United States Patent [19]

Itoh

[11] **3,765,504**

[45] **Oct. 16, 1973**

[54] **SPEAKER APPARATUS**

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[52] **U.S. Cl.** ..... **181/31 B,** 181/31 A
[51] **Int. Cl.** **G10k 13/00,** H04r 1/28
[58] **Field of Search** ..... 181/31 A, 31 B, 31 R, 181/30

[56] **References Cited**

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Attorney—Richard C. Sughrue et al.

[57] **ABSTRACT**

A speaker apparatus has a cabinet and at least one speaker unit secured to the cabinet, and includes at least one board for reflecting sound irregularly and diffusively into a reproducing room from the speaker unit.

2 Claims, 7 Drawing Figures

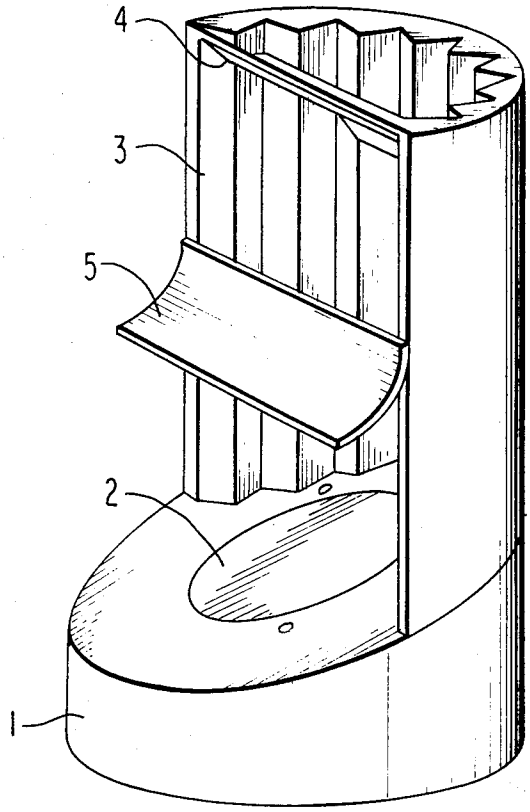


FIG. 1

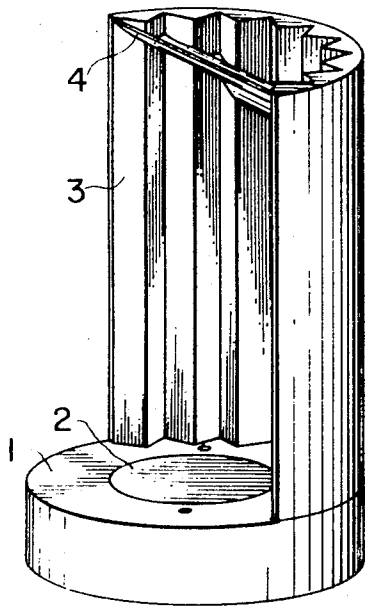


FIG. 2

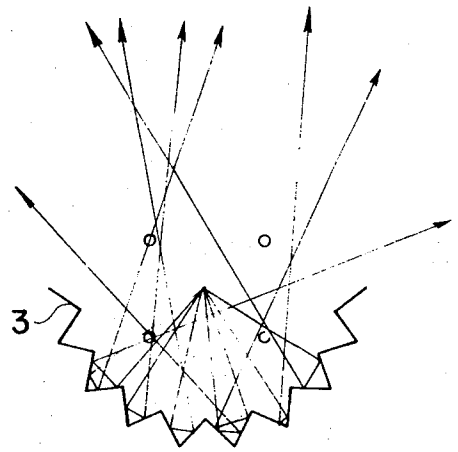


FIG. 3

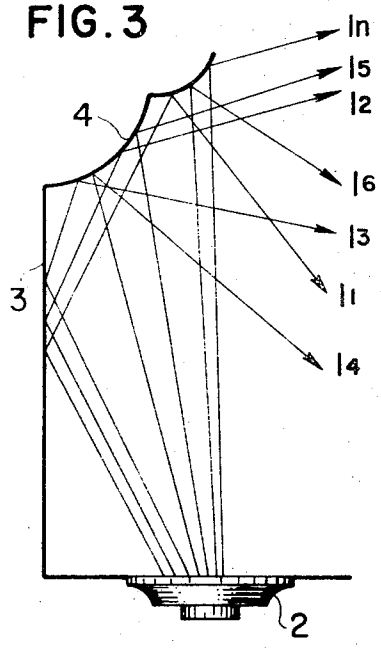


FIG. 4

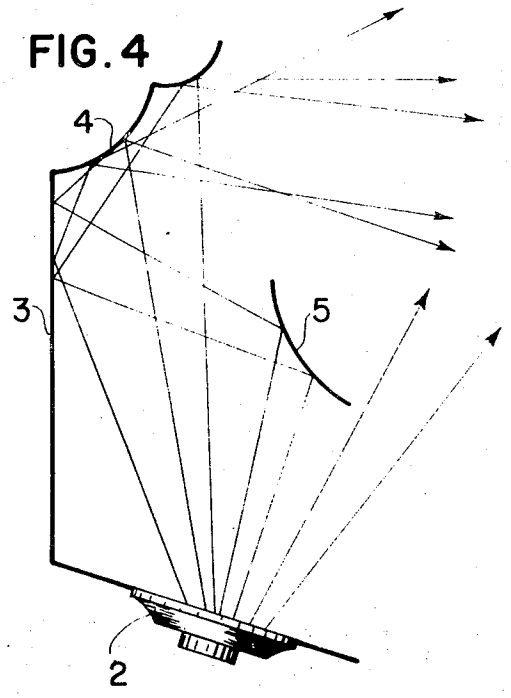


FIG. 5

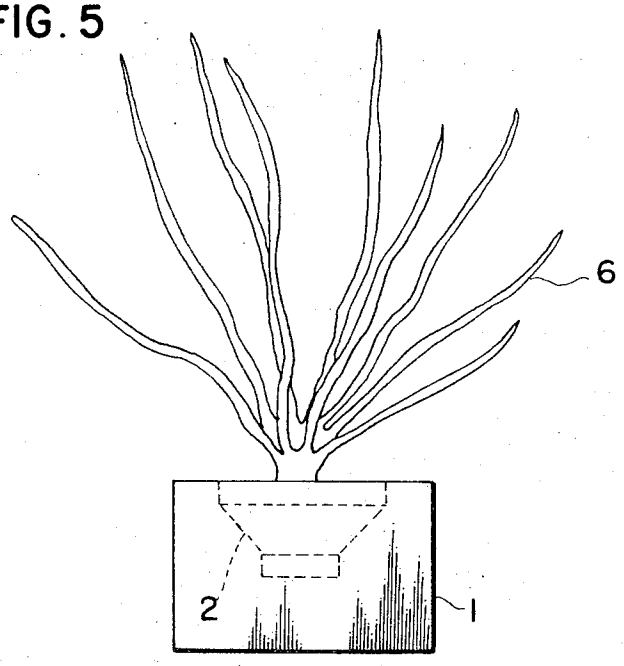


FIG. 6

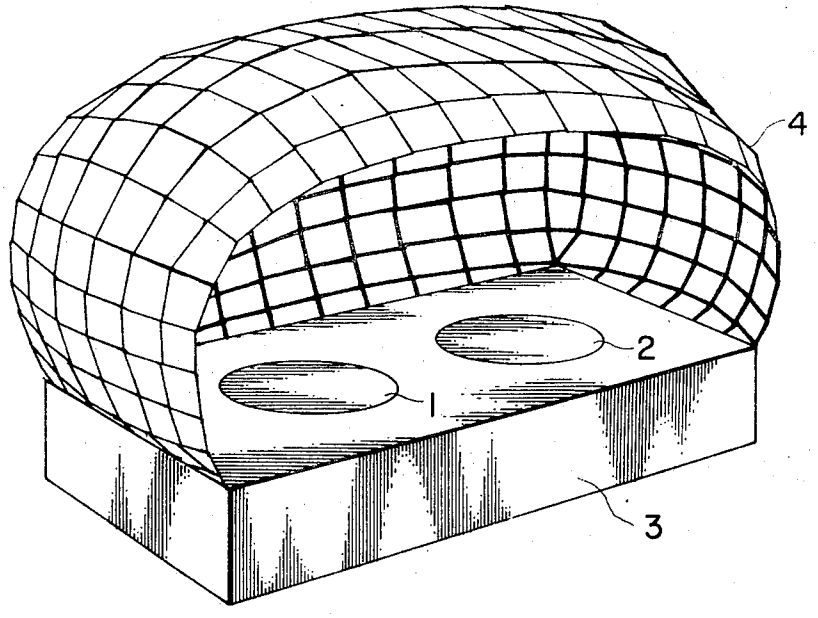
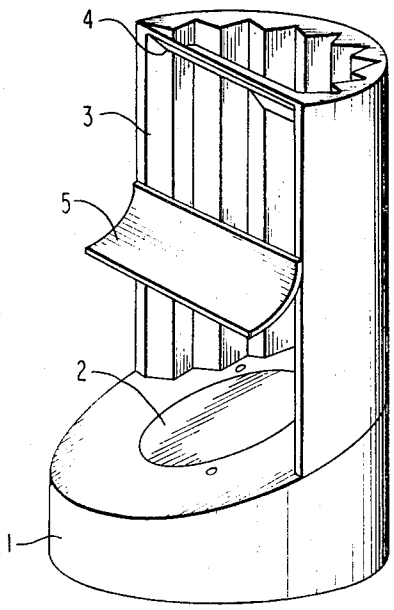


FIG.7



SPEAKER APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a speaker apparatus and, more particularly, to an irregular reflection and diffusion type speaker apparatus suitable for effective reproduction of a lifelike sound field.

2. Description of the Prior Art

The so-called lifelike sound field will be reproduced by a spatial combination of a single direct sound wave emitted from a sound source and multiple indirect sound waves derived therefrom. Listeners get a stereophonic effect by sensing mutually related direct and indirect sound waves through their left and right ears. Thus, in order to reproduce the lifelike sound field with a high degree of fidelity, it is necessary to provide an infinite number of sound transmission channels; this can scarcely be realized.

Hitherto, generally, the reproduction of sound in the form of a sound field is performed through utilization of sound reflection in a sound reproducing room; but the resultant reproduced sound field is short in terms of the indirect sound waves in comparison with a "live" sound field. Further, though a non-directional speaker is used to make effective use of sound reflection in the reproducing room, the overall sound effect is low in case the room has a decreased sound reflection efficiency. Moreover, there is the drawback that the aforementioned provision results only in a sound effect similar to that resulting from the use of a directional speaker because the direct sound wave going towards a listener is stronger than the indirect sound waves.

In the field of stereophonic reproduction, live sounds emitted from sound sources are picked up at two left and right locations in front of the sound sources and recorded in a recording medium. The recorded sounds are reproduced through left and right speakers positioned in the sound reproducing room so that the reproduced sound waves are spatially mixed to give listeners "a sense of presence." Thus, the aforementioned conventional systems are liable to suffer the influence of the acoustic efficiency of the reproducing room because the sound waves are spatially combined in the room.

Accordingly, it is an object of the instant invention to provide a speaker apparatus suitable for reproduction of a lifelike sound field.

It is a more specific object of the instant invention to provide an irregular reflection and diffusion type speaker apparatus which emits a combination of direct sound waves and reflective indirect sound waves to produce a lifelike sound field.

SUMMARY OF THE INVENTION

According to the instant invention, there is provided an irregular reflection and diffusion type speaker apparatus constructed so that sound signals emitted from one or more speaker units are reflected by at least one sound reflecting board adapted to reflect sounds irregularly and diffusively thereby resulting in an effect similar to the effect obtainable when a number of speaker units are arranged in the room which emit a number of time-different or phase-different sound signals or their combination with the result of generation of a sound field which gives listeners the sense of presence in the "live" sound field.

Further, the instant invention provides a single speaker apparatus for stereophonic reproduction which is constructed so that sound waves emitted from left and right speaker units in a single cabinet are mixed spatially through irregular reflection to generate the lifelike sound field which will spread in the reproducing room. The speaker apparatus is less susceptible of influence of the sound reflection efficiency of the reproducing room with respect to its generating sound field.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of an embodiment of an irregular reflection and diffusion type speaker apparatus according to the invention.

FIG. 2 illustrates the state of reflection of sound waves in a horizontal plane relating to the embodiment shown in FIG. 1.

FIG. 3 illustrates the state of reflection of sound waves in a vertical plane relating to the embodiment shown in FIG. 1.

FIGS. 4 and 5 are elevational side views of other embodiments of the speaker apparatus according to the invention.

FIG. 6 is a perspective view of a still another embodiment of the speaker apparatus according to the invention adapted for reproduction of stereo-sound.

FIG. 7 is a perspective view of the embodiment shown in FIG. 4.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIGS. 1 through 3, a cylindrical cabinet 1 with a bottom board, contains a speaker unit 2 secured thereto facing upward. The cabinet has sound reflecting boards 3 and 4 mounted on its upper side and above the speaker unit 2 to reflect sound waves irregularly and diffusively.

The reflecting board 3 is, for example, of the substantially semi-cylindrical type in which the interior sound wave reflecting surface is formed of a plurality of planar surfaces, with each planar surface forming an angle with an adjacent surface of less than 180°, and generally conforming to the semi-cylindrical configuration runs in a zigzag fashion, and is secured to the upper peripheral portion of the cabinet 1. Whereas, the reflecting board 4 has, for example, curved surface portions facing downward and is secured to the upper end portion of the reflecting board 3 obliquely with respect to the vertical line. Thus, the sound wave signals in space emitted from the speaker unit 2 travel as shown in FIG. 2 in a horizontal plane and as shown in FIG. 3 in a vertical plane.

In FIG. 3, reference characters l_1 through l_n designate the courses of propagation of various sound wave signals emitted from the speaker unit 2 in various directions. The sound waves emitted from the speaker unit 2 are reflected irregularly by the reflecting boards 3 and 4 so as to have random propagation directions to thereby transform into "multi-order" signals having different wave surfaces.

Further, since the resultant reflected signals take different propagation courses $l_1 \sim l_n$, they interfere with one another with differences in time and/or phase therebetween to generate interference fringes due to existence of a number of time-different sound signals or phase-different signals or the combination thereof. The

produced interference fringes spread in the sound reproducing room.

Therefore, it will be apprecaited that the reflection effect of sound reproduced in the room by the apparatus of the instant invention is remarkably high in comparision with the result of use of a conventional single-directional speaker, and the reproduced sound field in the listening room has the "sense of presence" similar to the live sound field.

Though there has been described one preferred embodiment of the instant invention, it should not be limited only to the foregoing construction. The sound reflecting boards can be embodied in any forms which can provide irregular reflection of sound, and the speaker unit can be disposed in the cabinet with an angle of inclination so as to enhance the effect of sound reflection.

In FIG. **4**, showing another embodiment of the instant invention, the speaker unit **2** is preferably disposed with an inclination to emit direct sound wave signals, and an additional reflecting board **5** is positioned in front of the reflecting board **3** above the speaker unit **2** to increase the effect of sound reflection of the apparatus.

In FIG. **5**, showing still another embodiment, a body **6** in the form of a plurality of long, thin, irregularly shaped projections or extensions, is disposed above the speaker unit **2** as a sound reflecting means to reflect sound irregularly and diffusively.

In FIG. **6** showing one embodiment of the speaker apparatus adapted to reproduce stereophonic sound, a cabinet **3** contains a left speaker **1** and a right speaker **2** facing upward. The left and right speakers are supplied, respectively, with a left and a right channel signals which were previously recorded on a recording medium after pick-up at two spaced left and right locations in front of the live sound field.

The cabinet **3** has a board **4** of the dome type disposed on its upper side to reflect sound irregularly. The front of the irregular reflection board **4** is open to define a sound wave emission port.

According to the sturcture of FIG. **6**, the sound waves emitted from the left and right speakers **1** and **2** reach the dome-shaped irregular reflection board **4** and are thereby reflected irregularly, then they propagate randomly to become a number of time-different or phase-different signals or their combination having mutually different wave surfaces. The resultant sound signals are mixed spatially to generate a stereophonic sound field which will then spread into the sound reproducing room through the sound emission port.

It should be noted that the irregular reflection board **4** is not necessarily limited to the dome type, but may have shapes, such as the form of a ceiling of a conventional concert hall, which reflects irregularly the sound waves emitted by the left and right speakers to create a stereophonic sound field wherein the generated sound field will spread into the reproducing room. The speakers **1** and **2** may be secured to the cabinet with an inclination, different from the state shown in FIG. **6**.

In summary, the instant invention provides a speaker apparatus which includes sound reflecting means to reflect irregularly and diffusively sound emitted by a speaker unit in a speaker cabinet to generate a sound field within the apparatus having a sound emission port through which the generated sound field spreads into a reproducing room, so that instant apparatus is less susceptive of influence of sound efficiency of the room.

What is claimed is:

1. In a speaker apparatus including a cabinet and at least one speaker unit, the improvement comprising: means secured to said cabinet for irregularly and diffusively reflecting sound emitted from said speaker to generate a number of indirect sound waves having different wave surfaces, said means for reflecting sound comprising a first substantially semi-cylindrical reflector board having a plurality of planar reflecting surfaces on the interior surface thereof, each planar reflecting surface forming an angle with an adjacent planar reflecting surface of less than 180° to form alternating projections and recesses around the interior of said semi-cylindrical reflector board, and a second reflector board positioned adjacent the end of said semi-cylindrical reflector board opposite said speaker, said second reflector board having curved reflecting surface portions, said first and second reflector boards being disposed in front of said speaker unit to irregularly and diffusively reflect sound emitted from said speaker unit, whereby an improved sound field is created in said speaker apparatus.

2. The speaker apparatus as specified in claim **1**, further comprising a third sound reflecting board having a curved reflecting surface and being mounted above said speaker in a spaced-apart relationship with said first and second reflector boards, wherein the sound waves reflected from said third sound reflecting board are directed toward said first and second sound reflector boards.

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