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(54) **A diaphragm for an electro-acoustic transducer**

(57) A diaphragm for an electro-acoustic transducer comprising a rigid substrate having two surfaces and a certain weight; wherein said substrate being made of

non-porous metal or alloy; and a coating applied to either or both surfaces of the substrate; said coating being made of plastic material and having a weight less than the weight of the substrate.

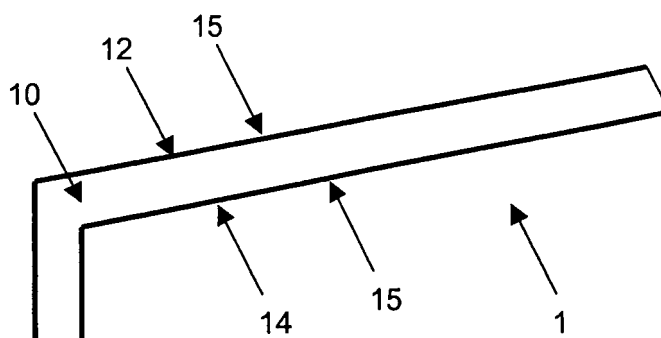


FIG. 1

Description

FIELD OF TECHNOLOGY

[0001] The present invention relates to a diaphragm for use in an electro-acoustic transducer and, more particularly, to an improvement with respect to the material constituting such a diaphragm.

BACKGROUND OF THE INVENTION

[0002] It is known in the art that the diaphragm for an electro-acoustic transducer, such as a speaker, is made of rigid material, such as metal, alloy, rubber, paper, etc. and usually has a layer coated on the surface thereof. For instance, US 6, 654, 476 B1 mentions the coating of the front surface of a dome-shaped diaphragm. US 4, 128, 138 and US 4, 129, 195 disclose a vinyl chloride sheet or an aluminium foil disposed on the surface of a diaphragm made of porous metal produced from nickel powder to eliminate the gas permeability of the porous metal. More often, this coating layer is made of anodised material. The addition of an anodised coating to the surface of a reactive metal or alloy usually provides a degree of protection from oxidisation of the surface of the metal, and/or to provide electrical insulation, which are important requirements by many speakers.

[0003] It is also well known in the art that a light-weight diaphragm with sufficient stiffness can avoid internal vibration and thus is advantageous for reproducing a high fidelity sound. In this regard, conventional coating materials are sometimes not desirable. Therefore, there is a need to look for new coating means to provide the diaphragm with good electrical insulation and protection against corrosion but without any significant increase in mass to the diaphragm. In addition, there is a similar need to protect other components of a speaker such as the dust cap, the dome, the tweeter dome, or any component that converts mechanical movement into acoustic energy.

SUMMARY OF THE INVENTION

[0004] The present invention provides a diaphragm for an electro-acoustic transducer comprising a rigid substrate made of metal or alloy that is non-porous, the substrate having two surfaces and a certain weight; and a coating, or a layer, sheet, film or foil, applied to either or both surfaces of the substrate, said coating being made of a plastic material and having a weight less than the weight of the substrate.

[0005] The use of non-porous metal or alloy ensures that the diaphragm has sufficient stiffness. The addition of the plastic coating to the surface(s) of the diaphragm substrate made of metal or alloy provides a degree of protection from oxidisation of the surface as well as electrical insulation. Moreover, to use a plastic material having a light weight guarantees no significant increase in

mass is added to the diaphragm, and this minimized weight-addition would be beneficial to the performance of the electro-acoustic transducer. Other benefits of using plastic material include increased damping over the whole diaphragm surface thus improving its acoustic performance. Furthermore, the coating may also be applied to dust caps, domes, tweeter domes, or any components of the electro-acoustic transducer that convert mechanical movement into acoustic energy.

[0006] One preferred kind of the plastic material constituting the coating is vinyl. Not only does a vinyl coating achieve the desired electrical insulation and corrosion protection for the diaphragm substrate, but it also improves the manufacturability of diaphragms during the forming process by acting as a lubricant within the press tools.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] The present invention can be better understood with reference to the following drawings and description. The components in the drawings are not necessarily to scale, emphasis instead being placed upon illustrating the principles of the invention. Moreover, in the figures, like reference numerals designate corresponding parts throughout the different views.

Fig. 1 is a cross sectional view of a metal/alloy diaphragm according to the present invention wherein both surfaces of the substrate of the diaphragm are coated with plastic material.

Fig. 2 is a cross sectional view of another metal/alloy diaphragm according to the present invention wherein the front surface of the substrate of the diaphragm is coated with plastic material.

Fig. 3 is a cross sectional view of another metal/alloy diaphragm according to the present invention wherein the reverse surface of the substrate of the diaphragm is coated with plastic material.

Fig. 4 is a cross sectional view of a coated tweeter dome according to the present invention wherein both surfaces of the dome are coated with plastic material.

Fig. 5 is a cross sectional view of another coated tweeter dome according to the present invention wherein the front surface of the dome is coated with plastic material.

Fig. 6 is a cross sectional view of yet another coated tweeter dome according to the present invention wherein the reverse surface of the dome is coated with plastic material.

DETAILED DESCRIPTION

[0008] The present invention is further described in detail with references to the figures illustrating examples of the present invention.

[0009] Fig. 1 is a cross sectional view of a diaphragm according to the present invention. It should be noted that, the diaphragm is only partly and asymmetrically shown in the figure, but this does not affect the effectiveness of supporting the explanation of the present invention. In this figure, the diaphragm 1 for an electro-acoustic transducer such as a speaker comprises a substrate 10 having two surfaces 12 and 14 and a certain weight, and a coating 15 applied to both surfaces. The substrate 10 may be of a cone-shape or a dome-shape, as both are commonly used shapes for diaphragms. But any other desired shape is applicable.

[0010] The substrate 10 is made of a rigid material, for example, a metal or an alloy that is non-porous. The metal may be aluminium, magnesium, or any other suitable metal commonly in practice. The alloy may contain one or more of the metals aluminium, beryllium, magnesium, titanium, etc. For the sake of convenience, the two surfaces of the substrate are called a front surface and a reverse surface, numbered as 12 and 14 respectively. Coating 15 is applied on both surfaces. The coating is made of a plastic material and has a weight less than the weight of the substrate 10. This plastic material may be a vinyl material, also called polymer material. Examples of vinyl include, but are not limited to, polyvinylchloride, polyvinylacetate, vinylspacelacquer, and vinylresin. The plastic coating may be applied to the substrate, for example, by spraying, dipping, printing or brushing.

[0011] Theoretically, in order to limit the weight added to the diaphragm, the coating should be as thin as possible; however, it should also be thick enough so as to satisfactorily provide electrical insulation and protection from oxidisation of the surface(s). For example, the thickness of the coating may range from 0.5 g/m² to 8 g/m²; moreover, the coating may have a thickness between 2 g/m² to 4 g/m², although this range can be changed to meet other specific requirements, such as requirements due to increased damping properties and the consequent acoustic performance improvements. The plastic material is light. For instance, for a certain type of plastic material, a thickness of 0.0025mm coating on each surface of the diaphragm corresponds to a weight of approximately 2 g/m². Furthermore, the coating may have a weight less than 1/10, or even 1/100 of the weight of the substrate 10. One exemplary set of values for the substrate and the coating is that the substrate 10 is 0.1 mm thick and the plastic coating is 0.001 mm thick.

[0012] Because both surfaces of the substrate are covered with the coating, the diaphragm in Fig. 1 may be called a double-polymer (plastic material) coated diaphragm.

[0013] Figs. 2 and 3 are cross sectional views of single polymer (plastic material) coated diaphragms. The dia-

phragm in Fig. 2 is the same as that in Fig. 1, except for that the coating is only applied to one surface, here the front surface 12, of the two surfaces of the substrate 10. Similarly, in Fig. 3, the coating is only applied to the reverse surface 14, of the two surfaces of the substrate 10. These single polymer (plastic material) coated diaphragms adds even less weight to the diaphragm.

[0014] Not only can the plastic material be applied to the diaphragm, but it may also be applied to other movable components of the electro-acoustic transducer, such as dust caps, domes, tweeter domes, and any components that convert mechanical movement into sound. For example, corresponding to Figs. 1 to 3 respectively, Figs. 4 to 6 illustrate a tweeter dome 4 coated with such plastic coating 45, either on one or both surfaces 42 and 44 of the substrate 40 of the tweeter dome.

[0015] The above described coating of the present invention provides numerous advantages. Firstly, as an alternative to anodising, the plastic coating electrically insulates and protects the coated substrate from corrosion without any significant increase in mass to the component being coated, leading to an improvement in the acoustic performance of the electro-acoustic transducer. Secondly, the use of a plastic coating also improves the manufacturability of the coated components during the forming process by acting as a lubricant within the press tools. Usually, tool ware occurs when the press tools are used over pure metal (such as aluminium) and alloys, thus lubricant, such as oil, is often required to help the metal or alloy to slide within the tool. However, conventional lubrication happens only on the tool surface and so there is a significant amount of metal- or alloy- build up on the tool surface over time. With to the present invention, however, there is plastic material, such as vinyl, within the press tools and acting as a lubricant. Thus, a much less build up of the metal or alloy would occur over the tool surface. Therefore, the present invention also has the advantage of reducing the tool ware and increases the tool life.

[0016] Although examples of the invention have been described here in above in detail, it is desired to emphasize that this has been done for the purpose of illustrating the invention and should not be considered as necessarily limitative of the invention, it being understood that many modifications and variations can be made by those skilled in the art while still practicing the invention claimed here in.

Claims

1. A diaphragm for an electro-acoustic transducer comprising:

a rigid substrate having two surfaces and a certain weight; wherein said substrate being made of non-porous metal or alloy; and
a coating applied to either or both surfaces of

the substrate; said coating being made of plastic material and having a weight less than the weight of the substrate.

2. The diaphragm of claim 1, wherein the metal is aluminium or magnesium. 5
3. The diaphragm of claim 1, wherein the alloy contains one or more of the metals aluminium, beryllium, magnesium, and titanium. 10
4. The diaphragm of one of claims 1-3, wherein the plastic material is a vinyl material.
5. The diaphragm of claim 4, wherein the vinyl material is polyvinylchloride. 15
6. The diaphragm of claim 4, wherein the vinyl material is polyvinylacetate. 20
7. The diaphragm of claim 4, wherein the vinyl material is vinyl lacquer.
8. The diaphragm of claim 4, wherein the vinyl material is vinyl resin. 25
9. The diaphragm of one of claims 1-8, having a cone-shape.
10. The diaphragm of one of claims 1-8, having a dome-shape. 30
11. The diaphragm of one of claims 1-10, wherein the coating has a thickness of 0,5 g/m² to 8g/m². 35
12. The diaphragm of claim 11, wherein the coating has a thickness of 2g/m² to 4g/m².
13. The diaphragm of one of claims 1-10, wherein the plastic material has a weight less than 1/10 of the weight of the substrate. 40
14. The diaphragm of claim 13, wherein the plastic material has a weight less than 1/100 of the weight of the substrate. 45

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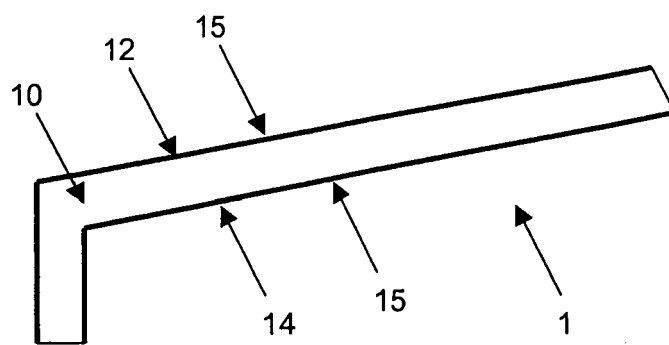


FIG. 1

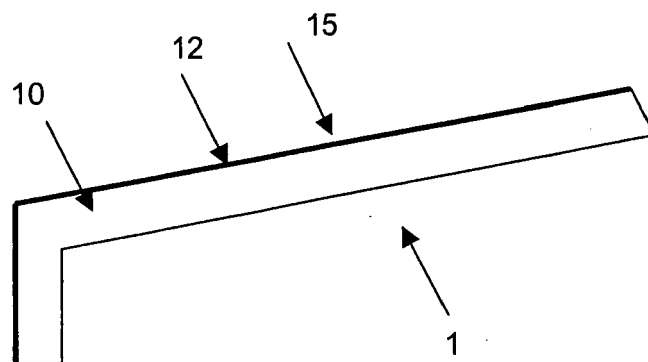


FIG. 2

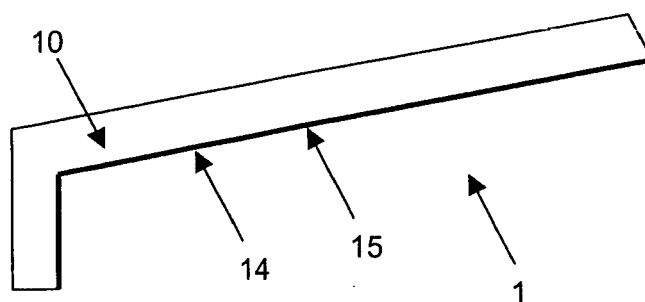


FIG. 3

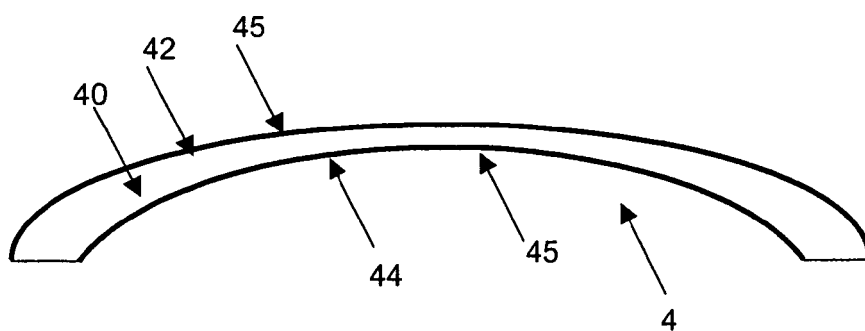


FIG. 4

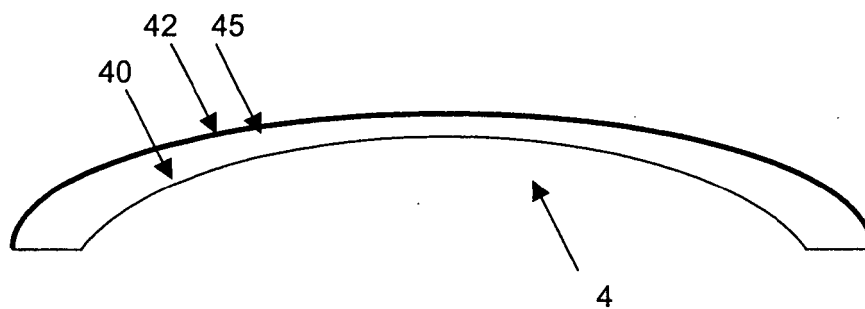


FIG. 5

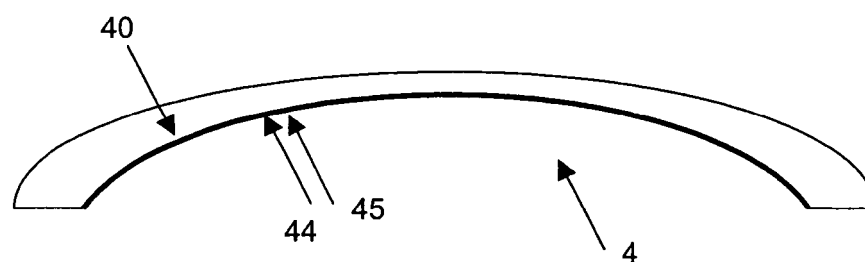


FIG. 6



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 05 02 3678

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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Y	* the whole document *	5-8,10	
Y	----- US 3 508 626 A (FRANKLIN ROBBINS) 28 April 1970 (1970-04-28) * column 3, line 53 - column 4, line 16 * * column 8, line 2 - line 51 *	5-8	
Y	----- PATENT ABSTRACTS OF JAPAN vol. 006, no. 144 (E-122), 3 August 1982 (1982-08-03) & JP 57 065997 A (ONKYO CORP), 21 April 1982 (1982-04-21) * abstract *	10	
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			TECHNICAL FIELDS SEARCHED (IPC)
			H04R
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 2 December 2005	Examiner Coda, R
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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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 05 02 3678

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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02-12-2005

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REFERENCES CITED IN THE DESCRIPTION

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