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Fosha, Jr. et al.

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[54] **ADVANCED COMPOSITION SKI**

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[52] **U.S. Cl.**..... **280/11.13 L**; 156/172; 161/68

[51] **Int. Cl.**..... **A63c 5/00**; A63c 5/12

[58] **Field of Search**..280/11.13 L, 11.13 S, 11.13 F; 156/172, 185; 161/68

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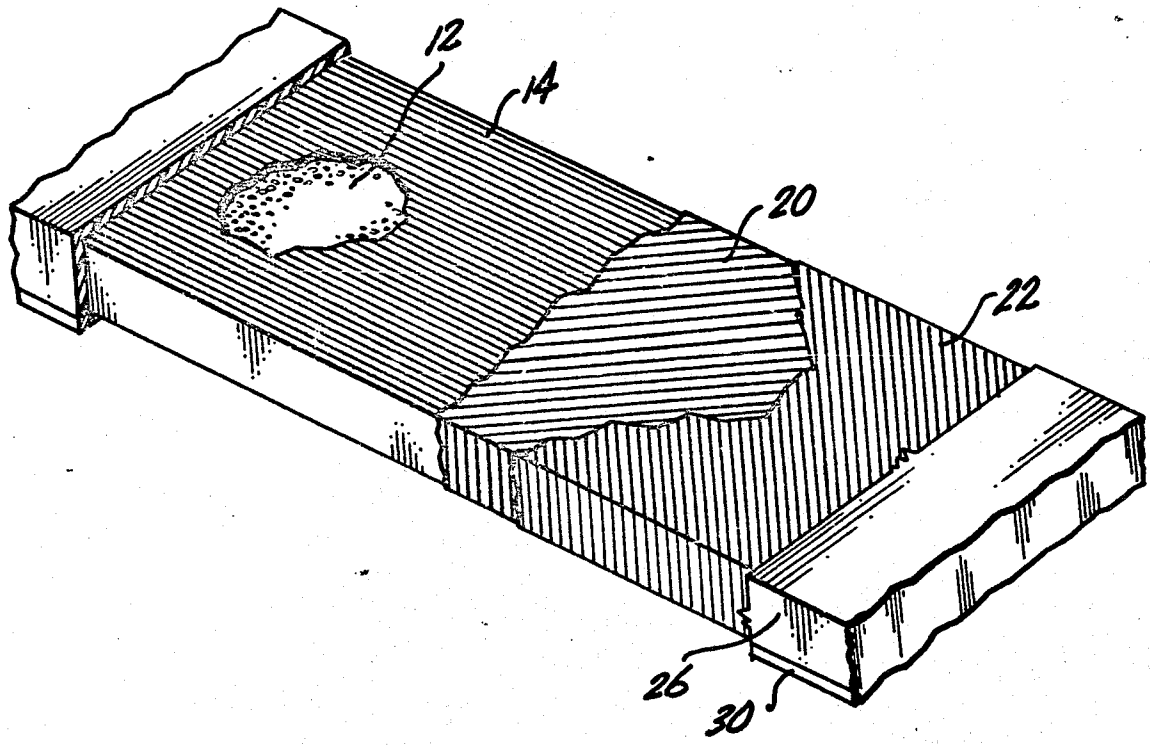
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[57] **ABSTRACT**

A lightweight ski and method of making same wherein the structural reinforcement for the ski has unidirectional graphite fibers in a resin matrix. Fibers extend longitudinally and at 45° from longitudinal.

2 Claims, 7 Drawing Figures



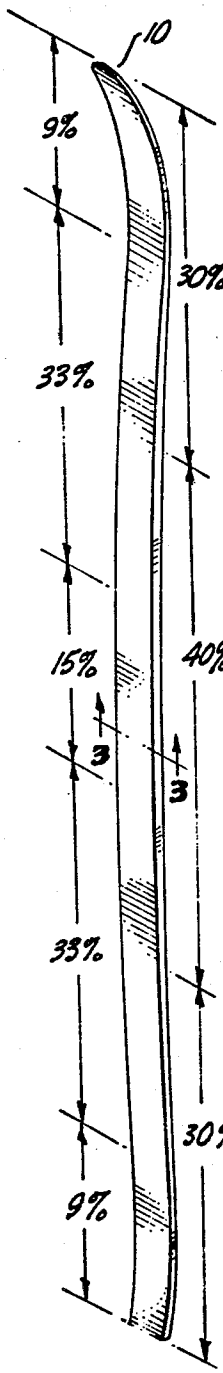


Fig. 1.

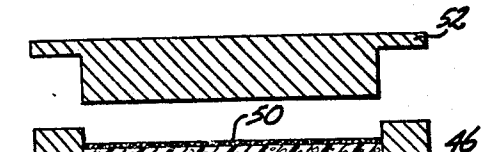


Fig. 5.

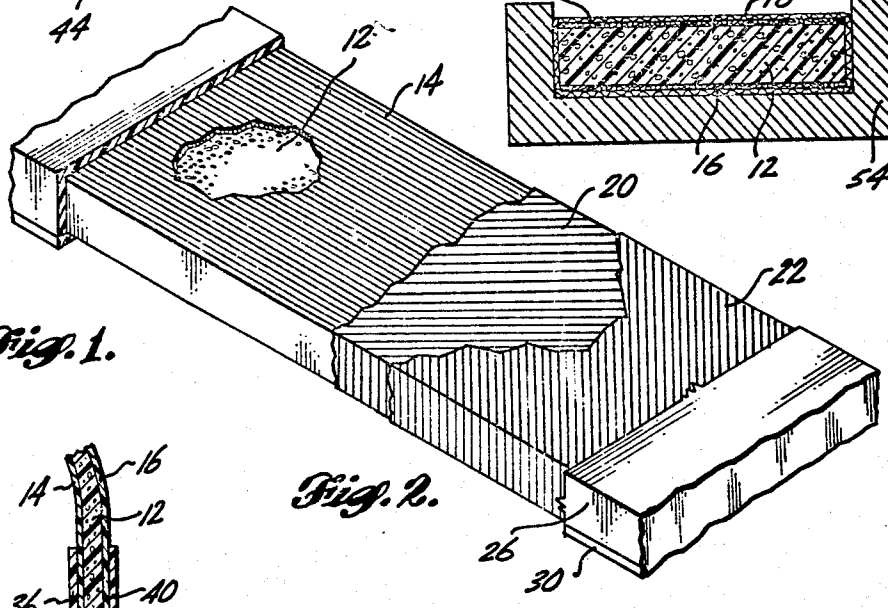


Fig. 2.

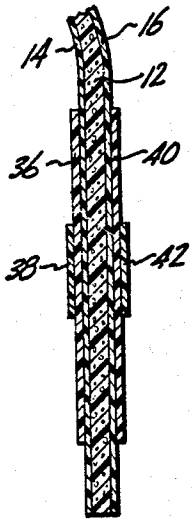


Fig. 4.

Fig. 7.

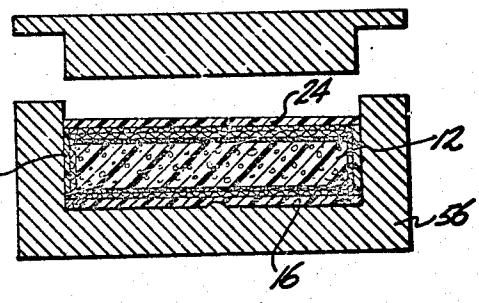


Fig. 6.

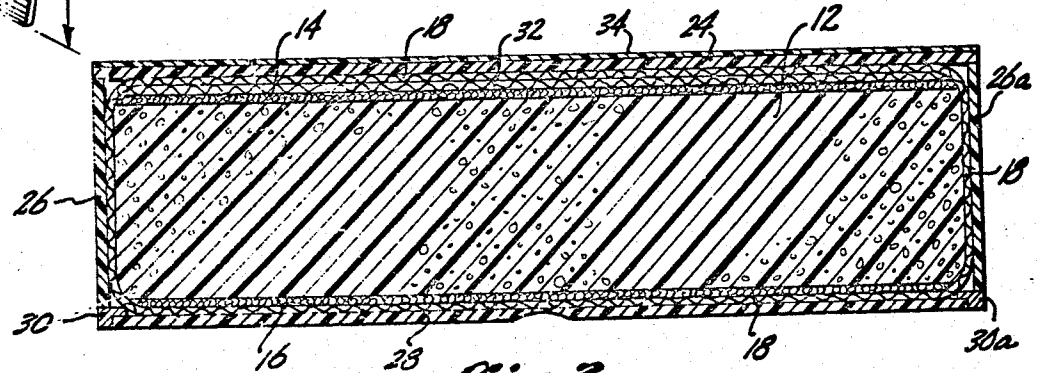


Fig. 3.

ADVANCED COMPOSITION SKI

BACKGROUND OF THE INVENTION

Recent art in making snow ski's have been to make ski's from a box structure for the sides, top and bottom which encases a core covered with a reinforcement of fiber glass all of which is laminated into a finished ski. The torsional and flexural characteristics of these ski's may be varied by changing the thickness pattern or by adding or subtracting material or by both. Providing ski's of varying thickness requires expensive tooling and adding materials increase the weight of the ski, while removing materials degrade the strength. Presently available standard size ski's (205 cm in length) have a minimum weight in excess of eight pounds per pair.

It was discovered that a ski may be obtained which weighs less than six pounds per pair and may have tailor-made flexural and torsional characteristics with a barely noticeable variation in thickness and/or weight.

BRIEF SUMMARY OF THE INVENTION

Unidirectional graphite fibers in a resix matrix are applied in a layer above and a layer below a core of a ski. The fibers are oriented such that they extend longitudinally along the core. It has been found that this combination of unidirectional graphite fibers in resin when incorporated into a ski with covering top, bottom and sides will provide proper reinforcement. In preferred embodiments the layer above and below the core will each have a thickness of from about 0.008 inch to 0.040 inch with a graphite volume percent of about 50 to 70 and a modulus of elasticity of about 10,000,000 p.s.i. to about 41,000,000 p.s.i. In yet other embodiments the thickness varies from about 0.016 inch to 0.032 inch and the modulus to from about 10,000,000 p.s.i. to 25,000,0000 p.s.i.

The greatest load bearing requirements on the ski, under the foot of the skier, is at approximately the lengthwise midpoint of the ski's. In practicing this invention the flexural characteristics may be varied from midpoint to the tip and from midpoint to the tail with stepwise layers of reinforcement with at least one layer extending the length of the ski, a second and shorter layer extending fore and aft from the lengthwise center of the ski and other yet shorter layers extending from the midpoint. The flexural characteristics may also be varied stepwise by the use of graphite fibers with different modulus of elasticity.

Unidirectional graphite fibers in a resin matrix spirally encompass the core of the ski with a layer of fibers extending at 45° from longitudinal in one direction and a second layer of fibers extending at 45° from longitudinal in the other direction, to control torsional characteristics. In one preferred embodiment each layer varies in thickness from about 0.004 inch to about 0.008 inch with a graphite volume percent of about 10 to 70 and the modulus of elasticity of from about 10,000,000 p.s.i. to 41,000,000 p.s.i. The torsional characteristics may be varied by stepwise layers or by varying the elastic modulus.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a ski.

FIG. 2 is a fragmented perspective view of the ski of FIG. 1, partially cut away to show the details of fiber orientation.

FIG. 3 is a cross section of the ski of FIG. 1 taken along the lines 3—3 in the direction of the arrows.

FIG. 4 is a lengthwise cross section of the ski of FIG. 1 showing only the core with an exaggerated thickness of layers of reinforcement having longitudinally extending fibers.

FIG. 5 is a sectional end view of core material located in a mold and sandwiched between reinforcing layers having longitudinally extending fibers.

FIG. 6 is a cross section as in FIG. 3 showing the assembled components of the ski in a mold.

FIG. 7 shows a sectional end view of a core with reinforcement layers in a mold.

DETAILED DESCRIPTION

This ski has as its reinforcement members unidirectional graphite fibers embedded in a resin. The graphite fibers or filaments are typically produced by using a rayon or pitch fiber, cross linking the polymer and finally converting to a graphite filament form of carbon at a temperature of about 1,000°C. High modulus and high strength characteristics of the filaments are developed in the filaments by stretching at temperatures of about 2,000°C. The tensile modulus of elasticity of the graphite fibers may be varied from about 27,000,000 p.s.i. to about 58,000,000 p.s.i. One may choose the fibers to place in a resin matrix to obtain the preferred tensile modulus of elasticity for use in ski's of from about 10,000,000 p.s.i. to about 41,000,000 p.s.i. for the cured matrix.

Bundles or tows of several thousand graphite filaments are encased in a resin matrix and flattened into tapes or broadgoods. The uncured thickness of these tapes may be from about 0.004 inch to 0.008 inch and the volume percent of graphite may be varied from about 10 to 70 percent. Several plies of these tapes may be placed one upon another without materially effecting the overall thickness of a ski. The fibers may be embedded in a matrix of epoxy, phenolic, and polyester resins to name a few of the resins that may be used with epoxy preferred. However, other resins may be used, and this is not intended to be limiting.

The arrangements of reinforcing unidirectional graphite fibers in a resin matrix is best shown in FIGS. 2 and 3. An integrated ski **10** has core **12**. This core may be of honeycomb, wood, or foamed plastic, such as but not limited to foamed polyurethane. A layer **14** of longitudinally extending graphite fibers in resin is placed above the core and a second layer **16** is placed below the core.

A pair **18** of reinforcing layers shown in FIG. 3 are positioned at 90° to each oher and are made up of a layer **20** and layer **22** best shown in FIG. 2. Layer **20** has unidirectional graphite fibers encircling the core **12** with the fibers extending at 45 degrees from longitudinal in one direction and fibers of layer **22** extending at 45 degrees in the other direction.

The core **12** with reinforcing layers **14, 16, 20** and **22** are alll encased or boxed in top section **24**, side section **26** and **26*a*** and bottom or runner section **28**. These encasing sections may preferably be made of acrylonitrile — butadiene — styrene (A.B.S.) or high density polyethylene known as P-Tex. The P-Tex is preferred as the bottom section to act as the running surface. These materials are in semi-rigid slabs and are formed to shape. The ski has L-shaped metal edge reinforcement runners **30** and **30*a***. If desired a metal or fiberglass rein-

forcement 32 may be used in the top center of the ski to accept fasteners from the binding. An optional decorative top sheet 34 may be used. A phenol formaldehyde or melamine formaldehyde resin is preferred for the decorative sheet as they are both abrasion resistant and color fast.

In one embodiment, see FIG. 4, the longitudinally extending reinforcing tape is arranged with additional layers 36 and 38 above the core and additional layers 40 and 42 below the core. These additional layers are centered on the lengthwise midpoint of the core and extend for varying lengths.

In yet another embodiment additional pairs of layers of 45° from longitudinal reinforcing tape extend stepwise varying lengths from the midpoint of the core.

Desired flexural and torsional strengths and flexibility patterns may be obtained by varying the structural strength of the fibers used at different points along the ski. In one preferred embodiment the longitudinally extending fibers in the reinforcing layer are made up by varying the number of plies, the modulus of elasticity and the volume percent of graphite at different lengths along the core. An overlap of about one-quarter inch is required for splicing between materials of different properties in the same ply. A center section layer, second section layer, extending outwardly from the center section in both directions and tip and tail sections extending outwardly from the second sections are used to obtain varying flexural characteristics. In one preferred embodiment the center section of about 15 percent of the length of the core has five plies of reinforcing tape above the core and four plies below the core with each ply of about 0.004 inch to 0.006 inch thick of a matrix with 65 percent graphite volume and an elastic modulus of about 23,000,000 p.s.i.; the second section of two parts with one part extending about 33 percent of the length of the core towards the tip, and the other extending about 33 percent of the length of the core towards the tail has four plies above and four plies below the core with each ply of about 0.004 inch to 0.006 inch thickness of reinforcing tape of 65 volume percent of graphite and an elastic modulus of about 18,000,000 p.s.i.; and a pair of end sections with each extending from a second section toward the tip or the tail of about 9 percent of the length of the core and having three plies above and three plies below the core with each ply about 0.004 inch to 0.006 inch thick of a reinforcing tape of 60 volume percent graphite and an elastic modulus of about 10,000,000 p.s.i. This preferred embodiment also uses a ply of reinforcing tape with graphite fibers extending at 45° in one direction from longitudinal and a second similar ply at 45° from longitudinal in the other direction. Each center section ply is about 0.004 inch to 0.006 inch thick and has a modulus of elasticity of about 10,000,000 p.s.i. and a graphite volume percent of 30 percent in the center about 40 percent of length. Each ply in the sections extending from the center section to the tip and from the center section to the tail have a thickness of about 0.004 inch to 0.006 inch, a graphite volume percent of about 65 and a modulus of elasticity of about 25,000,000 p.s.i.

The ski may be prepared by first preparing a core with cured reinforcing layers which is then placed inside the outer box-like members to form a ski assembly inside a mold and the assembly heated under pressure to obtain an integrated ski. The ski may also be prepared by making up the ski assembly in the final mold.

In FIG. 5 a reinforcing tape 44 of longitudinally extending graphite fibers in as resin is placed in the recess of a formed mold 46. Core material 48 and then another layer of reinforcing tape 50 of longitudinally extending graphite fibers in resin is placed on top and mold part 52 inserted into the recessed lower mold. The core with reinforcing layers is cured at about 250°–350°F at about 15–75p.s.i. The cured core with reinforcement is then cut to an undersize shape of a ski to become the reinforcement for a ski.

Alternatively reinforcement tapes 44 and 50 may each be placed in a formed mold or tool and cured at about 250°–350°F under pressures of about 15–75p.s.i. These tapes would then be coated with a suitable adhesive and bonded to core material 48 under temperatures and pressures as outlined above. If desired the shaped reinforced core now shown in FIG. 7 as core 12 with lower reinforcement 16 and upper reinforcement 14, may be encircled with a pair of 45° from longitudinal transverse reinforcing tape shown as 18 and either placed in the recessed mold 54 to be cured or placed directly in a ski assembly for final integration into a ski.

To form an integrated ski, see FIGS. 3 and 6, a bottom running surface member 28 is placed in a recessed mold 56, next metal edge members 30 and 30*a* are placed in the mold then side members 26 and 26*a*. The inside of these surfaces are coated with a suitable adhesive and the core with longitudinal and if desired transverse at 45 degree reinforcing fibers in resin placed inside the side and bottom box-type structure. The core with reinforcement may be prepared and precured or may be laid up inside the box structure. A top layer 24 with the side adjacent the structure coated with a suitable adhesive is placed on top to form a ski assembly which may be cured in the mold at about 250° to 350°F with a pressure of about 15 to 75 p.s.i. If desired the top center section of the ski may have metal or fiberglass sheet 32 placed in the assembly prior to curing. Optionally one may place decorative sheet 34 above the top member 24 before curing the assembly.

We claim:

1. An integrated ski comprising:

a. a core selected from materials consisting essentially of foamed plastic, wood and honeycomb;

b. a reinforcement layer above the core and a reinforcement layer below the core of unidirectional longitudinally extending graphite fibers imbedded in resin, each layer comprising: a center section extending throughout about the center 15 percent of length of the core of four plies, each about 0.004 inch to 0.006 inch thick of 65 volume percent graphite fibers and an elastic modulus of about 23,000,000 p.s.i., and one additional ply for the center section layer above the core, a second section extending outwardly in both directions from the center section, each part extending throughout about 33 percent of length of the core of four plies, each about 0.004 inch to 0.006 inch thick of 65 volume percent and an elastic modulus of about 18,000,000 p.s.i., and a third section of two parts with one part extending from the forward second section to the tip of the core and the second part extending from the aft part of the second section to the tail of the core with the parts of the third section each comprising three plies each about 0.004 inch to 0.006 inch thick of 60 volume percent of

graphite and an elastic modulus of about 10,000,000 p.s.i.

c. a pair of reinforcing layers of unidirectional graphite fibers imbedded in resin, one of which encircles the core with graphite fibers extending at 45° from longitudinal in one direction and the other encircles the core with its graphite fibers extending at 45° from longitudinal in the other direction, each layer in the pair comprises a center section extending throughout the center about 40 percent of length of the core of a single ply about 0.004 inch to 0.006 inch thick with a volume percent of graphite of about 30 percent and an elastic modulus of about 10,000,000 p.s.i., and a second section of two parts one of which extends from the center section to the nose of the core and the other extends from the center section to the tail of the core with each layer of the pair comprising a single ply about 0.004 inch to 0.006 inch thick with a volume percent of graphite of about 60 percent and an elastic modulus of about 23,000,000 p.s.i.

d. an outer bottom, top and sides of material consisting essentially of acrylonitrile — butadiene — styrene or high density polyethylene; and

e. a metal edge reinforcement at each junction between the bottom and a side.

2. An integrated ski as in claim 1, further comprising a metal layer between the top outer material and the core in the center section of the core.

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