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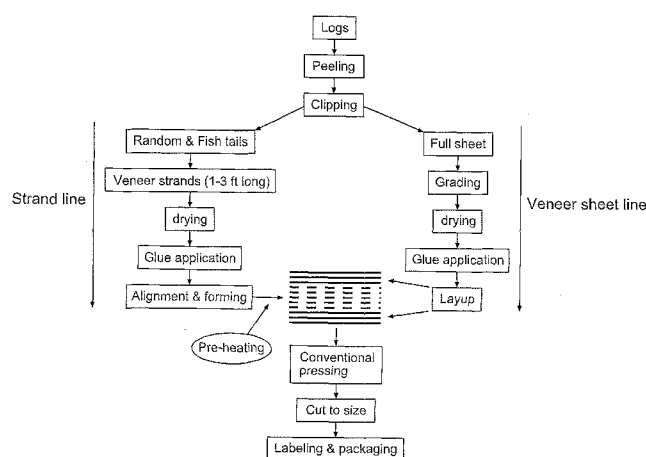


FIG. 4

(57) Abstract: A method for making a composite veneer strand lumber product core is provided. The method includes the steps of: (a) applying a resin to a plurality of veneer strands; (b) aligning the veneer strands and forming them into a mat; and (c) pressing the mat of veneer strands with a press. A method for making a composite veneer strand lumber product is also provided. The method includes the steps of (a) making a composite veneer strand lumber product core as described, the core having an upper face and a lower face; (b) applying a resin to a plurality of veneer sheets; (c) assembling one or more of the veneer sheets on each of the upper face and lower face of the core to form a three layer combination of: an upper veneer sheet layer, a core layer including strands and a lower sheet veneer layer; and (d) pressing the three layer combination together with a press.

COMPOSITE VENEER STRAND LUMBER AND METHODS AND SYSTEMS FOR MAKING SAME

Technical Field

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This invention relates to structural composite lumber (SCL) products and methods and systems for making same.

Background

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Developing structural composite lumber (SCL) is an important strategy for responding to decreasing timber resources and increasing demand for wood products.

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Commercially produced SCL products include oriented strand lumber (OSL), laminated veneer lumber (LVL), and parallel strand lumber (PSL, also known as Parallam™). LVL and PSL use veneers. PSL is a proprietary product often considered to have been invented by Barnes (US Patent No. RE 30,636). A similar product using veneer strands has also proposed by Parker (US Patent Application Publication No. US 2008/0110565).

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LVL, although lightweight, has low wood recovery because the product uses mostly full veneer sheets (normally 4 ft by 4 ft or 4 ft by 8 ft in size), and it does not use or uses very little non-full veneer sheets such as random (narrow) sheets and “fishtails” (as they are known in the art). The non-full veneer sheets that are wasted normally account for 15-20% of total wood volume. In the case of dry logs or mountain pine beetle (MPB) killed logs, the proportion of wasted non-full veneer sheets rises to 30-40%. In most cases, these waste veneers are converted to chips which are of low value.

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PSL aims to utilize all veneer sheets by cutting full and non-full veneer sheets into strands and gluing them using high pressure which, combined with high pressing temperature, results in high wood densification. The end product is usually 40-50 heavier than the original wood. Compared to LVL, PSL is also about 30-35% heavier. As such, the resulting volumetric

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recovery of wood is low. Another problem with PSL is the extra transportation cost that must be incurred in bringing veneer sheets in from other veneer mills.

PSL and OSL are not ideal composite lumbers in terms of forest utilization and production cost to achieve desired strength and stiffness. Producers of the two products claim a mass conversion of up to 65% of a whole log into high grade structural lumber, but the actual volume conversion from logs to products is typically only 35% or lower. Between these two products, OSL has much lower mechanical properties than PSL while PSL has a much higher wood cost than OSL. An SCL product as stiff as PSL and yet as inexpensive to produce as OSL is desirable.

Three criteria for developing a desirable structural lumber product are:

1. High specific Modulus of Elasticity (MOE);
2. High volume raw material conversion ratio; and
3. Scalable manufacturing process.

1. Product of high specific Modulus of Elasticity (MOE)

Modulus of elasticity (MOE) is a measure of material's stiffness. This property is of high importance for structural material, and is also commonly used to rate structural products. Different products have different MOE values, and accordingly there are requirements on MOE values of products for different end-applications. For example, the MOE value of regular oriented strand board (OSB) products is approximately 0.47 to 1.14E (MM psi) along the major axis and 0.08 to 0.36E (MM psi) across the major panel axis, respectively. For premium OSB products, the minimally required MOE ranges are 0.75 to 1.15 E and 0.25 to 0.5E respectively. For I-joist components, the minimally required MOE value is about 1.30 E (MM psi). For railroad ties, the required MOE value is equal to or above 1.80 E (MM psi). For specialty structural beam products, the MOE required by the customer may be as high as 2.1E (MM psi). The specific MOE is a material MOE divided by its density. It is also known as the MOE-to-weight ratio or MOE -to-density ratio. High specific MOE of a material means that it possess high MOE value at a relatively lower density, which is preferred.

2. High volume conversion ratio for final product from raw material

With the increase in wood product demand and the decrease in wood supply, the price of wood is increasingly getting higher. A low volume conversion ratio requires more raw materials required to produce a product with desired properties, which results in higher wood cost and makes the producers less competitive. In order to raise volume conversion ratio for the final products from raw wood materials, there are two keys:

- To make more usable strands out of the logs, i.e., less splinters, and fines or other waste during the strand preparation process.
- To optimize the structure of the product to make it stronger at a relatively lower density, i.e., to make a product with high specific MOE.

3. Pragmatic for large-scale production

Usually, it is easier to make a prototype product with excellent properties in a lab than in full production. A prototype SCL product should meet the following criteria for commercial potential:

- Easy, simple and reproducible in a large-scale production;
- Low production cost;
- Abundant supply of raw materials; and
- Easy acceptance by the current market, with potential to expand to new markets.

An SCL product that meets at least some of the above criteria and addresses at least some of the drawbacks of existing SCL products is desirable.

Summary

The following embodiments and aspects thereof are described and illustrated in conjunction with systems and methods which are meant to be exemplary and illustrative, not limiting in

scope. In various embodiments, one or more of the above-described problems have been reduced or eliminated, while other embodiments are directed to other improvements.

One aspect provides a method for making a composite veneer strand lumber product core

5 including the steps of:

- (a) applying a resin to a plurality of veneer strands;
- (b) aligning the veneer strands and forming them into a mat; and
- (c) pressing the mat of veneer strands with a press.

10 Another aspect provides a method for making a composite veneer strand lumber product including the steps of:

- (a) making a composite veneer strand lumber product core according to the above-noted method for making a composite veneer strand lumber product core, the core having an upper face and a lower face;
- 15 (b) applying a resin to a plurality of veneer sheets;
- (c) assembling one or more of the veneer sheets on each of the upper face and lower face of the core to form a three layer combination of: an upper veneer sheet layer, a core layer including strands and a lower sheet veneer layer; and
- (d) pressing the three layer combination together with a press.

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Another aspect provides a method for making a composite veneer strand lumber product including the steps of:

- (a) applying a resin to a plurality of veneer strands;
- (b) aligning the veneer strands and forming them into a mat of veneer strands;
- 25 (c) applying a resin to a plurality of veneer sheets;
- (d) assembling a layered combination of veneer sheets and veneer strands, the combination having a lower layer including one or more of said veneer sheets, a middle layer including the mat of veneer strands and an upper layer including one or more of said veneer sheets; and
- 30 (e) pressing said layered combination with a press.

Another aspect provides a method for making a composite veneer strand lumber product including the steps of:

- (a) applying a resin to a plurality of first veneer strands and a plurality of second veneer strands, wherein the first veneer strands are larger than the second veneer strands;
- (b) aligning the first veneer strands and forming them into a lower mat of veneer strands and an upper mat of veneer strands;
- (c) aligning the second veneer strands and forming them into a middle mat of veneer strands;
- (d) assembling a layered combination of veneer strands, the combination having a lower layer including the lower mat of veneer strands, a middle layer including the middle mat of veneer strands and an upper layer including the upper mat of veneer strands; and
- (e) pressing said layered combination with a press.

Another aspect provides a veneer strand lumber product including a first layer including one or more veneer sheets, a second layer including a plurality of veneer strands and a third layer including one or more veneer sheets.

Another aspect provides a method according to any of the above-noted methods including a final step of cutting the product produced by the method into lumber having desired predetermined dimensions.

Another aspects provides a system for carrying out any of the above-noted methods wherein logs are cut into both full veneer sheets and non-full veneer sheets, and wherein the non-full veneer sheets are subsequently clipped into the veneer strands.

In addition to the exemplary aspects and embodiments described above, further aspects and embodiments will become apparent by reference to the drawings and by study of the following detailed descriptions.

Brief Description of Drawings

In drawings which show non-limiting embodiments of the invention:

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Figure 1A shows a front schematic view of veneer strand lumber (VSL) according to one embodiment of the invention; Figure 1B shows a perspective view of the embodiment shown in Figure 1A.

10 Figure 2 is a flowchart showing a core layer formation and production process according to one embodiment of the invention.

Figure 3A shows a cross-section of a strand for making VSL according to one embodiment of the invention; Figure 3B shows VSL incorporating strands of the type illustrated in Figure
15 3A; Figure 3C shows a cross-section of a strand for making VSL according to one embodiment of the invention; Figure 3D shows VSL incorporating strands of the type shown in Figure 3C.

Figure 4 is a flowchart showing an integrated veneer sheet - veneer strand production system
20 according to one embodiment of the invention.

Figure 5 is a flowchart showing an integrated veneer sheet - veneer strand production system according to one embodiment of the invention.

25 Figure 6 is a flowchart showing an integrated veneer sheet - veneer strand production system according to one embodiment of the invention.

Figure 7 is a graph showing a pressing schedule for VSL according to one embodiment of the invention.
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Figure 8 illustrates the structure of VSL according to one embodiment of the invention alongside the structures of PSL, LVL, and OSL.

Figure 9 illustrates the structure of VSL according to one embodiment of the invention along side the structure of cross laminated timber (CLT).

- 5 Figure 10 is a table showing the density and bending properties of VSL according to one embodiment of the invention made from mountain pine beetle (MPB) killed logs.

Detailed Description

- 10 Throughout the following description, specific details are set forth in order to provide a more thorough understanding of the invention. However, the invention may be practiced without these particulars. In other instances, well known elements have not been shown or described in detail to avoid unnecessarily obscuring the invention. Accordingly, the specification and drawings are to be regarded in an illustrative, rather than a restrictive, sense.

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A low cost high performance SCL product termed veneer strand lumber (VSL) has been developed by the present inventors. VSL has been found to be lightweight, high yield, and to possess high stiffness and strength.

- 20 Certain embodiments of the invention relate to a three-layer VSL in which the upper and lower layers include veneer sheets in longitudinal alignment, and in which the core layer includes veneer strands in either longitudinal or lateral alignment. VSL differs from existing products such as LVL and PSL by combining the use of full veneer sheets and veneer strands in one product. The veneer strands can be cut from non-full veneer sheets including
- 25 “fishtails” and random veneer sheets, significantly minimizing the loss that would otherwise result from such waste veneers. Wood recovery with VSL is estimated to be 10-15% higher than PSL and LVL. The performance of VSL can be manipulated, for example, by using different grades of full sheets and densifications.

Certain embodiments of the invention relate to methods for making VSL, including making VSL in a single facility, eliminating for example the cost of shipping non-full veneer sheets. In certain embodiments VSL may be glued using one-step pressing, after the veneer sheet and veneer strand layers are processed separately in clipping, drying and glue applications and
5 joined together during the forming operation.

Certain embodiments of the invention (A) make and use veneer strands with specific geometry and size, (B) achieve excellent strand orientation by employing a vibrating orienter, (C) employ a dual resin system to easily handle resinated strands and achieve better bonding,
10 and/or (D) provide heating methods which achieve a faster rise in core temperature to shorten hot-pressing time.

VSL may be made from regular wood and lower quality wood such as MPB-killed wood, decadent wood (e.g. hem-fir), and other lignocellulosic materials such as bamboo, plant fibre,
15 hemp fibre, and the like.

Figures 1A and 1B shows the structure of VSL 10 according to one embodiment of the invention. VSL 10 includes upper surface layer 12 and lower surface layer 14 of continuous veneer sheets and a core layer 16 of veneer strands, all aligned in a longitudinal direction. In
20 alternative embodiments the veneer strands of the core layer may be aligned in a lateral direction to achieve more balanced properties in both directions. In some embodiments, the upper and lower surface layers may consists of 1-5 veneer sheets while the core layer is occupied by veneer strands. In some embodiments the upper and lower surface layers may consist of greater than 5 veneer sheets each. The number of sheets in the upper and lower
25 surface layers may or may not be the same.

Figure 2 illustrates an overall core formation and production process according to an embodiment. The logs are peeled, then clipped into strands. The strands may be 1/4 - 2 inches wide and may be 1 - 3 feet long. The strands may have angled cross-sections as
30 shown in Figures 3C and 3D. Compared to strands having rectangular cross-sections as shown in Figures 3A and 3B, strands having angled cross-sections may pack more closely during forming and reduce densification during pressing. The strands are dried, and then

applied with a structural glue or resin such as phenol formaldehyde (PF) in a different line. Next, the strands are aligned and formed into a parallel strand mat. While the alignment and mat formation step may be accomplished by many different means known in the art, the inventors have also invented a new strand mat forming system which is believed to be useful in this step, as described in US provisional application no. 61/331808, and in an International Patent Application filed concurrently with this present application, both of which are incorporated herein by reference in their entireties.

The strand mat may be preheated to 80-90 °C using hot air, steam or high frequency heating methods (e.g. microwave or RF radiation), before it is pressed. The mat may then be pressed using a conventional hot platen or other pressing method. Pre-heating enables the strand core to be compressed to a higher density. The completed mat may then be further cut and/or finished into a variety of VSL products including those shown in Figures 8 and 9, as discussed below. The foregoing method may, for example, be used to form the core of the VSL shown in Figure 3D.

Figure 4 illustrates an embodiment in which both veneer sheets and veneer strands for use in the invention are produced. The logs are peeled into veneers, which are then clipped into strands or full sheets depending upon sheet continuity. Non-full sheets such as fishtails and random sheets are clipped, preferably into angled strands (see Figures 3C and 3D), which may be 1/4 - 2 inches wide and 1 - 3 feet long. The full sheets are graded, dried and applied with a structural glue or resin such as phenol formaldehyde (PF) in a different line. The strands are likewise glued and aligned and formed into a parallel strand mat as described above. The strand mat may be preheated to 80-90 °C, before it is merged with full veneer sheets. The combination is then pressed using a conventional hot platen press. The pre-heating enables the strand core to be compressed to a higher density than that of the surface veneer sheets, in order to achieve adequate bonding throughout the product. Preheating also helps shorten the total press time. The resultant product may, for example, be the VSL shown in Figure 3D, comprising the densely packed core formed from optimally shaped and aligned strands, laminated together with veneer outer surface layers.

Figure 5 shows an embodiment in which the strand core is fed directly onto a lower layer of veneer sheets and then topped with a balanced upper layer of veneer sheets before being transported into the press. The press may use a high frequency heating method such as
5 microwave or RF radiation to ensure uniform consolidation.

Figure 6 shows an embodiment in which the strand core is merged with the veneer sheet faces and pressed using a conventional platen press without pre-heating or high frequency heating. This method is less expensive but may produce a product that is lower in density
10 and strength properties in the core.

Certain embodiments of the invention relate to a two-step pressing procedure wherein the core is pressed and glued before being laminated with veneer sheets on surface layers.

15 Figure 7 shows a pressing schedule according to certain embodiments which use a mat pressure substantially lower than those used for making conventional strand products. The mat pressure for VSL may be between 200-350 psi compared to 500-700 psi used for pressing conventional strand products. When preheating is used, a lower mat pressure (e.g. 200-280 psi) will be needed. The platen temperature is also much lower to reduce
20 densification in surface veneer sheets and gas pressure. In some embodiments, the platen temperature for VSL may be below 180 °C compared to temperatures of over 210 °C normally used for pressing conventional strand products.

Figure 8 illustrates VSL 20 according to an embodiment alongside PSL P, LVL L and OSL
25 O. VSL 20 has performance characteristics and applications similar to LVL and PSL.

Figure 9 illustrates VSL 30 according to an embodiment alongside cross laminated timber (CLT) C. CLT is an engineered wood product being increasingly used for higher storey buildings. VSL 30 is a thick, cross laminated VSL, similar to CLT C.
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Figure 10 is a table comparing the density and bending properties of VSL according to an embodiment made from MPB-killed logs to LVL and PSL. While density of the VSL is lower, bending MOEs of the VSL are comparable with existing LVL and PSL.

5 Features and advantages of the present invention include the following.

- High wood conversion ratio, i.e., high volume conversion rate for product from logs, thus better utilization of forest resource.
- Low wood costs from using small logs and underutilized species that cannot be peeled effectively and efficiently, allowing manipulation of resin and density levels in order
10 to attain properties required for end applications.
- Effective use of different types of resins and wood species to reduce materials cost and/or press cycle times.
- High MOE at relatively low density.
- Lower production costs due to high volume conversion ratio for the product from
15 logs, low wood cost, lower resin cost, resulting in lower total production costs of VSL compared to existing structural composite lumbers.
- Performance comparable to PSL at production costs comparable to OSL;
- Higher profit margin compared to PSL and OSL.
- Uniform, predictable, visually appealing and dimensionally stable.
- Large dimensions and long lengths, particularly suitable for use in specialty
20 commercial and residential applications.

According to some embodiments of the invention:

- VSL strands (0.080" - 0.130" thick) are much thicker than those used in OSL (0.045"
25 thick) and much shorter (1-3 feet long) than PSL strands (3-8 feet long). Thicker strands improve resin area coverage which in turn helps reduce resin costs. Shorter strands improve recovery.

- VSL manufacture involves improved alignment of strands and formation of strand mats through using a vibrating conveyor with alignment plates, or vibrating alignment plates, rather than a conventional disc orienter. Better alignment results in better strength and stiffness properties. More specifically, according to some embodiments VSL strands are oriented along the length of the lumber to enhance the strength and stiffness along this direction. This requirement is optimized through the use of vibrating conveyor systems, as described in US provisional application no. 61/331808. The vibrating conveyor system aligns the strands to form a strand mat for VSL. The resultant orientation angle values of strand layers formed are 6.25° and 5.33° for 1 to 2 foot strands for 3.5" gaps between every two adjacent alignment plates, respectively. Orientation may be further improved by reducing the plate gap. The vibrating conveyor system improves strand alignment, and better orientation is achieved even with short strands as long as their length is bigger than the gap between the alignment plates. The vibrating conveyor system also reduces voids in the products and improves the uniformity of the formed strand mat.
- An inexpensive but effective resin system is used instead of pMDI. In some embodiments, dual resin systems (e.g. pMDI/MURF, or pMDI/PF, or low molecular PF/high molecular PF) are used to make VSL according to some embodiments.
- VSL uses hot and humid compressed air injection instead of steam injection during pre-heating/hot pressing, or a combination of steam injection followed by hot and dry compressed air (use steam first to heat the mat, and then use hot & dry air to blow out the excessive steam to ensure the cure of PF resin after the curing temperature required is reached).
- VSL uses both full veneer sheets and non-full veneer sheets, allowing wood recovery to be maximized. Compared to LVL, VSL may improve the wood recovery by at least 10%.
- VSL is compressed less than PSL, which further improves volumetric recovery. The density of VSL is 10 -15% less than PSL, making the former lighter and significantly higher in volumetric recovery.
- VSL can be made in both parallel (longitudinal) and cross (lateral) layer orientations. Parallel VSL emulates the structure and performance of LVL and PSL, whereas cross

VSL can outperform and replace CLT due to superior rolling shear resistance and uniformity of VSL.

- VSL can also be made of 100% strands, preferably in a layered structure whereby smaller strands are placed in the middle layer and larger strands are placed in the outer layers, to maximize the recovery and properties. The terms “smaller” and “larger” may refer to one or more of width, length and thickness of the strands.
- There are at least three ways of making VSL in a one-step pressing procedure:
 - 1) The mat of aligned strands is formed and pre-heated to 80-90°C, and then merged with bottom and top veneer sheets, and finally consolidated using a conventional heating press.
 - 2) The mat of aligned strands is formed and overlaid with veneer sheets at the top and bottom faces, before consolidated using a high-frequency heating press.
 - 3) Same as 2) but using a conventional heating press instead of a high-frequency heating press.
- VSL can also be made using a two-step pressing procedure. The mat of strands is formed, pressed and glued first. The billet can be used as a solid core to be then overlaid with veneer sheets in a second pressing process.

While a number of exemplary aspects and embodiments have been discussed above, those of skill in the art will recognize certain modifications, permutations, additions and sub-combinations thereof. It is therefore intended that the following appended claims hereafter introduced are interpreted to include all such modifications, permutations, additions and sub-combinations as are within their true spirit and scope.

CLAIMS

1. A method for making a composite veneer strand lumber product core comprising:
 - (a) applying a resin to a plurality of veneer strands;
 - 5 (b) aligning the veneer strands and forming them into a mat; and
 - (c) pressing the mat of veneer strands with a press.
2. A method for making a composite veneer strand lumber product core according to claim 1, wherein the resin in step (a) comprises a dual system resin selected from the
10 group consisting of pMDI/MURF, pMDI/PF, and low molecular PF/high molecular PF.
3. A method for making a composite veneer strand lumber product core according to claim 1 or 2 further comprising between the steps (b) and (c), preheating the mat of
15 veneer strands.
4. A method for making a composite veneer strand lumber product core according to claim 3, wherein the preheating step comprises heating the mat of veneer strands to a
20 temperature of 80-90 °C.
5. A method for making a composite veneer strand lumber product core according to claim 4, wherein the preheating step comprises applying hot and humid compressed air.
- 25 6. A method for making a composite veneer strand lumber product core according to claim 4, wherein the preheating step comprises high frequency heating.
7. A method for making a composite veneer strand lumber product core according to claim 4, wherein the preheating step comprises applying steam followed by apply hot
30 and dry compressed air.

8. A method for making a composite veneer strand lumber product core according to any one of claims 1 to 7, wherein step (b) comprises aligning the veneer strands on a vibrating conveyor comprising alignment plates.
- 5 9. A method for making a composite veneer strand lumber product core according to any one of claims 1 to 7, wherein step (b) comprises passing the veneer strands through vibrating alignment plates.
- 10 10. A method for making a composite veneer strand lumber product core according to any one of claims 1 to 9, wherein step (c) comprises pressing the mat of veneer strands at a temperature of less than 180 °C.
- 15 11. A method for making a composite veneer strand lumber product core according to any one of claims 1, 2, and 8-10 wherein step (c) comprises pressing the mat of veneer strands at a pressure of 200 to 350 psi.
- 20 12. A method for making a composite veneer strand lumber product core according to any one of claims 3-7 wherein step (c) comprises pressing the mat of veneer strands at a pressure of less than 300 psi.
13. A method for making a composite veneer strand lumber product core according to claim 12 wherein step (c) comprises pressing the mat of veneer strands at a pressure of 200 to 280 psi.
- 25 14. A method for making a composite veneer strand lumber product core according to any one of claims 1, 2, and 8-11 wherein step (c) comprises applying heat during pressing.
- 30 15. A method for making a composite veneer strand lumber product core according to claim 14 wherein applying heat during pressing comprises applying high frequency heating.

16. A method for making a composite veneer strand lumber product core according to any one of claims 1 to 15 wherein the veneer strands are ¼ to 2 inches in width.
- 5 17. A method for making a composite veneer strand lumber product core according to any one of claims 1 to 16 wherein the veneer strands are 1 to 3 feet in length.
18. A method for making a composite veneer strand lumber product core according to any one of claims 1 to 17 wherein the veneer strands are 0.080 to 0.130 inches in
10 thickness.
19. A method for making a composite veneer strand lumber product core according to any one of claims 1 to 18 wherein the veneer strands comprise a rectangular cross-section.
- 15 20. A method for making a composite veneer strand lumber product core according to any one of claims 1 to 18 wherein the veneer strands comprise an angled cross-section.
21. A method for making a composite veneer strand lumber product comprising:
(a) making a composite veneer strand lumber product core according to the
20 method of any one of claims 1 to 20, the core having an upper face and a lower face;
(b) applying a resin to a plurality of veneer sheets;
(c) assembling one or more of the veneer sheets on each of the upper face and lower face of the core to form a three layer combination of: an upper veneer
25 sheet layer, a core layer comprising strands and a lower sheet veneer layer;
and
(d) pressing the three layer combination together with a press.
22. A method for making a composite veneer strand lumber product according to claim
30 21 wherein the resin in step (b) comprises a dual system resin selected from the group consisting of pMDI/MURF, pMDI/PF, and low molecular PF/high molecular PF.

23. A method for making a composite veneer strand lumber product according to claim 21 wherein step (d) comprises pressing the three layer combination at a temperature of less than 180 °C.
- 5 24. A method for making a composite veneer strand lumber product according to claim 21 wherein step (d) comprises pressing the three layer combination at a pressure of 200 to 350 psi.
- 10 25. A method for making a composite veneer strand lumber product according to claim 21 wherein step (d) comprises applying heat during pressing.
26. A method for making a composite veneer strand lumber product according to claim 25 wherein applying heat during pressing comprises applying high frequency heating.
- 15 27. A method for making a composite veneer strand lumber product according to any one of claims 21 to 26 wherein step (c) comprises assembling the core layer in a parallel orientation to the upper and lower veneer sheet layers.
- 20 28. A method for making a composite veneer strand lumber product according to any one of claims 21 to 26 wherein step (c) comprises assembling the core layer in a cross orientation to the upper and lower veneer sheet layers.
29. A method for making a composite veneer strand lumber product comprising:
- 25 (a) applying a resin to a plurality of veneer strands;
- (b) aligning the veneer strands and forming them into a mat of veneer strands;
- (c) applying a resin to a plurality of veneer sheets;
- (d) assembling a layered combination of veneer sheets and veneer strands, the combination having a lower layer comprising one or more of said veneer sheets, a middle layer comprising the mat of veneer strands and an upper layer
- 30 comprising one or more of said veneer sheets; and

(e) pressing said layered combination with a press.

30. A method for making a composite veneer strand lumber product according to claim
29 wherein the resin in step (a) comprises a dual system resin selected from the group
5 consisting of pMDI/MURF, pMDI/PF, and low molecular PF/high molecular PF.

31. A method for making a composite veneer strand lumber product according to claim
29 or 30 wherein step (b) comprises aligning the veneer strands on a vibrating
conveyor comprising alignment plates.

32. A method for making a composite veneer strand lumber product according to claim
29 or 30 wherein step (b) comprises passing the veneer strands through vibrating
alignment plates.

33. A method for making a composite veneer strand lumber product according to any one
of claims 29 to 32 wherein the resin in step (c) comprises a dual system resin selected
from the group consisting of pMDI/MURF, pMDI/PF, and low molecular PF/high
molecular PF.

34. A method for making a composite veneer strand lumber product according to any one
of claims 29 to 33 wherein step (d) comprises assembling the middle layer in a
parallel orientation to the upper and lower layers.

35. A method for making a composite veneer strand lumber product according to any one
of claims 29 to 33 wherein step (d) comprises assembling the middle layer in a cross
orientation to the upper and lower layers.

36. A method for making a composite veneer strand lumber product according to any one
of claims 29 to 35 further comprising between the steps (b) and (d), preheating the
mat of veneer strands.

37. A method for making a composite veneer strand lumber product according to claim 36, wherein the preheating step comprises heating the mat of veneer strands to a temperature of 80-90 °C.
- 5 38. A method for making a composite veneer strand lumber product according to claim 36 or 37, wherein the preheating step comprises applying hot and humid compressed air.
39. A method for making a composite veneer strand lumber product according to claim 10 36 or 37, wherein the preheating step comprises high frequency heating.
40. A method for making a composite veneer strand lumber product according to claim 36 or 37, wherein the preheating step comprises applying steam followed by apply hot and dry compressed air.
- 15 41. A method for making a composite veneer strand lumber product according to any one of claims 29 to 40, wherein step (e) comprises pressing the layered combination at a temperature of less than 180 °C.
- 20 42. A method for making a composite veneer strand lumber product according to any one of claims 29-35 and 41 wherein step (e) comprises pressing the layered combination at a pressure of 200 to 350 psi.
43. A method for making a composite veneer strand lumber product according to any one 25 of claims 36-40 wherein step (e) comprises pressing the layered combination at a pressure of less than 300 psi.
44. A method for making a composite veneer strand lumber product according to claim 30 43 wherein step (e) comprises pressing the layered combination at a pressure of 200 to 280 psi.

45. A method for making a composite veneer strand lumber product according to any one of claims 29-35 and 41 wherein step (e) comprises applying heat during pressing.
- 5 46. A method for making a composite veneer strand lumber product according to claim 45 wherein applying heat during pressing comprises applying high frequency heating.
47. A method for making a composite veneer strand lumber product according to any one of claims 29 to 46 wherein the veneer strands are $\frac{1}{4}$ to 2 inches in width.
- 10 48. A method for making a composite veneer strand lumber product according to any one of claims 29 to 47 wherein the veneer strands are 1 to 3 feet in length.
49. A method for making a composite veneer strand lumber product according to any one of claims 29 to 48 wherein the veneer strands are 0.080 to 0.130 inches in thickness.
- 15 50. A method for making a composite veneer strand lumber product according to any one of claims 29 to 49 wherein the veneer strands comprise a rectangular cross-section.
- 20 51. A method for making a composite veneer strand lumber product according to any one of claims 29 to 50 wherein the veneer strands comprise an angled cross-section.
52. A method for making a composite veneer strand lumber product comprising:
- 25 (a) applying a resin to a plurality of first veneer strands and a plurality of second veneer strands, wherein the first veneer strands are larger than the second veneer strands;
- (b) aligning the first veneer strands and forming them into a lower mat of veneer strands and an upper mat of veneer strands;
- (c) aligning the second veneer strands and forming them into a middle mat of veneer strands;
- 30 (d) assembling a layered combination of veneer strands, the combination having a lower layer comprising the lower mat of veneer strands, a middle layer

comprising the middle mat of veneer strands and an upper layer comprising the upper mat of veneer strands; and

(e) pressing said layered combination with a press.

- 5 53. A method for making a composite veneer strand lumber product according to claim 52 wherein the resin in step (a) comprises a dual system resin selected from the group consisting of pMDI/MURF, pMDI/PF, and low molecular PF/high molecular PF.
- 10 54. A method for making a composite veneer strand lumber product according to claim 52 or 53 wherein steps (b) and (c) comprise aligning the first and second veneer strands on a vibrating conveyor comprising alignment plates.
- 15 55. A method for making a composite veneer strand lumber product according to claim 52 or 53 wherein steps (b) and (c) comprise passing the first and second veneer strands through vibrating alignment plates.
- 20 56. A method for making a composite veneer strand lumber product according to any one of claims 52 to 55 wherein step (d) comprises assembling the middle layer in a parallel orientation to the upper and lower layers.
- 25 57. A method for making a composite veneer strand lumber product according to any one of claims 52 to 55 wherein step (d) comprises assembling the middle layer in a cross orientation to the upper and lower layers.
58. A method for making a composite veneer strand lumber product according to any one of claims 52 to 57, wherein step (e) comprises pressing the layered combination at a temperature of less than 180 °C.

59. A method for making a composite veneer strand lumber product according to any one of claims 52 to 58 wherein step (e) comprises pressing the layered combination at a pressure of 200 to 350 psi.
- 5 60. A method for making a composite veneer strand lumber product according to any one of claims 52 to 59 wherein step (e) comprises applying heat during pressing.
61. A method for making a composite veneer strand lumber product according to claim 60 wherein applying heat during pressing comprises applying high frequency heating.
- 10 62. A method for making a composite veneer strand lumber product according to any one of claims 52 to 61 wherein at least some of the first and second veneer strands comprise a rectangular cross-section.
- 15 63. A method for making a composite veneer strand lumber product according to any one of claims 52 to 61 wherein at least some of the first and second veneer strands comprise an angled cross-section.
- 20 64. A veneer strand lumber product comprising a first layer comprising one or more veneer sheets, a second layer comprising a plurality of veneer strands and a third layer comprising one or more veneer sheets.
- 25 65. A veneer strand lumber product according to claim 64, made by the method of any one of claims 21 to 28.
66. A veneer strand lumber product according to claim 64, made by the method of any one of claims 29 to 51.
- 30 67. A veneer strand lumber product according to claim 64 comprising a dual system resin selected from the group consisting of pMDI/MURF, pMDI/PF, and low molecular PF/high molecular PF.

68. A veneer strand lumber product according to claim 64 or 67 wherein the middle layer is in a parallel orientation to the upper and lower layers.
- 5 69. A veneer strand lumber product according to claim 64 or 67 wherein the middle layer is in a cross orientation to the upper and lower layers.
70. A veneer strand lumber product according to any one of claims 64, and 67-69 wherein the veneer strands are $\frac{1}{4}$ to 2 inches in width.
- 10 71. A veneer strand lumber product according to any one of claims 64, and 67-70 wherein the veneer strands are 1 to 3 feet in length.
72. A veneer strand lumber product according to any one of claims 64, and 67-71 wherein the veneer strands are 0.080 to 0.130 inches in thickness.
- 15 73. A veneer strand lumber product according to any one of claims 64, and 67-72 wherein the veneer strands comprise a rectangular cross-section.
74. A veneer strand lumber product according to any one of claims 64, and 67-72 wherein the veneer strands comprise an angled cross-section.
- 20 75. A veneer strand lumber product according to any one of claims 64-74 cut into lumber having desired predetermined dimensions.
- 25 76. A method according to any one of claims 21 to 63 comprising a final step of cutting the product produced by the method into lumber having desired predetermined dimensions.

77. A system for carrying out the method of any one of claims 21 to 51, wherein logs are cut into both full veneer sheets and non-full veneer sheets, and wherein the non-full veneer sheets are subsequently clipped into the veneer strands.

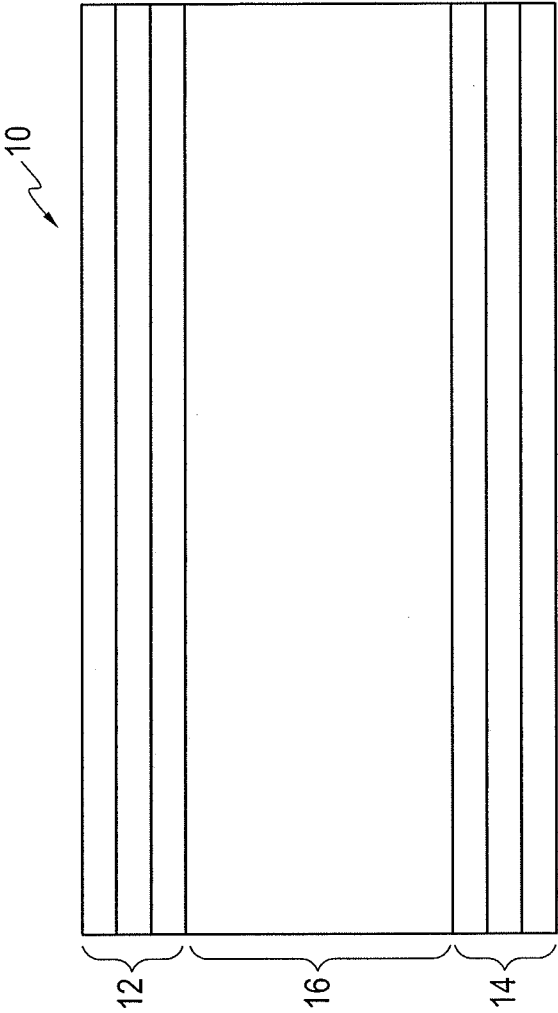


FIG. 1A

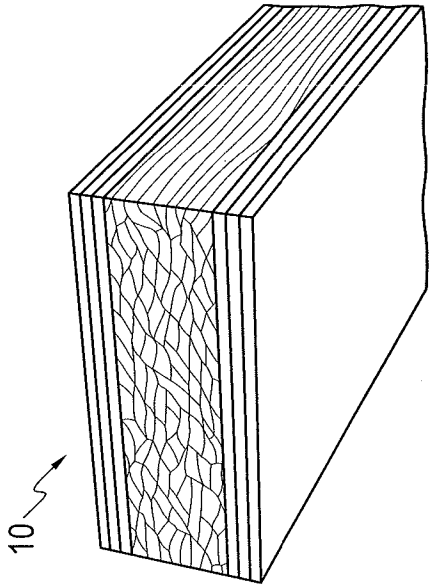


FIG. 1B

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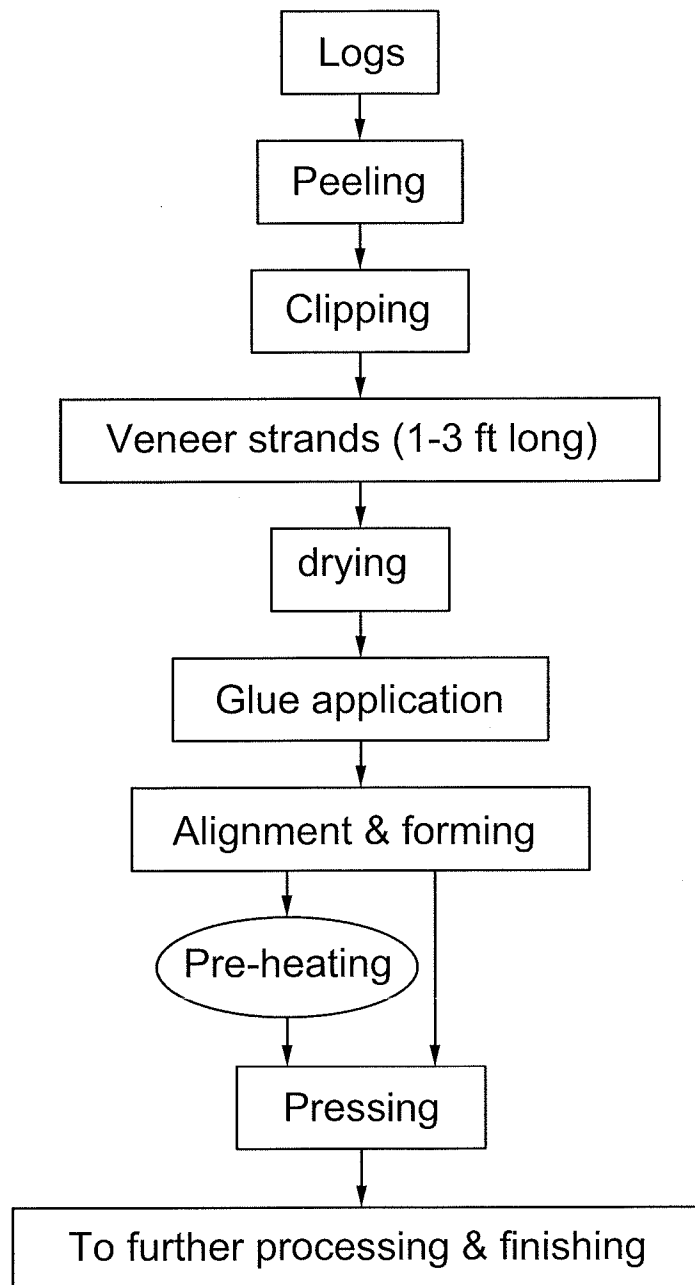


FIG. 2

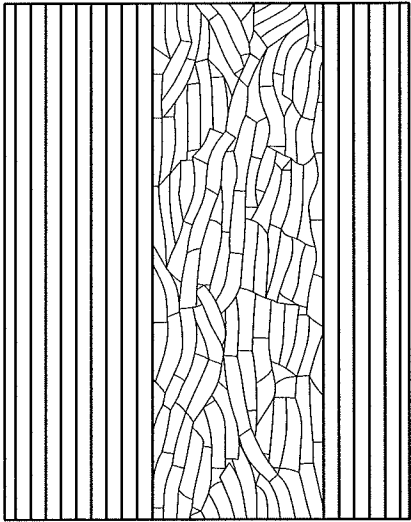


FIG. 3B

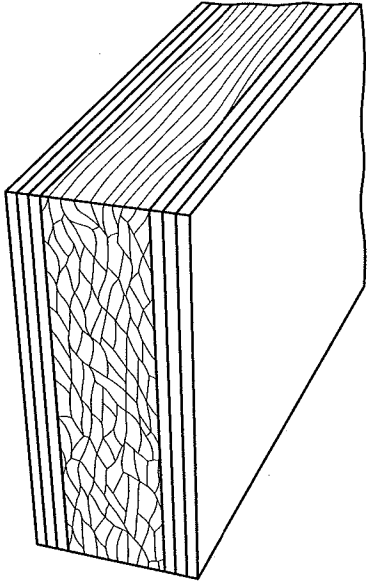


FIG. 3D



FIG. 3A



FIG. 3C

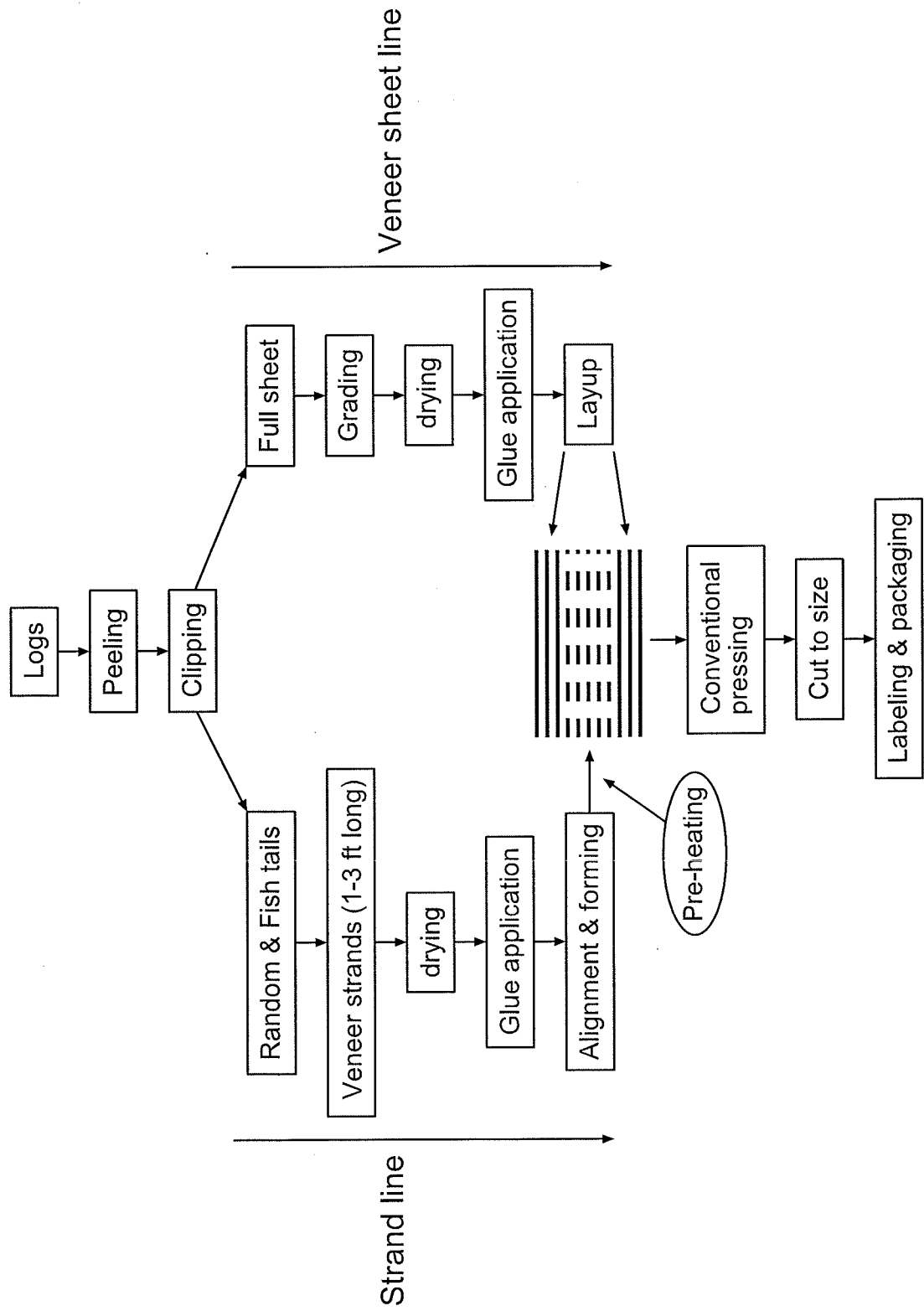


FIG. 4

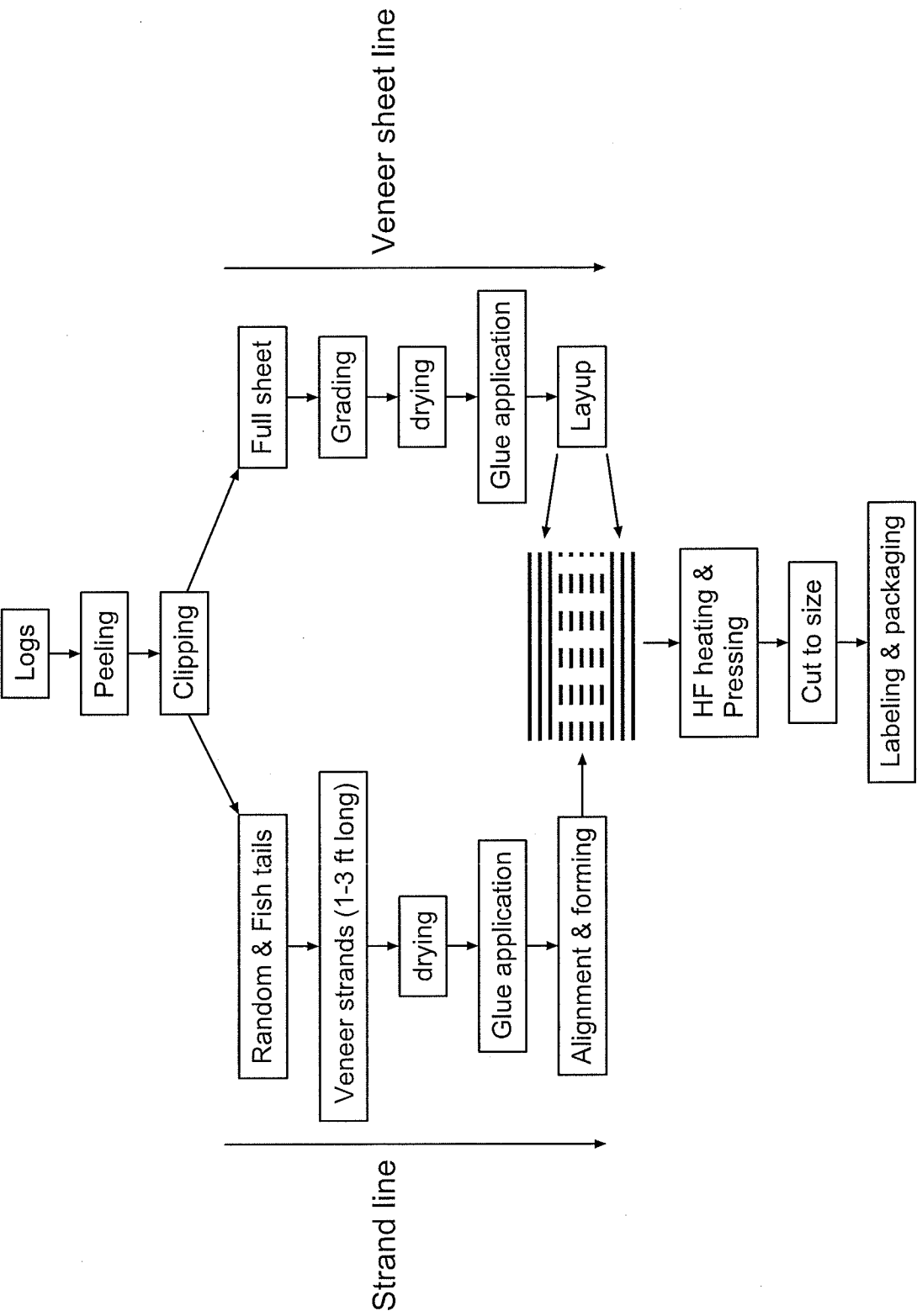


FIG. 5

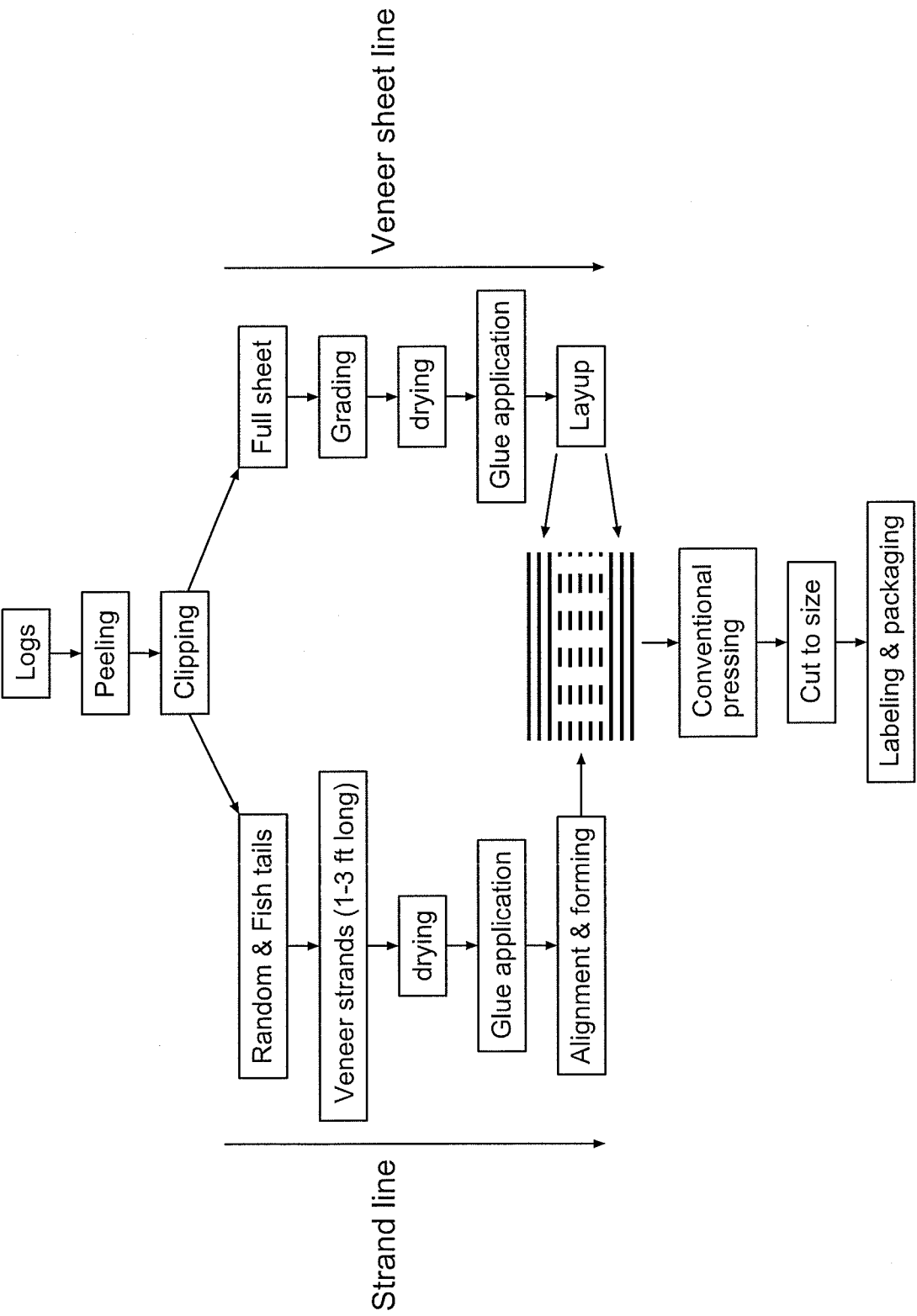


FIG. 6

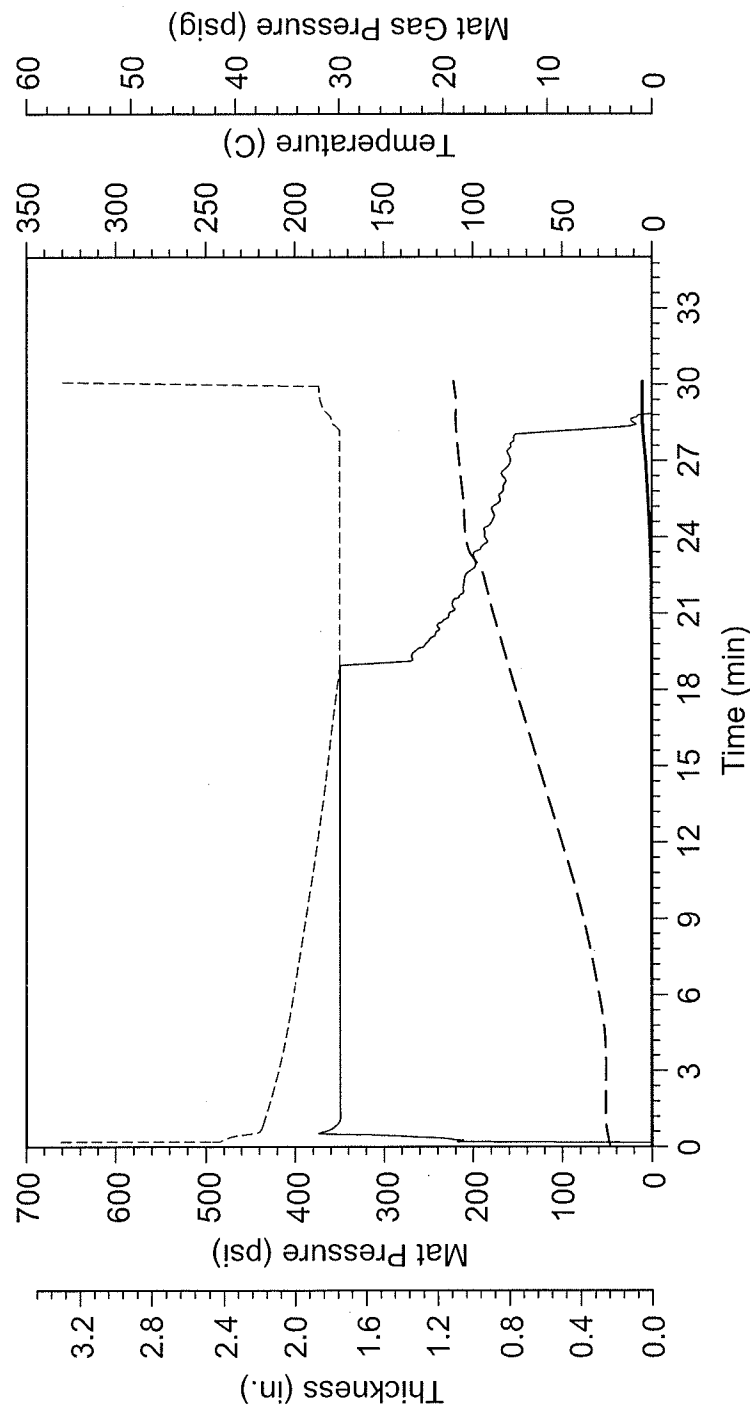


FIG. 7

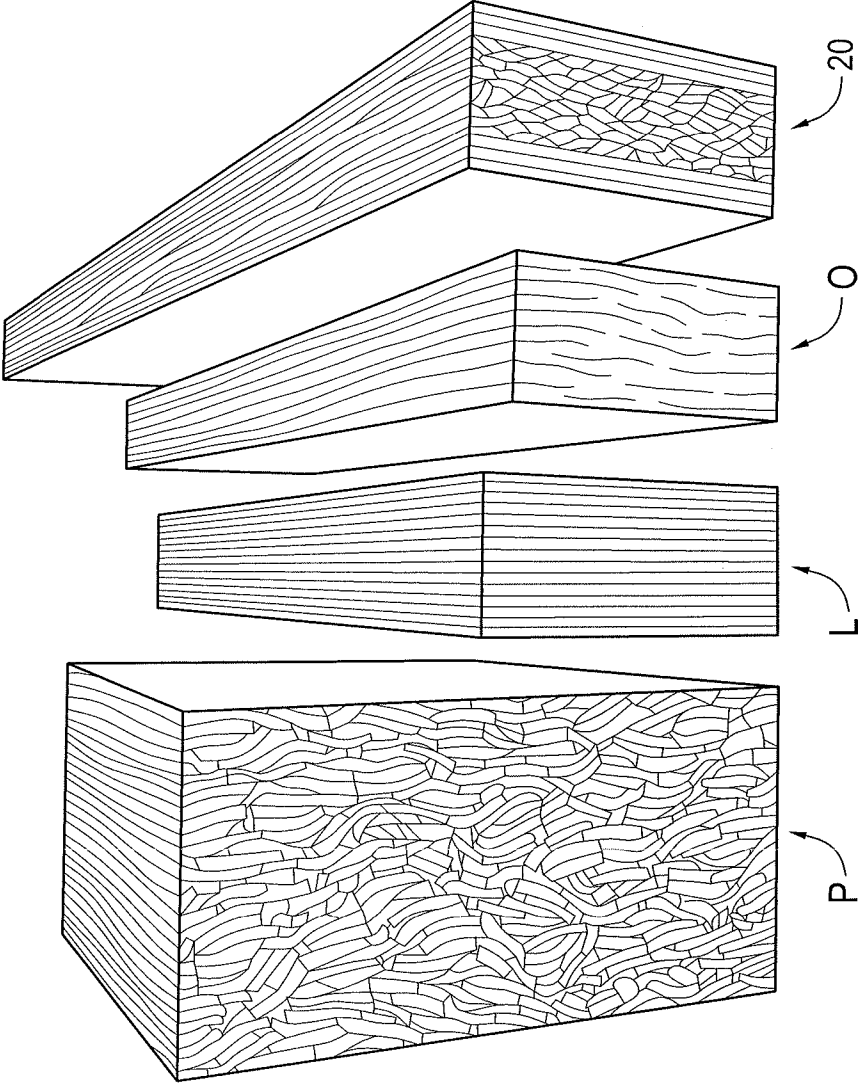


FIG. 8

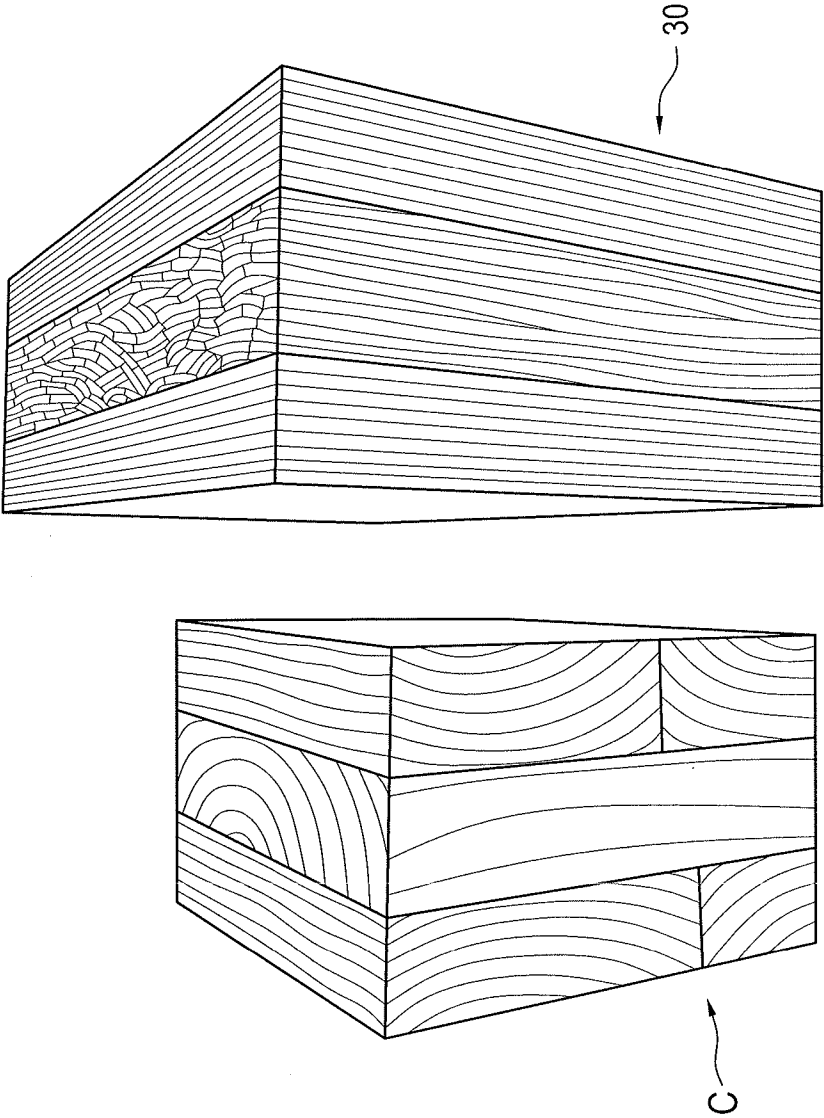


FIG. 9

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Board construction	Board ID & Features	Flatwise			Edgewise		
		Density (pcf)	MOE (Mpsi)	MOR (psi)	Density (pcf)	MOE (Mpsi)	MOR (psi)
3 MPB veneers on top and bottom, (3'+2'+1') mixed-length MPB veneer strand core	VSL - 1 (300psi pressure)	35.7	2.04	10547	35.8	1.89	9565
	VSL - 2 (350psi pressure)	36.0	2.07	9714	35.9	1.92	9806
	VSL - 3 (350psi pressure)	34.9	2.02	9637	34.5	1.88	9249
	VSL - 4 (280 psi pressure)	35.8	2.04	9543	35.5	1.83	8625
Microlam (LVL)		42	1.9			1.9	
Parallam (PSL)		40-45	2.0-2.0			2.0-2.2	

FIG. 10

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA2011/050273

A. CLASSIFICATION OF SUBJECT MATTER IPC: B32B 21/14 (2006.01) , B27N 3/18 (2006.01) According to International Patent Classification (IPC) or to both national classification and IPC																				
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) IPC: B32B 21/14 (2006.01) , B27N 3/18 (2006.01) Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Electronic database(s) consulted during the international search (name of database(s) and, where practicable, search terms used) Canadian Patent Database and Epodoc keywords : veneer strand lumber ; veneer sheet? ; veneer strand?																				
C. DOCUMENTS CONSIDERED TO BE RELEVANT <table border="1"> <thead> <tr> <th>Category*</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>X A</td> <td>US 2007/0144663 A1 (Huber Engineered Woods) 28 June 2007 (28-06-2007) [0017]; [0029]; [0031]; [0039]; [0044]</td> <td>1-20, 52-63 and 76 (when dependent upon claims 52-63) 21-51, 64-75 and 77</td> </tr> <tr> <td>X A</td> <td>US 5096765 (MacMillan Bloedel Limited) 17 March 1992 (17-03-1992) col. 4, line 57 - col. 5, line 17 ; Figure 3</td> <td>1-20 21-77</td> </tr> <tr> <td>A</td> <td>US 3769143 (International Paper Company) 30 October 1973 (30-10-1973) entire document</td> <td>1-77</td> </tr> <tr> <td>A</td> <td>US 2008/0110565 A1 (PARKER) 15 May 2008 (15-05-2008) entire document</td> <td>1-77</td> </tr> <tr> <td>A</td> <td>US 4061819 (MacMillan Bloedel Limited) 06 December 1977 (06-12-1977) entire document</td> <td>1-77</td> </tr> </tbody> </table>			Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	X A	US 2007/0144663 A1 (Huber Engineered Woods) 28 June 2007 (28-06-2007) [0017]; [0029]; [0031]; [0039]; [0044]	1-20, 52-63 and 76 (when dependent upon claims 52-63) 21-51, 64-75 and 77	X A	US 5096765 (MacMillan Bloedel Limited) 17 March 1992 (17-03-1992) col. 4, line 57 - col. 5, line 17 ; Figure 3	1-20 21-77	A	US 3769143 (International Paper Company) 30 October 1973 (30-10-1973) entire document	1-77	A	US 2008/0110565 A1 (PARKER) 15 May 2008 (15-05-2008) entire document	1-77	A	US 4061819 (MacMillan Bloedel Limited) 06 December 1977 (06-12-1977) entire document	1-77
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[X] Further documents are listed in the continuation of Box C. [X] See patent family annex. <table border="1"> <tbody> <tr> <td>* Special categories of cited documents :</td> <td>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</td> </tr> <tr> <td>"A" document defining the general state of the art which is not considered to be of particular relevance</td> <td>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</td> </tr> <tr> <td>"E" earlier application or patent but published on or after the international filing date</td> <td>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</td> </tr> <tr> <td>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</td> <td>"&" document member of the same patent family</td> </tr> <tr> <td>"O" document referring to an oral disclosure, use, exhibition or other means</td> <td></td> </tr> <tr> <td>"P" document published prior to the international filing date but later than the priority date claimed</td> <td></td> </tr> </tbody> </table>			* Special categories of cited documents :	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention	"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone	"E" earlier application or patent but published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art	"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family	"O" document referring to an oral disclosure, use, exhibition or other means		"P" document published prior to the international filing date but later than the priority date claimed							
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"P" document published prior to the international filing date but later than the priority date claimed																				
Date of the actual completion of the international search 6 July 2011 (06-07-2011)		Date of mailing of the international search report 15 August 2011 (15-08-2011)																		
Name and mailing address of the ISA/CA Canadian Intellectual Property Office Place du Portage I, C114 - 1st Floor, Box PCT 50 Victoria Street Gatineau, Quebec K1A 0C9 Facsimile No.: 001-819-953-2476		Authorized officer Nancy McMartin (819) 934-3598																		

INTERNATIONAL SEARCH REPORTInternational application No.
PCT/CA2011/050273

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 3916059 (MOLLOY et al) 28 October 1975 (28-10-1975) abstract	1-77
A	US 2429235 (Plymouth Cordage Co.) 21 October 1947 (21-10-1947) entire document	1-77

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CA2011/050273

Patent Document Cited in Search Report	Publication Date	Patent Family Member(s)	Publication Date
US2007144663A1	28 June 2007 (28-06-2007)	AR058631A1 CN101426647A PE09012007A1 WO2008127218A1	13 February 2008 (13-02-2008) 06 May 2009 (06-05-2009) 03 September 2007 (03-09-2007) 23 October 2008 (23-10-2008)
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US3916059A	28 October 1975 (28-10-1975)	None	
US2429235A	21 October 1947 (21-10-1947)	None	