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(71) Applicant: FIBRE CONVERTERS, INC. [US/US]; Post Office Box 117, 125 East Broadway, Three Rivers, MI 49093 (US).

(72) Inventor: ROBINSON, Leonard, W. ; 1681 Hawthorne Drive, Trenton, MI 48183 (US).

(74) Agents: FLYNN, Martin L., et al.; Flynn, Thiel, Boutell & Tanis, 2026 Rambling Road, Kalamazoo, MI 49008 (US).

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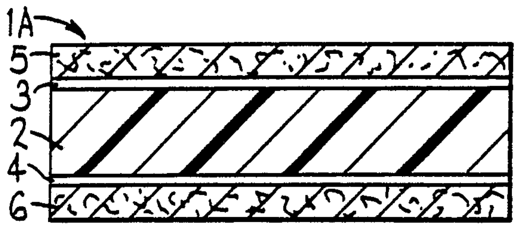

(57) Abstract

A thermoformable composite article includes a core layer (2, 2A, 2B) made of a synthetic resin foam, a pair of adhesive layers (3, 4) in contact with the opposite, upper and lower surfaces of the core layer, and a pair of fabric layers (5, 6) superposed on the opposite upper and lower surfaces of the core layer, the fabric layers (5, 6) being bonded to the core layer (2, 2A, 2B) by the adhesive layers (3, 4). At least one of the fabric layers (5, 6) is made of a non-woven fabric which has been impregnated with a thermoplastic or thermosetting resin. The thermoformable composite articles of the present invention are useful as sound-absorbing liners for automotive interiors.

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THERMOFORMABLE COMPOSITE ARTICLES

TECHNICAL FIELD

This invention relates to a thermoformable composite article, particularly a board, comprising a pair of fabric layers superposed on and adhered to opposite sides of a foam core made of a synthetic resin. At least one of the fabric layers is a non-woven fabric impregnated with a synthetic resin. Such thermoformable articles are useful, for example, as liners for automobile interiors.

BACKGROUND ART

Various materials have been used as liners for automotive interiors, but there is an increasing demand for liner materials which can be readily installed and have high sound absorption ability. Materials such as fiberglass and hardboard have been used as headliners, but headliners made of these materials are relatively heavy and difficult to install. Recently, thermoformable headliners made of a plastic foam, such as styrene-maleic anhydride resin foam, have been developed. Such headliners represent an improvement but do not have sufficient sound-absorbing ability.

A variety of composite articles wherein a fabric layer is superposed on a synthetic resin foam layer are known, but such articles are typically used for other purposes. For example, Martel United States Patent No. 3 876 491 discloses a synthetic suede product formed of a thermoplastic foam adhered to a fibrous substrate, wherein the foam is treated to have the surface characteristics of natural suede. Smith United States Patent No. 3 546 832 discloses a precast decorative panel wherein a core comprising a cured mixture of a thermoset resin and aggregates is formed in contact with an open mesh, such as a mat of glass fibers. Weissenfels United States Patent No. 3 915 772 discloses sheets or slabs of phenolic resin foam having a covering material adhered to at least one side thereof, which covering material is a fiber-containing material which is impregnated into at least one side of the foam. Such slabs having a covering material thereon are used for outside insulation. The covering material of Weissenfels may further be impregnated with a liquid comprising a phenol-aldehyde condensate, a polyamide, a butadiene polymer, or a polyvinyl-acetal. Similarly, Moss United States Patent No. 3 968 300 discloses a building panel comprising a facing sheet made of materials such as kraft paper, aluminum, asphalt and impregnated felts, which facing sheet is superposed on a cellular material made of a phenolic resin. Westfall

United States Patent No. 4 056 646 discloses a pliable, fiber-reinforced, flocked latex sheet comprising a fibrous sheet or scrim base material, a foamed latex and a flocking, suitable for use as a clothlike material. The foregoing patents indicate that the properties of a composite article including one or more fabric layers superposed on a foam core vary widely depending on the particular materials selected for the foam core. Such composite articles can be thick and of high rigidity and hence useful as building materials, or can be thin, flexible, and soft, and thus useful as cloth substitutes.

A large number of fabrics useful as coverings for core materials are known. LePoutre United States Patent No. 4 053 670 discloses non-woven fabrics made by impregnating a web of non-woven fibers with a chemical binder capable of thermal polymerization, the binder serving to increase the mechanical strength of the fabric. In a different context, Birmingham United States Patent No. 2 343 740 discloses a fibrous sheet impregnated with a binder which is superposed on the surface of a wood panel in order to mask imperfections in the wood. The foregoing patents demonstrate typical known uses for resin impregnated fabrics, particularly non-woven fabrics.

DISCLOSURE OF INVENTION

An object of the present invention is to provide a thermoformable composite article which can be thermoformed by heating the composite article, thereby rendering the composite article flexible, then conforming the composite article to a desired shape, and then cooling the composite article, whereby the article then retains the shape imparted by the thermoforming process.

It is a further object of the present invention to provide a thermoformable composite article which is high in sound absorbing ability.

These and other objects of the invention are met by providing a thermoformable composite article which comprises, as essential elements, a core layer made of a thermoformable synthetic resin foam, a pair of fabric layers disposed on the opposite, upper and lower sides of the core layer, at least one of these fabric layers being made of a non-woven fabric impregnated with a thermoplastic or thermosetting resin, and a pair of adhesive layers in contact with the opposite, upper and lower surfaces of the core layer, which adhesive layers effectively bond the fabric layers to the core layer. The synthetic resin foam used to form the core layer of the composite article according to the invention can be rigid or flexible, but it must be thermoformable at an elevated temperature. Specifically, the synthetic resin used to form the foam core layer must be thermoformable at an elevated temperature above the softening point of the resin, but below the melting point thereof. The thermoplastic or thermosetting resin impregnated in the non-woven fabric similarly renders the impregnated non-woven fabric layer thermoformable.

Such an article is useful as an automotive vehicle interior liner, since the composite article can be thermoformed as needed to fit the contour of an automotive vehicle interior, and once in place can render the vehicle interior quieter by absorption of engine noise, particularly noise at the dominant frequency produced by operation of the vehicle. The inventive article has several advantageous characteristics, including high sound absorption, low weight and ease of installation, which in combination make it more satisfactory for use as an automotive vehicle interior liner than materials previously used for this purpose.

In addition, the use of the non-woven fabric layer or layers makes it easier to thermoform the article, increases the bursting and tensile strength of the article, reduces warpage and provides good dimensional stability, modulus of rupture, modulus of elasticity and stiffness modulus.

BRIEF DESCRIPTION OF DRAWINGS

In the accompanying drawings:

Figure 1 is a cross-sectional view of a first embodiment of a composite article of the present invention.

Figure 2 is a cross-sectional view of the components used to form the composite article shown in Figure 1.

Figure 3 is a cross-sectional view of a composite article according to a second embodiment of the present invention.

Figure 4 is a cross-sectional view of the composite article shown in Figure 3, after voids have been formed therein.

Figure 5 is a top view of the composite article shown in Figure 4.

Figure 6 is a cross-sectional view of a composite article according to a third embodiment of the present invention.

Figure 7 is a cross-sectional view of the composite article shown in Figure 6, after the formation of voids therein.

Figure 8 is a cross-sectional view of the composite article shown in Figure 1, after the composite article has been embossed.

The foregoing drawings are not to scale. However, Figures 1 and 2 are substantially proportional and show the changes in the thickness of the layers that occur when the composite article is assembled.

MODES FOR CARRYING OUT THE INVENTION

Figure 1 illustrates the simplest embodiment of the present invention. The composite article 1A shown in Figure 1 comprises a synthetic resin foam core layer 2, the upper and lower surfaces of which are in contact with and adhered to a pair of adhesive layers 3 and 4, respectively. The adhesive layers 3 and 4 aid in adhering fabric layers 5 and 6, respectively, to the opposite faces of the foam core 2. At least one of the fabric layers 5 and 6 is made from a non-woven fabric impregnated with a thermoplastic or thermosetting resin. In the embodiment shown in Figure 1, both layers 5 and 6 are made of such a non-woven fabric impregnated with a thermoplastic or thermosetting resin.

Selection of appropriate materials for the layers of the composite articles according to the present invention is essential to achieving a satisfactory thermoformable composite article. The foam core 2 can be made of any well-known synthetic resin capable of forming a thermoformable foam. Preferred synthetic resins useful for this purpose include polystyrene and copolymers thereof, but other foam-forming synthetic resins, such as polyvinyl chloride, polyethylene, polyurethane, polyisocyanurate, polyphenol, epoxy and silicon resins, cellulose acetate, and various polyolefins can also be used, depending upon the desired application. Styrene-maleic anhydride copolymers are particularly preferred for use as the foam-forming synthetic resin because these copolymers have higher softening and melting points than polystyrenes. Conventional additives, such as foam controlling agents, pigments, wetting agents, bases to lower the pH, thickeners, resins such as melamine-formaldehyde resin, and fire retardants, can be incorporated into the foam-forming synthetic resin.

The foam core 2 is typically formed by a two-stage process. The first stage is a conventional extrusion process for molding polystyrene copolymers in order to form a sheetor board-like extruded product. A blowing agent is incorporated into the initially formed extruded product so that the extruded product is expandable. An air field can be used to form an integral skin on the extruded product. Formation of the foam core 2 is completed in the second stage by effecting expansion of the extruded product.

Figure 2 illustrates the same components as shown in Figure 1, before these components are bonded together to form the composite article. According to the preferred method of the present invention, one or both of the fabric layers 5 and 6 are previously impregnated with a thermoplastic or thermosetting resin, and are then coated on one face thereof with a heat-activated adhesive whereby to form the adhesive layers 3 and 4 which are integral with the fabric layers 5 and 6, respectively. The foam core 2 is then interposed between the adhesive-coated faces of the fabric layers 5 and 6, as shown in Figure 2, and the resulting assembly is pressed together under heat and pressure to bond the layers together by means of the adhesive and form the unitary composite article. During this laminating process, the foam core 2 preferably undergoes expansion so that its thickness increases up to 100 percent of its original dimension. Thus, comparing Figure 2 with Figure 1, it will be observed that the thickness of the core layer 2 of the unitary composite article (Figure 1) is greater than the thickness of core layer 2 prior to forming the composite article. This expansion causes the cell size of the foam core 2 to increase and its density correspondingly to decrease. The bonding step is conducted at an elevated temperature sufficient to effect bonding of the adhesive layers 3 and 4 to the foam core 2 and to cause foaming of the foam core 2.

If a thermosetting resin is used as the resin for impregnating the fabric layers 5 and 6, the temperature employed in the bonding step is not so high as to completely thermoset this resin; rather the resin is a B-stage resin. Thus, by heating the thus-formed composite article to a still higher temperature at a later time, thermoforming can be carried out wherein the resin impregnating the fabric layers 5 and 6 undergoes cross-linking and is thereby completely thermoset (C-stage resin).

In a modification of the foregoing process, the adhesive layers 3 and 4 can be formed on the opposite upper and lower faces of the foam core 2 prior to the bonding step, rather than on the fabric layers 5 and 6.

When a styrene-maleic anhydride copolymer is used as the synthetic resin foam core 2, such as a Dylark resin produced by Arco Chemical Company, particularly Dylark 232 resin, the step of bonding the fabric layers 5 and 6 to the core 2 is carried out at a temperature in the range of 118.3-129.4°C (245-265°F), at a pressure of 2.46-2.81 kilograms per square centimeter (35-40 pounds per square inch). The assembly of the fabric layers and foam core is then bump-pressed for about 8 to 12 seconds in order to remove moisture therefrom. The resulting composite article is then allowed to cool.

The foam core 2 is preferably a relatively rigid structural foam, as determined by the fact that it would rupture if it were substantially bent, particularly if it were bent around a 2.5 cm mandrel at a rate of 1 lap per 5 seconds at 15-25°C (59-77°F). The foam core 2 has a density in the range of 56-120 kilograms per cubic meter (3.5-7.5 pounds per cubic foot), after expansion. The foam core 2 generally has a thickness in the range of 0.127 to 1.27 centimeters (0.05 to 0.5 inches), preferably 0.254 to 0.762 centimeters (0.1 to 0.3 inches), after expansion. When the foam core 2 is made from styrene-maleic anhydride copolymer, the most desirable density is 80.1 to 88.1 kilograms per cubic meter (5-5.5 pounds per cubic foot) after expansion. The cell size of the foam core 2 is regulated during the expansion step. An average of 5-10 cells per 0.203 centimeters (0.08 inch) across the width of the foam core 2, particularly 8 cells per 0.203 centimeter (0.08 inch), is preferred. However, a broad range of from 5-25 cells per 0.203 centimeter (0.08 inch) can be employed. Generally, decreasing the average cell size increases the flexibility of the foam, such that at 20-25 cells per 0.203 centimeter (0.08 inch), the foam core of the present invention becomes flexible.

The flexibility or rigidity of the foam core 2 largely determines the structural properties of the resulting composite article. Although the composite article of the present invention can be relatively flexible, embodiments of the invention wherein the foam core is substantially rigid are particularly useful. If the composite article is to be used as an automotive liner, the foam core 2 should not sag at temperatures of less than 107.2°C (225°F). In other words, the Vicat softening point of the resin used to make the foam core 2 should be higher that

107.2°C (225°F). Polystyrene foams generally do not have a sufficiently high softening point to pass such a sag test, but styrene-maleic anhydride copolymers are capable of passing this test.

The composite article of the present invention is usually formed as a flat sheet or board.

The fabric layers 5 and 6 can be made from any known natural or snythetic fibers or fiber blends. Usable synthetic fibers include polyester, nylon and acrylic fibers. A non-woven polyester fabric made of 1.5-25 denier fibers is preferred. A fiber fineness range of 1.5-10 denier improves the acoustic properties of the polyester fabric. The fabric layers 5 and 6 generally have a weight per unit area in the range of 0.305 to 3.66 kilograms per square meter (1-12 ounces per square foot), and a thickness in the range of 0.254 to 2.03 centimeters (0.1-0.8 inches). The thickness of the fabric layers 5 and 6 is reduced by the press bonding process used to form the composite article. A comparison of Figures 1 and 2 shows that the thicknesses of the fabric layers 5 and 6 are reduced by the press bonding process. The preferred initial thickness range for the fabric layers 5 and 6 is 0.635 to 1.27 centimeters (0.25-0.5 inches).

The fabric layers 5 and 6 are previously impregnated with the thermosetting or thermoplastic resin before being brought into contact with and bonded to the foam core 2 as described above. Thermoplastic and thermosetting resins useful for this purpose include acrylics, styrenes, vinyl acetate, vinyl acetate-acrylics, phenolics and melamines. The impregnated fabrics can be prepared by dissolving the resin in a solvent and then treating the fabrics with the resin-solvent system by spraying, coating or the like. After the fabrics are thoroughly impregnated, the solvent is removed by drying. A preferred resin-solvent system is an ethylene-vinyl acetate copolymer dissolved in water. The weight ratio of resin solids to weight of fabric per unit area is desirably in the range of from 1:2 to 3:2, especially 1:1. It is generally useful to limit the total weight of the resin-impregnated fabric to a maximum of 0.542 kilograms per square meter (16 ounces per square yard), particularly 0.17 to 0.27 kilograms per square meter (5-8 ounces per square yard). A fire retardant, such as aluminum trihydrate, can be added to the resin solution so as to be incorporated into the fabric layers.

A thermosetting resin is most useful as the resin to be impregnated into the fabric layers 5 and 6. Such a thermosetting resin remains in the B-stage during the impregnation process, and is not actually cured until the composite article is subsequently finally thermoformed. If a non-woven fabric layer is used on only one side of the foam core 2, the other fabric layer can be made of any type of fabric, woven or non-woven, and need not be impregnated with the thermoplastic or thermosetting resin. Extensible paper can be used as the other fabric layer in such a case.

The adhesive layers 4 and 5 are made of a heat-activated glue effective to bond the resin-impregnated fabric layers 5 and 6 to the foam core 2. Any conventional heat-activated adhesive which is compatible with the other components can be employed. Preferred adhesives for the layers 4 and 5 include acrylic and styrene-butadiene-type adhesives. The adhesive layers are applied according to conventional techniques to either the foam core 2 or the fabric layers 5 and 6 so that the foregoing components will be effectively bonded together when pressed together under heating.

The finished composite article according to the present invention can be thermoformed by a procedure such as the following. The composite article is cut and shaped to a desired form, then preheated by stagewise preheating through temperatures of 66°C (150°F), 121°C (250°F) and finally 149°C (300°F) maximum. The foam core 2 is softened and rendered flexible by such heating. The sheet is placed in a cold (49-71°C, 120-160°F) die, and then thermoformed.

Figures 3, 4 and 5 show a second embodiment of the present invention wherein the foam core 2 of the composite article 1B is subdivided into a pair of separate foam cores 2A and 2B superposed directly on one another. Adhesive layer 10 is formed between the cores 2A and 2B. The adhesive layer 10 is essentially the same as the layers 3 and 4, but unlike these layers, the layer 10 has a series of gaps therein, i.e., it is discontinuous. During thermoforming a vacuum forming method can be used to form voids 7 within the composite material 1B, which voids 7 correspond to areas where no adhesive layer 10 is present. In the case of an automobile roof liner, the voids 7 are large, roughly oval spaces formed at positions corresponding to compartments separated by roof stringers. The resulting liner has improved sound absorbing ability. A matrix region 8 surrounds the void regions 7. In the region 8, the layers 2A and 2B are not substantially separated during thermoforming.

Figures 6 and 7 show a composite article 1C according to a third embodiment of the present invention. In this embodiment, the separate foam core layers 2A and 2B have an additional fabric layer 9 and heat-activated adhesive layers 10A and 10B interposed therebetween. In this embodiment, at least one of the fabric layers 5, 6 and 9 must be the non-woven fabric layer impregnated with the thermoplastic or thermosetting resin. Layer 10A is essentially the same as the layer 10 of the preceding embodiment, and allows the voids 7 to form between the foam core 2A and the fabric layer 9. The adhesive layer 10B is a continuous layer essentially the same as the layers 3 and 4. The additional fabric layer 9 further increases the sound absorption capacity of the composite article.

Figure 8 illustrates a fourth embodiment of the present invention wherein the composite article as shown in Figure 1 is embossed to form a composite article 1D having a plurality of depressions 11 in one face thereof. The size of the depressions can be varied in order to absorb the dominant sound frequency produced by the vehicle. Sound absorption is thus improved over the non-embossed embodiment shown in Figure 1.

Example

A pair of non-woven fabric layers made of Hoechst 90 polyester having a fiber fineness of 6 denier, a weight per unit area of 1.83 kilograms per square meter (6 ounces per square foot) and a thickness of approximately 0.32 centimeter (0.125 inch) were saturated with an ethylenevinyl acetate copolymer emulsion (Union Chemical, Amsco-Res 1170, 45% solids in water). The layers were then dried, whereby a pair of thermosetting resin-impregnated polyester non-woven layers were prepared. The dried layers were then each coated on one side with a layer of polyvinyl chloride adhesive (HC 6990, a product of Hughes Chemical Co., 55% total solids, 1.1 kilograms per liter (9.2 pounds per gallon)).

A foam core was formed from a rigid foam of styrene-maleic anhydride copolymer (Dylark 232, a product of Arco Chemical Co.) by a conventional extrusion process. The foam core had a thickness of about 0.239 centimeters (0.094 inches), and was in the form of a flat slab.

To form the coated fabric layers and foam core into an integral unit, the foam core was interposed between the adhesive-coated faces of the layers, and the resulting assembly was subjected to a laminating procedure. The liner-core assembly was heated to 129.4°C (265°F) and bump-pressed by a pair of platens under a pressure of 19,529 kilograms per square meter (50 tons per 25 square feet) for 10 seconds, whereby moisture was removed and the layers were effectively bonded to the foam core. During laminating the foam core underwent foaming and increased in thickness by approximately 100% to about 0.48 centimeters (0.19 inches). The fabric layers were decreased in thickness and made more dense by the bonding process, such that the thickness of the bonded article, after cooling, was about 0.71 centimeters (0.28 inches). After laminating, the composite article was allowed to cool. In the finished composite article, the foam core had a density of 80.1 kilograms per cubic meter (5 pounds per cubic foot) and consisted of closed cells, there being about 8 cells per 0.203 centimeter (0.08 inch) across the width of the foam core.

The finished article was essentially a rigid board suitable for infrared thermoforming upon heating to about 149°C (300°F).

Although particular preferred embodiments of the invention have been disclosed in detail for illustrative purposes, it will be recognized that variations or modifications of the disclosed invention, including the use of additional layers of fabric, adhesive or synthetic resin foam, lie within the scope of the present invention.

CLAIMS

1. A thermoformable composite article, comprising:

a core layer (2, 2A, 2B) consisting essentially of a thermoformable synthetic resin foam, said foam consisting essentially of closed cells and having an average of from 5 to 25 cells per 0.203 centimeter (0.08 inch) across the width of said core layer;

a pair of first and second adhesive layers (3, 4) adhered to the opposite, upper and lower faces of said core layer (2, 2A, 2B), respectively; and

a pair of fabric layers (5, 6) superposed on the opposite upper and lower faces of said core layer (2, 2A, 2B), which fabric layers (5, 6) are bonded to said surfaces of said core layer by said adhesive layers (3, 4), at least one of said fabric layers (5, 6) consisting essentially of a non-woven fabric impregnated with a thermoplastic or an uncross-linked thermosetting synthetic resin.

2. A composite article as claimed in Claim 1, wherein said synthetic resin foam has a softening point greater than 107.2°C (225°F).

3. A composite article as claimed in Claim 2, wherein said synthetic resin foam has a density in the range of 56 to 120 kilograms per cubic meter (3.5 to 7.5 pounds per cubic foot).

4. A composite article as claimed in Claim 2, wherein said synthetic resin foam consists essentially of a styrene-maleic anhydride copolymer.

5. A composite article as claimed in Claim 1, wherein said one of said fabric layers consists essentially of non-woven polyester fibers having finenesses in the range of 1.5-25 denier.

6. A composite article as claimed in Claim 5, wherein said thermoplastic or thermosetting resin consists essentially of ethylene-polyvinyl acetate resin.

7. A composite article as claimed in Claim 1, wherein said synthetic resin foam core has a thickness in the range of 0.127 to 1.27 centimeters (0.05 to 0.5 inches).

8. A composite article as claimed in Claim 1, wherein said composite article has a plurality of depressions therein spaced apart at regular intervals on one face thereof.

9. A composite article as claimed in Claim 1, wherein said thermoplastic or thermosetting resin consists essentially of an uncrosslinked thermosetting resin which undergoes crosslinking during thermoforming of said composite article.

10. A thermoformable composite article, comprising:

a core layer (2, 2A, 2B) consisting essentially of a thermoformable synthetic resin foam having a softening point higher than 107.2°C (225°F) and a density in the range of 56 to 120 kilograms per cubic meter (3.5 to 7.5 pounds per cubic foot), said foam consisting essentially of closed cells and having an average of from 5 to 25 cells per 0.203 centimeter (0.08 inch) across the width of said core layer;

a pair of first and second adhesive layers (3, 4) adhered to the opposite, upper and lower faces of said core layer (2, 2A, 2B), respectively; and

a pair of fabric layers (5, 6) superposed on the opposite upper and lower faces of said core layer (2, 2A, 2B), which fabric layers (5, 6) are bonded to said surfaces of said core layer by said adhesive layers, at least one of said fabric layers (5, 6) consisting essentially of a non-woven fabric impregnated with a thermoplastic or an uncrosslinked thermosetting synthetic resin.

11. A composite article as claimed in Claim 12, wherein said synthetic resin foam consists essentially of a styrene-maleic anhydride copolymer, said thermoplastic or thermosetting resin consists essentially of ethylene-polyvinylacetate resin, and said one of said fabric layers consists essentially of non-woven polyester fibers having finenesses in the range of 1.5-25 denier.

12. A composite article as claimed in Claim 12, wherein said thermoplastic or thermosetting resin consists essentially of uncrosslinked thermosetting resin which undergoes crosslinking during thermoforming of said composite article.

13. A composite article as claimed in Claim 12, wherein said fabric layers each have a thickness in the range of 0.254 to 2.03 centimeters (0.1 to 0.8 inch) and a weight per unit area of 0.305 to 3.66 kilograms per square meter (1 to 12 ounces per square foot), and said foam has an average of 5-10 cells per 0.203 centimeter (0.08 inch) across the width of said core layer.

14. A composite article as claimed in Claim 12, wherein said foam consists essentially of rigid structural foam.

15. A thermoformable composite article, comprising:

a core layer (2A, 2B) consisting essentially of a thermoformable synthetic resin foam, said foam consisting essentially of closed cells, said core layer comprising a pair of sub-layers (2A, 2B) of said snythetic resin foam, which sub-layers are not substantially bonded to each other in a plurality of spaced-apart regions (7) so that said sub-layers can be separated over said regions during thermoforming to form a plurality of voids in said core layer between said sub-layers;

a pair of first and second adhesive layers (3, 4) adhered to the opposite, upper and lower faces of said core layer (2A, 2B), respectively; and

a pair of fabric layers (5, 6) superposed on the opposite upper and lower faces of said core layer (2A, 2B), which fabric layers are bonded to said surfaces of said core layer by said adhesive layers (3, 4), at least one of said fabric layers (5, 6) consisting essentially of a non-woven fabric impregnated with a thermoplastic or an uncrosslinked thermosetting synthetic resin.

16. A composite article as claimed in Claim 17, wherein said thermoplastic or thermosetting resin consists essentially of uncrosslinked thermosetting resin which undergoes crosslinking during thermoforming of said composite article.

17. A composite article as claimed in Claim 17, wherein said synthetic resin foam has a softening point greater than 225°F and a density in the range of 56 to 120 kilograms per cubic meter (3.5 to 7.5 pounds per cubic foot), said foam consisting essentially of closed cells and having an average of from 5 to 25 cells per 0.203 centimeter (0.08 inch) across the width of said core layer.

18. A composite article as claimed in Claim 17, wherein said synthetic resin foam consists essentially of a styrene-maleic anhy-

dride copolymer, said thermoplastic or thermosetting resin consists essentially of ethylene-polyvinylacetate resin, and said one of said fabric layers (5, 6) consists essentially of non-woven polyester fibers having finenesses in the range of 1.5-25 denier.

19. A composite article as claimed in Claim 15, further comprising a third adhesive layer (10) interposed between said pair of sub-layers (2A, 2B) of said synthetic foam and effective to bond together said pair of sub-layers (2A, 2B) at positions other than said non-bonded regions (7).

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FIG. 1

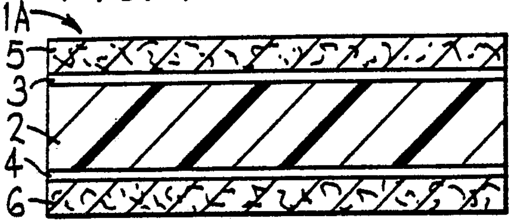


FIG. 2

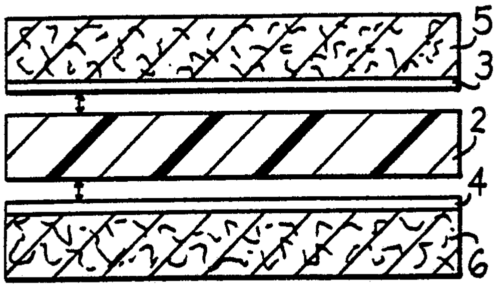
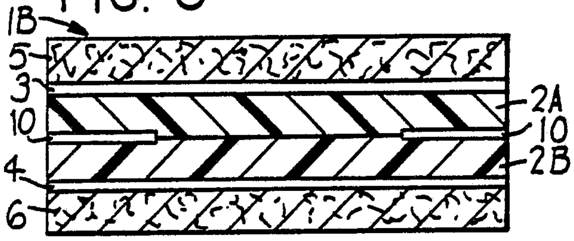


FIG. 3



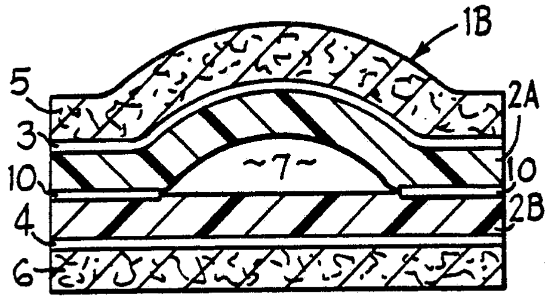


FIG. 4

FIG. 5

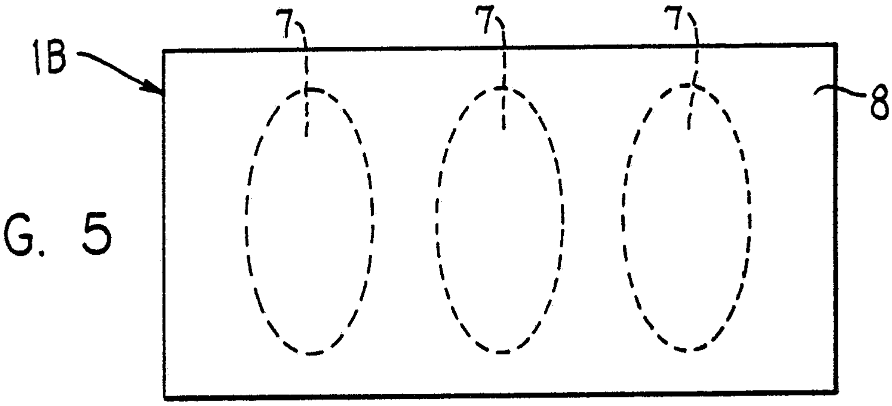
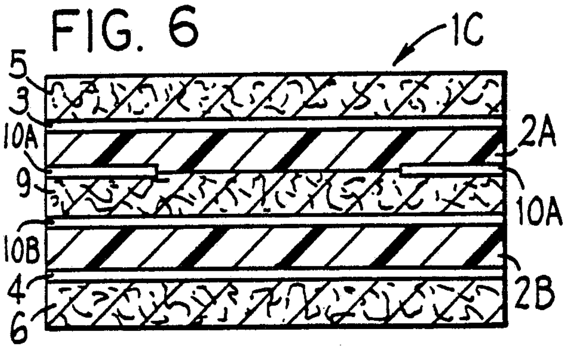


FIG. 6



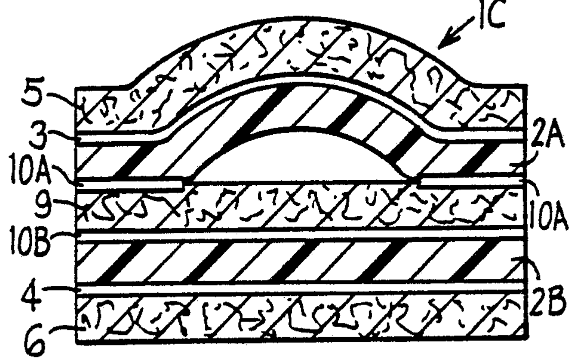


FIG. 7

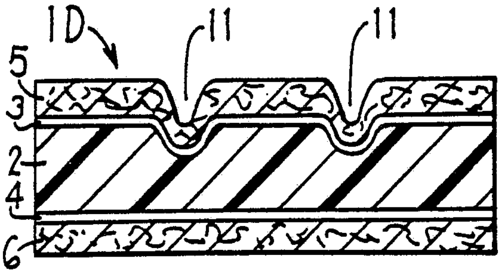


FIG. 8

INTERNATIONAL SEARCH REPORT

International Application No PCT/US85/00640

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC B32B 5/28, 5/32, 7/04
U.S. CL. 428/288, 316.6, 317.1, 319.7

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
U.S.	428/288, 316.6, 317.1, 317.7, 319.7,286

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [6]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
X,P	US, A, 4,476,183 (MONSANTO COMPANY) 09 OCTOBER 1984	1-19
X,P,	US, A, 4,489,126 (MONSANTO COMPANY) 18 DECEMBER 1984	1-19

* Special categories of cited documents: [15]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"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)

"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

"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

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"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.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
14 MAY 1985	24 MAY 1985
International Searching Authority [1]	**Signature of Authorized Officer** [20]
ISA/US	W. J. Van Balen W.J. Van Balen

Form PCT/ISA/210 (second sheet) (October 1981)