# United States Patent

**Sotome**

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[45] **Aug. 15, 1972**


[54] **SUSPENSION FOR LOUDSPEAKER**


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[30] **Foreign Application Priority Data**

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Feb. 13, 1970 Japan .....45/11986

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



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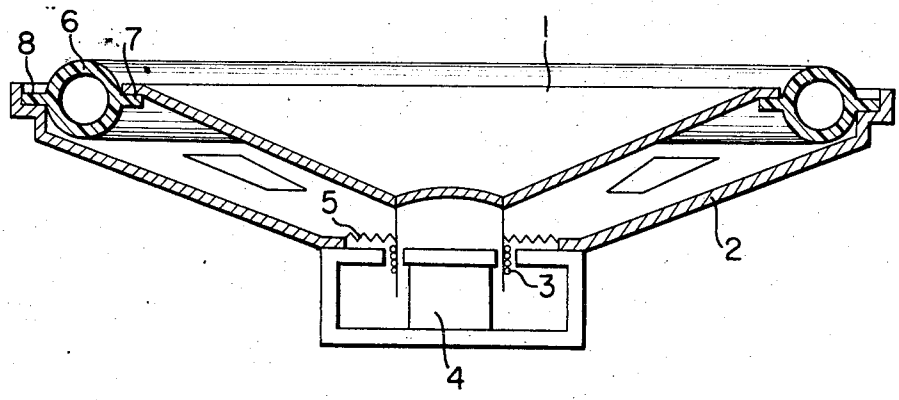
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[57] **ABSTRACT**

A loudspeaker in which a diaphragm is supported at its marginal edge on a frame by means of a suspension which consists of an annular, hollow member of rubber-like elastic material having a substantially circular shape in cross section, which is connected at its inside periphery to said marginal edge of the diaphragm and at its outside periphery to said frame. A method for making the annular suspension member of rubber-like elastic material which comprises continuously extruding a hollow tube having a substantially circular cross section of the rubber-like elastic material in a helical form having a predetermined diameter, and then cutting the helically extruded hollow tube to form annular suspension members successively.


**3 Claims, 14 Drawing Figures**



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SHEET 1 OF 4

FIG. 1

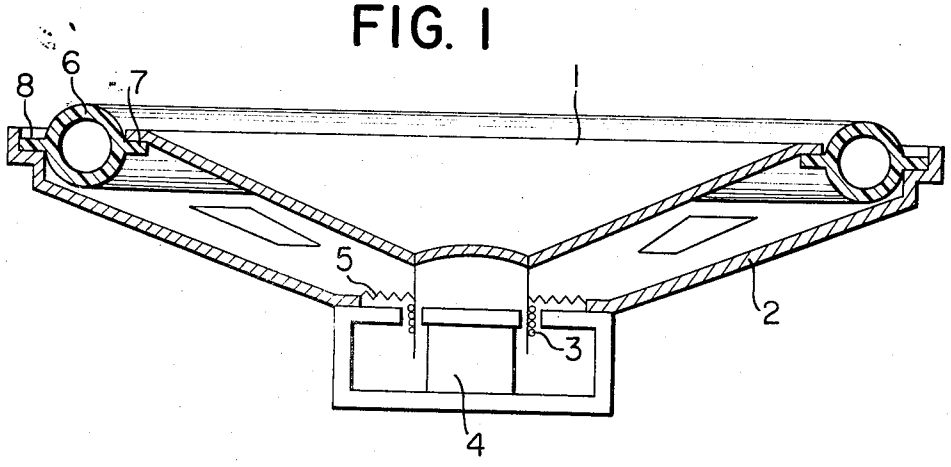



FIG. 2

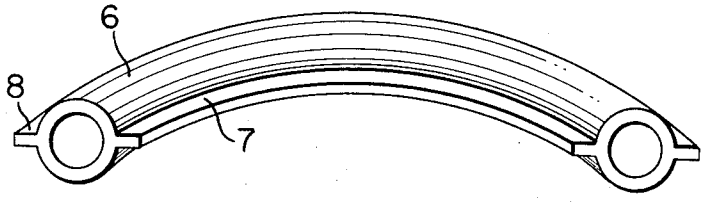
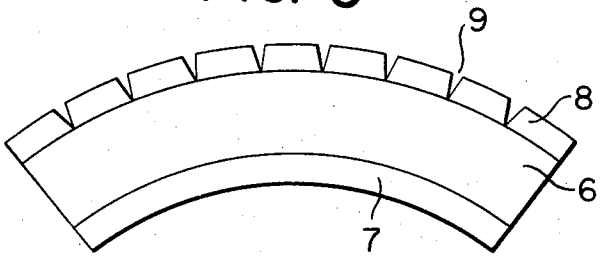



FIG. 3




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FIG. 4

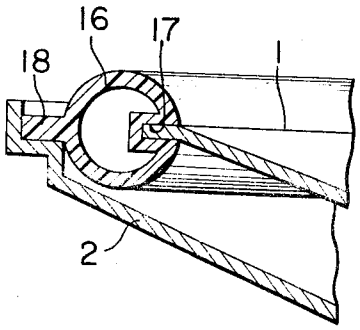



FIG. 7

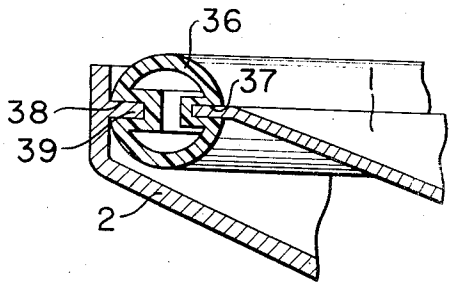



FIG. 5

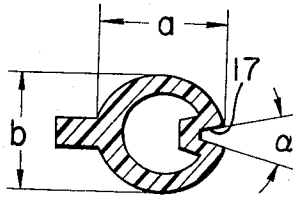



FIG. 8

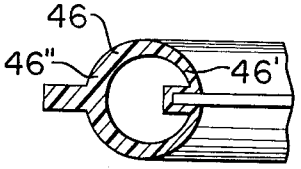



FIG. 6

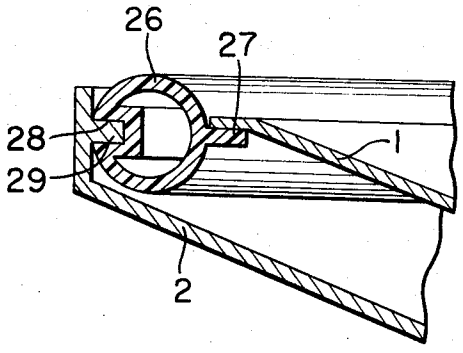
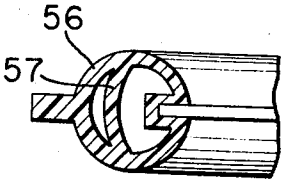



FIG. 9




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FIG. 10

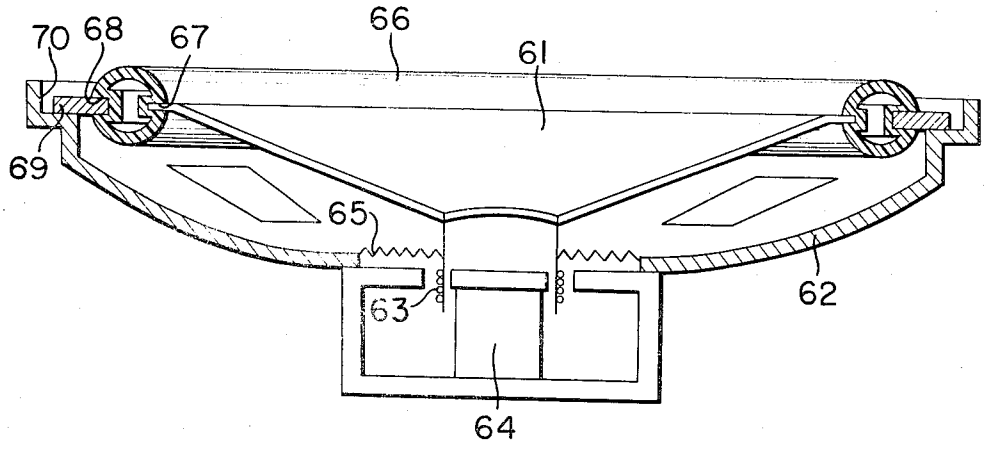
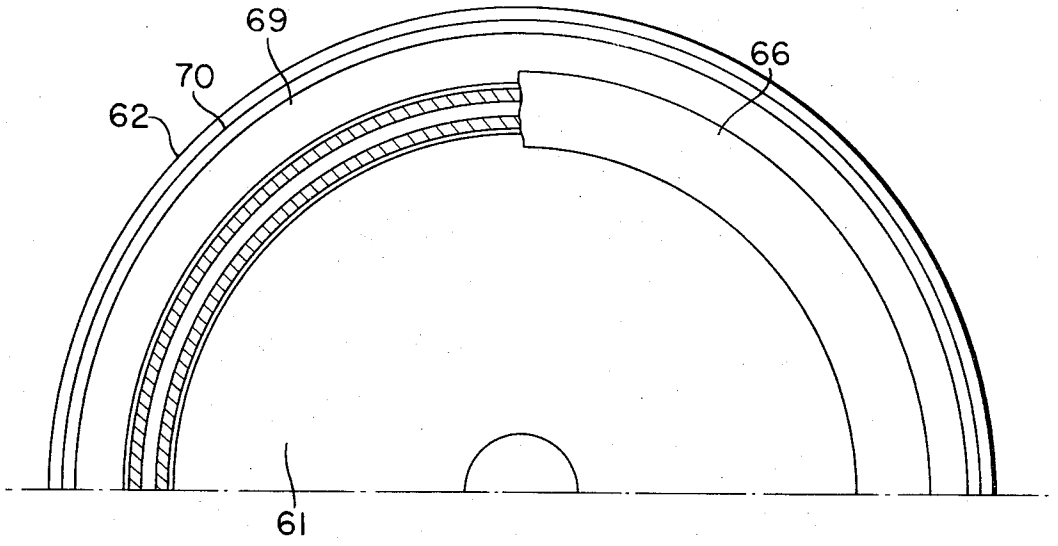



FIG. 11




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FIG. 12

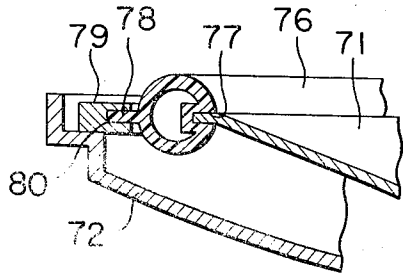



FIG. 13

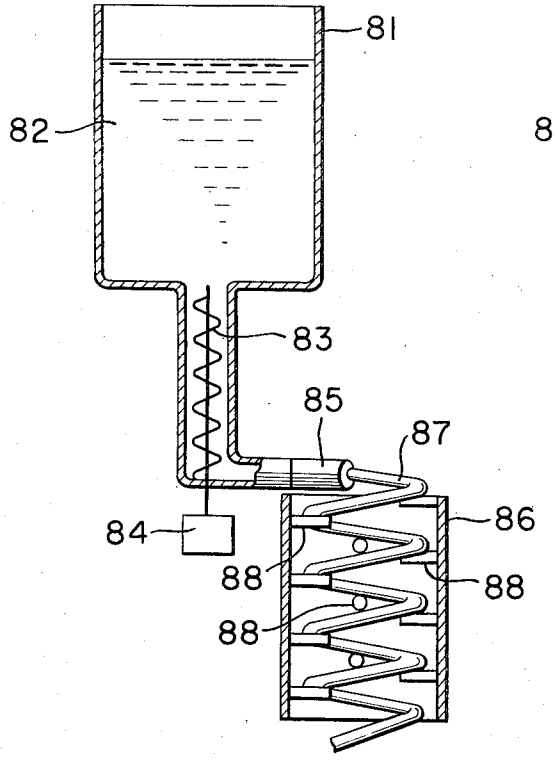
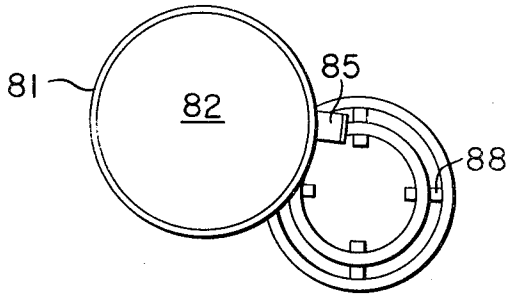



FIG. 14




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# SUSPENSION FOR LOUDSPEAKER

## BACKGROUND OF THE INVENTION

The present invention relates to an improvement in a suspension or edge portion of a diaphragm of a loudspeaker and a method for making same.

Heretofore, the suspension or edge portion of a diaphragm of a loudspeaker has been usually made of fabric material impregnated with phenol or urethane resin, non-woven fabric or rubber, which is formed in a corrugated or semi-curcular shape in cross section. In the conventional construction of the suspension, however, if it is so formed as to in crease its compliance in order to lower the minimum resonance frequency of the loudspeaker, the formal stability of the edge portion of the diaphragm is reduced and the durability and strength thereof is also reduced, so that it is susceptible to influence of difference in air pressure between front and rear sides of the diaphragm. Moreover, in the conventional construction, the suspension must be formed one by one, so that its productivity is relatively low.

## SUMMARY OF THE INVENTION

It is a general object of the present invention to eliminate the defects in the conventional construction of the suspension of the loudspeaker.

It is an object of the present invention to provide a suspension of a loudspeaker which has an increased compliance and an increased formal stability, and a method of making such suspension.

It is another object of the present invention to provide a suspension of a loudspeaker which is superior in durability and weather-resistant property and which is insusceptible to change due to aging and temperature change and a method of making such suspension.

It is another object of the present invention to provide a suspension of a loudspeaker which acts to vibrate in completely symmetric mode forward and backward, thereby providing a loudspeaker with superior characteristics.

It is a further object of the present invention to provide a method for producing a suspension of a loudspeaker at a high rate.

In accordance with an aspect of the present invention there is provided a suspension for supporting a marginal edge of a diaphragm on a frame of a loudspeaker, comprising an annular hollow member of rubber-like elastic material having a substantially circular cross section, which is connected at its inside periphery to said marginal edge of the diaphragm and at its outside periphery to said frame.

In accordance with another aspect of the present invention there is provided a method of making such suspension member, comprising continuously extruding a hollow tube having a substantially circular cross section of the rubber-like elastic material into a form of a helix having a predetermined diameter, and then cutting the helically extruded hollow tube to form annular suspension members successively.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a sectional view of a loudspeaker, showing an embodiment of the present invention;

FIG. 2 is a perspective view of a part of a suspension member of the loudspeaker as shown in FIG. 1;



FIG. 3 is a plan view of a part of the suspension member;

FIG. 4 is a sectional view of a part of loudspeaker, showing another embodiment of the present invention;

FIG. 5 is a schematic view illustrating a section of the suspension member shown in FIG. 4;

FIGS. 6 and 7 are sectional views, similar to FIG. 4, showing the other embodiments, respectively;

FIGS. 8 and 9 are sectional views showing the modified forms of the suspension member, respectively;

FIG. 10 is a sectional view showing another embodiment of the invention;

FIG. 11 is a plan view showing a half of the loudspeaker shown in FIG. 10;

FIG. 12 is a sectional view showing a modified form of the loudspeaker shown in FIG. 10;

FIG. 13 is a schematic sectional view showing an apparatus for producing the suspension member according to the present invention; and

FIG. 14 is a plan view of the same.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

Now, the invention will be explained with reference to the drawings which illustrate several embodiments of the present invention.

The loudspeaker shown in FIG. 1 includes a diaphragm 1, a frame 2, a voice coil 3 supported at the center of the rear side of said diaphragm, a magnetic circuit 4 and a damper 5. The diaphragm 1 is supported at the marginal edge thereof on the frame 2 by means of an annular hollow suspension member 6 having a substantially circular shape in cross section. In the embodiment as shown in FIG. 1, the suspension member 6 is integrally formed with an inside peripheral flange 7, to which the marginal edge of the diaphragm is adhesively fixed, and an outside peripheral flange 8, which is adhesively fixed to the frame 2. The suspension member 6 is made of rubber-like elastic material, such as natural rubber, synthetic rubber or foamed rubber such as foamed neoprene rubber or the like. The annular suspension member may be formed by extrusion molding of rubber-like elastic material. It may be either molded into an annular form at the time of extrusion, or it may be initially molded into a straight tube, which is then curved as it is assembled onto the marginal edge of the diaphragm. In the latter case, radial slits 9 may be cut in the outside peripheral flange 8 to facilitate to bend the straight extruded tube into the annular form.

FIG. 4 illustrates another embodiment of the invention, in which an annular suspension member 16 of substantially circular form in cross section is formed with an inside peripheral groove 17 which receives a marginal edge of a diaphragm and an outside peripheral flange 18 adhesively fixed to a frame 2. The suspension member may be formed from a straight extruded tube, where said member may preferably has a cross sectional shape as shown in FIG. 5 in which the horizontal diameter "$a$" is slightly longer than the vertical diameter "$b$" and the peripheral groove 17 has outwardly tapered surfaces including an angle of "$\alpha$". When the straight extruded tube is curved around the marginal edge of the diaphragm the cross sectional shape as shown in FIG. 5 is deformed into a true circular form as

shown in FIG. 4 and becomes to firmly grip said marginal edge of the diaphragm 1.

FIGS. 6 and 7 illustrate other two forms of the present invention. FIG. 6 shows an annular suspension member 26 which is formed with an inside peripheral flange 27 to which a marginal edge of a diaphragm 1 is fixed and an outside peripheral groove 28 which receives a flange 29 of a frame 2. FIG. 7 shows an annular suspension member 36 which is formed with an inside peripheral groove 37 which receives a marginal edge of a diaphragm 1 and an outside peripheral groove 38 which receives a flange 39 of a frame 2.

FIGS. 8 and 9 illustrate further modified forms of the suspension. FIG. 8 shows an annular suspension member 46, which is similar to that shown in FIG. 4, except that the thickness is gradually increased from minimum thickness at the inside periphery 46' which receives larger vibration to maximum thickness at the outside periphery 46'' which receives smaller vibration. FIG. 9 shows an annular suspension member 56, which is similar to that shown in FIG. 4, except that a bridge portion 57 is integrally formed therein to reinforce the suspension member and absort the vibration thereof.

Any of the embodiments explained above meet the objects of the present inventiin, but these embodiments may find some difficulty in centering the voice coil of the loudspeaker in the magnetic gap of the magnetic circuit owing to the fact that there is no clearance between the suspension member fixed around the diaphragm and the inside periphery of the frame. Such a difficulty can be avoided by providing an additional attaching ring around the annular suspension member of rubber-like elastic material.

FIGS. 10 and 11 illustrate an embodiment of the invention including such additional attaching ring. This embodiment comprises a diaphragm 61, a frame 62, a voice coil 63, a magnetic circuit 64, a damper 65 and a suspension member 66. The suspension member 66 is provided with an inside peripheral groove 67, which receives a marginal edge of the diaphragm 61, and an outside peripheral groove 68 to which an annular attaching ring 69 is fitted and fixed. The attaching ring 69 is made of solid material, such as aluminum, iron, brass, hard plastics or the like, and it is fixed on the frame such as by set screw or adhesive, with an adjusting clearance 70 between the outside periphery and the inside periphery of the frame.

FIG. 12 shows a further embodiment in which an annular suspension member 76 has an inside peripheral groove 77, to which a marginal edge of a diaphragm 71 is fitted, and an outside peripheral flange 78, and an attaching ring 79 has an inside peripheral groove 80 into which the outside peripheral flange 78 is fixed. The attaching ring 79 is fixed on a frame 72.

The loudspeaker as shown in FIGS. 10 and 12 is assembled by adhesively connecting the diaphragm, the suspension member and the attaching ring together, attaching the voice coil to the diaphragm and then fixing the attaching ring on the frame by means of set screws, adhesives or the like while centering the voice coil within the gap of said magnetic circuit using a suitable jig.

It will be understood from the above descriptions that a suspension member, which is of circular shape in cross section, has an increased formal stability, so that the hardness and the thickness of the suspension member can be reduced, compared with the conventional construction of the edge portion of the diaphragm, whereby the compliance thereof can be increased to ideally high value. Because the suspension member has a symmetric shape in cross section, harmonic distortion could not be produced by the asymmetric vibration of the edge portion of the diaphragm. The air contained in the tubular suspension member serves to suppress such vibration of the suspension that produces the variation of capacity in the suspension member, so that the self-vibration of the suspension which would adversely affect the vibration of the diaphragm is suppressed. The suspension member, which has relatively high strength against the vibration of air at the front and rear sides of the diaphragm, cannot produce distortion in the frequency characteristics under the influence of the air vibration. The suspension member is superior not only in its formal stability but in its durability and weather-resistant property in view of the material used for said member. The superior member, which has a circular section, is insusceptible to change due to aging and temperature change and keeps its shape for a long period. This member can be produced very easily and continuously with low cost, by the extrusion molding. In the construction of the suspension member including the attaching ring fixed therearound, the loudspeaker can be assembled easily with high accuracy.

The above suspension member may be initially molded in the form of a straight extruded tube, which is then bent into an annular form around the diaphragm, as explained above. However, it is preferable to mold the suspension member in an annular form at the time of extrusion thereof.

The present invention intends to provide a method for molding the suspension member in the annular form by continuously extruding a tube of rubber-like elastic material in a helical form and then cutting the helical tube successively to form the annular suspension members.

FIGS. 13 and 14 illustrate an apparatus for carrying out such method, which comprises a tank 81 containing rubber-like elastic material 82, a helical feeder 83 provided at the bottom of said tank, an electric motor 84 for driving said feeder, a curved extruding nozzle 85 for helically extruding the material and a guide 86 for guiding the extruded material 87 in the helical form. The helicoid has a diameter substantially equal to that of the final product suspension member to be mounted in a loudspeaker. The guide 86 has a plurality of guiding rollers 88 projecting radially inward thereof, and the extruded material 87 progressively descends in the guide in the helical form, while it is heated to be cured. The extruded material leaving the guide 86 is successively cut into annular suspension members. The annular member thus formed is adhesively fixed around the diaphragm.

When the suspension member is initially formed in an annular form, which is easily adapted around the diaphragm, no deformation of the suspension member may be caused at the time of attaching said suspension member around the diaphragm.

I claim:

1. A suspension for supporting a marginal edge of a diaphragm on a frame of a loudspeaker, comprising an annular, hollow member of elastic material having a substantially circular shape in cross section, said member being connected at its inside periphery to said marginal edge of the diaphragm and at its outside periphery to said frame.

2. A suspension for supporting a marginal edge of a diaphragm on a frame of a loudspeaker, comprising an annular, hollow member of elastic material having a substantially circular shape in cross section, said member being connected at its inside periphery to said marginal edge of the diaphragm, and an attaching ring



of solid material fixed at its inside to an outside periphery of said annular member and at its outside to said frame.

3. A loudspeaker comprising a diaphragm, a frame, a voice coil supported at the rear side of said diaphragm, a magnetic circuit supported by said frame for driving said voice coil, and an annular hollow suspension member of elastic material having a circular form in cross section, said suspension member being connected at its inside periphery to a marginal edge of said diaphragm and at its outside periphery to said frame.

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