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(71) Applicant: **NORTH CAROLINA STATE UNIVERSITY** [US/US]; 1021 Main Campus Drive, 2nd Floor, Raleigh, North Carolina 27606 (US).

(72) Inventors: **MAZE, Benoit**; 9137 Falkwood Road, Raleigh, North Carolina 27617-8210 (US). **POURDEYHIMI, Behnam**; 108 Tropez Lane, Cary, North Carolina 27511 (US).

(74) Agent: **ANDERSON, Lauren F.**; Womble Bond Dickinson (US) LLP, Attn: IP Docketing, P.O. Box 7037, Atlanta, Georgia 30357-0037 (US).

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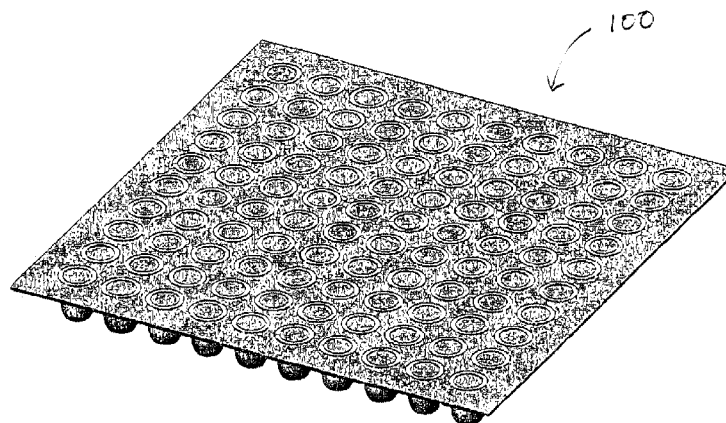


FIG. 1A

(57) Abstract: A molded nonwoven assembly and a method for manufacturing a nonwoven assembly are disclosed herein. The assembly includes a first nonwoven web of material having a surface defining a plurality of chambers in spaced apart relation therein, each of the plurality of chambers having an opening. The assembly also includes a plurality of biasing members, each of the biasing members being introduced within a respective one of the plurality of chambers. The assembly further includes a second nonwoven web of material engaged with the surface of the first nonwoven web of material to substantially overlie the surface of the first nonwoven web of material and enclose the plurality of biasing members within the respective plurality of chambers.



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A MOLDED NONWOVEN ASSEMBLY AND A METHOD FOR MANUFACTURING A MOLDED NONWOVEN ASSEMBLY

BACKGROUND OF THE INVENTION

One example of a conventional spring interior of a mattress or upholstered furniture unit is known as a pocketed coil spring assembly, which comprises a plurality of individual coil springs arranged in linear fashion into rows and columns and secured within fabric pockets. The fabric material of the pockets is typically sewn or otherwise secured so as to enclose the individual coil springs or a row of coil springs within a pocket of fabric material. The individual pocketed coil springs or rows of coil springs are then secured together, typically with adhesive applied to the exterior of the pocketed material or fasteners which pass through the fabric and the end turns of adjacent coil springs. A pocketed coil spring assembly is generally recognized as a more expensive product than a conventional unpocketed spring assembly because a pocketed coil spring assembly requires more labor and material to assemble.

Accordingly, a need exists for pocketed coil spring assemblies suitable for use in mattresses and other upholstered items that can be manufactured more efficiently.

SUMMARY OF THE INVENTION

A molded nonwoven assembly and a method for manufacturing a molded nonwoven assembly are described herein. In one aspect, a molded nonwoven assembly comprises a first nonwoven web of material having a surface defining a plurality of chambers in spaced apart relation therein, each of the plurality of chambers having an opening; a plurality of biasing members, each of the biasing members being introduced within a respective one of the plurality of chambers; and a second nonwoven web of material engaged with the surface of the first nonwoven web of material to substantially overlie the surface of the first nonwoven web of material and enclose the plurality of biasing members within the respective plurality of chambers.

In another aspect, a method for manufacturing a nonwoven assembly comprises defining a plurality of chambers in spaced apart relation in a surface of a first nonwoven web of material, each of the plurality of chambers having an opening; introducing a plurality of biasing members within a respective one of the plurality of chambers; and engaging a second nonwoven web of material with the surface of the first nonwoven web of material to substantially overlie the surface of the first nonwoven web of material and enclose the plurality of biasing members within the respective plurality of chambers.

The present disclosure thus includes, without limitation, the following embodiments:

Embodiment 1: A molded nonwoven assembly comprising: a first nonwoven web of material having a surface defining a plurality of chambers in spaced apart relation therein, each of the plurality of chambers having an opening; a plurality of biasing members, each of the biasing members being introduced within a respective one of the plurality of chambers; and a second nonwoven web of material engaged with the surface of the first nonwoven web of material to substantially overlie the surface of the first nonwoven web of material and enclose the plurality of biasing members within the respective plurality of chambers.

Embodiment 2: The assembly of any preceding embodiment, or any combination of preceding embodiments, comprising a plurality of reinforcing elements, each of the plurality of reinforcing elements substantially surrounding the opening of one of the plurality of chambers.

Embodiment 3: The assembly of any preceding embodiment, or any combination of preceding embodiments, wherein the plurality of reinforcing elements are welded to the surface of the first nonwoven web of material.

Embodiment 4: The assembly of any preceding embodiment, or any combination of preceding embodiments, wherein the second nonwoven web of material has a substantially planar surface engaged with the surface of the first nonwoven web of material to substantially overlie the surface of the first nonwoven web of material and enclose the plurality of biasing members within the respective plurality of chambers.

Embodiment 5: The assembly of any preceding embodiment, or any combination of preceding embodiments, wherein the second nonwoven web of material has a surface defining a plurality of chambers in spaced apart relation therein, each of the plurality of chambers having an opening such that the each of the openings of the plurality of chambers defined in the second nonwoven web of material is aligned with a respective opening of the plurality of chambers defined in the first nonwoven web of material when the surface of the second nonwoven web of material is engaged with the first nonwoven web of material to substantially overlie the surface of the first nonwoven web of material and enclose the plurality of biasing members within the respective plurality of chambers.

Embodiment 6: The assembly of any preceding embodiment, or any combination of preceding embodiments, wherein the first nonwoven web of material and the second nonwoven web of material are a spunbond or meltblown nonwoven web of material.

Embodiment 7: The assembly of any preceding embodiment, or any combination of preceding embodiments, wherein the first nonwoven web of material and the second nonwoven web of material comprises at least one thermoplastic polymer selected from the group consisting of polyesters, co-polyesters, polyamides, polyolefins, polyacrylates, thermoplastic liquid crystalline polymers, and combinations thereof.

Embodiment 8: The assembly of any preceding embodiment, or any combination of preceding embodiments, wherein a surface of the second nonwoven web of material is welded to the surface of the first nonwoven web of material.

Embodiment 9: The assembly of any preceding embodiment, or any combination of preceding embodiments, wherein the surface of the second nonwoven web of material is welded to the first nonwoven web of material around each of the openings of the plurality of chambers in the first nonwoven web of material.

Embodiment 10: The assembly of any preceding embodiment, or any combination of preceding embodiments, wherein the plurality of biasing members comprises springs.

Embodiment 11: A mattress or upholstered furniture unit comprising the molded nonwoven assembly of any preceding embodiment, or any combination of preceding embodiments.

Embodiment 12: A method for manufacturing a nonwoven assembly comprising: defining a plurality of chambers in spaced apart relation in a surface of a first nonwoven web of material, each of the plurality of

chambers having an opening; introducing a plurality of biasing members within a respective one of the plurality of chambers; and engaging a second nonwoven web of material with the surface of the first nonwoven web of material to substantially overlie the surface of the first nonwoven web of material and enclose the plurality of biasing members within the respective plurality of chambers.

Embodiment 13: The method of any preceding embodiment, or any combination of preceding embodiments, comprising welding a plurality of reinforcing elements to the surface of the first nonwoven web of material, each of the plurality of reinforcing elements substantially surrounding the opening of one of the plurality of chambers.

Embodiment 14: The method of any preceding embodiment, or any combination of preceding embodiments, wherein engaging the second nonwoven web of material comprises engaging a substantially planar surface of the second nonwoven web of material with the surface of the first nonwoven web of material to substantially overlie the surface of the first nonwoven web of material and enclose the plurality of biasing members within the respective plurality of chambers.

Embodiment 15: The method of any preceding embodiment, or any combination of preceding embodiments, wherein engaging the second nonwoven web of material comprises engaging a surface of the second nonwoven web of material defining a plurality of chambers in spaced apart relation therein, each of the plurality of chambers having an opening, with the first nonwoven web of material to substantially overlie the surface of the first nonwoven web of material and enclose the plurality of biasing members within the respective plurality of chambers, such that each of the openings of the plurality of chambers defined in the second nonwoven web of material is aligned with a respective opening of the plurality of chambers defined in the first nonwoven web of material when the surface of the second nonwoven web of material is engaged.

Embodiment 16: The method of any preceding embodiment, or any combination of preceding embodiments, comprising defining at least one of the plurality of chambers in the first nonwoven web of material and the second nonwoven web of material by a molding apparatus.

Embodiment 17: The method of any preceding embodiment, or any combination of preceding embodiments, comprising heating one of the molding apparatus and the nonwoven web of material prior to defining the plurality of chambers.

Embodiment 18: The method of any preceding embodiment, or any combination of preceding embodiments, comprising heating a male mold of the molding apparatus to a temperature of about 120 °C to about 150 °C and maintaining at least one of the first nonwoven web of material and the second nonwoven web of material at a temperature of about 100 °C to about 130 °C.

Embodiment 19: The method of any preceding embodiment, or any combination of preceding embodiments, comprising heating at least one of the first nonwoven web of material and the second nonwoven web of material to a temperature of about 140 °C to about 200 °C and maintaining a male mold of the molding apparatus at a temperature of about 150 °C to about 160 °C.

Embodiment 20: The method of any preceding embodiment, or any combination of preceding embodiments, comprising welding a surface of the second nonwoven web of material to the surface of the

first nonwoven web of material around each of the openings of the plurality of the chambers in the first nonwoven web of material.

These and other features, aspects, and advantages of the present disclosure will be apparent from a reading of the following detailed description together with the accompanying drawings, which are briefly described below. The present disclosure includes any combination of two, three, four, or more features or elements set forth in this disclosure or recited in any one or more of the claims, regardless of whether such features or elements are expressly combined or otherwise recited in a specific embodiment description or claim herein. This disclosure is intended to be read holistically such that any separable features or elements of the disclosure, in any of its aspects and embodiments, should be viewed as intended to be combinable, unless the context of the disclosure clearly dictates otherwise.

DESCRIPTION OF THE DRAWINGS

Having thus described the present disclosure in general terms, reference will now be made to the accompanying drawings, which are not necessarily drawn to scale, and wherein:

FIG. 1A illustrates a perspective view of a first embodiment of a molded nonwoven assembly as described herein;

FIG. 1B illustrates an exploded side view of the molded nonwoven assembly of FIG. 1A;

FIG. 2 illustrates a perspective view of a nonwoven web of material for a molded nonwoven assembly; as described herein;

FIG. 3 illustrates a perspective view of a plurality of chambers having an opening defined in a surface of a nonwoven web of material of a molded nonwoven assembly as described herein;

FIG. 4 illustrates a perspective view of a plurality of biasing members introduced into a plurality of chambers having an opening defined in a surface of a nonwoven web of material of a molded nonwoven assembly as described herein;

FIG. 5 illustrates a perspective view of a second nonwoven web of material having a substantially planar surface engaged with a surface of a first nonwoven web of material of a molded nonwoven assembly as described herein;

FIG. 6A illustrates a perspective view of a second embodiment of a molded nonwoven assembly as described herein;

FIG. 6B illustrates an exploded side view of the molded nonwoven assembly of FIG. 6A;

FIG. 7A illustrates a perspective view of an exemplary mattress comprising a molded nonwoven assembly as described herein;

FIG. 7B illustrates a perspective view of an exemplary upholstered furniture unit comprising a molded nonwoven assembly as described herein; and

FIG. 8 illustrates a method flow diagram for a method for manufacturing a molded nonwoven assembly as described herein.

DETAILED DESCRIPTION

The present invention now will be described more fully hereinafter. 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. As used in this specification and the claims, the singular forms "a," "an," and "the" include plural referents unless the context clearly dictates otherwise.

As described herein, the present invention relates to three-dimensional molded nonwoven structures such as molded nonwoven assemblies for mattresses or other upholstered furniture unit applications. The molded nonwoven assembly described herein comprises, in some aspects a first nonwoven web of material having a surface defining a plurality of chambers in spaced apart relation therein, each of the plurality of chambers having an opening; a plurality of biasing members, each of the biasing members being introduced within a respective one of the plurality of chambers; and a second nonwoven web of material engaged with the surface of the first nonwoven web of material to substantially overlie the surface of the first nonwoven web of material and enclose the plurality of biasing members within the respective plurality of chambers. Other applications for three-dimensional molded nonwoven structures are also contemplated.

Typical three-dimensional molded nonwoven structures are used in a variety of applications. Most notably, automotive parts account for a great majority of such applications including headliners, door liners, carpets, and the like. Most of these structures are molded to conform to the shape of the object they surround or support. The degree to which the fibers in the structure are extended is somewhat limited. Many nonwovens that are used in these applications are composed of fibers that have the ability to be drawn further during the molding process to accommodate the shapes required without being ruptured. Representative related art includes the following patent references: U.S. Pat. Nos. 2,029,376 to Joseph; 2,627,644 to Foster; 3,219,514 to Struycken; 3,691,004 to Werner; 4,104,430 to Fenton; 4,128,684 to Bomio et al.; 4,212,692 to Rasen et al.; 4,252,590 to Rasen et al.; 4,584,228 to Droste; 4,741,941 to Englebert et al.; 4,863,779 to Daponte; 5,165,979 to Watkins et al.; 5,731,062 to Kim et al.; 5,833,321 to Kim et al.; 5,851,930 to Bessey et al.; 5,882,322 to Kim et al.; 5,896,680 to Kim et al.; 5,972,477 to Kim et al.; 5,993,943 to Bodaghi et al.; 6,007,898 to Kim et al.; 6,631,221 to Penninckx et al.; and 7,060,344 to Pourdeyhimi et al.; and U.S. Appl. Pub. No. 2006/0194027 to Pourdeyhimi et al. The teachings of these references are incorporated by reference herein.

As used herein, the term "fiber" is defined as a basic element of nonwovens which has a high aspect ratio of, for example, at least about 100 times. In addition, "filaments/continuous filaments" are continuous fibers of extremely long lengths that possess a very high aspect ratio. "Staple fibers" are cut lengths from continuous filaments. Therefore, as used herein, the term "fiber" is intended to include fibers, filaments, continuous filaments, staple fibers, and the like. The term "multicomponent fibers" refers to fibers that comprise two or more components that are different by physical or chemical nature, including bicomponent fibers.

The term “nonwoven” as used herein in reference to fibrous materials, webs, mats, batts, or sheets refers to fibrous structures in which fibers are aligned in an undefined or random orientation. The nonwoven fibers are initially presented as unbound fibers or filaments, which may be natural or man-made. An important step in the manufacturing of nonwovens involves binding the various fibers or filaments together. The manner in which the fibers or filaments are bound can vary, and include thermal, mechanical and chemical techniques that are selected in part based on the desired characteristics of the final product. In certain embodiments, the preferred nonwoven materials are those with a random fiber orientation distribution. While common anisotropic structures can also be molded, the degree to which they can be drawn becomes more limited with increasing anisotropy.

The fibers according to the present invention can vary, and include fibers having any type of cross-section, including, but not limited to, circular, rectangular, square, oval, triangular, and multilobal. In certain embodiments, the fibers can have one or more void spaces, wherein the void spaces can have, for example, circular, rectangular, square, oval, triangular, or multilobal cross-sections. The fibers may be selected from single-component (*i.e.*, uniform in composition throughout the fiber) or multicomponent fiber types including, but not limited to, fibers having a sheath/core structure and fibers having an islands-in-the-sea structure, as well as fibers having a side-by-side, segmented pie, segmented cross, segmented ribbon, or tipped multilobal cross-sections.

In some embodiments, multicomponent fibers are produced and subsequently treated (*e.g.*, by contacting the fibers with a solvent) to remove one or more of the components. For example, in certain embodiments, an island-in-a-sea fiber can be produced and treated to dissolve the sea component, leaving the islands as fibers with smaller diameters. Exemplary methods for this type of process are described, for example, in U.S. Patent No. 4,612,228 to Kato *et al.*, which is incorporated herein by reference.

Fiber diameter is a common means of describing fibers with a circular cross-section. In the case of trilobal cross-sections, for example, the longest fiber dimension would be along an edge forming the trilobal cross-section. In the case of ribbon fibers, for example, the cross-section would have two distinct measures (width and thickness). The invention may use fibers of any cross-sectional shape and have a size of about 100 microns or less in diameter (*e.g.*, a round cross-section fiber of about 80 microns in diameter) or wherein at least one of the principal dimension is about 100 microns or less (*e.g.*, a ribbon fiber of about 100 microns $\times$ about 10 microns).

Advantageously, the fibers forming the nonwoven web have a diameter in the range from about 1 to about 100 microns, with a particularly advantage range being about 20 microns to about 50 microns. The fibers comprising the nonwoven web can have varying lengths and can be substantially continuous fibers, staple fibers, filaments, fibrils, and combinations thereof.

The fibers of the nonwoven web (including thermoplastic fibers and, optionally, one or more non-thermoplastic fibers) can be in any arrangement. Generally, the fibers are provided in a random, nonwoven arrangement. Although the present disclosure focuses on nonwoven webs, it is noted that the fibers described herein can also be used to manufacture traditional woven fabrics that can be used in place of, or in addition to, a nonwoven web.

The means of producing the nonwoven web can vary. In general, nonwoven webs are typically produced in three stages: web formation, bonding, and finishing treatments. Web formation can be accomplished by any means known in the art. For example, in certain embodiments, the web may be formed by a drylaid process, a spunlaid process, or a wetlaid process. In some embodiments, the nonwoven web is made by meltblowing or spunbonding processes.

Meltblowing is a process wherein a polymer (or polymers) is melted to a liquid state and extruded through a linear die containing numerous (*e.g.*, several hundred or more) small orifices. As the polymer is extruded, streams of hot air are rapidly blown at the polymer, rapidly stretching and/or attenuating the extruded polymer streams to form extremely fine filaments. The air streams typically stretch or attenuate the molten polymer by many orders of magnitude. The stretched polymer fibers are collected as a randomly entangled, self-bonded nonwoven web. The technique of meltblowing is known in the art and is discussed in various patents, for example, U.S. Pat. Nos. 3,849,241 to Butin, 3,987,185 to Buntin et al., 3,972,759 to Buntin, and 4,622,259 to McAmish et al., each of which is herein incorporated by reference in its entirety.

Meltblowing is generally capable of providing fibers with relatively small diameters. Diameter and other properties of meltblown fibers can be tailored by modifying various process parameters (*e.g.*, die design, polymer throughput, air characteristics, collector placement, and web handling). Attenuating the air pressure affects fiber size, as higher pressures typically yield finer fibers (*e.g.*, up to about 5 microns, such as about 1-5 microns) and lower pressures yield coarser fibers (*e.g.*, up to about 30 microns, such as about 10-30 microns).

The meltblowing process can use three major inputs for controlling the structure of the nonwovens being formed. These inputs are throughput, air and distance to the collector (DCD). Throughput can vary and will contribute to fiber size and can be measured in grams/hole/minute. The dies can have 30-50 holes per inch, for example, and this throughput can dictate the total fiber production per hour per meter, with an exemplary throughput range being about 0.5 to about 1.0 g/hole/min. Air can also affect fiber size and can be measured in volume of air consumed which can be measured in m³/hr per meter. The higher the air consumption, the higher the air velocity, which can result in higher drawing of the fibers. A conventional meltblowing unit can have as low as 200 and as high as 2000 m³/hr per meter. DCD can be related to moldability of a nonwoven structure and can be measured in millimeters. Allowing the spinnerette and collector to be too close, *i.e.*, a low DCD, can create too thick of a fabric that is stiff and likely to burst upon molding. The higher distances can result in higher thicknesses and therefore, a lower level of solidity (solid volume fraction or higher porosity) as well as lower degree of fiber to fiber bonding. Therefore, the DCD controls the porosity (measured in terms of air permeability) and bond strength (measured in terms of bursting strength). The DCD range of about 200 mm to about 350 mm provides a reasonable range for forming structures that are moldable.

Various test methods can be used to measure the physical properties of a polymer, and thereby characterize the thermoplastic polymer. The melt flow index, which relates to molecular weight, of a thermoplastic polymer can be measured, for example, using test methods outlined in ASTM D1238-13 entitled "Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer." This test

method serves to indicate the uniformity of the flow rate of the polymer. The intrinsic viscosity of a polymer can be measured, for example, using test methods described in ASTM D5225-09 entitled “Standard Test Method for Measuring Solution Viscosity of Polymers with a Differential Viscometer.” In certain embodiments, the polymer and/or polymer blend used in the invention can have a melt flow index of less than about 400 g/10 minutes or can have an intrinsic viscosity of at least about 2.0 dl/g or higher.

Various test methods can be used to measure the physical properties of a polymer, and thereby characterize the thermoplastic polymer. The melt flow index, which relates to molecular weight, of a thermoplastic polymer can be measured, for example, using test methods outlined in ASTM D1238-13 entitled “Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer.” This test method serves to indicate the uniformity of the flow rate of the polymer. The intrinsic viscosity of a polymer can be measured, for example, using test methods described in ASTM D5225-09 entitled “Standard Test Method for Measuring Solution Viscosity of Polymers with a Differential Viscometer.” Solution viscosity values are related to the average molecular size of that portion of the polymer which dissolves in the solvent. Various other test methods for several different physical properties of polymers are known in the art.

Spunbonding can employ various types of fiber spinning process (e.g., wet, dry, melt, or emulsion). Melt spinning is most commonly used, wherein a polymer is melted to a liquid state and forced through small orifices into cool air, such that the polymer strands solidify according to the shape of the orifices. The fiber bundles thus produced are then drawn, *i.e.*, mechanically stretched (*e.g.*, by a factor of 3-8) to orient the fibers. A nonwoven web is then formed by depositing the drawn fibers onto a moving belt. General spunbonding processes are described, for example, in U.S. Patent Nos. 4,340,563 to Appel *et al.*, 3,692,618 to Dorschner *et al.*, 3,802,817 to Matsuki *et al.*, 3,338,992 and 3,341,394 to Kinney, 3,502,763 to Hartmann, and 3,542,615 to Dobo *et al.*, which are all incorporated herein by reference. Spunbonding typically produces a larger diameter filament than meltblowing, for example. For example, in some embodiments, spunbonding produces fibers having an average diameter of about 20 microns or more.

Fibers used in thermoforming nonwoven substrates can include, for example, one or more thermoplastic polymers selected from the group consisting of: polyesters, co-polyesters, polyamides, polyolefins, polyacrylates, thermoplastic liquid crystalline polymers, and combinations thereof. In some embodiments a single layer meltblown or spunbond structure can be fabricated from fibers comprising polyester, co-polyester, polypropylene, polyethylene, or polyamide type polymeric materials, or combinations thereof.

After production of the fibers and deposition of the fibers onto a surface, the nonwoven web can, in some embodiments, be subjected to some type of bonding (including, but not limited to, thermal fusion or bonding, mechanical entanglement, chemical adhesive, or a combination thereof), although in some embodiments, the web preparation process itself provides the necessary bonding and no further treatment is used. In one embodiment, the nonwoven web is bonded thermally by using a calendar or a thru-air oven. In other embodiments, the nonwoven web is subjected to hydroentangling, which is a mechanism used to entangle and bond fibers using hydrodynamic forces. The term “hydroentangled” as applied to a nonwoven

fabric herein defines a web subjected to impingement by a curtain of high speed, fine water jets, typically emanating from a nozzle jet strip accommodated in a pressure vessel often referred to as a manifold or an injector. This hydroentangled fabric can be characterized by reoriented, twisted, turned and entangled fibers. For example, the fibers can be hydroentangled by exposing the nonwoven web to water pressure from one or more hydroentangling manifolds at a water pressure in the range of about 30 bar to about 1000 bar. In some embodiments, needle punching is utilized, wherein needles are used to provide physical entanglement between fibers.

The fibrous webs thus produced can have varying thicknesses. The process parameters can be modified to vary the thickness. For example, in some embodiments, increasing the speed of the moving belt onto which fibers are deposited results in a thinner web. Average thicknesses of the nonwoven webs can vary and in some embodiments, the web may have an average thickness of about 1 mm or less. Additionally, the stiffness of the structure can be controlled by employing larger diameter fibers and/or a higher basis weight. In some embodiments, the basis weight of the nonwoven web is about 500 g/m² or less. The basis weight of the a fabric can be measured, for example, using test methods outlined in ASTM D 3776/D 3776M-09ae2 entitled "Standard Test Method for Mass Per Unit Area (Weight) of Fabric." This test reports a measure of mass per unit area and is measured and expressed as grams per square meter (g/m²).

As an alternative means for nonwoven web formation, fibers can be extruded, crimped, and cut into staple fibers from which a web can be formed and then bonded by one or more of the methods described above. In some embodiments, staple or filament fibers can be used to form woven, knitted or braided structures as well. In another embodiment of the present invention, staple nonwoven fabrics can be constructed by spinning fibers, cutting them into short segments, and assembling them into bales. The bales can then be spread in a uniform web by a wetlaid process, airlaid process, or carding process and bonded as described above.

The molded fabric structures are typically formed from the nonwoven web through use of a combination of heat and pressure, such as exemplary conditions utilized in a variety of molding techniques including solid phase pressure forming, vacuum molding, bladder molding, match plate molding, stamping, pressing, calendaring and the like. Molding processes that can be adapted for use in the invention are described, for example, in U.S. Pat. No. 7,060,344 to Pourdeyhimi et al., which is herein incorporated by reference in its entirety.

The forming process can use sheet thermoforming equipment or calendar molding, for example. For example, a substantially planar nonwoven web can be preheated and then fed to molding equipment comprising a female mold and a male mold, wherein one of the mold pieces comprises projections that correspond (i.e., mate) with indentations/depressions included in the second mold piece. The female and male molds are pressed together as the fabric passes between the molds, thereby molding the fabric into the shape formed by the one or more projections and corresponding one or more indentations/depressions included on the female and male mold pieces. In both thermoforming and calendar molding processes, the molding equipment can be heated if desired.

Thermoforming of nonwoven substrates can be accomplished through a combination of two material phenomena: (1) rheological and (2) mechanical deformation. Rheological deformation implies that a certain amount a molecular movement is induced through the application of heat to the substrate thus softening the fiber to the point of laminar movement. To maintain fibrous characteristics without considerable change to molecular orientation and crystallinity, the forming temperature should be maintained above the glass transition and below the melting temperature (e.g., certain thermoplastic fibers or polymers have a melting temperature between 70-450° C).

In various embodiments, the projections or depressions within the substrate typically have a height and width between about 0.5 inches to about 3.5 inches, but the actual size of the depressions will vary depending on the size of the spring that will be placed in the depression. The shape of the depressions can also vary depending on the shape of the spring, but are generally cylindrical in shape. Accordingly, a molded nonwoven assembly and a method for manufacturing a nonwoven assembly incorporate fibers and nonwoven webs of material as described hereinabove.

Referring now to FIGS. 1A, 1B, a first embodiment of a nonwoven assembly is illustrated. The first embodiment of the nonwoven assembly is an asymmetric nonwoven assembly 100. The nonwoven assembly 100 comprises a first nonwoven web of material 102 having a surface 104. The first nonwoven web of material 102 is nonwoven web of material that may comprise at least one thermoplastic polymer selected from the group consisting of polyesters, co-polyesters, polyamides, polyolefins, polyacrylates, thermoplastic liquid crystalline polymers, and combinations thereof.

FIG. 2 illustrates an example of the first nonwoven web of material 102. The first nonwoven web of material 102 may comprise, for example, a continuous roll of material advantageously having a length of about 5 cm to about 2 km, a width of about 5 cm to about 3.2 m, and a thickness of about 100 μ m to about 2 mm. Other dimensions of the first nonwoven web of material 102 are also contemplated. In some aspects, the nonwoven assembly 100 is asymmetric about a plane substantially parallel to a planar surface of the first nonwoven web of material 102, as compared to a symmetric nonwoven assembly 200 illustrated in FIGS. 6A-6B.

In some aspects, the surface 104 of the first nonwoven web of material 102 defines a plurality of chambers 106 in spaced apart relation therein. For example, and as illustrated in FIG. 3, the plurality of chambers 106 is spaced apart about 2.5 cm to about 5 cm from one another in both an X direction and a Y direction. In this manner, there may be about 1 to about 3.5 million chambers in the first nonwoven web of material 102. In some aspects, each of the plurality of chambers has an opening. The opening of the plurality of chambers may comprise, in some aspects, a diameter of about 0.5 cm to about 10 cm and a depth of about 0.5 cm to about 10 cm. Other dimensions of the openings of the chambers are also contemplated, where the chambers may also be formed as having a square, triangular, or otherwise non-circular opening.

In some aspects, the plurality of chambers 106 is defined by a molding apparatus. For example, the molding apparatus may utilize at least heat and/or pressure to define the plurality of chambers 106 within the surface 104 of the first nonwoven web of material 102. As described herein, the molding apparatus may

comprise equipment utilized for standard molding techniques including solid phase pressure forming, vacuum molding, bladder molding, match plate molding, stamping, pressing, calendaring and the like.

As such, in some aspects, one of the molding apparatus and the first nonwoven web of material 106 may be heated prior to defining the plurality of chambers 106 therein. More particularly, in one aspect, a male mold of the molding apparatus may be heated to a temperature of about 120 °C to about 150 °C and the first nonwoven web of material 102 may be maintained at a temperature of about 100 °C to about 130 °C. In another alternative aspect, the first nonwoven web of material 102 may be heated to a temperature of about 140 °C to about 200 °C and a male mold of the molding apparatus may be maintained at a temperature of about 150 °C to about 160 °C.

In some aspects, the nonwoven assembly 100 comprises a plurality of reinforcing elements 108. For example, the reinforcing elements 108 comprise springs sized to substantially surround the opening of one of the plurality of chambers 106. As such, the size of the reinforcing elements 108 depend on the size and/or shape of the opening of the plurality of the plurality of chambers 106. In some aspects, the springs 108 are of a metallic material.

In some aspects, the nonwoven assembly 100 also comprises a plurality of biasing members 110. The biasing members 110 comprise, in some aspects, springs. Each of the biasing members 110 may be introduced within a respective one of the plurality of chambers 106 as illustrated in FIG. 4. As such, the biasing members 110 may comprise dimensions that correspond to the dimensions of the plurality of chambers 106. For example, the biasing members 110 comprise about a 2 cm diameter and about a 4 cm height to about a 5 cm diameter and about 10 cm height. However, biasing members 110 having different dimensions are also contemplated.

The nonwoven assembly 100 may further comprise a second nonwoven web of material 112 engaged with the surface 104 of the first nonwoven web of material 102. In some aspects, the second nonwoven web of material 112 is similar to the first nonwoven web of material 102 and may comprise at least one thermoplastic polymer selected from the group consisting of polyesters, co-polyesters, polyamides, polyolefins, polyacrylates, thermoplastic liquid crystalline polymers, and combinations thereof. In some instances, the first nonwoven web of material 102 and the second nonwoven web of material 112 are a spunbond or meltblown nonwoven web of material.

As illustrated in FIG. 5, and more particularly in FIG. 1B, the second nonwoven web of material 112 has a substantially planar surface 114 that is configured to substantially overlies the surface of the first nonwoven web of material 102 and enclose the plurality of biasing members 110 within the respective plurality of chambers 106. In some aspects, the surface 114 of the second nonwoven web of material 112 is welded to the surface 104 of the first nonwoven web of material 102. More particularly, for example, the surface 114 of the second nonwoven web of material 112 is welded to the surface 104 of the first nonwoven web of material 102 around each of the openings and/or the plurality of reinforcing elements 108 of the plurality of the chambers 106 in the first nonwoven web of material 102.

Referring now to FIGS. 6A-6B, a second embodiment of a nonwoven assembly is illustrated. The second embodiment of the nonwoven assembly is a symmetric nonwoven assembly 200. The materials,

sizes, dimensions, and all other components of the second embodiment of the nonwoven assembly 200 may be the same or substantially similar to the first embodiment of the nonwoven assembly 100 described above.

The nonwoven assembly 200 comprises a first nonwoven web of material 202 having a surface 204 defining a plurality of chambers 206 in spaced apart relation therein, each of the plurality of chambers having an opening. In some aspects, the nonwoven assembly 200 may comprise a plurality of reinforcing elements 208, each of the plurality of reinforcing elements 208 substantially surrounding the opening of one of the plurality of chambers 206. The nonwoven assembly 200 may also comprise a plurality of biasing members 210, each of the biasing members 210 being introduced within a respective one of the plurality of chambers 206. The nonwoven assembly 200 may also further comprise a second nonwoven web of material 212 engaged with the surface 204 of the first nonwoven web of material 202 to substantially overlie the surface of the first nonwoven web of material 202 and enclose the plurality of biasing members 210 within the respective plurality of chambers 206.

However, unlike the first embodiment of the nonwoven assembly 100 described herein, the second embodiment of the nonwoven assembly 200 is symmetric about a plane substantially parallel to a planar surface of first nonwoven web of material 202. As such, and as illustrated in FIGS. 6A and 6B, the second nonwoven web of material 212 is configured like the first nonwoven web of material 202 as having a surface 214 defining a plurality of chambers 216 in spaced apart relation therein.

For example, and as illustrated in FIG. 6A, the plurality of chambers 216 is spaced apart substantially the same as or similar to the plurality of chambers 106 described above in reference to the first embodiment 100, as well as to the plurality of chambers 206. Likewise, for example, the plurality of chambers 216 is defined by a molding apparatus, like the plurality of chambers 106, 206. For example, the molding apparatus may utilize at least heat and/or pressure to define the plurality of chambers 216 within the surface 214 of the second nonwoven web of material 212. As described herein, the molding apparatus may comprise equipment utilized for standard molding techniques including solid phase pressure forming, vacuum molding, bladder molding, match plate molding, stamping, pressing, calendaring and the like.

As such, in some aspects, one of the molding apparatus and the nonwoven web of material (i.e., one or both of the first nonwoven web of material 202 and the second nonwoven web of material 212) may be heated prior to defining the plurality of chambers therein. More particularly, in one aspect, a male mold of the molding apparatus may be heated to a temperature of about 120 °C to about 150 °C and at least one of the first nonwoven web of material 202 and the second nonwoven web of material 212 may be maintained at a temperature of about 100 °C to about 130 °C. In another alternative aspect, at least one of the first nonwoven web of material 202 and the second nonwoven web of material 212 may be heated to a temperature of about 140 °C to about 200 °C and a male mold of the molding apparatus may be maintained at a temperature of about 150 °C to about 160 °C.

As such, each of the openings of the plurality of chambers 216 defined in the second nonwoven web of material 212 may be aligned with a respective opening of the plurality of chambers 206 defined in the first nonwoven web of material 202 when the surface 214 of the second nonwoven web of material 212 is engaged with the surface of the first nonwoven web of material 202 to substantially overlie the surface 204

of the first nonwoven web of material 202 and enclose the plurality of biasing members 210 within the respective plurality of chambers 206.

The first or second embodiment of the nonwoven assembly 100, 200 may thus be utilized in any sort of practical application. For example, and as illustrated in FIGS. 7A, 7B, a mattress 300A or an upholstered furniture unit 300B may comprise a molded nonwoven assembly such as that described above.

Accordingly, a nonwoven assembly 100, 200 may be manufactured as described above as having either an asymmetric or symmetric profile. In some exemplary aspects, such an assembly may be manufactured through an automated manufacturing process in as little as five minutes per cycle. Other exemplary aspects may be manufactured in either more or less time, depending on the applications and methods utilized. One exemplary method for manufacturing a nonwoven assembly, generally designated 400, is illustrated in FIG. 8.

In a first step, 402, a plurality of chambers is defined in spaced apart relation in a surface of a first nonwoven web of material, each of the plurality of chambers having an opening.

In a second step, 404, a plurality of biasing members is introduced within a respective one of the plurality of chambers.

In a third step, 406, a second nonwoven web of material is engaged with the surface of the first nonwoven web of material to substantially overlies the surface of the first nonwoven web of material and enclose the plurality of biasing members within the respective plurality of chambers.

In an additional step, a plurality of reinforcing elements is welded to the surface of the first nonwoven web of material, each of the plurality of reinforcing elements substantially surrounding the opening of one of the plurality of chambers. In some aspects, engaging the second nonwoven web of material comprises engaging a substantially planar surface of the second nonwoven web of material with the surface of the first nonwoven web of material to substantially overlies the surface of the first nonwoven web of material and enclose the plurality of biasing members within the respective plurality of chambers. In other aspects, wherein engaging the second nonwoven web of material comprises engaging a surface of the second nonwoven web of material defining a plurality of chambers in spaced apart relation therein, each of the plurality of chambers having an opening, with the first nonwoven web of material to substantially overlies the surface of the first nonwoven web of material and enclose the plurality of biasing members within the respective plurality of chambers, such that each of the openings of the plurality of chambers defined in the second nonwoven web of material is aligned with a respective opening of the plurality of chambers defined in the first nonwoven web of material when the surface of the second nonwoven web of material is engaged.

In an additional step, at least one of the plurality of chambers is defined in the first nonwoven web of material and the second nonwoven web of material by a molding apparatus.

In an additional step, one of the molding apparatus and the nonwoven web of material is heated prior to defining the plurality of chambers. In some aspects, a male mold of the molding apparatus is heated to a temperature of about 120 °C to about 150 °C and at least one of the first nonwoven web of material and the second nonwoven web of material is maintained at a temperature of about 100 °C to about 130 °C. In other aspects, at least one of the first nonwoven web of material and the second nonwoven web of material is

heated to a temperature of about 140 °C to about 200 °C and a male mold of the molding apparatus is heated at a temperature of about 150 °C to about 160 °C.

In an additional step, a surface of the second nonwoven web of material is welded to the surface of the first nonwoven web of material around each of the openings of the plurality of the chambers in the first nonwoven web of material.

It will be understood that various details of the invention may be changed without departing from the scope of the invention. Furthermore, the foregoing description is for the purpose of illustration only, and not for the purpose of limitation, the invention being defined by the claims. Many modifications and other embodiments of the invention will come to mind to one skilled in the art to which this invention pertains having the benefit of the teachings presented in the foregoing description. Therefore, it is to be understood that the invention is not to be limited to the specific embodiments disclosed and that modifications and other embodiments are intended to be included within the scope of the appended claims. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.

CLAIMS:

1. A molded nonwoven assembly comprising:
a first nonwoven web of material having a surface defining a plurality of chambers in spaced apart relation therein, each of the plurality of chambers having an opening;
a plurality of biasing members, each of the biasing members being introduced within a respective one of the plurality of chambers; and
a second nonwoven web of material engaged with the surface of the first nonwoven web of material to substantially overlie the surface of the first nonwoven web of material and enclose the plurality of biasing members within the respective plurality of chambers.
2. The assembly of Claim 1, comprising a plurality of reinforcing elements, each of the plurality of reinforcing elements substantially surrounding the opening of one of the plurality of chambers.
3. The assembly of Claim 2, wherein the plurality of reinforcing elements are welded to the surface of the first nonwoven web of material.
4. The assembly of Claim 1, wherein the second nonwoven web of material has a substantially planar surface engaged with the surface of the first nonwoven web of material to substantially overlie the surface of the first nonwoven web of material and enclose the plurality of biasing members within the respective plurality of chambers.
5. The assembly of Claim 1, wherein the second nonwoven web of material has a surface defining a plurality of chambers in spaced apart relation therein, each of the plurality of chambers having an opening such that the each of the openings of the plurality of chambers defined in the second nonwoven web of material is aligned with a respective opening of the plurality of chambers defined in the first nonwoven web of material when the surface of the second nonwoven web of material is engaged with the first nonwoven web of material to substantially overlie the surface of the first nonwoven web of material and enclose the plurality of biasing members within the respective plurality of chambers.
6. The assembly of Claim 1, wherein the first nonwoven web of material and the second nonwoven web of material are a spunbond or meltblown nonwoven web of material.
7. The assembly of Claim 1, wherein the first nonwoven web of material and the second nonwoven web of material comprises at least one thermoplastic polymer selected from the group consisting of polyesters, co-polyesters, polyamides, polyolefins, polyacrylates, thermoplastic liquid crystalline polymers, and combinations thereof.

8. The assembly of Claim 1, wherein a surface of the second nonwoven web of material is welded to the surface of the first nonwoven web of material.
9. The assembly of Claim 8, wherein the surface of the second nonwoven web of material is welded to the first nonwoven web of material around each of the openings of the plurality of chambers in the first nonwoven web of material.
10. The assembly of Claim 1, wherein the plurality of biasing members comprises springs.
11. A mattress or upholstered furniture unit comprising the molded nonwoven assembly of Claim 1.
12. A method for manufacturing a nonwoven assembly comprising:
defining a plurality of chambers in spaced apart relation in a surface of a first nonwoven web of material, each of the plurality of chambers having an opening;
introducing a plurality of biasing members within a respective one of the plurality of chambers; and
engaging a second nonwoven web of material with the surface of the first nonwoven web of material to substantially overlie the surface of the first nonwoven web of material and enclose the plurality of biasing members within the respective plurality of chambers.
13. The method of Claim 12, comprising welding a plurality of reinforcing elements to the surface of the first nonwoven web of material, each of the plurality of reinforcing elements substantially surrounding the opening of one of the plurality of chambers.
14. The method of Claim 12, wherein engaging the second nonwoven web of material comprises engaging a substantially planar surface of the second nonwoven web of material with the surface of the first nonwoven web of material to substantially overlie the surface of the first nonwoven web of material and enclose the plurality of biasing members within the respective plurality of chambers.
15. The method of Claim 12, wherein engaging the second nonwoven web of material comprises engaging a surface of the second nonwoven web of material defining a plurality of chambers in spaced apart relation therein, each of the plurality of chambers having an opening, with the first nonwoven web of material to substantially overlie the surface of the first nonwoven web of material and enclose the plurality of biasing members within the respective plurality of chambers, such that each of the openings of the plurality of chambers defined in the second nonwoven web of material is aligned with a respective opening of the plurality of chambers defined in the first nonwoven web of material when the surface of the second nonwoven web of material is engaged.

16. The method of Claim 15, comprising defining at least one of the plurality of chambers in the first nonwoven web of material and the second nonwoven web of material by a molding apparatus.

17. The method of Claim 16, comprising heating one of the molding apparatus and the nonwoven web of material prior to defining the plurality of chambers.

18. The method of Claim 17, comprising heating a male mold of the molding apparatus to a temperature of about 120 °C to about 150 °C and maintaining at least one of the first nonwoven web of material and the second nonwoven web of material at a temperature of about 100 °C to about 130 °C.

19. The method of Claim 17, comprising heating at least one of the first nonwoven web of material and the second nonwoven web of material to a temperature of about 140 °C to about 200 °C and maintaining a male mold of the molding apparatus at a temperature of about 150 °C to about 160 °C.

20. The method of Claim 12, comprising welding a surface of the second nonwoven web of material to the surface of the first nonwoven web of material around each of the openings of the plurality of the chambers in the first nonwoven web of material.

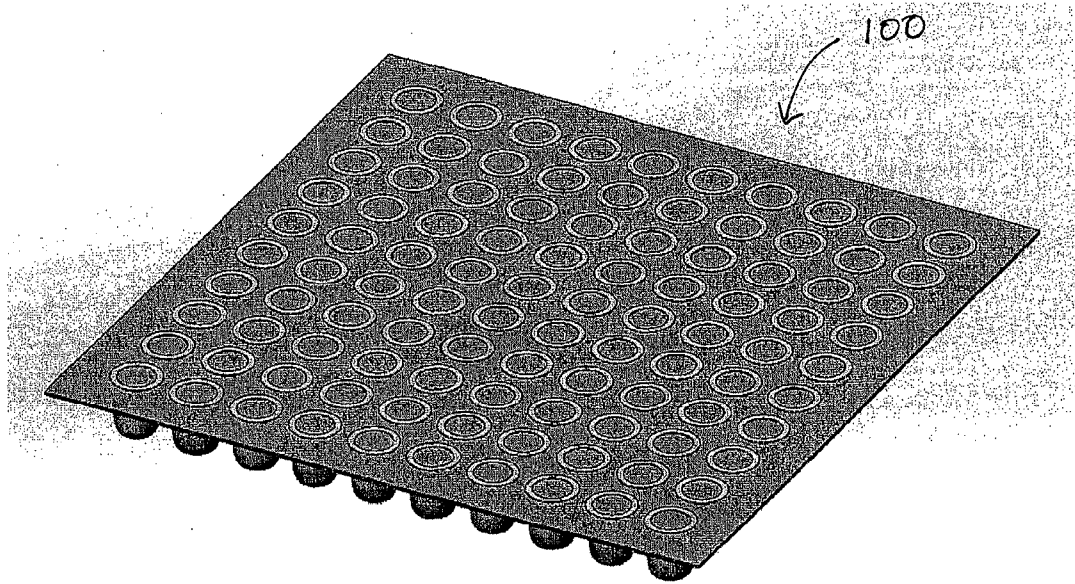


FIG. 1A

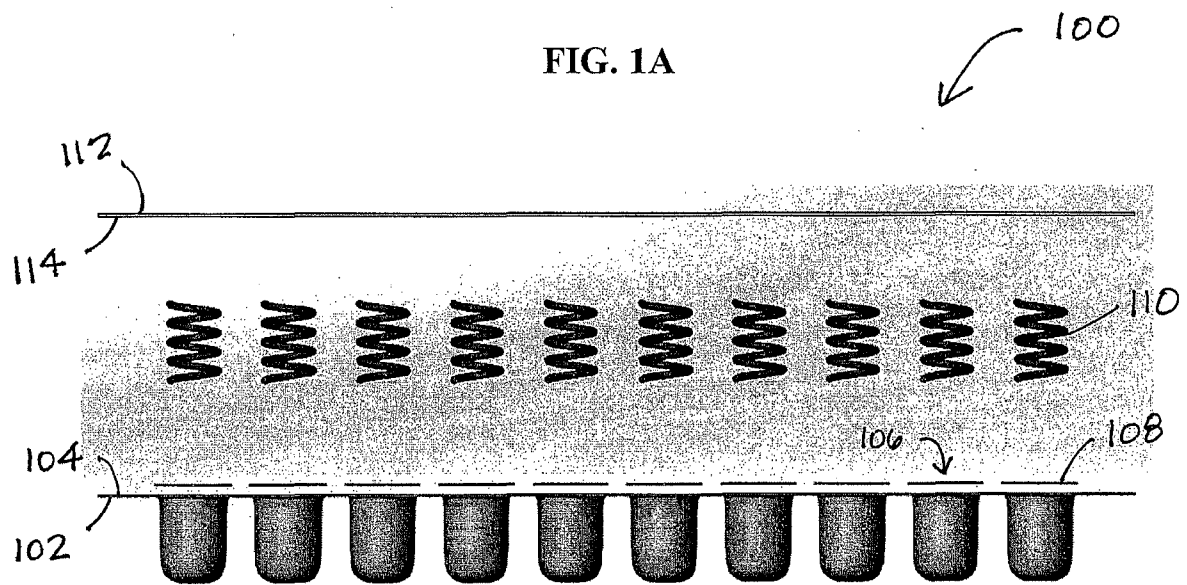


FIG. 1B

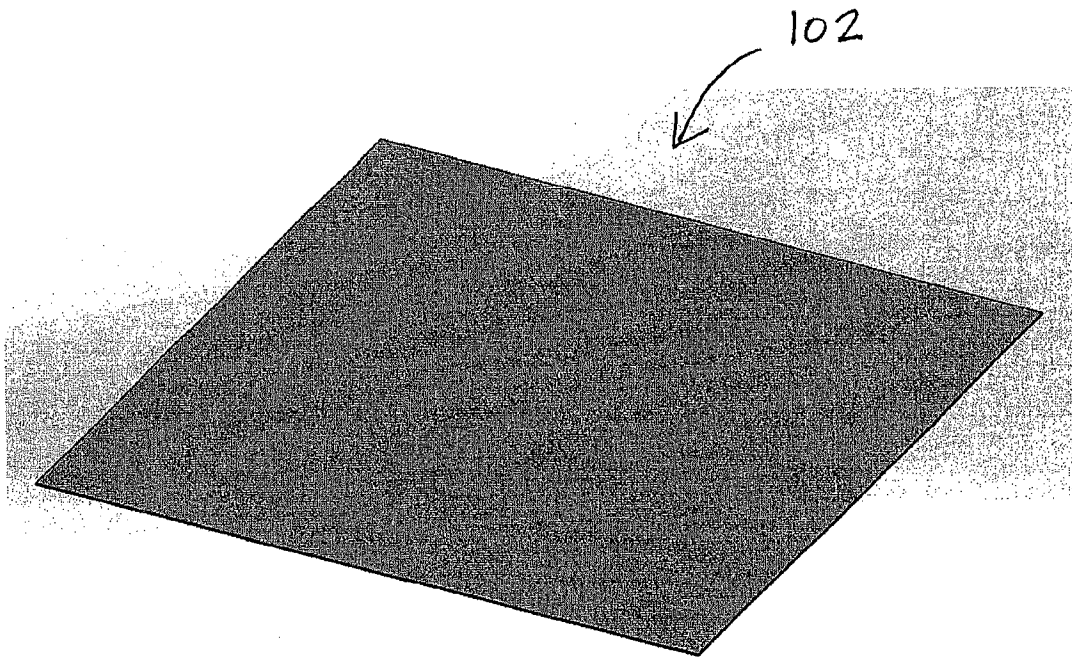


FIG. 2

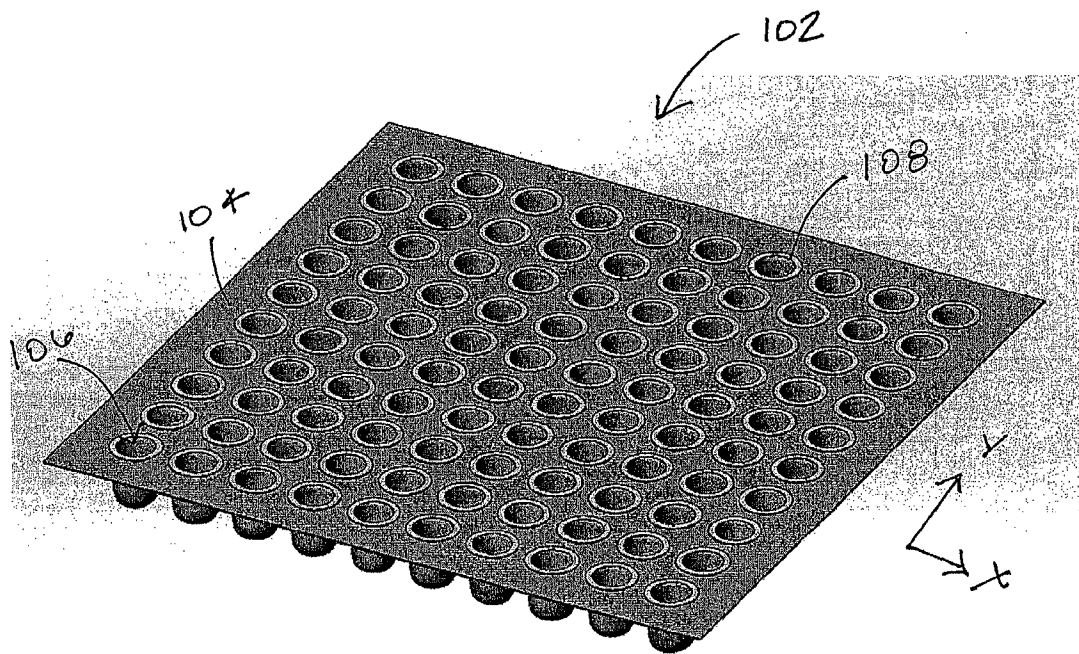


FIG. 3

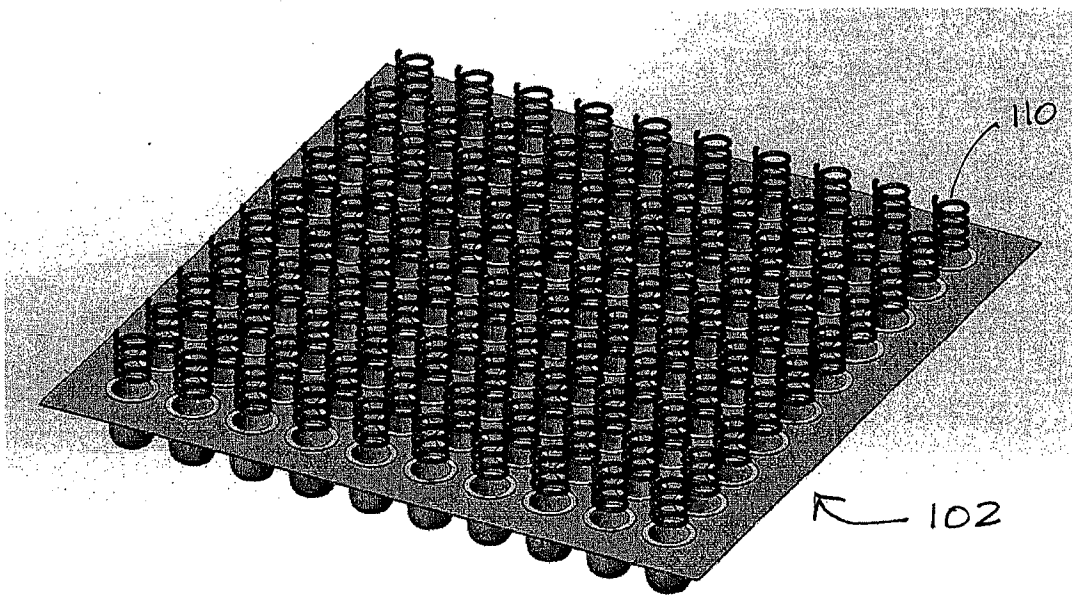


FIG. 4

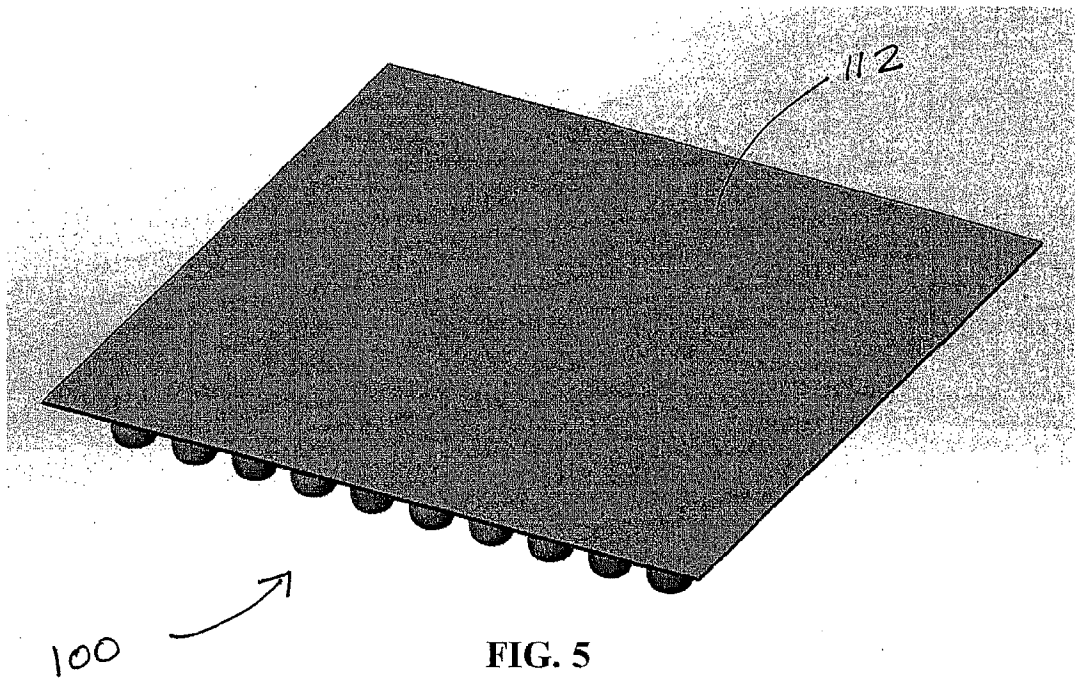


FIG. 5

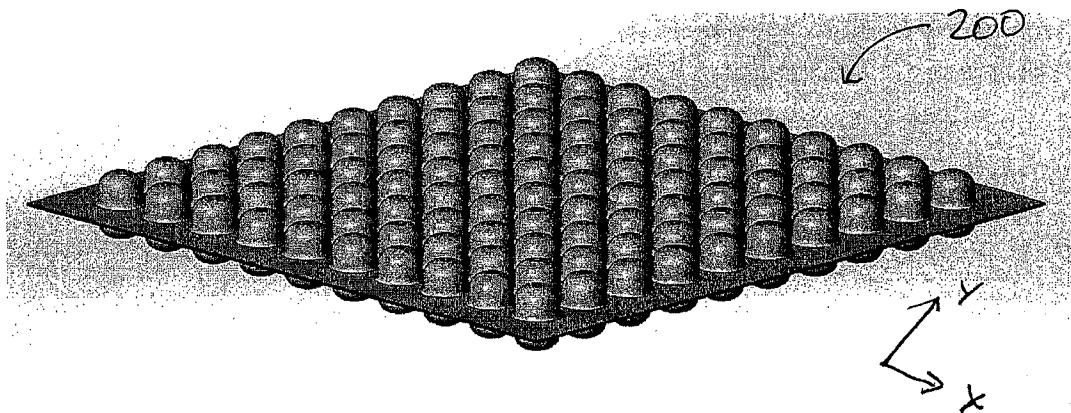


FIG. 6A

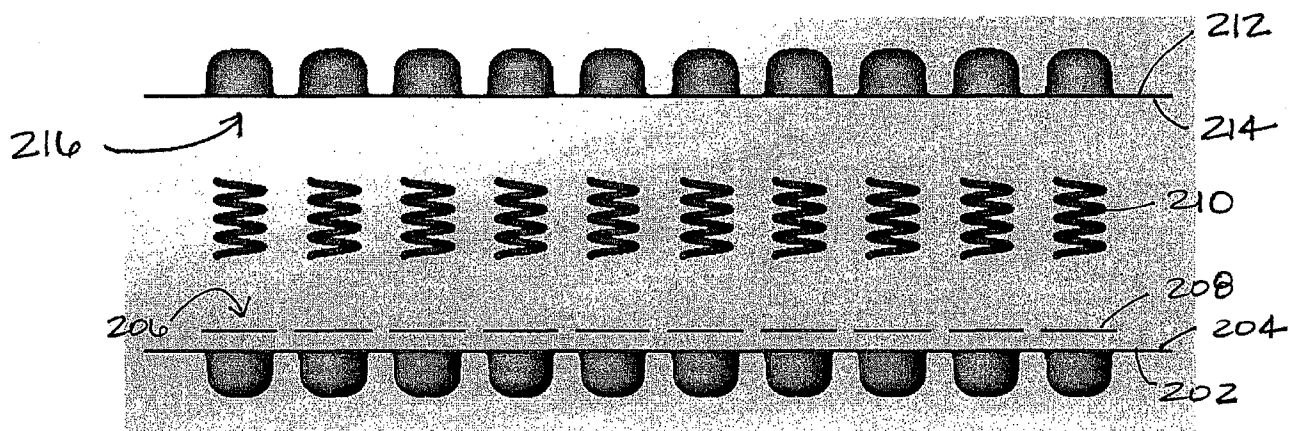


FIG. 6B

200

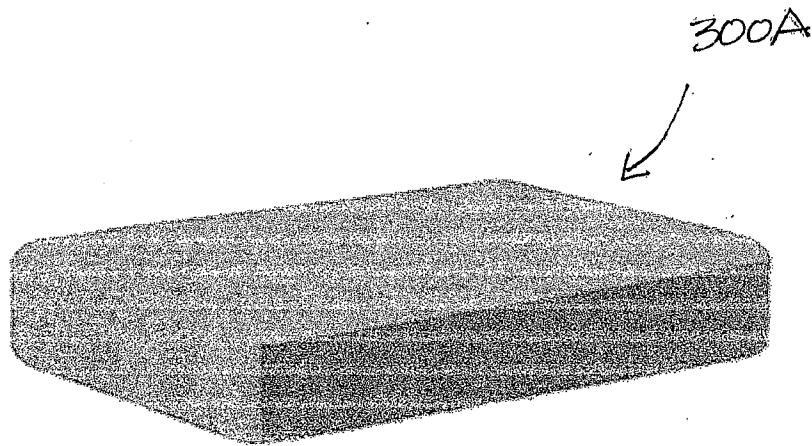


FIG. 7A

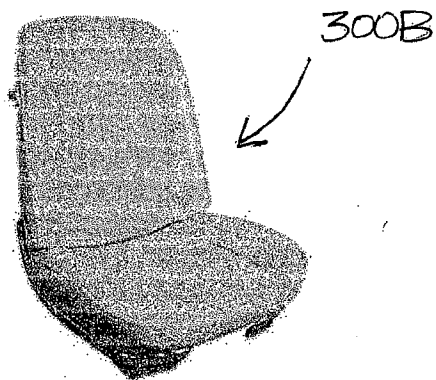


FIG. 7B

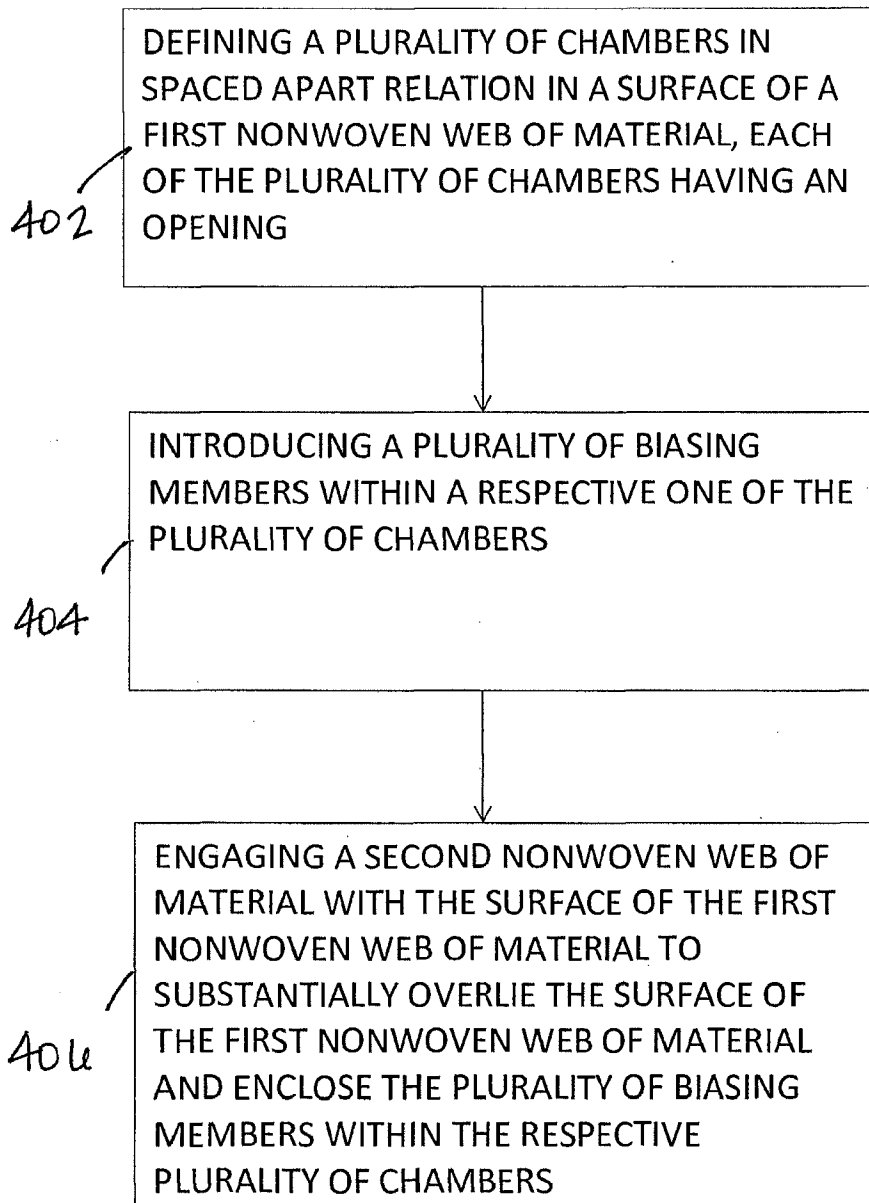


FIG. 8

400

INTERNATIONAL SEARCH REPORT

International application No.

PCT/IB 2018/052994

A. CLASSIFICATION OF SUBJECT MATTER		
D04H 13/00 (2006.01) B68G 7/054 (2006.01) A47C 21/06 (2006.01) B29C 51/12 (2006.01) B32B 33/00 (2006.01)		
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)		
D04H 3/00-3/14, B68G 7/00-7/054, A47C 7/02, 5/12, 21/00-21/06, B29C 43/00-43/30, 51/12, B32B 33/00		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
PatSearch (RUPTO internal), Esp@cenet, PAJ, USPTO, Information Retrieval System of FIPS		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2013/0174350 A1 (MICHAEL ALLMAN et al.) 11.07.2013, fig. 1a	1-20
A	US 2003/0019043 A1 (STEVE BRYANT et al.) 30.01.2003	1-20
A	US 2009/0226683 A1 (BERNARD PERRY et al.) 10.09.2009	1-20
A	US 2016/338493 A1 (ZINUS INC) 24.11.2016	1-20
☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
* Special categories of cited documents:	“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	
“A” document defining the general state of the art which is not considered to be of particular relevance	“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	
“E” earlier document but published on or after the international filing date	“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	
“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)	“&” document member of the same patent family	
“O” document referring to an oral disclosure, use, exhibition or other means		
“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	Date of mailing of the international search report	
17 July 2018 (17.07.2018)	02 August 2018 (02.08.2018)	
Name and mailing address of the ISA/RU: Federal Institute of Industrial Property, Berezhkovskaya nab., 30-1, Moscow, G-59, GSP-3, Russia, 125993 Facsimile No: (8-495) 531-63-18, (8-499) 243-33-37	Authorized officer N. Akinshina Telephone No. (495)531-64-81	

INTERNATIONAL SEARCH REPORT

International application No.

PCT/IB 2018/052994

A. CLASSIFICATION OF SUBJECT MATTER		
D04H 13/00 (2006.01) B68G 7/054 (2006.01) A47C 21/06 (2006.01) B29C 51/12 (2006.01) B32B 33/00 (2006.01)		
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)		
D04H 3/00-3/14, B68G 7/00-7/054, A47C 7/02, 5/12, 21/00-21/06, B29C 43/00-43/30, 51/12, B32B 33/00		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
PatSearch (RUPTO internal), Esp@cenet, PAJ, USPTO, Information Retrieval System of FIPS		
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“E” earlier document but published on or after the international filing date	“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	
“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)	“&” document member of the same patent family	
“O” document referring to an oral disclosure, use, exhibition or other means		
“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	Date of mailing of the international search report	
17 July 2018 (17.07.2018)	02 August 2018 (02.08.2018)	
Name and mailing address of the ISA/RU: Federal Institute of Industrial Property, Berezhkovskaya nab., 30-1, Moscow, G-59, GSP-3, Russia, 125993 Facsimile No: (8-495) 531-63-18, (8-499) 243-33-37	Authorized officer N. Akinshina Telephone No. (495)531-64-81	