United States Patent [19]

Hale

[11] **3,834,487**

[45] **Sept. 10, 1974**

[54] **SANDWICH CORE PANEL WITH STRUCTURAL DECOUPLING BETWEEN THE OUTER FACE SHEETS THEREOF**

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[52] **U.S. Cl.** ..... **181/33 G,** 52/144, 52/618, 161/68, 161/127, 161/131

[51] **Int. Cl.** **E04b 1/84**

[58] **Field of Search** ..... 52/144, 145, 618; 161/68, 161/69, 125, 127, 130, 131, 139; 181/33 G

[56] **References Cited**

UNITED STATES PATENTS

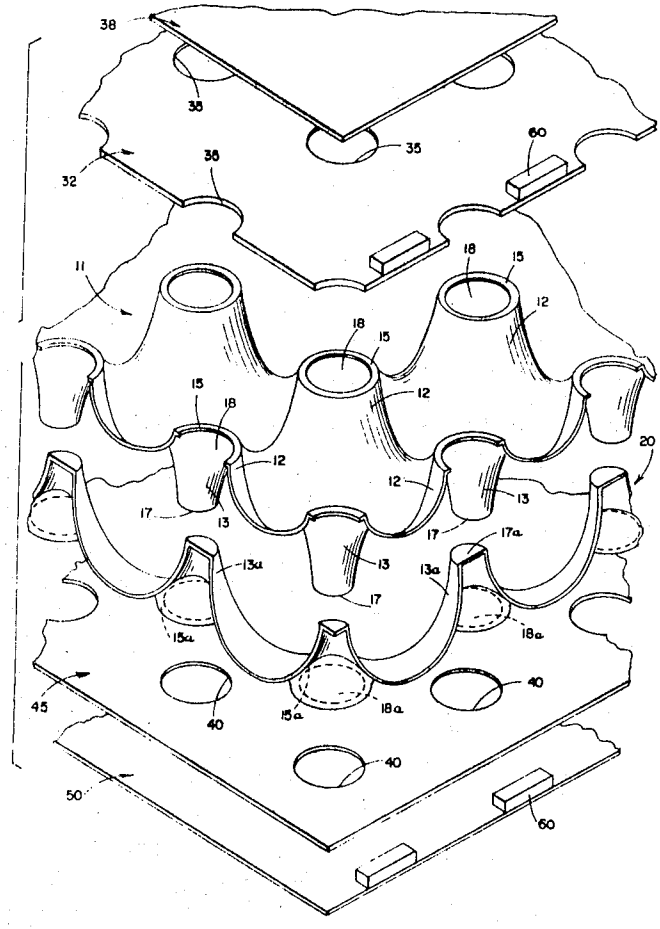
2,481,046	9/1949	Scurlock	181/33 G
3,013,641	12/1961	Compton	161/127
3,108,924	10/1963	Adie	181/33 G UX
3,227,598	1/1966	Robb	161/68
3,479,779	11/1969	Ziegler	52/144
3,525,663	8/1970	Hale	181/33 G UX
3,527,664	9/1970	Hale	161/68
3,663,346	5/1972	Schoen	161/68

Primary Examiner—Richard B. Wilkinson
Assistant Examiner—John F. Gonzales
Attorney, Agent, or Firm—Edward A. Sokolski

[57] **ABSTRACT**

A sandwich core panel is formed from an inner and an outer pair of face sheets which are spaced from each other and having core structures formed from first and second anticlastic membranes respectively sandwiched therebetween. The membranes each have a first set of nodes which project in a first direction and a second set of nodes which project in a direction opposite to the first direction. The nodes of the first set have end faces of a smaller diameter than the end portions of the second set. The end face portions of the second set of nodes of both membranes have apertures formed therein such that the end portions of the first sets of nodes of each of the membranes pass through the node end portions of the other membrane. The end face portions of the first set of nodes for each of the membranes is adhered to the inner surface of a respective one of the outer face sheets, while the end portions of the other set of nodes of each of the membranes is adhered to the inner surface of a respective one of the inner face sheets. This arrangement provides a structurally rigid unit having a high strength to weight ratio with decoupling between the face sheets such that the transfer of energy therebetween is attenuated.

4 Claims, 3 Drawing Figures



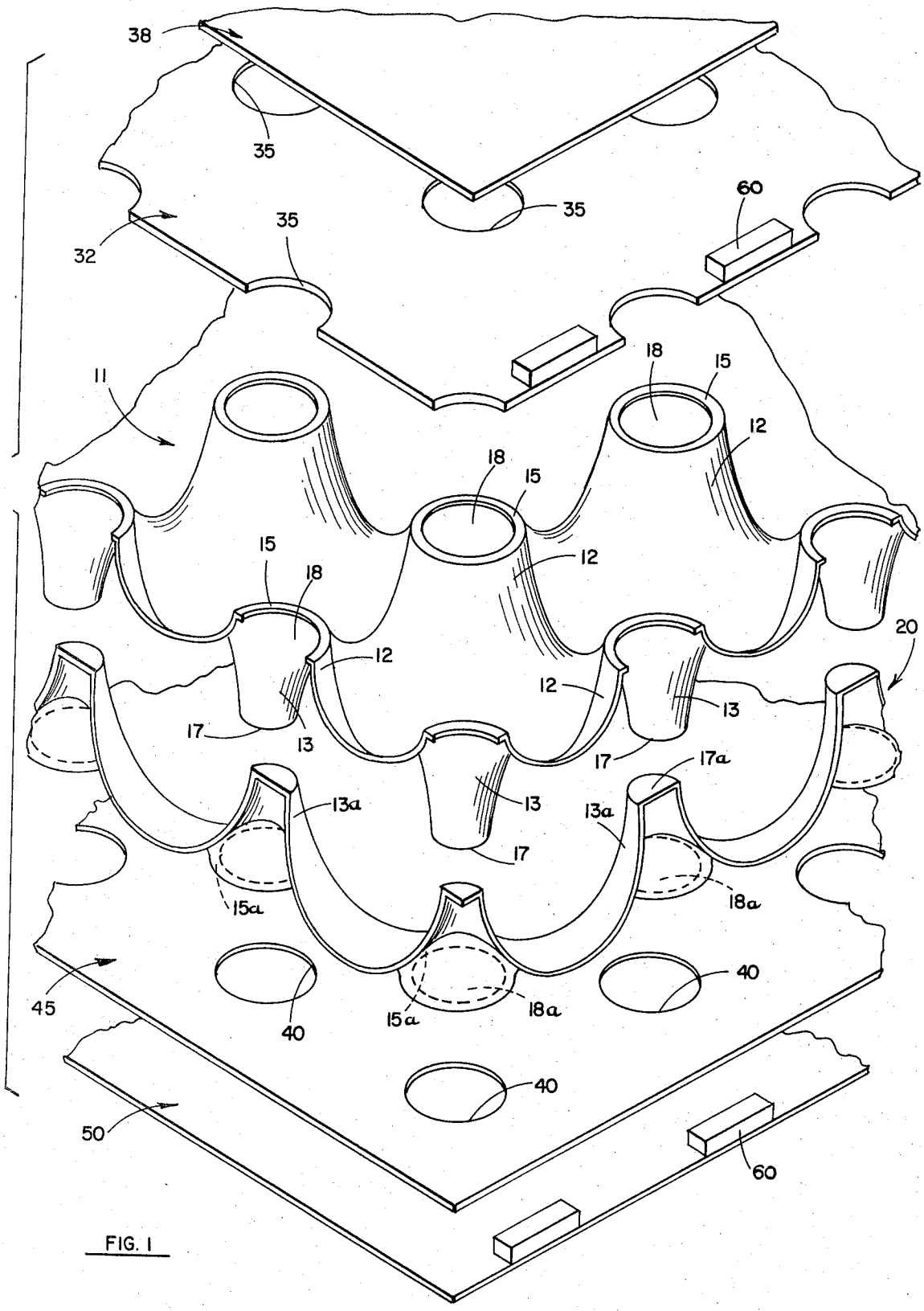

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FIG. 1

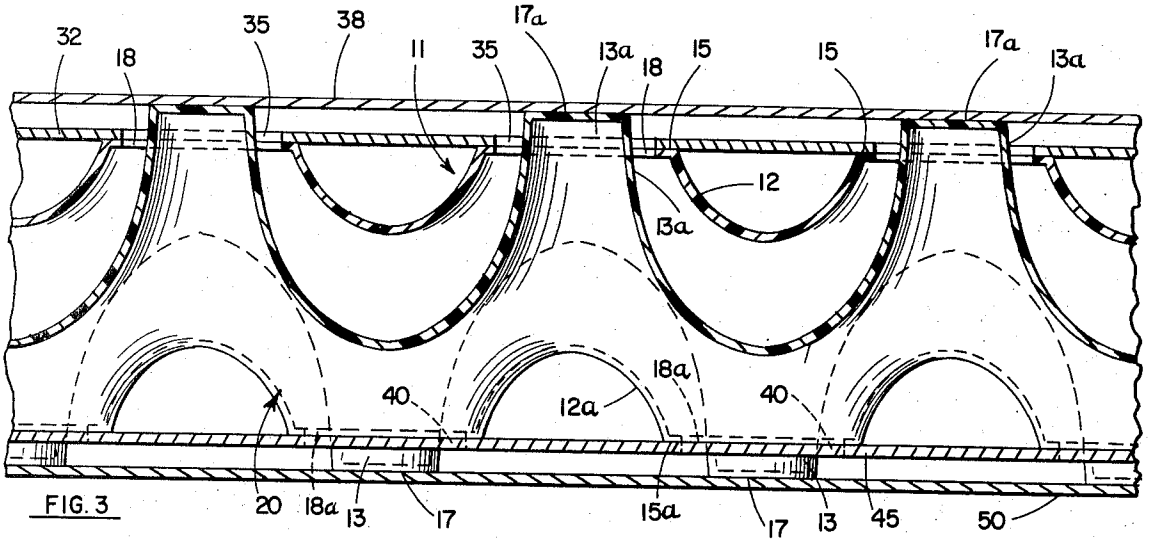

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FIG. 3

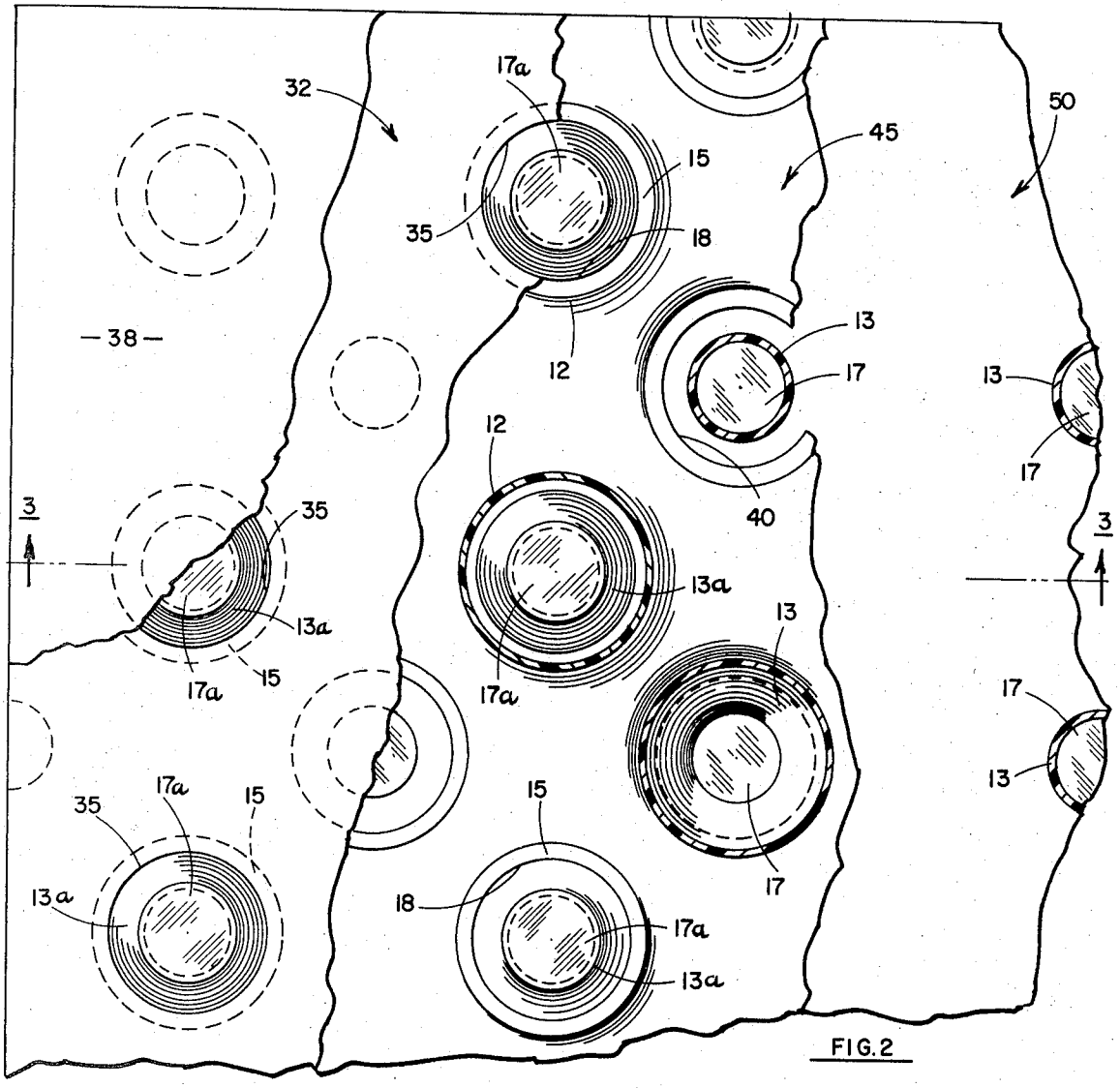

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FIG. 2

SANDWICH CORE PANEL WITH STRUCTURAL DECOUPLING BETWEEN THE OUTER FACE SHEETS THEREOF

This invention relates to sandwich core panels, and more particularly to such a panel having structural decoupling between the face sheets thereof.

In my U.S. Pat. No. 3,525,663, an anticlastic cellular core structure for use in sandwich panels is described. This core structure comprises essentially oppositely projecting nodes which extend between the face sheets. In the embodiment of FIG. 9 of this prior patent, a core structure having nodes projecting in one direction having a greater end face diameter than that of the nodes projecting in the opposite direction and wherein a pair of membranes having such a node configuration are nested together is described.

The device of this invention provides an improvement over the anticlastic core structure panel of my aforementioned patent, this improvement utilizing a pair of similar membrane elements which are fitted together with the panel outer face sheets in a manner such as to provide structural decoupling and thus noise attenuation between such outer face sheets, at the same time providing a structurally rigid unit. This end result is achieved by utilizing an inner face sheet opposite each of the outer face sheets and attached thereto with minimal surface contact between the oppositely positioned inner and outer face sheets. The end faces of one of the sets of nodes of each of the membranes are each attached to a separate one of the outer face sheets, while the end face portion of the other of the sets of nodes of each of the membranes is attached to a separate one of the inner face sheets. In this manner, a unit is provided having excellent structural characteristics for handling both compressive and shear loads, at the same time providing decoupling between the outer face sheets, thus giving the panel energy barrier characteristics.

It is therefore an object of this invention to provide a high strength to weight ratio sandwich core panel having energy insulation characteristics.

It is a further object of this invention to improve the noise deadening characteristics of sandwich core panels having anticlastic core structure.

Other objects of this invention will become apparent as the description proceeds in connection with the accompanying drawings, of which:

FIG. 1 is an exploded view of a preferred embodiment of the invention;

FIG. 2 is a top plan view of the preferred embodiment with successive layers of the structure shown; and

FIG. 3 is a cross-sectional view taken along the plane indicated by 3—3 in FIG. 2.

Briefly described, the sandwich core panel of the invention is as follows: A panel is formed from a pair of similar panel sections which are joined together to form an integral unit. Each of these sections comprises an anticlastic membrane which is sandwiched between an inner face sheet and an outer face sheet. The membranes each have a first set of modes which project in a first direction, and a second set of nodes which project in a direction opposite to this first direction. The first set of nodes has apertured end faces which are adhered to one of the inner face sheets, while the second set of nodes are adhered to the outer face sheet on the opposite side of the panel. The first set of nodes have a larger end face diameter than that of the second set of nodes and the apertures thereof are large enough to receive the end portions of the other set of nodes therethrough. Apertures are formed in the inner face sheets where the first set of nodes are adhered thereto, these apertures being aligned with the apertures in the node end faces and having a large enough diameter to receive the end portions of the second set of nodes therethrough. The edges of the inner face sheets are each attached to the edges of a respective one of the outer face sheets, such as to provide a space between the surfaces of the attached inner and outer face sheets. The nodes of the membranes are thus interleaved, with the second set of nodes of each of the membranes being fitted through the apertures in the first set of nodes of the other of the membranes, as well as the apertures in the inner face sheets. A composite unit is thus formed from a pair of sandwich structures, each of such structures comprising an anticlastic membrane, one of the nodes of which is attached to an inner face sheet and the other of the nodes of which is attached to an outer face sheet. The only physical connection between the two structures occurs along a portion of the edges of the face sheets such that the transfer of energy between the outer face sheets is minimized.

Referring now to the drawings, a preferred embodiment of the invention is illustrated. First anticlastic membrane **11** has a first set of nodes **13** projecting in a first direction and a second set of nodes **12** projecting in a direction opposite to said first direction. Nodes **12** have an end face portion **15** which has a greater diameter than the end face portion **17** of nodes **13.** The end face portions **15** of nodes **12** have apertures **18** formed therein. A second membrane **20** is similar in configuration to membrane **11** having nodes **13***a* with end faces **17***a* which correspond to nodes **13** and end faces **17** of membrane **11,** and nodes **12***a* and end faces **15***a* which correspond to the nodes **12** and end faces **15** of membrane **11.** The nodes **13***a* of membrane **20** are fitted through apertures **18** of nodes **12** and apertures **35** formed in inner face sheet **32** and the end faces **17***a* of these nodes are adhered to outer face sheet **38** of the panel. The end faces **15***a* of nodes **12***a* of membrane **20** are adhered to inner face sheet **45** at the portions thereof surrounding apertures **40** formed therein. In similar fashion to nodes **13***a*, nodes **13** of membrane **11** pass through apertures **18***a* of nodes **12***a* and apertures **40** of inner face sheet **45,** with the end faces **17** of these nodes being adhered to the inner surface of outer face sheet **50.** Also, in similar fashion to that described for membrane **20,** the end face portions **15** of nodes **12** are adhered to the portions of inner face sheet **32** surrounding apertures **35.** Inner face sheets **32** and **45** are connected to outer face sheets **38** and **50** respectively, in spaced relationship therefrom by means of spacer tab members **60** which are placed along the edges of the panel and cemented to the edge portions of both the inner and outer face panels.

Anticlastic membranes **11** and **20** are thus interleaved with each other in a speced relationship, there being a first sandwich panel section formed by inner face sheet **45** and outer face sheet **38** with anticlastic membrane **20** sandwiched therebetween, and a second sandwich panel structure formed by inner face sheet **32** and outer face sheet **50** with anticlastic membrane **11** sandwiched therebetween. It is to be noted that the

only contact between these two panel sections occurs along the edge portions thereof at the interfaces between separator pads **60** and the inner and outer face sheets. The integrated structure has a high strength to weight ratio, yet in view of the lack of interconnection between the outer face panels except at limited parts of the edge portions thereof, acoustical coupling between the outer face sheets is minimized such as to make for an efficient sound barrier. The acoustical properties of the panel structure can be further enhanced by filling the interior volume with a sound absorbing material such as Fiberglas.

While the device of the invention has been described and illustrated in detail, it is to be clearly understood that this is intended by way of illustration and example only and is not to be taken by way of limitation, the spirit and scope of this inveniton being limited only by the terms of the following claims.

I claim:

1. A sandwich core panel structure comprising:

first and second outer face sheets,

first and second inner face sheets, said inner face sheets having a plurality of spaced apertures formed therein,

a first anticlastic membrane having a first set of nodes projecting in a first direction and a second set of nodes projecting in a direction opposite to said first direction,

a second anticlastic membrane having a first set of nodes projecting in said opposite direction and a second set of nodes porjecting in said first direction,

the nodes of said second sets of nodes having end faces with a greater diameter than the end faces of the first sets of nodes,

means for connecting said first and second outer face sheets to said first and second inner face sheets respectively at the edges thereof with their broad surfaces opposite to each other in spaced relationship,

the end faces of said second set of nodes of said first and second membranes having apertures formed therein and being adhered to said first and second inner face sheets respectively at the portions thereof surrounding the apertures formed in said inner face sheets,

the end faces of the first set of nodes of said first and second membranes passing through the apertures in the second set of nodes of said second and first membranes and said second and first inner face sheets respectively, the end faces of the first set of nodes of said first and second membranes being adhered to said second and first outer face sheets respectively,

whereby said membranes are interleaved with each other in spaced relationship and said outer face sheets are substantially acoustically decoupled from each other.

2. The device of claim **1** wherein the means for separating said inner and outer face sheets from each other comprises spacer tab members spaced along edges of said face sheets.

3. A sandwich core panel structure comprising:

a first anticlastic membrane having a first set of nodes projecting in a first direction and a second set of nodes projecting in a direction opposite to said first direction,

a second anticlastic membrane having a first set of nodes projecting in said opposite direction and a second set of nodes projecting in said first direction,

the end faces of the second sets of nodes having a greater diameter than that of the first sets of nodes and having apertures formed therein,

the nodes of said membranes being interleaved with each other in spaced relationship with the first set of nodes of each membrane passing through the apertures in the second set of nodes of the other membrane,

first and second outer face sheets spaced from each other in opposing relationship,

the membranes being sandwiched between said outer face sheets with the end faces of the first set of nodes of said first and second membranes being adhered to said second and first outer face sheets respectively, and

first and second inner face sheets spaced from each other in opposing relationship between said outer face sheets, said inner face sheets having apertures formed therein through which the end portions of said first set of nodes pass, the end faces of said second sets of nodes being adhered to said inner face sheets at the portions thereof surrounding said apertures.

4. The structure of claim **4** and including spacer tab members attached to edge portions of said inner and outer face sheets for holding each of said inner face sheets to an associated one of said outer face sheets.

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