United States Patent [19]

Troutner

[11] **3,813,842**

[45] **June 4, 1974**

[54] **LAMINATED, VARIABLE DENSITY, STRUCTURAL WOOD PRODUCTS AND METHOD FOR MAKING THE SAME**

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[22] Filed: **Apr. 26, 1972**

[21] Appl. No.: **247,897**

Related U.S. Application Data

[63] Continuation of Ser. No. 867,184, Oct. 17, 1969, abandoned.

[52] **U.S. Cl.** **52/693,** 52/642, 52/746, 144/317

[51] **Int. Cl.** **E04c 3/14**

[58] **Field of Search** ..... 52/642, 643, 693; 161/116; 287/20.92 L; 144/317, 315, 320

[56] **References Cited**

UNITED STATES PATENTS

2,097,322	10/1937	Hervey	287/20.92 L
2,126,711	8/1938	Atwood	144/317 X
2,279,820	4/1942	Hamilton	144/317
2,295,454	9/1942	Cesare	144/315 R
2,344,722	3/1944	Pasquier	144/317
2,381,134	8/1945	Newmark	144/317 X
2,452,739	11/1948	Fairchild	144/317 X
2,710,276	6/1955	Mottet	161/116 X
2,876,153	3/1959	Dorland et al.	161/7 X
2,786,005	3/1957	Clark	161/7 X
3,137,899	6/1964	Troutner	52/693

FOREIGN PATENTS OR APPLICATIONS

89,595	10/1935	Sweden	144/315 R
442,481	2/1936	Great Britain	144/315 R
476,979	12/1937	Great Britain	144/317
518,233	2/1940	Great Britain	52/693

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[57] **ABSTRACT**

Trusses and other structural products are made by applying glue to the side faces of a plurality of thin strips of wood, stacking the strips flatwise onto two adjacent stacks whereof the adjacent ends are interleaved, and applying across the surfaces of the stacks, in a direction substantially normal to the planes thereof, presure sufficient to consolidate the interleaved portion to the thickness of the remaining portion and to apply to both portions clamping pressure sufficient adhesively to unite the strips by setting of the glue interfaces therebetween. This forms an integral structural product having portions of normal density and strength and portions of increased density and strength useful as points of connection and bearing.

2 Claims, 14 Drawing Figures

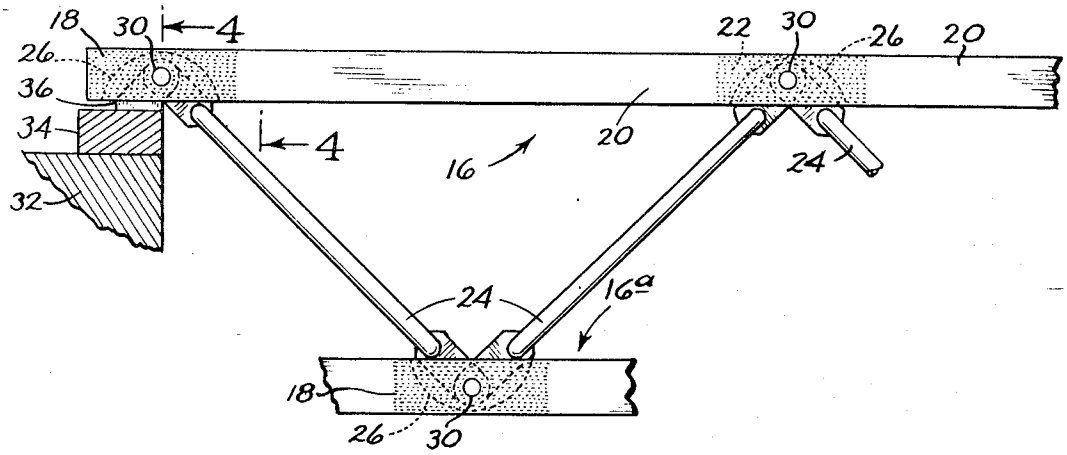


Fig. 1.

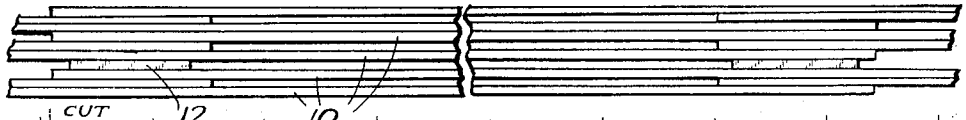
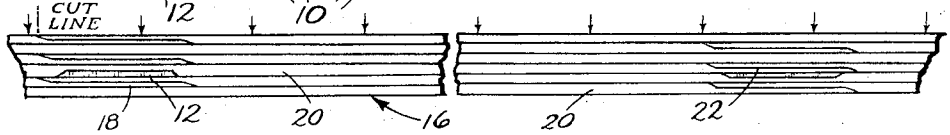


Fig. 2.



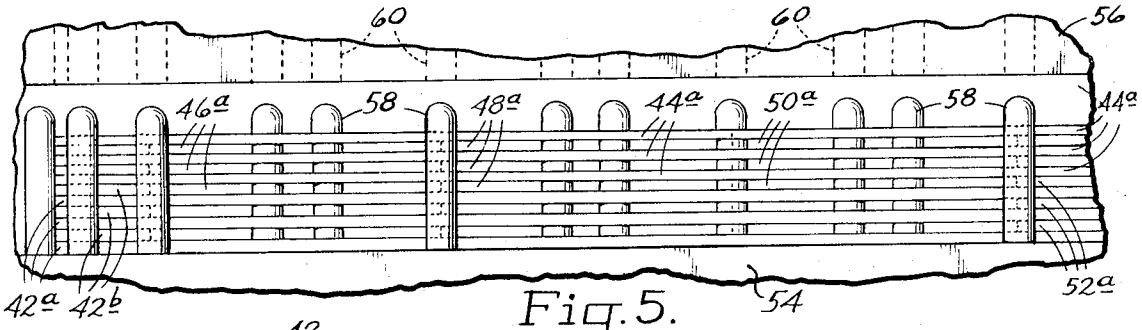


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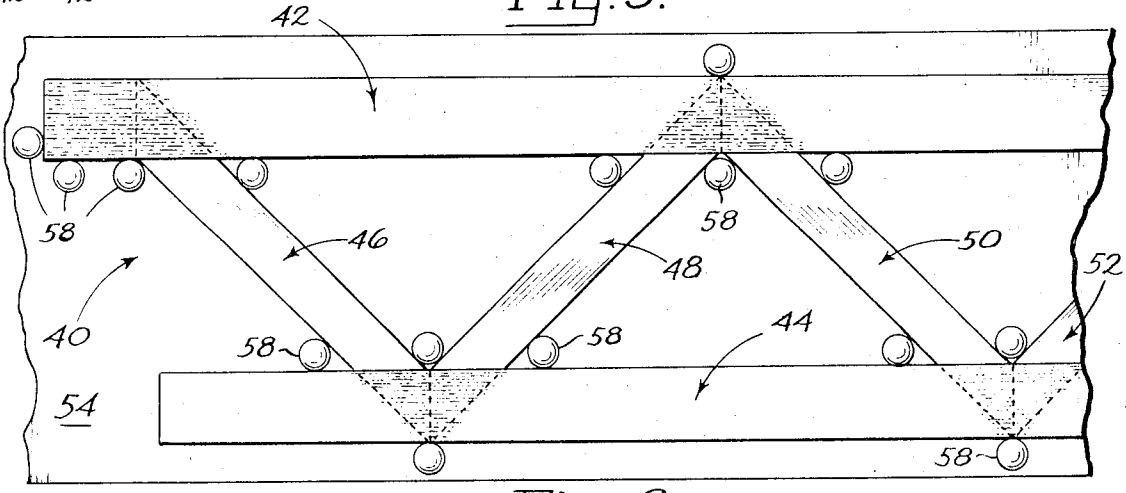


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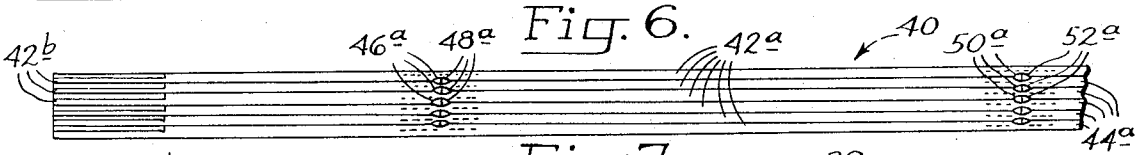


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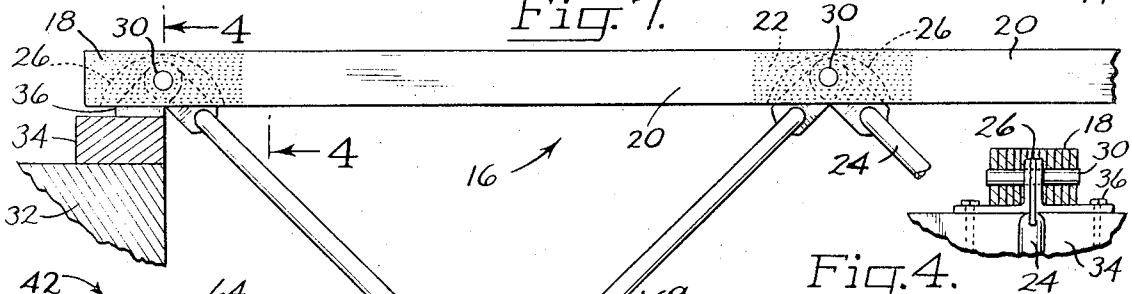


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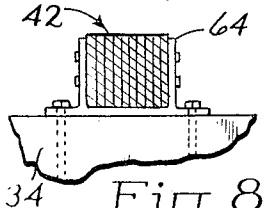


Fig. 8.

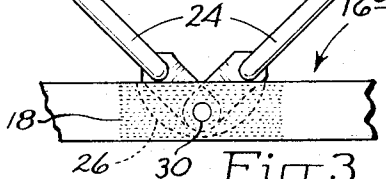


Fig. 3.

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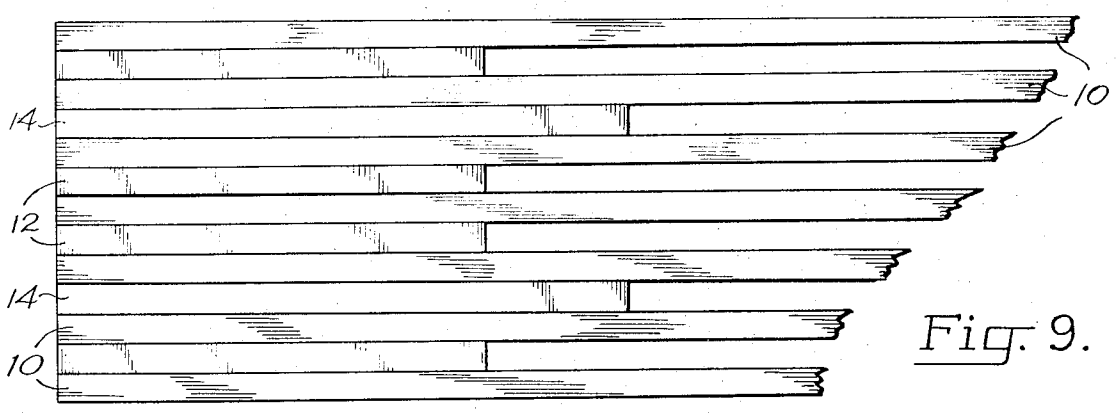


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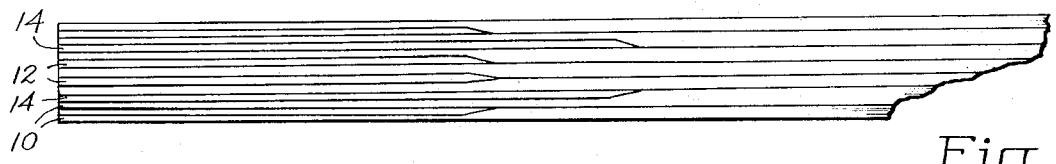


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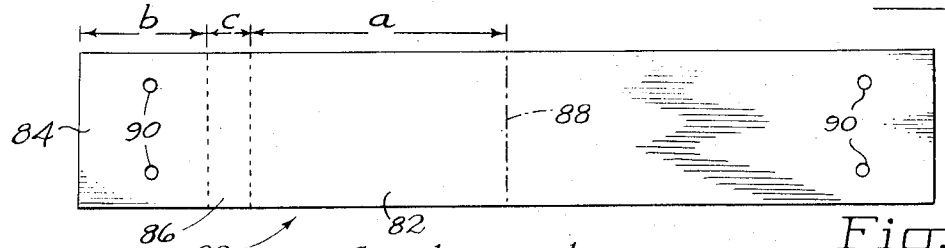


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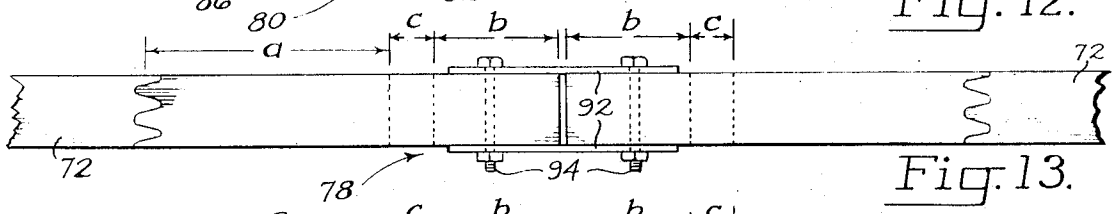


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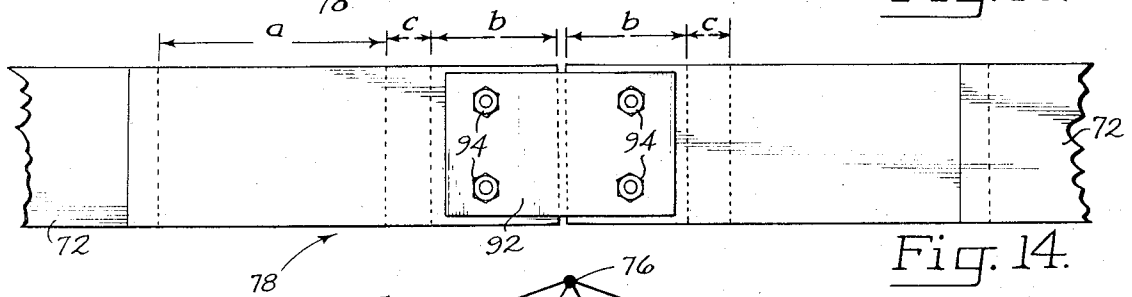


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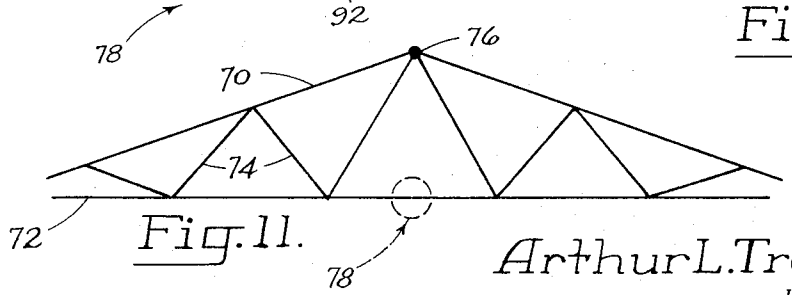


Fig. 11.

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LAMINATED, VARIABLE DENSITY, STRUCTURAL WOOD PRODUCTS AND METHOD FOR MAKING THE SAME

This is a continuation of U.S. Pat. application Ser. No. 867,184 filed Oct. 17, 1969.

This application is a continuation-in-part of the U.S. Pat. application of Arthur L. Troutner, Ser. No. 751,169, filed Aug. 8, 1968 for Laminated, Variable Density Structural Wood Products and Method for Making the Same.

This invention relates to wood trusses and other structural wood products and to a method for making the same.

In the manufacture of composite wood products, it historically has been a problem to obtain satisfactory glued joints of high efficiency with minimum bulk. Conventionally, high strength glue joints are obtained by scarfing or finger jointing the wood components. Part of the substance of the components to be joined is removed and the resulting parts lapped and fitted to obtain necessary glue lines.

However, multiple unit joints such as occur at the intersection of chords and webs (links) of a structural truss require the use of mechanical fasteners including nails, screws, bolts, split rings, shear plates, toothed plates, toothed rings and various combinations of the same. The application of such fasteners requires removal of part of the net section of the chords and/or webs in order to accommodate the joints. This reduces the efficiency of the truss.

Another difficulty attending the application of fasteners in wood joints is the tendency of the wood to split, due to the low value of wood in cross grain tension. This is a particular problem in the case of joints made with multiple bolts, split rings, or shear plates where there is eccentric loading which results in placing cross grain tensile loads on the joints.

Still a further problem attending the application of joints of the character under consideration is the relatively low connector bearing value of wood loaded in compression parallel to the grain, in relation to the total tension stress available in the cross section of the member being completed. An even lower bearing value is obtained when the wood is loaded perpendicular to the grain.

A typical instance occurs in the manufacture of structural trusses of the class described in my letters U.S. Pat. No. 3,137,899.

In the manufacture of trusses of this class the opposed faces of a pair of spaced wood chords are routed out at predetermined intervals to provide slots. Transverse holes are drilled to intercept the slots.

Webs made of metal tubes with flattened, perforated ends are arranged zig-zag between the chords with their ends overlapped and inserted in the slots. Pins are driven through the transverse openings in the chords and through the registering perforations in the ends of the webs to form a composite structural truss.

It is apparent that in a construction such as this, part of the net section of the chords is removed to accommodate the ends of the webs. The efficiency of the chords correspondingly is reduced.

It is the primary purpose of the present invention to provide a continuous, laminated, variable density, structural wood product in which compensation is made for the foregoing factors and in which the joints are of great strength and durability.

A further object of the present invention is to provide a laminated wood product of greatly increased structural reliability due to the scattering of natural defects of the wood by multiple laminations.

It is another purpose of the present invention to provide a method of making jointed, laminated variable density wood products which is adaptable to the fabrication of composite trusses and numerous other categories of composite structural wood products.

Still a further object of this invention is the provision of a method for making laminated, variable density, structural wood prodcuts which may be carried out easily, efficiently, and economically without using elaborate equipment or time consuming manual operations.

The manner in which the foregoing and other objects of this invention are accomplished will be apparent from the accompanying specification and claims considered together with the drawings, wherein:

FIG. 1 is a fore-shortened view in side elevation of a plurality of stacked, interleaved, wood strips illustrating the first step of the presently described method;

FIG. 2 is a fore-shortened view in side elevation similar to FIG. 1, but illustrating the structure of the laminated, variable density product resulting from the practice of the method;

FIG. 3 is a fragmentary view in side elevation of a structural truss including as essential components laminated, variable density, structural wood products made by the presently described method;

FIG. 4 is a transverse sectional view of the truss of FIG. 3 taken along line 4—4 of that figure and illustrating the manner of mounting the truss between bearing walls;

FIGS. 5 and 6 are schematic fragmentary views in side elevation and plan, respectively, illustrating apparatus and method employed in the fabrication of a second type of structural truss including the laminated, variable density structural units prepared by the method of the invention, FIG. 5 being viewed before consolidation and FIG. 6 after consolidation;

FIG. 7 is a fragmentary top edge view of an integral structural truss made using the method and apparatus of FIGS. 5 and 6;

FIG. 8 is an end view of the structural truss of FIG. 7, illustrating its manner of mounting on a bearing wall.

FIGS. 9 and 10 are fragmentary views in side elevation, similar to FIGS. 1 and 2, FIG. 9 illustrating an alternate method of stacking the wood strips and FIG. 10 illustrating the resulting pressed product;

FIG. 11 is a schematic view in elevation of a third type of structural truss including laminated, variable density structural wood components made by the present described method; and

FIGS. 12, 13 and 14 are views in elevation, plan and elevation, respectively illustrating the manner of making and applying to the truss structure of FIG. 11 the herein described laminated, variable density components.

In its broad aspect, the present method of making laminated, variable density structural, wood products comprises applying glue to the side surfaces of a plurality of thin strips of wood such as wood veneer strips in uniform thickness cut to size. The strips are stacked

flatwise in at least two adjacent stacks whereof the adjacent ends are interleaved. If desired, the strips may be interleaved at an angle to provide strength characteristics in a different direction as required for a connection to a joining member or to prevent splitting of the fibers, as is common in wood grain.

Pressure is applied across the surfaces of the stacks in a direction substantially perpendicular to their planes. The pressure is applied in magnitude predetermined to consolidate the interleaved portions to the thickness of the remaining portions of the stacks, as well as to apply to both portions of the stacks clamping pressure sufficient adhesively to unite the strips by setting the glue interfaces therebetween. Heat then is applied as required to stabilize the product in its united, consolidated, condition.

This produces a structural product having planar side faces, but containing certain areas having the original density and strength of the wood and other areas, i.e., the interleaved areas, having a substantially increased density and strength. This variable density provides a structural member with portions which may be machined and nailed with ease and other portions of increased strength, useful at points of connection or bearing.

The densified areas usually contain substantially double the numbers of structural fibers contained in the adjacent, undensified areas although this ratio may be varied to suit strength requirements. Accordingly the areas may be routed out or drilled in the joining procedure to provide joints of greater strength in which compensation is made for removal of the structural fibers.

Considering the foregoing in greater detail and with particular reference to the drawings:

The basic method of my invention is shown in FIGS. 1 and 2 illustrating the manner of fabricating an elongated wooden structural member such as a chord employed in a structural truss.

The material employed in the practice of the method comprises a plurality of thin strips of wood veneer, die- or otherwise cut to size. A preferred stock for this purpose comprises conventional plywood veneer having a uniform thickness of, for example, 0.10, 0.125, 1.187, or 0.230 inches. It thus is possible to utilize veneers resulting from the plywood manufacturing operation.

The side faces of the strips are precoated with a suitable adhesive which may comprise a conventional hot press glue applied in approximately the same spreads as are employed in manufacturing plywood.

The wooden strips precut to size and precoated with adhesive, then are stacked continuously as shown in FIG. 1. In compositing the stack, certain of the strips 10 are arranged longitudinally end to end, aligned with each other and overlapped in number and pattern as required to produce a spliced structural chord of the desired length and density.

If desired, densification may by achieved by the use of densifying laminae in the form of small pieces inserted between the long strips at spaced intervals. Such a short piece is indicated at 12 in FIG. 1. If it is desired to taper or feather out the densified area, densifying laminae of two or more lengths may be employed as the short laminae 12 and longer laminae 14 in the embodiments of FIGS. 9 and 10.

Use of the individual densifying laminae has the further advantage of making it possible to tailor the density of the product to the desired level. This may be accomplished merely by adding the densifying laminae in the necessary number. In addition, use of the individual laminae makes it possible to adjust the position of the densified areas to any desired location in the structural member. This may be accomplished without cross cutting or trimming the member.

Tapering the densified region by introduction of areas of intermediate density serves the important function of reducing the stress values resulting from sudden density change, thereby improving the properties of the member.

The grain direction of the laminae may be varied to achieve desired and predetermined properties in the densified product. The grain of structural laminae 10 in general will run lengthwise, substantially parallel to each other. However, the grain of the densifying laminae may be oriented parallel, perpendicular to, or at an angle to the grain of the longitudinal laminae.

Thus the grain of the longitudinal laminae is essentially parallel to the direction of the force applied to the finished assembly. However, the grain of the densifying laminae is substantially at right angles as required to increase the bearing and tensile values of the densified area.

The stack may be assembled rapidly and conveniently by alternating the stack components in a suitable jig or form with the components overlapped and interleaved to the desired degree.

The assembly either is laid up in a press, or is transferred thereto. Pressure is applied in a direction substantially perpendicular to the plane of the stack, i.e., in the direction of the arrows of FIG. 1. The pressure thus applied is predetermined in magnitude to consolidate the interleaved portions to the thickness of the remaining portions and to apply to both portions clamping pressure sufficient adherently to unite the strips by setting of the glue interfaces therebetween.

Stated otherwise, pressure is applied sufficient to contact the strips outside the interleaved area and to bond them. This contemporaneously compresses the strips in the interleaved areas to a fraction of their original thicknesses.

Depending upon the end use of the product, and the identity of the glue employed, heat also is applied to the assembly, preferably after its consolidation. The amount of heat thus applied is sufficient to set the glue without adversely affecting the wooden components of the structure. It also relaxes the fibers and stabilizes the assembly in its final form. To accomplish this purpose, sufficient heat should be applied to heat the innermost glue line to 200°–350° F.

After consolidation of the assembly and setting of the glue, the resulting continuous strip is subdivided at suitable locations to provide a unit having densified areas in desired locations.

The placement and arrangement of the densified areas are determined partly or solely by the location of necessary joint and bearing areas in the finished product. Thus, where the product is to comprise a chord 16 to be employed in the fabrication of a structural truss, the panel points of the truss, i.e., the joints at which the chords and web members are united, will determine the location of the densified regions.

This will require terminal densified regions 18 for attachment of chord support and terminal web members, a plurality of intermediate undensified regions 20 of

normal strength, and a plurality of intermediate densified regions **22** for attachment of the intermediate web members. This consideration is developed further in connection with the construction of the structural truss illustrated in FIGS. **3** and **4.**

In the truss of these figures, there are employed as component parts upper chord **16,** above referred to, a lower chord **16a** of analogous structure, and a plurality of web members (links) **24.** The latter are of known construction and comprise tubes of steel or other metal having flattened, transversely perforated ends.

To accommodate the web members, the densified regions **18, 22** are routed out to form slots **26.** All of the densified areas are drilled transversely to form bores which intercept the slots.

In the assembly of the truss, the chords and web members are arranged as shown in FIG. **3,** with the flat ends of the web members inserted in the slots with the perforations of the flat ends registering with the holes drilled through the chords. Pins **30** then are inserted through the registered holes to tie the assembly together.

In the erection of the truss, it is placed spanning the distance between a pair of bearing walls, beams or other supports. One of these is indicated at **32.**

The support mounts a bracket or clip **36.** This comprises a T-shaped member, the base of which is angled inwardly with respect to the truss. It enters end slot **26.** In addition, the central segment is provided with a transverse aperture which is aligned with the transverse holes drilled through terminal densified region **18** of the chord, where it is secured by one of pins **30.**

A structural truss having the above construction is of great strength. This strength is improved by the presence of densified areas **18** located at the joints of the composite structure. Even though these areas have been routed out and transversely bored, in view of their compression they contain the same number of uncut structural fibers as the adjacent undensified areas.

Wood fiber strength is proportional to its density, so the effective strength of the chords is not materially reduced by removal of their substance during the routing and drilling operation. This removal has been compensated by increased density in the areas of routing and drilling. Joints of substantially increased strength thus are obtained.

The foregoing principle may be utilized in the fabrication of strong, integrated, all wood, jointed products such as the integral structural truss illustrated in FIGS. **5–8** inclusive.

The truss of those figures comprises an upper chord **42,** a lower chord **44** and diagonally arranged web members or links **46, 48, 50, 52.** All of these members may be comprised of strips of plywood veneer precut to size and glued together, face to face.

Upper chord **42** may be comprised of a stack of strips of veneer **42***a*, spliced together end to end to achieve the desired length. Terminal pieces **42***b* also are provided to create a densified, strong terminal area.

Similarly, lower chord **44** is comprised of laminae **44***a*.

Web members **46, 48, 50** and **52** are comprised of stacks of individual strips **46***a*, **48***a*, **50***a* and **52***a*, respectively. The ends of the strips are cut diagonally as required to achieve the desired web angles.

As in the case of the previously described embodiments, the face surfaces of the strips are coated with a suitable adhesive. The strips then are assembled in a jig illustrated in FIGS. **5** and **6.** As shown, each web pair is interleaved between two chord laminations. Preferably the jig comprises components of the press used for the consolidation operation.

To this end there may be provided a lower press platen **54** and an upper press platen **56.** The press platens and the press of which they are components may be conventional in construction with the exception that the lower press platen is provided with vertically extending guide bars **58** and the upper press platen is provided with registering guideways **60.**

The arrangement of the guides is such that the guides form a jig in which the precoated strips may be placed with their ends interleaved in proper orientation to achieve the desired truss configuration. If desired, a number of truss assemblies may be placed in the jig at one time, separating each assembly by means of separating plates or other parting instrumentalities.

Upon closing the press, the assemblies are consolidated, densified in the overlapped areas, and glued together in all areas. The result is an integral truss having the configuration shown in FIG. **6** and the structure shown in FIG. **7.** The joint and bearing areas shaded in FIG. **6** represent the densified areas of great strength.

The manner of erection of the truss is similar to that of the companion truss illustrated in FIG. **3.** The overhanging upper end of upper chord **42** is placed in bearing relation against plate **34** of a structural wall, as shown in FIG. **8.** A special bearing clip or bracket **64** is interposed between the chord end and the plate. The bracket has a generally U-shaped configuration which receives the chord end. Clip flanges are nailed to the plate and the clip sidewalls are nailed to the chord end for stabilizing and mounting the truss.

Another application of the presently described method and product is illustrated in FIGS. **11–14** inclusive. This application involves the production and use of densified wood connectors in the construction of long structural members.

A typical application is in the fabrication of a ridged truss joist illustrated schematically in FIG. **11.**

Such a truss joist is made in two sections. Each includes an upper chord **70** and a lower chord **72** interconnected by a plurality of web members or links **74.** The two sections are arranged end to end and the two upper chords joined by a ridge connector **76.** The two lower chords are joined by the herein described densified connector, indicated generally at **78.**

In the manufacture of the densified connector, there first is prepared a double flitch, illustrated in FIG. **12.** This product may be variously dimensioned, but in a typical case where it is to be used in conjunction with 2×6 lumber, it may be about 4 feet long by 6 inches wide by 2 inches thick. It is composited using the technique described above, preferably that illustrated in FIGS. **9** and **10.**

It thus comprises two identical halves. Each half includes a normal density segment **82** having a length "*a*," wherein the wood is substantially uncompressed; a high density section **84** having a length "*b*" including a predetermined number of short densifying laminae **12**; and an intermediate density section **86** having a length "*c*" and a predetermined number of densifying laminae **14** of intermediate length.

The double flitch is cut transversely along a central cut line 88. Its densified ends are drilled to provide transverse openings 90.

There thus are provided two flitches, each of which may be connected to an end of one of lower chord segments 12. This may be variously accomplished, preferably by scarfing the meeting ends of the flitch and chord segment and gluing them together.

There thus are fashioned two composite lower chord segments which are laid together end to end in the manner illustrated in FIG. 11, with the densified ends adjacent each other. The two ends then are connected by means of connecting plates 92 laid along the side faces of the chords. Bolts 94 penetrate both the connecting plates and openings 90.

In this manner the above noted desirable properties may be imparted to the joint while maintaining economy of construction through the use of chords which consist mostly of ordinary lumber, but have densified ends through which the connection is made.

Having thus described my invention in preferred embodiments, I claim as new and desire to protect by letters patent:

1. A uniformly thick integral structural wood truss comprising a plurality of strips of wood, said plurality of strips comprising a plurality of groups of strips, at least one of said groups of strips defining a first chord, at least another of said groups of strips defining a second chord, and others of said groups of strips defining a plurality of web members, said strips being stacked and arranged flatwise with strips of different groups being interleaved, the strips defining each group being superimposed on each other, said strips being interleaved so that predetermined superimposed areas of the strips of each of said groups are interleaved with predetermined superimposed areas of the strips of another group, said strips defining said first chord being spaced apart from said strips defining said second chord, said groups of strips defining said web members interconnecting said chords, each of at least some of said groups having at least one portion constituted by superimposed areas of the strips of that group not interleaved with strips of any other group so that the assembly of stacked strips has a plurality of interleaved portions and a plurality of non-interleaved portions, each of said strips being of substantially uniform thickness throughout its length, said superimposed strips being glued to each other and pressure-consolidated, sustantially without extrusion of the wood, in a direction substantially perpendicular to the planes of the strips sufficiently to consolidate the interleaved portions to the thickness of the remaining portions, said truss being of substantially uniform thickness so that said consolidated truss has predetermined portions of a first density and other predetermined portions of greater than said first density.

2. The method for making a uniformly thick integral structural wood truss which comprises

a. applying glue to the side faces of a plurality of strips of wood of substantially uniform thickness throughout their length, said plurality of strips comprising a plurality of groups of strips, at least one of said groups of strips defining a first chord, at least another of said groups of strips defining a second chord, and others of said groups of strips defining a plurality of web members for interconnecting said chords,

b. stacking said strips flatwise while interleaving strips of different groups to provide an assembly of stacked, interleaved strips, the strips defining each group being superimposed on each other, the strips being interleaved so that predetermined superimposed areas of the strips of each of said groups are interleaved with predetermined superimposed areas of the strips of another group, said strips being so stacked and interleaved that said strips defining said first chord are spaced apart from said strips defining said second chord, with said groups of strips defining said web members interconnecting said chords,

c. each of at least some of said groups having at least one portion constituted by superimposed areas of the strips of that group not interleaved with strips of any other group so that the assembly of stacked strips has a plurality of interleaved portions and a plurality of non-interleaved portions, and

d. applying pressure across the opposite surfaces of the assembly of stacked strips in a direction substantially perpendicular to the planes of the strips and in magnitude predetermined to press and consolidate, without substantial plastic flow of the wood, the interleaved strips portions to the same thickness as the non-interleaved strip portions to thereby provide the interleaved portions with densities greater than the densities of the non-interleaved portions,

e. said pressure applying to all portions of the assembly clamping pressure sufficient adherently to unite the strips by setting of the glue interfaces therebetween.

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