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Hasenwinkle

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[54] LOG CUTTING AND REJOINING PROCESS

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[52] U.S. Cl. ..... **144/315 R**; 144/309 L; 144/314 R; 144/326 R; 156/304

[51] **Int. Cl.²** **B27D 1/00**

[58] **Field of Search** .... 156/304; 144/313, 314 R, 144/314 B, 315 R, 315 A, 316, 309 L, 326 R, 309 R, 309 Q

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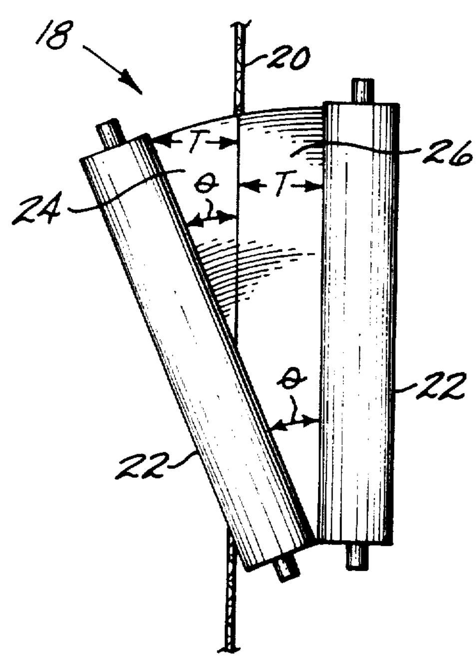
[57] ABSTRACT

A process for making solid and composite lumber products from generally cylindrical logs includes the steps of cutting a log radially into a plurality of first sector-shaped pieces and then cutting from the sector-shaped pieces at least one solid member having the cutting plane thereof substantially parallel to one of the cut surfaces of the sector-shaped piece, then accumulating at least two smaller sector-shaped pieces and bonding them together such that the thin edge of one is approximately adjacent the thick edge of the other. Thus from a cylindrical log both solid lumber as well as composite lumber is produced resulting in improved lumber yield. The lumber products thusly formed are then machined into a desired shape or additional joining steps can be performed to increase the size.

11 Claims, 7 Drawing Figures



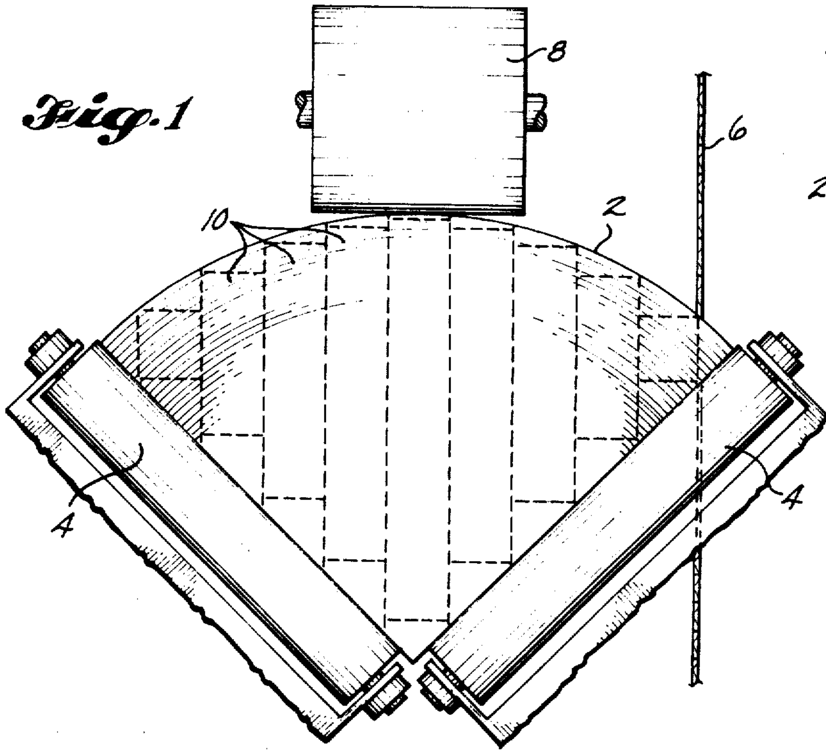


Fig. 1

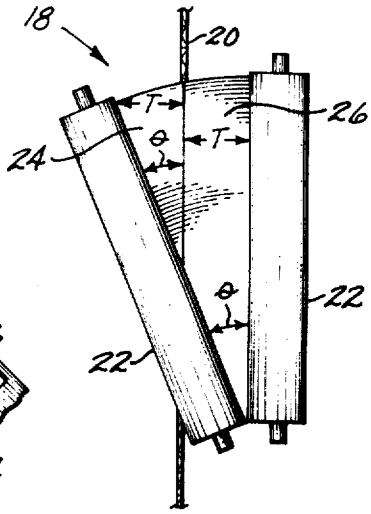
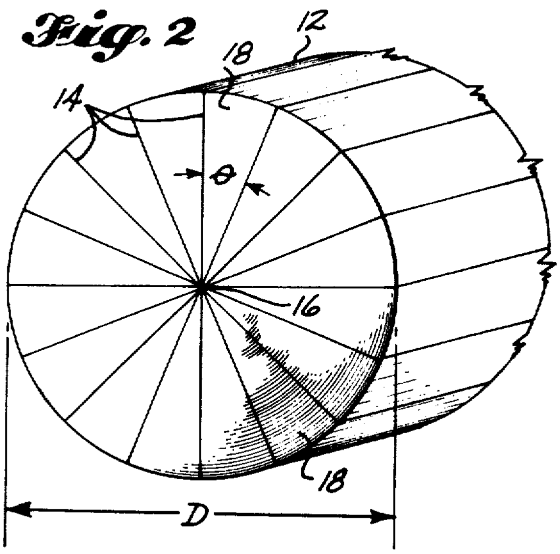


Fig. 3

Fig. 2



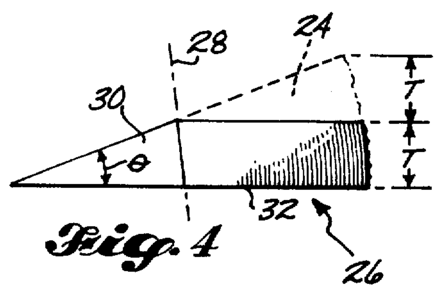


Fig. 4

Fig. 5

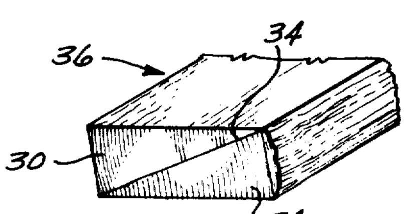


Fig. 6

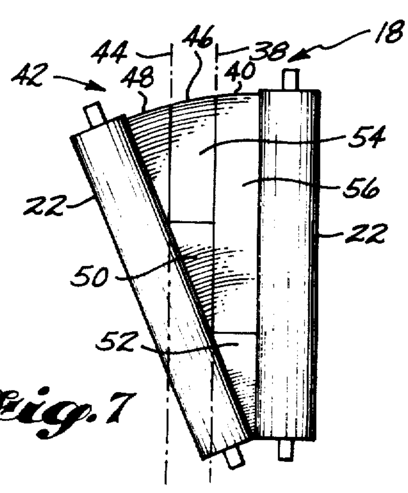


Fig. 7

LOG CUTTING AND REJOINING PROCESS

BACKGROUND OF THE INVENTION

This invention relates generally to a new process for converting round logs into lumber products, primarily dimension lumber. More particularly, it relates to a log cutting and subsequent rejoining process for converting logs to lumber products whereby the yield of lumber from the wood volume is substantially increased. In the co-pending commonly assigned patent application (Log Cutting and Rejoining Process, Ser. No. 333,911 filed Feb. 20, 1973) a cutting and rejoining process is disclosed that can be utilized for increasing the lumber yield of smaller diameter logs which includes certain of the steps employed in the cutting and rejoining process to be presently described. The disclosure of the above noted commonly assigned patent application is incorporated herein by reference for purposes of providing a complete description of the present invention.

The centuries old conversion process of sawing logs into rectangular lumber results in a very low yield in that, of the total volume of wood in a log, usually less than half is or can be converted into usable lumber. This is primarily because of the constraint that only square or rectangular pieces are cut from a cylindrical log. The actual lumber yields utilizing known processes, of course, vary depending upon a number of factors, such as log diameter, but even with the best available computer controlled sawing machines a normal yield of lumber from a log is 60–**70** percent of the total wood volume. The term "lumber" is intended to mean those wood products traditionally having the highest marketable value that are derivable on a longitudinal sawing basis from a log and which are generally rectangular in cross-section.

The most commonly used log-to-lumber converting process is that where saws make a plurality of longitudinal cuts through the log with each successive cut generally being in a plane parallel or perpendicular to the previous cut. With this process, it is obvious that there are yield limitations simply from the fact that the beginning raw material is cylindrical while the desired final lumber product is rectangular in nature. The wood volume not converted into lumber is utilized in a variety of other ways, none of which offer the value of a lumber product. The sawdust can be used as fuel, particleboard and the like. The solid wood slabs and edgings can be chipped into small pieces suitable for wood pulp production or likewise they can be used for fuel.

In the past, there have been many suggestions of ways to increase the recovery of solid wood products that could be converted from a log. Veneer production and subsequent laminating methods has been one suggestion. In veneer production the cylindrical log is converted into pieces of wood veneer which can then be laminated together to form various wood products. Such composite products and their converting processes do convert more of the wood volume into generally solid wood products, but they still do not generally have the market acceptance or characteristics of lumber. The aforementioned pending patent application dislcoses a process and resulting product that can be employed to greatly increase the yield of solid wood products from cylindrically shaped logs. The process as disclosed is generally for logs of small diameter such as from 5 to 15 inches in diameter. It became apparent

when considering larger diameter logs that cutting sector-shaped pieces according to the disclosed process would present difficult handling problems. For example, when cutting the larger diameter logs into sectors where the final lumber product was to have a nominal thickness of 1½ inches, the sector angle would be relatively small and a large number of resulting thin sectors would be produced which would be difficult to handle according to the process.

Thus, a need was recognized for an improved process offering the same high yield advantages of the process disclosed in the aforementioned patent application but that allowed larger diameter logs to be cut into a fewer number of sectors even when desiring a final product that had, for example, a 1½ inch nominal thickness. The present process is one that can produce a plurality of solid pieces of lumber as well as a plurality of sector-shaped pieces which are then bonded together in order to form composite pieces of lumber. Of course, the solid pieces of lumber cut from the log will have a generally high value and will have the market acceptance of lumber as presently known. It is anticipated that the composite pieces of lumber will also have a high value and will be generally accepted in the marketplace.

The resulting solid pieces of lumber produced by the present process will have a substantially vertical grain pattern over their wide dimension as will the composite pieces of lumber. Thus, the resulting lumber products will have all of the benefits and characteristics associated with presently known vertical grain lumber, such as improved drying characteristics, better stability, and the like.

Accordingly, from the foregoing, one object of the present invention is to provide a process that will convert generally cylindrical logs into solid and composite lumber products in which the percentage of log volume that is converted to lumber product is substantially increased.

Another object of the present invention is to provide a process similar to that in pending patent application Ser. No. 333,911 which can be utilized with generally larger diameter logs in order to reduce the sizes of the cut sectors.

Still a further object is to provide a lumber cutting process that produces substantially all vertically grained lumber.

These and other objects will become more apparent and better understood upon reading the following specification in conjunction with the attached drawing.

SUMMARY OF THE INVENTION

Briefly, this invention is practiced in one form by cutting a log segment radially into a plurality of first sector-shaped pieces. Each of the sector-shaped pieces then has at least one longitudinally extending piece of lumber cut therefrom having the cutting plane substantially parallel to one of the cut surfaces of the sector-shaped piece. At least two of the remaining smaller but similarly sized sector-shaped pieces are accumulated and bonded together such that the thin edge of one is approximately adjacent the thick edge of the other. Then, the solid piece of cut lumber and the composite piece of lumber can be edged and surfaced in any suitable manner. In order to form lumber pieces of wider dimension, a plurality of the resulting smaller pieces may be edge bonded together.

DESCRIPTION OF THE DRAWING

FIG. 1 is an end elevation view schematically depicting a prior art cutting pattern.

FIG. 2 is an isometric view schematically depicting the initial cutting pattern for the process of the present invention.

FIG. 3 shows an end elevation view of an individual large sector-shaped piece as it will be cut for further processing.

FIG. 4 is an end elevation view showing the larger trapezoidal piece that has been cut from an individual large sector and has imposed thereon a generally vertical cutting plane for yielding one smaller sized sector and also a vertical edging plane for edging the curvilinear edge portion.

FIG. 5 is an end elevation view showing the smaller sector-shaped piece that was removed by the cutting process depicted in FIg. 3 and which has imposed thereon an edging plane that indicates removal of the curvilinear edge portion.

FIG. 6 is also an end elevation view depicting a composite piece of lumber that has been formed by bonding together two of the equal sized smaller sector-shaped pieces.

FIG. 7 is a view similar to FIG. 3 in which two longitudinal cutting planes are imposed on the larger sector-shaped piece to indicate an additional longitudinal cut.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Prior Art Quarter Sawing

The quarter sawing process and products produced therefrom are well known in the lumber manufacturing art. Quarter sawing has, however, been little used in the lumber industry primarily because of excessive waste. By referring to FIG. 1, one quarter sawing method is graphically depicted and shows a large sector piece 2 positioned between a plurality of feed rolls 4. The sector piece 2 is one that has been cut from a generally cylindrically shaped log (not shown) and represents an approximate quarter section of the log. Such quarter sections may be cut in any known manner, such as by the use of a band mill or gang saw. The large sector piece 2 has been positioned within the feed rolls 4 such that it may be fed longitudinally through the suitable sawing machine having a saw 6 extending in a vertical plane so as to always be generally parallel to a line bisecting the sector piece 2. A suitable top hold down roll 8 may be provided in order to confine the sector piece 2 within the feed rolls 4 as it passes through the sawing machine. The longitudinal sawing pattern for large sector piece 2 is depicted by the generally parallel and vertical lines superimposed over the end of sector piece 2 and are all planes that are parallel to a line that bisects the angle of sector piece 2. The resulting plurality of sawn pieces depicted collectively at 10 are then edged back to the desired width dimension on any suitable edging machine (not shown). It is the edging step that results in a substantial amount of waste as will be apparent when referring to FIG. 1.

Present Invention

Depicted in FIG. 2 is an isometric end view of a typical generally cylindrically-shaped longitudinally extending log 12. Log segment 12 is typical in that it has been cross-cut to a suitable length for further processing and has preferably been debarked prior to the further processing. For example, in a typical stud mill operation, the standard length of log segment 12 would be approximately 8 feet 6 inches with each of the segments 12 then being longitudinally cut into a plurality of typical 2×4 pieces of lumber. Superimposed over the end view of log segment 12 are a plurality of radial cutting planes depicted as 14 with each cutting plane 14 essentially passing through the center 16 of log segment 12.

The first decision that must be made with a given log segment is what the sector cutting pattern should be. For ease of cutting, the pattern selected should produce an even number of sector-shaped or first pieces each indicated as 18. Each sector piece 18 has several given parameters depending on the selected number of cuts to be made for a particular log segment 12. For example, in FIG. 2, sixteen cuts are indicated which will result in 16 individual sector-shaped pieces 18. With the given number of cuts at sixteen, the angle θ of each sector-shaped piece 18 will be equal to 22.5°. Another given parameter is the ultimate desired thickness of the final solid or composite lumber product. Here, for example, assume it is desired to produce a finished dimensional product having a nominal thickness of 1½ inches in a dry surfaced condition, then the diameter of the log segment 12 required can be calculated by using the following equation:

$$D = \frac{2\,(x)\,(T)}{\sin\theta} \qquad (1)$$

where x is the number of times the final product thickness is desired from each large sector,

T is the thickness of the final product in the green unsurfaced condition,

θ is the angle of the large sectors between radial faces to be cut from the log segment which will be less than 90°, and

D is the diameter of the log segment.

A table can be prepared in solving for log diameters when the angle θ is known for a given equal number of radial cuts and for a selected number of secondary longitudinal cuts (x value). As a general rule, and as will be apparent to those skilled in the art, the thickness in solving equation (1) will be the green thickness plus the kerf resulting from sawing and will be assumed to be 1.76 inches which should be taken by way of example only with the 0.26 inch (that amount over the 1.50 inches final thickness) to be taken only as a reasonable estimate of a normal allowance for cutting, drying, and surfacing losses. The table follows and the calculated values of diameter are derived by solving equation (1) for the given number of equal radial cuts.

Number of Cuts	Angle θ	Calculated Diameter (D) in Inches x=1	x=2	x=3
8	45°	5		
10	36°	6	11.9	
12	30°	7	14.0	
14	25.7°	8.1	16.1	24.2
16	22.5°	9.2	18.3	27.4
18	20°	10.3	20.5	30.7
20	18°	11.4	22.7	34.0

It will be seen from the values in the above table that as the diameter increases, fewer number of larger sectors can be cut if the number of secondary longitudinal cuts on the resulting large sectors is increased. With additional secondary longitudinal cuts made to the large sector **18**, an additional number of the smaller sectors will result as will become apparent.

As previously mentioned, the log segment **12** as depicted in FIG. 2 has a cutting pattern whereby 16 sector-shaped pieces are produced. As may be seen by referring to the above table, the diameter of such a log segment can be approximately 9.2 inches, 18.3 inches, or 27.4 inches depending upon the number of additional longitudinal cuts to be made. Larger size logs could also be cut into sixteen sectors according to the above equation (1). Assume for purposes of further description that the sector-shaped piece **18** as depicted in FIG. **3** has an angle θ of 22.5° and was cut from a log segment having a diameter of 18.3 inches, and that one longitudinal cut ($x=2$) will be made by the vertical saw **20** through sector piece **18.** The sector piece **18** will be positioned with respect to vertical saw **20** such that the cutting plane will be substantially parallel to one of the longitudinally extending radial faces on sector piece **18.** In order to so position and cut the sector piece, it may be constrained between a pair of opposed feed rolls **22** that are in a V-shaped configuration and which can be independently adjusted to increase or decrease the angle therebetween. Of course, it will be appreciated that the vertical saw **20** may be positioned laterally relative to the sector-shaped piece **18** such that it can follow the proper cutting plane and yield the proper thicknesses (T) for the resulting pieces.

As the sector-shaped piece **18** in FIG. **3** passes through the vertical saw **20,** two resulting pieces are produced. One piece is a smaller third sector-shaped piece **24** which has as its thickness the T-dimension as described above. The other resulting piece, also having the T-dimension, is a trapezoidally shaped second piece **26** which has two opposing parallel surfaces and one surface that previously formed a portion of one large sector face. Both pieces **24, 26** will have as one of their surfaces a curvilinear edge which was originally a portion of the circumference of the log segment **12.**

FIGS. **4** and **5** depict each of the pieces **24, 26** and their respective dimensions. Trapezoidal piece **26,** having the two parallel surfaces, has the thickness indicated as T. The plane **28** passing through piece **26** is to indicate an additional longitudinal cut that is made through the piece **26** in order to yield an additional smaller fourth sector piece **30** and the solid piece **32,** generally in the shape of a parallelogram. Sector piece **30** can be cut from the larger piece **26** by any suitable cutting means (not shown). It should be appreciated that the previously cut smaller sector piece **24** and the smaller sector piece **30** will, generally have the same smaller included angle which will be equal to the angle θ. Similarly, both of the smaller sector pieces **24, 30** will have approximately the same radial dimension as may be determined by simple calculation. After cutting the smaller sector piece **30** from larger trapezoidal piece **26,** additional processing may be carried out on resulting solid piece **32** which could include a known drying step, reducing the moisture content to a desired level and also a further machining step of surfacing the piece **32** to finally desired dimensions.

Since a primary object of the present invention is to reduce waste, the resulting smaller sector-shaped pieces **24, 30** will be bonded together in order to form composite lumber products. Referring first to FIG. **5,** the smaller sector-shaped piece **24** is depicted and has its thickness indicated as T. Since there are two generally equal sized smaller sector-shaped pieces **24, 30** produced from the cutting steps just described, they can be combined according to the process steps described in the commonly assigned pending patent application. Normally, the smaller sector-shaped pieces **24,** 30 will be dried using a known drying process to the proper moisture content prior to being joined together. The bonding step is simply one of applying a suitable adhesive to appropriate faces of the smaller sector pieces and then joining together two such pieces whereby the thin edge of one is approximately adjacent the thick edge of the other as is depicted in FIG. **6.** The bonding line **34** is then cured by the application of temperature and/or pressure in order to form the composite piece **36.** As will be apparent when referring to FIG. **6,** after bonding the two smaller sector pieces **24, 30** together, the two shorter sides will be at an angle from vertical and one side will still have a portion of the curvilinear circumference of the log in place. This condition presumes that the smaller sector pieces **24, 30** have not been surfaced prior to bonding. In order to form the final composite lumber product, it will be apparent to one skilled in the art that composite piece **36** will be suitably machined to either surface the piece to a true rectangle or to surface the two longer parallel sides as well as the two shorter sides such that a parallelogram is formed. Similar surfacing, as previously noted, can be carried out on the solid piece **32** to form either a rectangle or parallelogram.

Additional processing can be carried out with either the solid piece **32** and/or the composite piece **36.** For example, a plurality of compatible, similar sized, solid pieces **32** could be edge glued together in a manner to form wider dimension composite lumber products. By compatible pieces it is meant that the shorter longitudinal edges mate with respect to their angles. In a similar fashion, a plurality of composite pieces **36** that have been machined into parallelograms, where the parallelograms are of similar size, can likewise be edge glued to form wider dimension composite products. These additional processing steps are fully described in the aforementioned pending patent application. It will be appreciated that all of the products formed by the foregoing process steps will result in a very high yield of lumber product from the beginning log segment and will also result in a lumber product that is substantially vertical grained. Similarly, the larger diameter logs can be cut into larger sectors and processed according to the previously described steps, thereby reducing the volume of wood handled as narrow sector pieces.

Turning now to FIG. **7,** a description will be given where a sector-shaped piece **18** is to be cut in a longitudinal direction twice ($x=3$) rather than once. According to the preceding table, when sixteen sectors are cut from a single log and two additional longitudinal cuts are to be made, the log diameter will be equal to approximately 27.4 inches. Such being the case, of course, sector piece **18** will have larger overall dimensions (volume), thereby making it possible to make the two additional longitudinal cuts in cutting for a 1½ inches nominal thickness end product. In FIG. **7** the plurality of feed rolls **22** are positioned in order to make the initial longitudinal cut along plane of cut **38** which will be substantially parallel to one of the radial surfaces of sector piece **18.** By so making the first longitudinal cut along plane **38** there will result one trapezoidally shaped piece **40** similar to piece **26** of FIG. **3** and a sector-shaped piece **42** which is similar to the piece **24** of FIG. **3** but which has twice the thickness (T) of the trapezoidally shaped piece **40.** The resulting sector-shaped piece **42** is then repositioned between the plurality of feed rolls **22** for the second longitudinal cut along plane **44.** The cut along plane **44** will similarly divide sector-shaped piece **42** into two pieces, one being a second smaller trapezoidally shaped piece **46** and the second being a smaller sector-shaped piece **48.** It should thus be appreciated that with the longitudinal cuts along planes **38** and **44** two trapezoidally shaped pieces and one sector shaped piece of wood will be produced, with each resulting piece having a predetermined thickness (T) equal to the other.

As described previously, the trapezoidally-shaped pieces **40, 46** will then have removed therefrom additional sector-shaped pieces **50, 52** having their small included angles equal to the calculated angle θ. Thus, in the double longitudinal cutting step as depicted in FIG. **7,** there will result three smaller sector-shaped pieces **48, 50,** and **52** each being substantially the same size. Similarly, the rectangularly-shaped pieces of lumber that result are designated as **54** and **56.** The rectangularly shaped pieces **54, 56** can, of course, be surfaced in the manner desired to result in either finished dimension lumber or surfaced pieces for additional edge gluing to produce wider dimension products. The resulting smaller sector pieces **48, 50** and **52,** each having the proper predetermined thickness, will then be joined together in pairs as previously described, preferably after drying, in order to form the composite lumber pieces **36.** Similarly, after appropriate surfacing bonded sector pairs may be edge glued together to form the wider widths as desired.

It has been previously mentioned that the values listed in the above table should be taken by way of example only and actually represent values for generally straight perfect cylinders having the calculated diameter. Of course, such will not always be the case in the actual lumber manufacturing environment. For example, log segments will come to the manufacturing facility with a wide variety of different diameters that do not fall exactly on the table values and likewise log segments are not perfect cylinders, but rather have varying amounts of taper. In the aforementioned pending patent application several processes are described for recognizing the aberrations of various log segments and for capturing additional lumber yield from these aberrations. It should be apparent to those skilled in the art upon reviewing the process as described in the pending patent application that those same processes with minor variations can be applied to the present invention and can improve the lumber yield even further.

Another feature of the present invention must be appreciated for a full understanding of its advantages and versatility. For example, it may be desirable in some cases to make the first longitudinal parallel cut so as to yield a thin nominally sized 1 inch board with the remaining smaller sector pieces being sized so as to result in the 1½ inches nominal sized composite product after bonding and surfacing. In such a case, of course, equation (1) will have a different value of assumed thickness and conversely the calculated log diameters will be different as compared to those in the table. If, in fact, a nominal 1 inch board is cut from a larger sector, the included smaller sector piece will normally be considered as waste, since it will be smaller than the remaining sector.

In order to compare values of equivalent lumber yield in terms of board feet per hundred cubic feet of log volume (BF/CCF), several calculated values based on 1½ inch product will be cited. These values should be taken by way of example only and were calculated using obvious mathematical relationships that were fully disclosed and described in the aforementioned pending patent application. As an example, when a 16.1 inch diameter log is cut into fourteen sectors and one additional longitudinal cut is made, the resulting theoretical equivalent lumber in a typical 8-foot log segment will be 1,275 BF/CCF and correspondingly, if a 24.2 inch log segment is cut fourteen times, the resulting yield will be 1,278 BF/CCF. These values, of course, presume that in a given 8-foot log segment, all of the resulting smaller sectors will be bonded in the manner described in order to form composite pieces of lumber.

Thus, it will be appreciated that a log cutting process has been described that will substantially increase the yield of lumber product as well as reduce the number of sector-shaped pieces to be handled when breaking down the larger diameter log segments. Similarly, the resulting lumber products will be of substantially vertical grain configuration with all the inherent benefits of vertical grain lumber.

While a detailed description of the basic process has been described together with certain variations to offer flexibility, it is understood that many additional changes and modifications may be made to the basic process without departing from the spirit of the invention. All such modifications are intended to be included within the scope of the appended claims.

What is claimed is:

1. The process for making solid and composite lumber products from generally cylindrical logs comprising the steps of:

longitudinally cutting the logs along radial cutting planes into a plurality of first pieces that are generally sector-shaped in cross section and with the resulting angle between radial faces being less than 90°,

cutting the first pieces along at least one longitudinal plane of cut that is substantially parallel to one of their radial faces thereby forming at least second pieces that are generally trapezoidal in cross section and third pieces that are sector-shaped in cross section, smaller in size than the first pieces, and having the resulting angle between radial faces less than 90°, and

accumulating any two of the smaller sector-shaped pieces that are substantially equal in size and bonding them together along radial faces such that the thin edge of one is approximately adjacent the thick edge of the other.

2. The process as in claim **1** in which the longitudinal planes of cut that are parallel to a radial face are positioned so as to yield substantially equal thicknesses in the resulting pieces.

3. The process as in claim 1 further including the step of machining the second pieces and the bonded together smaller sector-shaped pieces into desired shapes.

4. The process as in claim 2 in which the desired shapes are parallelograms.

5. The process as in claim 3 further including the step of bonding a plurality of the parallelograms together edgewise to form wider width, generally planar, composite pieces.

6. The process as in claim 4 further including the step of rip cutting the wider composite pieces in selected widths.

7. The process as in claim 1 further including the step of cutting at least the second pieces along a longitudinal plane of cut that is approximately normal to their parallel faces so as to remove fourth pieces therefrom that are sector-shaped in cross section and substantially equal in size to the third pieces.

8. The process as in claim 7 including the step of accumulating any two of the third or fourth sector-shaped pieces and bonding them together along radial faces such that the thin edge of one is approximately adjacent the thick edge of the other.

9. The process as in claim 1 including the step of drying the smaller pieces cut from the first pieces prior to bonding.

10. The process as in claim 1 including the step of cross cutting the logs into preselected lengths.

11. The process as in claim 1 in which the first pieces to be cut from a selected log are sized according to the equation:

$$D = \frac{2\,(x)\,(T)}{\sin\theta}$$

where x is the number of times the final product thickness is desired from the first pieces,

T is the height of the first sector-shaped pieces before accounting for losses,

D is the diameter of the log before accounting for losses, and

θ is the angle between radial faces of the first pieces that is less than 90°.

* * * * *