



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

| | | |
|--|--|--|
| (51) International Patent Classification ⁶ : B32B 1/04, 3/02, 3/26, 5/24, 5/22, 7/12 | A1 | (11) International Publication Number: WO 96/31341 (43) International Publication Date: 10 October 1996 (10.10.96) |
| (21) International Application Number: PCT/US96/04458 (22) International Filing Date: 1 April 1996 (01.04.96) (30) Priority Data: 08/416,198 4 April 1995 (04.04.95) US (71) Applicant: DIVERSITECH CORPORATION [US/US]; 1512 Covington Highway, Conyers, GA 30207 (US). (72) Inventor: SWEENEY, Jeff, S.; 2103 McKinley Road, Atlanta, GA 30318 (US). (74) Agents: HARTSELLE, William, A. et al.; Jones & Askew, 37th floor, 191 Peachtree Street, N.E., Atlanta, GA 30303-1769 (US). | (81) Designated States: AL, AM, AT, AU, AZ, BB, BG, BR, BY, CA, CH, CN, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IS, JP, KE, KG, KP, KR, KZ, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, UZ, VN, ARIPO patent (KE, LS, MW, SD, SZ, UG), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG). Published <i>With international search report.</i> | |
| (54) Title: LIGHT-WEIGHT HIGH-STRENGTH COMPOSITE PAD AND METHOD OF MAKING SAME | | |
| (57) Abstract The present invention relates to a low-weight, high-strength composite pad, and a method of making the same. The composite pad has a substantially rigid board and at least one reinforcing coating on one or more sides of the board. The reinforcing coating has a foamable material with a fibrous fabric bonded thereto. At least one layer of a slurry mixture then covers the reinforcing coating. Also generally described, the method of making the present invention involves forming in a mold a reinforced core of the substantially rigid board, the foamable material, and the fibrous fabric, removing the reinforced core from the mold, and then applying the layer of slurry mixture thereto. | | |

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

| | | | | | |
|----|--------------------------|----|--|----|--------------------------|
| AM | Armenia | GB | United Kingdom | MW | Malawi |
| AT | Austria | GE | Georgia | MX | Mexico |
| AU | Australia | GN | Guinea | NE | Niger |
| BB | Barbados | GR | Greece | NL | Netherlands |
| BE | Belgium | HU | Hungary | NO | Norway |
| BF | Burkina Faso | IE | Ireland | NZ | New Zealand |
| BG | Bulgaria | IT | Italy | PL | Poland |
| BJ | Benin | JP | Japan | PT | Portugal |
| BR | Brazil | KE | Kenya | RO | Romania |
| BY | Belarus | KG | Kyrgystan | RU | Russian Federation |
| CA | Canada | KP | Democratic People's Republic of Korea | SD | Sudan |
| CF | Central African Republic | KR | Republic of Korea | SE | Sweden |
| CG | Congo | KZ | Kazakhstan | SG | Singapore |
| CH | Switzerland | LI | Liechtenstein | SI | Slovenia |
| CI | Côte d'Ivoire | LK | Sri Lanka | SK | Slovakia |
| CM | Cameroon | LR | Liberia | SN | Senegal |
| CN | China | LT | Lithuania | SZ | Swaziland |
| CS | Czechoslovakia | LU | Luxembourg | TD | Chad |
| CZ | Czech Republic | LV | Latvia | TG | Togo |
| DE | Germany | MC | Monaco | TJ | Tajikistan |
| DK | Denmark | MD | Republic of Moldova | TT | Trinidad and Tobago |
| EE | Estonia | MG | Madagascar | UA | Ukraine |
| ES | Spain | ML | Mali | UG | Uganda |
| FI | Finland | MN | Mongolia | US | United States of America |
| FR | France | MR | Mauritania | UZ | Uzbekistan |
| GA | Gabon | | | VN | Viet Nam |

5

1

10 **"LIGHT-WEIGHT HIGH-STRENGTH COMPOSITE
PAD AND METHOD OF MAKING SAME"**

15 **Technical Field**

 The present invention relates generally to composite
materials and a method of making the same and more particularly
to a light-weight high-strength composite structure for use as an
20 equipment pad, a building panel, and other applications.

Background of the Invention

 Numerous types of composite materials have been
25 employed in the past to replace concrete in structures such as
equipment pads, building panels, and other applications requiring
a high amount of strength and durability. These composite
materials are preferred because they are light-weight and can
support the same or even greater loads as compared to concrete.
30 Further, while concrete equipment pads and other structures must
be poured at the construction site, structures made from
composite materials can be easily transported and erected with
little site preparation.

An example of such an equipment pad made from a composite material is found in commonly owned U.S. Patent No. 4,505,449, entitled "Lightweight Concrete Cladded Heavy Equipment Base." The preferred embodiment of this invention
5 comprises a polystyrene foam core covered on five sides with a fiberglass and cement composition. The resultant pad is from 1/8th to 1/16th the weight of an ordinary concrete base, but with sufficient load strength to act as a heavy equipment pad. U.S. Patent No. 4,505,449 is incorporated hereto by reference.

10

Other commonly owned inventions have employed various types of composite materials. For example, one method uses a foam board covered on one or more of its sides with a high strength outer layer comprising a non-woven web impregnated
15 with a cementitious slurry binder. This outer layer is largely crack resistance with greater ductility and toughness than ordinary cement or concrete. The pad is made by placing the foam board in a mold, surrounding the board with the cementitious slurry and impressing the non-woven web into the
20 slurry. Pressure is then applied to the outer layer while the materials are cured. Approximately 24 hours are required for the materials to cure in the mold. A thirty inch by thirty inch by two inch pad made from this method has an approximate concentrated load strength of 300 pounds per square inch and
25 flexural strength of approximately 350 pounds in a mid span loading test.

As the acceptance and use of structures made from composite materials has increased, there has been a constant
30 demand on manufacturers to produce such structures with ever increasing load strength and flexibility and ever decreasing gross weight and costs. In order to accomplish these goals, there is a recognized need to decrease the number of materials used to create the composite materials while maintaining the strength and
35 weight of the structure. There is also a need to accelerate the

time required for the manufacturing process or a means to make the process more efficient.

Summary of the Invention

5
10
15
20
Generally described, the present invention relates to a low-weight, high-strength composite material, and a method of making the same. The composite material has a reinforced core comprising a rigid board and at least one reinforcing coating on one or more sides of the board. The reinforcing coating comprises a foamable material with a fibrous fabric bonded thereto. At least one layer of a slurry mixture then covers the reinforcing coating. Also generally described, the method of making the present invention involves forming the reinforced core in a mold, removing the reinforced core from the mold and then coating the reinforced core with an outer layer of the slurry mixture. The reinforced core is formed in the mold by first placing a reinforcing fabric in the mold, injecting a foamable material into the mold and then pressing a rigid foam board into the foamable material. After a short time, the reinforced core is removed from the mold and then coated with the outer layer of slurry mixture.

25
30
35
In a preferred embodiment, the composite material is used to manufacture a composite pad. The composite pad has an expanded polystyrene board covered on five sides with a layer of a polyurethane foam material. The polyurethane foam may include a filler material such as sand for bulk and strength. The outer surface of the polyurethane foam is reinforced with a needle punched non-woven fabric. This fabric is bonded to and partially impregnated by the upper surface of the polyurethane foam to create the reinforcing coating for the reinforced core. This reinforced core is then covered with an outer layer of cementitious slurry. The cementitious slurry bonds to the reinforcing coating of the reinforced core by partially

impregnating the fibrous fabric on the outer surface of the polyurethane foam.

The preferred method of making the subject invention involves first making the reinforced core by lining a mold with the fibrous fabric, injecting the foamable material, and placing the rigid board into the mold. The foamable material will expand and cure in the mold in approximately four minutes. The reinforced core may then be removed from the mold and the outer layer of the slurry mixture applied via spraying, screeding, rolling, or other methods. The cementitious slurry may then be surface treated to achieve the desired texture or color.

A composite pad made according to the present invention has substantial advantages over those known in the art. The invention results in a structure that can support over 325 pounds per square inch of concentrated load and over 400 pounds in flexural strength. The composite pad, however, weighs only 1/12th of its solid concrete counterpart. Significantly, the method of the subject invention requires far less mold time than standard methods. Rather than adding the cementitious slurry to the reinforced core while in the mold and requiring hours or days for the finished product to cure, the present invention only forms the reinforced core in the mold and then later adds the slurry mixture once the reinforced core has been removed from the mold. The reinforced core can be formed in any type of mold in minutes, thereby significantly increasing the availability and repeat use of the molds. Further, applying the slurry mixture to the reinforced core outside of the mold allows for easier and more consistent control of the surface finishing process.

The subject invention is therefore efficient and flexible. A high degree of efficiency is achieved by separating the forming/molding or shaping process of the reinforced core from the final coating process. The amount of raw materials is reduced

by using the same fibrous fabric as a reinforcing material for the reinforced core and for the outer layer. By forming the reinforcing coating integrally with the foamable material, the invention eliminates a separate step of applying reinforcement to either the reinforced core or the outer layer. Flexibility is achieved through the use of numerous types of rigid boards, foamable materials, fillers, fibrous fabric reinforcement, and outer layers within the same basic process to produce end products with a wide array of uses.

10

Therefore, it is an object of the present invention to provide a high-strength, low-weight composite material and a method of making the same.

15

It is a further object of the present invention to provide a structure made from composite materials with significantly less weight and equal if not greater strength as compared to concrete structures of similar dimensions.

20

It is a further object of the present invention to provide an improved composite material for use as a heavy equipment pad, building panels, or other structures requiring significant load strength and durability.

25

It is a further object of the present invention to provide an improved method of making composite material structures with fewer materials and in less time.

30

It is a further object of the present invention to provide a method of making composite material structures in which the forming/molding or shaping steps are separated from the surface coating steps so as to decrease greatly the amount of mold time required.

It is a further object of the present invention to provide an improved composite material structure comprising a reinforced core, which is constructed from a rigid board and a high strength reinforcing coating comprised of a foamable material and a fabric, and an outer surface layer.

Other objects, features, and advantages of the present invention will become apparent upon reading the following detailed description of the preferred embodiment of the invention, when taken in conjunction with the drawings and appended claims.

Brief Description of the Drawings

Figure 1 is a perspective view of the major components of the composite material of the present invention.

Figure 2 is a cross-sectional view illustrating the specific arrangement of the reinforced core while in the mold.

Figure 3 is a cross-sectional view of the fibrous fabric impregnated by the foamable core material and the cementitious slurry.

Detailed Description of the Invention

Referring to the drawings, in which like numerals represent like parts throughout the several views, Figures 1 through 3 show the preferred embodiment of a composite material structure, an equipment pad 10. The equipment pad 10 comprises a substantially rigid board 15 constructed from expanded polystyrene or any rigid material such as wood, paper, plastic, metal, or sheet rock. The board can be formed in any type of outer shape depending upon the shape of the desired end product, while the interior can be a solid form or a honeycomb or

similar configuration. While the use of the rigid board 15 is preferred because of the stability the board 15 adds to the end product such as the equipment pad 10, there may be applications in which the rigid board 15 may be omitted or substantially
5 reduced in size.

The substantially rigid board 15 is covered with a foamable material 20 of polyurethane, polyisocyanurate, expanded polystyrene, or other substantially rigid foams. The
10 foamable material 20 also may contain a filler 30 such as a mixture of moderately coarse sand to add bulk and strength. Plastic, gravel, or ground waste material also may be used.

In the preferred embodiment, the foamable material
15 20 is placed on five sides of the rigid board 15 such that a bottom surface 25 of the rigid board 15 is left exposed. The exposure of the bottom surface 25 allows for easier installation of the equipment pad 10 at the construction site because the expanded polystyrene or other rigid board 15 will easily conform to the
20 ground configuration. Further, by leaving the bottom surface 25 exposed, the equipment pads 10 can be easily stacked during manufacture and distribution without fear of damaging the surface of the adjacent equipment pad 10.

25 The foamable material 20 is reinforced with a fibrous fabric 35 to add strength and durability. A bottom surface 36 of the fibrous fabric 35 is bonded to and partially impregnates an outer surface 21 of the foamable material 20 to form a reinforcing coating 17 around the rigid core 15. At this
30 point, the rigid board 15 with the reinforcing coating 17 thereon is referred to as a reinforced core 18. The fibrous fabric 35 is preferably a needle-punched polypropylene non-woven such as a three dimensional web of lofty, discrete polypropylene fibers with a fiber volume of approximately 3 to 20 percent. The fibrous
35 fabric 35, however, can be any type of synthetic or natural

fibrous material, including spunbonded fabrics, mesh, glass mats, or even paper.

5 An outer layer 40 of a slurry mixture is then applied to the reinforcing coating 17 of the reinforced core 18. The slurry mixture 40 bonds to and impregnates an upper surface 37 of the fibrous fabric 35 of the reinforcing coating 17. The fibrous fabric 35 therefore acts as a durable interface between the foamable material 20 and the slurry mixture 40. When cured, the
10 outer layer of the slurry mixture 40 provides the pad 10 with a hardened outer surface appropriate for the desired end use. The slurry mixture 40 is preferably a cementitious mixture, but can include mixtures of concrete, plaster, epoxy, synthetic resins, polymers, paint, or water proofing compounds, depending upon
15 the requirements of the end use. Any type of known cementitious slurry can be used, including a mixture of 10 parts Portland cement, 1 part microsilica, 5 parts fine sand, 4 parts water, and 0.1 parts water reducing superplasticizer.

20 The preferred method of making the subject invention comprises first creating the reinforced core 18 in a mold 45 by lining the mold 45 with the fibrous fabric 35, spraying or injecting the foamable material 20 into the mold 45 and onto the fabric 35, and positioning the rigid board 15 (if
25 desired) therein. The molding process with foamable material 20 is one of low pressure, i.e., 2 to 10 pounds per square inch, and can be accomplished in steel, aluminum, or even wooden molds 45. The foamable material 20 consistently self-seeks the shape of the mold 45, thereby pushing the reinforcing coating 17 to the
30 outer surface of the molded shape. The foamable material 20 of polyurethane foam expands and cures in approximately four minutes. The reinforced core 18 can be individually molded in any form for the desired end use, such as in the case of the equipment pad 10.

35

After the reinforced core 18 has cured, the reinforced core 18 can be removed from the mold 45, allowing the mold 45 to be reused almost immediately. The slurry mixture 40 is applied at any convenient time to the outside of the reinforced core 18. By applying the slurry mixture 40 outside of the mold 45, the surface finishing process can be readily observed and controlled to ensure a uniform finish. The slurry mixture 40 is applied onto the upper surface 37 of the fibrous fabric 35 of the reinforced core 18 by hand rubbing, rolling, dripping, screeding, spraying, or other known methods. Further, a masonry paint or a modified slurry mixture 40 can be applied over the slurry soaked reinforced core 18 to achieve the desired texture, color, or aesthetic uniformity. Depending upon the desired thickness, the slurry mixture 40 generally hardens or cures in approximately 24 hours.

The reinforced core 18 also can be manufactured in a continuous molding process. A continuously molded reinforced core 18 can be cast or laminated by unwinding a strip of the fibrous fabric 35 in a continuous mold 45 by known methods, spraying or dispensing the foamable core material 20 on top of the fibrous fabric 35 as discussed above, adding filler 30 such as sand and the rigid board 15 (as desired), curing the reinforced core 18 in the mold 45 for the required time, and cutting the reinforced core 18 into panels or pads 10 with a flying-type cut-off saw (not shown). The reinforced core 18 can be coated with the slurry mixture 40 on a continuous line either before or after the saw is operated. The slurry mixture 40 can be applied to the continuous core 18 by spraying, screeding, rolling, or the other methods described above.

An example of an equipment pad 10 manufactured according to the preferred embodiment of this invention employs the use of a 1 1/2 inch thick rigid board 15 made of expanded polystyrene in the range of 1 to 2 pounds per cubic foot. The

rigid board 15 is then covered on five sides with 1/2 inch of the foamable material 20 of polyurethane foam in the range of 2 to 4 pounds per cubic foot with 0.6 pounds per square foot of filler 30 of sand. The foamable material 20 is impregnated into the
5 fibrous fabric 35 of an 8 ounce per square yard, needle-punched, polypropylene non-woven with 1/4 inch loft or thickness.

By itself, the polyurethane foamable material 20 has a flexural strength of 30 to 100 pounds, i.e., the foamable
10 material 20 fails at mid-span under loads of 30 to 100 pounds when supported only at its two ends. By adding the fibrous fabric 35 to the foamable material 20 surrounding the rigid core 15, a 30 inch by 30 inch by 2 inch reinforced core 18 requires from 200 to 350 pounds to fail under the same loading conditions.
15 Further, the reinforced core 18 can support concentrated loads of at least 125 to 200 pounds per square inch. This load strength is two to four times stronger than the strength of the foamable core material 20 itself.

20 The slurry mixture 40 is then applied to the reinforced core 18. A layer of 1 1/2 pounds per square foot of the slurry mixture 40 results in an equipment pad 10 that can support over 325 pounds per square inch of concentrated load and requires over 400 pounds per square inch of flexural load to fail
25 in the mid-span test described above. The weight of such an equipment pad 10, however, is only 1/12th to 1/16th of a solid concrete counterpart.

In addition to equipment pads 10, other types of
30 structures may be constructed according to the present invention. For example, building panels may be constructed according to the present invention with various finishing layers such as masonry paint added to the slurry mixture 40 or applied on top of the slurry mixture 40. The subject invention also can be employed as
35 a stucco substrate in other construction applications. Preferably,

a reinforced core 18 of approximately 1 inch is reinforced and impregnated with a slurry mixture 40 with a flat trowel to create a nailable panel ready for a stucco finish coat. Depending upon the types of materials used, a high strength, low weight building
5 panel constructed according to the present invention can provide thermal insulation, noise reduction, fire resistance, and water proofing.

Other embodiments of the invention include
10 structures used as panels in clean rooms or chemical rooms wherein the slurry mixture 40 is an epoxy resin or polymer coating for the desired properties. Further, the invention can be modified for use as a floating dock by using large billets of expanded polystyrene as the rigid board 15 to provide buoyancy.

15
While this invention has been described in specific detail with reference to the disclosed embodiments, it will be understood that many variations and modifications may be affected within the spirit and scope of the invention as described
20 in the appended claims.

CLAIMS

We claim:

- 5 1. A low-weight, high-strength composite material, comprising:
 a substantially rigid board;
 at least one reinforcing coating covering one or more sides of said substantially rigid board;
10 said reinforcing coating comprising a foamable material with a fibrous fabric bonded thereto; and
 at least one layer of a slurry mixture covering said reinforcing coating.
- 15 2. The composite material of Claim 1 wherein said substantially rigid board comprises expanded polystyrene.
3. The composite material of Claim 1 wherein said foamable material further comprises filler material such as
20 sand.
4. The composite material of Claim 1 wherein said foamable material comprises polyurethane foam.
- 25 5. The composite material of Claim 1 wherein said fibrous fabric comprises a needle-punched, polypropylene non-woven web.
6. The composite material of Claim 1 wherein
30 said slurry mixture comprises a cementitious slurry.
7. The composite material of Claim 1 wherein said slurry mixture comprises epoxy resins.

8. The composite material of Claim 1 wherein a lower surface of said fibrous fabric is partially impregnated by said foamable material.

5 9. The composite material of Claim 1 wherein an upper surface of said fibrous fabric is partially impregnated by said slurry mixture.

10 10. The composite material of Claim 1 wherein said fibrous fabric acts as an interface between said foamable material and said slurry mixture.

15 11. The composite material of Claim 1 wherein said material is adapted for use as a heavy equipment pad.

12. The composite material of Claim 1 wherein said material is adapted for use as a building panel.

20 13. The composite material of Claim 1 wherein said material weighs from 1/12th to 1/16th of the weight of a solid concrete counterpart.

25 14. The composite material of Claim 1 wherein said material can support loads of over 325 pounds per square inch without failing.

30 15. The composite material of Claim 1 wherein said substantially rigid board is covered on five sides by said reinforcing coating.

16. A method for making a low weight, high strength composite material, comprising the steps of:
forming a reinforced core in a mold;
said reinforced core comprising a substantially
5 rigid board, a foamable material, and a fibrous fabric;
removing said reinforced core from said mold; and
applying a slurry mixture thereto.

17. The method of Claim 16 wherein said step of
10 forming said reinforced core in a mold comprises the steps of:
lining said mold with said fibrous fabric;
injecting said foamable material into said mold
such that said fabric is bonded to and partially impregnated with
said foamable material; and
15 placing said rigid board into said foamable
material.

18. The method of Claim 16 wherein forming said
reinforced core in a mold comprises the steps of:
20 unwinding a strip of said fibrous fabric into a
mold;
injecting said foamable material into said mold
and onto said fibrous fabric;
placing said rigid board into said foamable
25 material; and
cutting a pad from said reinforced core.

19. The method of Claim 16 wherein said step of
applying said slurry mixture comprises spraying said slurry onto
30 said reinforced core.

20. The method of Claim 16 wherein said step of
applying said slurry mixture comprises screeding said slurry onto
said reinforced core.

21. The method of Claim 16 wherein said step of applying said slurry mixture comprises rolling said material onto said reinforced core.

5 22. The method of Claim 16 further comprising the step of texturing said slurry mixture.

23. A composite material structure, comprising:
a foamable material; and
10 a fibrous fabric bonded thereto;
said fibrous fabric comprising a needle-punched, polypropylene non-woven fabric.

24. The composite material structure of Claim 23
15 wherein said foamable material further comprises filler material such as sand.

25. The composite material structure of Claim 23
20 wherein said foamable material comprises polyurethane foam.

26. The composite material structure of Claim 23 further comprising a slurry mixture applied to said fibrous fabric.

27. The composite material structure of Claim 23
25 wherein said slurry mixture comprises a cementitious slurry.

28. A reinforced composite structure, comprising:
a fibrous fabric with an upper and a lower
30 surface;
a foamable material partially impregnating and bonding to said lower surface of said fibrous fabric; and
a slurry mixture partially impregnating and bonding to said upper surface of said fibrous fabric.

29. The reinforced composite structure of Claim 27 further comprising a said substantially rigid board bonded to said foamable material.

5 30. The reinforced composite structure of Claim 28 wherein said foamable material further comprises filler material such as sand.

10 31. The reinforced composite structure of Claim 28 wherein said foamable material comprises polyurethane foam.

15 32. The reinforced composite structure of Claim 28 wherein said fibrous fabric comprises a needle-punched, polypropylene non-woven fabric.

 33. The reinforced composite structure of Claim 28 wherein said slurry mixture comprises a cementitious slurry.

20 34. The reinforced composite structure of Claim 28 wherein said slurry mixture comprises epoxy resins.

1/2

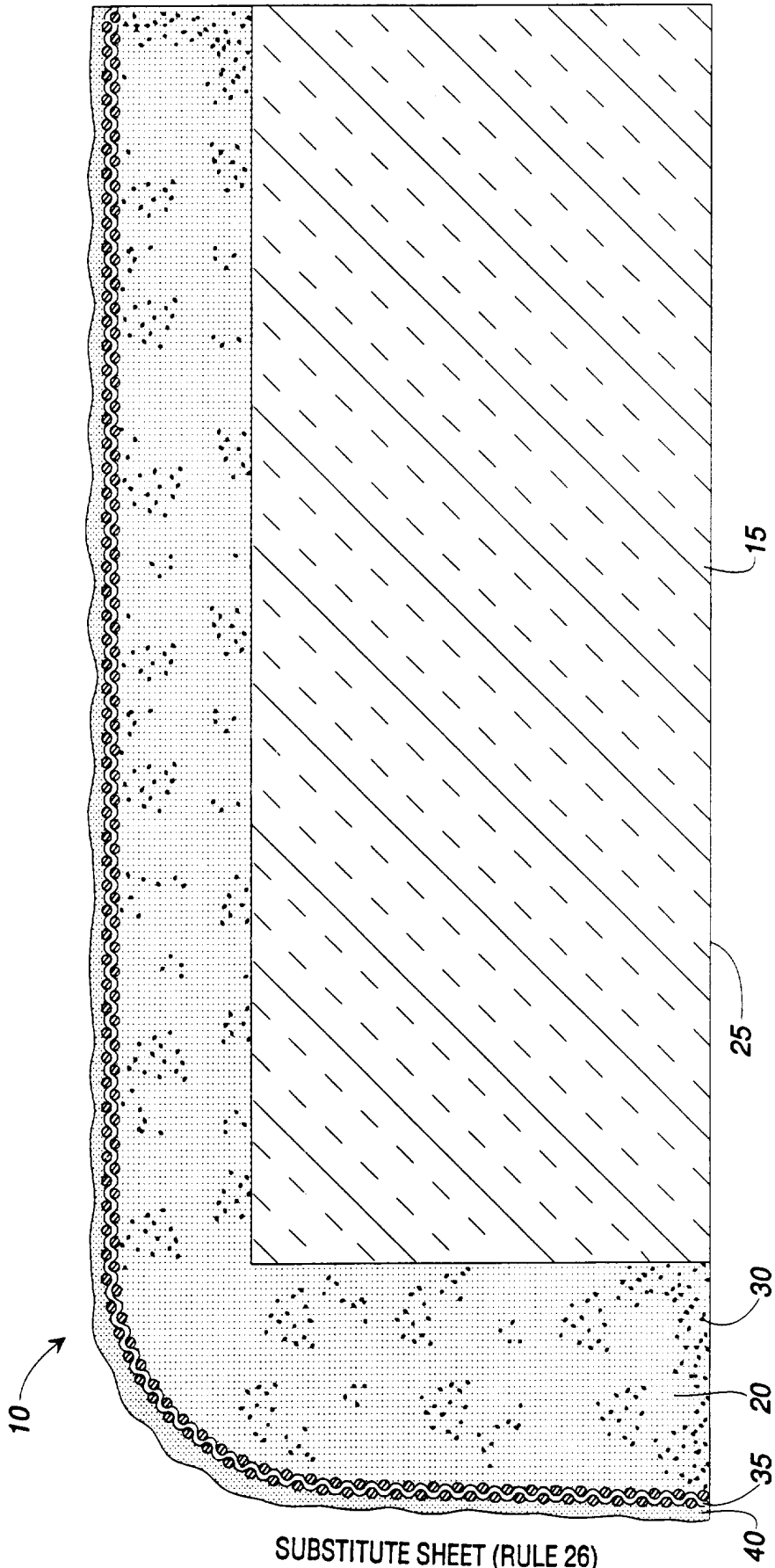


FIG. 1

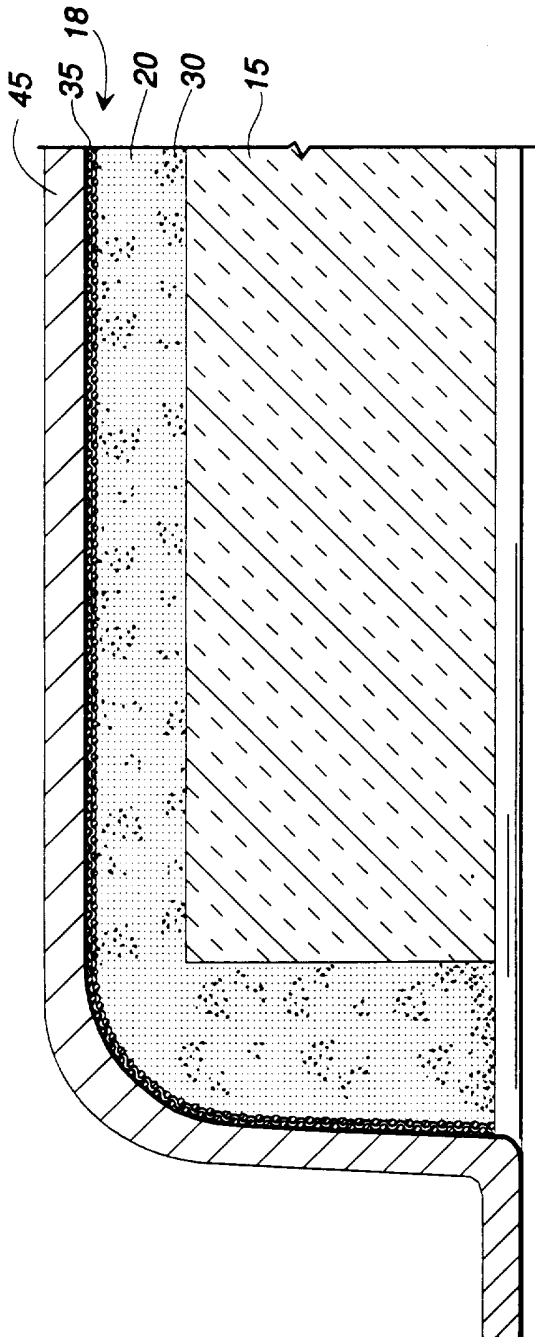


FIG. 2

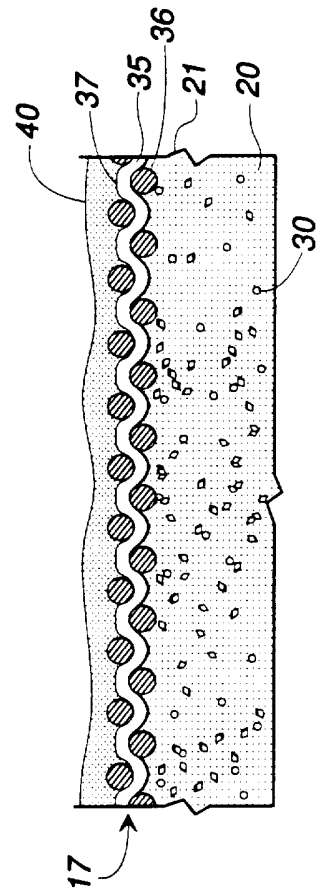


FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US96/04458

| A. CLASSIFICATION OF SUBJECT MATTER IPC(6) :B32B 1/04, 3/02, 3/26, 5/24, 5/22, 7/12 US CL :428/311.1, 311.5, 317.5, 317.7, 317.9, 68, 71, 74, 312.4 According to International Patent Classification (IPC) or to both national classification and IPC | | | | | | | | | | | | | | | | | | | |
|--|--|--|---|--|--|--|--|---|---|--|---|--|---|---|---|---|---|------------|--|
| B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) U.S. : 428/311.1, 311.5, 317.5, 317.7, 317.9, 68, 71, 74, 312.4 Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched NONE Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) NONE | | | | | | | | | | | | | | | | | | | |
| C. DOCUMENTS CONSIDERED TO BE RELEVANT | | | | | | | | | | | | | | | | | | | |
| <table border="1"> <thead> <tr> <th>Category*</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>Y</td> <td>US, A, 5,268,226 (SWEENEY) 07 December 1993, see entire document.</td> <td>1-34</td> </tr> <tr> <td>Y</td> <td>M.G. HALPERN, "RIGID FOAM LAMINATES", published 1972 by Noyes Data Corporation (N.J.), pages 156-157.</td> <td>1-34</td> </tr> <tr> <td>Y</td> <td>US, A, 5,162,060 (BREDOW et al.) 10 November 1992, see entire document.</td> <td>7</td> </tr> <tr> <td>Y</td> <td>US, A, 4,636,425 (JOHNSON et al.) 13 January 1987, see entire document.</td> <td>7</td> </tr> <tr> <td>Y</td> <td>US, A, 4,743,624 (BLOUNT) 10 May 1988, see entire document.</td> <td>1-6 & 8-34</td> </tr> </tbody> </table> | Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. | Y | US, A, 5,268,226 (SWEENEY) 07 December 1993, see entire document. | 1-34 | Y | M.G. HALPERN, "RIGID FOAM LAMINATES", published 1972 by Noyes Data Corporation (N.J.), pages 156-157. | 1-34 | Y | US, A, 5,162,060 (BREDOW et al.) 10 November 1992, see entire document. | 7 | Y | US, A, 4,636,425 (JOHNSON et al.) 13 January 1987, see entire document. | 7 | Y | US, A, 4,743,624 (BLOUNT) 10 May 1988, see entire document. | 1-6 & 8-34 | |
| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. | | | | | | | | | | | | | | | | | |
| Y | US, A, 5,268,226 (SWEENEY) 07 December 1993, see entire document. | 1-34 | | | | | | | | | | | | | | | | | |
| Y | M.G. HALPERN, "RIGID FOAM LAMINATES", published 1972 by Noyes Data Corporation (N.J.), pages 156-157. | 1-34 | | | | | | | | | | | | | | | | | |
| Y | US, A, 5,162,060 (BREDOW et al.) 10 November 1992, see entire document. | 7 | | | | | | | | | | | | | | | | | |
| Y | US, A, 4,636,425 (JOHNSON et al.) 13 January 1987, see entire document. | 7 | | | | | | | | | | | | | | | | | |
| Y | US, A, 4,743,624 (BLOUNT) 10 May 1988, see entire document. | 1-6 & 8-34 | | | | | | | | | | | | | | | | | |
| <input type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex. | | | | | | | | | | | | | | | | | | | |
| <table border="0"> <tr> <td>* Special categories of cited documents:</td> <td>"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</td> </tr> <tr> <td>"A" document defining the general state of the art which is not considered to be of particular relevance</td> <td>"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</td> </tr> <tr> <td>"E" earlier document published on or after the international filing date</td> <td>"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</td> </tr> <tr> <td>"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)</td> <td>"&" document member of the same patent family</td> </tr> <tr> <td>"O" document referring to an oral disclosure, use, exhibition or other means</td> <td></td> </tr> <tr> <td>"P" document published prior to the international filing date but later than the priority date claimed</td> <td></td> </tr> </table> | | * 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 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 | | | | | | | |
| * 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 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 30 MAY 1996 | Date of mailing of the international search report 16 JUL 1996 | | | | | | | | | | | | | | | | | | |
| Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230 | Authorized officer TERREL MORRIS Telephone No. (703) 308-23-1 | | | | | | | | | | | | | | | | | | |