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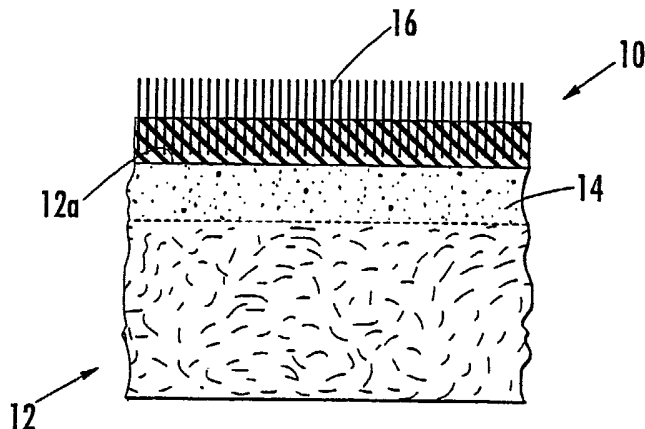
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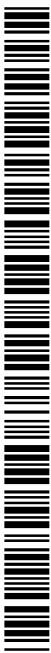
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(54) Title: MULTI-DENSITY SOUND ATTENUATING LAMINATES AND METHODS OF MAKING SAME



(57) Abstract: Sound attenuating laminates, and methods of making the same, are provided. Heat is applied to a surface of a non-woven, fibrous layer of material (12), to form a stratum of melted fibers (14) having a density greater than that of the remainder of the fibrous layer (12). The density of the melted fibers (14) is effective in attenuating noise traversing the fibrous layer of material (10). Upholstery material (16), such as carpeting, is attached to the surface of the heated fibrous layer (10). The fibrous layer (10) and upholstery material (16) are then subjected to compressive molding pressure to obtain a desired shape. The compressive molding pressure may further tune attenuating properties of the fibrous layer (10) by selectively changing the densities of portions of the fibrous layer (10).



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MULTI-DENSITY SOUND ATTENUATING LAMINATES AND METHODS OF MAKING SAME

FIELD OF THE INVENTION

The present invention relates generally to
acoustical insulation materials and, more particularly,
to acoustical insulation materials utilized within
5 vehicles.

BACKGROUND OF THE INVENTION

It is generally considered desirable to reduce
noises generated from appliances, and from within
10 buildings, vehicles, and the like. With respect to
vehicles, road noise, tire noise, engine noise, vehicle
vibrations, etc., may pass through a vehicle body and
into the passenger compartment.

It is generally considered desirable to reduce
15 the level of noise within a vehicle passenger
compartment. Noises, such as road noise, engine noise,
vibrations, etc., may be attenuated through the use of
various acoustically absorptive (or reflective)
materials. For example, sound attenuating materials are
20 conventionally provided in conjunction with carpeting,
door panels, and headliners.

Various sound attenuating materials have been
developed for use in reducing noise levels within
passenger compartments of vehicles. For example, U.S.
25 Patent No. 4,851,283 to Holtrop et al., proposes a
thermoformable laminate for use in headliners. The
headliner comprises a non-woven fabric bonded to a foamed

polymer sheet. The fabric is formed from a blend of low melting staple fibers and high melting staple fibers.

U.S. Patent No. 5,298,694 to Thompson proposes a non-woven acoustical insulation web. The web comprises thermoplastic fibers, and particularly a blend of melt-blown microfibers and crimped bulking fibers.

U.S. Patent No. 5,677,027 to Masuda et al., proposes a sound insulating structure comprising a covering layer, a panel, and a cushioning layer. The cushioning layer comprises a first fiber such as polyethylene terephthalate (PET) and a second fiber that is of a shell-core construction wherein the majority of the core is PET.

U.S. Patent No. 5,817,408 to Orimo et al., proposes a sound insulating structure which includes low and high density thermoplastic fibers. PET is preferred as a thermoplastic synthetic fiber.

U.S. Patent No. 4,529,639 to Peoples, Jr. et al. proposes a molded foam-backed carpet assembly which includes a carpet layer, a moldable thermoplastic polymer layer and one or more foam pads fusibly bonded to the thermoplastic layer and extending over less than the entire surface of the thermoplastic polymer layer to provide desired cushioning and sound and thermal insulation only in preselected areas of the carpet.

In general, the ability of conventional materials to attenuate sound increases as the amount of material increases. Unfortunately, increased materials often increases the weight of sound attenuating material, which may be undesirable. Accordingly, there is a continuing need for acoustical insulation materials that exhibit superior sound attenuating properties, while also being lightweight and low in cost.

SUMMARY OF THE INVENTION

In view of the above discussion, sound attenuating laminates, and methods of making the same, are provided. According to an embodiment of the present invention, a surface of a non-woven (or woven), fibrous layer of material (e.g., containing thermoplastic or thermosetting fibers) is heated to form a stratum of melted fibers having a density different (*i.e.*, greater) than that of the remainder of the fibrous layer. The density of the melted fibers is effective in attenuating noise traversing the fibrous layer of material. Upholstery material (preferably heated), such as carpeting, is attached to a surface (either adjacent to or opposite from stratum of melted fibers) of the heated fibrous layer. The fibrous layer and upholstery material is then subjected to compressive molding pressure to obtain a desired shape. The compressive molding pressure may further tune the sound attenuating properties of the fibrous layer by selectively changing the densities of one or more portions of the fibrous layer.

According to other embodiments of the present invention, a surface of a first non-woven (or woven), fibrous layer of material is heated such that fibers adjacent the surface form a stratum of melted fibers that has a density greater than a density of the remainder of the fibrous layer. The density of the stratum is effective to attenuate noise traversing the first fibrous layer of material. Upholstery material, such as carpeting, is attached to a surface (either adjacent to or opposite from stratum of melted fibers) of the heated first fibrous layer. The first fibrous layer and upholstery material are then subjected to compressive molding pressure (preferably in the presence of heat) to obtain a desired shape. The compressive molding pressure may further tune the sound attenuating properties of the first fibrous layer by selectively changing the densities

of portions of the fibrous layer. A second non-woven (preferably heated), fibrous layer of material is attached to an opposite surface of the first fibrous layer. The first and second fibrous layers and upholstery material are then subjected to compressive molding pressure (preferably in the presence of heat). The compressive molding pressure may further tune the sound attenuating properties of the combined first and second fibrous layers by selectively changing the densities of portions of the first and second fibrous layers.

By controlling and differentially molding and/or melting fibers through temperature and pressure variation, laminates according to embodiments of the present invention can be "tuned" to provide desired sound deadening and absorption properties in selected locations. The term "tuned" means that portions of laminates can be formed to have a specific acoustic impedance designed to attenuate sound in one or more frequencies or frequency bands. Moreover, laminates according to embodiments of the present invention may have reduced overall weight compared with conventional sound proofing materials, and without sacrificing sound attenuation properties.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which form a part of the specification, illustrate key embodiments of the present invention. The drawings and description together serve to fully explain the invention.

Fig. 1 is a flowchart of operations for producing a sound attenuating laminate configured to attenuate noise from a noise source, according to embodiments of the present invention.

Fig. 2 is a flowchart of operations for producing a sound attenuating laminate configured to

attenuate noise from a noise source, according to other embodiments of the present invention.

Fig. 3 is a cross-sectional view of a sound attenuating laminate configured to attenuate noise from a noise source, according to embodiments of the present invention.

Figs. 4A-4E schematically illustrate operations for producing the sound attenuating laminate of Fig. 3.

Fig. 5 is a cross-sectional view of a sound attenuating laminate configured to attenuate noise from a noise source, according to other embodiments of the present invention.

Figs. 6A-6D schematically illustrate operations for producing the sound attenuating laminate of Fig. 5.

Fig. 7 is a partial perspective view of an interior compartment of a vehicle wherein a sound attenuating laminate according to embodiments of the present invention is attached thereto.

Fig. 7A is an enlarged partial section view of the sound attenuating laminate of Fig. 7 taken along lines 7A-7A.

DETAILED DESCRIPTION OF THE INVENTION

The present invention now is described more fully hereinafter with reference to the accompanying drawings, in which preferred embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art.

In the drawings, the thickness of lines, layers and regions may be exaggerated for clarity. It will be understood that when an element such as a layer,

region, substrate, or panel is referred to as being "on" another element, it can be directly on the other element or intervening elements may also be present. In contrast, when an element is referred to as being
5 "directly on" another element, there are no intervening elements present. It will be understood that when an element is referred to as being "connected" or "attached" to another element, it can be directly connected or attached to the other element or
10 intervening elements may also be present. In contrast, when an element is referred to as being "directly connected" or "directly attached" to another element, there are no intervening elements present. The terms "upwardly", "downwardly", "vertical", "horizontal" and
15 the like are used herein for the purpose of explanation only.

Embodiments of the present invention provide sound attenuating laminates for use in various applications, particularly automotive applications.
20 Exemplary automotive applications within which sound attenuating laminates according to embodiments of the present invention may be utilized include, but are not limited to, headliners, dashboards, carpeting, door panels, and pillars.

25 According to embodiments of the present invention, a sound attenuation laminate includes a fibrous layer of material. By selectively controlling heat and/or pressure parameters over a predetermined time interval, the fibers are differentially melted. A
30 less dense portion or stratum of melted fibers is formed that is configured to be placed against the metal (or other) portion of a vehicle, and a compacted, higher density portion or stratum of melted fibers is formed that is configured to be bonded to upholstery material,
35 such as carpeting and decorative fabric. However, it is not required that the higher density portion be bonded

to upholstery fabric. The higher density portion may be placed against the metal (or other) portion of a vehicle.

5 By controlling and differentially molding and/or melting the fibers through temperature and pressure variation, a fibrous layer can be "tuned" to provide desired sound deadening and absorption properties in selected locations. Moreover, laminates according to embodiments of the present invention may have reduced overall weight without sacrificing
10 soundproofing properties.

In addition, embodiments of the present invention are not limited to a unidirectional density gradient (*i.e.*, from less dense to more dense).
15 Embodiments of the present invention may have various density gradients (*e.g.*, dense, less dense, more dense, etc.).

Referring to Fig. 1, a method of producing a sound attenuating laminate configured to attenuate noise from a noise source, according to embodiments of the present invention, is illustrated. A non-woven, fibrous layer of material having a first density is provided (Block 100). Fibers within the layer may include natural fibers, thermosetting fibers, thermoplastic fibers,
20 and/or any blend or percentage of natural fibers, thermosetting fibers and/or thermoplastic fibers. Exemplary fibers include, but are not limited to, acetate, acrylic, nylon 6, nylon 6/6, polyethylene terephthalate (PET), recycled PET, BiCo PET, and NOMEX® brand fibers. A preferred fiber is PET fiber.
30

A surface of the fibrous layer is heated such that fibers adjacent the surface form a stratum of melted fibers within the fibrous layer that has a second density greater than the first density (Block 110). Exemplary
35 heat applied to the surface of the fibrous layer may be at a temperature of between about 400°F and about 480°F,

preferably between about 450°F and about 460°F. However, embodiments of the present invention are not limited to these temperatures. Temperatures may vary depending on the fibers utilized. In addition, melting may occur in various ways and is not limited to conventional heating methods. For example, energy in the form of microwaves and infrared radiation may be utilized to melt fibers. As used throughout, the term "heat" shall be intended to include all forms of energy capable of melting fibers according to embodiments of the present invention.

The density of the fibers within the stratum of melted fibers is effective to attenuate noise traversing the fibrous layer of material. Exemplary thickness of the stratum of melted fibers may be between about one millimeter (1 mm) and about four millimeters (4 mm). By controlling the amount of heat applied, different densities can be achieved to thereby "tune" the fibrous layer to attenuate noise at selective frequencies.

A heated upholstery material, such as carpeting and/or other fabric, is attached to the surface of the heated fibrous layer (Block 120). In the case of carpeting, the backing side of the carpeting is attached to the fibrous layer surface. The fibrous layer and upholstery material are then subjected to compressive molding pressure to obtain a desired shape (Block 130). The compressive molding pressure may further tune the sound attenuating properties of the fibrous layer by selectively changing the densities of portions of the fibrous layer. Exemplary compressive molding pressure may be between about two pounds per square inch (2 psi) and about eleven and one half pounds per square inch (11.5 psi), preferably between about two and one half pounds per square inch (2.5 psi) and about three and one half pounds per square inch (3.5 psi). However, embodiments of the present invention are not limited to these pressures. Pressures may vary depending on the

fibers utilized.

Referring to **Fig. 2**, a method of producing a sound attenuating laminate configured to attenuate noise from a noise source, according to other embodiments of the present invention, is illustrated. A first non-woven, fibrous layer of material (e.g., containing thermoplastic and/or thermosetting fibers) having a first density is provided (Block 200). Heat is applied to a first surface of the first fibrous layer such that fibers adjacent the first surface form a stratum of melted fibers that has a second density greater than the first density and that is effective to attenuate noise traversing the first fibrous layer of material (Block 210). Exemplary heat applied to the surface of the fibrous layer may be at a temperature of between about 400°F and about 470°F, preferably between about 450°F and about 480°F. However, embodiments of the present invention are not limited to these temperatures. Temperatures may vary depending on the fibers utilized.

Upholstery material (preferably heated), such as carpeting and/or other fabric, is attached to a surface of the heated fibrous layer (Block 220). In the case of carpeting, the backing side of the carpeting is attached to the first fibrous layer surface. The first fibrous layer and upholstery material are then subjected to compressive molding pressure to obtain a desired shape (Block 230). The compressive molding pressure may further tune the sound attenuating properties of the first fibrous layer by selectively changing the densities of portions of the fibrous layer. Exemplary compressive molding pressure may be between about two pounds per square inch (2 psi) and about eleven and one half pounds per square inch (11.5 psi), preferably between about two and one half pounds per square inch (2.5 psi) and about three and one half pounds per square inch (3.5 psi). However, embodiments of the present

invention are not limited to these pressures. Pressures may vary depending on the fibers utilized.

5 A second non-woven (preferably heated), fibrous layer of material is attached to an opposite surface of the first fibrous layer (Block 240). The first and second fibrous layers and upholstery material are then subjected to compressive molding pressure (Block 250). The compressive molding pressure may further tune the sound attenuating properties of the combined first and second
10 fibrous layers by selectively changing the densities of portions of the first and second fibrous layers. Exemplary compressive molding pressure may be between about two pounds per square inch (2 psi) and about four pounds per square inch (4 psi), preferably between about
15 between about two and one half pounds per square inch (2.5 psi) and about three and one half pounds per square inch (3.5 psi). However, embodiments of the present invention are not limited to these pressures. Pressures may vary depending on the fibers utilized.

20 Referring to Fig. 3, a sound attenuating laminate 10 that is configured to attenuate noise from a noise source, according to embodiments of the present invention, is illustrated. The illustrated sound attenuating laminate 10 is carpeting material for use
25 within the passenger compartment of a vehicle. However, embodiments of the present invention are not limited to carpeting applications. Other exemplary automotive applications within which sound attenuating laminates according to embodiments of the present invention may be
30 utilized include, but are not limited to, headliners, dashboards, carpeting, door panels, and pillars. Moreover, applications in which sound attenuating laminates according to embodiments of the present invention are used are not limited to vehicle
35 applications.

The illustrated sound attenuating laminate 10

includes a non-woven, fibrous layer of material 12 having a stratum 14 of melted and/or molded fibers (e.g., PET fibers) adjacent a surface 12a of the fibrous layer 12 and carpeting 16 attached to the surface 12a of the fibrous layer 12. The stratum 14 of melted and/or molded fibers has a density that is greater than the density of the remaining portion of the fibrous layer of material 12 and that is effective to attenuate noise traversing the fibrous layer of material 12. Depending on the application in which the sound attenuating laminate 10 is used, the stratum 14 of melted and/or molded fibers may have a thickness of between about one millimeter (1 mm) and about four millimeters (4 mm).

Referring to Figs. 4A-4E, operations for producing the exemplary sound attenuating laminate 10 of Fig. 3 are illustrated. A surface 12a of the fibrous layer of material 12 is heated (Fig. 4A) to form a stratum 14 of melted fibers adjacent the surface, and heated upholstery material such as carpeting 16 is added (Fig. 4B). The fibrous layer 12 having a densified (*i.e.*, multi-density) stratum of fibers (and including a layer of upholstery) is subjected to compressive molding pressure to obtain a desired shape (Figs. 4C-4E).

Referring to Fig. 5, a sound attenuating laminate 30 that is configured to attenuate noise from a noise source, according to other embodiments of the present invention, is illustrated. The illustrated sound attenuating laminate 30 is configured for use as carpeting within vehicle passenger compartments. However, sound attenuating laminates having the illustrated configuration may be used in various applications, without limitation.

The illustrated sound attenuating laminate 30 includes a first non-woven, fibrous layer of material 32 having a stratum of melted and/or molded fibers 34 (e.g.,

PET fibers) adjacent a surface 32a of the first fibrous layer 32 and carpeting 36 attached to the surface 32a of the fibrous layer 32. The stratum of melted and/or molded fibers 34 has a density greater than the density of the remaining portion of the first fibrous layer 32 and is effective to attenuate noise traversing the first fibrous layer of material 32.

A second non-woven fibrous layer of material 35 is attached to the first non-woven, fibrous layer 32. The second non-woven fibrous layer of material 35 may have a density (or densities) similar to or different from the density of the stratum of melted and/or molded fibers 34 and of the remaining portion of the first fibrous layer 32. Carpeting 36 is attached to a surface of the first fibrous layer of material 32.

Referring to Figs. 6A-6D, operations for producing the sound attenuating laminate 30 of Fig. 5 are illustrated. A surface 32a of a fibrous layer of material 32 having carpeting 36 attached thereto is heated and/or molded to form a stratum 34 of melted and/or molded fibers adjacent the carpeting 36 (Fig. 6A). The fibrous layer 32 and carpeting are subjected to compressive molding pressure to obtain a desired shape (Fig. 6B). A heated second non-woven fibrous layer of material 35 is attached to the first non-woven, fibrous layer 32 and subjected to compressive molding to produce the sound attenuating laminate 30 (Figs. 6C-6D).

Referring to Figs. 7 and 7A, an interior compartment 52 of a vehicle 50 is illustrated with a sound attenuating laminate 10 according to embodiments of the present invention attached to a portion thereof. The illustrated sound attenuating laminate 10 includes a non-woven, fibrous layer of material 12 having a stratum 14 of melted fibers with a greater density than that of the

remaining portion of the fibrous layer of material 12. The density of the stratum 14 of melted fibers is effective to attenuate noise traversing the fibrous layer of material 12 from a noise source external to the vehicle compartment 52.

Example

A fibrous layer of PET fibers was heated with hot air at 420°F for 92 seconds. Carpeting material was heated via infrared radiation to a temperature of 330°F and attached to the fibrous layer. The laminate formed by the fibrous layer and carpeting material was subjected to compressive pressure of between about two pounds per square inch and about eleven pounds per square inch (2-11 psi) via a mold to produce a densified laminate. The laminate was removed from the mold, cooled, and trimmed via a water jet.

The foregoing is illustrative of the present invention and is not to be construed as limiting thereof. Although a few exemplary embodiments of this invention have been described, those skilled in the art will readily appreciate that many modifications are possible in the exemplary embodiments without materially departing from the novel teachings and advantages of this invention. Accordingly, all such modifications are intended to be included within the scope of this invention as defined in the claims. Therefore, it is to be understood that the foregoing is illustrative of the present invention and is not to be construed as limited to the specific embodiments disclosed, and that modifications to the disclosed embodiments, as well as other embodiments, are intended to be included within the scope of the appended claims. The invention is defined by the following claims, with equivalents of the claims to be included therein.

THAT WHICH IS CLAIMED IS:

1. A method of producing sound insulating material, comprising:
providing a non-woven, fibrous layer of material having a first density; and
5 heating a surface of the fibrous layer such that fibers adjacent the surface form a stratum of melted fibers within the fibrous layer that has a second density greater than the first density and that is effective to attenuate noise traversing the fibrous layer of material.
2. The method of Claim 1, wherein the stratum of melted fibers has a thickness of between about one millimeter (1 mm) and about four millimeters (4 mm).
3. The method of Claim 1, wherein the surface is heated to a temperature of between about 450°F and about 460°F.
4. The method of Claim 1, further comprising subjecting the fibrous layer to compressive molding pressure to obtain a desired shape.
5. The method of Claim 4, wherein the compressive molding pressure is between about two pounds per square inch (2 psi) and about eleven and one half pounds per square inch (11.5 psi).
- 5 6. The method of Claim 1, wherein the step of heating the surface of the fibrous layer comprises heating selected portions of the surface such that fibers adjacent the selected portions of the surface form
5 respective strata within the fibrous layer, each having a second density greater than the first density and each

effective to attenuate noise traversing the fibrous layer of material.

7. The method of Claim 1, wherein the fibers are selected from the group consisting of thermosetting fibers and thermoplastic fibers.

8. The method of Claim 1, wherein the fibers comprise polyethylene terephthalate (PET) fibers.

9. A method of producing a sound attenuating laminate configured to attenuate noise from a noise source, comprising:

5 providing a non-woven, fibrous layer of material having a first density;

10 heating a surface of the fibrous layer such that fibers adjacent the surface form a stratum of melted fibers within the fibrous layer that has a second density greater than the first density and that is effective to attenuate noise traversing the fibrous layer of material;

15 attaching upholstery material to the surface of the heated fibrous layer wherein the carpet comprises a fabric side and an opposite backing side and wherein the backing side is attached to the surface of the fibrous layer; and

subjecting the fibrous layer and upholstery material to compressive molding pressure to obtain a desired shape.

10. The method of Claim 9, wherein the stratum of melted fibers has a thickness of between about one millimeter (1 mm) and about four millimeters (4 mm).

11. The method of Claim 9, wherein the surface of the fibrous layer is heated to a temperature of between about 450°F and about 460°F.

12. The method of Claim 9, wherein the compressive molding pressure is between about two pounds per square inch (2 psi) and about eleven and one half pounds per square inch (11.5 psi).

13. The method of Claim 9, wherein the fibers are selected from the group consisting of thermosetting fibers and thermoplastic fibers.

14. The method of Claim 9, wherein the fibers comprise polyethylene terephthalate (PET) fibers.

15. The method of Claim 9, wherein the upholstery material comprises carpeting.

16. A method of producing a sound attenuating laminate configured to attenuate noise from a noise source, comprising:

5 providing a first non-woven, fibrous layer of material having a first density, and having opposite first and second surfaces;

10 heating the first surface of the first fibrous layer such that fibers adjacent the first surface form a stratum of melted fibers within the first fibrous layer that has a second density greater than the first density and that is effective to attenuate noise traversing the first fibrous layer of material;

15 attaching upholstery material to the first surface of the heated first fibrous layer wherein the upholstery material comprises a fabric side and an opposite backing side and wherein the backing side is attached to the first surface of the fibrous layer;

20 subjecting the first fibrous layer and upholstery material to compressive molding pressure to obtain a desired shape;

attaching a second non-woven, fibrous layer of

material to the second surface of the first fibrous layer; and

25 subjecting the first and second fibrous layers and upholstery material to compressive molding pressure.

17. The method of Claim 16, wherein the stratum of melted fibers has a thickness of between about one millimeter (1 mm) and about four millimeters (4 mm)

18. The method of Claim 16, wherein the surface of the first fibrous layer is heated to a temperature of between about 450°F and about 460°F.

19. The method of Claim 16, wherein the first fibrous layer and upholstery material are subjected to compressive molding pressure of between about two pounds per square inch (2 psi) and about eleven and one half
5 pounds per square inch (11.5 psi).

20. The method of Claim 16, wherein the first and second fibrous layers and upholstery material are subjected to compressive molding pressure of between about two pounds per square inch (2 psi) and about eleven
5 and one half pounds per square inch (11.5 psi).

21. The method of Claim 16, wherein the fibers are selected from the group consisting of thermosetting fibers and thermoplastic fibers.

22. The method of Claim 16, wherein the fibers comprise polyethylene terephthalate (PET) fibers.

23. The method of Claim 16, wherein the upholstery material comprises carpeting.

24. A sound attenuating laminate configured to

attenuate noise from a noise source, comprising:

a non-woven, fibrous layer of material having a first stratum of molded fibers that has a first density and a second stratum of melted fibers that has a second density greater than the first density and that is effective to attenuate noise traversing the fibrous layer; and

upholstery material attached to a surface of the fibrous layer.

25. The sound attenuating laminate of Claim 24, wherein the first stratum of molded fibers has a thickness of between about four millimeters (4 mm) and about twenty six millimeters (26 mm), and wherein the second stratum of melted fibers has a thickness of between about one millimeter (1 mm) and about four millimeters (4 mm).

26. The sound attenuating laminate of Claim 24, wherein the fibrous layer comprises fibers selected from the group consisting of thermosetting fibers and thermoplastic fibers.

27. The sound attenuating laminate of Claim 24, wherein the fibrous layer comprises polyethylene terephthalate (PET) fibers.

28. The sound attenuating laminate of Claim 24, wherein the upholstery material comprises carpeting.

29. A sound attenuating laminate configured to attenuate noise from a noise source, comprising:

a first non-woven, fibrous layer of material having a first stratum of molded fibers that has a first density and a second stratum of melted fibers that has a second density greater than the first density and that is

effective to attenuate noise traversing the fibrous layer;

10 a second non-woven fibrous layer of material attached to the first non-woven, fibrous layer; and upholstery material attached to a surface of the first fibrous layer.

5 30. The sound attenuating laminate of Claim 29, wherein the first stratum of molded fibers has a thickness of between about four millimeters (4 mm) and about twenty six millimeters (26 mm), and wherein the second stratum of melted fibers has a thickness of between about one millimeter (1 mm) and about four millimeters (4 mm).

31. The sound attenuating laminate of Claim 29, wherein the first and second fibrous layers comprise fibers selected from the group consisting of thermosetting fibers and thermoplastic fibers.

32. The sound attenuating laminate of Claim 29, wherein the first and second fibrous layers comprise polyethylene terephthalate (PET) fibers.

33. The sound attenuating laminate of Claim 29, wherein the upholstery material comprises carpeting.

34. A vehicle, comprising:
an interior compartment comprising a panel having a surface; and
5 sound insulating material attached to the panel surface, comprising a non-woven, fibrous layer of material having a first stratum of molded fibers that has a first density and a second stratum of melted fibers that has a second density greater than the first density and that is effective to attenuate noise traversing the

10 fibrous layer.

35. The vehicle of Claim 34, further comprising upholstery material attached to a surface of the fibrous layer.

36. The vehicle of Claim 34, wherein the first stratum of molded fibers has a thickness of between about four millimeters (4 mm) and about twenty six millimeters (26 mm), and wherein the second stratum of melted fibers
5 has a thickness of between about one millimeter (1 mm) and about four millimeters (4 mm).

37. The vehicle of Claim 34, wherein the fibrous layer comprises fibers selected from the group consisting of thermosetting fibers and thermoplastic fibers.

38. The vehicle of Claim 34, wherein the fibrous layer comprises polyethylene terephthalate (PET) fibers.

39. The vehicle of Claim 34, wherein the upholstery material comprises carpeting.

40. A vehicle, comprising:
an interior compartment comprising a panel having a surface; and
sound insulating material attached to the panel
5 surface, comprising:

a first non-woven, fibrous layer of material having a first stratum of molded fibers that has a first density and a second stratum of melted fibers that has a second density greater than the first density and that
10 is effective to attenuate noise traversing the

fibrous layer; and

a second non-woven fibrous layer of material attached to the first non-woven, fibrous layer.

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41. The vehicle of Claim 40, further comprising upholstery material attached to a surface of the first fibrous layer.

42. The vehicle of Claim 40, wherein the fibrous layer comprises fibers selected from the group consisting of thermosetting fibers and thermoplastic fibers.

43. The vehicle of Claim 40, wherein the fibrous layer comprises polyethylene terephthalate (PET) fibers.

44. The vehicle of Claim 41, wherein the upholstery material comprises carpeting.

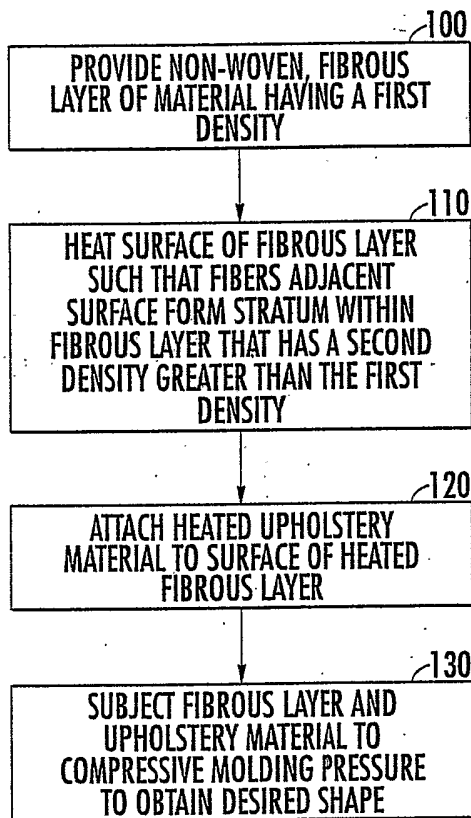


FIG. 1.

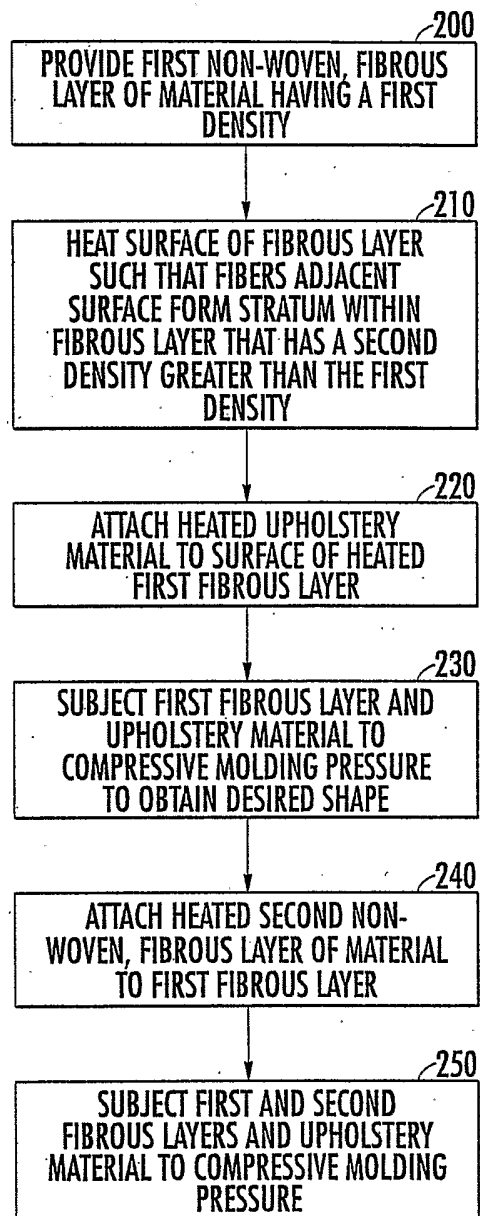


FIG. 2.

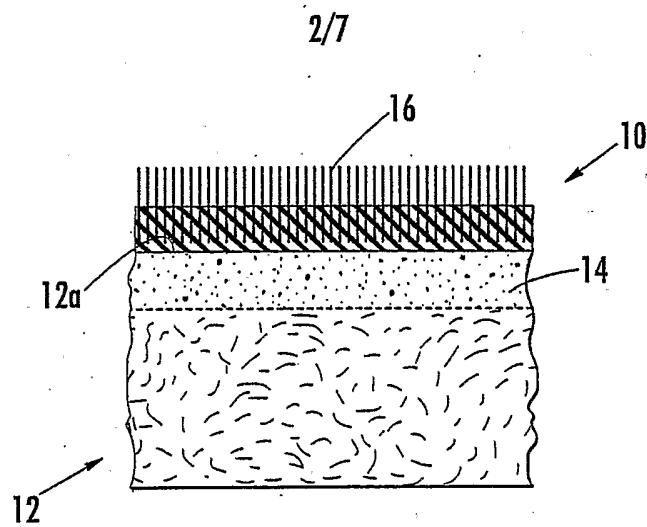


FIG. 3.

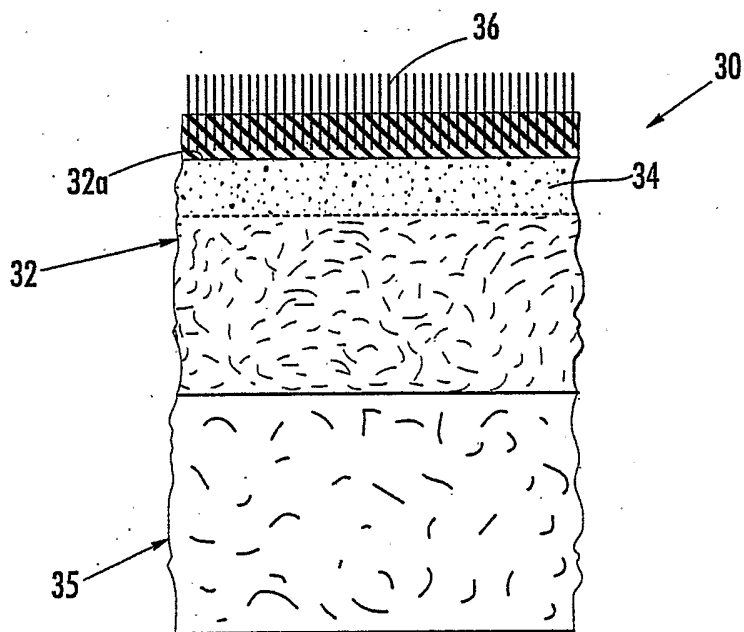


FIG. 5.

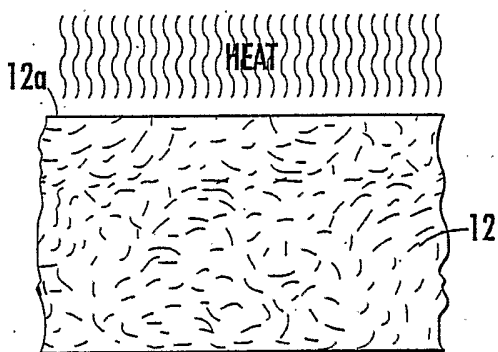


FIG. 4A.

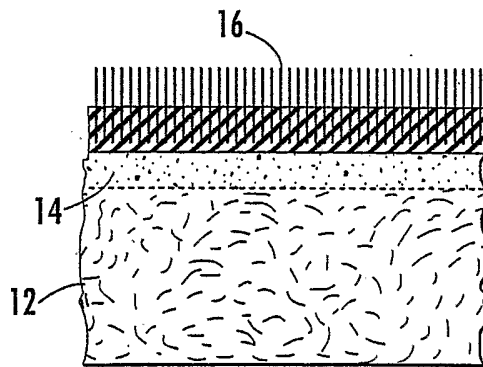


FIG. 4B.

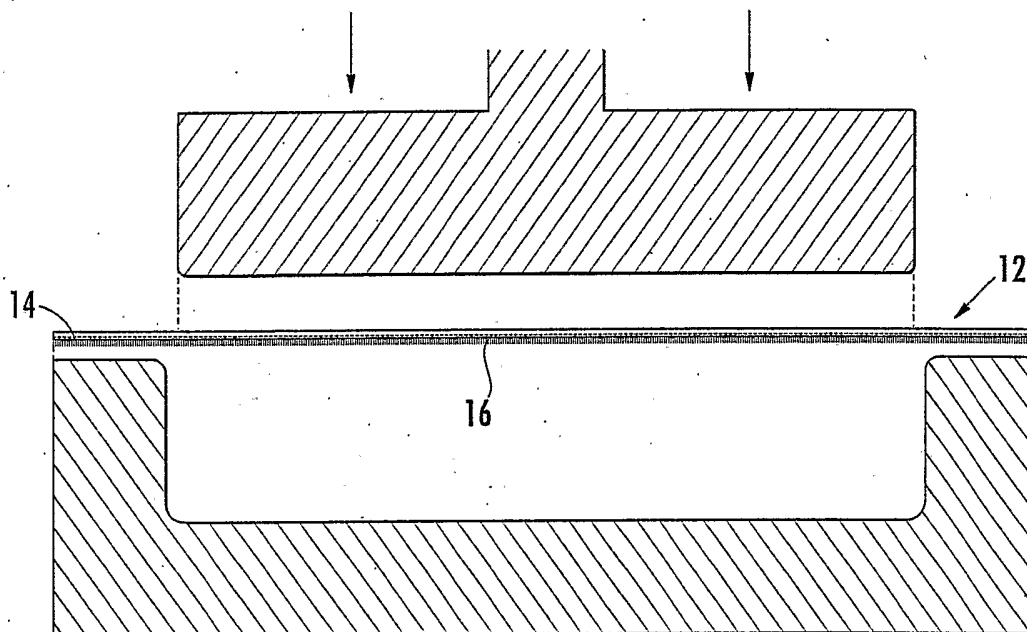


FIG. 4C.

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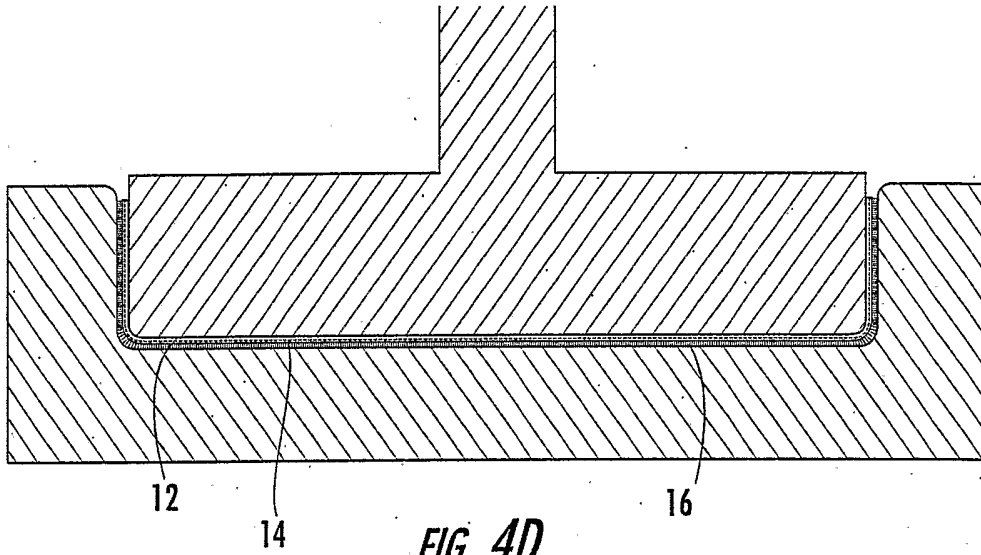


FIG. 4D.

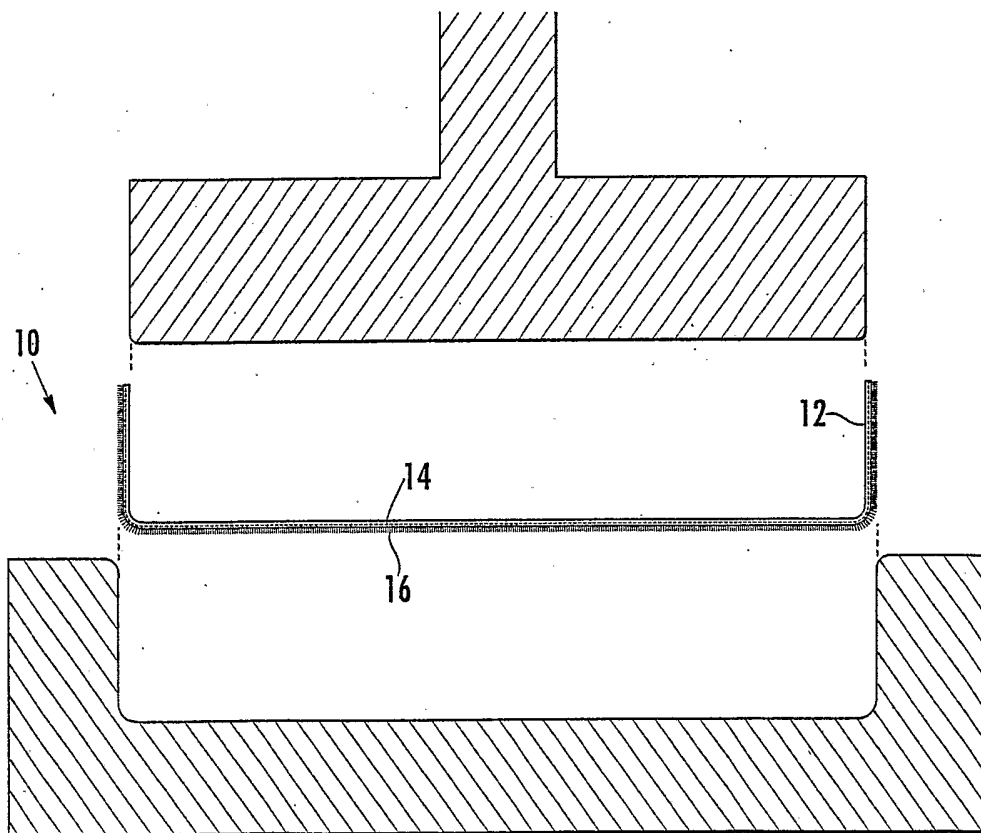


FIG. 4E.

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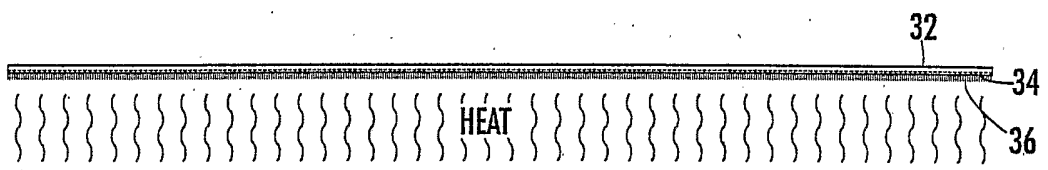


FIG. 6A.

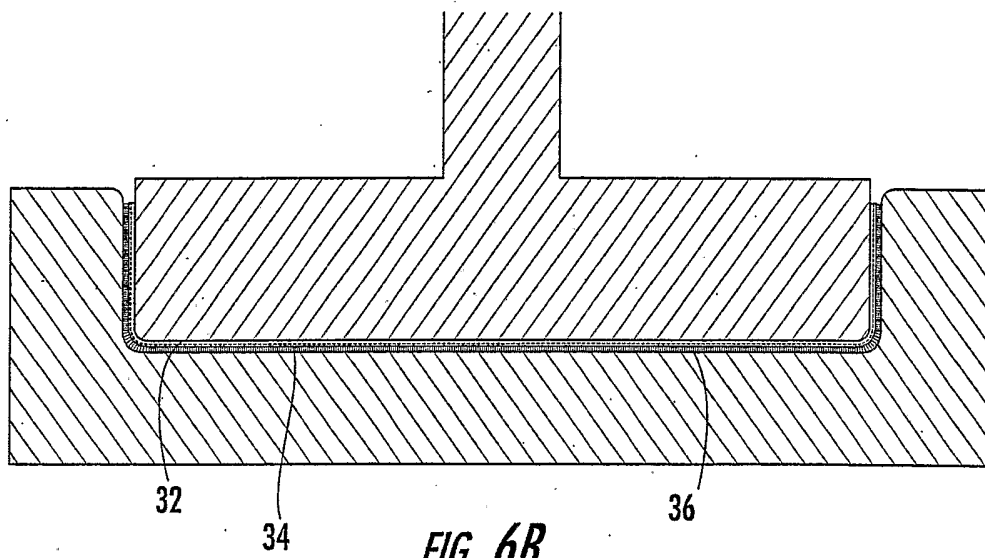


FIG. 6B.

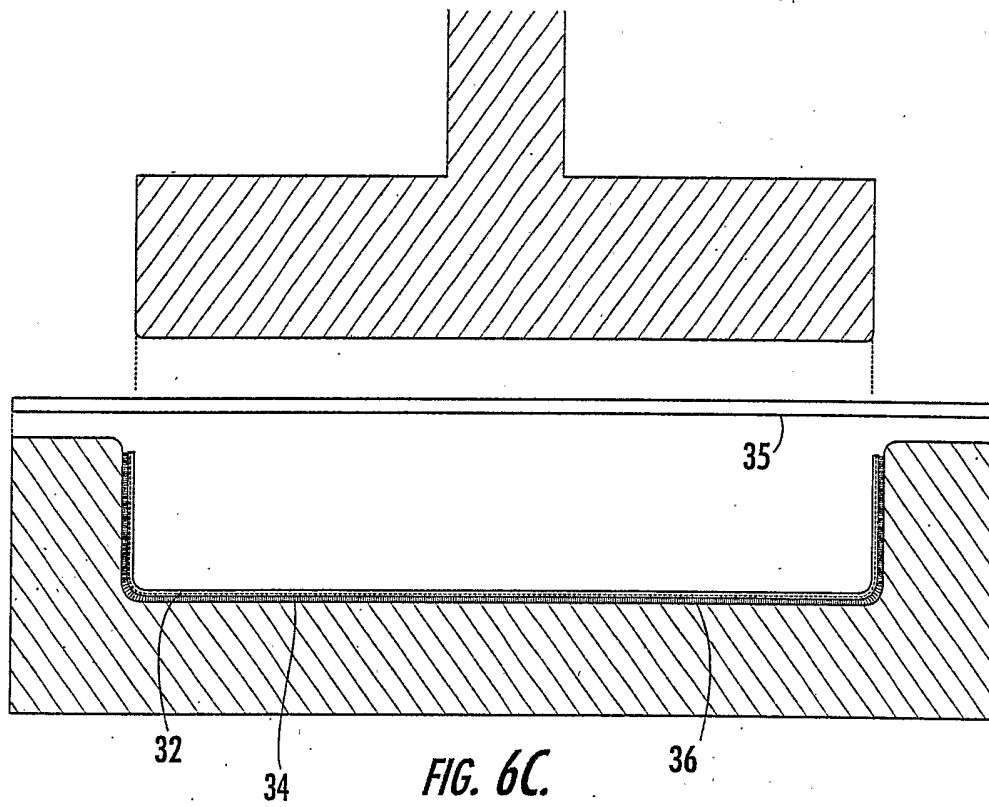


FIG. 6C.

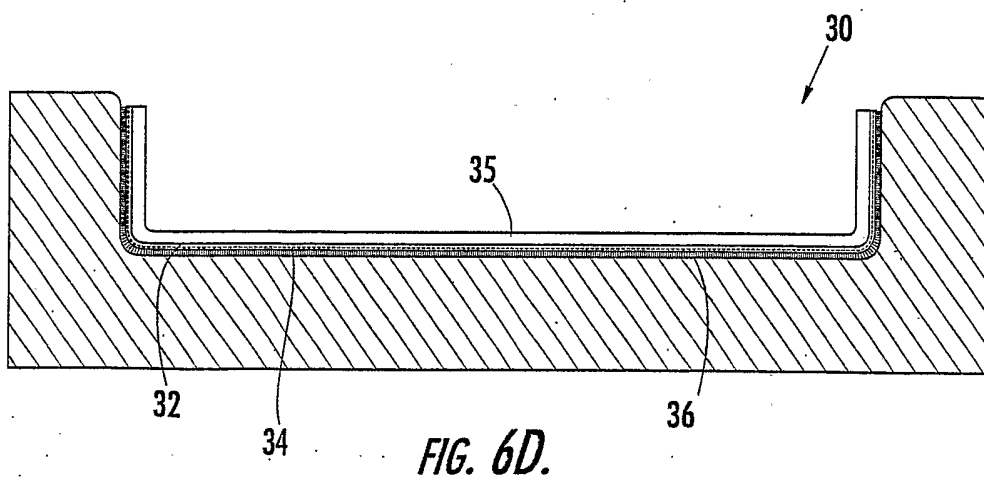
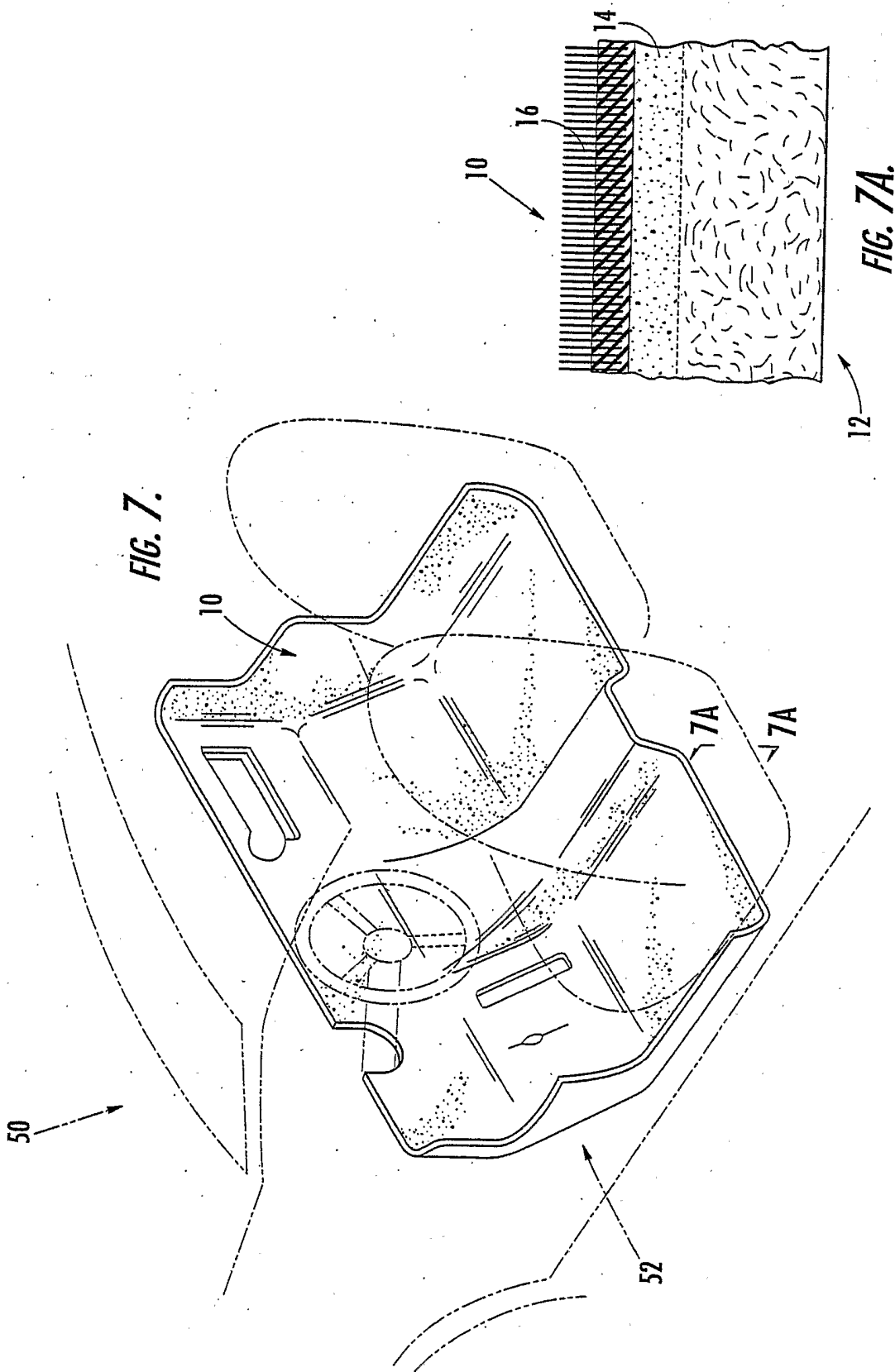


FIG. 6D.



INTERNATIONAL SEARCH REPORT

International application No.

PCT/US02/32557

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : E04B 1/82
 US CL : 181/290

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
 U.S. : 181/290, 286

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
 NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
 EAST (US, EPO, JPO, IBM-TDB)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5,554,238 A (ENGLISH) 10 September 1996 (10.09.2002), column 6, lines 5-10.	1-44
X	US 5,456,872 A (AHRWEILER) 10 October 1995 (10.10.1995), column 3, lines 38-40; column 2, line 2	1, 4, 6, 7
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Y		2, 3, 5, 8-44
X	US 4,199,635 A (PARKER) 22 April 1980 (22.04.1980), column 3, lines 38-40; figures 1, 5.	1, 4, 6, 7
---		-----
Y		2, 3, 5, 8-44

Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents:	
"A" document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"E" earlier application or patent published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search 27 December 2002 (27.12.2002)	Date of mailing of the international search report 10 APR 2003
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