



(11) **EP 1 841 280 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
03.10.2007 Bulletin 2007/40

(51) Int Cl.:
H04R 7/06 (2006.01)

(21) Application number: **06300298.4**

(22) Date of filing: **29.03.2006**

(84) Designated Contracting States:
**AT BE BG CH CY CZ DE DK EE ES FI FR GB GR
HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI
SK TR**
Designated Extension States:
AL BA HR MK YU

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(54) **Loudspeaker diaphragm**

(57) A loudspeaker diaphragm includes an upper flat skin and a lower flat skin that are substantially parallel to a transversal axis, and an enhancement core sandwiched between the upper flat skin and the lower flat skin. The enhancement core comprises a multiple ribs extending in different inclined angles alternately between the upper and lower flat skins, and arranged with a configuration so as to form a triangle-shaped or trapezoid-shaped cross section including a series of triangles or

trapezoids between the upper and lower flat skins, whereby the transversal movement or vertical movement, e.g. the spring back effect (expansion and contraction) applying on the diaphragm are resisted. The inventive diaphragm is designed with a light weight whereas a sufficient rigidity, advantageously less break modes is also achieved so as to eliminate distortion in the sound reproducing. Furthermore, the inventive diaphragm can be integrally manufactured so as to reduce the cost.

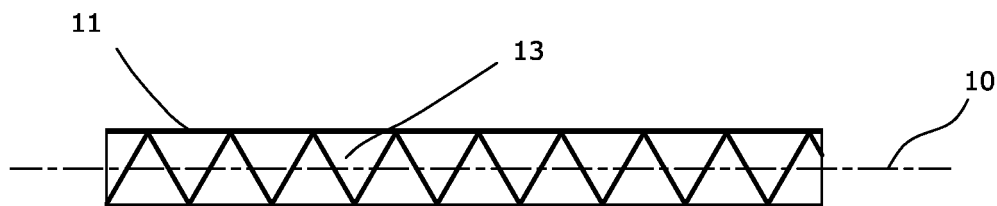


Fig. 1

Description

FIELD OF THE INVENTION

[0001] The present invention relates to a field of loudspeaker, and more particularly to a flat loudspeaker diaphragm structure having an enhancement core sandwiched between outer skins.

BACKGROUND OF THE INVENTION

[0002] A common loudspeaker generally includes a conical diaphragm typically manufactured of paper or plastic, and a dust cap usually provided at the central area of the conical diaphragm. However, at increased frequencies, the conical diaphragm can not efficiently overcome inertia forces, and begins to vibrate not as a rigid body, but rather in parts, causing corresponding increased distortion in reproduced sound. In addition, the conical form of the diaphragm causes sound to reach a point at different times (the "cavity effect").

[0003] It is known that a flat diaphragm minimizes the "cavity effect". However, the common conical shape of the diaphragm of given material is substantially more rigid than a flat diaphragm of the same material.

[0004] Figs. 4-5 show a flat diaphragm 20. For responding a high frequency, the flat diaphragm may have many break modes, e.g. many huge dips 201 and peaks 202 on the flat diaphragm 20, which occur distortion and poor treble.

[0005] With reference to Figs. 6-7, a sandwiched flat diaphragm structure, as disclosed in US Pat. No. 6,097,829, includes two sheets of flat skins 30 and a honey-comb core 31 sandwiched between the flat skins by glue or the like. The flat skins are made of carbon fibre, and the honey-comb core is made of aramid (or nomex).

[0006] Therefore, the afore mentioned sandwiched diaphragm structure have enough rigidity to mitigate sound distortion. Furthermore, because the skins are flat, the unwanted "cavity effect" is eliminated.

[0007] However, the honey-comb diaphragm structure has a heavy mass, so it needs a strong and huge driving motor (magnet). The skins and honey-comb core may be partially separated to occur buzz sound. Moreover, manufacturing the honey-comb diaphragm structure is difficult.

[0008] As illustrated in Fig. 8, another sandwiched loudspeaker diaphragm is composed of two flat skins 40 and a rectangular core 41. However, with reference to Figs. 9-10, when transverse wave exists, the rectangular core 41 may have a transversal movement along with the flat skins 40 to occur harmonic distortion. At the same time, the vertical force will cause a spring back effect (expansion and contraction) on the diaphragm in the operation mode, as shown in Fig. 11, the sound reproduced by the diaphragm is distorted.

SUMMARY OF THE INVENTION

[0009] The present invention provides a loudspeaker diaphragm which is lightweight and easily manufactured whereas with sufficient rigidity, and capable of resisting transversal and vertical movement so as to reduce break modes and eliminate sound distortion.

[0010] For achieving the objective mentioned above, the present invention provides a loudspeaker diaphragm comprising an upper flat skin and a lower flat skin that are substantially parallel to a transversal axis, and an enhancement core sandwiched between the upper and lower flat skins, characterized in that the enhancement core is composed of multiple ribs extending in different inclined angles alternately between the upper and lower flat skins. Preferably, the inclined angle of one rib relative to the transversal axis is supplementary to the inclined angle of an adjacent rib relative to the transversal axis.

[0011] According to an aspect of the invention, the multiple ribs of the enhancement core are arranged in a configuration with a triangle-shaped or trapezoid-shaped cross section including a series of triangles or trapezoids between the upper and lower flat skins, whereby the transversal movement or vertical movement, e.g. the spring back effect (expansion and contraction), applying on the diaphragm are resisted. Advantageously, the inventive loudspeaker diaphragm is light weight with sufficient rigidity, and less break modes is achieved so as to mitigate the sound distortion.

[0012] According to another aspect of the invention, the multiple ribs of the enhancement core are integrally formed with the upper and lower flat skins. Therefore it can be advantageously manufactured integrally, so as to reduce the manufacturing cost.

BRIEF DESCRIPTION OF DRAWINGS

[0013]

Fig. 1 is a front sectional view of a first embodiment of a loudspeaker diaphragm in accordance with the present invention;

Fig. 2 is a partially enlarged schematic view of inclined angles of two adjacent ribs of the loudspeaker diaphragm in accordance with the present invention;

Fig. 3 is a front sectional view of a second embodiment of a loudspeaker diaphragm in accordance with the present invention;

Fig. 4 is a schematic view of a common single layer flat diaphragm;

Fig. 5 is a schematic view illustrating the vibration of the flat diaphragm in reproducing sound;

Fig. 6 is a top partially sectional view of a conven-

tional honey-comb diaphragm;

Fig. 7 is a front sectional view of the conventional honey-comb diaphragm in Fig. 5;

Fig. 8 is a front sectional view of a rectangular structured diaphragm;

Figs. 9-10 are front sectional views showing the transversal movement of the rectangular structured diaphragm when transverse wave exists; and

Fig. 11 is a front sectional view showing the spring back effect on the rectangular structured diaphragm.

DETAIL DESCRIPTION OF PREFERRED EMBODIMENTS

[0014] The present invention relates to a loudspeaker diaphragm having an enhancement core sandwiched between outer skins.

[0015] As illustrated in Fig. 1, in a first embodiment, a loudspeaker diaphragm in accordance with the present invention includes an upper flat skin 11 and a lower flat skin 12 that are extending substantially parallel to a transversal axis 10, and an enhancement core 13 sandwiched between the upper flat skin 11 and the lower flat skin 12. The enhancement core 13 is composed of multiple ribs extending in different inclined angles alternately between the upper flat skin 11 and the lower flat skin 12. In this embodiment, the multiple ribs of the enhancement core 13 are connected one by one so as to form a triangle-shaped cross section including a series of triangles between the upper and lower skins 11, 12. In particular, according to an partially enlarged schematic view of inclined angles of two adjacent ribs of the loudspeaker as illustrated in Fig. 3, angle A of one rib 131 relative to the transversal axis 10 is supplementary to angle B of an adjacent rib 132 relative to the transversal axis 10, that is to say, the two inclined angles A and B of the two adjacent ribs 131, 132 are supplementary to the each other. Therefore, the loudspeaker diaphragm having the multiple ribs extending in different inclined angles alternately between the upper and lower flat skins 11, 12 and integrally formed with the upper and lower flat skins 11, 12 is capable of resisting both transversal and vertical waves existing during the sound reproducing.

[0016] With reference to Fig. 3, in a second embodiment, a loudspeaker diaphragm is formed in a similar configuration as the first embodiment shown in Fig.1, wherein an enhancement core 14 is sandwiched between the upper flat skin 11 and the lower flat skin 12 that are parallel to the transversal axis 10. The enhancement core 14 is similarly composed of multiple ribs extending in different inclined angles alternately between the flat skins 11, 12. Specially, in this embodiment, the enhancement core 14 is formed with a configuration that the multiple ribs are discrete so as to form a trapezoid-

shaped cross section including a series of trapezoids. The inclined angles of each two adjacent ribs of the enhancement core 14 are supplementary to the each other.

[0017] Advantageously, as set forth in foregoing context, the inventive loudspeaker diaphragm with the triangle-shaped or trapezoid-shape enhancement core 13, 14 is capable of providing resistance against the transversal movement or vertical movement, e.g. the spring back effect (expansion and contraction) applying on the diaphragm, thus less break modes are achievable, and therefore sound distortion reproduced by the diaphragm is mitigated.

[0018] Because the inventive loudspeaker diaphragm with the enhancement core 13, 14 sandwiched in the outer skins 11, 12 have a light weight whereas with a sufficient rigidity, the speaker can use a small drive unit (magnet) for reproducing sound. Moreover, since the enhancement core 13, 14 of the loudspeaker diaphragm is integrated with the outer skins 11, 12, it will not separate from the upper and lower skins 11, 12, no buzz sound will occur in the sound reproducing. Furthermore, as the structure of the inventive loudspeaker diaphragm is simple, and the whole diaphragm can be integrally made, the manufacture of the diaphragm is advantageously easy and the manufacture cost is reduced.

[0019] Even though numerous characteristics and advantages of the present invention have been set forth in the foregoing description, together with details of the structure and function of the invention, the disclosure is illustrative only. Changes may be made in detail, especially in matters of shape, size, and arrangement of parts within the principles of the invention to the full extent indicated by the broad general meaning of the terms in which the appended claims are expressed.

Claims

1. A loudspeaker diaphragm comprising an upper flat skin (11) and a lower flat skin (12) that are extending substantially parallel to a transversal axis, and an enhancement core (13, 14) sandwiched between the upper and lower flat skins (11, 12), **characterized in that** the enhancement core (13, 14) is composed of multiple ribs extending in different inclined angles alternately between the upper and lower flat skins (11, 12).
2. The loudspeaker diaphragm according to claim 1, **characterized in that** the multiple ribs of the enhancement core (13, 14) are integrally formed with the upper flat skin (11) and the lower flat skin (12).
3. The loudspeaker diaphragm according to claim 1 or 2, **characterized in that** the multiple ribs of the enhancement core (13, 14) are connected one by one so as to form a triangle-shaped cross section including a series of triangles between the upper and lower

flat skins (11, 12).

4. The loudspeaker diaphragm according to claim 1 or 2, **characterized in that** the multiple ribs of the enhancement core (13, 14) are discrete with each other so as to form a trapezoid-shaped cross section including a series of trapezoids between the upper and lower flat skins (11, 12). 5
5. The loudspeaker diaphragm according to any one of the preceding claims, **characterized in that** the included angle of one rib relative to the transversal axis is supplementary to the included angle of an adjacent rib relative to the transversal axis. 10

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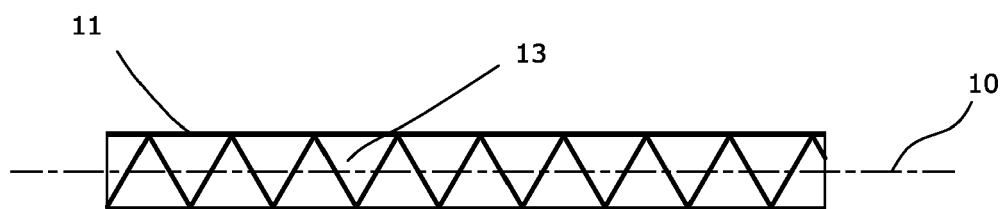


Fig. 1

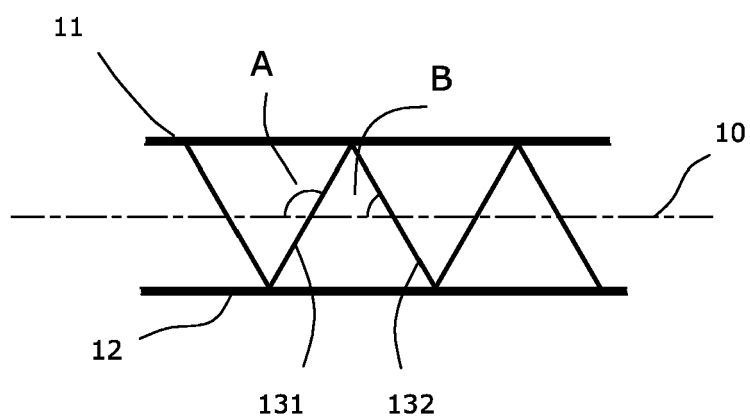


Fig. 2

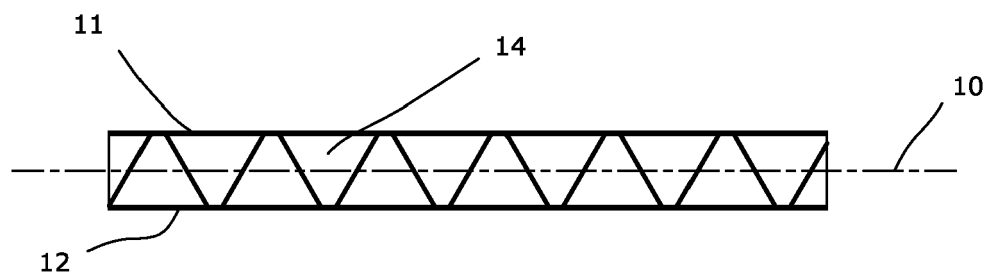


Fig. 3



Fig. 4

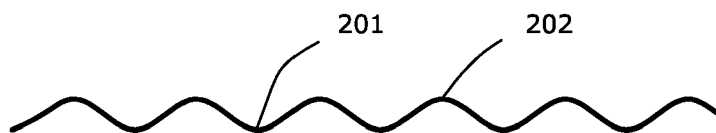


Fig. 5

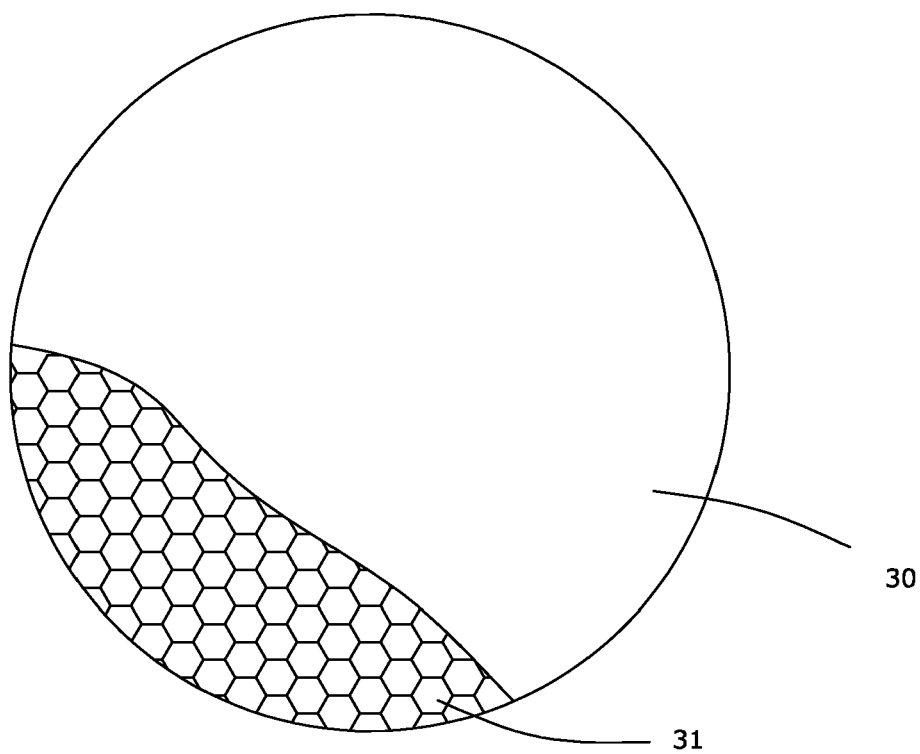


Fig. 6

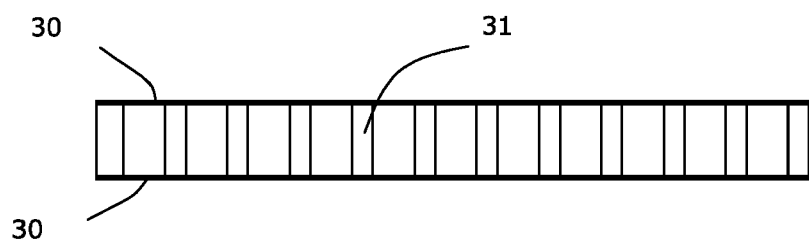


Fig. 7

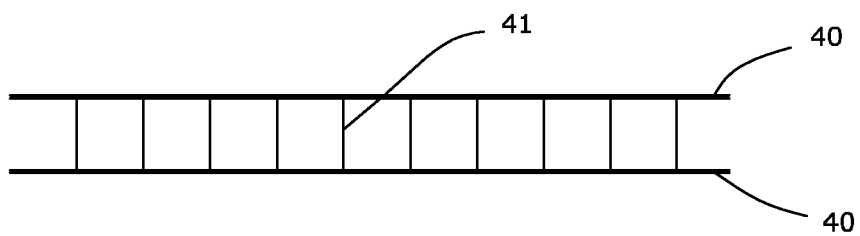


Fig. 8

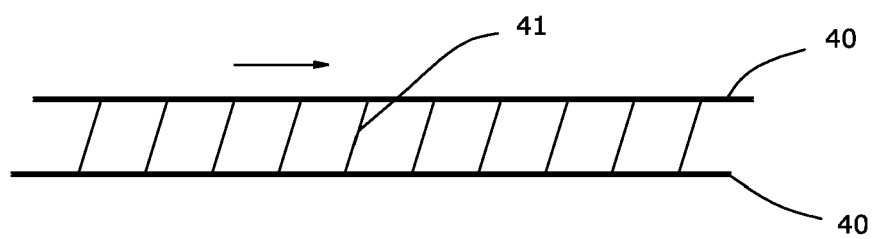


Fig. 9

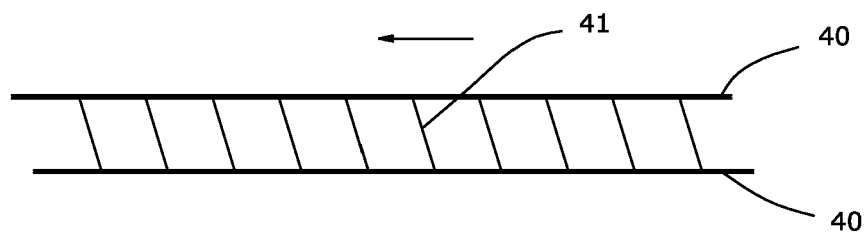


Fig. 10

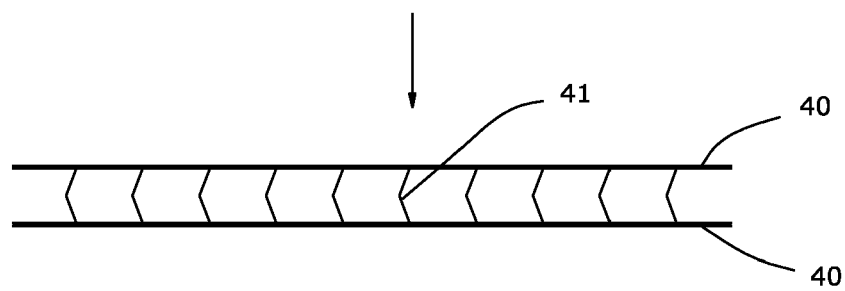


Fig. 11



European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 06 30 0298

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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 21 September 2006	Examiner Righetti, Marco
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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EUROPEAN SEARCH REPORT

Application Number
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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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Place of search Munich		Date of completion of the search 21 September 2006	Examiner Righetti, Marco
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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