NOVEL WOOD BENDING METHOD

Filed Aug. 15, 1960, Ser. No. 49,759

6 Claims. (Cl. 144—327)

This invention relates to shaped wooden members and to a method of wood bending or wood forming to make such members. More particularly, this invention relates to a wood bending or forming method whereby it is possible by employing a plurality of elongated wooden members to produce therefrom a solid, curved unitary wooden form or shape.

In previously known wood bending or forming operations it has been a practice to employ wooden sheets or slats and to bend these sheets only in one direction or plane into a desired shape. Since these sheets have a substantially greater transverse dimension or width than thickness, it is possible to bend these sheets successfully and without damage or breakage only in one direction or in one plane, i.e., in a plane perpendicular to the greater transverse dimension. If an attempt is made to bend these sheets in any other direction or plane, the sheets are usually damaged or ruptured during the bending operation. Accordingly, the forms or shapes available by bending these materials are limited.

It is an object of this invention to provide an improved wood forming or bending operation.

It is another object of this invention to provide a method whereby it is possible to manufacture solid, unitary wooden members having a substantially small radius of curvature relative to the thickness of the member.

A further object is to provide a process for manufacturing an elongated wooden member bent in a plane in which said wooden member has a transverse dimension of substantially equal magnitude.

Yet another object of this invention is to provide a method whereby elongated wooden articles having substantially any curved shape or form may be prepared.

How these and other objects of the invention are achieved will become apparent in the light of the accompanying disclosure made with reference to the accompanying drawings wherein:

FIG. 1 illustrates a perspective view of an assembly or bundle of elongated, straight wooden members prepared for use in the forming or bending operation of this invention.

FIG. 2 illustrates, partly in perspective and partly in section, a portion of the assembly of wooden members pressed into a form.

FIG. 3 illustrates a step in the wood bending or forming operation of this invention; and

FIG. 4 illustrates a solid unitary wooden form bent in two directions or planes and manufactured in accordance with this invention.

In accordance with this invention, an improved wood bending or forming method is provided by assembling a bundle comprising a plurality of adhesive-coated elongated wooden members. The wooden members employed have a cross-sectional shape such that when fitted together the wooden members will form a solid unitary member. The assembled bundle is then pressed at one location or one end thereof into an elongated form having a desired curved shape and the individual wooden members of the bundle fitted together therein to provide at that initial location a solid unitary wooden piece. The fitting and pressing or forming operation is then continued lengthwise along the bundle while continuously pressing and fitting together the assembled bundle within the form. The fitting and forming operation is carried out until the form is filled or until all or the desired amount of the assembled bundle has been pressed and fitted within the form. Following the fitting, pressing and forming operation, the bundle is maintained in the form for a period of time sufficient to substantially permanently set the wooden members therein to form the desired solid unitary member.

Before the fitting and pressing operation the surfaces of the wooden members of the assembled bundle are coated with an adhesive or bonding agent so as to form a multiplicity of bonds between the surfaces of the pressed, fitted wooden members within the form. In the practice of this invention, preferably just prior to the pressing and fitting operation, it is desirable to steam the bundle or to soak the bundle by water immersion followed by steaming, in order to soften or plasticize the individual adhesive-coated wooden members of the assembled bundle so that the pressing and fitting operation can more readily be carried out and the assembled bundle can more easily be made to conform to the shape of the form into which it is pressed and fitted.

As indicated hereinabove, the cross-sectional shape of the wooden members making up the assembled bundle is that such these members can be fitted or nested together to form a solid unitary member without substantially any void space between the fitted wooden members. Wooden members having a square cross-sectional shape are particularly useful in the practice of this invention.

Wooden members having other cross-sectional shapes such as rectangles, hexagons, equilateral triangles and the like, or any other cross-sectional shape which permits the members to be fitted slidably together are also useful.

The cross-sectional dimensions of the wooden members comprising the assembled bundle should be such that during the fitting, pressing and forming operations the wooden members of the bundle are not subjected to a stress great enough to cause breaking or rupture of the wooden members. Therefore, in the practice of this invention wooden members having a square or substantially square, cross-sectional shape, e.g., about 1/4 inch square, are preferred, although wooden members having a rectangular cross-sectional shape are also useful particularly if one cross-sectional dimension, e.g., width, is not substantially greater, such as not one and one-half times greater than another cross-sectional dimension, e.g., thickness.

Referring now to the drawings, particularly FIG. 1 thereof, there is illustrated an assembly or bundle 1 of a plurality of adhesive-coated elongated wooden members 2 having a square cross-section, about 1/4 inch square. The bundle 1 is held or lashed together at one end thereof, such as by means of a band 3, and the wooden members 2 of the bundle are held spaced apart toward the other end thereof by suitable spacing means, such as by means of one or more grid spacers 4. These spacers 4 are employed to separate and to expose the surfaces of the wooden members 2 making up the bundle 1 at a position removed from the fastened or lashed end of the bundle. The bundle, if desired, may then be soaked or immersed in water, hot or cold, e.g., at a temperature in the range 40°—180° F. There may be added to the water a minor amount of a surfactant or wetting agent such as sodium tetradecyl sulfate, e.g., Tergitol 4, to permit penetration of the wooden members and the penetration of water into the fibers thereof. The soaking operation, prior to steam-
ing, is particularly useful if the wooden members have a thickness greater than ⅜ inch. The bundle 1 is then inserted in a steam chest or oven which is maintained in contact with steam, such as steam at substantially atmospheric pressure and at a temperature of about 212° F. for a period of time sufficient to plasticize or soften the individual wooden members 2. Higher or lower steaming temperatures, if desired, may be employed if satisfactory and effective to soften the wooden members. The steaming time sufficient to soften or plasticize the wooden members varies with the number of members 2 comprising the bundle 1 and the size or cross-sectional area of the individual wooden members 2. Usually a steaming time in the range 5–60 minutes, more or less, in a steam chest maintained at about 212° F. is sufficient to satisfactorily soften the wooden members.

In the practice of this invention the wooden members 2 are coated or treated with a suitable bonding agent or adhesive prior to soaking and steaming, either individually or in the bundle, so that after bundle 1 has been steamed it can be placed directly in a form having the desired shape and pressed, fitted and formed therein into the shape outlined by the form. If the wooden members 2 are not pre-coated with adhesive or suitable wood bonding agent, the wooden members 2 of the bundle 1 following the steaming operation must be then coated with the adhesive. Such a coating operation intervening between the steaming operation and the fitting, pressing and forming operation, introduces a delay during which cooling of the steamed bundle 1 and reduction in plasticity of the wooden members 2 thereof takes place.

Various thermosetting or thermostrengthening adhesive or bonding agents may be employed. Since the wooden members 2 are pre-coated with the adhesive prior to the steaming operation, the adhesive should be stable during the steaming operation. Such suitable bonding or adhesive agents are known and include polyvinyl acetate copolymer containing adhesives, e.g., polyvinyl acetate copolymer adhesive commercially available and sold as Woodloc 40-0212. Other steam-stable adhesives or bonding agents include vinyl adhesives and rubber base adhesives. When a polyvinyl acetate adhesive is employed the adhesive coating the members is cured thereon by permitting the carrier (water) to evaporate completely. The curing of the adhesive can be accelerated by heating the coated member to about 150° F. to yield the wooden members encapsulated within the cured adhesive.

Referring now to FIGS. 2 and 3 of the drawings, following the steaming operation the bundle 1 is pressed and formed into a suitable mold or form having a desired shape, such as steel form 5 having an L-shaped cross-section. The fitting-forming operation is commenced at the fastened or lashed end or portion of bundle 1, and wooden members 2 making up bundle 1 are maintained fitted together within form 5 to form therein at that location a solid unitary piece. With grid-like spacers 4 removed the fitting-forming operation is continued and advanced lengthwise along bundle 1, fitting the individual wooden members 2 together as the forming operation is advanced along bundle 1 within form 5 so as to form therein a continuous, solid unitary wooden member having a shape conforming to that of form 5. As bundle 1 is fitted and formed within form 5 it is maintained, pressed and fitted therein by suitable means, such as by means of a plurality of cooperating form members, e.g., L-shaped form segments 6 having a shape complementary to and conforming to that of corresponding portions along form 5, which serve to press silicone rubber (Silastic), neoprene or rubber pads 7 against bundle 1 within form 5 so as to cause bundle 1 thereto to conform to the shape of form 5. Suitable clamping pressure can be exerted upon cooperating form members 6 by means of C-clamps 8 and the like.

During the fitting-forming operation carried out upon bundle 1 in form 5 no extraneous tension bands or the like are employed associated with bundle 1. Also, during the forming operation wooden members 2 of bundle 1 are free to slide along one another, each member 2 bending or flexing at the part of corresponding portion located on members 2 nearest the inside of form 5 which would have the greatest tendency to break on their tension sides during the forming or bending operation are backed up by outer layers of members 2 so that breakage of members 2 during the forming operation is substantially eliminated. This frees members 2 of small cross-section within the form during the fitting-forming operation permits the individual members to be bent in a wide variety of configurations without setting up excessive stresses in any particular member or portion of the member. This permits the individual members of the bundle to be bent as a curve lying in a plane wherein the complete bundle has a substantial dimension. Furthermore, since each member has a small cross-sectional dimension in any direction, it may be bent in any direction without stressing it unduly, so that the entire bundle may likewise be bent in any direction.

The aforesaid forming operation is continued and bundle 1 of wooden members 2 conformed to the shape of form 5 until either substantially all of the bundle 1 has been fitted and formed together within form 5 or until the forming operation has been completed. The solid unitary member has been provided within form 5.

When the desired solid unitary member has been formed, it is maintained, pressed and fitted within form 5 for a suitable length of time to substantially permanently set the wooden members thereof into the desired solid unitary plastic member. The formed bundle 1 within form 5, preferably immediately following the fitting-forming operation, is subjected to heat-sealing and drying. To this end the formed bundle within form 5, still maintained clamped therein between form 5 and cooperating form segments 6 by C-clamps 8 is placed in a drying oven through which hot air or other suitable hot gas is circulated. The formed, clamped bundle in form 5 is maintained in the drying oven for a period of time sufficient to effect satisfactory bonding and drying of the formed bundle, such as a period of time sufficient to bring the internal temperature of the formed bundle within the form to about above 200° F., such as about 235° F. This internal temperature can readily be obtained by circulating hot air through the drying oven at a temperature of about 300° F. for a period of time in a range of about 30–120 minutes, more or less, the exact time depending upon oven temperature, air circulation rate, or thickness of the formed bundle 1 within the form, etc. Lower oven temperatures, e.g., about 250° F., may be employed but the curing time or residence time in the drying oven is correspondingly increased.

As an aid in the heat-sealing and drying operation it is desirable that form 5 be provided with perforations 5a to provide access of gases or vapors to and from bundle 1 therein. Similarly, cooperating form segments 6 and rubber pads 7 are also desirablely provided with perforations 6a and 7a respectively. Rubber pads 7 which are employed to avoid damage to and to distribute the forming pressure to the wooden members 2 during the forming operation, should exhibit low compression set at the oven temperatures. Suitable rubber pads are those about ½" thick and having a 50 durometer hardness and which compress not greater than about 20% under a forming pressure of 300 p.s.i. upon exposure to a temperature of 250° F. for about one hour or upon exposure to a temperature of 300° F. for about 20 minutes. The elasticity of the rubber pads allows for follow-up on the formed members as the wood shrinks during the heat-sealing and drying operation.

During the drying operation, if a thermosetting adhesive or bonding agent is employed to coat wooden members...
members 2 making up bundle 1, thermosetting of the adhesive also advantageously occurs. Following the heat-sealing and drying operation, bundle 1, still clamped within form 5, is taken out of the drying oven and permitted to cool to about room temperature and is maintained in form 5 for a period of time, from about one to about ten days, to allow the moisture content to become uniform throughout the formed bundle before the resulting formed bundle is released as a solid unitary member having the desired form. If desired the formed bundle, after removal from the drying oven and cooling, can be removed from the form and clamped in a drying form during the seasoning operation.

Referring again to the drawings, particularly FIG. 4 thereof, there is illustrated a solid unitary wooden form or shape 9 manufactured in accordance with this invention. It is to be noted that the wooden form 9 is made up of a plurality of individual wooden members 2 which have been fitted together and shaped by employing the practices of this invention to provide a single, solid unitary member having the shape or form illustrated therein. The individual wooden members 2 comprising wooden form 9 are substantially permanently shaped and bonded together by following the practices of this invention. It is to be noted that wooden form 9 is bent in at least two planes substantially 90° apart.

A solid wooden member having substantially any desired shape can be manufactured by following the practices of this invention. The practice of this invention is particularly useful for the manufacture of intricate wooden shapes useful in furniture manufacture and as structural members in buildings, equipment and the like.

The length of the wooden members assembled and treated in accordance with this invention should be sufficiently great to permit the desired wooden shape to be made therefrom so as to avoid the necessity of abutting wooden members lengthwise end to end during the forming process of this invention. In most instances wooden members having a length in the range 4–25 feet, more or less, such as a length in the range 10–15 feet are satisfactory.

Substantially any number of individual wooden members might be employed in the final wooden form, depending upon the shape and size of the wooden members and/or the wooden form itself. A number of individual wooden members, such as a number in the range 10–100, e.g., in the range 20–40, fitted together to form a solid unitary shape might be employed. Wooden members capable of being fitted together, such as wooden members having a square cross-section in the range 0.125–1.0 inch square, particularly in the range 0.25–0.5 inch square are useful. Wooden members having larger or smaller sizes are, of course, useful depending upon the shape desired in the final wooden product, the curvatures and radii of curvatures of the bends therein and the location and number of the bends. It is important, however, that in the practice of this invention the members making up the bundle being formed and shaped possess a relatively small cross-sectional dimension parallel to the plane of desired curvature or the direction of bending and that this dimension be not more than 0.5 R wherein R is the radius of curvature of the bend, preferably at least 0.005 R, such as a dimension in the range 0.01 R–0.2 R.

While the wooden shape illustrated has a square cross-section, the invention is not limited in that respect, and other cross-sectional contours, e.g., oblong, triangular, etc., may be used.

The practice of this invention is generally applicable to all woods, including such woods as walnut, pine, oak, hickory, fruitwoods and any other type of wood which can be steamed and bent. Indeed, the practice of this invention is applicable to substantially any material, even synthetic materials, which is capable of being softened upon steaming or upon exposure to heat and then capable of being bent or shaped and bonded together into a desired final shape.

As will be apparent to those skilled in the art in the light of the accompanying disclosure, many modifications, changes and substitutions are possible in the practice of this invention without departing from the spirit or scope thereof.

I claim:

1. A wood forming method which comprises assembling a stacked bundle comprising a plurality of adhesiv-coated elongated wooden members, said wooden members having a relatively small cross-sectional area and a cross-sectional shape such that when fitted together said members form a solid member, the assembled bundle comprising said members stacked in superposed and side-by-side relationship and having all the grain in substantially one direction and being held together at a location and the wooden members fitted together at said location such that the assembled bundle at said location has a solid cross-section and the other portions of the members making up the assembled bundle at locations removed from the aforesaid location being disposed so that said members are separated from one another and fit together to starting at the aforesaid location, progressively from said location lengthwise along said bundle, pressing and forming the assembled bundle into a desired shape under conditions such that the members comprising said bundle are fitted together to form a solid unitary member with no void space between said members and maintaining the assembled, fitted and formed members in the desired shape for a sufficient period of time to substantially permanently set the members thereof and to form a single solid member having all the grain in substantially one direction.

2. A wood forming method which comprises assembling a stacked bundle comprising a plurality of adhesive-coated elongated wooden members, said wooden members having a relatively small cross-sectional area and a cross-sectional shape such that when fitted together said members form a solid member, the assembled bundle comprising said members being stacked in superposed and side-by-side relationship and having all the grain in substantially one direction and being held together at a location and the wooden members fitted together at said location such that the assembled bundle at said location has a solid cross-section and the other portions of the members making up the assembled bundle at locations removed from the aforesaid location being disposed so that said members are separated from each other, steaming the assembled bundle for a period of time sufficient to soften said members, progressively from said location lengthwise along said bundle, pressing the resulting steamed bundle into a form having a desired shape starting at said location where said wooden members are fitted together so that the assembled bundle has a solid cross-section, continuously pressing the assembled bundle into said form while advancing the bundle pressing operation lengthwise along the assembled bundle under conditions such that the wooden members comprising said bundle slide along each other and to form a continuous solid unitary member having all the grain in substantially one direction and having the desired shape and subjecting the resulting assembled solid bundle to an elevated temperature and maintaining said bundle for a sufficient period of time to permanently set the assembled bundle to form a single solid member.

3. A method in accordance with claim 1 wherein the wooden members have a square cross-sectional shape.

4. A method in accordance with claim 1 wherein the wooden members have a rectangular cross-sectional shape.

5. A method in accordance with claim 1 wherein said wooden members have a square cross-sectional shape in the range 0.125–1.0 inch square.

6. A wood forming method which comprises assembling a stacked bundle comprising a plurality of adhesive-
coated elongated wooden members, said wooden members having a relatively small cross-sectional area and a cross-sectional shape such that when fitted together said members form a solid member, the assembled bundle comprising said members stacked in superposed and side-by-side relationship and being held together at a location and the wooden members fitted together at said location such that the assembled bundle at said location has a solid cross-section and the other portions of the members making up the assembled bundle at locations removed from the aforesaid location being disposed so that said members are separated from each other, starting at the aforesaid location progressively from said location lengthwise along said bundle, pressing and forming the assembled bundle into a desired shape under conditions such that the members comprising said bundle are fitted together to form a solid unitary member with no void space between said members and maintaining the assembled, fitted and formed members in the desired shape for a sufficient period of time to substantially permanently set the members thereof and to form a single solid member having a substantial cross-sectional area of substantial thickness and breadth as compared with the cross-sectional area and thickness and breadth of the wooden members making up said formed member.

References Cited in the file of this patent

UNITED STATES PATENTS

<table>
<thead>
<tr>
<th>Patent Number</th>
<th>Inventor</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,016,684</td>
<td>Fisher</td>
<td>Feb. 6, 1912</td>
</tr>
<tr>
<td>1,465,583</td>
<td>Walsh et al.</td>
<td>Aug. 21, 1923</td>
</tr>
<tr>
<td>1,906,392</td>
<td>McLeod</td>
<td>May 2, 1933</td>
</tr>
<tr>
<td>2,074,854</td>
<td>Owens</td>
<td>Mar. 23, 1937</td>
</tr>
<tr>
<td>2,207,939</td>
<td>Nordby</td>
<td>June 16, 1940</td>
</tr>
<tr>
<td>2,350,915</td>
<td>Miller</td>
<td>June 6, 1944</td>
</tr>
<tr>
<td>2,392,079</td>
<td>Andreeff</td>
<td>Jan. 1, 1946</td>
</tr>
</tbody>
</table>

FOREIGN PATENTS

<table>
<thead>
<tr>
<th>Patent Number</th>
<th>Country</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>4306/26</td>
<td>Australia</td>
<td>Oct. 18, 1926</td>
</tr>
</tbody>
</table>