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- Amended claims in accordance with Rule 86 (2) EPC.
- A request for correction of the description and claim 4 has been filed pursuant to Rule 88 EPC. A decision on the request will be taken during the proceedings before the Examining Division (Guidelines for Examination in the EPO, A-V, 3.).

(54) Sound insulating panel

(57) A multilayered, sound insulating panel comprising a facing layer (1), a plastic foam core layer (2) attached thereto, a structure (3), to which the core layer is fixed at seperated contact points (4) leaving gaps (5) between the core layer (2) and the structure (3), and, in case of long spans and/or thin facing layers, travel stops to keep the core layer (2) at a certain distance from the structure (3), wherein the core layer material is a semi-rigid, cellular material containing more than 50 % open cells, and has a tensile strength of more than 50 kPa, and has a compressive strength from 5 to 200 kPa, at 10 % deformation. The core layer (2) is substantially attached (leaving only a few gaps) to the facing layer (1). The distance between the contact points (4) is at least 350 mm. The structure (3) is, for instance, a wall or a ceiling or a second facing layer (1).

The new panels are useful in the construction and other industries for improving the sound insulating properties of buildings and/or machinery. Long span vibration of the core layer (2) attached to the facing layer (1) provides particularly good damping at all frequencies and specifically at the resonant and the critical frequencies.

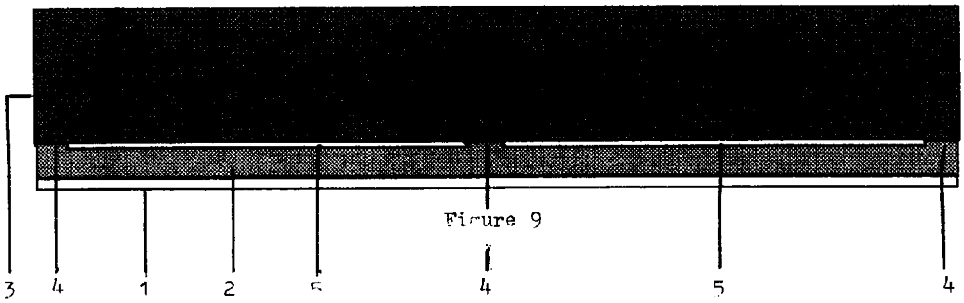

Figure 9

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Description

[0001] The present invention refers to sound insulating elements, more specifically to sound insulating multilayered elements or panels comprising an open-cell, semi-rigid foam core, at least one hollow space, and at least one outer facing layer. More specifically the invention refers to light weight, relatively thin panels, laminates or boards to be attached to walls or ceilings or to be used as partition walls in new or existing buildings improving thereby the sound insulation performance. Besides, the invention refers to sound insulating elements such as panels excelling prior art elements in constructional simplicity and to the use of such new, sound insulating, multilayered elements or panels in the construction and other industries by attaching the elements to walls, ceilings, and other parts of the building or machinery acoustically to be improved.

[0002] In the construction industry it is well known to use panels as partition walls in order to subdivide the building area into seperate areas such as rooms and offices. Usually they consist of an insulating mineral fiber core and two outer facing layers encompassing the core and an air gap or hollow space. The insulating materials such as mineral fibers are arranged between the facing layers in such a manner so as to provide thermal and/or acoustic insulation.

[0003] It is also known to use multilayered sound insulating laminates or boards, containing mineral fibers as insulation material, as panels to be fixed to walls or ceilings for reducing sound and noise propagation, transmission and sound radiation. By applying sound insulating elements to walls or ceilings it is possible to upgrade residential buildings or office buildings improving their sound insulation performance. Thus, older constructions can be adjusted to comply with modern often higher regulation standards. Noises from neighbours or external sources or emanating from inside the room can be reduced substantially.

[0004] However, a major disadvantage of such partitions or panels having mineral fiber cores is the lack of mechanical strength of such fibers. For that reason the facing layers must be secured, e. g. by means of screws or frames, and supported by metal or timber studs. This requires an extensive manufacturing process.

[0005] In JA 0221 642 a noise insulating panel is disclosed in which a porous material, such as glass wool or foamed synthetic resin is stacked between facing layers formed by plywood, gypsum board, or an acryl plate in such a manner as to be out of contact with at least one surface material. According to the teaching of this specification, a frame must be used in order to stabilize or fix this condition. This frame is fitted to the above assembly to form a panel. This, of course, is an relatively intricate and hence expensive procedure. Furthermore, it is a well known method extrapolated from conventional timber frame walls or panels.

[0006] DE 3710 057 discloses a multilayered acoustic insulation panel for internal walls which has air gaps between a layer of mineral wool and an outer chipboard facing layer. This insulation panel contains a main panel made of chipboard which is spaced apart by ribs from a facing layer or cover panel which is also made of chipboard. The inner surfaces of these two panels are covered with fiber board which is held in place by glue. For attaining good sound damping performance the two fiber boards are different in weight. This multilayered panel consists of five layers, i. e. two chipboard layers, each of which is glued to a fiber board, plus a mineral wool layer in the middle of the sandwich serving as acoustic insulation material. The mineral wool fills the space only partly in such a way that an air gap is provided for between the mineral wool and one of the fiber boards which is glued to the inner surface of the cover panel. The latter is secured by screws to the ribs. As can be seen from the description, the design of this multilayered panel is quite complicated. Its fabrication is therefore relatively expensive. The acoustic performance is achieved by increasing the mass rendering such panels difficult to transport and to install.

[0007] According to several proposals, organic plastics have been used instead of mineral fibers, such as, for example, the well-known open-cell polyurethane foam laminates. However, such laminates exhibit the disadvantage of being brittle and having a poor tensile strength (about 30 kPa).

[0008] In U.S. Patent No. 4,317,503 a sound insulating building element is disclosed which includes a plurality of parallel layer elements of which a first inner, thick element is constituted by a layer of mineral fibers or stiff plastic foam and contains a plurality of cavities. A second inner stiff element which is substantially pervious to air is connected to one main surface of the first inner element and an outer impervious element. The outer impervious element is arranged at a small distance from the second inner element in such a manner that substantially the entire outer element can oscillate freely in relation to the second inner element. A major disadvantage of this type of building elements is the complex and costly manufacturing process of such multilayered structures.

[0009] Other known types of partitions are the multilayered structures including those having a foam or honeycomb core. The foam cores, however, although possessing suitable mechanical strength properties, are very poor as far as the sound insulating properties are concerned. In order to overcome this problem, the foam core would have to be of an unacceptable thickness and weight.

[0010] Generally speaking, there are several known types of systems for increasing the sound insulation performance of walls such as:

Increasing the mass of the wall which is, of course, the most basic way of providing better sound insulation (mass law);

using resilient panels or sandwich structures the components of which, that is facing layer or layers and core layer, vibrate without phase relation so that part of or most of the incident acoustic energy is convened into mechanical energy, which will be dissipated through internal friction and deformations (mass-spring-mass system).

[0011] The drawback of the increase of the mass of the wall or any similar structure following the mass law is that rather heavy and thick structures are required for good performance.

[0012] The drawback of common mass-spring-mass systems is that their resonant frequency will very often disturb the overall performance when it is wrongly positioned and too sharp.

[0013] Better results are obtained by using sound insulating elements or panels as disclosed in WO 95/14 136. Those multilayered insulating panels or elements comprise in a preferred embodiment (a) two outer facing layers, and (b) a soft synthetic core material which is a single, continuous, soft, synthetic foam core layer having hollow profiles and being arranged in intimate contact with both outer layers through contact points in alternate patterns, thereby providing gaps between the core layer and the opposing outer layer.

[0014] What is actually disclosed in the specification, the drawings, the claims and the abstract of WO 95/14 136 is the following:

a sandwich element comprising two facing layers, e. g. gypsum boards, and a core material between the facing layers;

the core layer comprises an elastic, closed-cell polyethylene foam, or rigid, closed-cell polyurethane foam, or other closed-cell plastic foams, e. g. based on polyvinyl chloride, or polystyrene;

the second facing layer can be a brick structure, thus referring indirectly to a wall, to which the core layer can be glued. e.g. with mortar;

the core layer contains cavities in special geometrical arrangement;

there are gaps between the core layer and the facing layers;

the gaps are confined between the core layer and the facing layers by contact points or areas which are arranged in an alternate pattern with respect to the opposing facings;

empirical measures and theoretical considerations are applied for best results in the mass-spring-mass-system.

[0015] Panels as disclosed in WO 95/14 136 possess both acoustic insulating properties and mechanical strength. While this art provides lighter and cheaper panels with good acoustic properties compared to previously known products, it was still highly desirable to provide thin panels and room partition elements having both sound insulating properties and good mechanical strength, which would be particularly useful for up-grading residential and office buildings and for designing partitions with improved sound insulation performance. Also, there was a need for more economical methods for producing and installing such sound insulating panels.

[0016] Accordingly, the present invention is a multilayered, sound insulating panel comprising a facing layer, a plastic foam core layer attached thereto, a structure, to which the core layer is fixed at seperated contact points by means of stripes, patches, dabs, or other geometrical protrusions (generally called "contact points" hereunder) leaving gaps between the core layer and the structure, and, in case of long spans and/or thin facing layers, travel stops to keep the core layer at a certain distance from the structure, which panel is characterized in that

the core layer material is a semi-rigid, cellular material containing more than 50 %, preferably more than 90 % open cells,

and has a tensile strength of more than 50 kPa, preferably more than 90 kPa,

and has a compressive strength from 5 to 200 kPa, preferably from 15 to 80 kPa, at 10 % deformation,

and the attachment of the core layer to the facing layer is substantial, which means that a substantial area of the outer surface of the core layer should be attached, e. g. by means of adhesive, to a substantial area of the surface of the facing layer, leaving only a few gaps,

and the distance between the contact points is at least 350 mm, and it is even more preferred that this distance ranges from 450 to 600 mm.

[0017] Preferably, the core layer material is a polyurethane foam.

[0018] The facing layer plus the core layer plus the contact points usually have a thickness of at least 10 mm, preferably from 10 to 200 mm, and even more preferred from 20 to 80 mm.

[0019] Preferably, the core layer material has a specific air flow resistance from 5000 to 800 000 Ns/m4; more preferred is a range from 5 000 to 300 000 Ns/m4.

[0020] The loss factor of the core layer material is preferably greater than 0.1, preferably greater than 0.2 (as defined by SAE Sound and Heat Insulation Materials

Committee, SAE Handbook, 1994, Volume 1, page 2.30); the loss factor can reach 0.3, or even more.

[0021] The distance of the travel stops, if any, or the distance of the core layer from the structure, at 0 % deformation, are preferably at least 0.1 mm, a range from 2 to 10 mm being more preferred.

[0022] Preferably, the total contact points area is related to the total area of the panel in a ratio of less than 20 %; even more preferred is a ratio of less than 6 %.

[0023] For instance, the structure, to which the core layer is fixed at seperated contact points, can be a wall or a ceiling or any other suitable constructional element.

[0024] On the other hand, the structure can be a second facing layer as well. The resulting sandwich panel can be used as a partition element or partition wall.

[0025] The panels according to the invention are useful in the construction and other industries for improving the sound insulating properties of buildings and/or machinery.

[0026] A particularly surprising feature of the invention is that long span vibration of the core layer attached to the facing layer provides particularly good damping at all frequencies and specifically at the resonant and the critical frequencies.

[0027] The gaps created between the core layer and the structure can vary considerably depending on the actual needs in a given case. The thickness usually ranges from 0.1 to 200 mm. Sometimes this thickness is selected between 20 and 50 mm so as to allow for passing cables, pipes and other services between a wall and a sound insulating panel. Apart from those special consideration, the thickness of the gaps is often in the range from 1 to 10 mm, preferably from 2 to 5 mm.

[0028] In case of a plasterboard (or a board from any other material insufficiently stiff) being used as facing layer, and if, for example, the plasterboard is 10 mm thick and its span exceeds 400 mm or is 13 mm thick and its span exceeds 600 mm, respectively, a "mid span" travel stop system made of a stripe or patches can be installed to limit the plasterboard deformation. By way of example, if a 1200 mm wide plasterboard laminate is installed with contact points (stripes) of 40 mm width at the edges of the board, thereby providing for a free span of 1 120 mm, a travel stop stripe will be fixed in the middle of the board in order to reduce the span. The width of the travel stop stripe will be between 30 and 39.9 mm, preferably between 35 and 38 mm, if the contact stripe width is e. g. 40 mm.

[0029] The realization of the invention by adhering to the parameters as defined in the specification and the claims, particularly by using a specific foam material and applying specific designs with regard to the core layer, the facing layer (-s) and the travel stops, will result in a multilayered, sound insulating panel with very low resonant frequency and surprisingly high damping of vibrations, specifically at the resonant frequency.

[0030] Examples of "structures" to which the core layer is fixed or attached are concrete or brick walls or gypsum blocks or plasterboards or other masonry structures. On the other hand, the structure, as referred to, can be a second facing layer as well, which can be prefabricated to make a sandwich panel.

[0031] The facing layer (-s) can be made of any material typically employed to produce insulating panels or elements. Exemplary materials useful as facing layers include plastic or particle boards, thick paper or cardboards, fiber boards, gypsum plaster boards, flexible plastic films or foils, metal sheets, such as steel, lead, or aluminium sheets, plywood, timber boards, and chipboards, most typical being gypsum plaster boards, and chipboards. The preferred material for use as facing layer is gypsum board in the building applications and metal sheet in the industrial applications.

[0032] Typically, the thickness of the facing layer ranges from 0.5 to 100 mm, preferably from 0.5 to 25 mm.

[0033] In one embodiment of the invention, the core layer made of polyurethane foam and having seperated polyurethane foam patches as contact points at one of its two surfaces, is substantially attached by means of adhesives at its other ("outer") surface to a facing layer, thus forming a panel. Usually, such a panel will be prefabricated thereby avoiding assembling on site. The panel will then be fixed to a concrete wall through the contact points, usually by glueing with a suitable adhesive such as polyurethane glue, neoprene contact or transfer adhesive, or by mechanical fixing.

[0034] In another embodiment of the invention, a sandwich panel is fabricated by applying the same method as above, except for glueing the panel first obtained through the contact points to a second facing layer rather than to a wall. The sandwich panel thus obtained can be fixed to a wall, ceiling, floor, or other building structure, or it can also be used as a room partition standing on its own. Such a partition element is usually secured on the floor and/or at the ceiling.

[0035] The contact points can be machined from the polyurethane foam layer or can be made from other suitable materials, such as plastics other than polyurethane, glue or other adhesives; wood, plaster, metal etc., as long as the inventive criteria are fulfilled.

[0036] The new panels are particularly useful for refurbishing existing buildings, but also as elements in new constructions. They offer a thin, light weight solution to improve sound insulation, thus eliminating or damping sounds and noises which without the sound insulating panels are transmitted through walls, floors, ceilings and partitions.

[0037] On the basis of examples it will be demonstrated hereunder that the panels or elements according to the invention are to a surprising degree substantially superior as compared to prior art sound insulating panels or elements with respect to a combination of sound insulation/ mechanical strength/ light weight/thickness properties and production/installation methods. They do not lack good mechanical strength, possess a high acoustic damping performance, reduce and lower the resonant frequency. The thin gap between the core layer and the structure is acting as a first very soft spring, and the core layer is acting as a second hard spring. Because of the hardness of the core layer, the deformation of the panel is strongly restricted which makes it compatible with the intended use in buildings.

[0038] The following examples are given to illustrate the invention and should not be interpreted as limiting it in any way.

Example 1

[0039] Four insulating panels (No. 1 to 4) in the shape of sandwich partition elements, surface area 1050 mm x 2050 mm, total thickness 75 mm, were built by assembling in each case two 12.5 mm thick plasterboard facing layers containing a 50 mm thick core layer.

[0040] Panel No. 1 was a standard sandwich partition element, containing a semi-rigid, open-cell polyurethane foam material according to the present invention with the following properties: Air flow resistance 200 000 Ns/m4; tensile strength: 120 kPa; compressive strength: 35 kPa at 10 % deformation; loss factor: 0.35. It is represented in **Figure 1.**

[0041] Panel No. 2 was a sandwich partition element whose core material was a closed-cell, Strandfoam* profiled polyethylene foam material as used in WO 95/14 136 having the following properties: tensile strength: 20 kPa; compressive strength at 10 % deformation: 20 kPa.

[0042] As can be seen from **Figure 2**, the core layer of this partition element forms hollow profiles and is arranged in intimate contact with both outer facing layers through contact areas in alternate patterns thereby providing 5 mm thick gaps between the core layer and the two facing layers.

[0043] Panel No. 3 was a sandwich partition element with the same design or configuration as panel No. 2, in which, however, the core layer was of the same material as in panel No.1, that is according to the invention. It is represented in **Figure 3.**

[0044] Finally, panel No. 4 was a sandwich partition element according to the present invention. The core layer was attached to one of the facing layers - in **Figure 4** to the upper one - through two contact points by means of a polyurethane adhesive. The distance between the contact points was 970 mm, and the width of the contact points was 40 mm each. The gap created between the contact points, the core layer and the facing layer was 5 mm thick. The bonding to the other - in **Figure 4** lower facing layer - was complete, i. e. continuous over the whole area. The core layer was of the same material as in panels 1 and 3, i. e. according to the invention.

[0045] The sound insulating performance of these four sandwich partition elements was as under:

Panel 1: 34 dB (A) pink noise Panel 3: 43 dB (A) pink noise
Panel 2: 38 dB (A) pink noise Panel 4: 46 dB (A) pink noise

[0046] The data demonstrate how important the core material is (3 versus 2) and how essential the design is (3 versus 1, and 4 versus 3). By far the best performance was achieved with panel 4. Here both the core material and the design are according to the invention.

Example 2

[0047] In this example the "structure" in the meaning as used herein was a 100 mm thick concrete wall.

State of the art

[0048] To this wall a commercial glass fiber plasterboard laminate was attached through mortar dabs, which were approximately 10 mm thick. Since the laminate consisted of a 10 mm thick plasterboard and a 50 mm thick glass fiber core, the total thickness of the plasterboard-laminate plus dabs was therefore 70 mm. The resulting wall-plasterboard-laminate attached to the wall is shown in cross sectional view in **Figure 5.**

[0049] The sound transmission of the wall covered with the sound insulating panel was measured to be 57 dB (A).

Invention

[0050] Now a plasterboard laminate according to the invention was attached to the above 100 mm concrete wall (see **Figure 6**). The plasterboard in this case was 13 mm thick and 1200 mm wide. The core layer material was a 35 mm thick open-cell polyurethane (properties of the polyurethane as described in example 1, panel 1). The contact points were made of 3 stripes of the same polyurethane as used for the core layer. These stripes were 2 500 mm long and 5 mm thick, and they had been machined from the polyurethane slab when cutting out the core layer. That is, they constituted an integral part of the very core layer.

[0051] Since their width was 30 mm, the distance between the contact points was 555 mm. The ratio of the area of the contact points to the area of the core layer was 7.5 %.

[0052] 9 patches of transfer adhesive were applied on these contact points. These patches having a width of 30 mm, a length of 450 mm and a thickness of 2 mm were located top, mid, and bottom with regard to the core layer. The ratio of the adhesive patch area to the full core layer area was 4.2 %. The adhesive patches

* = Trademark of The Dow Chemical Company

formed part of the "contact points", that is the above described, 5 mm thick, 30 mm wide, and 2 500 mm long stripes. Therefore, a safe gap was created, particularly useful in the case of uneven walls to prevent the core layer from touching the support structure The total thickness of the panel - facing layer plus core layer plus contact points plus adhesive - figured up to a total of 55 mm.

[0053] The sound transmission of the wall panelled according to the invention was 59 dB (A). Altough the sound insulating panel according to the invention was 21.4 % thinner than the prior art panel, its performance was even better than that of the panel according to the state of the art..

Example 3

[0054] In this example a new sound insulating panel is compared with two prior art panels. The support structure was in each case a 160 mm thick concrete wall having a size of 2 500 x 4 000 mm.

State of the art

[0055]

a) The wall was insulated though 10 mm mortar dabs with a 50 mm thick fiber board as core layer and a 10 mm thick plasterboard as facing layer (total thickness thus 70 mm). The panel attached to the wall is shown in **Figure 7.** The sound transmission was found to be 61 dB (A).

b) For this sample the wall was covered with a 25 mm thick glassfiber quilt and a 13 mm thick plasterboard using 25 mm studs to form a panel with a total thickness of 47 mm as demonstrated in **Figure 8**. The sound transmission was found to be 60 dB (A).

Invention

[0056]

c) Now the wall was insulated with a panel according to the invention. For this purpose, a 30 mm thick polyurethane core layer of the invention (2), to which a 10 mm thick plasterboard was bonded as outer facing layer (1), was glued with a polyurethane adhesive to the wall ("structure") (3) at distant contact points (4) creating a 5 mm gap (5). The contact points (4) were made by cutting 3 stripes from the same polyurethane as used for the core layer (2). These stripes were 2 500 mm long and 5 mm thick. They were glued to the core layer (2).

[0057] Since their width was 30 mm, the distance between the contact points (4) was 555 mm. The ratio of the area of the contact points (4) to the area of the core layer (2) was 7.5

[0058] 9 patches of transfer adhesive were applied on these contact points (4). These patches having a width of 30 mm, a length of 350 mm and a thickness of 2 mm were located top, mid, and bottom with regard to the core layer (2). The ratio of the adhesive patch area to the full core layer area was 3.1 %. The adhesive patches formed part of the "contact points" (4), that is the above described, 5 mm thick, 30 mm wide, and 2 500 mm long stripes. Therefore, a safe gap (5) was created, as shown in **Figure 9**, particularly useful in the case of uneven walls to prevent the core layer (2) from touching the support structure The sound transmission was found to be 63 dB (A).

[0059] The panel according to the invention (c) performed much better than the prior art panel (b) having the same thickness and was even superior to the prior art panel (a) which was 50 % thicker.

Claims

1. A multilayered, sound insulating panel comprising a facing layer, a plastic foam core layer attached thereto, a structure, to which the core layer is fixed at seperated contact points leaving gaps between the core layer and the structure, and, in case of long spans and/or thin facing layers, travel stops to keep the core layer at a certain distance from the structure, **characterized in that**

   the core layer material is a semi-rigid, cellular material containing more than 50 %, preferably more than 90 % open cells,

   and has a tensile strength of more than 50 kPa, preferably more than 90 kPa,

   and has a compressive strength from 5 to 200 kPa, preferably from 15 to 80 kPa, at 10 % deformation,

   and the attachment of the core layer to the facing layer is substantial,

   and the distance between the contact points is at least 350 mm, and preferably ranges from 450 to 600 mm.

2. Panel according to claim 1, **characterized in that** the core layer material is a polyurethane foam.

3. Panel according to claim 1 to 2, **characterized in that** the facing layer plus the core layer plus the contact points have a thickness of at least 10 mm, preferably from 10 to 200 mm, and even more preferred from 20 to 80 mm.

4. Panel according to any one of the claims 1 to 3, **characterized in that** the core layer material has a specific air flow resistance from 5000 to 800 000 Ns/m4, preferably from 5 000 to 300 000 Ns/m4.

5. Panel according to any one of the claims 1 to 4, **characterized in that** the core layer material has a loss factor of more than 0.1, preferably more than 0.2.

6. Panel according to any one of the claims 1 to 5, **characterized in that** the distance of the travel stops, if any, or the distance of the core layer from the structure, at 0 % deformation, is at least 0.1 mm, and preferably ranges from 2 to 10 mm.

7. Panel according to any one of the claims 1 to 6, **characterized in that** the total contact points area is related to the total area of the panel in a ratio of less than 20 %, preferably less than 6 %.

8. Panel according to any one of the claims 1 or 7, **characterized in that** the structure is a wall, a ceiling, or a second facing layer.

9. Use of the panel according to any one of the claims 1 to 8 in the construction and other industries for improving the sound insulating properties of buildings and/or machinery.

10. Use of the panel according to claim 8, wherein the structure is a second facing layer as a partition element or partition wall.

Amended claims in accordance with Rule 86(2) EPC.

1. A multilayered, sound insulating panel comprising a facing layer, a plastic foam core layer attached thereto, a structure, to which the core layer is fixed at seperated contact points leaving gaps between the core layer and the structure, and, in case of long spans and/or thin facing layers, travel stops to keep the core layer at a certain distance from the structure, **characterized in that**

the core layer material is a semi-rigid, cellular material containing more than 50 %, preferably more than 90 % open cells,

and has a tensile strength of more than 50 kPa, preferably more than 90 kPa,

and has a compressive strength from 5 to 200 kPa, preferably from 15 to 80 kPa, at 10 % deformation,

and the attachment of the core layer to the facing layer is substantial,

and the distance between the contact points is at least 350 mm, and preferably ranges from 450 to 600 mm.

2. Panel according to claim 1, **characterized in that** the core layer material is a polyurethane foam.

3. Panel according to claim 1 to 2, **characterized in that** the facing layer plus the core layer plus the contact points have a thickness of at least 10 mm, preferably from 10 to 200 mm, and even more preferred from 20 to 80 mm.

4. Panel according to any one of the claims 1 to 3, **characterized in that** the core layer material has an air flow resistivity from 5000 to 800 000 Ns/m4, preferably from 5 000 to 300 000 Ns/m4.

5. Panel according to any one of the claims 1 to 4, **characterized in that** the core layer material has a loss factor of more than 0.1, preferably more than 0.2.

6. Panel according to any one of the claims 1 to 5, **characterized in that** the distance of the travel stops, if any, or the distance of the core layer from the structure, at 0 % deformation, is at least 0.1 mm, and preferably ranges from 2 to 10 mm.

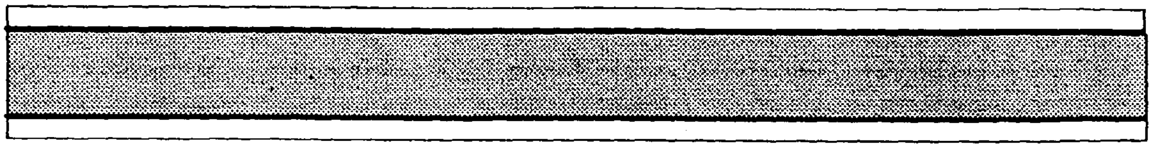

Figure 1

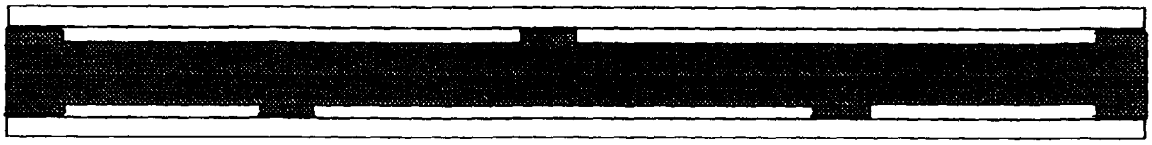

Figure 2

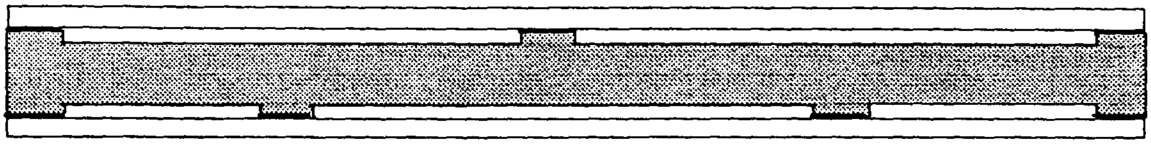

Figure 3

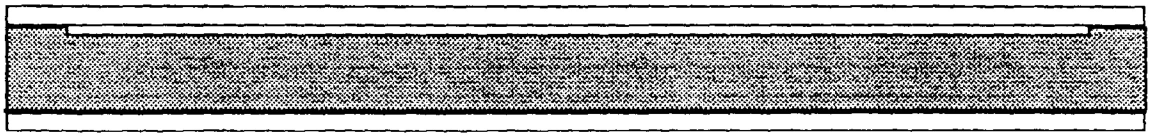

Figure 4

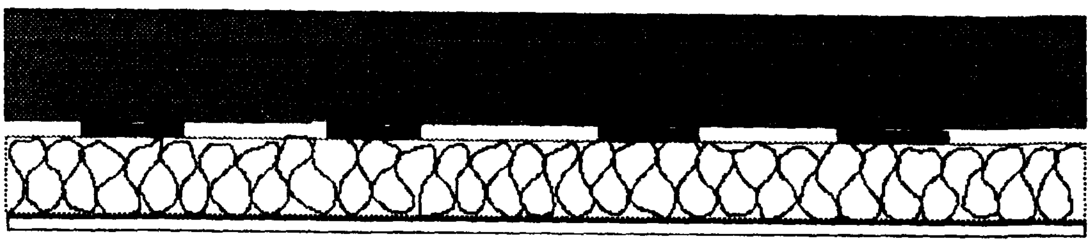

Figure 5

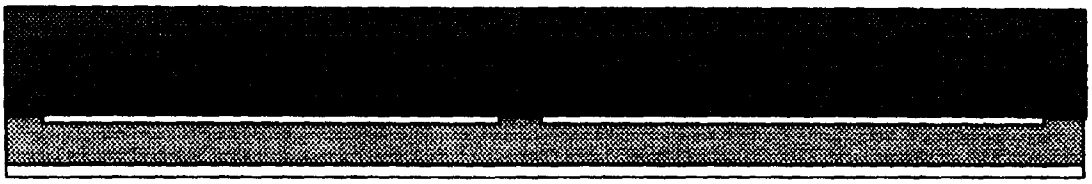

Figure 6

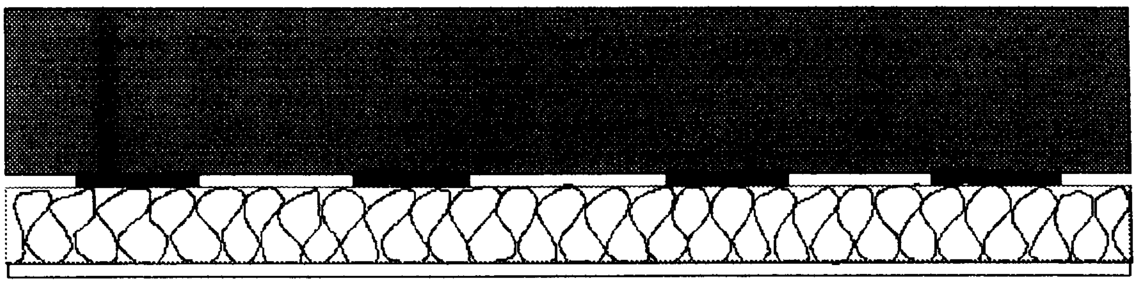

Figure 7

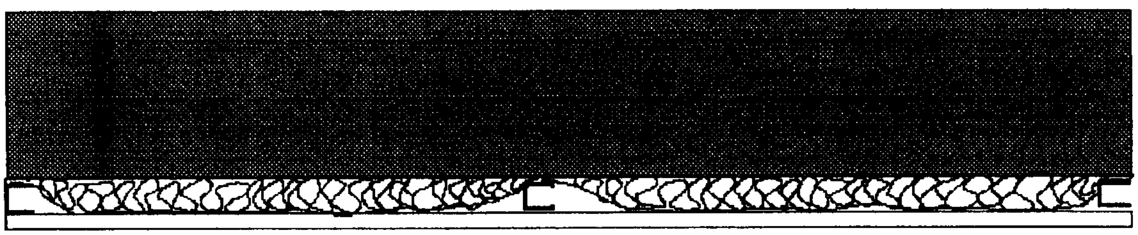

Figure 8

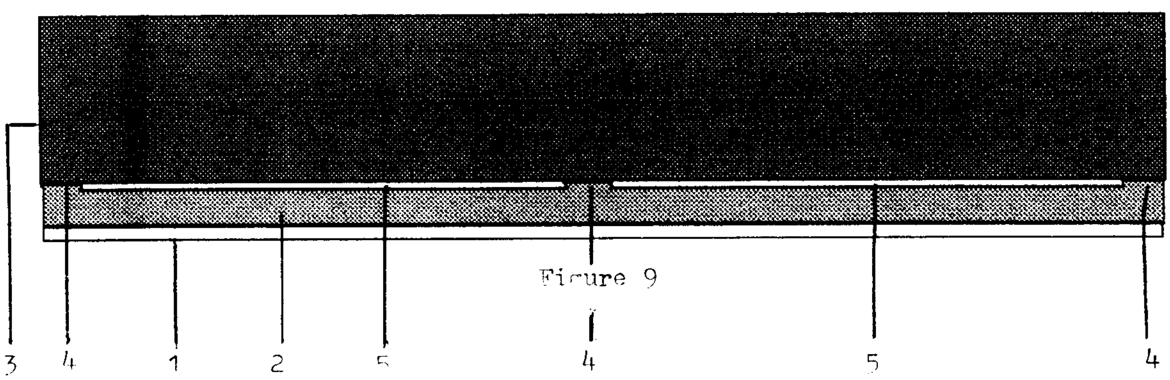

Figure 9

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EUROPEAN SEARCH REPORT

Application Number
EP 98 11 1295

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	DE 93 18 446 U (BASF AG) 27 January 1994 * page 1, line 22 - line 34 * * page 2, line 8 - line 17; figure 1 *	1-3,8	E04B1/86
A	EP 0 637 820 A (ROTH SA FRERES) 8 February 1995 * column 2, line 30 - column 3, line 9; figure 1 *	1,2,8,9	
A	EP 0 575 771 A (GREINER & SOEHNE C A) 29 December 1993 * page 4, line 42 - page 5, line 11; figures 1-3 *	1,8	
D,A	US 4 317 503 A (SOEDERQUIST JAN ET AL) 2 March 1982 * column 3, line 58 - column 4, line 37; figures 4-6 *	1	
A	EP 0 732 684 A (RIETER AUTOMOTIVE INTERNATIONA) 18 September 1996 * column 6, line 12 - line 37 *	4	TECHNICAL FIELDS SEARCHED (Int.Cl.6) E04B
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	11 November 1998	Kriekoukis, S

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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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 98 11 1295

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82