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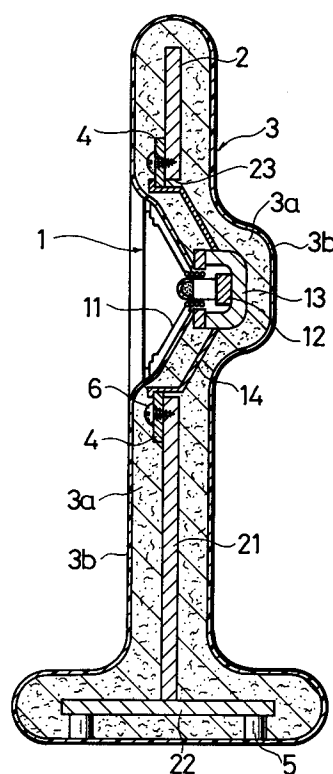
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(54) **Speaker unit casing structure.**

(57) Disclosed is a speaker unit casing structure including a speaker unit support of a high-rigid material. To prevent radiation of the resonance sound from the rigid parts of the speaker system, the high-rigid material parts of the speaker unit and the speaker unit support are covered with a sound absorbing material (3a), and the covering of the sound absorbing material is covered with a sheet (3b) of sound barrier material which is characteristic of an increased acoustical loss.

FIG. 1**EP 0 531 998 A2**

The present invention relates to an improvement in or relating to speaker unit casing structure. More specifically the present invention relates to a speaker unit casing structure which prevents radiation of the resonance sound from a speaker unit, a rear opening type speaker unit support such as a baffle or frame, or an enclosure type speaker unit support, thereby reproducing acoustic signals with high fidelity.

No matter which type or shape the speaker unit support may be of, the rear opening type or the enclosure type, the speaker unit support must be rigid enough to assure the stable fixing of the speaker unit, and at the same time, it must have an inner acoustic loss enough to reduce its resonance to a possible minimum.

There is, however, no material to meet these requirements. Only from the rigid point of view the speaker unit support may be preferably made of metal, ceramics or glass. In an attempt to reduce the weight of the speaker unit support, and accordingly reduce its resonance time to possible minimum, metal speaker unit supports of honeycomb structure are used. This honeycomb structure, however, cannot get rid of the sharp "Q" of the speaker unit support. The weight reduction of glass or ceramic supports is impossible, and therefore their resonance time cannot be reduced with recourse to weight reduction. In this connection a rubber piece is used at a place at which a speaker unit is fixed to the speaker unit support, thereby suppressing transmission of vibration from the speaker unit to the speaker unit support. Disadvantageously the use of such rubber piece between the speaker unit and the speaker unit support prevents the stable fixing of the speaker unit to the speaker unit support. Also, disadvantageously a clear rising sound of recorded sound can be hardly reproduced.

Only from the angle of inner acoustic loss the speaker unit support is preferably made of wood or plastics. These materials may have a flattened "Q", compared with the high-rigid materials described above. The materials, however, allow the sound to travel at such a slow speed that a heavy, thick resonance sound may be caused. As may be understood, the problems cannot be completely solved with recourse to selection of materials.

All materials which are somewhat rigid, ranging from plastics to fine ceramics, will cause resonance. In an attempt to reduce undesired resonance a deadening material such as lead or rubber is applied to rigid materials, but this remedy deteriorates the reproduced sound by causing heavy, thick sound to accompany the reproduced sound. If no remedy is taken to reduce resonance in the speaker unit support, an appreciable amount of distortion will appear in the reproduced sound.

In an attempt to reduce above described problems it was proposed that an enclosure type speaker unit support is stuffed with a sound absorbing material as is taught in US Patent 2,315,896, US Patent 3,275,100, or Japanese Utility Model 2-126,493(A).

As for the rear opening type speaker unit support there have been few proposals other than putting of a rubber piece between a speaker and an associated speaker unit support.

Parts other than the cone or diaphragm of a speaker unit, such as the permanent magnet, the cone housing or the diaphragm support, the electrode support are made of high-rigid materials, and these high-rigid parts of the loudspeaker if attached to a rear-opening type speaker unit support, will be exposed outside, permitting radiation of the resonance sound from such high-rigid parts in addition to the speaker unit support.

As for the enclosure type speaker unit support: in case where the speaker unit support is made of plywood board, wood and any other materials which are characteristic of a large amount of inner acoustic loss, as proposed in US Patents 2,315,896 and 3,275,100, a heavy, thick resonance sound is liable to be caused because of a relatively slow acoustic transmission speed in these materials. Also, disadvantageously the stable supporting of speaker units are hardly attainable. The total weight of the box-like speaker system is supported by the whole bottom area of the box-like housing, and it is most likely that the air which is trapped in very small irregular spaces in the interference between the bottom surface of the housing and the floor of the room will cause resonance, producing resonance sound.

In case where a speaker system has legs to stand on the floor, as in Japanese Utility Model 2-126493(A), the resonance sound of the speaker unit support is liable to be transmitted to the floor via such legs.

As may be understood from the above, it is realized that not only the speaker unit support but also parts of the speaker unit other than the cone or diaphragm of the speaker cannot get rid of resonance. Complete elimination of the resonance of the speaker unit support is impossible with recourse to the deadening of resonance sound, but the confining and shielding of the acoustic energy from the resonance of the speaker unit support is practically possible. It was found that the enclosing of the speaker unit support within a sound shielding barrier is effective to prevent radiation of the resonance sound from the inside of the enclosure to the surrounding air, and that the resonance sound can be eliminated almost completely from the acoustic point of view.

Thus, the inventor proposes that at least the speaker support unit of a high-rigid material is confined and enclosed by an acoustic barrier. Also, the inventor proposes that the high-rigid parts of a loudspeaker when attached to a rear-opening type speaker unit support are confined and enclosed by an acoustic barrier. This has the effect of eliminating the resonance sound, thus substantially improving the quality of the reproduced sound. The complete enclosure of the housing has the effect of eliminating undesired transmission of the resonance sound to the floor via its legs, and of getting rid of resonance which otherwise, would be caused in the small spaces in the interface between the bottom surface of the housing and the floor.

A speaker unit casing structure including a rear-opening type speaker unit support of a high-rigid material is so constructed according to the present invention that the high-rigid material parts of said speaker unit and the whole inner and outer surface of said speaker unit support are covered with a sound absorbing material, and that the covering of the sound absorbing material is covered with a sheet of sound barrier material which is characteristic of an increased acoustic loss, thus providing a sound barrier enclosure.

A speaker unit casing structure including a box-like speaker unit support of a high-rigid material is so constructed according to the present invention that the whole inner and outer surface of said box-like enclosure is covered with a sound absorbing material, and that the covering of the sound absorbing material is covered with a sheet of sound barrier material which is characteristic of an increased acoustic loss, thus providing a sound barrier enclosure.

Examples of high-rigid materials are hard metals such as steel, hard plastics, glass, ceramics or fine ceramics. Speaker units may be of dynamic type or condenser type.

Examples of sound absorbing materials are glass-wool or rock wool of relatively high density. Examples of sound shielding or barrier materials are rubber impregnated with pulverized lead or soft plastics such as polypropylene, which materials are characteristic of an increased inner acoustic loss.

With a view to eliminate the irregular interface between the bottom of the housing and the floor it is preferable that legs are fixed to the bottom of the housing and that such legs are confined within the sound barrier enclosure.

In operation the speaker unit is responsive to electric signals for radiating reproduced sound from the front of the speaker unit, and at the same time, the sound wave in the opposite phase reaches the speaker unit support, the permanent magnet, the cone or diaphragm support, the electrode support and any other high-rigid parts of the loudspeaker

so that the speaker unit support and these high-rigid parts may resonate, but the resonance sound cannot leak out of the surrounding acoustic barrier. The rigid speaker unit support assures the stable supporting of the speaker unit.

In case that legs are fixed to the bottom of the housing and that such legs are confined within the sound barrier enclosure there can be caused no resonance sound in the interface between the housing of the speaker system and the floor.

While assuring the stable supporting of the speaker unit thanks to use of a high-rigid material in making a speaker unit support, radiation of resonance sound is practically prevented, and accordingly the quality of reproduced sound is improved. This is particularly true with a rear-opening type speaker unit support, which has been hitherto regarded as being incapable of providing pure sound because of resonance of its baffle.

Other objects and advantages of the present invention will be understood from the following description of preferred embodiments of the present invention, which are shown in accompanying drawings:

Fig.1 is a longitudinal section of an inverted "T"-shaped speaker unit support of rear-opening type according to one preferred embodiment of the present invention;

Fig.2 is a section of the speaker unit used in Fig.1, showing how the yoke and cone housing of the speaker unit are covered;

Fig.3 is a cross section of a rear-opening type speaker unit support having a condenser speaker unit attached thereto according to another embodiment of the present invention;

Fig.4 is a longitudinal section taken along the line X-X in Fig.3 and seen in the direction indicated by arrows;

Fig.5 is a cross section taken along the line Y-Y in Fig.4 and seen in the direction indicated by arrows; and

Fig.6 is a longitudinal section of a box-like speaker support unit according to still another embodiment of the present invention.

In the drawings same parts are indicated by same reference numerals. Fig.1 shows a speaker system using a speaker unit casing according to a first embodiment of the present invention, particularly using a rear-opening type, inverted "T"-shaped baffle or speaker unit support. It comprises a dynamic loudspeaker unit 1, a flat baffle or speaker support unit 2 and a sound barrier or shielding enclosure 3.

The flat baffle 2 is made of fine ceramics, and is given an inverted "T"-shape, which is composed of a vertical board 21 and a horizontal board 22. A dynamic speaker unit 1 is attached to the circumference of the opening of the vertical board 21 via

an associated annular frame 4 and screws 6. Four legs 5 are fixed to the bottom surface of the horizontal board 22. The flat baffle 2 may be made of glass, ceramics, hard plastics or any other high-rigid materials.

The speaker unit 1 comprises a center permanent magnet 12, a "U"-shaped yoke 13 and a cone or diaphragm 11 attached to the yoke 13. A cone housing 14 is fixed to the circumference of the yoke 13, and at the same time to the annular frame 4, which is fixed to the circumference of the opening of the vertical board 21 by screws 6 as described earlier.

The flat baffle 2 and the high-rigid parts of the speaker unit, that is, the cone housing 14 and the yoke 13 of the speaker unit are confined and enclosed by the sound shield 3. Specifically the front side excluding of the cone 11 of the speaker unit is shielded by the sound shield, and the rear side of the speaker unit is completely shielded by the sound shield. As shown, the unit frame 4, flat baffle 2, cone housing 14 and the rear side of yoke 13 are covered by a sound absorbing material such as glass-wool 3a of relatively high density, and this sound absorbing covering is covered by a sheet of sound barrier material 3b which is characteristic of an increased acoustic loss, such as pulverized lead-impregnated rubber sheet. All corners of the sound barrier 3b are rounded to cause a sound shielding effect due to diffraction.

The cone housing 14 of the speaker unit may be of a cross shape as seen in Fig. 2. Such a speaker unit is enclosed without leaving its high-rigid parts exposed, and the enclosure has four openings H.

When the dynamic speaker 1 is put in operation, the speaker unit support 2 and the yoke 13 and cone housing 14 of the speaker unit permit radiation of resonance sound of high-frequency range, and then the high-frequency resonance sound from such high-rigid parts will be absorbed in the surrounding sound absorbing layer 3a, and will be shielded by the overlying sound barrier 3b, which has a very flattened "Q" factor. The sound absorbing material used is of such a high-density that the lagging effect may be caused, which lagging effect would be caused to absorb the resonance sound produced by the fluid flowing at an increased speed in pipings.

The sound barrier 3b will prevent radiation of resonance sound which otherwise, would be caused by the air trapped in the irregularities appearing in the interface between the legs 5 of the speaker unit support and the floor.

Figs.3 to 5 show a rear-opening type speaker unit support included in a speaker unit casing structure according to another embodiment of the present invention. A condenser speaker unit is in-

dicated by 1a; a speaker unit support or frame is indicated by 2a; and a sound shield to enclose the speaker unit support 2a in a sealed manner is indicated by 3.

The condenser speaker unit 1a comprises a plate-like diaphragm 11a, a unit frame 4a to hold the plate-like diaphragm 11a, electrode nets 100 spaced from and stretched horizontally over the front and rear sides of the plate-like diaphragm 11a, a plurality of electrode supports 101 vertically extending to support the electrode nets 100, and reinforcements 102 horizontally extending to support the electrode supports 101 at their centers. Each electrode net 100 has a plurality of opposite "U"-shaped ends fixed to the front and rear surface of the frame 4a respectively, and the major plane of the electrode net 100 is held on its opposite sides by the vertical electrode support strips 101. The horizontal reinforcements 102 are applied to the electrode supports 101 at their centers where the plate-like diaphragm 11a will vibrate at an increased amplitude.

As seen from Figs.3 to 5, the high-rigid parts of the speaker unit 1a, that is, unit frame 4a, electrode supports 101, reinforcements 102 and frame 2a are enclosed by the sound shield 3 in a sealed fashion. The sound shield 3 is composed of a sound absorbing material 3a such as glass-wool of relatively high density, which completely cover unit frame 4a, electrode supports 101, reinforcements 102 and frame 2a, and a sound barrier sheet 3b such as pulverized lead impregnated rubber sheet to cover the sound absorbing material 3a. The overlying sound barrier 3b is rounded at each corner to provide the sound shielding effect due to diffraction, as is the case with the first embodiment.

In operation, the frame 2a, unit frame 4a and electrode supports 101 cause radiation of resonance sound of high-frequency range, and then the high-frequency resonance sound from such high-rigid parts will be absorbed in the surrounding sound absorbing layer 3a, and will be shielded by the overlying sound barrier 3b, which has a very flattened "Q" factor.

Fig.6 shows a still another embodiment of the present invention using an enclosure type speaker unit support. In the drawing a dynamic speaker unit is indicated by 1a; an enclosure type speaker unit support 2c, and a sound shield 3 to enclose the speaker unit support 2c in a sealed fashion.

The speaker unit support 2c is a box-like structure of fine ceramics, having an opening 21c on its front side and a dynamic loudspeaker 1a attached to the circumference of the opening by an associated unit frame 4a and screws 5a. The speaker unit support 2c has three legs 5a on its bottom.

The speaker unit support 2c along with its legs 5a are enclosed by the sound shield 3 in a sealed

fashion, only leaving the cone 11a of the speaker unit visible from the exterior. The sound shield 3 is composed of a sound absorbing material 3a such as glass-wool of relatively high density to completely cover the speaker unit support 2c, and a sound barrier sheet 3b such as pulverized lead impregnated rubber sheet to cover the sound absorbing material 3a.

When the dynamic loudspeaker 1a works, the speaker support unit 2c causes radiation of resonance sound, and then the resonance sound will be absorbed in the surrounding sound absorbing layer 3a, and will be shielded by the overlying sound barrier 3b, which has a very flattened "Q" factor. The sound absorbing material of a relatively high-density will cause the lagging effect such as seen in deadening the resonance sound due to the fluid flowing at a high-speed in piping.

The sound barrier 3b will prevent radiation of resonance sound which otherwise, would be caused by the air trapped in the irregularities appearing in the interface between the legs 5a and 5b of the speaker unit support 2c and the floor.

Claims

1. A speaker unit casing structure including a speaker unit support of a high-rigid material characterized in that said speaker unit support is of a rear-opening type, and that the high-rigid material part of said speaker unit and the whole inner and outer surface of said speaker unit support are covered with a sound absorbing material, and the covering of the sound absorbing material is covered with a sheet of sound barrier material which is characteristic of an increased acoustical loss, thus providing a sound barrier enclosure.
2. A speaker unit casing structure claimed in Claim 1, wherein said speaker unit is a dynamic loudspeaker unit.
3. A speaker unit casing structure claimed in Claim 1, wherein said speaker unit is a condenser loudspeaker unit.
4. A speaker unit casing structure claimed in any of Claims 1 to 3, wherein said speaker unit support is an inverted-"T" shaped flat baffle.
5. A speaker unit casing structure claimed in Claim 4, wherein said speaker unit support has legs on its bottom, said legs being confined within said sound barrier enclosure.
6. A speaker unit casing structure claimed in any of Claims 1 to 5, wherein said sound barrier

material is a lead-impregnated rubber.

7. A speaker unit casing structure including a speaker unit support of a high-rigid material characterized in that said speaker unit support is a box-like enclosure, the whole inner and outer surface of said box-like enclosure is covered with a sound absorbing material, and the covering of the sound absorbing material is covered with a sheet of sound barrier material which is characteristic of an increased acoustical loss, thus providing a sound barrier enclosure.
8. A speaker unit casing structure claimed in Claim 7, wherein said speaker unit support has legs on its bottom, said legs being confined within said sound barrier enclosure.

FIG. 1

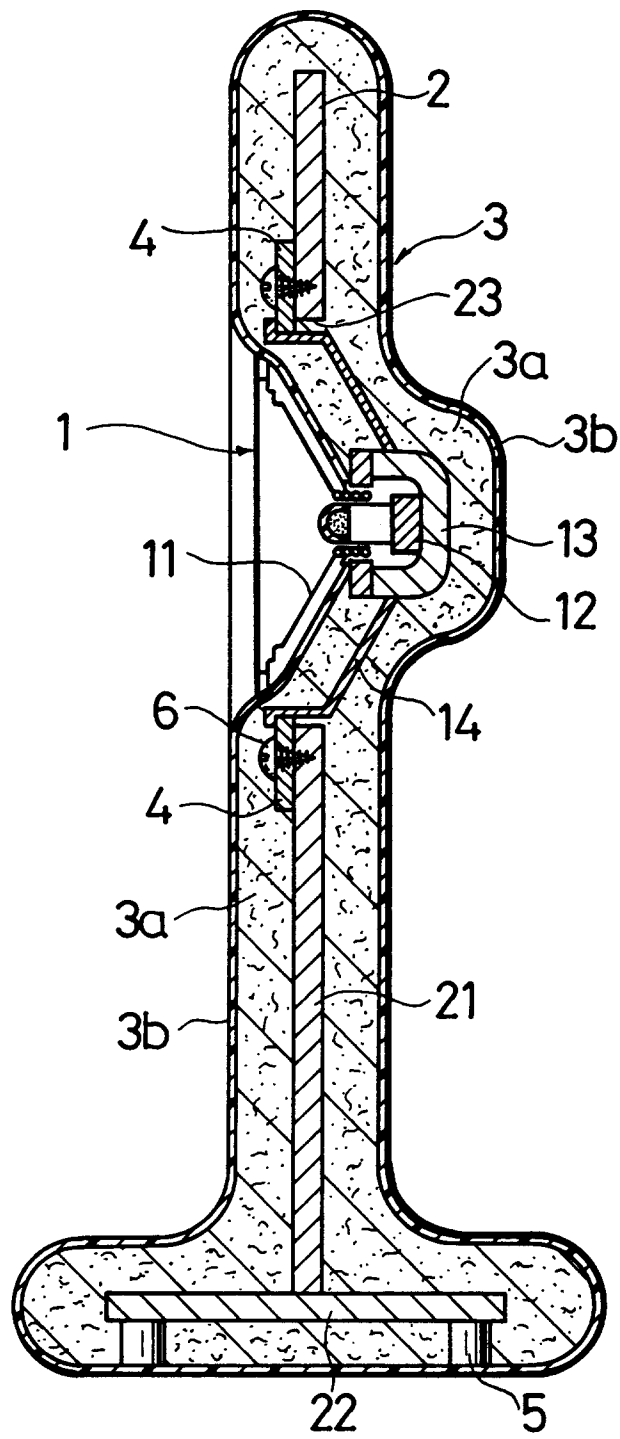


FIG. 2

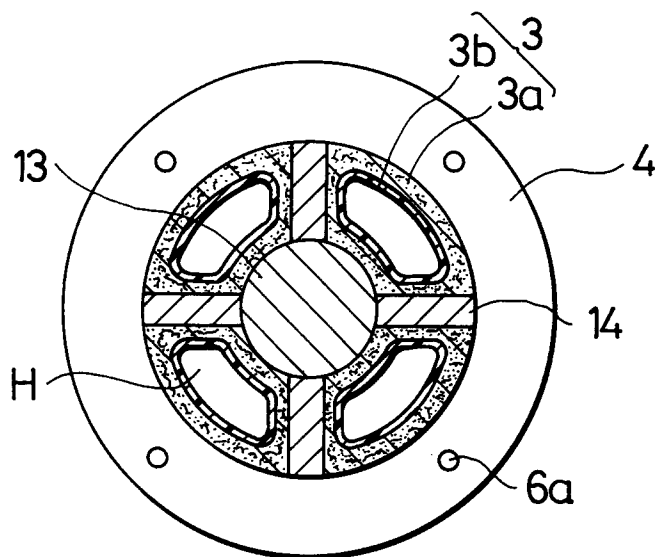


FIG. 3

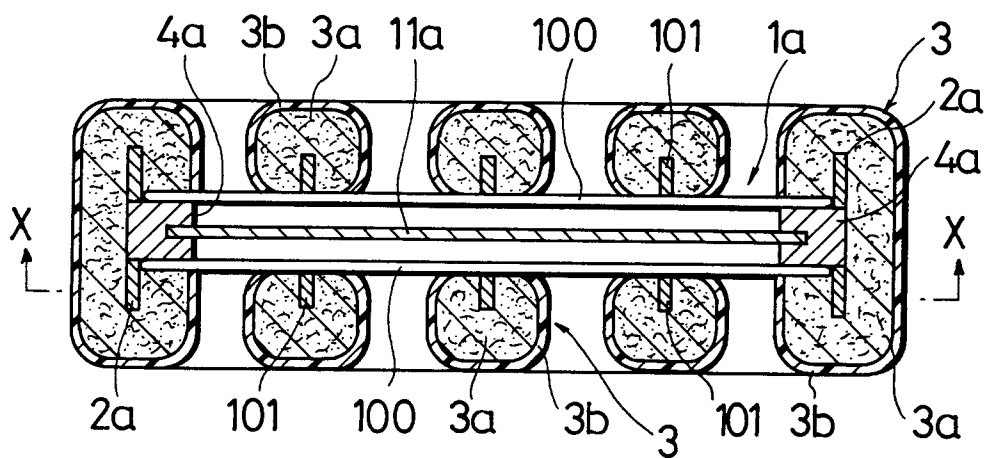


FIG. 4

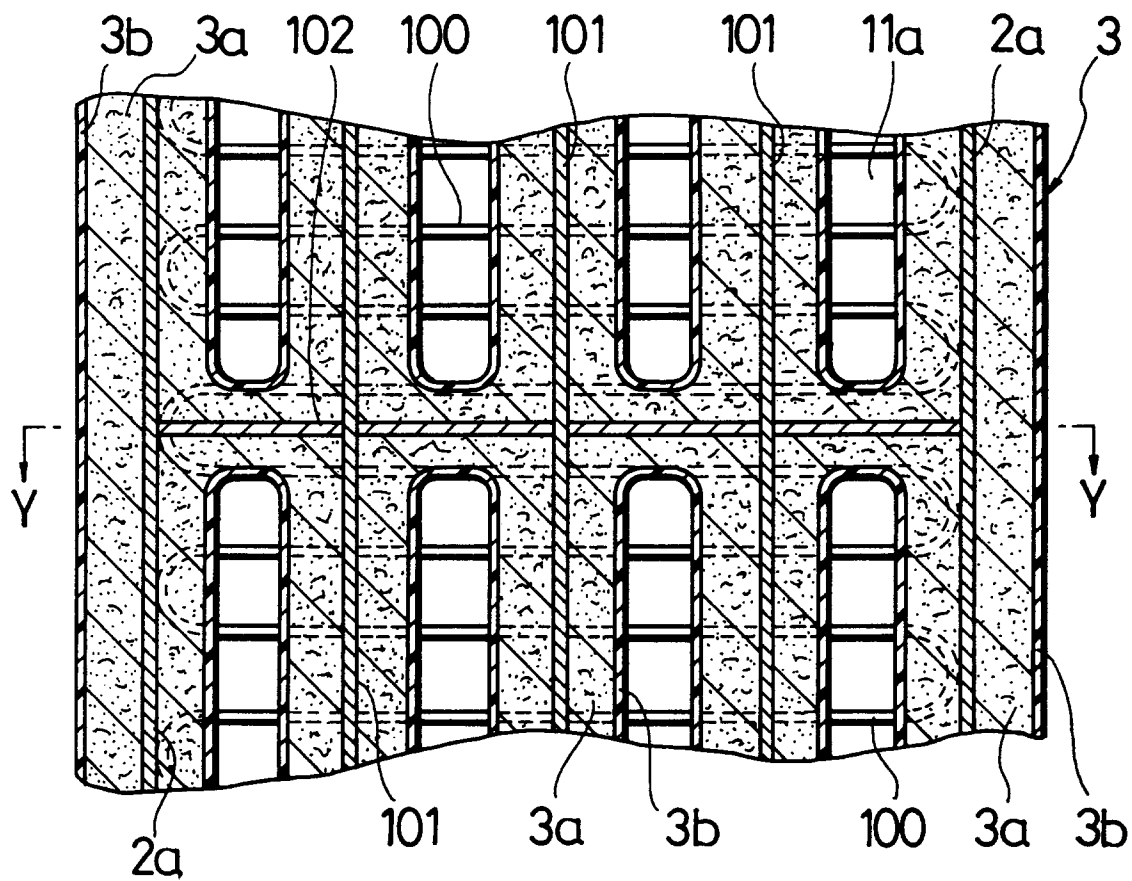


FIG. 5

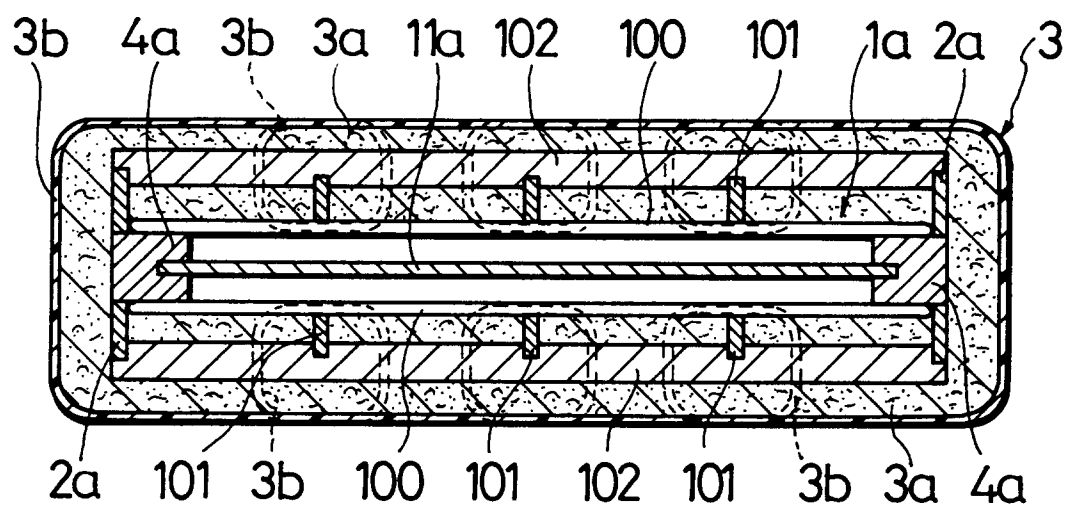


FIG. 6

