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(71) Applicant : **Bridgestone Corporation**
No. 10-1 Kyobashi 1-Chome
Chuo-Ku
Tokyo (JP)

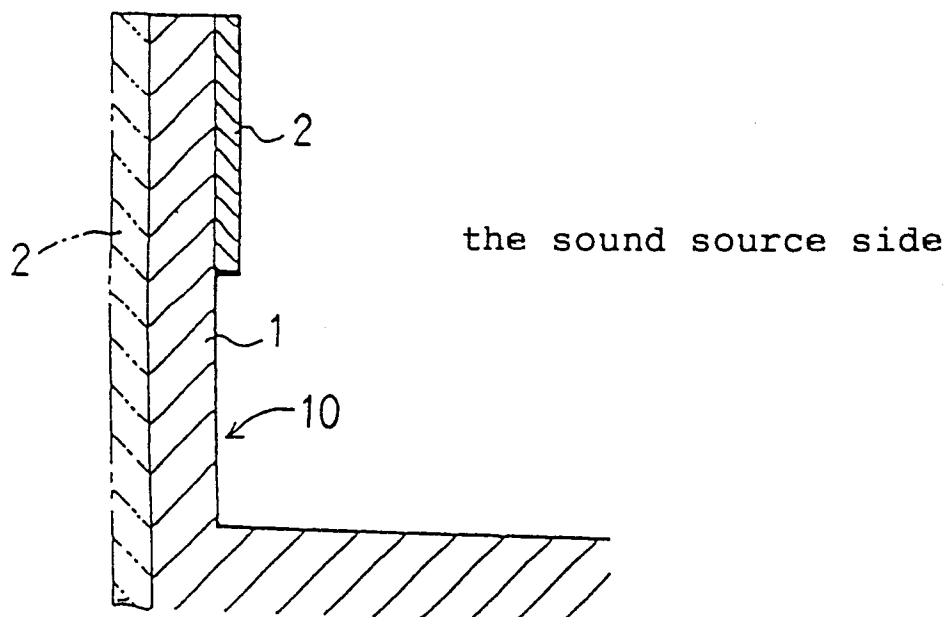
(72) Inventor : **Murase, Masanori**
4-7-502, Ogawahigashimachi 3-chome
Kodaira-shi, Tokyo (JP)
 Inventor : **Mizuno, Keiichiro**
6-18-607, Kamata 1-chome
Ota-ku, Tokyo (JP)
 Inventor : **Iida, Kazuyoshi**
306-517, Oaza Sinkou
Iruma-shi, Saitama-ken (JP)

(74) Representative : **Whalley, Kevin**
MARKS & CLERK,
57-60 Lincoln's Inn Fields
London WC2A 3LS (GB)

(54) **Soundproof wall.**

(57) A soundproof wall comprising a wall structure (10) having a rising portion (1) and a sound absorbing member (2) or hollow structure (4) attached to either the inner or outer side, or to both, of the rising wall portion. The soundproof wall is highly effective in sound absorption and can advantageously be manufactured with reduced costs.

FIG.1



The present invention relates to a soundproof wall intended for use as erected along railways and highways, around houses, schools, factories, airport buildings, etc. and in similar places from or to which undesired sound or noise should desirably be attenuated or shut off.

To insulate or attenuate undesired sound or noise, it has so far been proposed to use a porous concrete panel, panel made of aluminum or similar metal, and a wall formed from an assembly of boxes made of aluminum or FRP and which have glass wool or the like packed therein. Recently, such box is made of ceramic.

The soundproof wall made only of a porous concrete panel does not effectively absorb or attenuate sound, has no sufficient shock resistance and has the strength reduced when wetted in rain. The box made of aluminum, FRP or ceramic having glass wool or the like packed therein is effective in sound absorption but expensive in case many pieces are assembled to form a soundproof wall.

Accordingly, the present invention aims at providing a soundproof wall highly effective in sound absorption or attenuation and advantageous in view of manufacturing costs.

According to one aspect of the present invention, a soundproof wall is provided which comprises a wall structure having a rising portion and a sound absorbing member or hollow structure attached to either the inner or outer side, or to both, of the rising wall portion.

According to another aspect of the present invention, a soundproof wall is provided which comprises a wall structure having a rising portion and a portion overhanging at the top of the rising wall portion toward and/or away from a sound source, and a sound absorbing member or hollow structure attached to any one or more of the inner and outer sides of the rising wall portion and the upper and lower sides of the overhanging wall portion.

The sound absorbing member or hollow structure according to the present invention can be easily attached with bolts to the surface of an existing concrete wall erected along a railway, for example, absorbs sound highly effectively and can be manufactured with a reduced cost.

The present invention, with further features and advantages thereof, may be best understood by reference to the following description taken in connection with the accompanying illustrative drawings.

FIG. 1 is a sectional view of a first preferred embodiment of the present invention in which a sound absorbing member is attached to a rising portion of a wall structure on either the inner or outer side (on the sound source side or opposite side), or on both, thereof;

FIG. 2 is a partially fragmentary perspective view of the sound absorbing member used in the first embodiment;

FIG. 3 is a sectional view of a variant of the first embodiment in which the sound absorbing member is so attached to the wall structure as to cover the upper portion of the rising wall portion;

FIG. 4 is a sectional view of a second variant of the first embodiment in which a sound absorbing member is attached to either side of the rising wall portion at the upper half portion thereof as spaced from each wall surface;

FIG. 5 is a sectional view of a third variant of the first embodiment in which a sound absorbing member is attached to either side of the rising wall portion at the upper portion thereof as shown in FIG. 4 except that the outer one of the sound absorbing members (opposite to the sound source side) is fixed directly to the wall surface;

FIG. 6 is a sectional view of a fourth variant of the first embodiment, similar to that shown in FIG. 5 except that the inner one of the sound absorbing members (on the sound source side) is fixed directly to the wall surface;

FIG. 7 is a sectional view of a fifth variant of the first embodiment similar to that in FIG. 3 except that the top and inner sound absorbing members are attached to the rising wall portion as spaced from the wall surface;

FIG. 8 is a front view of a variant of the sound absorbing member used in first embodiment of the present invention, installed on the rising wall portion;

FIG. 9 is an explanatory drawing of a noise measurement effected with the soundproof wall according to the first embodiment;

FIG. 10 is a sectional view of a second embodiment of the present invention in which the wall structure has a portion overhanging provided at the top of the rising wall portion thereof toward and/or away from a sound source and the sound absorbing member is attached to the upper side of the overhanging wall portion;

FIG. 11 is a sectional view of a variant of the second embodiment of the present invention in which two sound absorbing members are attached with one fixed to the upper side of the overhanging wall portion and the other fixed to the inner side of the rising wall portion;

FIG. 12 is a sectional view of a second variant of the second embodiment in which two sound absorbing members are attached with one fixed to the lower side of the overhanging wall portion and the other fixed

to the inner side of the rising wall portion;

FIG. 13 is a sectional view of a third variant of the second embodiment in which two sound absorbing members are attached with one fixed to cover the overhanging wall portion around the inner end (on the sound source side) thereof and the other fixed to the inner side of the rising wall portion;

5 FIG. 14 is a sectional view of a fourth variant of the second embodiment in which two sound absorbing members are attached with one fixed to the overhanging wall portion to cover the outer-end corner thereof and the other fixed to the inner side of the rising wall portion;

FIG. 15 is a sectional view of a fifth variant of the second embodiment in which the overhanging wall portion and inner side of the rising wall portion are covered entirely with the sound absorbing members;

10 FIG. 16 is an explanatory drawing of a noise measurement effected with the second embodiment of the soundproof wall according to the present invention;

FIG. 17 schematically shows three examples (A), (B) and (C) of the soundproof walls used in the noise measurement shown in FIG. 16;

15 FIG. 18 is a sectional view of a wall structure other than the simple rising wall structure and the one having the overhanging portion, which have been illustrated and described above;

FIG. 19 is a sectional view of a further wall structure;

FIG. 20 is a sectional view of a yet further wall structure;

FIG. 21 is a sectional view of a third embodiment of the present invention, in which the hollow structure according to the present invention is attached to the rising wall portion of the wall structure;

20 FIG. 22 is a perspective view of a first variant of the hollow structure according to the present invention;

FIG. 23 is a sectional view of a second variant of the hollow structure according to the present invention;

FIG. 24 is a perspective view of a fourth embodiment of the present invention in which a third variant of the hollow structure constructed by tubular members different in length and diameter from one another, is attached to the rising wall portion;

25 FIG. 25 is a perspective view of a fourth variant of the hollow structure;

FIG. 26 is a sectional view of a fifth embodiment of the present invention in which the hollow structure shown in FIG. 25 attached to the rising portion of the wall structure having an overhanging portion;

FIG. 27 is a sectional view of a sixth embodiment of the present invention in which a combination of a hollow structure shown in FIG. 22 and sound absorbing member, both according to the present invention, attached to the upper portion of the rising wall portion; and

30 FIG. 28 is a sectional view of a variant of the sixth embodiment in which a combination of a hollow structure shown in FIG. 23 and a sound absorbing member, is used on the upper portion of the rising wall portion.

In the first embodiment of the present invention shown in FIG. 1, a wall structure 10 has a rising portion 1, and a sound absorbing member 2 is attached with bolts or similar fasteners to the upper half of one side of the rising wall portion 1 (on the sound or noise source side). This arrangement of the sound absorbing member 2 permits to attenuate a diffracted wave of a sound or noise coming from the top end of the rising wall portion 1. Alternatively, the sound absorbing member 2 may be attached to the rising wall portion 1 over the outer side thereof as indicated with two-dot chain line in FIG. 1. In the latter case, the reflection of the diffracted wave can be minimized. Otherwise, the sound absorbing member 2 may be attached on either side, inner and outer, of the rising wall portion 1. Further alternatively, the sound absorbing member 2 may also be attached to the lower half of the inner side of the rising wall portion 1. The sound absorbing member 2 attached to the upper or lower half of the rising wall portion 1 will be capable of sufficiently attenuating the sound or noise, which will lead to a correspondingly lower cost.

45 The sound absorbing member 2 employed in this embodiment is composed of a flat box 21 made of aluminum, FRP, ceramic or the like, and a fiber 22 such as glass wool packed inside the box 21. The box 21 may have small holes 23 formed in the outer surface thereof. Also, the box 21 has formed therein at every corner thereof fixing holes 24 through which a fastener such as bolt or the like is introduced to fix the sound absorbing member 2 to the rising wall portion 1 of the wall structure 10.

50 The fiber 22 packed in the box 21 of the sound absorbing member 2 should preferably be a fiber block of 0.04 to 0.15 g/cm³ in mean apparent density, formed by compacting, from a short fiber of 30 or less deniers at the center of fiber diameter distribution. This combination of the short fibers of 30 or less deniers with an apparent density falling in a predetermined range permits to increase the ventilation resistance in the fiber block, thereby providing an improved sound absorption. Assume here that a fiber of 30 or more deniers is used for this purpose. The fiber block formed from the fiber will have a lower density even with a same apparent density so that the ventilation resistance will be lower, resulting in a poor sound absorption. On the contrary, if it is tried to improve the sound absorption by forming such fiber block higher only in the apparent density, the fiber block will be too hard and more likely to reflect incident sound. Namely, the sound absorption will be poorer. To avoid the above, the upper limit of the fiber-block apparent density should be set to 0.15 g/cm³ as

in the above.

On the other hand, a fiber block having made of a short fiber of 30 or less deniers will have no larger ventilation resistance if its apparent density is 0.04 g/cm³ or less. No sufficient sound absorption can be expected of a sound absorbing member thus made. The short fiber may be any one selected from synthetic fibers such as polyester, polypropylene, polyethylene, nylon, Vinyon, etc. as well as natural fibers such as wool, cotton, hemp, etc. For production of a fiber block used in the sound absorbing member according to the present invention, a bituminous or similar material is processed by a melt spinning or similar method to be fibrous and mixing the fiber thus produced in an amount of 10 or more percent by weight into the above-mentioned short fiber. A fiber block formed from this mixture will insulate or absorb sound very effectively. Of course, a fiber block formed, by packing, from only one of the above-mentioned synthetic or natural fibers, also provides an equivalent sound insulation and absorption. The above-mentioned similar material to the bituminous contains 30 or more % by weight of a bituminous of which the brittleness and temperature dependence are improved through modification thereof by addition of a resin, rubber or thermoplastic elastomer. The reason why the fiber block, made of a short fiber to which the bituminous fiber made from a bituminous or similar material, insulates and absorbs sound highly effectively is that the bituminous has an excellent damping property which will be imparted to the fiber block if the bituminous is added to the latter.

The fiber block can also be formed by setting in a mold a short-fiber aggregate containing a binder and preformed to a flat shape (preformed fiber block), and compressing it while it is being heated. Such a preformed fiber block may be a polyester fiber clenched with a binder such as polyethylene fiber, low melt-point polyester fiber or bituminous fiber.

The fiber block can be produced by using any of the above-mentioned methods. For a more uniform filling and smaller density distribution of the fiber block, however, a method should preferably be adopted in which discrete fiber pieces resulted from splitting of a fiber are blown into a mold along with a gas (air), and only the gas is discharged through a multi-hole network while only the short fiber is filled into the mold to form a fiber block. By this fiber filling by transfer with air, it is possible to fill the fiber in a desired shape and produce a fiber block which is generally uniform, soft and porous. As mentioned above, a binder is used to form and clench the material filled in the mold. The binder used for this purpose may be selected from a variety of materials including a reaction-sensitive phenol resin which will be melted when heated, a reaction-sensitive urethane adhesive will react with a blown-in steam, etc. However, a fibrous binder can be used suitably for the purpose of the present invention. The fibrous binder may be any one selected from a low melt-point polyester fiber which will be melted when heated or applied with a steam and a polyethylene or polypropylene fiber which will be melted when heated or in a steam and be solidified when cooled. Preferably, the fiber should be composed of low and high melt-point components. Moreover, the fiber should advantageously be a composite one in which the low melt-point component exists outside the high melt-point one to serve as the fiber surface, in view of the durability and acoustic property of the preformed fiber block or sound absorbing member. More particularly, by molding the composite fiber as heated to a temperature higher than the melt point of the low melt-point component and lower than that of the high melt-point component, the binder can bind the preformed fiber block by the low melt-point component melted while the binder keeps a complete fibrous state, thereby assuring a high durability and acoustic property of the sound absorbing member. Also, the binder may be any other material which is fibrous like the bituminous fiber and is meltable when heated or otherwise. To mold a porous layer having a fibrous binder mixed therein, it is preferred to adjust the temperature of a mold to lower than the melt point of the binder and melt the binder with a hot blast or steam blow at a higher temperature than the melt point. In this case, addition of a means of enabling a selection between the hot and cold blasts will lead to a further improvement of the molding cycle, and the blow of a hot blast will uniformly melt and solidify the entire porous layer to the deepest point thereof. Thus, a soft and lightweight fiber block having a desired shape can be produced by blowing a short fiber as the material together with the fibrous binder into a mold and then a hot blast into the mold to melt the binder which in turn will bind the short fiber. The fiber block thus produced is superior in dimensional precision and soundproof performance.

As shown in FIG. 3, the sound absorbing member 2 may be attached to cover the top as well as the inner and outer sides of the rising wall portion 1. When the soundproof wall according to the present invention is used along a railway, the sound absorbing member 2 thus installed can effectively absorb an aerodynamic sound generated at the lateral side of a railway vehicle running at a high speed and attenuate a diffracted wave and reflected one of the wave.

Also the sound absorbing members 2 may be used on the rising wall portion 1 as spaced a predetermined distance therefrom as shown in FIGS. 4 to 7. In these variants, it can be expected that an effective sound attenuation is attained due to a cancellation between a direct wave from a sound source and a sound wave passing through the space between the sound absorbing member 2 and surface of the rising wall portion 1.

FIG. 8 shows a variant of the sound absorbing member 2, composed of a fiber block 22 of which the surface

is waved and a frame 31 surrounding all the four sides of the fiber block. A plurality of fasteners 11 used provided in predetermined places on the frame 31, and the anchor bolts 20 buried in the rising wall portion 1 are to be inserted into these fasteners 11 to fix the sound absorbing members 2 to the rising wall portion 1. In this variant, the fiber (fiber block) 22 is exposed to the sound source side. For a water repellency and weatherability of the sound absorbing member 2, the exposed surface of the fiber block 22 is coated with a water repellent made of ceramic, silicon or fluorocarbon resin. For example, a ceramic-made water repellent may be sprayed to the exposed surface of the fiber block 22 molded in a predetermined shape. Also, a fiber previously applied with such water repellent may be preformed into a fiber block 22 by adopting the previously-mentioned method. The frame 31 is installed to embrace the edges of the fiber block 22. The frame 31 is made of a galvanized sheet iron, aluminum sheet or the like of about 1.2 mm in thickness.

FIG. 9 schematically shows the method for noise measurement adopted for testing the effect of the soundproof wall according to the present invention. There were set two sound sources, lower and upper, 50 and 51 each using a speaker. A microphone was placed at a measurement position A. In FIG. 9, all the dimensions are in mm. This noise measurement as in FIG. 9 was effected in an anechoic room. The experiments were conducted in four kinds with the soundproof wall. In the first experiment, a 500 mm-high sound absorbing member 2 was attached to the inner side (on the sound source side) of the rising wall portion 1 at a position 100 mm lower from the top thereof. In the second experiment, a sound absorbing member 2 having a height of 1,000 mm was attached similarly on the rising wall portion 1. In the third experiment, a same sound absorbing member 2 as that in the second experiment was attached as in the second experiment and also a 500 mm-high sound absorbing member 2 was additionally attached as spaced 100 mm down from the first sound absorbing member 2 on the same rising wall portion 1. In the fourth experiment, a sound absorbing member 2 was attached to the wall structure 10 along the total height of the inner surface of the rising wall portion 1. Of course, a noise measurement was done with no sound absorbing member 2 attached on the rising wall portion 1. Also, sounds of different frequencies were used for each of these measurements. The noise levels were measured in all the experiments 1 to 4 and the sound measurement with no sound absorbing member 2. Table 1 shows the sound attenuation by the sound absorbing members 2 in the above experiments 1 to 4 with reference to the sound levels measured with no sound absorbing member 2. The rising wall portions 1 used in these experiments were all a lightweight concrete panel of 100 mm in thickness, 2,000 mm in height, and the sound absorbing members 2 were a one illustrated and described with reference to FIG. 8.

Table 1

Frequency	Experiment 1	Experiment 2	Experiment 3	Experiment 4
63 Hz	0	0	0	1
125 Hz	1	1	1	1
250 Hz	1	1	1	2
500 Hz	1	2	2	3
1 kHz	2	3	5	5
2 kHz	3	5	6	10
4 kHz	5	7	7	14

In Table 1, the sound attenuation is given in decibels (dB) as measured in a 1/1 octave band. A sound of about 100 decibels (dB) was generated from the lower sound source 50.

The experiment results revealed that each of the sound absorbing members 2 attached on the rising wall portions 1 provided a sound attenuation in each frequency range. From the standpoint of costs, however, the soundproof wall in the second experiment was the most effective in practice. It was also proved that the sound absorbing member 2 attached at the upper portion of the rising wall portion 1 most effectively attenuated the sound from the upper sound source 51.

The wall structure 10 may have a portion 3 overhanging at the top the rising portion 1 thereof toward (and/or away from) the sound source as shown in FIG. 10. The sound absorbing member 2 may be attached to the upper side of the overhanging wall portion 3. Alternatively, one more sound absorbing member 2 may be used as attached to the inner side (on the sound source side) of the rising wall portion 1 in addition to the one attached to the overhanging wall portion 3, as shown in FIG. 11. Also, the sound absorbing members 2 may be used on both the bottom of the overhanging wall portion 3 and the inner side of the rising wall portion 1, respectively, as shown in FIG. 12. Otherwise, two sound absorbing members 2 may be used with one of them attached to the overhanging wall portion 3 around the end portion thereof (top, side and bottom) while the other is attached to the inner side of the rising wall portion 1, as shown in FIG. 13. In addition, two sound absorbing members 2 may be used with one of them attached around the outer-end corner of the rising wall portion 1 while the other is attached to the outer side of the wall, as shown in FIG. 14. Moreover, the sound absorbing members 2 may be used as attached to the inner side of the rising wall portion 1 and the entire overhanging wall portion 3, respectively, as shown in FIG. 15.

FIG. 16 illustrates a noise measurement effected with the soundproof wall having the sound absorbing member 2 used on the wall structure 10 having the overhanging portion 3. In this measurement, the overhanging wall portion 3 was made of a plywood of 50 mm in thickness. The other measuring conditions were the same as in the measurement having previously been described with reference to FIG. 9. The sound absorbing member 2 in FIG. 16 was used on the inner side of the rising wall portion 1 of the wall structure 10 (as in the aforementioned third experiment). Three experiments 5 to 7 were conducted with three examples of the soundproof walls shown in FIGS. 17(A) to 17(C), respectively. The sound attenuation by such soundproof walls was determined at the measuring point A. The results of the experiments 5 to 7 with the sound from the lower sound source 50 are shown in Table 2, and the experiment results with the sound from the upper sound source 51 are shown in Table 3. A sound of 100 decibels was generated from the upper sound source 51.

Table 2

Frequency	Experiment 5	Experiment 6	Experiment 7
63 Hz	0	0	0
125 Hz	0	0	0
250 Hz	0	0	0
500 Hz	0	1	0
1 kHz	2	2	1
2 kHz	3	3	4
4 kHz	2	2	3

Table 3

Frequency	Experiment 5	Experiment 6	Experiment 7
63 Hz	0	0	0
125 Hz	0	0	0
250 Hz	0	1	0
500 Hz	0	5	2
1 kHz	0	3	0
2 kHz	0	3	0
4 kHz	0	2	0

As it is revealed from the experiment results shown above, such soundproof walls shown in FIGS. 17(A) to 17(C), respectively, provided a nearly same effect in attenuation of the sound from the lower sound source 50. As shown, however, the soundproof wall having the sound absorbing member 2 used on the overhanging

wall portion 3 showed a remarkable attenuation of the sound from the upper source 51, especially in the frequency range of 500 Hz or higher.

FIG. 18 shows a wall structure 10 formed concave at the base of the rising wall portion 1 thereof. FIGS. 19 and 20 show further wall structures 10, respectively, formed thicker at the base of the rising wall portion 1. Even on such wall structures 10, the sound absorbing member 2 can be attached in a desired place. The wall structure 10 may have an overhanging portion 3 provided atop the rising wall portion 1 thereof.

In addition to the sound absorbing member 2 shown in FIGS. 2 and 8, the soundproof wall according to the present invention may use a sound absorbing member 2 made by preparing two aluminum sheets and placing, as bonded between them, an aluminum substrate having many holes formed therein. Alternatively, it may be made by preparing two aluminum sheets, forming on the inner surfaces of the aluminum sheets a ceramic film having many fine holes formed therein and placing, as bonded between the sheets, an aluminum substrate having many holes formed therein. In these cases, the fine holes in the ceramic film should preferably be about 5 to 20 μm in diameter, the holes in the aluminum substrate be about 1 to 20 mm in diameter, the aluminum sheet be about 0.5 to 4 mm thick, and the aluminum substrate be about 0.2 to 2 mm thick.

FIG. 21 is a sectional view of the third embodiment of the soundproof wall according to the present invention. The soundproof wall comprises a non-sealed hollow structure 4 formed from many tubular or hollow members 41, attached as laid side by side on the inner surface of the rising wall portion 1 of the wall structure 10. The hollow structure 4 shown in FIG. 21 comprises three layers of the tubular members 41 different in length from one layer to another. The tubular members 41 are mutually joined to one another and also the tubular member layers are also mutually joined to one another. In the third embodiment shown in FIG. 21, the tubular members 41 in the layer attached directly on the inner side of the rising wall portion 1 are longer than those in the other layers while the tubular members 41 in the layer laid farthest from the inner side of the rising wall portion 1 are the shortest in length. On the contrary, the tubular members 41 in the innermost layer may be shorter in length than those in the other layers while the tubular members 41 in the outermost layer may be the longest. The sound passes from below to above through the bores in the tubular members 41. Such hollow structure 4 may be used on the outer side of the rising wall portion 1.

Sound measurement was done at a position of 1 m distant from the rising wall portion 1 on which the hollow structure 4 was attached to the upper half thereof, the measuring position being located opposite to the sound source side and at a same level as the bottom end of the rising wall portion 1. The measured acoustic pressure was 5 to 6 dB lower than that measured with no hollow structure used on the rising wall portion 1. Although FIG. 21 shows the hollow structure 4 composed of three layers of tubular members 41, it may of course be a one consisting of a single, two or three or more such layers.

FIG. 22 is a perspective view of a variant of the hollow structure 4 according to the present invention, composed of a single layer including a series of identical tubular members 41 vertically joined side by side to each other. FIG. 23 is a sectional view of the second variant of the hollow structure 4 according to the present invention, having a single layer including a series of identical tubular members 41 horizontally joined side by side to each other. Both the hollow structures 4 in FIGS. 22 and 23 may be used together as superposed on each other. Although the tubular members 41 shown in FIGS. 22 and 23 have a cylindrical shape, they may be shaped polygonal. The hollow-structure tubular member 41 is made of a material selected from among metals such as aluminum, synthetic resins such as FRP, and ceramics. The hollow structure 4 cannot be used only on a wall structure 10 having a rising wall portion 1 but on a one having an overhanging portion 3. Furthermore, it can also be used on the wall structure 10 as shown in FIGS. 18 to 20.

In addition, the hollow structure 4 may be formed from a combination of tubular members 41 different in diameter and length as shown in FIG. 24. Although the tubular members 41 shown in FIG. 24 are laid horizontally, they may be arranged vertically.

FIG. 25 is a perspective view of the fourth variant of the hollow structure 4. The hollow structure 4 is constructed by a series of tubular members 41 each partially cut off longitudinally thereof (to a trough-like structure having a C-shaped section as shown), joined side by side to each other. Such hollow structure 4 may be used in combination with those shown in FIGS. 21 to 24. Also the hollow structure 4 may be constructed by a combination of such trough-like members 41 different in size of the longitudinal opening, depth and in orientation.

FIG. 26 is a sectional view of the fifth embodiment of the present invention in which the hollow structure 4 as shown in FIG. 25 is attached to the inner side of the rising wall portion 1 of the wall structure 10 having also an overhanging portion 3. Sound measurement was done at a position of 1 m distant from the rising wall portion 1 on which the hollow structure 4 was attached to the upper half thereof, the measuring position being located opposite to the sound source side and at a same level as the bottom end of the rising wall portion 1. The measured acoustic pressure was 6 to 7 dB lower than that measured with no hollow structure 4 attached on the rising wall portion 1 and overhanging portion 3.

FIG. 27 is a sectional view of the sixth embodiment of the present invention using a combination of the hollow structure 4 and the sound absorbing member 2. As shown, the non-sealed hollow structure 4 is attached to the upper half of the inner side of the rising wall portion 1, and the sound absorbing member 2 is attached to the hollow structure 4.

FIG. 28 is a sectional view showing a combination of the hollow structure 4 shown in FIG. 23 and the sound absorbing member 2. The hollow structure 4 is installed to the inner side of the rising wall portion 1 and the sound absorbing member 2 is installed to the hollow structure 4.

The combination of the hollow structure 4 and sound absorbing member 2 can also be used as attached to a wall structure 10 having an overhanging portion 3, or to a desired side of a wall structure 10 as shown in FIGS. 18 to 20. In the combined use shown in FIG. 27, the hollow structure 4 may be used as extended over the entire surface from the top to bottom of a rising wall portion 1 with the sound absorbing member 2 attached only to the upper half of the rising wall portion 1. Also in the embodiments shown in FIGS. 27 and 28, only the hollow structure 4 or sound absorbing member 2 may be attached to the surface other than where the combination of the hollow structure 4 and sound absorbing member 2 is used.

As having been described in the foregoing, the sound absorbing member according to the present invention can be easily attached to an existing wall structure with fasteners such as bolt or the like. It absorbs sound with an extremely high effectiveness and can advantageously be manufactured with reduced costs. Also, many tubular or hollow members horizontally or vertically joined side by side to each other to form a hollow structure provide an improved sound absorption, and such hollow structure can be manufactured with a low cost. The hollow structure thus manufactured is very lightweight, so it can be easily handled. The combination of the hollow structure with the sound absorbing member provides a further improved sound absorption or attenuation.

Claims

1. A soundproof wall comprising a wall structure (10) having a rising portion (1) and a sound absorbing member (2) or hollow structure (4) attached on either the inner or outer side, or both, of the rising wall portion.
2. A soundproof wall comprising a wall structure (10) having a rising portion (1) and a portion (3) overhanging at the top of the rising wall portion toward and/or away from a sound source, and a sound absorbing member (2) or hollow structure (4) attached to any one or more of the inner and outer sides of the rising wall portion (1) and the upper and lower sides of the overhanging wall portion (3).
3. A soundproof wall as claimed in claim 2, characterized in that the sound absorbing member (2) is attached to any one or more of the top, bottom and side of the overhanging wall portion (3).
4. A soundproof wall as claimed in any of claims 1 to 3, characterized in that the sound absorbing member (2) is a fiber block (22) made of a short fiber of 30 or less deniers in the center of fiber diameter distribution and which has a mean apparent density of 0.04 to 0.15 g/cm³.
5. A soundproof wall comprising a wall structure (10) having a rising portion (1) or having a said rising portion (1) and an overhanging portion (3) provided at the top of the rising wall portion and extending toward and/or away from a sound source, and a hollow structure (4) constructed a series of tubular or hollow members (41) horizontally or vertically joined side by side to each other, attached to any one or more of the inner and outer sides of the rising wall portion (1) and the upper and lower sides of the overhanging wall portion (3).
6. A soundproof wall as claimed in claim 5, characterized in that a sound absorbing member (2) is attached over a hollow structure (4).

FIG.1

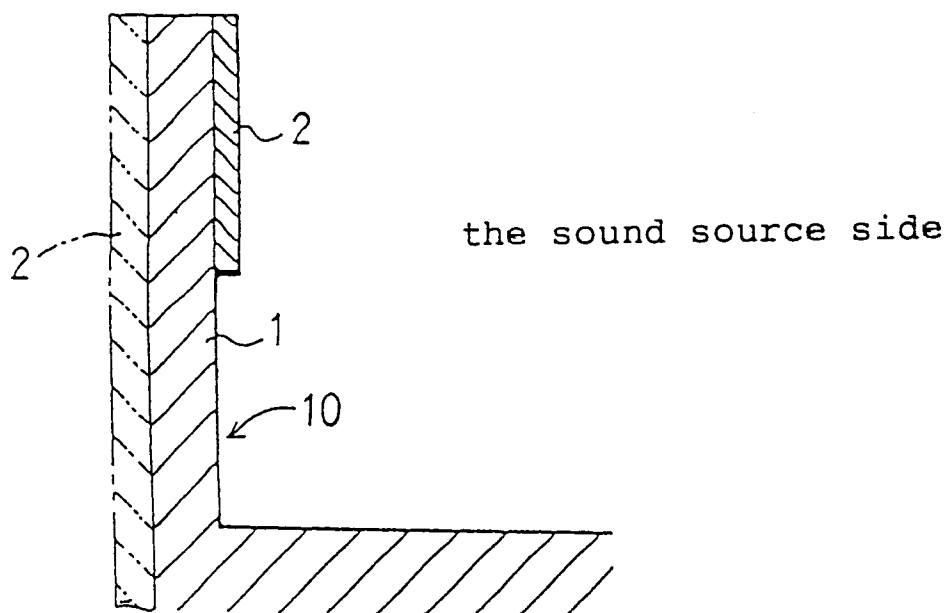


FIG.2

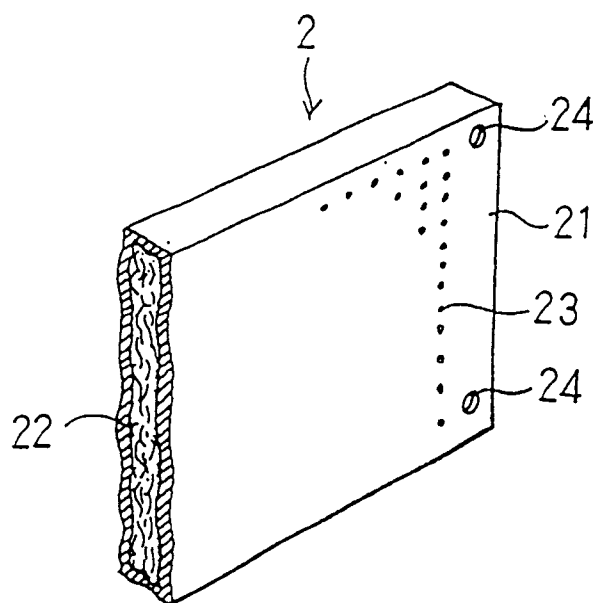


FIG.3

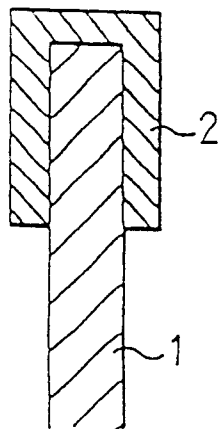


FIG.4

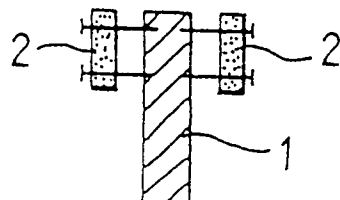


FIG.5

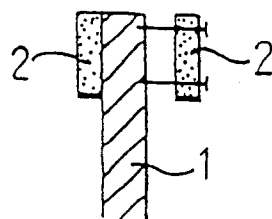


FIG.6

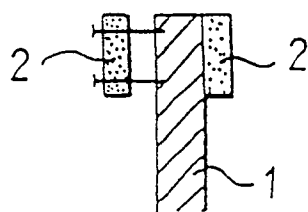


FIG.7

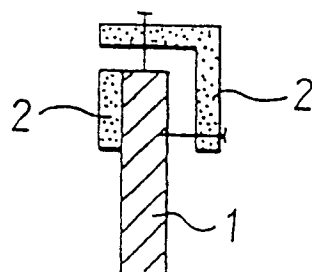


FIG. 8

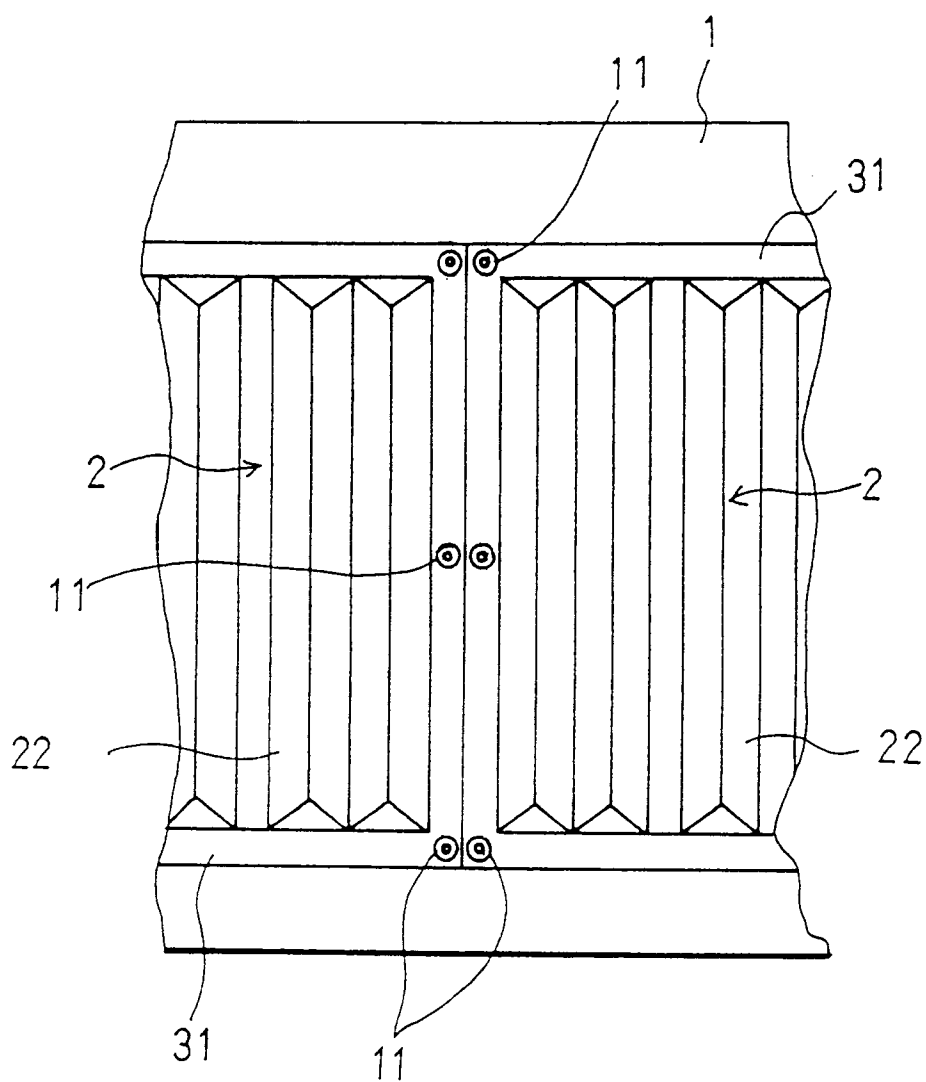


FIG. 9

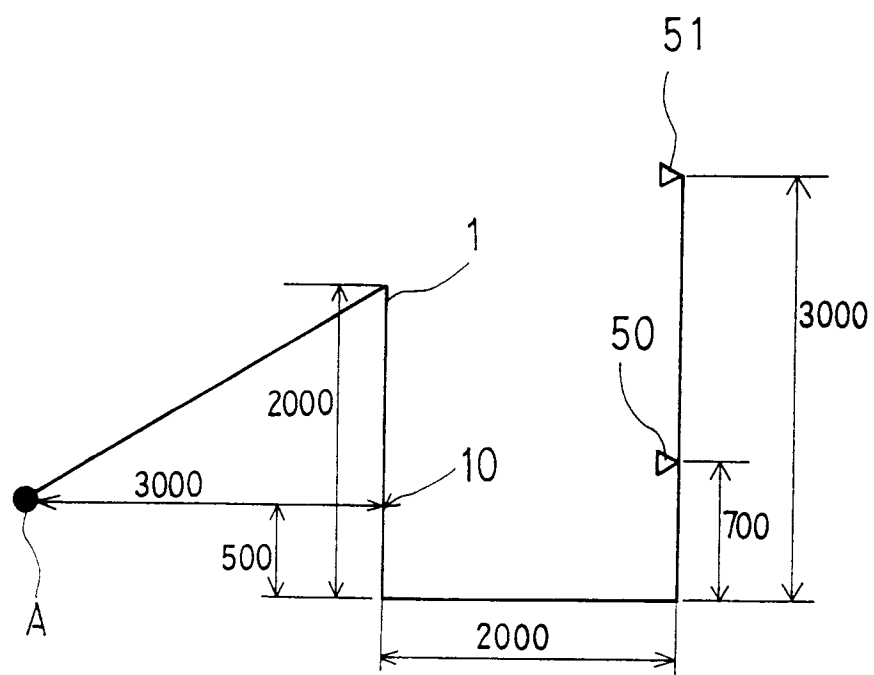


FIG.10

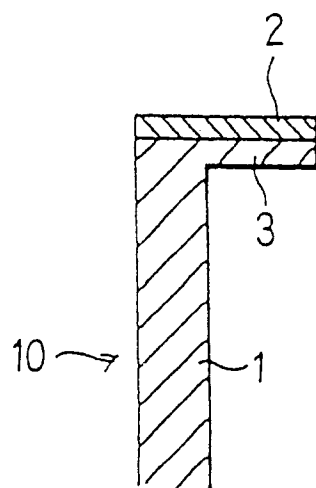


FIG.11

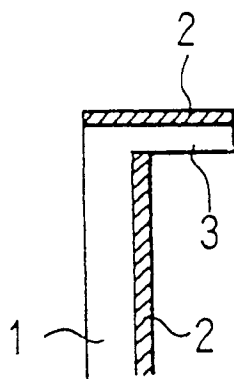


FIG.12

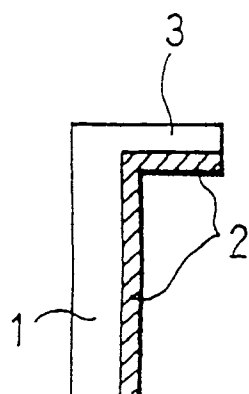


FIG.13

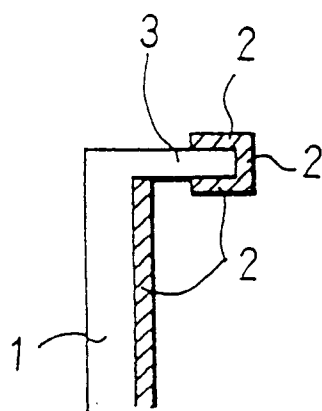


FIG.14

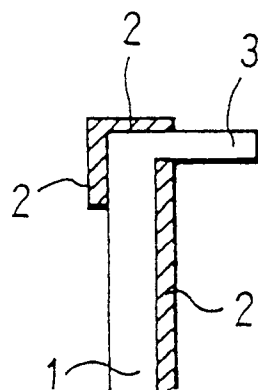


FIG.15

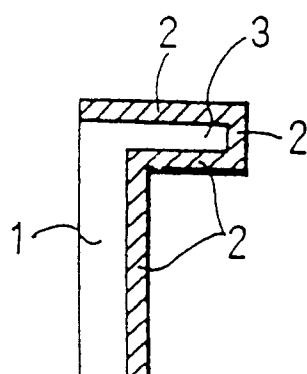


FIG. 16

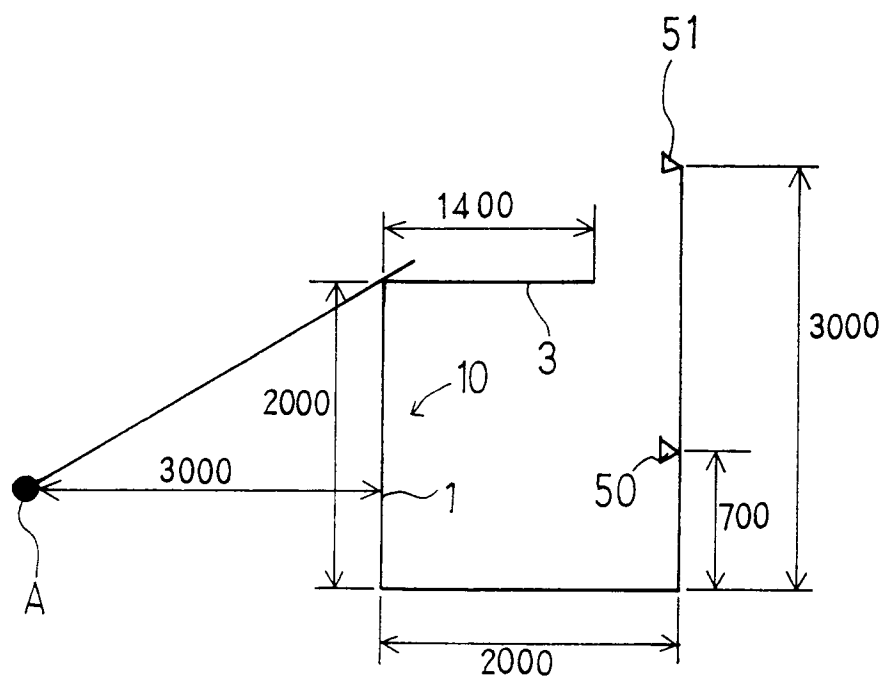
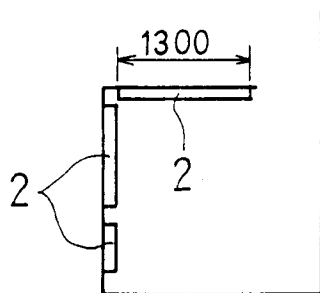
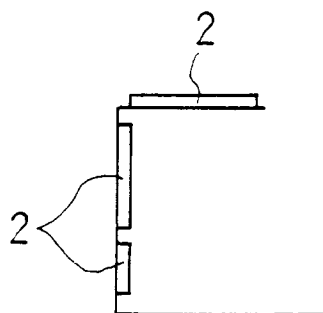


FIG. 17

(A)



(B)



(C)

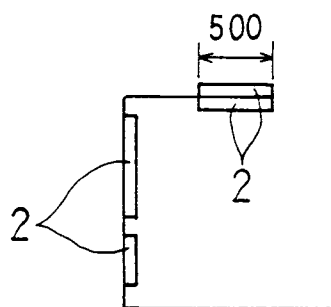


FIG. 18

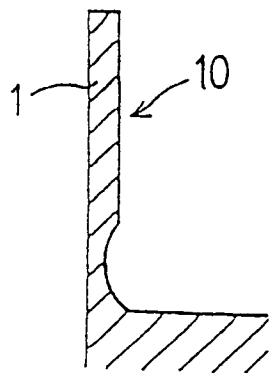


FIG. 19

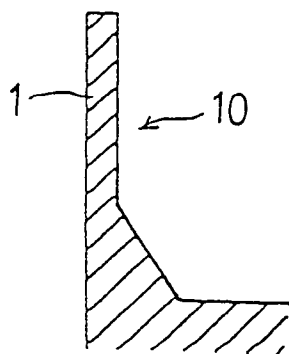


FIG. 20

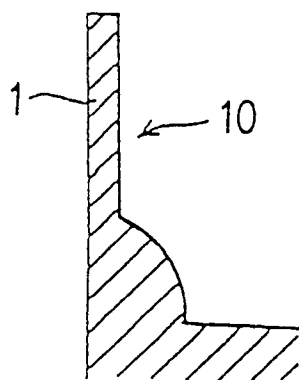


FIG.21

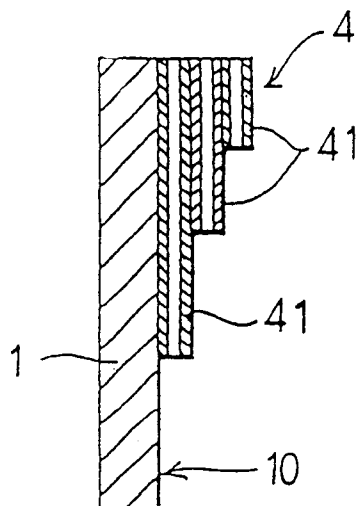


FIG.22

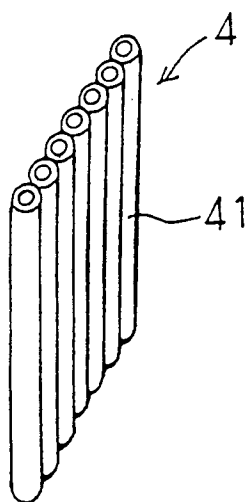


FIG.23

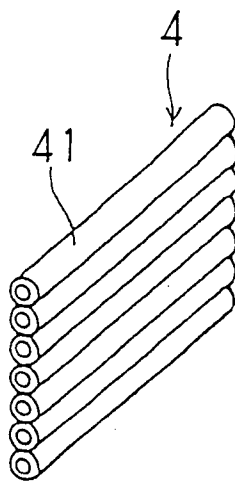


FIG.24

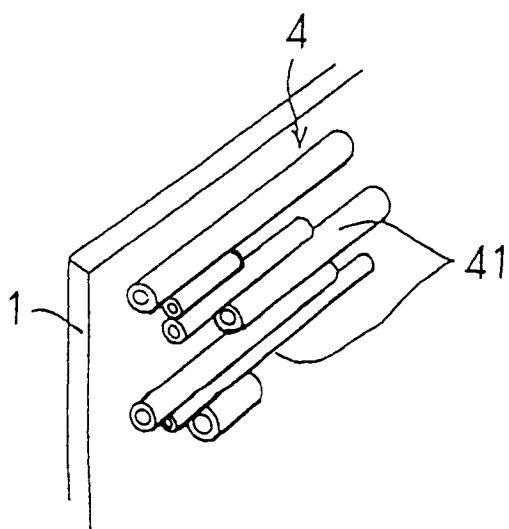


FIG.25

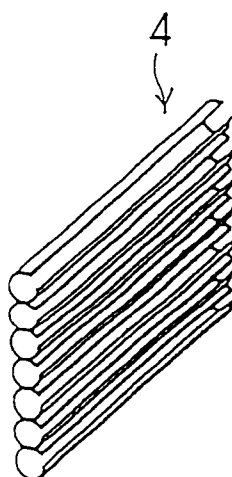


FIG.26

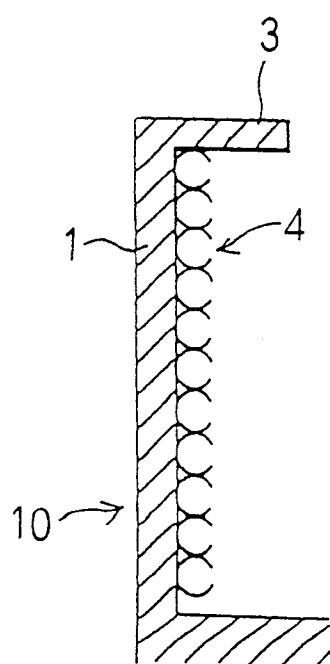


FIG. 27

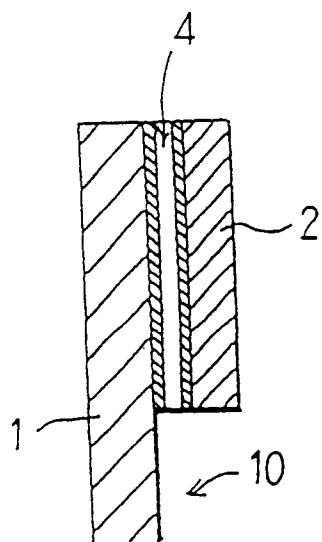
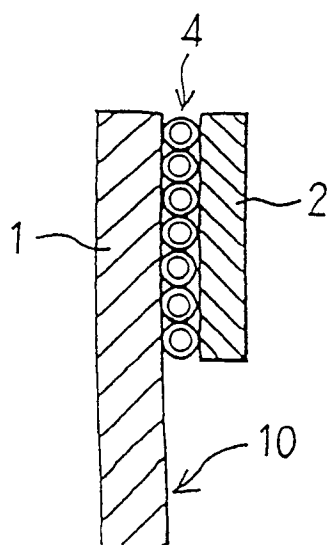


FIG. 28





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 95 30 0798

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)
X	EP-A-0 160 358 (M. AMRAM) * page 8, line 18 - line 23; figure 2A * ---	1-3,5	E01F8/00
X	WO-A-93 12298 (D. HOTHERSALL) * page 5, line 27 - line 36 * * page 11, line 18 - line 24; figures 2,7,11,12 * ---	1-3,6	
X	WO-A-90 08238 (P. VETTERLI) * page 4, line 26 - line 33; figure 4 * ---	1-3 4,5	
X	PATENT ABSTRACTS OF JAPAN vol. 17, no. 381 (P-1574) 16 July 1993 & JP-A-05 061 488 (BRIDGESTONE CORP.) 12 March 1993	1,5	
A	* abstract * ---	2	
P,X	FR-A-2 697 040 (L'ENTREPRISE INDUSTRIELLE S.A.) * page 12, line 30 - line 34; figures 1B,3 * ---	1-3	
X	DE-A-42 20 547 (D. LUDWIG) * figures 5,7,9 * ---	1	
Y	CH-A-590 366 (SCHALLEX AG) * page 1, line 27 - line 31 * ---	4	
Y	FR-A-2 226 910 (SOCIÉTÉ ÉLASTOMÈRES ET PLASTIQUES) * figure 3 * -----	5	
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 22 May 1995	Examiner Verveer, D
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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