

June 19, 1973

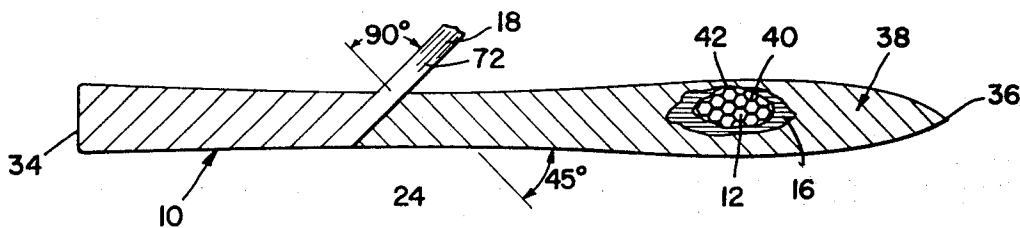
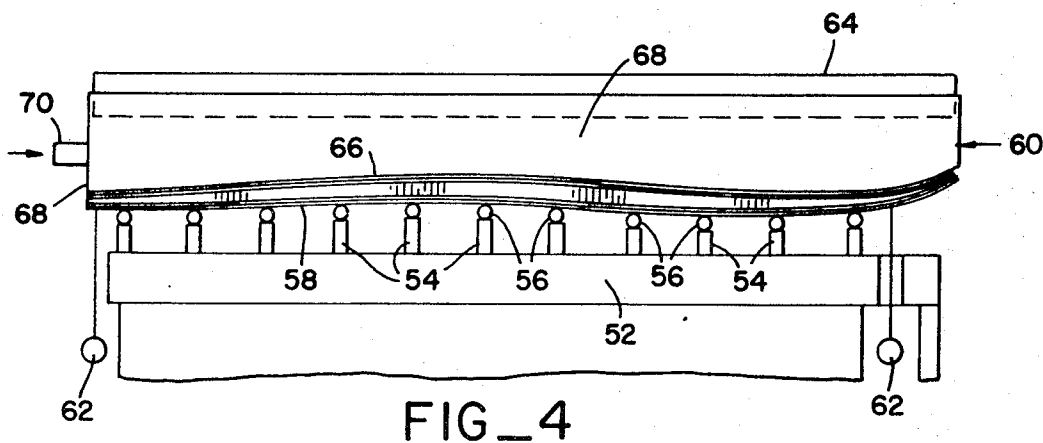
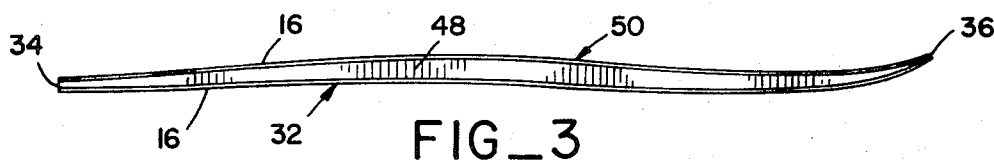
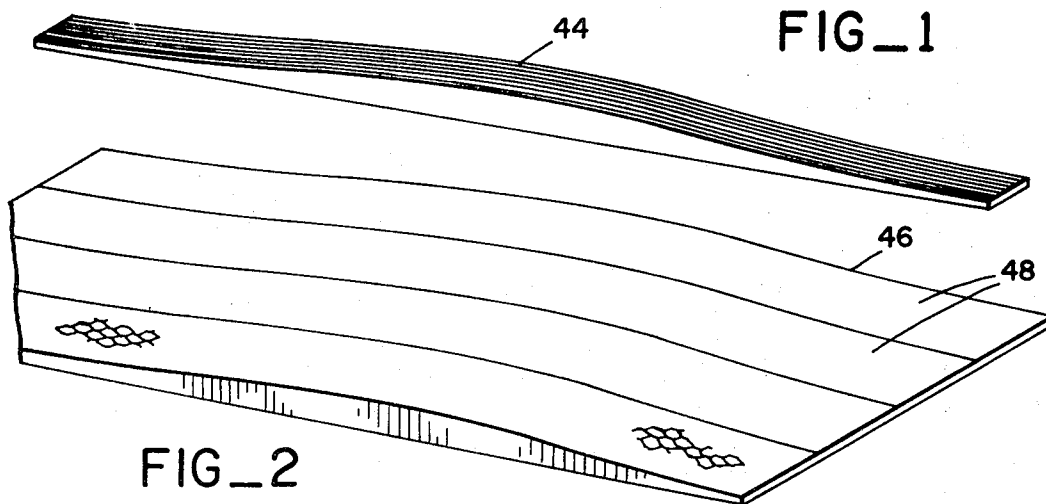
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3,740,301

ELONGATED LIGHTWEIGHT STRUCTURE

Filed July 14, 1971

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

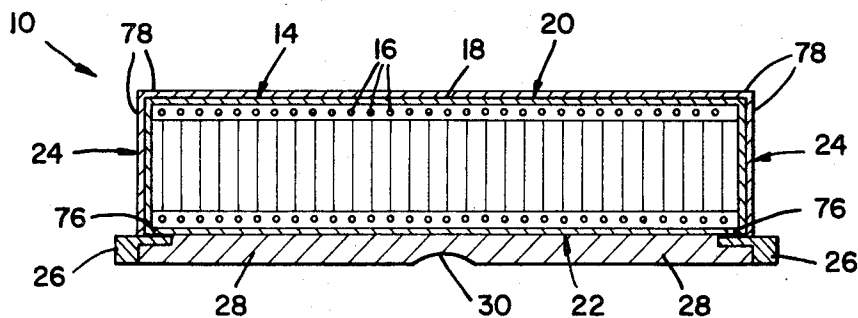


FIG_6

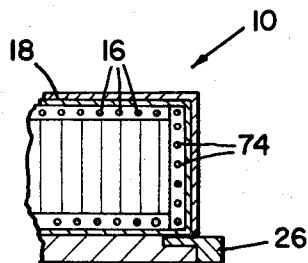


FIG_7

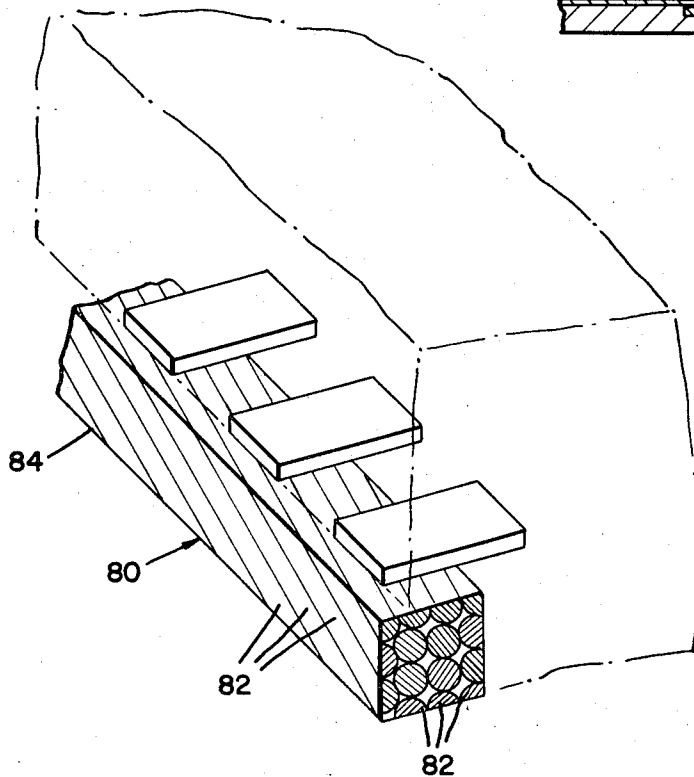


FIG_8

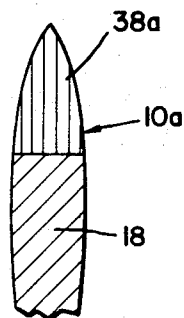


FIG_9

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ELONGATED LIGHTWEIGHT STRUCTURE

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Continuation-in-part of abandoned application Ser. No.
55,768, July 17, 1970. This application July 14, 1971,
Ser. No. 162,600

Int. Cl. B32b 5/12

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13 Claims

ABSTRACT OF THE DISCLOSURE

A lightweight ski constructed of a honeycomb core with its ribbon direction parallel to the length of the ski, first reinforcing fibers extending parallel to the ski length, and second reinforcing fibers disposed diagonally completely around the ski. The fibers are bonded to each other and to the honeycomb core.

RELATED APPLICATIONS

This application is a continuation-in-part application of the commonly owned, copending patent application for "Ski," bearing Ser. No. 55,768, filed July 17, 1970, now abandoned.

BACKGROUND OF THE INVENTION

Skis have developed from an original, relatively simple ski constructed of a simple board, to skis laminated of a multiplicity of individual wood lamina, composite metal-wood skis and finally to composites of wood-plastic, metal-plastic and pure plastic skis. It has been suggested to manufacture skis having solid outer metallic or non-metallic layers, which provide the ski with the necessary strength, and lightweight interior cores, such as foam or honeycomb cores. In the case of honeycomb skis, the honeycomb was primarily employed to provide a means of facing separation while the ski's strength was derived from the facings applied to the core. The honeycomb core skis were constructed so that the honeycomb ribbon or "L" direction is perpendicular to the ski length.

Substantial controversy existed and continues to exist as to which type of ski represents the or comes closest to an ideal ski. Partially, this is a result of the, as of yet, undefined parameters which an ideal ski has to fulfill. It is also a result of each ski having some advantages over some or all others in a particular aspect while the remaining ski characteristics are no more or less than average.

SUMMARY OF THE INVENTION

The present invention provides a lightweight ski which comprises a honeycomb core in which the honeycomb ribbon or "L" direction is parallel to the ski length. First strands extend in the direction of the ski length and are rigidly connected to exterior surfaces of the honeycomb core. A plurality of continuous second strands envelope the core and are angularly inclined with respect to the ski length and rigidly connected to the core. It is preferred that a plurality of second strand layers are formed around the core and that the strands in each such layer are cross-wound with respect to the strands in the other layer, preferably at an angle of 90°.

As used in this specification, the term "strand" means relatively thin, elongate members of round or other cross sections which can be manufactured of a single strand of material, extruded plastic or metal or the like, or of a plurality of spun fibers. The fibers can be constructed of a variety of materials such as fiberglass, carbon, boron, or the like.

In the considered judgment of expert skiers, the ski

or the present invention has proven superior to prior art skis in virtually all respects. It is lightweight, weighing generally about 10% less than the very lightest prior art ski known to applicants and closer to 20 or more percent lighter than the majority of various brand skis sold in the market today. The present ski has excellent handling characteristics in all types of snow, such as powder snow, packed snow or ice; it is highly responsive to control by the skier, particularly when performing sharp turns where at least part of the ski lifts off the ground due to weight shifting and jumping by the skier; and it has proven virtually indestructible through intensive use. The extreme durability of the ski is dramatized by the fact that it can be bent 90° about a relatively small radius of a few inches without damaging the ski or causing permanent deformation. The back end of a ski of the present invention may be placed in the horizontal gap between a lower door edge and the floor and then bent into an upright position substantially parallel to the door side. After release of the ski the ski returns to its original position without permanent deformation, cracking or any other adverse effects.

When applicants first filed a patent application for this invention, the above-referenced parent application, applicants were informed and believed that the superior characteristics of their ski were functions of particular ski parameters. Those were mainly thought to be the controllable load-deflection characteristics and the high torsional and lateral ski strength and rigidity.

On the basis of further research and consideration of the subject matter, applicants find that they are unable to pinpoint one or more characteristics of their ski which result in its superior performance in terms of its skiability as well as its strength, ruggedness and durability. Applicants believe, but do not know, that the factors mentioned in the above-referenced parent application are at least partially responsible. However, applicants believe that there might well be other or additional factors not yet known to or isolated by applicants that determine or affect the ski characteristics. In addition, applicants have found out that they are presently virtually unable to even identify, much less quantify, all the specific characteristics of the ski which make it superior in performance over others.

Although the present invention is presently primarily utilized in conjunction with various types of snow skis, it is equally advantageously employed for constructing other relatively large and bulky articles such as water skis, surf boards, airplane skis for landing aircraft on snow fields, helicopter pontoons, and the like in which lightweight, high-strength, durability and resiliency are of importance.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective side elevational view showing an unexpanded machined honeycomb block used in the construction of the skis of the present invention;

FIG. 2 is a perspective side elevational view of the expanded honeycomb and illustrates the honeycomb sections that are subsequently formed into the skis;

FIG. 3 is a side elevational view of a honeycomb sandwich with the honeycomb core contoured in its ribbon direction in accordance with the longitudinal contour of the final ski;

FIG. 4 is a schematic elevational view of an apparatus for molding the contoured honeycomb sandwich section illustrated in FIG. 3;

FIG. 5 is a plan view, with parts broken away, of an individual ski being wrapped to form a box section about the honeycomb core;

FIG. 6 is an elevational view, in section, of a finished ski;

FIG. 7 is a fragmentary elevational view similar to FIG. 6 but illustrates another embodiment of the present invention;

FIG. 8 is a fragmentary perspective elevation of flexible steel edges applied to the ski (shown in phantom lines) in accordance with the present invention; and

FIG. 9 is a plan view of a ski similar to FIG. 5 and illustrates another embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIGS. 5 and 6, a ski 10 constructed in accordance with the present invention comprises a core 12 surrounded by a box member 14 having first, longitudinally extending strands 16 and second, transversely extending strands 18 which are spirally wrapped about the core and the first strands. The ski includes top and bottom sides 20 and 22 and upright sides 24. Hard edge members, such as steel edge members 26 and a low friction base 28 including a longitudinal groove 30 are affixed to the bottom side of the ski and form the ski's gliding surface. The ski has a longitudinal camber, as indicated at 32, and terminates in an aft ski end 34 and a forward ski tip 36 defined by an upwardly curved ski shovel 38. Suitable bindings (not shown) are affixed to the ski at its mid-section for securely fastening a skier's boot (not shown) to the ski.

Referring now to FIGS. 1 through 4, core 12 is a honeycomb core defined by a plurality of undulating ribbons intermittently secured to each other at nodal points 42. The core is so positioned that the "L" or ribbon direction of the honeycomb coincides with the ski length while the "W" direction of the honeycomb extends perpendicular to the ski length. Such honeycomb has a greater strength in the ribbon direction than in its "W" direction. This positioning of the core significantly adds to the longitudinal ski strength without increasing the weight of the ski. Moreover, by positioning the honeycomb core in this manner it can be machined in its unexpanded form and yield expanded honeycomb of substantially improved dimensional accuracy as compared to honeycomb cores in which the ribbon direction extends lateral to the ski length.

The honeycomb core of ski 10 may be constructed of any suitable material such as aluminum, reinforced plastics, cellulose materials and the like although at the present it is preferred to construct it of thin aluminum foils with a cell size of between $\frac{1}{8}$ to $\frac{3}{8}$ inch, $\frac{1}{4}$ inch being the preferred size for yielding the optimum weight-to-strength-to-cost ratio.

An unexpanded honeycomb block 44 is first machined as illustrated in FIG. 1, or the core may be machined after expansion. The lower surface of the block, which ultimately forms the bottom side 22 of the ski, remains flat while the upper side is contoured to provide the ski with various thickness over its length, as illustrated in FIG. 3, to control its strength and flexibility. The finish shaped unexpanded honeycomb block is expanded into a honeycomb core 46 illustrated in FIG. 2. Those portions of the core which are located where fastening screws attach bindings and the like on the finished skis are filled, or substantially filled with a resin to anchor the screws.

Core sections 48 are now faced with one or more layers of first strands 16 to define a honeycomb sandwich 50 having a width a plurality of times greater than the width of the final ski. Although various strand materials can be employed it is presently preferred to use sheets or laminates having unidirectional fiberglass strands which are preimpregnated with a suitable resin. As used in this specification the term "unidirectional sheets" denotes sheets in which a majority of the high strength strands are parallel and run in one direction. One or more of the sheets are bonded to each honeycomb core section face to obtain the desired strength and deflection charac-

teristics for the final ski. The sheets extend past the forward end of the honeycomb core and define ski shovel 38 and ski tip 36 to provide the shovel with a greater degree of flexibility than the remainder of the ski. Thereafter the preimpregnated sheets are brought into intimate contact with the core section faces and cured to securely bond the sheets to the core. At the same time the resin is cured the core section is longitudinally deformed so that the resin cures while the sandwich has the desired longitudinal contour, including camber 32 and shovel 38, of the finished ski.

A preferred apparatus for curing the resin, bonding the strand sheets to the core and shaping the sandwich is illustrated in FIG. 4. It comprises a base 52 which supports a plurality of upright interchangeable blocks 54 carrying transverse rods 56. Blocks 54 can be replaced by blocks with differing height to thereby vary the contour defined by the uppermost part of rods 56. Placed over the rods and supported by them is a metal plate 58 which includes an upwardly curved forward end 60. Weights 62 are attached to the aft end of the plate and to a point just aft of the upwardly curved portion 60 which bias the plate downwardly into firm engagement with transverse rods 56. The plate thereby conforms to the contour defined by the rods and support blocks.

One or more first strand sheets are placed on plate 58, the honeycomb core section 48 is placed on the sheets and one or more additional first strand sheets are placed on the honeycomb core section. Thereafter a heated pressure ram 62 is brought to bear against the sheets and core section to thereby deform them in accordance with the shape of plate 58 and, simultaneously therewith, cure the resin so that the sheets and the core are securely bonded to each other. In a preferred construction the pressure ram is defined by an upper support 64, a curved contact plate 66 and downwardly extending, flexible skirts 68 which are secured and sealed to the upper support and the contact plate. A fluid inlet 70 provides communication with the interior space defined by the skirts and the contact plate. During molding hot air or steam is introduced into that interior space and provides the necessary biasing pressure to deform the honeycomb sandwich and the necessary temperature to cure the resin.

Referring to FIGS. 5 and 6, after the honeycomb sandwich has been finish formed and bonded it is severed into a plurality of strips having a width slightly greater than the maximum width of the final ski. Thereafter each strip is routed along a template (not shown) to give it the final plan outline of the ski (illustrated in FIG. 5) and form a ski sandwich. The second strands 18 are now applied to the ski.

Preferably, the strands are supplied in the form of long, relatively narrow bands 72 of a unidirectional fiber material having a plurality of parallel, longitudinally extending strands 18. The band is spirally wound about the ski sandwich so that the latter is completely enveloped by the former and the second strands define the exterior of the skis. Preferably, two or more layers of second strands are made which are cross-wound. After the bands have been wound about the ski sandwich they are impregnated with a resin, unless they are of the preimpregnated type, are placed in a suitable press (not separately shown) and heated to cure the resin. By applying an additional resin coat to the exterior of the wound bands and by employing sufficient pressure in the press the ski is given a smooth finished surface. Coloring agents are incorporated into the resin, or they are separately applied to the exterior of the wound bands prior or after the curing cycle, to give the finished ski the desired appearance.

Referring briefly to FIG. 9, a ski 10a is illustrated in which second strands 18 terminate at the aft end of ski shovel 38a. The ski shovel thereby exhibits greater lateral flexibility which is desired under certain skiing conditions,

The remainder of the ski retains the stiffness imparted by the cross-wound strands.

Referring briefly to FIG. 7, to increase the lateral strength of the ski and virtually eliminate any lateral ski deflection elongate strands 74 of a high strength material, such as fiberglass, boron or carbon filament strands are placed along sides 24 of the ski and bonded thereto with a bonding agent and with the subsequently wrapped bands 72. The longitudinal tracking stability of the ski is thereby substantially improved.

A wide choice of materials is available for the construction of the box member 14; presently it is preferred to employ thin fiberglass sheets, having a thickness of as little as .005 inch, for constructing the facings of the honeycomb core and defining longitudinal strands 16. The sheets are preferably preimpregnated with an epoxy resin and a catalyst that react under the influence of heat or an epoxy-catalyst mixture can be applied to the sheet just before they are placed on the honeycomb core sections 48.

Referring to FIG. 6, edge members 26 protrude past ski sides 24 and are secured to ski bottom 22 with a suitable bonding agent 76. Base 28 is placed over bottom side 22 and between the edge members and suitably bonded thereto to finish the ski.

To prevent damage to the upper ski side 20, and particularly to the upper corners, it is presently preferred to apply a relatively tough, resilient and abrasion resistant top edge or protective layer 78 over the exterior of the otherwise finished ski. The protective layer preferably extends across the full width of the top side and extends at least past the immediate vicinity of the top ski edges. Depending on its material, the protective layer can be coated, sprayed or bonded to the ski.

To prevent the transmission of substantial longitudinal forces via edge members 26, as would be the case if the edge members are continuous members bonded to the ski, they can be defined by a plurality of relatively short end-to-end mounted edge member sections. Force transmittal via the edge members between the tip and the aft end of the ski are thereby prevented. However, when the ski is subjected to vertical forces it deforms in a polygonal pattern instead of along a more desirable, continuous, smooth curve.

Referring now to FIG. 8, to overcome such polygonal ski deflection and reduce the force transmittal via the edge members to no more than a few percent of the total transmitted force a longitudinally flexible edge member 80 is mounted to each side of the ski. The flexible edge member is defined by a plurality of spirally wound metallic, e.g. steel strands 82 which are rolled or otherwise formed into a square or rectangular cross-section to define sharp outer edges 84. A plurality of inwardly extending, longitudinally spaced tabs are secured to the upper side of the flexible edge, as by welding them thereto, and are bonded to the underside 22 of the ski in the same manner as the continuous edge members 26 illustrated in FIG. 6 are bonded to the ski. During vertical deflection of the ski the flexible member bands with the ski without any significant transmission of longitudinal forces. Thus, virtually all longitudinal forces are transmitted via the honeycomb core and the surrounding box member. Since their construction has been closely controlled the force-deflection characteristic of a pair of matched skis is virtually identical. Furthermore, since the skis are water impermeable and their deflection characteristics are not

influenced by temperature changes encountered under atmospheric conditions the skis remain matched throughout their service life.

We claim:

1. An elongate lightweight article comprising: a honeycomb core extending over at least a major portion of the length, a fiber reinforced sheet secured to sides of the core and including substantially unidirectional first fiber strands parallel to the article length, and a diagonally oriented fiber reinforced wrapping secured to the sheet and the core and extending over at least a major portion of the article length, the wrapping including substantially unidirectional second fiber strands, whereby the article has sufficient strength to resiliently withstand a relatively sharply radiused, 90° bend.
2. An article according to claim 1 wherein the second strand means comprise a plurality of layers, each layer having strand means at an angular inclination with respect to strand means in an adjacent layer.
3. An article according to claim 2 wherein the second strand means in the layers are at an angular inclination with respect to each other of about 90°.
4. An article according to claim 1 wherein an end of the article defined by the first and second strand means only and the core terminates at a longitudinal position spaced from said end.
5. An article according to claim 1 wherein the core comprises honeycomb with a ribbon direction substantially parallel to the article length.
6. An article according to claim 1 wherein the second strand means extend diagonally with respect to the first strand means.
7. An elongate, lightweight article having a length substantially greater than its width, comprising: an expanded honeycomb core with ribbons extending in the direction of the length, first strands extending in the direction of the length rigidly connected to exterior surfaces of the honeycomb core, and a plurality of continuous second strands enveloping the core, angularly inclined with respect to the length and rigidly connected to the core.
8. An article according to claim 7 wherein the first strands define sheets bonded to faces of the core.
9. An article according to claim 7 wherein some of the second strands are angularly inclined with respect to others of the second strands.
10. An article according to claim 7 wherein the second strands form side walls of the article.
11. An article according to claim 7 wherein the second strands define an elongate band of strands wrapped about the core and the first strands.
12. An article according to claim 7 wherein the honeycomb core terminates short of at least one longitudinal end of the article to increase the longitudinal flexibility of the article.
13. An article according to claim 7 wherein the second strands terminate short of an end of the article.

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