

[54] **ARTICLE AND METHOD OF QUASI-ISOTROPIC CORE FILAMENTS**

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[73] Assignee: **The United States of America** as represented by the Secretary of the Army

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[51] Int. Cl. **B32b 5/12**

[58] Field of Search **161/DIG. 4, 55, 57, 58, 68, 161/127, 130, 131, 140; 156/161, 170, 173, 174, 175, 433, 197, 434, 169, 443; 244/123, 124**

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[57] **ABSTRACT**

A quasi-isotropic sandwich-type structural core filament winding made by a jig on which the fiber filaments are interwoven in a manner where each fiber lays on top of the preceding fiber so that when the winding is completed, a core is produced which consists of a series of tetrahedrons, half of which point upwards and half point downwards. The completed winding is then coated with an epoxy resin and cured, when removed from the jig. The jig may be of varied shapes so that the core is flat, cylindrical, air foil or other irregular shapes.

10 Claims, 8 Drawing Figures

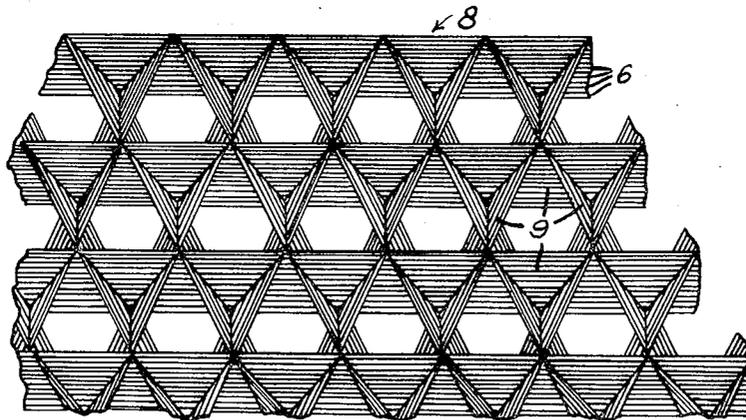


Fig. 1.

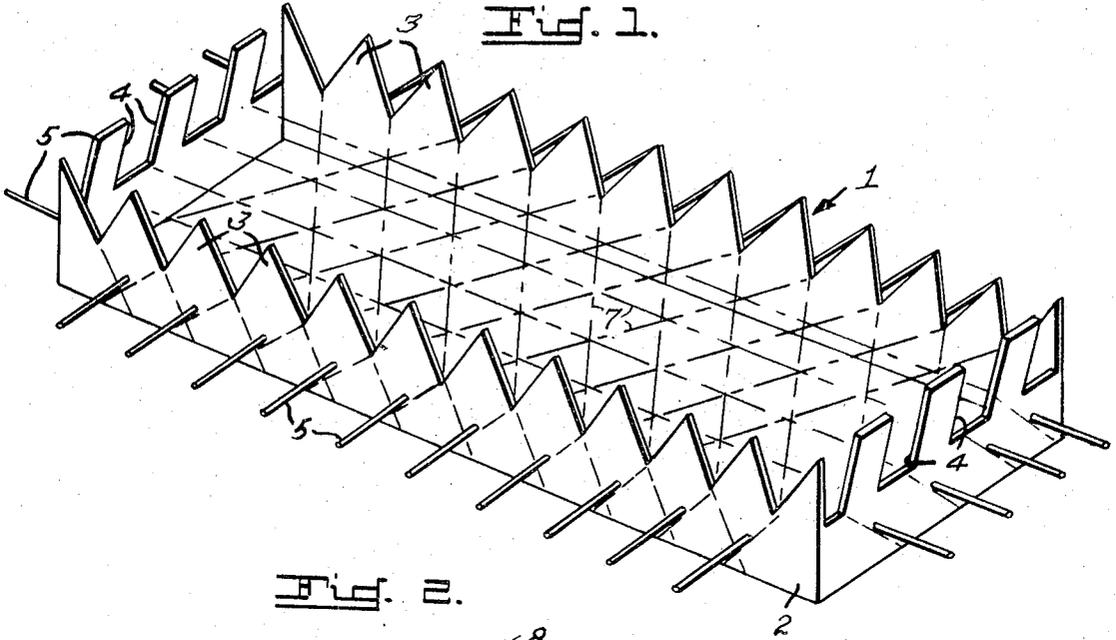


Fig. 2.

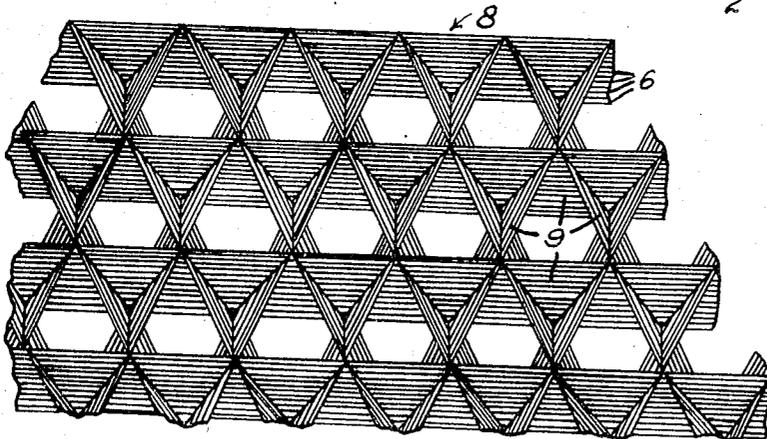
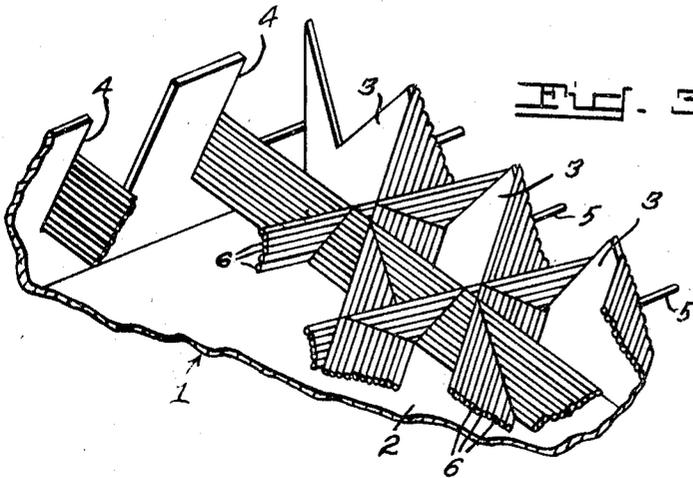


Fig. 3.



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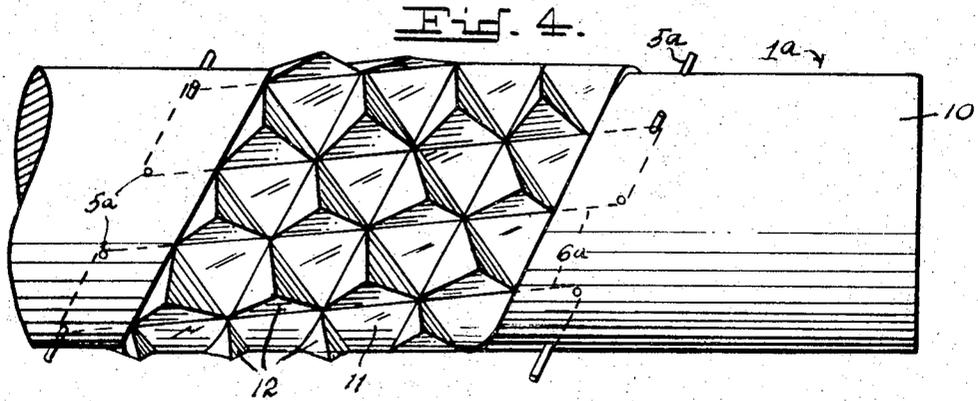


Fig. 5.

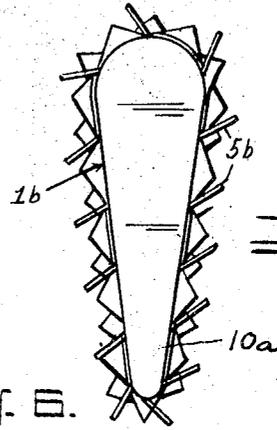
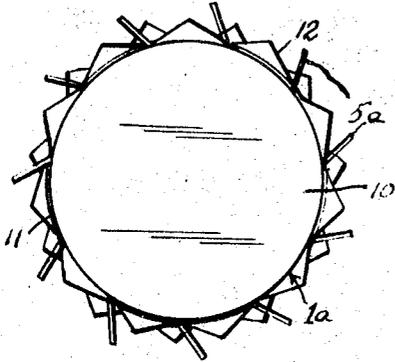


Fig. 6.

Fig. 7.

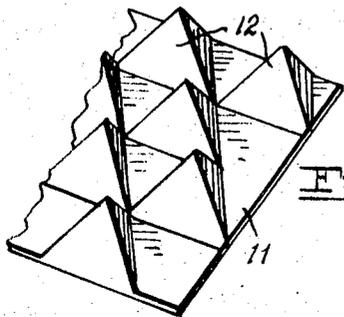
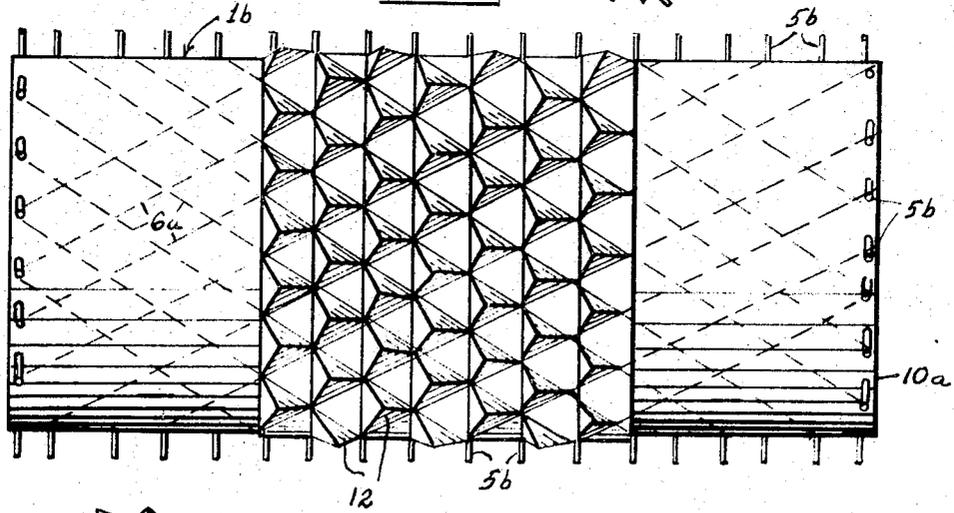


Fig. 8.

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ARTICLE AND METHOD OF QUASI-ISOTROPIC CORE FILAMENTS

The invention described herein may be manufactured, used, and licensed by or for the Government for governmental purposes without the payment to me of any royalty thereon.

Constructional cores of the honeycomb type have many uses such as, for instance, aircraft construction. Most cores produced consisted of a pair of walls with the core sandwiched between them. This construction led to difficulties in bonding, as well as lacking load carrying strength, its strength being only in a perpendicular direction to the face walls.

The present invention is designed to provide a structural core that is capable of load carrying in all directions and also to provide a core of varying shapes, such as flat, round, or airfoil, etc. A jig is provided on which fiber filaments are interwoven in order to produce tetrahedrons, pointing up and down. The jig may consist of a rectangular frame having upstanding fingers, to produce a flat core, or of pins arranged in a helical manner around a cylindrical mandrel and a sheet of tetrahedral raised knobs wrapped around the mandrel between the pins, so that a winding is produced which consists of series of tetrahedrons, half of which point upwards and half of which point downwards.

It is therefore a principal object of this invention to provide a jig upon which fibrous filaments may be wound to produce a structural core core that possesses quasiisotropic properties including tension, compression, bending and torsional rigidity.

It is another object of this invention to produce a structural core of a series of tetrahedrons, half of which point upwards and half of which point downwards.

A further object is to provide a jig whereby the core may be made flat, round or in airfoil shape by interweaving fibrous filaments on the jig wherein each fiber lays on top of the preceding fiber.

A still further object is to provide a core of lightweight construction.

Other objects and advantages will be apparent from the following description and drawings in which:

FIG. 1 is a perspective view of a jig used to produce a flat structural core;

FIG. 2 is a fragmentary view of a portion of the completed winding;

FIG. 3 is an enlarged detail view illustrating the manner of winding the fibrous filaments;

FIG. 4 is a fragmentary side view of a jig used to produce a cylindrical core;

FIG. 5 is an end view of the jig of FIG. 4;

FIG. 6 is a side view of a jig to produce an airfoil-shaped winding;

FIG. 7 is an end view of the jig of FIG. 6, and,

FIG. 8 is a portion of a sheet used in the forms of FIGS. 4-7 and illustrating the tetrahedrons.

Referring in detail to the drawings in which reference character 1 designates generally the jig used to wind a flat core as seen in FIG. 1.

Jig 1 comprises a rectangular-shaped frame 2 having triangular fingers 3 on two of its sides. Its ends have slots 4. Extending from all four sides are pins 5, as shown.

To produce the windings of this invention, fibrous filaments 6 are interwoven among the fingers 3 and slots 4 in the manner shown by broken lines 7. Each filament 6 lays on top of the preceding one, as seen in FIG. 3. The winding is continued until the last fiber 6 is at the apex of the triangular fingers 3. Due to the inclined edges of fingers 3, the finished winding, generally indicated by 8, produces a three-dimensional effect which consists of series of tetrahedrons 9, one-half of which will point up and the other half down. Pins 5 act to hold the windings of fibers 6 in place on the frame 2.

The completed winding is now coated with an epoxy resin to stiffen the winding. It is then cured and removed from the jig 1.

Winding 8, instead of being flat, as seen in FIG. 2 may be cylindrical, for use as shafting, etc. In this case a modified jig 1a is used as shown in FIGS. 4 and 5 and consists of a cylindrical

mandrel 10. A sheet 11 of a material such as a fiber glass and having upstanding knobs 12 of a tetrahedral shape as seen in FIG. 8 is wrapped in a helical manner about mandrel 10. Pins 5a are driven into mandrel 10, which may be of wood, in a helical path along the edges of sheet 11, as shown. Filaments 6a are then interwoven between the three faces of the tetrahedral knobs 12 to form a winding which will be of the same pattern as shown in FIG. 2 with the exception that it will be cylindrical. The winding is coated with an epoxy resin and cured. The overhanging filaments are cut and the winding removed from mandrel 10, then sheet 11 is removed from the inside of the winding. Pins 5a hold the winding on the mandrel and are placed in expedient points on the mandrel.

In FIGS. 6 and 7 is shown a further modified jig 1b on which an airfoil-shaped winding may be produced and consists of a mandrel 10a which is airfoil in shape. Sheet 11 is wrapped around mandrel 10a and pins 5b are driven into the mandrel 10a at its top and bottom edges, as shown. The winding is performed in the same manner as on jigs 1 and 1a. The winding is coated, or dipped, in an epoxy resin for stiffening and cured. Pins 5b which are driven through sheet 11 are removed and the overhanging filaments are cut and the finished winding removed from the mandrel 10a. Pins 5b maintain the winding in place on the mandrel.

The method of making the structural core, whether flat, cylindrical or airfoil is identical and comprises weaving the filaments 6, one above the other on the jig around the pins 5, 5a or 5b and the fingers 3 or the knobs 12, whichever jig is used, then coating or dipping the completed core 8 with an epoxy resin to bind the core, curing the core, then cutting any overhanging filaments and removing the core from the jig.

It is apparent from the foregoing that a structural core has been devised that may be made in a variety of shapes.

What is claimed is:

1. As an article of manufacture, a unitary structural core comprising a series of interwoven fiber filaments, each filament being disposed above another, said interwoven filaments defining a series of symmetrical tetrahedrons arranged in longitudinal rows, each row of tetrahedrons being in offset sequential relation to the tetrahedrons in an adjacent row, whereby two sides of all tetrahedrons are disposed in oppositely inclining, parallel planes and the remaining sides are disposed in parallel longitudinal planes, all planes intersecting along a line extending from an apex of the base of each tetrahedron to its apex.

2. An article of manufacture as set forth in claim 1 wherein one-half of said tetrahedrons point upwards and the other half point downwards.

3. An article of manufacture as set forth in claim 1 wherein said core is a flat sheet.

4. An article of manufacture as set forth in claim 1 wherein said core is cylindrical.

5. An article of manufacture as set forth in claim 1 wherein said core is of airfoil shape.

6. A method for making a structural core of longitudinal rows of tetrahedrons which comprises interweaving a plurality of rows of fibrous filaments upon each other over an offsetting jig whereby the filament rows mounted on top of each other are each offset from the preceding row to form biased surfaces that intersect to define a plurality of tetrahedrons, coating said interwoven filaments with a resin and curing the resin coated filaments.

7. A method as set forth in claim 6 wherein said filaments are composed of polyester fibers.

8. A method as set forth in claim 6 wherein the formed structural core is a cylinder and the jig is a circular mandrel having a sheet of offset tetrahedral molds mounted thereon.

9. A method as set forth in claim 8 wherein said cylindrical structure is separated from the jig by removing the mandrel and extracting the sheet of tetrahedron molds from the inside of the structural core.

10. A method as set forth in claim 6 wherein said tetrahedrons formed by said method are symmetrical.