United States Patent [19]

Schott

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[45] **Apr. 8, 1975**

[54] **REINFORCED CELLULAR PANEL CONSTRUCTION**

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[21] Appl. No.: **362,257**

[52] **U.S. Cl.** **161/68;** 52/615; 161/127

[51] **Int. Cl.**..... **B32b 3/12;** E04b 2/28; E04c 2/32

[58] **Field of Search** 161/68, 69, 127; 52/615

[56] **References Cited**

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Primary Examiner—Philip Dier

Attorney, Agent, or Firm—Barnes, Kisselle, Raisch & Choate

[57] **ABSTRACT**

A reinforced, light panel structure for use as a structural module having a pair of spaced, parallel sheets separated by and joined to a shaped insert in the form of a continuous sheet with multiple, adjacent, closed wall, circularly cross-sectioned, conical projections extending in spaced array in alternately opposite directions from a common plane to provide a plurality of contact surfaces secured to the inside surfaces of the spaced parallel sheets.

3 Claims, 17 Drawing Figures

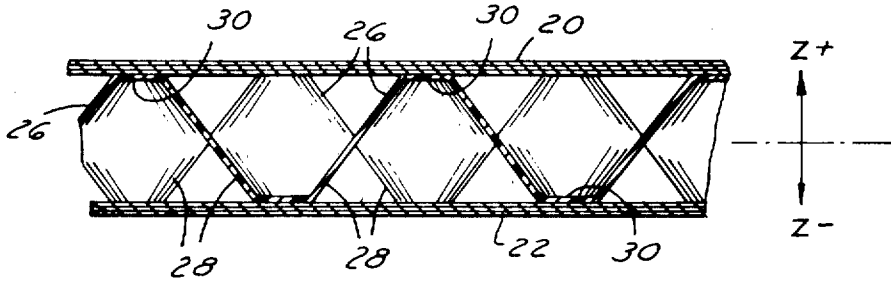


FIG. 1

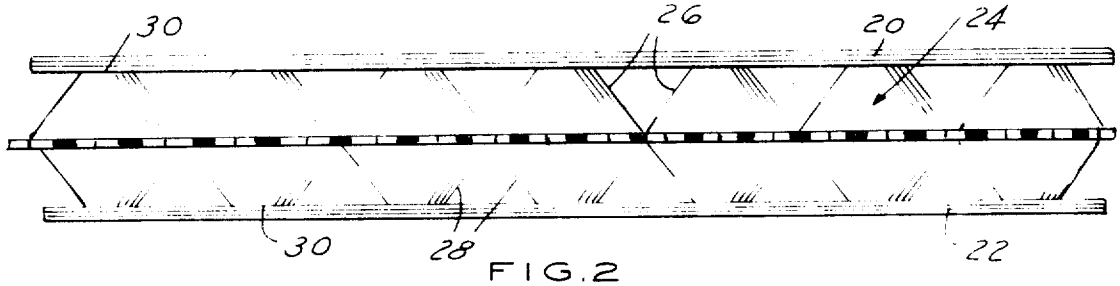


FIG. 2

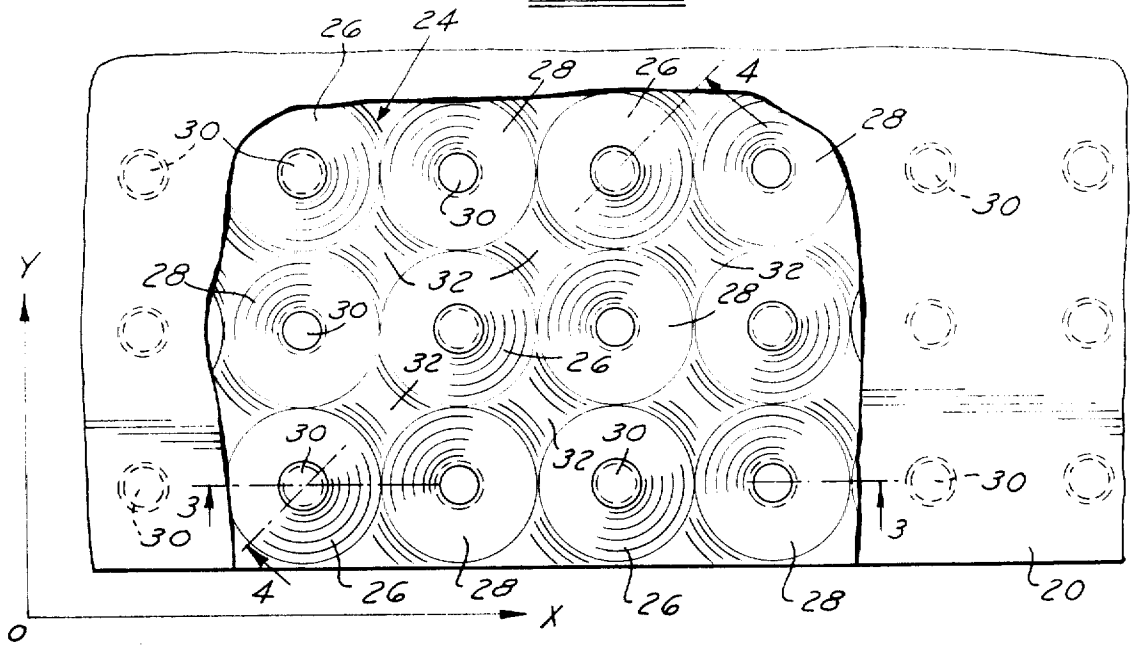


FIG. 3

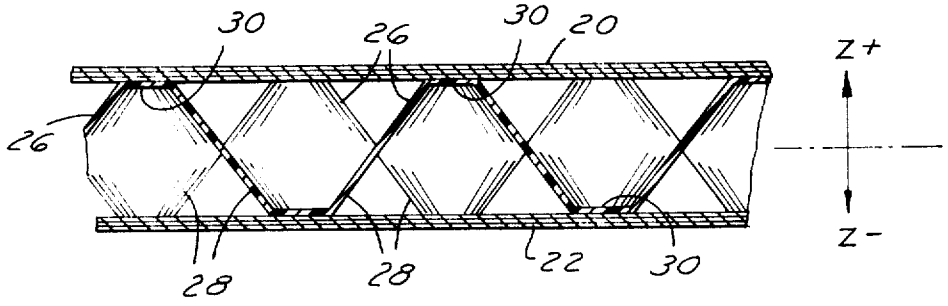


FIG. 4

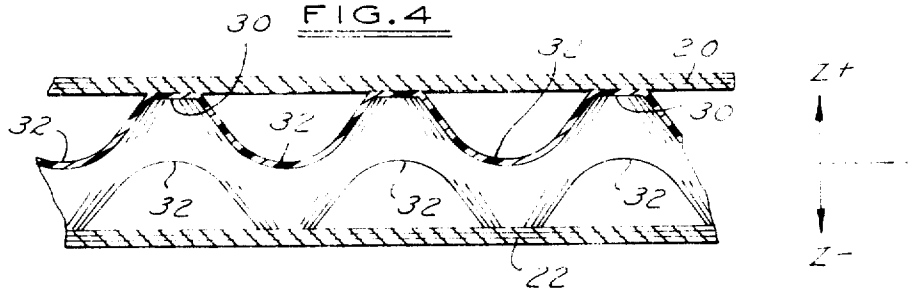


FIG. 6

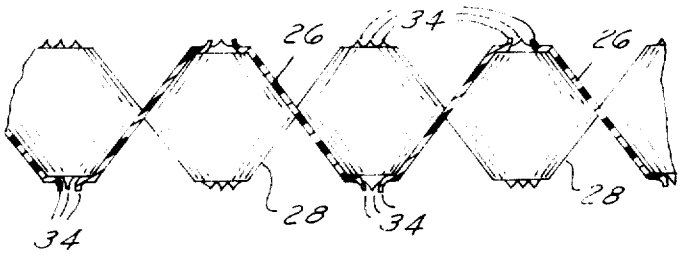


FIG. 5

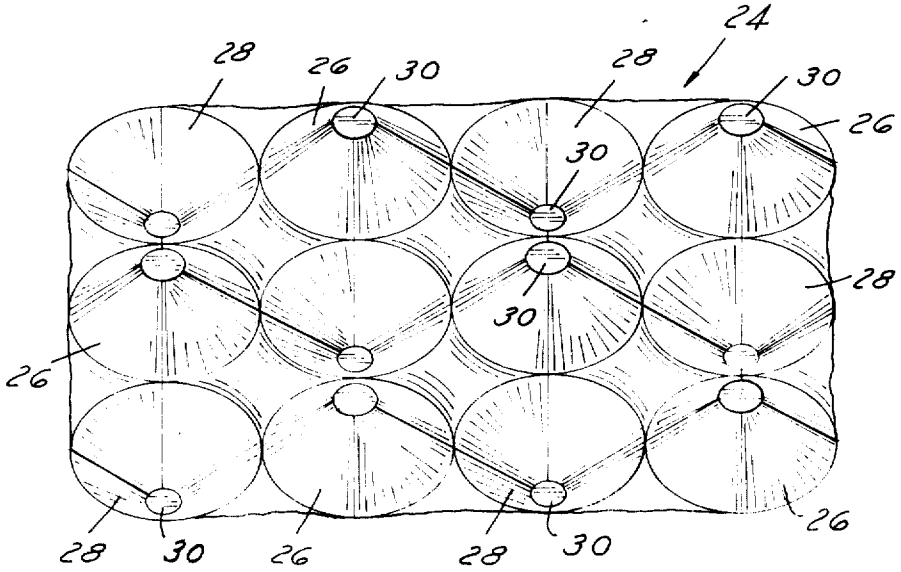


FIG. 7

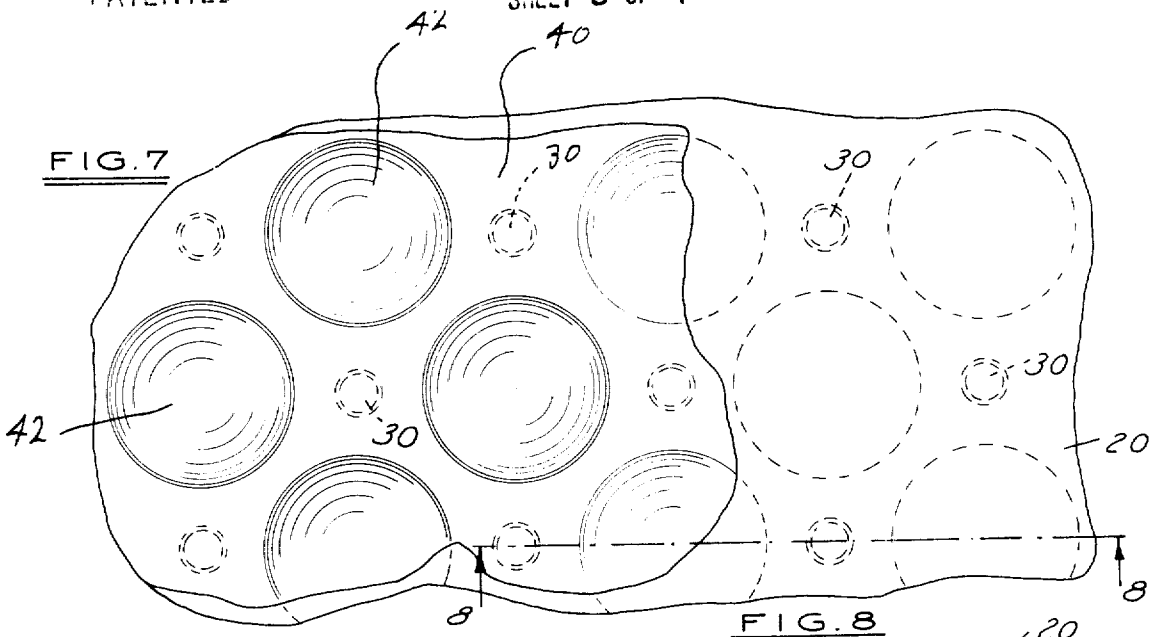


FIG. 8

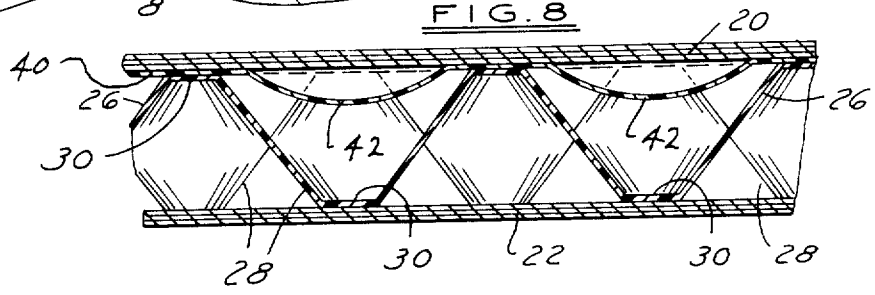


FIG. 9

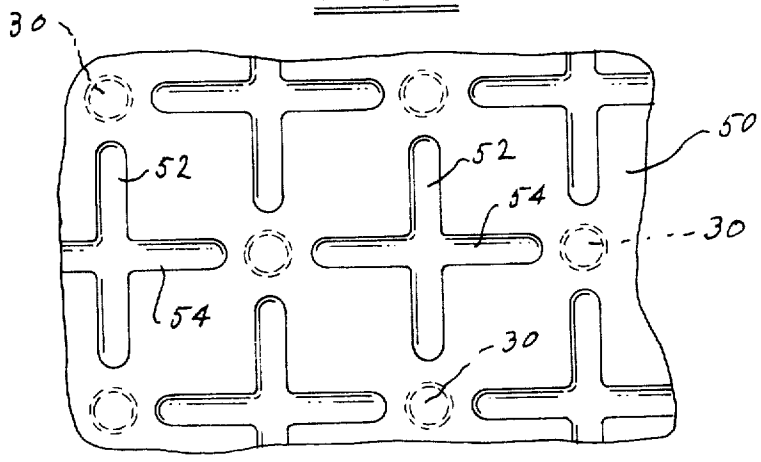


FIG. 10

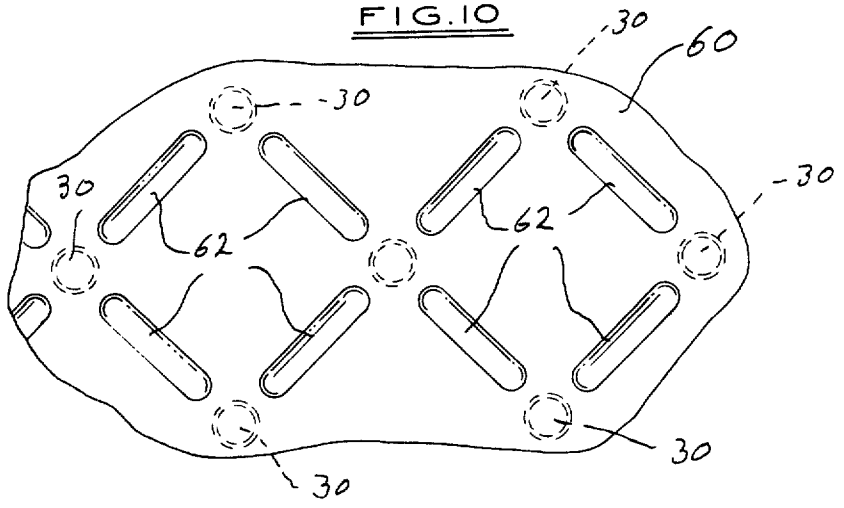


FIG. 11

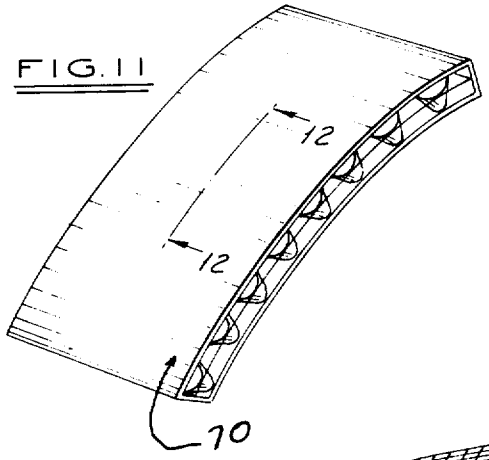


FIG. 17

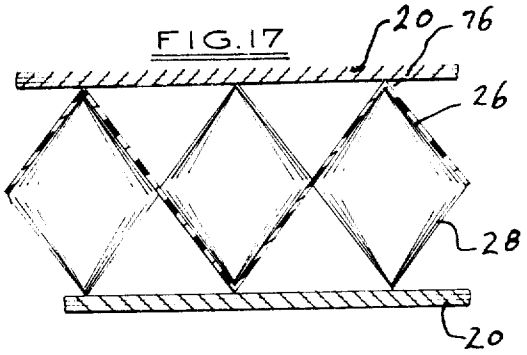


FIG. 12

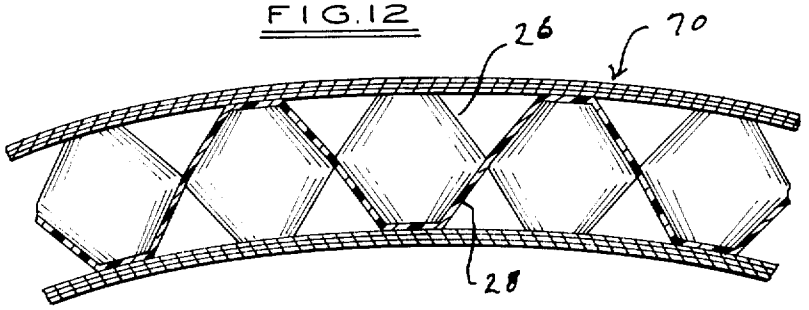


FIG. 13

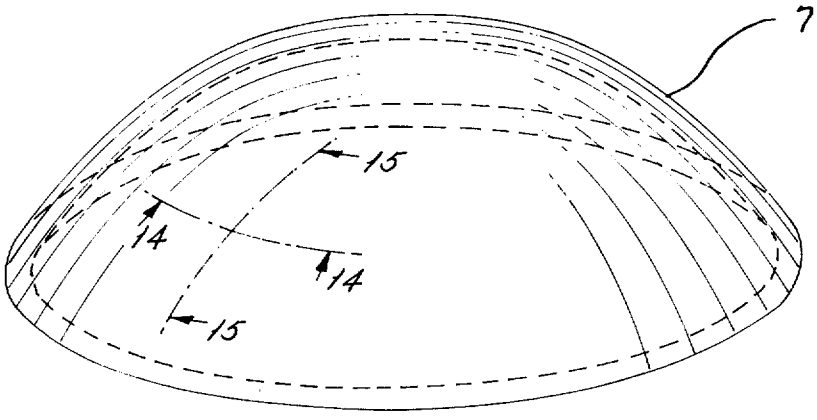


FIG. 14

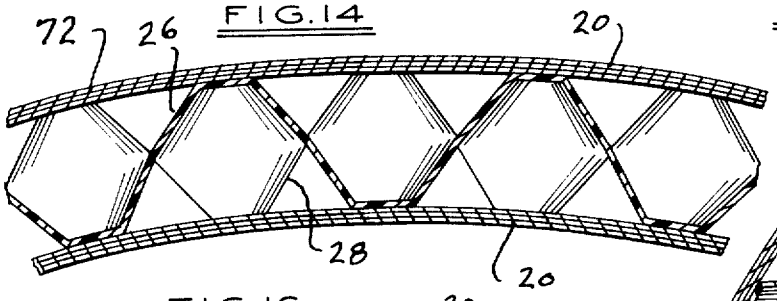


FIG. 15

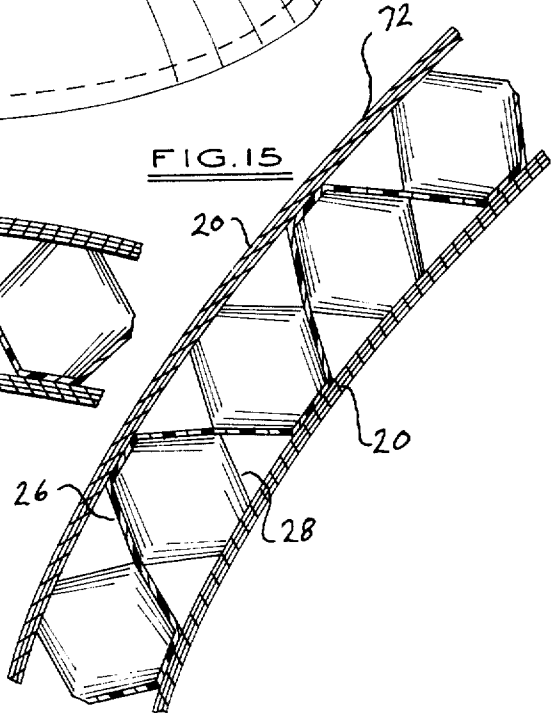
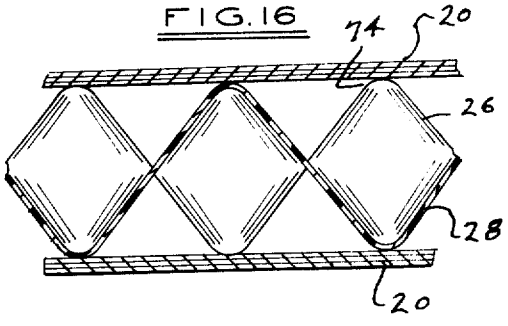


FIG. 16



REINFORCED CELLULAR PANEL CONSTRUCTION

This invention relates to a panel construction and more particularly to a structural panel that can be used for modular assembly for many different purposes.

It is an object of the present invention to provide a panel construction which is extremely light and inexpensive to manufacture and one which has considerable impact strength and resistance to bending.

Another object of the invention is to provide a panel construction which may be used for aircraft, furniture, housing, housing walls, ceilings, floors, shipping containers, house and freight trailers, and for many other applications where a preformed, lightweight panel having insulating and strength characteristics is required.

Reference is made to U.S. Pat. No. 3,673,057 issued June 27, 1972 relating to a cellular structure. The present invention is intended to be an improvement on the structure shown in this patent in that the core material is more readily formed in a less expensive process and the resulting structure is substantially stronger by reason of the inherent nature of the core structure when combined with the sheet envelopes.

It is therefore, an object to provide a strong, light, core material which combines with a tension skin to provide a strong panel material. The circularly cross-sectioned cones provide a triangulation structure in multiple directions to rigidify the assembly.

It is a further object to provide an improved panel construction which can be readily formed, which will be light in weight, and which can be adapted to varying contours by reason of its basic construction.

Other objects and features of the invention will be apparent in the following description and claims in which the principles of operation together with details of construction are shown and described in connection with the best mode presently contemplated for the practice of the invention.

Drawings accompany the disclosure and the various views thereof may be briefly described as:

FIG. **1**, a sectional view of a completed panel.

FIG. **2**, a top view of the panel showing a portion of one side removed to illustrate the core formation.

FIG. **3**, a sectional view looking into the side of the end of the completed panel.

FIG. **4**, a sectional view taken on line **4—4** of FIG. **2**.

FIG. **5**, a perspective view of the core element.

FIG. **6**, a modified view showing fastening tabs on the truncated ends of the conical projections.

FIG. **7**, a breakaway plan view illustrating a panel construction with a reinforced outer skin.

FIG. **8**, a sectional view on line **8—8** of FIG. **7**.

FIG. **9**, a modified skin reinforcement design.

FIG. **10**, a second modification of a skin reinforcement design.

FIG. **11**, an illustration of an arched panel.

FIG. **12**, a sectional view on line **12—12** of FIG. **11**.

FIG. **13**, an illustration of a domed panel.

FIGS. **14** and **15**, sectional views on line **14—14** and **15—15** of FIG. **13**.

FIGS. **16** and **17**, views illustrating panel reinforcement sheets with rounded and pointed cones.

Referring to the drawings:

In FIG. **1**, it will be seen that the panel construction is formed with two side sheets **20** and **22** and a core construction indicated generally at **24**.

The panel may be made in any number of different sizes and from different materials depending on the load to be carried and the weight desired. In some instances, the side sheet **20**, panels **22**, can be formed of a plywood. In other instances, they may be formed of sheet metal. In some instances, they might be formed of a cloth or plastic sheeting having good tensile characteristics. The core can be formed either of sheet metal of from sheet plastic, fiber glass, and other synthetic materials. The core is formed by taking a sheet of material and forming conical projections from each side of a base departure plane so that alternately the projections are up and down in both the X direction and the Y direction as shown in FIG. **2**; and as shown in FIG. **3**, the projections extend in the Z plus (Z+) direction and the Z minus (Z−) direction. The projections are formed as closed hollow cones circular in cross section with straight side walls as shown best in FIG. **3**, and the cones are preferably truncated to have a closed apex with a flat surface to assist in the securing of the panels to the core. The lines which generate the cones are preferably straight to provide a triangulation design as shown particularly in FIGS. **1** and **3** where the lines from the inside of the skin panels extend straight from one panel to the other. This bridging effect results in a structure which is very strong in resisting compression or sheer forces.

With reference to the drawings, the upwardly projecting cones are illustrated at **26** and the downwardly projecting cones are illustrated at **28**. These cones have flat surfaces **30** which lie in a plane which coincides with the inside of the side sheet panels **20** and **22**. In the assembly, the side sheets **20** and **22** may be fastened to the apices of the cone in various ways depending on the materials. For example, if the core is formed from sheet metal and the otuer sheets are metal, there could be a heat bonded, brazed, soldered or spot welding juncture at the top of each cone. If the core material is a plastic, the side sheets may be adhered by eith a solvent or fusion process if the materials are compatible to this extent or by the use of a suitable adhesive. Plywood side sheets can be adhered to the plastic core by adhesive. In many instances, even a plastic sheet or a paper sheet may be applied for certain applications. The tensile strength of the skin layers is important to the overall strength of the device.

While the walls of each cone are generally circular in cross-section and strictly conical in the sense that the walls are straight, as illustrated in FIGS. **1** and **3**, nevertheless, the formation of the units as illustrated in FIG. **4** provides joining radii areas **32** which are inherent in the particular formation. This has an advantage in that the structure can be shaped into various curvatures in one direction or the other or in both directions so that a structure can be formed with compound curvature as for example, the nose of an airplane or the leading edge and end of an airplane wing. The structure with the conial formations therefore, has the advantage that it can be shaped in simple or compound curves preferably before the side structures are applied so that the side structures will maintain the configuration. The cones are spaced in the X and Y directions, FIG. **2**, so that the conical walls are straight and continuous from apex to apex in the Z+ and Z− directions — FIG. **4**. This is shown best in FIG. **3**.

In FIG. **6**, a modified structure is shown in which the end plates or apices of the cones are perforated to pro-

vide projections **34** which can be utilized to fasten the core structure to a molded material such as a plastic which can be molded directly on to the cones or a plaster wall structure, for example.

In FIG. **7**, a modified construction is shown in which a skin pane **40** is provided with formed depressions **42** extending between the apices of the inner core to reinforce the skin panel **40** against bending between the portions where it is fastened to the apices **30** of the core section. Where the skin panel **40** is to be covered with another panel **20** as shown in FIG. **8**, these depressions can be concave from the outside. In other instances, they can be convex.

In FIG. **9**, a modified reinforcement skin construction is shown where a skin panel **50** has deformations from the surface in the form of a cross, the respective bars **52** and **54** extending between the apices of the reinforcing cones to reinforce the skin panel between these points of contact.

In FIG. **10**, another modification of a reinforced skin construction is shown in a skin panel **60** with elongate deformations **62** formed out of the plane of the skin panel to reinforce the skin panel between the apices. These deformations **42**, **52** and **62** can be molded into the skin panel prior to its assembly whether the panel is made of metal or plastic and in the case of the embodiment shown in FIGS. **9** and **10** will constitute ridges on the surface of the panel extending either to the outside or the inside.

In FIGS. **11** to **15**, the panel is illustrated in a curved formation. The core of the panel is so designed that it may be bent in either a single curve in the form of an arch as shown in the component **70** of FIG. **11**, sectioned in FIG. **12**, or as a double compound curve as shown in the segment **72** sectioned in FIGS. **14** and **15**. The conical construction lends itself to being shaped in either a single arched curve or a compound curve and thus has advantages over other core constructions which do not have this flexibility.

In FIGS. **16** and **17**, there are illustrated other types of cones, one having a rounded apex **74** as shown in FIG. **16** and one having a sharp apex **76** as shown in FIG. **17**.

The conical configuration, together with the triangulation which results from the formation of the cores, provides an extremely rigid structure which has great resistance against crushing and also against bending once the side sheets are applied. In addition, the structure has inherent resistance to any shear stresses that might be applied to the opposing walls. Accordingly, the resultant structure is extremely strong and relatively light in comparison to its strength.

I claim:

1. In a panel construction module of the type having a hollow core with a plurality of projections to each side of center and a sheet of material on each side of said core secured on the inner side to respective apices of said projections to provide a rigid construction, that improvement which comprises a core of sheet material formed outward to each side Z+ and Z− of the sheet with conical hollow projections, the bases of which lie in contiguous circles in the plane of said sheet and extending in a regular pattern to a plane on each side of the base departure plane of the sheet, each cone having substantially straight side walls from one apex of the Z− cones to the apex of the Z+ cones in planes cutting the core in the X and Y direction through the center of the cones, said side walls being disposed at a substantial angle to the departure plane.

2. A panel construction module as defined in claim **1** in which the rigidifying sheets are provided with embossed deformations between the apices and away from the plane of the sheets to provide rigidifying structure.

3. A panel construction as defined in claim **2** in which said deformations comprises concave depressions between said apices.

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