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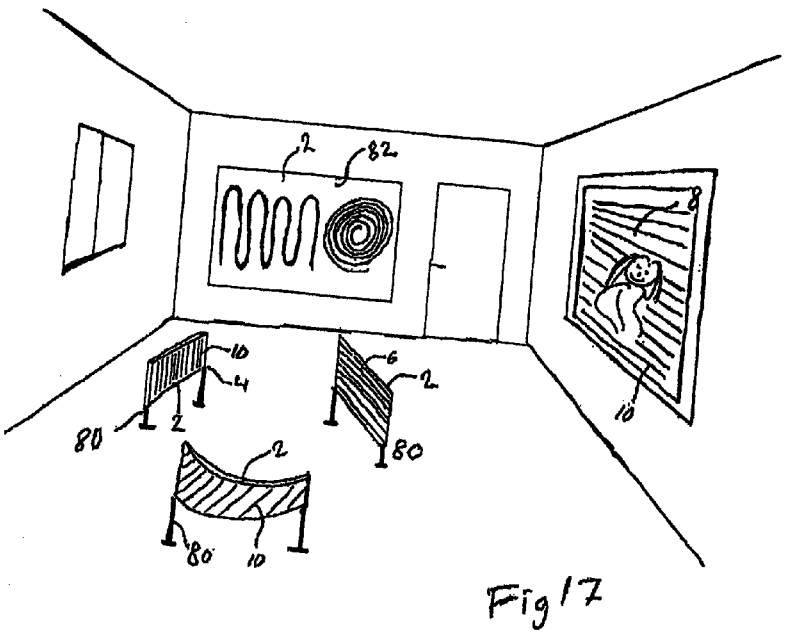


Fig 17

(57) Abstract: The present invention relates to a sound absorbent comprising a first cover layer (4), a second cover layer (6) and an intermediate layer (8), said intermediate layer (8) comprising walls (13) delimiting a plurality of cells (12,12a,12b,12c,12d) open in a first end (14) and a second end (16), said cells being arranged adjacent one another, said first open end (14) of said plurality of cells being covered by said first cover layer (4), said second open end (16) of said plurality of cells being covered by said second cover layer (6). In accordance with the invention, said first layer (4) is provided with at least one micro-slit (10) by mechanical machining, the micro-slit (10) extending through said first layer (4), such that sound waves are allowed to penetrate said micro-slit (10) and to enter the first open end (14) of said cell.

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A Sound Absorbent

BACKGROUND OF THE INVENTION

The present invention relates to a sound absorbent comprising a first cover layer, a second cover layer and an intermediate layer, said intermediate layer comprising walls delimiting a plurality of cells open in a first end and a second end, said cells being arranged adjacent one another, said first open end of said plurality of cells being covered by said first cover layer said second open end of said plurality of cells being covered by said second cover layer.

It also relates to a method of manufacturing such a sound absorbent.

Such a sound absorbent and such a method are known from US-A-4 850 093. The known sound absorbent suffers acoustically from the drawback of an insufficient low sound attenuation. Furthermore, during manufacture a face plate of titanium is provided with the very small holes by laser drilling. Drilling of a large number of holes is time consuming and thus expensive, in particular since a laser equipment is utilised. Furthermore, the face plate is provided on a cellular/honeycomb core, made for example of paper. In order not to destroy the paper honey comb core, it is thus necessary to first perform the laser drilling operation for preventing the paper core from achieving burn damages from the laser beam. Furthermore, while connecting the face plate to the paper core, excessive glue may enter the laser drilled holes and cause a lower sound attenuation. Consequently, the known production method is complicated, expensive and inefficient from a sound attenuation perspective.

Sound absorbents having a core of different configurations and materials are known from US-A-4 479 992, GB-A-2 486 120, WO 2006/114090 and US-A-4 291 080.

OBJECT OF THE INVENTION

The object of the present invention is to provide a sound absorbent, which has an improved sound attenuation.

CONFIRMATION COPY

SUMMARY OF THE INVENTION

This object is achieved by the sound absorbent as initially defined, wherein said first layer is provided with at least one micro-slit by mechanical machining, the micro-slit extending through said fist layer, such that sound waves are allowed to penetrate said micro-slit and to enter the first open end of said cell. Hereby is achieved an efficient sound absorbent which is less expensive to manufacture.

It should be noted that the provision of micro-slits in a sound absorbent is known *per se* from WO 97/27370.

The object is also achieved by the method as initially defined, whereby said micro-slits are made by mechanical machining by a mechanical tool.

Preferably, said second layer is provided with a at least one micro-slit, such that sound waves are allowed to penetrate said micro-slit and to enter the second open end of said cell.

Suitably, the length of said micro-slit is in the range of 2 mm – 2 km, more preferably 10 - 1000 mm, most preferably 100 - 1000 mm.

Preferably, the width of said slit is in the range of 1 micrometer to 1 mm, more preferably 10 micrometer to 0,9 mm, most preferably 0,3 – 0,5 mm.

Suitably, the thickness of said wall is in the range of 10 micrometers to 0,5 mm, more preferably 30 micrometers to 0,3 mm, most preferably 50 micrometers to 0,2 mm.

Preferably, at least every second wall is shaped by a corrugated sheet or plate, every second wall being a substantially plane sheet or plate arranged between every second corrugated sheet or plate.

Suitably, the thickness of said first layer and optionally of said second layer is in the range of 10 micrometers to 5 mm, more preferably 20 micrometers to 0,9 mm, most preferably 50 micrometers to 0,6 mm.

Preferably, the walls of said intermediate layer are made of a cellulose material, polymer material or metal. Suitably, said first layer is made of a cellulose material, polymer material or metal. Preferably, said second layer is made of a cellulose material, polymer material or metal.

Examples of suitable cellulose materials are paper, paper-board, veneer, wood, cellulose acetate, cellulose nonwoven, fiber-board, with or without surface treatment.

Examples of suitable polymer materials are polyethylene (PE), poly propane (PP), polyvinylchloride (PVC).

Examples of suitable metals are aluminium and steel. The first layer could for aesthetic purposes me made of e.g. copper, silver or gold.

Preferably, the thickness (t_c) of said intermediate layer is in the range of 1 – 200 mm, more preferably 5 – 50 mm, most preferably 10 – 30 mm. The greater the thickness (t_c), the better the low-frequency absorption.

Suitably, the ratio of cells per square meter of a cross-section of the intermediate layer is within the range of 1 to 100 000 000 more preferably 100 to 1 000 000, most preferably 500 to 200 000. It should be noted that the higher the ratio, the higher the sound absorption.

Preferably, in the method said micro-slit is made by mechanical machining by a mechanical tool.

Suitably, the method includes choosing an intermediate layer of a predetermined material, choosing a first layer of a predetermined layer and choosing a second layer of a predetermined material.

Preferably, the first layer is connected e.g. by gluing to the intermediate layer before the micro-slits are made in the first layer. Likewise, the second layer is connected e.g. by gluing to the intermediate layer before the micro-slits are made in the second layer.

The glue will affect both mechanical stability and vibration damping of the element.

Suitably, the first layer, as well as the second layer are connected e.g. by gluing to the intermediate layer before the micro-slits are made in the first layer. Hereby handling problems of the single-layer in severely cut condition are avoided.

Preferably, the slit in the second layer is made after said first layer as well as said second layer are connected to the intermediate layer, before the micro-slit is made in the first layer.

Suitably, mechanical machining includes punching, whereby said mechanical tool is e.g. a punch knife. Alternatively, mechanical machining includes slitting by means of a slitting machine, whereby said mechanical tool is a knife. Alternatively, said mechanical tool is a cutting blade with a cutting edge.

Preferably, the method includes choosing a mechanical tool out of a set of tool sizes to achieve a predetermined slit width, connecting said mechanical tool to a computer numerical control machine, and programming the slit length, the slit depth and the distance between the slits to achieve a desired sound attenuation.

It should be noted that the mechanical machining method according to the invention excludes laser machining, cutting by cutting electrodes, and cutting by cutting blowpipes and chemical machining, such as photo-etching, since such methods may destroy parts of the cells, and will have then have a negative influence on the sound attenuation.

DRAWING SUMMARY

In the following, the invention will be described in more detail with reference to the attached drawings, in which

Fig. 1 illustrates partly in a cut out view a sound absorbent provided with a first layer provided with micro-slits, a second layer and an intermediate layer;

Fig 2 is a cross-section of a part of the intermediate layer along a line shown in figure 1;

Fig. 3 illustrates an intermediate layer with cells of diamond shape cross-section;

Fig. 4 illustrates an intermediate layer with cells of square shape cross-section;

Fig. 5 illustrates an intermediate layer with cells of a corrugated shape cross-section;

Fig. 6 illustrates an intermediate layer with cells of honey-comb cross-section;

Fig. 7 illustrates an intermediate layer with cells of another kind of a honey-comb cross-section;

Figs. 8A-8C illustrate an intermediate layer with cells of varying cross-section;

Fig. 9 is a magnification of the first layer with micro-slits shown in Fig 1;

Fig. 10 illustrates an equipment for manufacturing the micro-slits shown in Figs. 1 and 9;

Fig. 11 illustrates interrupted micro-slits:

Figs 12A and 12B illustrate differently shaped sound absorbents;

Figs 13A-13F also illustrate differently shaped sound absorbents;

Fig 14 illustrates a sound absorbent with angled cells;

Fig 15 illustrates sound absorbents mounted in the ceiling;

Fig 16 illustrates a sound absorber as a piece of art; and

Fig 17 illustrates different uses of the sound absorbent.

DETAILED DESCRIPTION

Figure 1 shows a sound absorbent 2 having the shape of a rectangular parallelepiped with substantially equal thickness **T**, comprising a first layer 4, a second layer 6 and an intermediate layer 8. The latter has likewise the shape of a rectangular parallelepiped with equal core thickness t_c.

The first layer 4 is made of a cellulose material, polymer material or metal and has a first thickness t_1, while the second layer 6 has a second thickness t_2. The material of the second layer 6 is of a cellulose material, polymer material or metal, and may be of the same material as the first layer 4, even though the first and second layers may be made of different materials.

The total thickness **T** of the sound absorbent 2 is thus the sum of the first thickness t_1, the core thickness t_c and the second thickness t_2.

The first thickness t_1 of said first layer is in the range of 10 micrometers to 5 mm, more preferably 20 micrometers to 0,9 mm, most preferably 50 micrometers to 0,6 mm. The second thickness t_2 of said second layer is preferably in the same range as the first thickness t_1, but may be thinner or thicker than said range. On the other hand, the second thickness t_2 of said second layer may be substantially the same as the first thickness t_1.

The first layer 4 and the second layer 6 are arranged on opposite sides of the intermediate layer 8, and are thus parallel to one another.

The intermediate layer 8 comprises plurality of elongated cells 12, the length of which corresponds to the core thickness t_c of the intermediate layer 8. The cells 12 are defined by walls 13, the thickness of which is in the range of 10 micrometers to 0,5 mm, more preferably 30 micrometers to 0,3 mm, most preferably 50 micrometers to 0,2 mm. The walls 13 are made of a cellulose material, polymer material or metal.

The core thickness, i.e. the thickness t_c of the intermediate layer 8, is in the range of 1 – 200 mm, more preferably 5 – 50 mm, most preferably 10 – 30 mm.

The elongated cells 12 as such have first and second open ends 14, 16 but are covered by the first layer 4 and the second layer 6.

The first layer 4 is provided with a plurality of substantially parallel micro-slits 10, penetrating the first layer 4 substantially through the first thickness t_1 to the intermediate layer 8, hereby connecting the cells 12 to the surrounding air.

In order to achieve a desired sound attenuation, the ratio of cells per square meter of a cross-section of the intermediate layer 8 is within the range of 1 to 100 000 000 more preferably 100 to 1 000 000, most preferably 500 to 200 000.

Figure 2 shows in cross-section along lines II-II in figure 1, a number of cells 12 of different geometries; each cell 12a is defined by a wall 13 of circular cross-section 18a, while each cell 12b is defined by a wall 13 of a star-shaped cross-section 18b. The star-shaped cells 12b are placed between the circular cells 12a for filling out the residual space between the circular-shaped cells, in order to improve sound attenuation compared to if the spaces were filled with e.g. glue.

Figure 3 shows cells 12 of yet another shape. A plurality of corrugated sheets 20a, 20b are formed to sharp ridges 22 and valleys 24 (i.e. zig-zag form) and are connected to one another at ridges 22 of the second corrugated sheet 20a and valleys 24 of the first corrugated sheet 20a contacting one another. Hereby, each cell 12 is defined by walls 13, together having a diamond or rhomboid cross-section 18c.

Alternatively, a plane sheet is placed between the first and second corrugated sheets 20a, 20b, while the valleys 24 of the first corrugated sheet 20a is connected to one side of the plane sheet, while the ridges 22 of sheet 20b are connected to the opposite side of the plane sheet. Hereby, each cell 12 is defined by the plane sheet and the walls 13, and the cross-section of the cells will be triangular. It should be noted that for manufacturing reasons, it is preferable to arrange the valleys and ridges of the first and second sheets 20a, 20b in a mirror shaped manner, such that the valleys and ridges can be connected to the plane sheet simultaneously, e.g. by spot or line welding.

Figure 4 shows cells 12 of yet another shape. A plurality of corrugated sheets 20a, 20b is formed to the shape of a square wave. A first plane sheet 26a and second plane sheet 26b are attached to each side of the corrugated sheet 20a. Hereby, cells 12d are defined by walls 13, together forming a square cross-section 18d.

Alternatively, if the corrugated square wave sheets 20c are connected to one another straight above one another, the cross-section of the cells will be square.

According to another alternative, the corrugated square wave sheets 20c may be connected to one another without the sheet 26a, 26b (in a manner corresponding to that of Fig 3), whereby the cross-section of the cells will be rectangular.

Fig. 5 shows an alternative configuration of the intermediate layer 8, according to which plane sheets 26a, 26b, 26c etc. are put between sinus-wave shaped sheets 20a, 20b, 20c etc. The cross-section of the cells will be half-a-sinus-wave or substantially half-circular. The plane sheets 26a, 26b, 26c etc. are provided with micro-slits 10. Of course, also the sinus-wave shaped sheets 20a, 20b, 20c etc. may be provided with micro-slits.

It should be noted that for manufacturing reasons, it is preferable to arrange the valleys and ridges of the first and second sheets 20a, 20b in a mirror shaped manner, such that the valleys and ridges sinus-waves can be connected to the plane sheet simultaneously, e.g. by spot or line welding.

If the configuration of Fig. 5 is used without plane sheets between the sinus-wave shaped, while connecting the valleys directly to the ridges of neighbouring sinus-wave sheets, the cross-section of the cells will instead be lemon-shaped (or substantially circular or oval).

It should also be noted that the walls of the intermediate layers of all configurations i.e. if Figures 1-4 and 6-8 may be provided with micro-slits. Correspondingly, the walls of the intermediate layer of Figure 5 may not be provided with micro-slits at all, i.e. neither the plane sheets, nor the sinus-wave shaped sheets. On the other hand, either the plane sheets or the sinus-wave sheets may be provided with micro-slits.

Figure 6 shows another variant of the cells 12, according to which a plurality of first corrugated sheets 20d are shaped with plane ridges 22 and sharp valleys 24, while a plurality of second corrugated sheet 20d is mirror shaped, i.e. with sharp ridges 22 and plane valleys 24, and placed relative one another in the manner shown in Fig. 3. Hereby, the cross-section of cells 12 (made up by walls 13) between the plane ridges 22 and plane valleys 24 will be hexagonal, while the cells between the sharp ridges 22 and sharp valleys 24 will be diamond, rhomboid or square shape.

Of course, also in this case, a plane sheet may be put between the corrugated sheets.

In Figure 7 is shown a possibility of achieving differently sized cells. In this way, a way of varying the sound attenuation is created.

The cells 12 shown in Figs. 1 – 7 are all cylindrical, i.e. the cross-section in the elongation of the cell 12 from the first open end 14 to the second open end 16 is constant.

In Figs 8A-8C are shown an alternative configuration of the cells with varying cross-section.

As can be seen in Figs 8A-8B, the wall 13 forming each cell 12 has a waist 30 or a time-glass shape. At the first open end 14, the cell 12 has a first cross-section 18'. The cross-section narrows to about the middle of the elongation of the cell 12, and then widens towards the second open end 16 to a second cross-section 18". The first cross-section 18' is substantially the same as the second cross-section 18", and the waist 30 is substantially mid-ways between the first end and the second end.

Of course, the waist 30 may be positioned closer to the first open end 14 or to the second open end 16. Likewise, the first cross-section 18' may be larger than the second cross-section 18" and vice versa.

As shown in Fig 8C, the cross-section 18 may instead be frusto-conical 32, i.e. the cross-section is circular, the diameter of which varying continuously from the first open end 14 to the second open end 16. The first cross-section 18' at the first open end 14 is larger

than the second cross-section 18" at the second end 16, or vice versa.

In each of the variants, the first and the second layers 4, 6 are connected to the intermediate layers shown in figures 2-7 and 8A-8C in the manner shown in Figure 1, i.e. such that it covers the open ends 14, 16 of the cells 12. This adds to the mechanical stability of the absorber in a direction from the first open 14 towards the second end 16, and vice versa, or in other words from the first layer 4 to the second layer, i.e. across the thickness $\mathbf{t_c}$ of the intermediate layer 8. This is of great importance when manufacturing the micro-slits, since the absorber may collapse during machining if the intermediate layer is not stable enough.

In Fig. 9, a cut-out of the first layer 4 is shown. As shown, the micro-slits 10 have a width **a** and are arranged parallel to and at a distance **b** from one another, and as shown in Fig. 10, the micro-slits have a length **L**.

Fig. 10 furthermore shows the manufacture of micro-slits in a sound-absorbent 2. A robot 50 controlled by a micro-computer 52 is programmed to control the movements of a robot arm 54. A tool holder 56 is provided with an exchangeable cutting tool 58, such as a cutting blade or a knife.

Alternatively, the tool as such may be oscillating, such as a jigsaw, or rotating, such as a circular saw or an end mill. Yet alternatively, the tool may be a punch knife. In both cases, the robot only needs another programming of the computer.

A cutting tool 58 for cutting a micro-slit of the width **a** chosen, such that the cut micro-slit has a width **a** within a range of 1 micrometer to 1 mm, more preferably 10 micrometer to 0,9 mm, most preferably 0,3 – 0,5 mm.

The computer 52 of the robot 50 is programmed such that it will control the robot arm to perform longitudinal movements and cut slits at a distance **b** from one another, such that neighbouring slits 10 are cut at a distance **b** within a range of 1 micrometer to 10 mm, more preferably 10 micrometer to 5 mm, most preferably 0,5 – 2 mm.

The computer 52 is furthermore programmed to control the robot arm to cut said slits to

a length **L** within the range of 2 - 2000 mm, more preferably 10 - 1000 mm, most preferably 100 - 1000 mm.

As can be seen in Fig 11, a plurality of aligned slits 10 may each have a length L, while together having a total length $\mathbf{L_{tot}}$ which may be within the range of 4 mm up to several meters; only the size of the sound absorbent 2 sets the upper limit.

Figs 12A – 12 B shows a circular sound absorbent 2 with a plurality of parallel slits 10. In the case of Fig 12A, the diameter of the circular sound absorbent 2 sets the upper limit of the length of each slit **L** (or in case of a plurality of aligned slits (cf. Fig 11) the total length $\mathbf{L_{tot}}$).

However, in the variant shown in Fig. 12B, a spirally shaped single slit 10 is provided in the first layer 4. Depending on the distance between neighbouring turns of the spiral, the length of the slit **L** may be many meters.

In all embodiments above, the intermediate layer has been shown to have a constant thickness $\mathbf{t_c}$, such that first layer 4 and the second layer 6 are parallel to one another.

As shown in Figs 13A – 13F, the thickness $\mathbf{t_c}$ of the intermediate layer may instead be everything else than constant, and thus, the first layer 4 and the second layer 5 will not be parallel.

In Fig 13A, the intermediate layer 8 is concave 60 on the side facing the first layer 4 in such a way that the first layer 4 is caused to be concave as well, while the opposite side of the intermediate layer 8 is plane, and hence also the second layer 6 is plane.

In Fig 13B, the intermediate layer 8 is concave 60 also on the side facing the second layer 4, and thus, the first and second layers 4, 6 are both concave 60.

In Fig 13C, the intermediate layer 8 is instead convex 62 on the side facing the first layer 4 in such a way that the first layer 4 is caused to be convex 62 as well, while the opposite side of the intermediate layer 8 is plane, and hence also the second layer 6 is plane.

In Fig 13D, the intermediate layer 8 is convex 62 also on the side facing the second layer 6, and thus, the first and second layers 4, 6 are both convex 62.

In Fig 13E, the intermediate layer 8 is concave 60 on the side facing the first layer 4 in such a way that the first layer 4 is caused to be concave 60 as well, while the opposite side of the intermediate layer 8 is convex 62, and hence also the second layer 6 is convex 62. Another concave-convex shape is shown in Fig. 17.

Fig 13F shows a different configuration of the sound absorbent 2, wherein the intermediate layer has a double sloping side facing the first layer 4, such that also the first layer is double sloping, wile the opposite side of the intermediate layer facing the second layer 6 is plane. Of course, also the side of the intermediate layer 8 facing the second layer 6 may be double sloping.

In the figures referred to above, the cells 12 of the intermediate layer 8 has been shown to have a length corresponding to the core thickness t_c of the intermediate layer 8.

As can be seen in Fig. 14, the cells 12 may instead be inclined with respect to a normal to the layers 4 and 6. The angle α may be in the range 0° - 30°.

Fig 15 shows rectangular sound absorbents 2 attached to a ceiling by fastening means 72 hanging from a ceiling. In this case, when sound is to be absorbed from two sides, not only the first layer 4 is provided with micro-slits 10, but also the second layer 6.

Furthermore, as can be seen, in Fig 15, the elongated slits may be provided diagonally to edges of the rectangular sound absorbent. Of course, all the above shown variants of sound absorbers 2 may be provided with slits arranged at an angle to and in the plane of the first (or second) layer.

Fig. 16 shows a sound absorbent 2 with a pattern of micro-slits 10 that also have an aesthetic effect.

Fig 17 shows a room provided with different kinds of sound absorbents 2 provided with

micro-slits 10 on the first as well as the second layer 4, 6, and furthermore supported by stands 80; this kind of sound absorbent 2 is suitable for example in open plan offices.

Fig 17 also shows sound absorbents 2 in the form of pieces of art 82, 84, where the pattern of the micro-slits as such have an aesthetic effect in item 82 (the surface preferably having a uniform colour, such as white, to emphasize the pattern of the micro-slits), whereas in item 84, an image is provided on the surface of the first layer 4, and micro-slits are provided in the image. The micro-slits 10 will in this case be more or less invisible, depending on the character and colouring of the image.

List of reference signs used

2	sound absorbent
4	first layer
6	second layer
8	intermediate layer
10	micro-slit
12, 12a, 12b, 12c, 12d	cell
13	wall
14	first open end
16	second open end
18, 18a, 18b, 18c, 18', 18"	cross-section
20a, 20b, 20c, 20d	corrugated sheets
22	ridge
24	valley
26, 26a, 26b, 26c	plane sheet
30	waist
32	frusto-conical
50	robot
52	micro-computer
54	robot arm
56	tool holder
58	cutting tool
60	concave
62	convex

72	fastening means
80	stand
82	piece of art 82
84	piece of art

t_1	first thickness
t_2	second thickness
t_c	core thickness
T	total thickness
a	width
b	distance
L	length
L_{tot}	total length
α	angle

CLAIMS

1. A sound absorbent comprising a first cover layer (4), a second cover layer (6) and an intermediate layer (8), said intermediate layer (8) comprising walls (13) delimiting a plurality of cells (12,12a,12b,12c,12d) open in a first end (14) and a second end (16), said cells being arranged adjacent one another, said first open end (14) of said plurality of cells being covered by said first cover layer (4), said second open end (16) of said plurality of cells being covered by said second cover layer (6), **characterised in that** said first layer (4) is provided with at least one micro-slit (10) by mechanical machining, the micro-slit (10) extending through said first layer (4), such that sound waves are allowed to penetrate said micro-slit (10) and to enter the first open end (14) of said cell.

2. A sound absorbent according to claim 1, wherein said second layer (6) is provided with a at least one micro-slit (10), such that sound waves are allowed to penetrate said micro-slit and to enter the second open (16) end of said cell.

3. A sound absorbent according to claim 1 or 2, wherein the length (L) of said micro-slit is in the range of 2 mm – 2 km, more preferably 10 - 1000 mm, most preferably 100 - 1000 mm.

4. A sound absorbent according to any one of claims 1 to 3, wherein the width (a) of said slit is in the range of 1 micrometer to 1 mm, more preferably 10 micrometer to 0,9 mm, most preferably 0,3 – 0,5 mm.

5. A sound absorbent according to any one of the preceding claims, wherein the thickness of said wall (13) is in the range of 10 micrometers to 0,5 mm, more preferably 30 micrometers to 0,3 mm, most preferably 50 micrometers to 0,2 mm.

6. A sound absorbent according to any one of the preceding claims wherein at least every wall sheet is shaped by a corrugated sheet or plate (20a, 20b, 20c, 20d), every second wall being a substantially plane sheet or plate (26, 26a, 26b, 26c) arranged between every second corrugated sheet or plate (20a, 20b, 20c, 20d).

7. A sound absorbent according to any one of the preceding claims, wherein the thickness (t_1) of at least one of said first layer (4) and said second layer (6) is in the range of 10 micrometers to 5 mm, more preferably 20 micrometers to 0,9 mm, most preferably 50 micrometers to 0,6 mm.

8. A sound absorbent according to any one of the preceding clams, wherein at least one of said intermediate layer (8), said first layer (4) and said second layer (6) is made of a cellulose material, polymer material or metal.

9. A sound absorbent according to any one of the preceding claims, wherein the thickness (t_c) of said intermediate layer is in the range of 1 – 200 mm, more preferably 5 – 50 mm, most preferably 10 – 30 mm.

10. A sound absorbent according to any one of the preceding claims, wherein the ratio of cells per square meter of a cross-section of the intermediate layer (8) is within the range of 1 to 100 000 000 more preferably 100 to 1 000 000, most preferably 500 to 200 000.

11. Method of manufacturing a sound absorbent according to any one of the preceding claims, whereby said micro-slit (10) is made by mechanical machining by a mechanical tool.

12. Method according to claim 11, including choosing an intermediate layer of a predetermined material, choosing a first layer (4) of a predetermined layer and choosing a second layer (6) of a predetermined material.

13. Method according to claim 12, whereby at least the first layer (4) of said first and second layers is connected e.g. by gluing to the intermediate layer (8) before the micro-slits are made in the first layer (4).

14. Method according to claim 21, whereby mechanical machining includes one of punching, whereby said mechanical tool is e.g. a punch knife; slitting by means of a slitting machine, whereby said mechanical tool is a knife; and cutting, whereby said mechanical tool is a cutting blade with a cutting edge.

15. Method according to any one of claims 11-14, including choosing a mechanical tool out of a set of tool sizes to achieve a predetermined slit width, connecting said mechanical tool to a computer numerical control machine, and programming the slit length, the slit depth and the distance between the slits to achieve a desired sound attenuation.

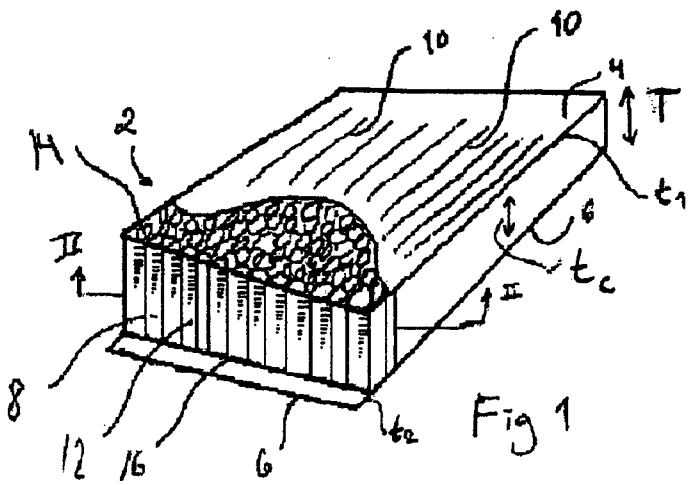

10
10
4
T
H
2
II
II
8
12
16
6
t_1
t_c
t_2

Fig 1

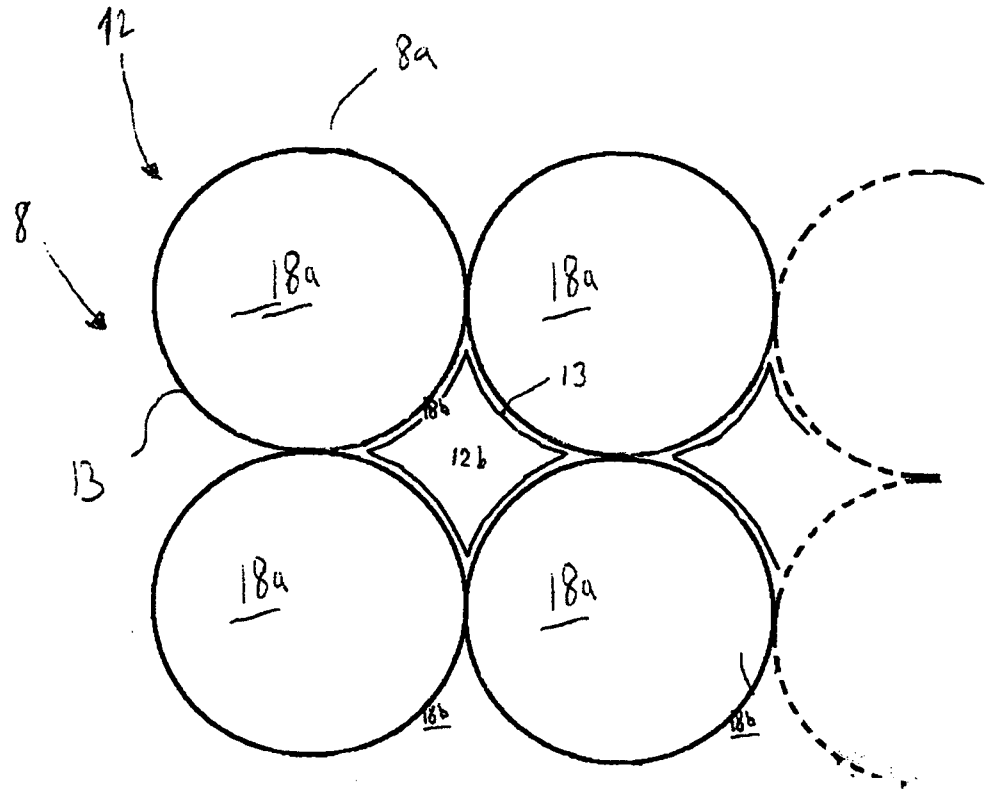

12
8a
8
18a
18a
13
13
18b
12b
18a
18a
18b
18b

Fig 2

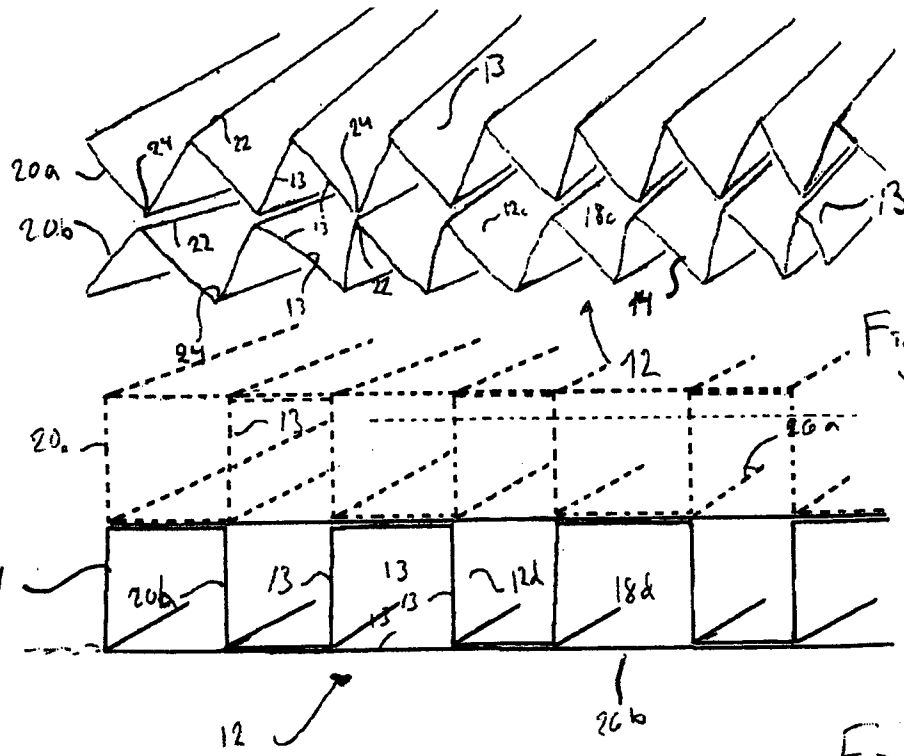


Fig 3

Fig 4

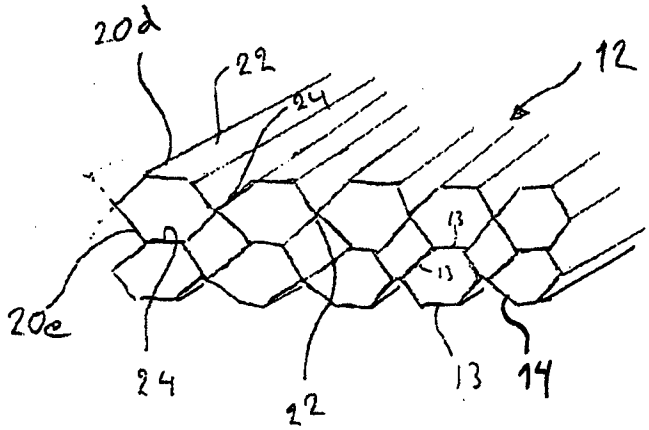


Fig 6

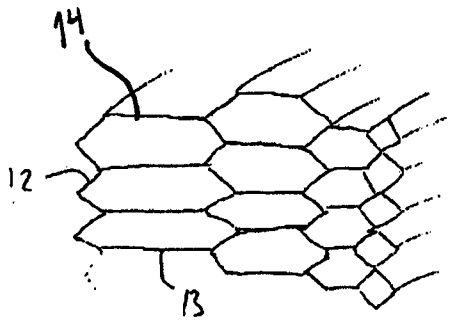


Fig 7

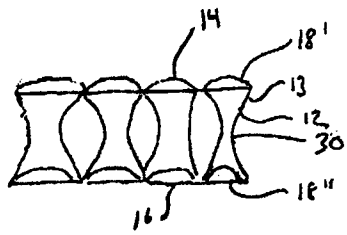


Fig 8B

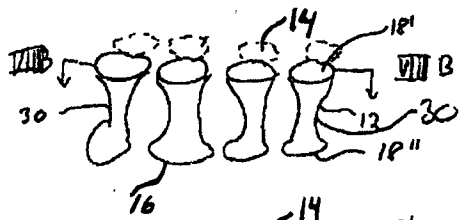


Fig 8A

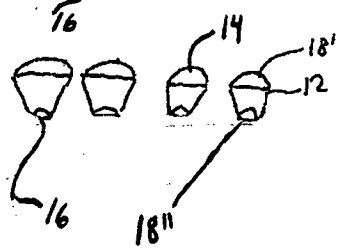


Fig 8C

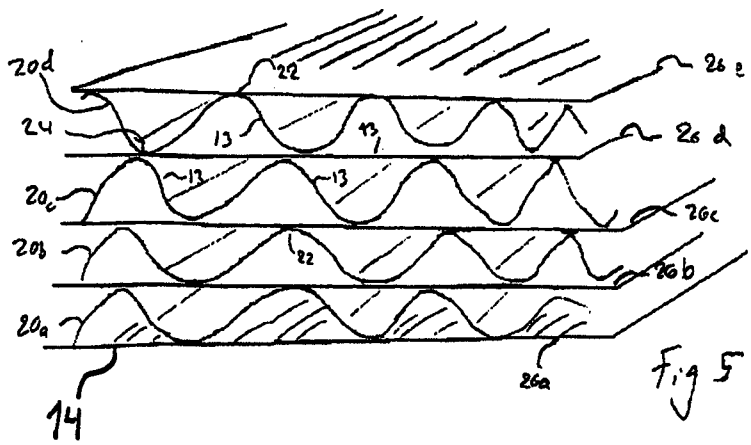

20d
22
26e
24
13
13'
26d
20c
13
13
26c
20b
22
26b
20a
14
26a

Fig 5

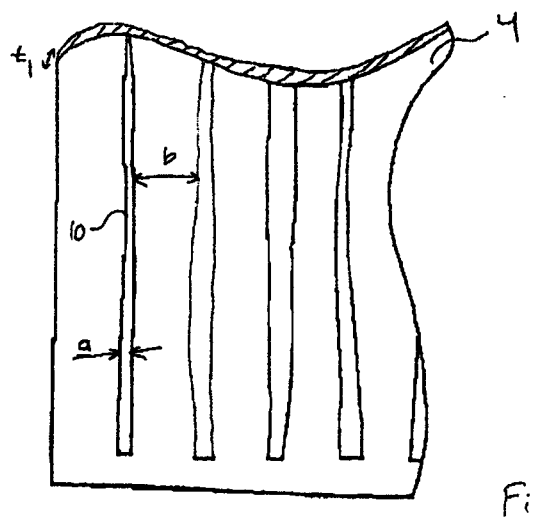

4
t1
b
10
a

Fig 9

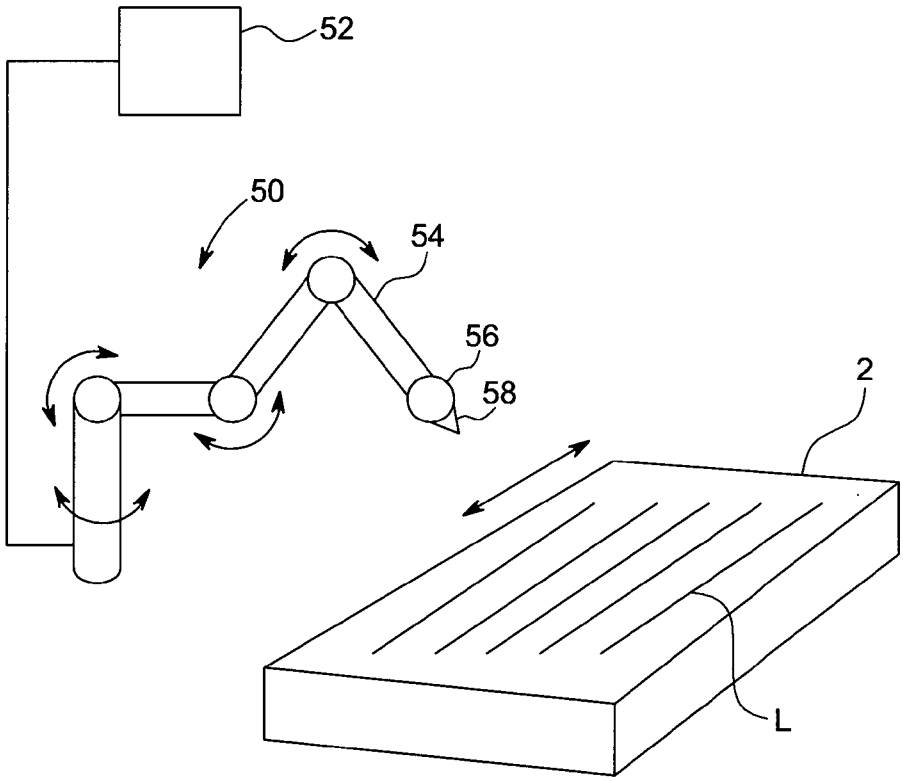


FIG. 10

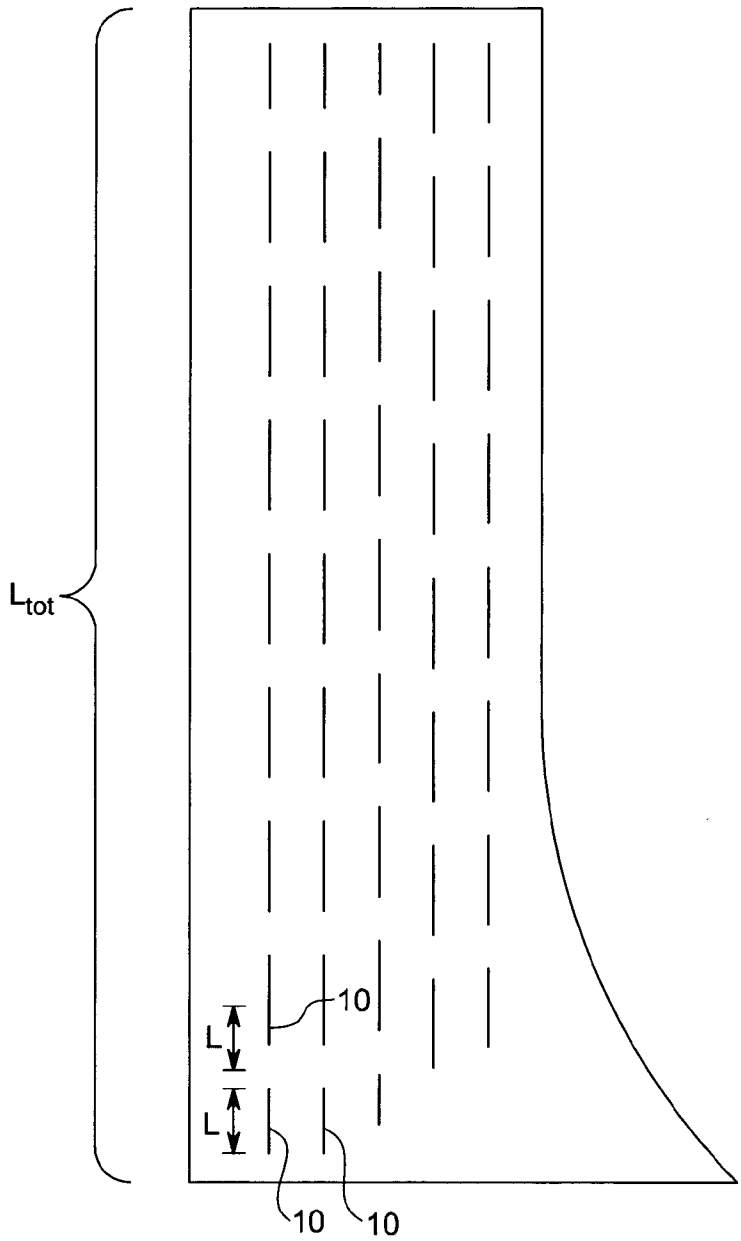


FIG. 11

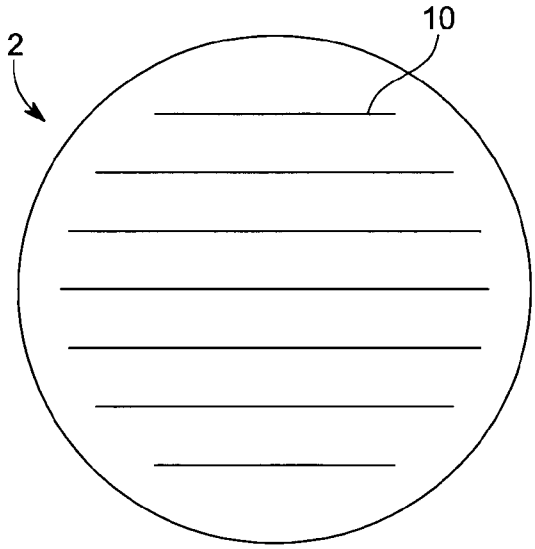


FIG. 12A

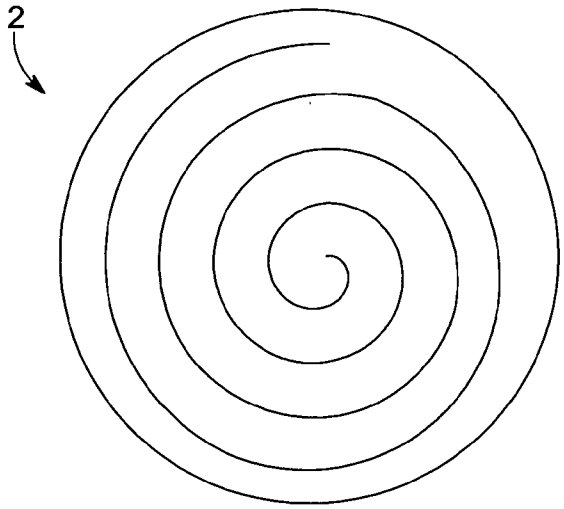


FIG. 12B

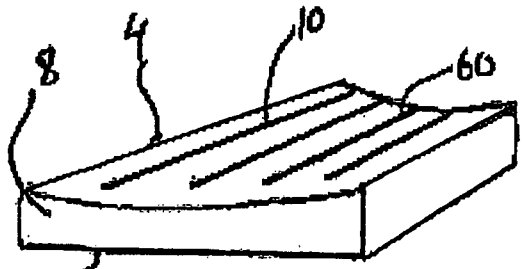


Fig 13A

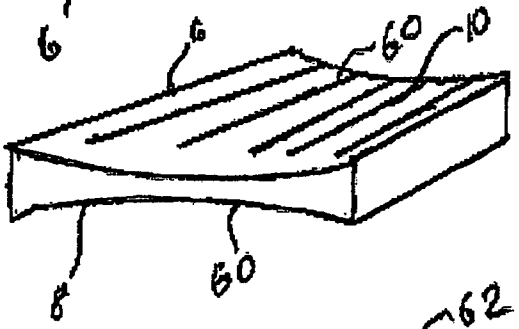


Fig 13B

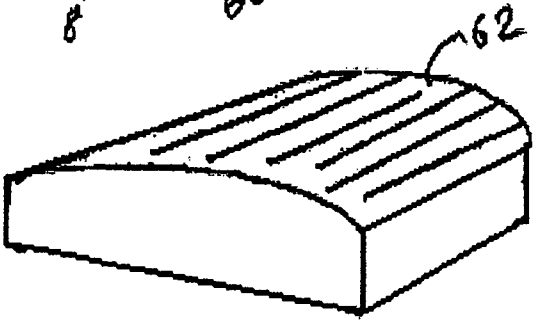


Fig 13C

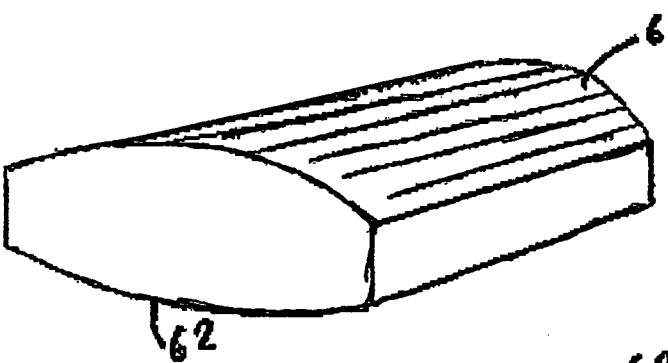


Fig 13D

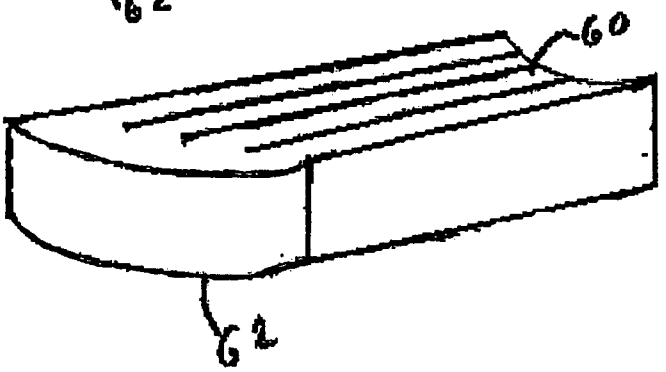


Fig 13E

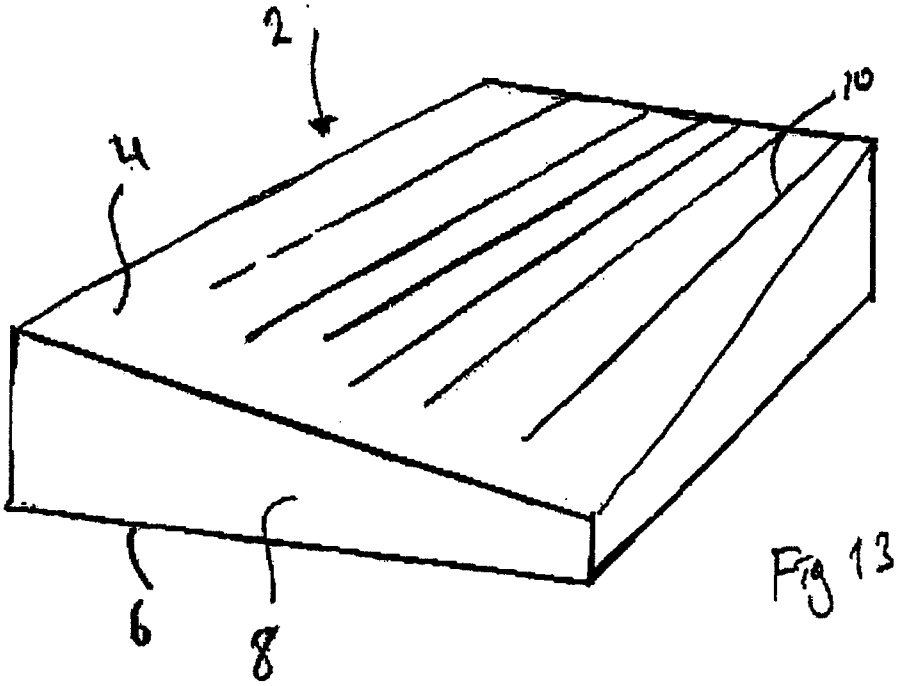


Fig 13F

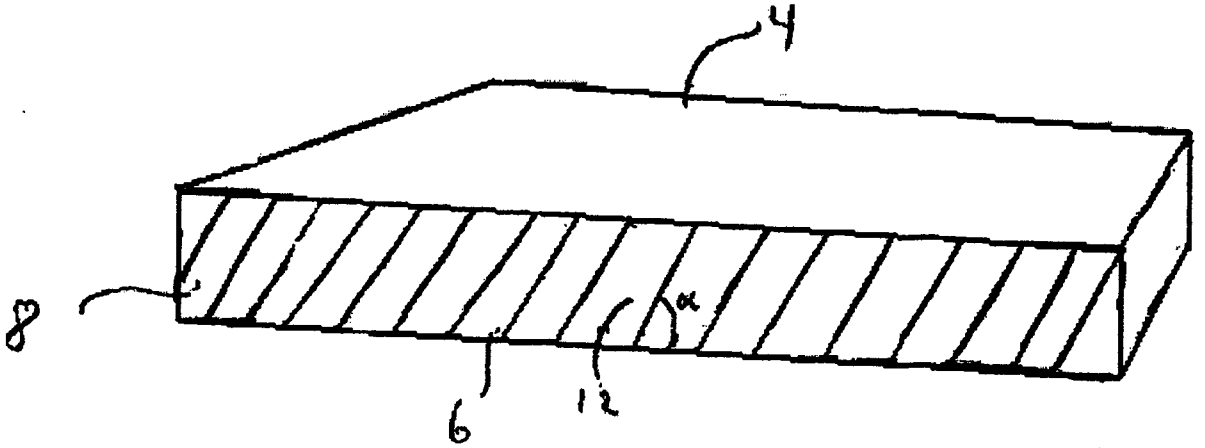


Fig 14

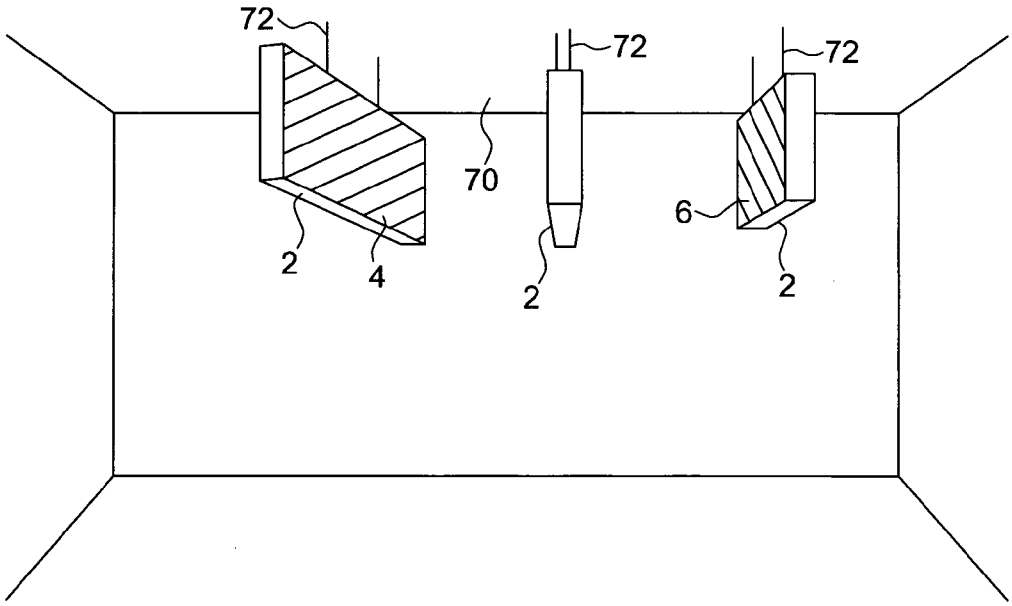


FIG. 15

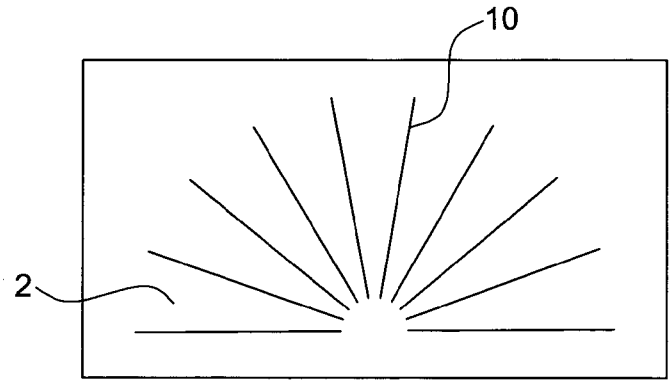


FIG. 16

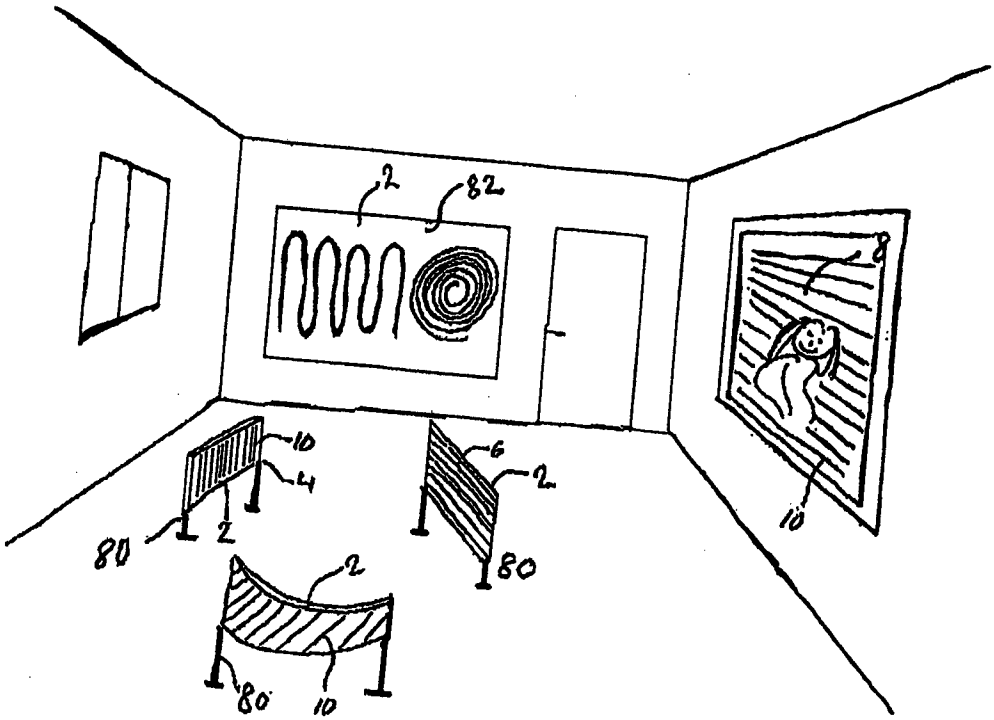


Fig 17