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(54) **PIEZO-ELECTRIC ACTUATOR-TRANSDUCER FOR SOUND REPRODUCTION SYSTEMS**

PIEZOELEKTRISCHER BETÄTIGER-WANDLER FÜR TONWIEDERGABE-SYSTEME

ACTIONNEUR-TRANSDUCTEUR PIEZO-ELECTRIQUE DESTINE A DES SYSTEMES DE REPRODUCTION DE SONS

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Description

Field of the invention

[0001] The present invention is related to piezo-electric actuator-transducers for sound reproduction systems.

State of the prior art

[0002] More particularly, the invention is directed to sound reproduction system applications wherein the piezoelectric actuator-transducer defines a vibration means to be secured to a panel forming part of a structure and whose vibrations would normally constitute an undesired effect. Examples of these applications are disclosed and illustrated in WO 97/16048 in the name of the same Applicant (unpublished at the priority date of the present application), wherein the panel to which the piezo-electric actuator-transducer is applied consists of a vehicle body element. In these and similar applications the piezo-electric actuator-transducer comprises in a known way a thin ceramic plate having a securing face thereof to said panel and a pair of electrodes connected to the plate. In the above-mentioned prior document examples of how the piezo-electric actuator-transducer is secured to the vibrating panel are also provided, including the aid of a structural adhesive, normally a high elasticity modulus resin, layered onto the securing face of the piezo-electric actuator-transducer to the panel.

Statement of the invention

[0003] The present invention is directed to a novel and unique expedient enabling to enhance securing of the piezo-electric actuator-transducer both in connection to a safer and more reliable anchoring thereof, and as far as easier and more convenient fixing operation thereof are concerned.

[0004] According to the invention, this object is achieved primarily by virtue of the fact that the ceramic plate of the piezo-electric actuator-transducer is fitted within a substantially tray-like container made of a relatively flexible material, having a peripheral flange provided with an adhesive layer; a seat, surrounded by said peripheral flange and having a shape complementary to that of the ceramic plate, in which said ceramic plate is housed and fixed with the securing face thereof facing to the outside of the container and arranged in a lowered plane with respect to the adhesive layer of said peripheral flange; and a receptacle interposed between said peripheral flange and said seat for the ceramic plate.

[0005] The provision of the above container enables on one hand to effectively protect the piezo-electric actuator-transducer in its installed condition and on the other hand, due to its relatively flexible construction, to make securing operation of the ceramic plate (which is instead relatively rigid and fragile) easier even onto non perfectly planar, and even curved or crowned surfaces.

[0006] Moreover the receptacle provided between the peripheral flange of the container and the seat for the ceramic plate is able to further facilitate application of the piezo-electric actuator-transducer onto the related panel, since, upon adhesion of the adhesive layer of the peripheral flange of the container against the panel onto which the piezo-electric actuator-transducer is to be applied, any excess or squeezed amount of the structural adhesive layered over the securing face of the ceramic plate is allowed to pour into the receptacle, thus being received and captured thereby. Accordingly the adhesive surfaces of the peripheral flange and of the securing face of the ceramic plate are ensured to be arranged substantially at the same level, i.e. under perfect adhesive contact with the panel to which the piezo-electric actuator-transducer is secured.

[0007] The container may be conveniently closed by a covering sheet peelably adhering to the adhesive layer of said peripheral flange and to be removed prior to securing the piezo-electric actuator-transducer onto said panel.

[0008] The receptacle interposed between the peripheral flange and the seat for the ceramic plate of the container is advantageously designed as an annular channel, and according to a preferred embodiment of the invention this annular channel is communicating with said seat for the ceramic plate through passages arranged substantially at the same level of the securing face of the ceramic plate.

[0009] Depending upon the shape of the ceramic plate, the housing may be circular, quadrangular or even polygonal.

[0010] Moreover the flange of the container, which is normally made of moulded thermoplastic material, may be formed with a passage for outer wires connected to the electrodes of the piezo-electric actuator-transducer.

Brief descrprition of the drawings

[0011] The invention will now be disclosed in detail with reference to the accompanying drawings, purely provided by way of non limiting example, in which:

- figure 1 is a rear perspective view of a piezo-electric actuator-transducer according to a preferred embodiment of the invention,
- figure 2 is a front perspective view of the piezo-electric actuator-transducer,
- figure 3 is a cross sectioned and enlarged view showing the piezo-electric actuator-transducer of figures 1 and 2 in its fixed condition to a vibrating panel, and
- figure 4 is a perspective view showing the piezo-electric actuator-transducer immediately prior to fixing thereof to the panel such as shown in figure 3.

Detailed description of a preferred embodiment of the invention

[0012] Referring initially to figures 1 and 2, reference numeral 1 generally designates a piezo-electric actuator-transducer according to the invention, to be employed with a sound reproduction system comprising a sound pick-up or sound receiver apparatus, an amplifier apparatus and at least one vibrating-element sound emitter, formed by a panel or the like to which the piezo-electric actuator-transducer 1 is secured in the way which will be clarified herebelow.

[0013] The vibrating panel to which the piezo-electric actuator-transducer is to be secured, diagrammatically depicted as P in figure 3, may be constituted by a structural member of motor-vehicle body or by the shall of a helmet, or by the body of an illuminating apparatus or by any other element adapted to vibrate so has to produce sounds.

[0014] The piezo-electric actuator-transducer 1 is formed, according to the invention, by a thin ceramic plate 2 of a conventional type, provided also in a way known per se with a pair of electrodes (not shown) connected to outer wires 3, and by a container 4 within which the ceramic plate 2 is fitted and permanently fixed.

[0015] In the case of the shown example the ceramic plate 2 and the container 4 have a circular design: it is however to be pointed out that the shape of either one or both may be different, for instance quadrangular or polygonal.

[0016] The ceramic plate 2 may be for instance of the type produced and marketed by Hoechst AG under the trade name Sonox® P 51 and the like.

[0017] The container 4 has a generally cup or tray-like configuration and is made of a relatively flexible material, for instance a moulded thermoplastic material. The container 4 is formed with a peripheral annular flange 5 whose face intended to be placed into contact with the panel P is covered by an adhesive layer 6 which can be constituted, for instance, by a bi-adhesive annular film.

[0018] Innerly of the peripheral flange 5, the container 4 is formed with a lowered seat 7 having a shape complementary of that of the ceramic plate 2, within which this ceramic plate 2 is housed and fixed, in correspondence of its inner face, by means of an adhesive layer 8.

[0019] As better shown in figure 3, the depth of the seat 7 is greater than the thickness of the ceramic plate 2 added to the thickness of the inner adhesive layer 8, whereby the outer face of this ceramic plate 2, designated as 2a, is arranged in a lowered plane with respect to the outer surface of the adhesive layer 6 of the peripheral flange 5. The difference in height therebetween may be normally comprised between 0.05 and 0.03 mm, and is preferably about 0.1 mm.

[0020] Between the seat 7 and the annular flange 5, the container 4 is formed with a receptacle designed as an annular channel 9, which is also lowered with respect to the peripheral flange 5. This intermediate annular channel 9 is in communication with the seat 7 through passages arranged substantially at the same level as the outer face 2a of the ceramic plate 2. In the case of the shown example, these passages are formed by a number of radial grooves 10 provided on top of the wall delimiting the seat 7.

[0021] In correspondence of the seat 7, the container 4 may be formed with outer stiffening ribs 11. Moreover the back of the annular flange 5 is conveniently provided with an integral tunnel 12 passed through by the outer wires 3.

[0022] In the condition preceding its application, depicted in figures 1 and 2, the piezo-electric actuator-transducer 1 is provided with a cover sheet 13 adhering in a peelable way to the adhesive layer 6 of the peripheral flange 5, so as to overlay the outer face 2a of the ceramic plate 2.

[0023] Upon application of the piezo-electric actuator-transducer 1 onto the panel 2, the cover sheet 13 is removed (such as shown in figure 2), so as to expose the adhesive layer 6 and the outer face 2a of the ceramic plate 2.

[0024] Then a layer of structural adhesive 14, normally comprising a high elasticity modulus resin (for instance an epoxy resin) is deposited onto the outer face 2a, such as shown in figure 4.

[0025] Thereafter the piezo-electric actuator-transducer 1 is brought into contact against the panel P, adhering thereonto the adhesive layer 6 of the peripheral flange 5, as well as the structural adhesive layer 14 applied on the outer face 2a of the ceramic plate 2. At this stage, any excess or squeezed amount of the structural adhesive 14 pours through the passages 10 into the receptacle 9, thus being captured therein. This ensures the thickness of the structural adhesive 14 to be that necessary and sufficient to fill the gap between the outer face 2a of the ceramic plate 2 and the outer surface of the adhesive layer 6 of the peripheral flange 5. Accordingly, in the fixed condition shown in figure 3, both the adhesive surfaces defined by the adhesive layer 6 and by the structural adhesive 14 are perfectly contacting the surface of the panel P.

[0026] The flexibility of the container 4, namely of its flange 5, enables accommodation, and thus a most efficient anchoring, of the piezo-electric actuator-transducer 1 even to panels P having a non perfectly planar configuration, i.e. with a curved and even crowned design.

[0027] It will be apparent from the above that the container 4 enables both to make application of the piezo-electric actuator-transducer 1 easier, and to achieve a particularly safe and reliable anchoring thereof in the applied condition. Additionally the container 4 provides efficient protection of the ceramic plate 2 in the fixed condition of the piezo-electric actuator-transducer 1 to the panel P.

[0028] Naturally the details of construction and the embodiments may be widely varied with respect to what

has been disclosed and illustrated, without thereby departing from the scope of the present invention such as defined in the appended claims.

Claims

1. Piezo-electric actuator-transducer (1) for sound reproduction systems in which said piezo-electric actuator-transducer (1) defines a vibration means to be secured to a panel (P) forming part of a structure such as a vehicle body or the like, and wherein said piezo-electric actuator-transducer (1) comprises a thin ceramic plate (2) having a securing face (2a) thereof to said panel (P) and a pair of electrodes (3) connected to said plate (2), characterized in that said ceramic plate (2) is fitted within a substantially tray-like container (4) made of a relatively flexible material, having a peripheral flange (5) provided with an adhesive layer (6); a seat, surrounded by said peripheral flange (5) and having a shape complementary to that of said ceramic plate (2), in which said ceramic plate (2) is housed and fixed with said securing face (2a) thereof facing to the outside of the container (4) and arranged in a lowered plane with respect to the adhesive layer (6) of said peripheral flange (5); and a receptacle (9) interposed between said peripheral flange and said seat (7) for the ceramic plate (2).

2. Piezo-electric actuator-transducer according to claim 1, characterized in that said container (4) is closed by a covering sheet (13) peelably adhering to the adhesive layer (6) of said peripheral flange (5) and to be removed prior to securing the piezo-electric actuator-transducer (1) onto said panel (P).

3. Piezo-electric actuator-transducer according to claim 1, characterized in that the container (4) is formed, in correspondence of said seat (7) for the ceramic plate (2), with outer stiffening ribs (11).

4. Piezo-electric actuator-transducer according to claim 1, characterized in that said receptacle (9) has an annular channel design.

5. Piezo-electric actuator-transducer according to claim 4, characterized in that said annular channel (9) is in communication with said seat (7) for the ceramic plate (2) through passages (10) arranged substantially at the same level of said securing face (2a) of the ceramic plate (2).

6. Piezo-electric actuator-transducer according to claim 1, characterized in that said peripheral flange (5) of the container (4) is formed with a passage (12) for outer wires (3) connected to said electrodes.

7. Piezo-electric actuator-transducer according to any of the preceding claims, characterized in that said container (4) has a circular shape.

8. Piezo-electric actuator-transducer according to any of claims 1 through 6, characterized in that said container (4) has a quadrangular shape.

9. Piezo-electric actuator-transducer according to any of claims 1 through 6, characterized in that said container (4) has a polygonal shape.

10. Piezo-electric actuator-transducer according to any of the preceding claims, characterized in that said container (4) is made of moulded plastic material.

Patentansprüche

1. Piezo-elektrischer Steller-Wandler (1) für Tonwiedergabesysteme, in welchem der piezo-elektrische Steller-Wandler (1) ein Vibrationsmittel definiert, um an einer Tafel (P), die eine Konstruktion wie ein Fahrzeugkörper oder ähnliches bildet, befestigt zu werden, und wobei der piezo-elektrische Steller-Wandler (1) eine dünne Keramikplatte (2) umfaßt, die eine Befestigungsseite (2a) an der Tafel (P) und ein Paar Elektroden (3), die mit der Platte (2) verbunden sind, aufweist, dadurch gekennzeichnet, daß die Keramikplatte (2) in einen im wesentlichen tablettartigen Behälter (4) eingepaßt wurde, welcher aus einem relativ flexiblen Material hergestellt wurde, und einen peripheren Flange (5) aufweist, welcher mit einer klebenden Schicht (6) versehen ist; einem Sitz, umgeben von dem peripheren Flange (5) und welcher eine Form komplementär zu der der Keramikplatte (2) aufweist, in welchem die Keramikplatte (2) untergebracht und mit der Befestigungsfläche (2a) gegenüber der Außenseite von dem Behälter (4) fixiert ist und in einer niedrigeren Ebene unter Berücksichtigung der klebenden Schicht (6) von dem peripheren Flange (5) angeordnet ist; und ein Aufnehmer (9), welcher zwischen dem peripheren Flange und dem Sitz (7) für die Keramikplatte (2) angeordnet ist.

2. Piezo-elektrischer Steller-Wandler gemäß Anspruch 1, dadurch gekennzeichnet, daß der Behälter (4) durch eine Abdeckschicht (13) geschlossen ist, welche ablösbar an der Klebeschicht (6) von dem peripheren Flange (5) haftet, um vor dem Befestigen des piezo-elektrischen Steller-Wandlers (1) auf der Tafel (P) entfernt zu werden.

3. Piezo-elektrischer Steller-Wandler gemäß Anspruch 1, dadurch gekennzeichnet, daß der Behälter (4) in Übereinstimmung mit dem Sitz (7) für die Keramikplatte (2) mit äußeren Versteifungsrippen

(11) ausgebildet ist.

4. Piezo-elektrischer Steller-Wandler gemäß Anspruch 1, dadurch gekennzeichnet, daß der Aufnehmer (9) einen ringförmigen Rinnenaufbau aufweist.

5. Piezo-elektrischer Steller-Wandler gemäß Anspruch 4, dadurch gekennzeichnet, daß die ringförmigen Rinnen (9) mit dem Sitz (7) für die Keramikplatte (2) durch Durchgänge (10), die im wesentlichen auf der selben Ebene von der Befestigungsfläche (2a) von der Keramikplatte (2) angeordnet sind, in Verbindung stehen.

6. Piezo-elektrischer Steller-Wandler gemäß Anspruch 1, dadurch gekennzeichnet, daß der periphere Flange (5) von dem Behälter (4) mit einem Durchlaß (12) für äußere Drähte (3), die mit den Elektroden verbunden sind, ausgebildet ist.

7. Piezo-elektrischer Steller-Wandler gemäß einem der vorgenannten Ansprüche, dadurch gekennzeichnet, daß der Behälter (4) eine kreisförmige Form aufweist.

8. Piezo-elektrischer Steller-Wandler gemäß einem der Ansprüche 1 bis 6, dadurch gekennzeichnet, daß der Behälter (4) eine viereckige Form aufweist.

9. Piezo-elektrischer Steller-Wandler gemäß einem der Ansprüche 1 bis 6, dadurch gekennzeichnet, daß der Behälter (4) eine polygonale Form aufweist.

10. Piezo-elektrischer Steller-Wandler gemäß einem der vorgenannten Ansprüche, dadurch gekennzeichent, daß der Behälter (4) aus geformtem Plastikmaterial hergestellt ist.

Revendications

1. Actionneur-transducteur piézoélectrique (1) pour systèmes de reproduction de sons dans lesquels ledit actionneur-transducteur piézoélectrique (1) définit un moyen de vibration destiné à être fixé à un panneau (P) faisant partie d'une structure, comme par exemple une carrosserie de véhicule ou analogue, et où ledit actionneur-transducteur piézoélectrique (1) comprend une plaque de céramique mince (2) qui possède une face de fixation (2a) audit panneau (P) et une paire d'électrodes (3) connectées à ladite plaque (2), caractérisé en ce que ladite plaque de céramique (2) est installée à l'intérieur d'un conteneur sensiblement du type plateau (4) fait en une matière relativement souple, possédant : un rebord périphérique (5) doté d'une couche d'adhésif (6) ; un siège, entouré par ledit rebord périphérique (5) et ayant une forme complémentaire de celle de ladite plaque de céramique (2), dans lequel ladite plaque de céramique (2) est logée et fixée de façon que sa dite face de fixation (2a) soit tournée vers l'extérieur du conteneur (4) et soit disposée dans un plan abaissé par rapport à la couche d'adhésif (6) dudit rebord périphérique (5) ; et un réceptacle (9) s'interposant entre ledit rebord périphérique et ledit siège (7) destiné à la plaque de céramique (2).

2. Actionneur-transducteur piézoélectrique selon la revendication 1, caractérisé en ce que ledit conteneur (4) est fermé par une feuille de revêtement (13) collant de manière pelable à la couche d'adhésif (6) dudit rebord périphérique (5) et destinée à être enlevée avant la fixation de l'actionneur-transducteur piézoélectrique (1) sur ledit panneau (P).

3. Actionneur-transducteur piézoélectrique selon la revendication 1, caractérisé en ce que le conteneur (4) est doté, en correspondance avec ledit siège (7) destiné à la plaque de céramique (2), de nervures de raidissement externes (11).

4. Actionneur-transducteur piézoélectrique selon la revendication 1, caractérisé en ce que ledit réceptacle (9) possède une forme de canal annulaire.

5. Actionneur-transducteur piézoélectrique selon la revendication 4, caractérisé en ce que ledit canal annulaire (9) est en communication avec ledit siège (7) destiné à la plaque de céramique (2) via des moyens de passage (10) disposés sensiblement au même niveau que ladite face de fixation (2a) de la plaque de céramique (2).

6. Actionneur-transducteur piézoélectrique selon la revendication 1, caractérisé en ce que ledit rebord périphérique (5) du conteneur (4) est doté d'un moyen de passage (12) destiné aux fils conducteurs externes (3) connectés auxdites électrodes.

7. Actionneur-transducteur piézoélectrique selon l'une quelconque des revendications précédentes, caractérisé en ce que ledit conteneur (4) possède une forme circulaire.

8. Actionneur-transducteur piézoélectrique selon l'une quelconque des revendications 1 à 6, caractérisé en ce que ledit conteneur (4) possède une forme quadrangulaire.

9. Actionneur-transducteur piézoélectrique selon l'une quelconque des revendications 1 à 6, caractérisé en ce que ledit conteneur (4) possède une forme polygonal.

10. Actionneur-transducteur piézoélectrique selon l'une quelconque des revendications précédentes, caractérisé en ce que ledit conteneur (4) est fait en matière plastique moulée.

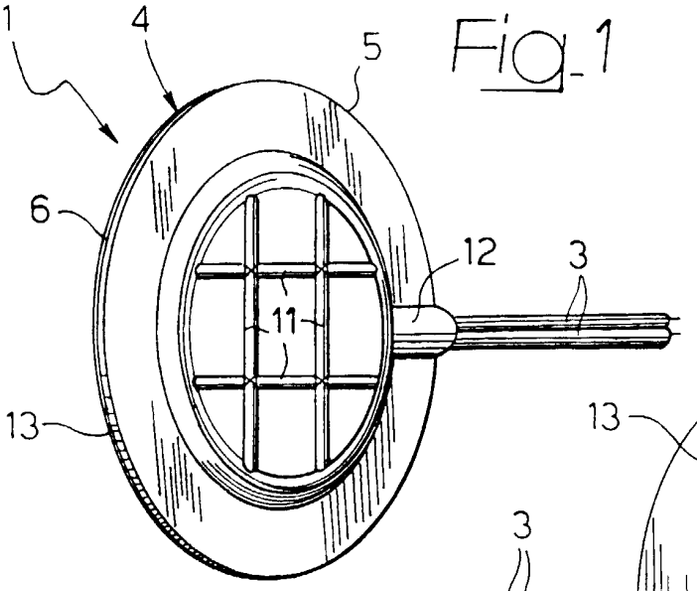

Fig_1

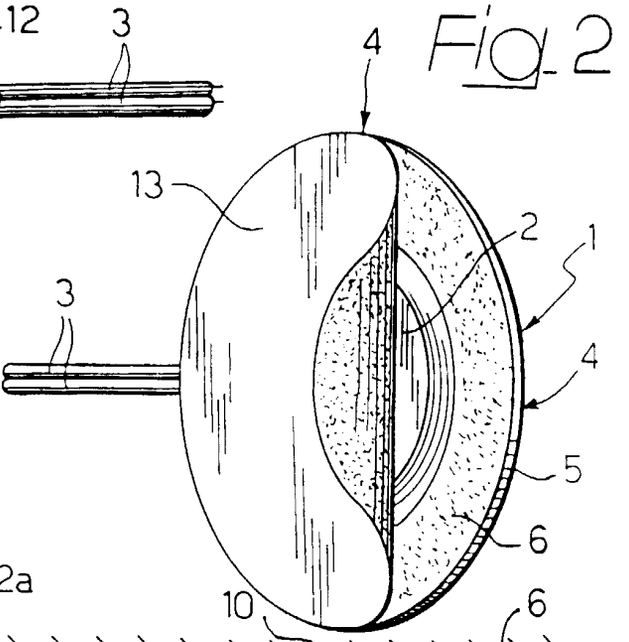

Fig_2

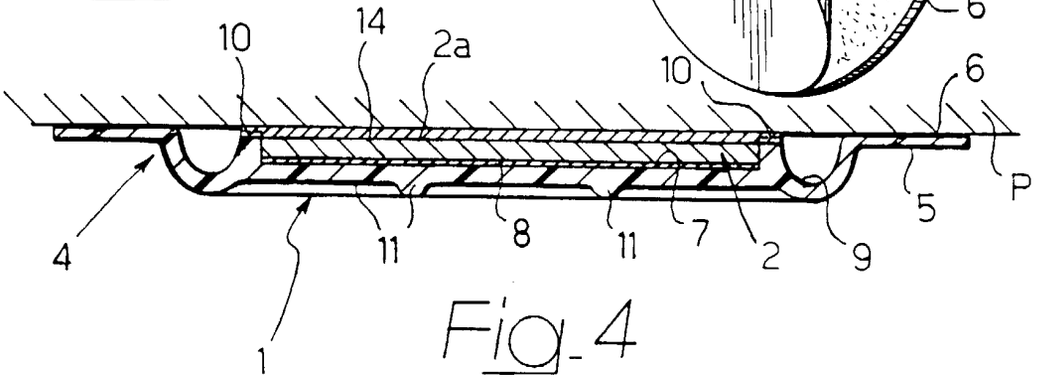

Fig_3

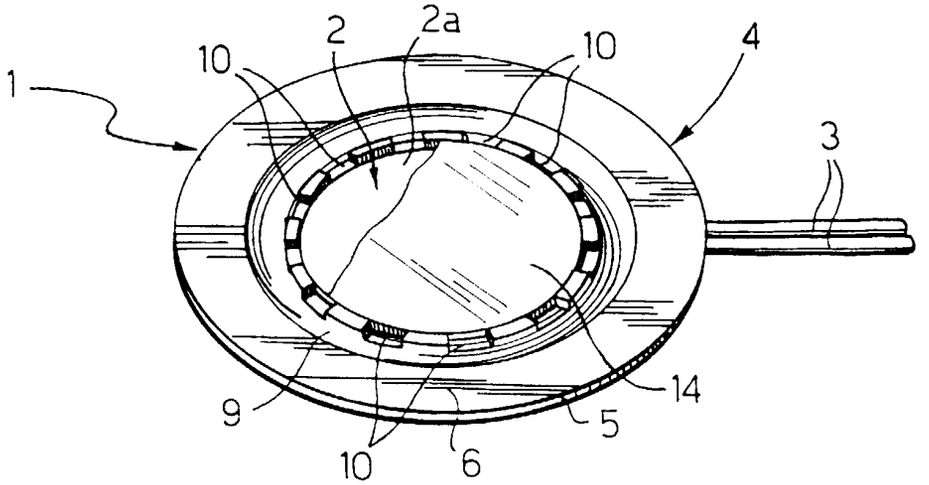

Fig_4