, and therefore, a portion of the force exerted creates tension or compression in the sidewall adding strength and thereby reducing vibration.

The curvilinear sidewall **12** also reduces standing waves which are normally produced by the reflection of a plane wave on any surface which is normal to the direction of propagation of the sound source. Standing waves occur when a reflected wave meets the incident wave in phase and at an equal sound level. As is known in the art, the result is additive, causing a node or peak at the frequency of the incident wave. Since the shape of the present speaker enclosure **11** has no normal angles and no parallel sides, standing waves are substantially reduced. In addition, as is conventionally done, standing waves can be further reduced by the use of sound absorbing material (not shown), such as fiberglass insulation, which also provides damping for the loudspeakers.

Attached to the sidewall **12** at the top and bottom thereof should be a top **14** and a bottom **15**, which can be constructed out of any suitable material and shaped in a circular cross section to fit the ends of the sidewall **11**. As shown in FIG. 2, both the top and bottom may be secured to annular rings **17, 18** fixedly secured to the sidewall **12**. The top **14** and bottom **15**, being parallel, can produce standing waves. However, due to the relatively small surface area of the top **14** and bottom **15** relative to the over-all surface area of the speaker enclosure **11,** the results are negligible.

Finally, conventional loudspeaker responses may vary as much as **10**db due to the configuration of the speaker enclosure **11.** The detrimental effects of the sound diffraction is substantially reduced by eliminating the sharp boundaries of the enclosure **11** thereby reducing diffracted waves in amplitude. In addition, since all edges vary radially from the speaker diaphragm, this produces random phase relationships between the primary source and the diffracted sound waves, also reducing the effect thereof.

Since higher audible frequencies travel in a straight line and do not have the capability to bend around obstacles in their path, it is important to raise high frequency drivers to ear level and above the usual accumulation of furniture found in a home. Therefore, a plurality of speakers **20–25** should be mounted by any suitable method in the upper half of the speaker enclosure **12** in apertures **27–32** formed therein. It is preferable that the edges of the apertures **27–32** be perpendicular to the tangent of the sidewall **11** and therefore, due to the curvature of the sidewall **12,** the speakers **20–25** will be tilted slightly upward.

Preferably, loudspeakers **20–26** should be spaced at equidistant intervals along the circumference of the sidewall **12.** This increases stability of the direction of the emanating sound. Since direct sound is received a fraction of a second earlier than indirect sound, the omnidirectional speakers maintain directional clues while providing the listener with a broad sound source.

Further, utilizing the plurality of speakers **20–26** instead of a single speaker improves speaker capability and produces a superior transient response. Transient response of a speaker is inversely related to the moving mass of the speaker. To improve transient response, the moving mass of the speaker is reduced by decreasing the physical size of the cone. However, reduction in cone size decreases power output capability in low frequency response. Therefore, by utilizing a plurality of smaller speaker elements, power output capability is maintained and transient response is improved.

In addition, the resonant frequency of the speakers is lowered due to mutual coupling by connecting the loudspeakers in phase and in relatively close physical relationship. This increases the reactive and resistive component of the air loading at lower frequencies even though the radiation resistance of the loudspeaker, which is the air loading to which the loudspeaker can deliver acoustic power, is increased. The increased effect of the reactive and resistive components of air loading provides a substantial improvement in the low frequency response. Furthermore, cone excursion is reduced because for the same input power, the multiple loudspeakers will move less than one loudspeaker and due to the reduction of cone excursion, Doppler distortion is decreased or reduced to an inaudible level.

Since the major benefit obtained from this invention is the general shape of the speaker enclosure **11,** and more particularly, the sidewall **12,** two embodiments of the invention are shown, one in FIGS. **1** and **2** which utilizes multi-range speakers **20–25** circumferentially spaced about the upper half of the speaker enclosure **11;** and FIGS. **3** and **4,** which utilizes high frequency speakers **35–40,** conventionally referred to as tweeters, circumferentially spaced about the upper half of the speaker enclosure **11,** and a low frequency speaker **42,** conventionally referred to as a woofer, positioned in the lower half of the speaker enclosure.

By utilizing the full range speakers **25–30** as shown in FIGS. **1** and **2,** the need for cross-over networks to differentiate between high and low frequency signals are eliminated. When utilizing cross-over networks, problems may be present, primarily at the cross-over frequency. For example, when operating at the cross-over frequency, power capability is usually reduced to approximately one-half of the total available power. In addition, transient distortion is usually present at or near the cross-over frequency due to the sharp attenuation rate in the network. This is caused by the phase shift created by the components of the electrical cross-over network through which the signal passes. As is known, the phase shift becomes greater as the number of components is increased. In addition, some cross-overs utilize resonant networks which may be shock-excited at certain frequencies causing momentary oscillation or ringing after the original signal has been removed. Also, the increased number of components increases the time and expense in design for components, construction, and test, and increases the possibility of error and failure.

The second embodiment is shown in FIGS. **3, 4,** and **5** wherein high frequency speakers **35–40** are utilized along with a low frequency speaker **42.** The utilization of this combination of special purpose loudspeakers can create a greater degree of efficiency and sound reproduction by reducing intermodulation distortion and providing more reserve power handling capabilities. In addition, it permits adjustment of sound levels, thereby creating a more balanced sound output.

Intermodulation distortion occurs when a single vibrating loudspeaker attempts to produce a high frequency note while simultaneously producing a low frequency note. Any irregularity of the loudspeaker while attempting to produce a low frequency sound will influence the tonal quality of the high frequency sound. The isolation of the high frequency sounds to their own loudspeakers renders them mechanically unrestricted by low frequency sounds, thereby eliminating intermodulation distortion. To further effectuate this as far as air loading, a rigid diaphragm **46,** which may also be mounted on an annular ring **47,** should be inserted in the speaker enclosure **11** dividing the speaker enclosure **11** into two cahmbers, **48** and **49.**

Since low frequency sounds have a longer wave length, they do not have the propensity to form the narrow beam which characterizes high frequency sounds. Therefore, the low frequency speaker **42** may be positioned in the enclosure **11** directed downwardly and may be mounted in any suitable manner, such as on the annular ring **50** fixedly secured to the sidewall **12** as shown in FIG. 4. To assure 360° radial sound dispersion in an horizontal plane, a geometric member **51** should be utilized at the bottom of the speaker enclosure **11** and apertures **54–57** of any suitable shape should be formed around the circumference of the geometric member, to allow sound emmission to the surrounding environment. The geometric member can be of any suitable and preferred shape with its high point at the center of the low frequency speaker and its low point at the outer circumference of the speaker. Suitable members could be the cone, as shown in FIG. 4, an eliptical horn, etc.

A conventional cross-over network is shown in FIG. 5, which may be utilized with the present invention. Speakers 35–40, collectively shown as a single speaker 55, are connected in a series parallel arrangement to give an over-all nominal impedance of a single speaker utilized alone. The speakers 35–40 are serially connected to the input terminals 62 through a variable potentiometer 64 and capacitor 66. The capacitor 66 passes high frequency signals to the high frequency speakers and prevents low frequency signals. Low frequency signals are fed to the low frequency speaker from the input 62 through inductor 68 which passes low frequency signals to the speaker and prevents high frequency signals. Representative values of capacitance and inductance resistance are 4.2 microfarads, 0.28 millihenries, and 60 ohms, respectively. This will provide an input impedance of 8 ohms, a cross-over frequency of 350 Hz and an attenuation rate of 6db per octave.

Variable potentiometer 64 is a brilliance control which can be adjusted to compensate for irregularities in response attributable to the environment in which the speaker enclosure is utilized. In rooms containing rugs, drapes and soft chairs, etc., sound emmission will generally be dull and muted, which requires more brilliance. In a listening room containing hard floors, walls, ceilings, etc., it will generally be necessary to reduce the brilliance. In each of these situations, the sound responses from the woofer or low frequency speaker should be utilized as a reference sound level, and the brilliance control should be adjusted to vary the volume of the tweeters or high frequency section of the speaker system.

In general, while I have described two specific embodiments of my invention, it is to be understood that this is for the purposes of illustration only, and many variants can be made within the scope of my invention. For example, the top, bottom and the rigid diaphragm can be of curvilinear design to further reduce parallel sides and consequent effect of standing waves. It should also be obvious that a more highly specialized speaker network could be used including high frequency, low frequency and mid-range frequency loudspeakers.

I claim as my invention:

1. A speaker enclosure comprising:

a planar top;

a planar bottom below said top;

a geometrically barrel-shaped sidewall connected between said top and said bottom having a generally circular horizontal cross section with the greatest diameter at approximately the midpoint of the height of said enclosure and curving inwardly both upwardly and downwardly so that the smallest diameter cross section occurs where said sidewall joins said top and said bottom of said speaker enclosure and having an aperture formed therein disposed between the midpoint and the top of said speaker enclosure; and;

a speaker element having a longitudinal axis fixedly secured to the interior of said sidewall and directed to penetrate through the aperture formed therein so that the internal surface of the sidewall opposite the speaker which intercepts the longitudinal axis of the speaker is neither parallel to nor tangentially parallel to a plane perpendicular to the longitudinal axis of the speaker whereby sound emanating from the back of the speaker is reflected downwardly to a point other than the back of the speaker.

2. The speaker enclosure of claim 1 wherein the radius of curvature of each vertical portion of the sidewall extends beyond the area bounded by the vertical cross section.

3. The speaker enclosure of claim 1 wherein the sidewall has a plurality of apertures formed circumferentially therein and wherein a plurality of speaker elements having longitudinal axes are fixedly secured to the interior of the sidewall and directed to penetrate through the apertures formed therein so that the internal surface of the sidewall opposite each speaker which intercepts the longitudinal axis of each speaker is neither parallel to nor tangentially parallel to a plane perpendicular to the longitudinal axis of that speaker whereby sound emanating from the back of each speaker is reflected downwardly to points other than the back of the speaker.

4. The speaker enclosure of claim 3 wherein said speaker elements are multi-range speaker elements.

5. The speaker enclosure of claim 3 wherein said plurality of speaker elements are equidistantly spaced about the circumference of said sidewall.

6. The speaker enclosure of claim 3 wherein said plurality of speaker elements are all disposed circumferentially about said sidewall on the same horizontal plane.

7. The speaker enclosure of claim 3 further comprising a horizontal diaphragm dividing said speaker enclosure into two air-tight chambers and wherein said plurality of speaker elements are high frequency speaker elements and are located in the upper chamber and having at least one low frequency speaker disposed in said lower chamber.

8. The speaker enclosure of claim 7 wherein said low frequency speaker is directed downwardly and having means for dispersing said low frequency sound including apertures formed in the sidewall enclosing the lower chamber of said speaker enclosure; and a geometrically shaped member attached to said bottom having a highest point in alignment with the center of said low frequency speaker and sloping downwardly so that its lowest edge is at the circumferential edge of said geometric shaped member.

9. The speaker enclosure of claim 7 further comprising an electrical cross-over network connected with said plurality of high frequency speaker elements and said low frequency speaker element.

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