United States Patent [19]

Molnar

[11] **3,928,106**

[45] **Dec. 23, 1975**

[54] **METHOD OF MANUFACTURING A SKI**

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[73] Assignee: **Molnar & Co., Inc.**, Boulder, Colo.

[22] Filed: **May 14, 1974**

[21] Appl. No.: **469,654**

[52] **U.S. Cl.** ..... **156/210;** 9/310 R; 156/245; 156/292; 264/286; 264/328; 280/11.13 L

[51] **Int. Cl.²** **B31F 1/22**

[58] **Field of Search** ..... 156/245, 210, 292; 9/310 A, 310 C, 310 R; 280/11.13 L, 11.13 V; 264/241, 250, 251, 328, 286

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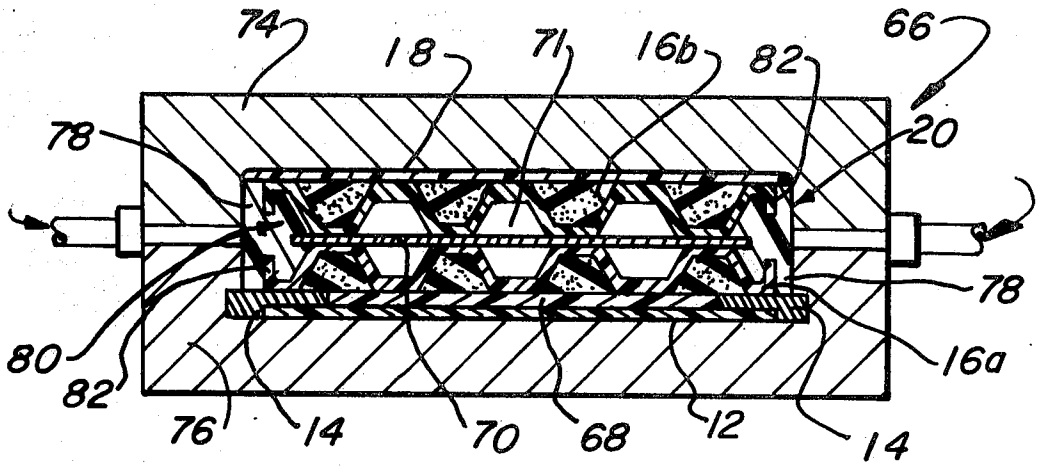
Primary Examiner—Caleb Weston

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[57] **ABSTRACT**

The method of the present invention includes the steps of forming a pair of elongated corrugated structural sheets with longitudinally extending open channels therein in the general peripheral configuration of the ski to be manufactured, forming planar top and bottom sheets to conform in general peripheral configuration to that of the structural sheets, filling at least one of the open channels in at least one of the structural sheets with a filler material, applying a layer of adhesive material between the structural sheets to thereby bond the structural sheets into a unified structural body, and affixing the planar top and bottom sheets to opposite faces of the unified structural body.

15 Claims, 12 Drawing Figures



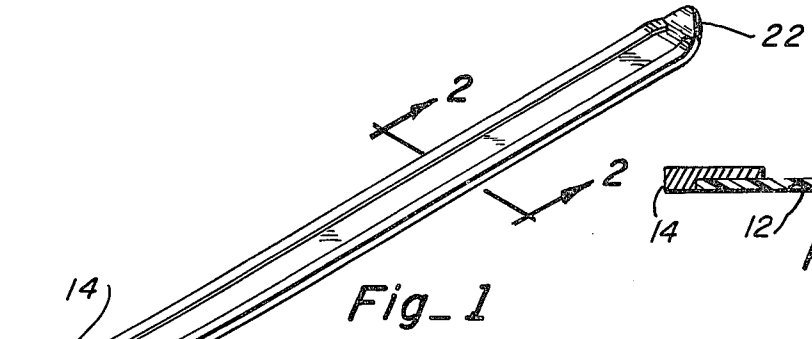


Fig_1

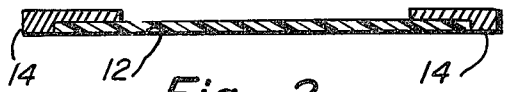


Fig_2

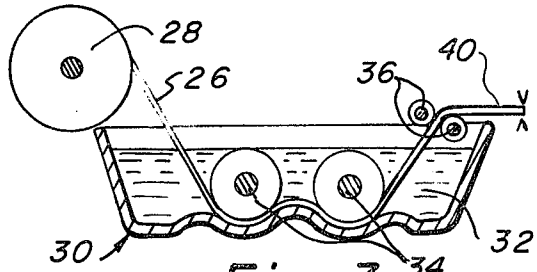


Fig_3

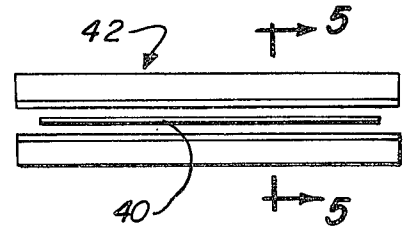


Fig_4

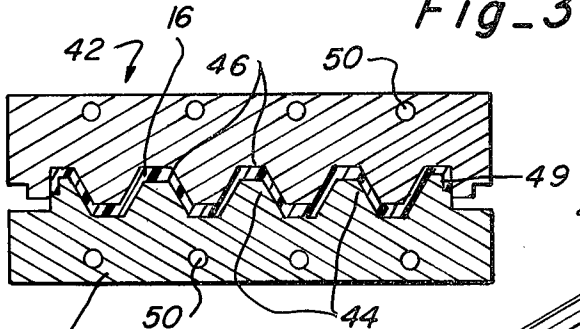


Fig_5

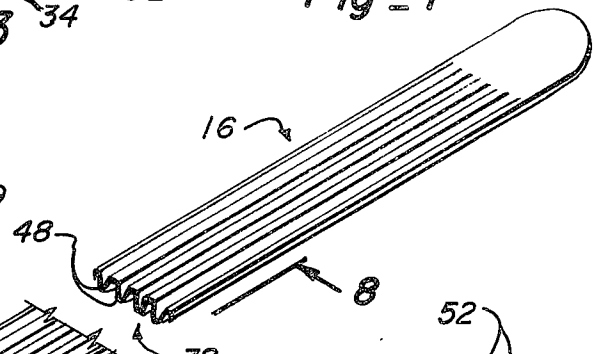


Fig_6

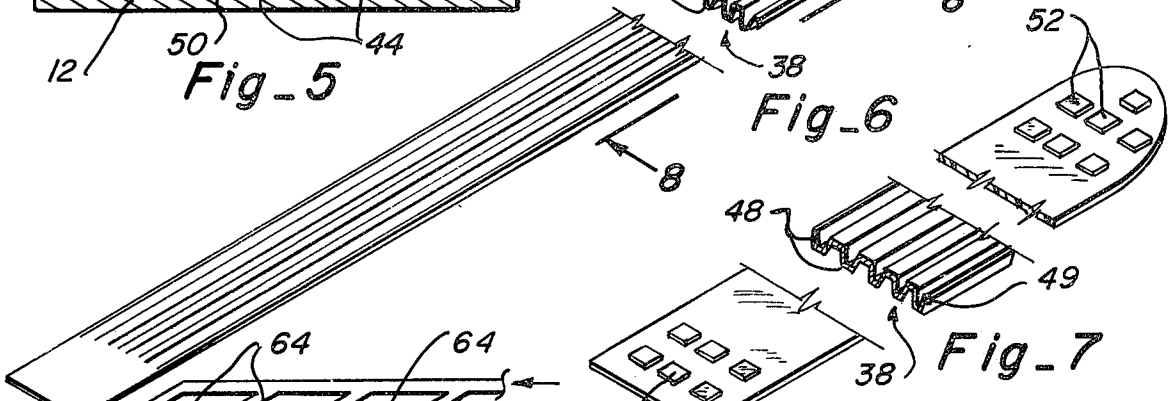


Fig_7

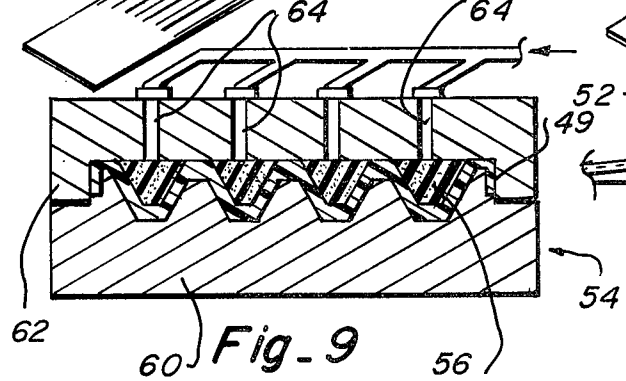


Fig_9



Fig_8

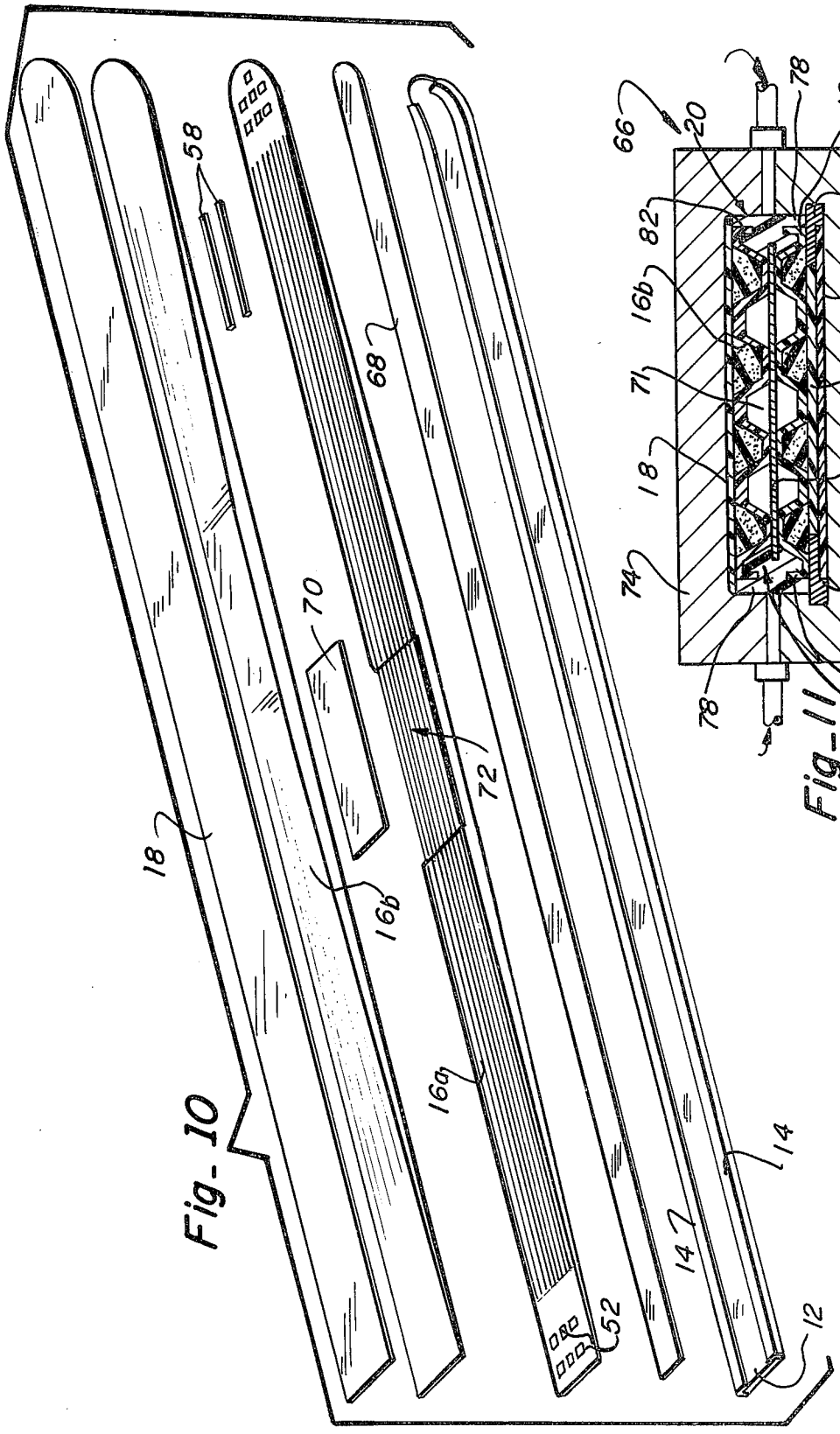


Fig. 10

Fig. 11

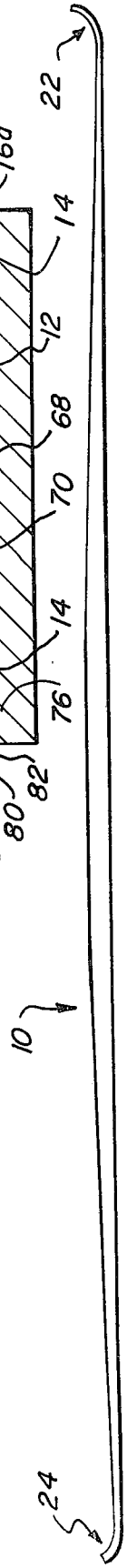


Fig. 12

METHOD OF MANUFACTURING A SKI

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to ski construction and more particularly to a method of manufacturing snow skis.

2. Description of the Prior Art

Typical skis, particularly those used for snow skiing, have previously been manufactured by forming a one-piece core body which extends substantially the full length and width of the ski, bonding a rigidifying strip of metal or the like to opposite faces of the core, then bonding a bottom sheet with a running surface to the rigidifying strip on the lower surface of the core and finally finishing the ski by bonding plastic strips along opposite side edges of the core and along the top surface of the rigidifying sheet on the upper surface of the core. One of the inherent problems in manufacturing a ski in this manner, is that the resultant ski is susceptible to delamination. More particularly, it can be appreciated that when a ski flexes, the top surface is compressed and the bottom surface is tensioned creating a tendency to break any bond lines except along the central neutral plane of the ski which has no compressive or tensioning stresses. Accordingly, with typical prior art skis wherein the rigidifying structural elements of the ski are bonded to the core on opposite sides of the neutral plane, there is a tendency for the structural elements to become separated or delaminated from the core of the ski causing a complete failure of the ski.

Other snow skis have been manufactured by completely surrounding a core member or members with a plastic material but when the ski is manufactured in this manner, it is very difficult to obtain the required delicate balance between rigidity and flexibility, while maintaining other important characteristics of the ski such as torsional response and vibration dampening. Accordingly, skis manufactured in this manner normally do not result in a ski having the desired performance characteristics, quality and uniformity of construction.

OBJECTS OF THE INVENTION

It is an object of the present invention to provide a new and improved method of manufacturing a ski wherein the resultant product will have the desired balance between rigidity and flexibility while maintaining the torsional response and vibration dampening characteristics of the ski.

It is another object of the present invention to provide a new and improved method of manufacturing a ski wherein the resultant ski product is durable, long-lasting and will not delaminate under normal use conditions.

It is another object of the present invention to provide a new and improved method of manufacturing a ski wherein a pair of corrugated structural sheets are bonded together into a unified structural body and at least some of the open channels in the corrugated structural body are filled with a filler material during manufacture of the ski.

It is another object of the present invention to provide a new and improved method of manufacturing a ski which results in a ski of uniform high quality.

It is another object of the present invention to provide a new and improved method of manufacturing a ski wherein the side walls of the ski are injected in locked relationship with the remainder of the ski during assembly of same.

It is another object of the present invention to provide a method of manufacturing a ski wherein the structural elements of the ski are bonded together along the central neutral plane of the ski to avoid delamination of the structural elements.

It is still another object of the present invention to provide a method of manufacturing a ski which is light weight to reduce moments of inertia and to increase maneuverability of the ski.

SUMMARY OF THE INVENTION

In accordance with the present invention, a ski can be manufactured which will have increased durability against repeated flexing and the customary stresses of skiing. The ski can be manufactured with independent controlled, predetermined distribution of longitudinal and torsional flexibility and also have the ability to dampen vibrations induced in the structure.

The method includes the step of bonding together along the neutral plane of the ski a pair of corrugated structural sheets to form a unified structural body of the ski and wherein the thickness of adhesive applied between the structural sheets is instrumental in establishing the desired balance between rigidity and flexiblity of the ski. Another step in the method of manufacturing the ski in accordance with the present invention is filling at least one of the open corrugations in at least one of the structural sheets with a filler material, the elasticity of which determines the torsional response of the ski. Still another step in the manufacture of the ski consists of adhesively bonding a bottom sheet to the structural body wherein the elasticity of the adhesive used determines the dampening characteristics of the ski.

Accordingly, by manufacturing a ski in accordance with the method of the present invention, the desired balance between rigidity and flexibility can be obtained while maintaining and/or changing the desired torsional response and vibration dampening characteristics of the ski. Further, the method of the present invention includes the step of forming side walls which are locked to the structural body so that they cannot be severed or released therefrom in normal usage.

It will be appreciated from the following detailed description of the method, that relatively rigid metal or fiberglass structural sheets are not required in the assembly of the ski to give the ski the desired rigidity but rather the rigidity is obtained by uniquely forming and assembling the parts in accordance with the particular method.

Other objects, advantages and capabilities of the present invention will become more apparent as the description proceeds taken in conjunction with the accompanying drawings.

FIGURE DESCRIPTION

FIG. 1 is a perspective view of the bottom sheet of a ski with metal edges affixed thereto.

FIG. 2 is an enlarged section taken along line 2—2 of FIG. 1.

FIG. 3 is a diagrammatic vertical section taken through an apparatus for impregnating resin in a fiberglass sheet which may be used in the method of the present invention.

FIG. 4 is a longitudinal elevational view of a mold which may be used in the process of the present invention to form the structural sheets.

FIG. 5 is an enlarged vertical section taken along line 5—5 of FIG. 4.

FIG. 6 is a perspective view of a structural sheet used in the method of the present invention with a portion thereof removed for clarity.

FIG. 7 is an enlarged perspective view similar to FIG. 6 showing parts of the structural sheet removed for clarity.

FIG. 8 is a fragmentary view taken in the direction of the arrows 8—8 of FIG. 6.

FIG. 9 is a vertical transverse section taken through an injection mold which may be used to fill the open channels in a structural sheet with a filler material.

FIG. 10 is an exploded perspective view of the component parts of a ski manufactured in accordance with the method of the present invention.

FIG. 11 is a transverse vertical section taken through an assembly mold which may be used to assemble the component parts of the ski in accordance with the present invention.

FIG. 12 is a side elevational view of a ski manufactured in accordance with the present invention.

DESCRIPTION OF A PREFERRED EMBODIMENT

Before describing in particularity the steps utilized in the method of the present invention, it should be mentioned that the particular order of the steps described hereinafter are not necessarily critical and that certain steps could take place before others and still obtain the benefits of the overall method of manufacture.

A ski **10** manufactured in accordance with the method of the present invention would include as component parts, a bottom sheet **12** having the bottom running surface to which metal edges **14** are attached, a pair of structural sheets **16** bonded together and to the bottom sheet, a top sheet **18** bonded to the opposite surface of the structural sheets **16** from the bottom sheet, and side walls **20** which extend longitudinally of the ski on opposite sides thereof. The particular manner in which these elements are prepared and assembled comprises the method of the present invention. Before assembling the component parts of the ski in accordance with the method of the present invention, it is preferable that the various parts be prepared for assembly so that the assembly of the parts can be done rapidly and efficiently in one operation.

The bottom sheet **12** of the ski is first formed by cutting a flexible high molecular weight polyethylene material, for example, a material marketed under the mark "P-tex" by Inter Montana Sports in Switzerland, in the peripheral configuration desired for the ski. For a typical snow ski, this configuration would be an elongated relatively thin rectangle with a rounded or pointed tip at one end as illustrated in FIG. 1.

Metal running edges **14**, which are conventionally used on snow skis, would then be cut from metal strips to the proper length and normally cleaned by sand blasting. The metal edges **14**, which are shown in FIGS. **1** and **2**, are then bonded to opposite side edges of the bottom sheet along substantially the entire length thereof. Preferably, before bonding the metal edges to the bottom sheet, the leading and trailing ends of the metal edges are curved in an arcuate manner so that when they are attached to the bottom sheet, they form an upturned leading tip **22**, FIG. **1**, and a more moderately upturned trailing end **24** of the bottom sheet.

The top sheet **18** of the ski can then be cut to conform substantially in peripheral configuration to that of the bottom sheet **12** and to be of substantially the same size except that the top sheet is slightly wider than the bottom sheet so as to have an equivalent width to that defined by the bottom sheet **12** with the metal running edges **14** affixed thereto as shown in FIG. **2**. The top sheet is cut preferably from a polyurethane material or from acrylonitrile-butadiene-styrene, commonly known as ABS.

The structural sheets **16**, which are unified in a manner to be described hereinafter, are an important feature of the ski as their construction eliminates the necessity of the metal or fiberglass sheet of material which has previously been necessary in snow skis to obtain the desired balance between rigidity and flexibility of the ski. The structural sheets could be formed in several ways but preferably, they are formed either from a pre-impregnated fiberglass resin sheet such as that manufactured under the mark "Scotchply" by 3M Company of Minneapolis, Minnesota, or from a fiber cloth such as one made of glass, boron, sapphire, carbon, graphite, ceramic, or any combination thereof which is post-impregnated with a resin such as epoxy, polyester or vinylester. Another suitable material for the structural sheets would be a reinforced thermoplastic. As illustrated in FIG. **3**, if the structural sheets **16** are made from the post-impregnated fiber cloth, they can be made by first passing the fiber cloth material **26** from a roll **28** into a tub **30** of resin **32** wherein spaced rollers **34** pinch the fiber cloth against the bottom of the tub in establishing an effective impregnation of the resin into the cloth and then wringing excess resin from the cloth as it is drawn from the tub by a pair of closely spaced pinching rollers **36**. The resin impregnated cloth, regardless of whether it is pre-impregnated or post-impregnated is cut to the desired peripheral configuration which would conform to that of the top and bottom sheets **18** and **12** respectively, and while it would be the same length as the top and bottom sheets, it would be cut wider than the top and bottom sheets to allow for the formation of corrugations **38** therein in a manner to be described presently.

After the resin impregnated fiber cloth **40** has been cut to the desired size and shape, it is molded to take the form shown in FIG. **6**. This could be done in several ways but preferably, it is done by placing the cut sheet of resin impregnated fiber cloth **40** into a mold **42** having male and female segments **44** and **46** respectively, which, as best shown in FIG. **5**, cooperate in forming longitudinally extending corrugations in the sheet. The corrugations **38** are characterized by trough-like channels **48** which open in opposite directions from both faces of the sheet. Also, at opposite side edges of the structural sheet, flanges **49** are formed which as will be described later, establish a locking groove for positively retaining the side walls of the ski. To accelerate the setting up or curing of the resin impregnated material in the mold, the mold may include heating elements **50** which raise the temperature of the mold and thereby, according to known phenomena, accelerate hardening of the resin. The longitudianlly extending corrugations **38** are formed substantially along the entire length of the ski but are terminated short of the leading and trailing ends of the ski as it is desirable in ski construction that the leading and trail-

ing ends have more flexibility than the intermediate portion of the ski.

Preferably, the mold is provided with mating male and female portions which form dimples **52** in the flat leading and trailing ends of the structural sheet **16** with the dimples in the disclosed form being of square configuration as shown in FIG. **7.** These dimples, as will be appreciated with the description hereafter, serve to facilitate interconnection of the structural sheets and in a manner such that the flexibility of the leading and trailing ends of the ski can be controlled with an injected plastic material which also protects the leading and trailing tips.

After the structural sheets **16** have been molded into the form shown in FIG. **6,** they are placed in an injection mold **54** of the type shown in FIG. **9,** wherein a filler material **56** which is preferably an elastic semi-flexible foam such as a synthetic polyurethane, epoxy, or syntactic foam, is injected into either all or selected ones of the open corrugatins **48** on one side of the structural sheet. Depending upon the torsional response desired for the ski, the corrugations on one side of both structural sheets used in a ski can be filled or selected ones of the open channels in either of the structural sheets can be filled. Further, if it is desired that one location along the length of the ski be more rigid than the rest of the ski, strips **58** of a more rigid material, FIG. **10,** such as a pre-cured semi-rigid plastic or wood, may be inserted into the open corrugations **48** at the location where the rigidity is desired, prior to injecting the foam **56** into the channels. The mold **54** illustrated in FIG. **9** has a bottom or female mold portion **60,** which could be identical to the female portion **46** of the mold **42** illustrated in FIG. **5** for forming the structural sheets, and a top mold portion **62** which has injection openings **64** aligned with each open channel so that the foam **56** can be injected into the channels in a conventional manner. After the foam has cured or set up, the structural sheet is removed from the injection mold **54** and is ready for assembly with the other component parts of the ski.

The component parts of the ski are assembled in an assembly mold **66** illustrated in FIG. **11** and preferably, the bottom sheet **12** is first placed in the mold with the running edges **14** extending along opposite sides of the hollow cavity in the mold. It will be appreciated that a space exists between the metal running edges **14** across the top surface of the bottom sheet **12** and this space is filled with a flexible adhesive bonding medium for securing the bottom sheet to the adjacent structural sheet. Preferably, the space is filled with a fiber cloth **68,** FIG. **10,** which has been impregnated with a suitable adhesive.

The lower structural sheet **16***a* is then placed on top of the bottom sheet and the resin impregnated fiber cloth **68** so that the foam filled channels **48** in the structural sheet are directed downwardly in engagement with the resin impregnated fiber cloth **68.** A layer of adhesive material such as an epoxy resin is then spread across the top surface of the lower structural sheet. After the adhesive has been spread on the lower structural sheet, a metal or fiberglass binding plate **70** may be placed on the top of the lower structural sheet **16***a* at approximately the longitudinal center thereof, as shown in FIG. **10.** The binding plate serves as a means for positively anchoring ski bindings to the ski after it is complete. If the binding plate **70** is used, the structural sheets are preferably provided with a recessed portion **72** at the approximate longitudinal center to receive the binding plate and this recess could be formed in the mold of FIG. **5** as the corrugations are formed. Following placement of the binding plate **70** upon the lower structural sheet **16***a*, the upper structural sheet **16***b* is placed in face-to-face abutting relationship with the lower structural sheet and the binding plate **70** with the foam filled open corrugations of the upper sheet facing in an upward direction so that a plurality of open tubular channels **71** are established between the structural sheets. The adhesive used to bond the structural sheets **16***a* and **16***b* is also placed on the square dimples **52** at opposite ends of the structural sheets so that these dimples are also bonded and securely attached. It will be appreciated, however, that a space will exist between the structural sheets at the leading and trailing ends between the square dimples **52** and this space as will be mentioned later, will be filled with a plastic material to obtain desired rigidity for the leading and trailing ends of the ski. With the structural sheets **16** in face-to-face relationsip, a flexible adhesive is spread across the top surface of the upper structural sheet **16***b* and the top sheet **18** of the ski placed thereon so that each component part of the ski is positioned in place within the assembly mold. The top half **74** of the assembly mold is then placed upon the bottom half **76** to press the component parts of the ski against each other and they are retained in this pressed relationship until the adhesives used between adjacent parts cure thereby securely bonding the component parts of the ski together.

While the adhesives are curing or afterwards, the side walls **20** of the ski are formed by injecting a plastic material **78** into the sockets **80** defined by the flanges **49** on opposite sides of each structural sheet so that each side wall is integral and positively locked to the bonded structural sheets so that delamination is prevented. The side wall material is preferably polyurethane, polyethylene, polysulfone, a syntactic foam or ABS. It will be appreciated that the side wall material **78** is injected into the side of the ski either at one or a plurality of spaced locations along the length of the ski and on opposite sides thereof and the material, since it is injected under pressure, flows not only along the sides of the ski but into the leading and trailing ends of the ski between the square dimples **52** so that the leading and trailing ends of the ski obtain the balance between rigidity and flexibility desired for these locations. After the complete side walls and leading and trailing ends of the ski have been filled with the plastic injected material **78,** it is allowed to cure until hardened and the ski is then removed from the assembly mold.

The ski **10** is in its final assembled form will appear as shown in FIG. **12.** The assembly mold **66,** of course, is designed to form the upturned leading and trailing ends **22** and **24** respectively, of the ski and to form the desired arch or longitudinal camber of the ski.

It has been found that by manufacturing skis in accordance with the aforedescribed method, that a ski can be made in a fast, efficient and reliable manner and will result in a product which will not delaminate under normal use conditions as has been characteristic of prior art skis. Further, by manufacturing the ski in accordance with the method of the present invention, complete and independent control is maintained over the balance between rigidity and flexibility as well as the torsional response and vibration dampening characteristics of the ski.

Although the present invention has been described with a certain degree of particularity, it is understood that the present disclosure has been made by way of example and that changes in details of structure may be made without departing from the spirit thereof.

What is claimed is:

1. A method of manufacturing a ski comprising the steps of:
- forming a pair of elongated corrugated structural sheets with open channels therein in the general pheripheral configuration of the ski to be manufactured,
- forming a bottom sheet to conform in general peripheral configuration to that of the structural sheets,
- filling at least one of the open channels in at least one of the structural sheets with a filler material,
- applying a layer of adhesive material to at least one of the structural sheets so that when the structural sheets are placed in face-to-face abutting relationship, the contacting surfaces of the structural sheets will be bonded leaving open tubular passages between the structural sheets,
- placing the structural sheets in face-to-face relationship with the adhesive material therebetween to bond the structural sheets into a unified structural body,
- affixing the bottom sheet to one face of the unified structural body, and
- applying a top layer to the opposite face of the unified structural body.

2. The method of claim 1 wherein a plate is positioned betewwn the structural sheets and at the approximate longitudinal center thereof before the structural sheets are unified into the structural body.

3. The method of claim 1 further including the step of injection molding side walls to opposite edges of the structural body.

4. The method of claim 1 wherein said corrugated structural sheets are formed by placing a sheet of resin impregnated fiberglass between the male and female die portions of a mold, inserting the male die portion into the female die portion to force the fiberglass sheet to assume the configuration of the die portions, allowing the fiberglass sheet to cure until it has hardened, and removing the hardened fiberglass sheet from the mold.

5. The method of claim 4 wherein said sheet of resin impregnated fiberglass is formed by advancing a sheet of woven fiberglass matting through a bath of resin and subsequently removing excess resin from the fiberglass matting.

6. The method of claim 1 further including the step of affixing elongated metal strips along opposite side edges of the bottom sheet after the bottom sheet has been formed.

7. The method of claim 6 wherein said metal strips are affixed to the bottom sheet by an adhesive mixture.

8. The method of claim 1 wherein the open channel in at least one of the structural sheets is filled with a filler material by placing the structural sheet in an enclosed mold and injecting the filler material under pressure into the open channel.

9. The method of claim 8 wherein the oppositely facing open channels on both structural sheets are filled.

10. The method of claim 8 wherein a semi-rigid strip of material is placed at a pre-selected location in the open channel to be filled with the filler material before the filler material is injected into the channel.

11. A method of manufacturing a ski comprising the steps of:
- forming a bottom sheet in the peripheral configuration of the ski to be manufactured,
- forming a pair of corrugated structural sheets conforming to the general peripheral configuration of the bottom sheet with open channels in both faces of at least one structural sheet,
- filling at least some of the open channels in the structural sheets with a filler material,
- placing the bottom sheet in an assembly mold with a layer of adhesive on the top surface thereof,
- placing the structural sheets with a layer of adhesive therebetween in face-to-face relationship in the assembly mold on top of the bottom sheet so that the structural sheets are bonded along the surfaces of engagement and have open tubular passages therebetween,
- closing the assembly mold, and injecting a hardenable plastic material into the assembly mold along both sides of the assembled components of the ski to form the sides of the ski,
- allowing the adhesives and hardenable plastic material to cure before removing the assembled ski from the assembly mold, and
- applying a top layer over the uppermost structural sheet.

12. The method of claim 11 further including the step of affixing metal strips along opposite sides of the bottom sheet prior to placing the bottom sheet in the assembly mold.

13. The method of claim 11 wherein said corrugated structural sheets are formed by placing a sheet of resin impregnated fiberglass between the male and female die portions of a mold, inserting the male die portion into the female die portion to force the fiberglass sheet to assume the configuration of the die portions, allowing the fiberglass sheet to cure until it has hardened, and removing the hardened fiberglass sheet from the mold.

14. The method of claim 13 wherein at least one of said structural sheets is recessed at approximately its longitudinal center and a metal plate is placed in the recess between the structural sheets when the structural sheets are placed in the assembly mold.

15. The method of claim 14 wherein a strip of a semi-rigid material is placed at a selected location in at least one of the open channels in at least one of the structural sheets prior to filling the open channel with a filler material.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,928,106 Dated December 23, 1975

Inventor(s) Arpad A. Molnar

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 21, after "also" insert -- will --.

Column 7, line 32, delete "betewwn" and insert -- between --.

Signed and Sealed this

eleventh Day of *May 1976*

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks