

# United States Patent

Sotome

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## [54] LOUDSPEAKER

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- [52] U.S. Cl. ....181/32 R  
[51] Int. Cl. ....G10k 13/00, H04r 7/00  
[58] Field of Search .....181/32 R, 31 R, 24

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## [57] ABSTRACT

A loudspeaker including a diaphragm, means for driving said diaphragm, an annular suspension member of rubberlike elastic material attached to the marginal edge of said diaphragm and a supporting frame to which said suspension member is fixed, characterized in that said suspension member has a relatively large radial width and a tapered thickness which gradually decreases from the outer peripheral portion to the inner peripheral portion, and said member is fixedly connected at said outer peripheral portion to the supporting frame and at said inner peripheral portion to said marginal edge of the diaphragm.

1 Claim, 5 Drawing Figures

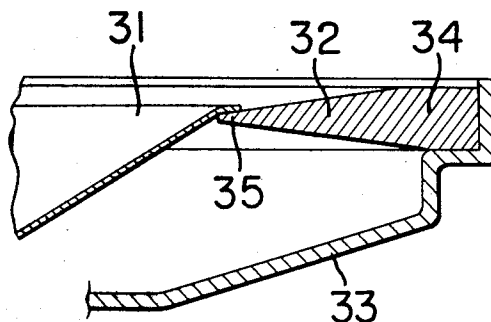


FIG. 1

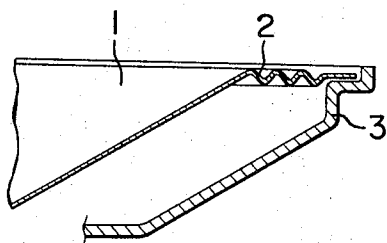


FIG. 4

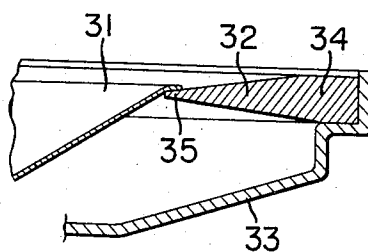


FIG. 2

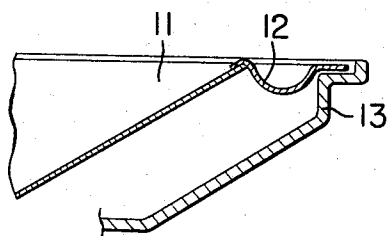


FIG. 5

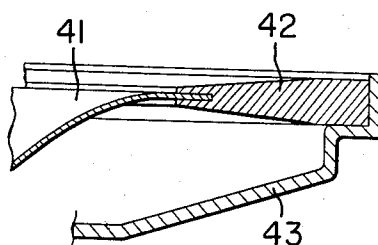
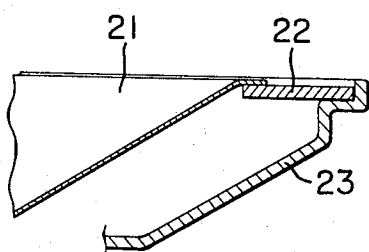


FIG. 3



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## LOUDSPEAKER

## BACKGROUND OF THE INVENTION

The present invention relates to a loudspeaker. More particularly, it relates to a suspension for supporting a marginal edge of a diaphragm of a loudspeaker onto a supporting frame.

Heretofore, various forms of suspension have been used to support an edge of a diaphragm of a loudspeaker. Typical forms are shown in FIGS. 1, 2 and 3.

FIG. 1 shows a suspension in which a diaphragm 1 is formed at its edge portion with a corrugation 2, whose outer periphery in turn is fixed at its periphery on a supporting frame 3. In such a suspension, the available amplitude of the diaphragm can be increased by increasing the number of waves of the corrugation 2 or increasing the radial width of the suspension portion, but the suspension portion having a large radial width and being macroscopically of flat shape, tends to produce free vibration, which will cause deep dips in the frequency characteristic of the loudspeaker.

FIG. 2 shows a suspension in which a diaphragm 11 has, adhered to the marginal portion thereof, a roll-shape suspension 12 whose outer periphery in turn is fixed to a supporting frame 13. This suspension has an advantage over the one shown in FIG. 1, in that relatively large available amplitude can be obtained with relatively narrow radial width of the suspension, which is of unflat shape. The larger available amplitude, however, cannot be obtained without the increase of the radial width and the corresponding increase of radius of curvature of the roll-shape suspension. The increase of the radius of curvature causes extreme decrease of the strength of the suspension itself so that the suspension may produce resonance in opposite phase relative to that of the diaphragm or it may be adversely affected by the vibrating air on the front and rear sides of the diaphragm.

FIG. 3 shows a suspension in which a diaphragm 21 is attached at its periphery to a suspension sheet member 22 made of foamed urethane or the like material, whose outer periphery in turn is fixed on a supporting frame 23. The suspension of FIG. 3 produces good results in the small amplitude range, but it has the same defects as explained with reference to FIG. 1 in the large amplitude range.

## SUMMARY OF THE INVENTION

It is a general object of the present invention to provide a loudspeaker which eliminates the disadvantages of the prior art as noted above.

It is a particular object to provide a loudspeaker in which a radial width of an edge portion is increased so that a large available amplitude can be obtained with small deformation of the suspension body itself.

It is another object of the present invention to provide a loudspeaker having a suspension which provides lesser free vibration and greater damping action than those of the prior art, and which has sufficient strength to resist the vibrating air on the front and rear sides of the diaphragm, so that few and little peaks and dips appear in the frequency characteristic throughout the whole sound range from low to high frequency sound.

It is a further object of the present invention to provide a loudspeaker in which lowest resonance frequency can be easily lowered so that satisfactorily low-frequency sound can be reproduced even when mounted in a small cabinet.

In accordance with the present invention there is provided a loudspeaker which comprises a diaphragm, means for driving said diaphragm, an annular suspension member of elastic material, such as rubber, attached to the marginal edge of said diaphragm, said annular suspension member having a relatively large radial width and a tapered thickness which gradually decreases from its outer peripheral portion to its inner peripheral portion, and a supporting frame to which said annular suspension member is fixed at the outer peripheral portion thereof.

## DESCRIPTION OF DRAWINGS

FIGS. 1, 2 and 3 are sectional views, showing diaphragm suspension portions of three conventional types of loudspeaker, respectively; and

FIGS. 4 and 5 are sectional views, showing diaphragm suspension portions of two forms of loudspeaker according to the present invention, respectively.

## DETAILED DESCRIPTION

Referring to the drawings, FIG. 4 shows a form of a loudspeaker according to the present invention, which includes a diaphragm 31 driven by any conventional driving means (not shown), an annular suspension member 32 made of rubberlike elastic material attached to the marginal edge of said diaphragm and a supporting frame 33 to which said annular suspension member is fixed, said annular suspension member 32 having a relatively large radial width. Said suspension member 32 has an increased thickness at its outer peripheral portion 34, which is fixed on the supporting frame 33. The thickness gradually decreases from the outer peripheral portion 34 toward its inner peripheral portion 35 to which the marginal edge of the diaphragm is adhered.

FIG. 5 shows another form of a loudspeaker according to the present invention, which includes a diaphragm 41, a suspension member 42 and a supporting frame 43. The construction of these elements is substantially same as that shown in FIG. 4, except that the marginal edge of the diaphragm 41 is not adhered to the inner peripheral surface of the suspension member, as shown in FIG. 4, but inserted into and fixedly held by a groove formed in the inside peripheral surface of the annular suspension member 42.

In practice, the radial width of the annular suspension member as shown in FIGS. 4 and 5 for supporting the diaphragm having the diameter of 30-40 cm. or more may be about 3-10 cm., depending on the size of the diaphragm or the setting of the lowest resonance frequency, and the thickness of said member at the outer peripheral portion fixed on the supporting frame may be about 5-20 mm.

Although two forms of the connection between the diaphragm and the suspension member are illustrated in FIGS. 4 and 5, such connection may be constructed in other forms. For example, the diaphragm and the suspension member may be overlapped together over the larger width of connection, in order to avoid the occurrence of abrupt boundary condition change which would produce reflection of vibration.

It will be understood that the present invention provides a loudspeaker in which a large available amplitude can be obtained since the diaphragm is supported at its marginal edge on the supporting frame through the relatively wide annular suspension member made of rubberlike elastic material, and a flat frequency characteristic is obtained because the tapered form of said suspension member serves to reduce the resonance of the suspension portion and smoothly absorb the vibration. The suspension member, which is made of rubberlike elastic material, has good damping and vibration-absorbing property. Because the suspension member has gradually reduced thickness toward its inside periphery, it produces under any vibrating frequency the vibration of only minimum mass portion of said member required to obtain the amplitude corresponding to said vibrating frequency, and consequently good radiation efficiency and good transient property can be obtained. The suspension member, which is thick and durable, serves to improve the durability and weather-resistant property of a loudspeaker. The loudspeaker can reproduce low-frequency sound even when mounted in a small cabinet in view of the fact that the lowest resonance frequency can be easily lowered.

I claim:

1. A loudspeaker comprising a diaphragm, means for driving said diaphragm, an annular suspension member of elastic material, and a supporting frame, said annular suspension member having a relatively large radial width and a tapered thickness which gradually reduces from its outer peripheral

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portion to its inner peripheral portion and said member being  
fixedly connected at said inner peripheral portion to the mar-  
ginal edge of said diaphragm and at said outer peripheral por-  
tion to said supporting frame.

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