United States Patent [19]

Shiga et al.

[11] **3,717,218**

[45] **Feb. 20, 1973**

[54] **LOUDSPEAKER**

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[22] Filed: **April 1, 1971**

[21] Appl. No.: **130,086**

[30] **Foreign Application Priority Data**

April 7, 1970 Japan 45/29692

[52] **U.S. Cl.** ..... **181/32 R**

[51] **Int. Cl.** **G10k 13/00**, H04r 7/00

[58] **Field of Search** ..... 181/32 R

[56] **References Cited**

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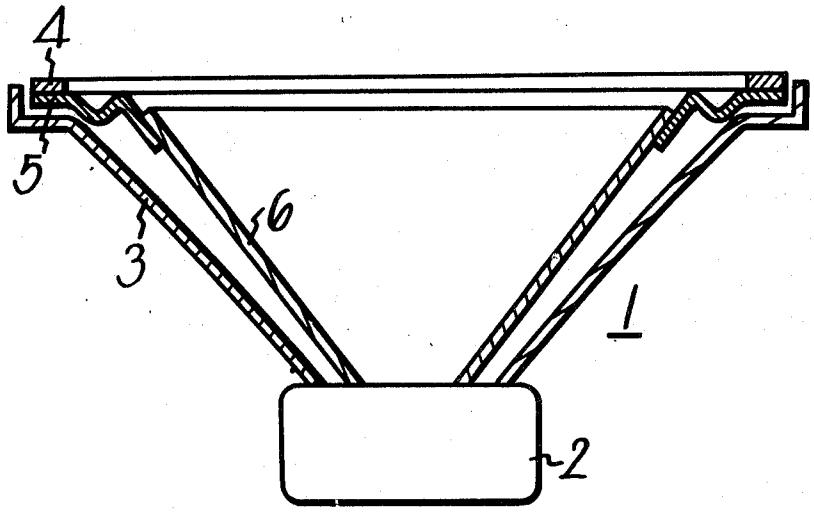
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[57] **ABSTRACT**

A loudspeaker having a cone suspension system which is formed of materials such as collagen fiber, a mixture of collagen fiber with other fiber, collagen fiber impregnated with asphalt or latex, or other fibers impregnated with asphalt or latex to improve the frequency response characteristic.

7 Claims, 3 Drawing Figures

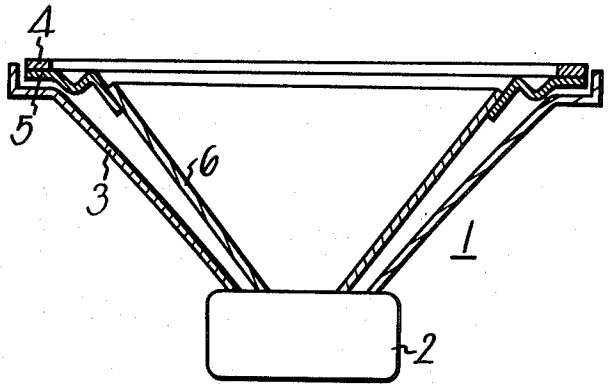


PATENTED FEB 20 1973

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SHEET 1 OF 2

Fig. 1



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Fig. 2

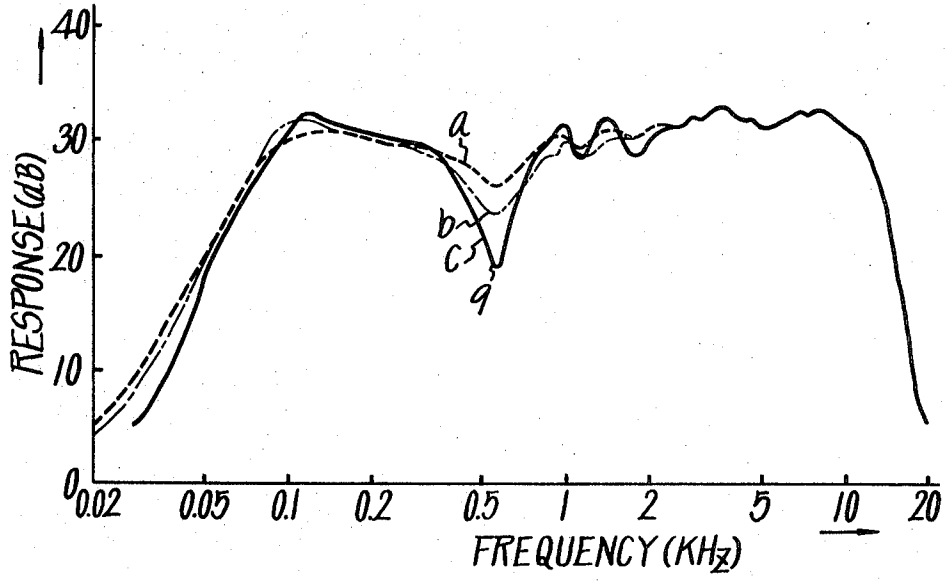
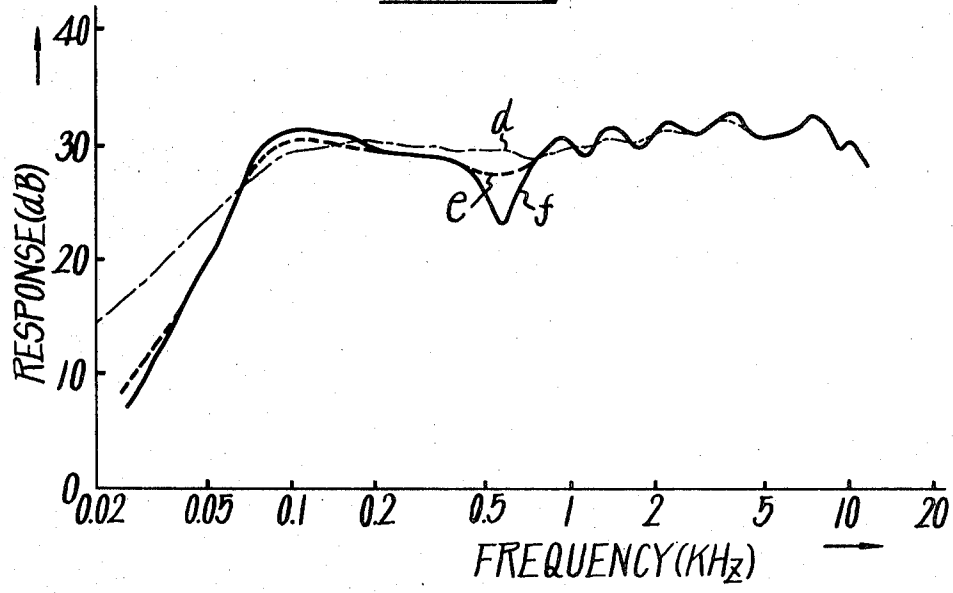


Fig. 3



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LOUDSPEAKER

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a loudspeaker, and more particularly to a loudspeaker with a cone suspension system for supporting the cone of the loudspeaker.

2. Description of the Prior Art

For the suspension of the cone in conventional loudspeakers a free edge is employed which is formed of oxhide or cowhide, kid skin or synthetic foam rubber. Leather is a natural product and it is difficult to obtain uniform quality and is expensive and unsuitable for mass production. Synthetic foam rubber is also expensive and has a frequency characteristic which causes a decrease in the damping effect, and the synthetic foam rubber is used only in high-grade or special loudspeakers.

SUMMARY OF THE INVENTION

One object of this invention is to provide a loudspeaker having a cone suspension which provides for improved response in the low-frequency band and lowers the Q in the vicinity of the resonance frequency of the low-frequency band.

Another object of this invention is to provide a loudspeaker having a cone suspension which provides for improved response in the middle-frequency band and prevents anti-resonance due to the suspension.

Another object of this invention is to provide a loudspeaker having a cone suspension which has uniform characteristics in the middle-frequency band and compensates for distortion in the high-frequency band.

Another object of this invention is to provide a loudspeaker with a cone suspension made of collagen fiber or of material containing collagen fiber.

Still another object of this invention is to provide a loudspeaker with a collagen cone suspension containing latex or asphalt.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 shows, partly in cross-section, one example of a loudspeaker of this invention;

FIG. 2 is a graph illustrating the frequency response characteristics of the loudspeaker of this invention and a conventional loudspeaker; and

FIG. 3 is a graph similar to FIG. 2, showing the frequency response characteristics of a modified form of this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

For a better understanding of this invention, the characteristics of a loudspeaker will be discussed.

"Q" is defined for a loudspeaker by the equation $Q=F_2-F_1/F_0$ where F_0 is the resonant frequency of the speaker and F_1 is the frequency below F_0 where the response is 3dB below the response at F_0 and F_2 is the frequency above F_0 where the response is 3dB below the response at F_0.

Generally, the frequency response characteristics of a loudspeaker is divided into the low-, middle- and high-frequency ranges according to the vibration modes of the loudspeaker. For the low-frequency response characteristic in the vicinity of the resonance frequency, the speaker should have a Q of about 0.7. With Q greater than 0.7, the low-frequency characteristic abruptly rises in the vicinity of the resonance frequency and deteriorates the transient response. With Q smaller than 0.7, the reproduction of low-frequency sound is not adequate and the transient response is excessively damped. Since the cone performs a piston movement as a substantially unitary structure with the cone suspension over the low-frequency range to the middle-frequency range, the response characteristic in the middle-frequency range is substantially flat. However, the cone and the cone suspension (edge) vibrate in opposite phase at a frequency higher than a certain frequency in the middle-frequency range. This introduces a dip or trough in the frequency response which increases distortion and deteriorates quality of sound. When the width of the cone suspension is great, the sound wave radiated from the suspension is large and the dip or trough in the characteristic is deep. When the width of the cone suspension is small, on the contrary, the dip or trough in the characteristic is shallow. However, the narrow cone suspension causes non-linearity in the low-frequency range when the amplitude of the cone is great, and non-linear distortion increases and resonance in the low-frequency range increases. This makes it necessary to decrease the trough in the characteristic in the middle-frequency range which depends on the material, shape and size of the cone suspension.

The material of the cone may be a mixture of Japanese paper as of "mitsumata," a mulberry paper or the like or foreign paper as of pulp or the like with other fibers or porous foam synthetic resin. The fixed edge of the cone suspension is formed generally of the same paper fiber as that used for the cone and is hard and stiff which causes non-linear distortion. Attempts to remove this drawback introduces anti-resonance in the middle-frequency range and causes a deep trough in the frequency characteristic. To avoid this, the cone suspension is often coated with damping material such as viscolloid or the like but the characteristic of the coated damping material deteriorates with time and is effective only for a short time.

Thus the object of the present invention is to provide a loudspeaker with a cone suspension which has excellent low-frequency characteristics and prevents anti-resonance in the middle-frequency characteristic.

Collagen is the material used in the cone suspension in this invention. Collagen is contained in the skins of animals and is obtained by the following method. The first step is to immerse a chrome-tanned hide for about 16 hours in about 500 percent by weight of water (with respect to the chrome-tanned hide) which has a temperature of 50° to 60°C and which contains about 0.05 percent by weight of non-ionic activator relative to the chrome-tanned hide. Then, the chrome-tanned hide is rinsed with water in a drum for one hour, after which the hide is subjected to a neutralization treatment for one hour in about 200 percent by weight of water relative to the chrome-tanned hide which has a temperature of about 40°C and which contains approximately 1.0 percent by weight of soda dicarbonate relative to the hide. Then the hide is rinsed with water for thirty minutes. Next, the hide is treated with about 2.5 per-

cent by weight of sulfonated olive oil relative to the hide together with approximately 200 percent by weight of water relative to the hide which has a temperature of about 60°C for 30 minutes. Then the hide is dehydrated by a centrifugal hydroextractor and dried by a hot-air blower at about 50°C to adjust the water content to about 35 to 45 percent. The hide is then tapped with a stamp mill for about thirty minutes and is pressed against a cloth provided with needles 5 mm. long and wrapped around the peripheral surface of a wooden roll which is driven at a speed of 1,300 rpm and is 3 inches in diameter and 5 inches wide. Thus, the fiber of the hide is frayed to obtain collagen fiber.

The collagen fiber thus obtained is a cluster of very thin fibers and many thin monofils are divided from one fascicule. The fiber is very soft but strong. The collagen fiber substantially dampens vibrations and is effective for attenuating sound vibrations.

FIG. 1 illustrates one example of a loudspeaker according to this invention.

In FIG. 1 reference numeral 1 indicates generally a loudspeaker, in which a frame 3 is supported by a yoke 2 which has a magnet disposed centrally thereof. An edge or cone suspension member 5 is fixed between the periphery of the frame 3 and an annular gasket 4. The making of the edge or the cone suspension member 5 will be described later. A cone 6 is connected to a voice coil disposed in a magnetic gap between the magnet and the yoke 2. The contact faces of the edge or cone suspension member 5 and the cone 6 are bonded together with a suitable adhesive binder.

The cone suspension member 5 is manufactured in the following manner:

EXAMPLE I

Material	
collagen	70% (by weight)
wood pulp	28% (by weight)
polyvinyl alcohol (as a binder)	2% (by weight)

The above materials are mixed and formed into a sheet having a thickness of 0.25 mm. The sheet is molded by a press at a temperature of 120° to 130°C under a pressure of 1 Kg/cm^2.

EXAMPLE II

Material	
collagen	50% (by weight)
rayon	30% (by weight)
cotton	18% (by weight)
polyvinyl alcohol	2% (by weight)

The sheet is formed and molded under the same conditions as in Example I.

FIG. 2 is a graph showing frequency response characteristics of a loudspeaker having a diameter of 20 cm and provided with the cone suspension member 5. Curve *a* is for a speaker produced constructed according to Example I. Curve *b* is for a loudspeaker similar having a cone suspension member 5 constructed according to Example II. Curve *c* illustrates the response of a conventional loudspeaker of the prior art. In FIG. 2, the abscissa represents frequency in KHz and the ordinate represents response in dB.

As will be apparent from FIG. 2, in the conventional loudspeaker a trough 9 is produced in the characteristic *c* (solid line curve) at about 500 Hz in the middle-frequency. However, in loudspeakers according to this invention, the characteristics curves *a* and *b* (curve a in dotted line, curve be in dash-claim line) are flattened and the characteristics in the low-frequency range are gentle and the characteristics in the high-frequency range are improved. In other words, the dip or trough has been substantially reduced.

Another embodiment of the invention comprises a cone suspension such as produced by the methods of Examples I or II which is impregnated with latex or asphalt. For example, the sheet produced in the Examples of I or II is impregnated with latex or asphalt and is dried at 70° to 80°C, then is molded in a press.

The amount of latex or asphalt impregnated into the sheet is about 10 to 50 percent by weight relative to the sheet. The frequency characteristic of a loudspeaker employing such a cone suspension member is as shown in FIG. 3.

In FIG. 3, the ordinate represents response in dB and the abscissa frequency in KHz. A dash-dot line curve d is the frequency characteristic of a loudspeaker employing a cone suspension impregnated with about 25 percent by weight of latex. A dotted line curve *e* is the frequency characteristic of a loudspeaker employing a cone suspension impregnated with less than 10 percent by weight of latex. A solid line curve f is the frequency characteristic of a loudspeaker using a cone suspension impregnated with more than 50 percent by weight of latex. We have found that the optimum value of latex is 25 percent.

In the foregoing Examples, the amounts of collagen used are respectively selected at about 70 and 50 percent but, in practice, the softness of the cone suspension can be variously selected by selecting the amount of collagen in the range of 50 to 100 percent. An increase in the amount of collagen used causes an increase in the softness of the cone suspension.

The amount of latex or asphalt impregnated into the sheet for the cone suspension (in Example III) can be selected at will. An increase in the amount of latex or asphalt used causes an increase in the hardness of the cone suspension.

It will be seen that the loudspeaker of this invention compensates for the lowering of response due to anti-resonance in the middle-frequency range.

In the invention a natural hide is not used but a hide is processed into collagen fiber and then used after being shaped into a desired form. This ensures uniformity in the quality of the edges or cone suspensions produced. Collagen fibers may be produced from waste hides. Accordingly, the present invention provides speakers of low cost and improved performance.

It will be apparent that many modifications and variations may be effected without departing from the scope of the novel concepts of this invention.

What is claimed is:

1. A loudspeaker having a cone with a cone suspension means made of a sheet of randomly aligned collagen fibers and polyvinyl alcohol as a binder.

2. A loudspeaker having a cone with a cone suspension means according to claim 1 wherein said randomly aligned collagen sheet includes wood pulp.

3. A loudspeaker having a cone with a cone suspension means according to claim 1 wherein said randomly aligned collagen sheet includes rayon and cotton.

4. A loudspeaker having a cone with a cone suspension means according to claim 1 wherein said randomly aligned collagen sheet is impregnated with latex.

5. A loudspeaker having a cone with a cone suspension means according to claim 4 wherein the amount of latex in said sheet of randomly aligned collagen fibers is about 10 to 50 percent by weight with respect to said sheet.

6. A loudspeaker having a cone with a cone suspension means according to claim 1 wherein said randomly aligned collagen sheet is impregnated with asphalt.

7. A loudspeaker having a cone with a cone suspension means according to claim 1 wherein said randomly aligned collagen sheet has about 50 to 100 percent by weight of collagen with respect to the weight of the sheet.

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