Summer 8-1-1964

Laminating Wood Components of Varying Individual Thickness

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LAMINATING WOOD COMPONENTS OF VARYING INDIVIDUAL THICKNESS

A Research Paper

Presented to

the Graduate Faculty

Central Washington State College

In Partial Fulfillment

of the Requirements of the Degree

Master of Education

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by

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August 1964

THIS PAPER IS APPROVED AS MEETING THE PLAN 2 REQUIREMENT FOR THE COMPLETION OF A RESEARCH PAPER.

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CENTRAL WASHINGTON STATE COLLEGE

Graduate Division

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Tuesday, August 11, 1964

1:00 p.m.

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CHAPTER I

INTRODUCTION

This paper deals with a new process in woodworking--one which overcomes some old woodworking problems in lamination. Although terms used in describing this process are quite common, a review of their meaning in relation to this paper may be helpful.

The two words, laminating wood, refer to the process of gluing two or more pieces of wood together. This may mean that the grains run at right angles to one another (1:14), but the more general interpretation is that the grain of the pieces runs parallel (2:9, 3:247, 7:16). The separate pieces that are glued together to form the laminate or finished piece are often referred to as laminae or components. The remaining words, varying individual thickness, are all familiar. Now the complete title might be described in this way: The process is one of gluing together a number of pieces of wood with their grains running parallel; the thickness of each of these pieces is not uniform from one end to the other. (See Figure 1, page 2.) In the paper, the writer will justify and explain the process described above.

The search for evidence of this type of lamination was made in the Central Washington State College Library

LAMINATE OF COMPONENTS OF VARYING INDIVIDUAL THICKNESS

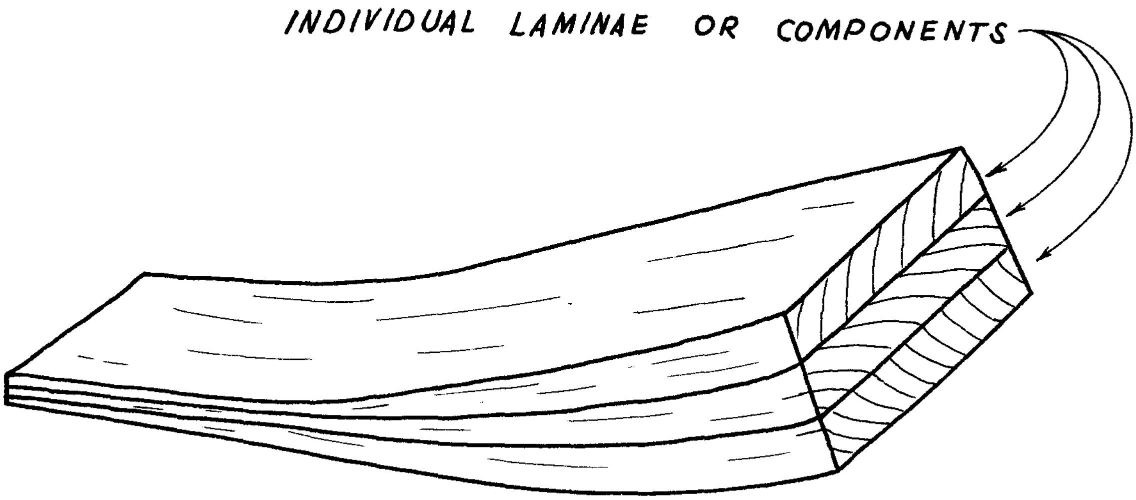


FIGURE 1

A BENT LAMINATE CONSTRUCTED OF THREE COMPONENTS OF VARYING INDIVIDUAL THICKNESS and the University of Washington Library. Letters to the United States Government Printing Office and the Forest Products Research Laboratory of England brought useful background information. Visits were made to furniture and sporting goods stores, a furniture manufacturer, and a diving board manufacturer. No evidence of laminating wood components of varying individual thickness was found.

The usefulness of the process coupled with the fact that there is no evidence of the process being used today, justifies this research paper.

The remainder of this paper will lead the reader through the history of lamination and the justification of laminating wood components of varying individual thickness. The actual mechanical processes--the how to do it--is described as well as some possible uses of the process.

CHAPTER II

HISTORY OF LAMINATION

Although there is some evidence of knowledge of the process of lamination before Christ (2:9), the important applications and developments have taken place during the twentieth century. Credit is given to Europe for first using glued laminated structural members in 1907 (3:247). It wasn't long until this process was initiated in the United States. In 1934 the Forest Products Laboratory built one of the first buildings in the United States using glued laminated arches (3:247). Two years later, in 1936, a staff member of this same Forest Products Laboratory saw many glued laminated forms while in Europe. He reported that these laminated pieces were seen particularly in Switzerland, Sweden and Germany (1:14).

Inadequate laminating glues were probably the major reason that laminating wasn't widely used until the last few decades (2:29, 8:20). Many of the older glues required heating before use. This is a disadvantage in laminating because the glue often cools before all the laminae can be coated with glue, put together, and clamped. This, plus the fact that the old animal and fish glues were not water resistant, held laminating to a minimum until the development of modern glues.

In the past thirty years great advances have been made in improving adhesives. Some of the modern glues have many advantages that make them ideal for laminating. They do not have to be heated, and they have slow setup so that the craftsman has time to get all the laminae coated with glue, assembled, and clamped. In addition, some glues are water resistant and others are water proof.

During the same time glues were being improved, it was becoming harder to obtain top quality wood of adequate dimensions (2:10). One logical way to increase the dimensions of wood was to laminate. So with this greater need for lamination and the new glues being produced by science, the process of lamination began to gather prominence. Today its use extends into many woodworking industries (3:247, 4:6).

CHAPTER III

CHARACTERISTICS OF LAMINATION

Many of the characteristics of the more traditional type of lamination are common to the variation discussed in this paper--laminating wood components of varying individual thickness. For this reason a review of these characteristics will put the reader in a better position to understand the usefulness of the variation.

Lamination has been used by the woodworking craftsman for three basic reasons--bending, build-up, and strength.

Bending of solid wood may be accomplished to some degree by steaming or soaking the piece and then holding it in predetermined shape until dry. The success of this method is limited primarily by the thickness of the wood, species of the wood, and the radius of the bend (5:6-8). Lamination will overcome these problems as thin pieces of nearly any species of wood can be bent to small radii (5:35). So, to accomplish extreme bends, the woodworker cuts the wood into thin strips, bends them to shape, and holds them together with glue.

Build-up is necessary when it is impossible to find solid pieces of quality wood adequate in size. Evidence of this is often seen in the heavy beams used in many modern commercial buildings. Lamination allows better utilization of wood, as nearly all of the tree can be cut into veneer or small pieces of wood suitable for laminating. They may then be built up by lamination, into sizes suitable for use.

Strength of laminated pieces is greater than the strength of solid pieces of wood of the same size (8:20, 3:247). If the piece is laminated from dry lumber, it will remain relatively constant in dimension under dry use and be resistant to checks, splits, and loosened fastenings (3:247).

Lamination is not without disadvantages. The greater or more serious of these are: cost, equipment and skills, and glue lines.

Cost of laminated structural members is greater than the cost of solid green members (3:249). The material must be dried and the individual laminae must be milled. These preparations require extra labor expense which must be added to the glue and clean-up costs.

Equipment and skills that are used in lamination are not always available (5:35). Lamination requires kilns for drying the material, machines for milling the laminae, and equipment for clamping the laminate. In addition, this equipment requires skilled operators.

Glue lines which are usually visable on the sides are sometimes objectionable for aesthetic reasons (5:35).

The writer would like to elaborate on this characteristic since unsightly glue lines are one of the justifications of this study. Lamination, as we have always seen it, uses laminae of uniform thickness. By gluing a number of them together into a straight or bent piece, the result is a laminate of unvarying thickness. (See Figure 2, page 9.) As mentioned earlier, glue lines that show on the edges are sometimes objectionable, especially if the wood used is of light color such as birch. When using a dark wood like mahogany or walnut, these glue lines are much less noticeable. However, and this is important, if the thickness of the laminated piece is reduced to the extent of cutting across one or more glue lines, these joints become quite noticeable and unsightly.

STANDARD LAMINATION

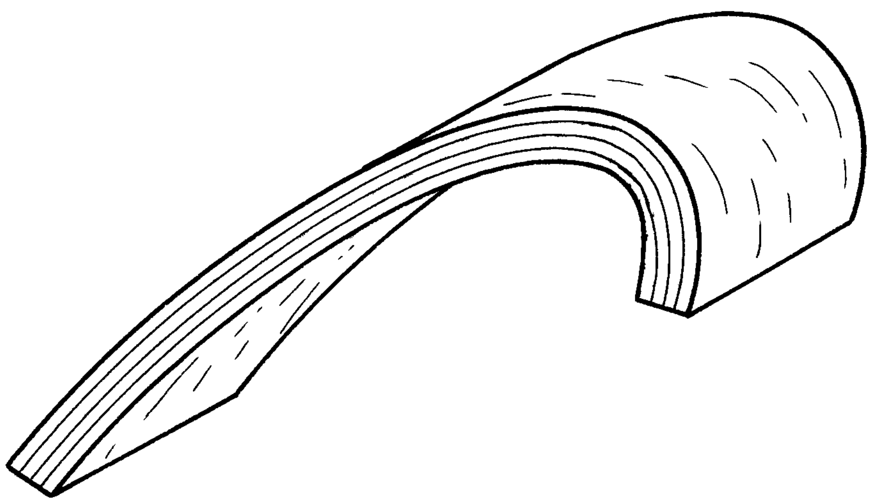


FIGURE 2

A STANDARD LAMINATION — A LAMINATION IN WHICH THE INDIVIDUAL LAMINAE ARE OF UNIFORM THICKNESS

CHAPTER IV

JUSTIFICATION OF LAMINATING COMPONENTS OF VARYING THICKNESS

If lamination, as it has been used for years, has all the advantages explained in Chapter III, why laminate wood components of varying thickness? This question may be answered by asking three other questions of any woodworking problem:

1. Will it be necessary to use lamination for one of the three reasons--bending, build-up, or strength?
2. Will the finished project or part be of varying thickness, or will it branch so that the total thickness of the two branches is either greater or less than the thickness of the main stem? (See Figure 3 and 4, page 11.)
3. Will it be undesirable to cut across glue lines for reasons of strength or aesthetics? This is one of the major objections to standard lamination. When tapering or sculpturing a laminated piece, it becomes necessary to cut across the glue lines at an angle. (See Figure 5, page 12.) This reduces the number of laminae in that cross section, thus reducing the strength (8:20).

SALAD SPOON

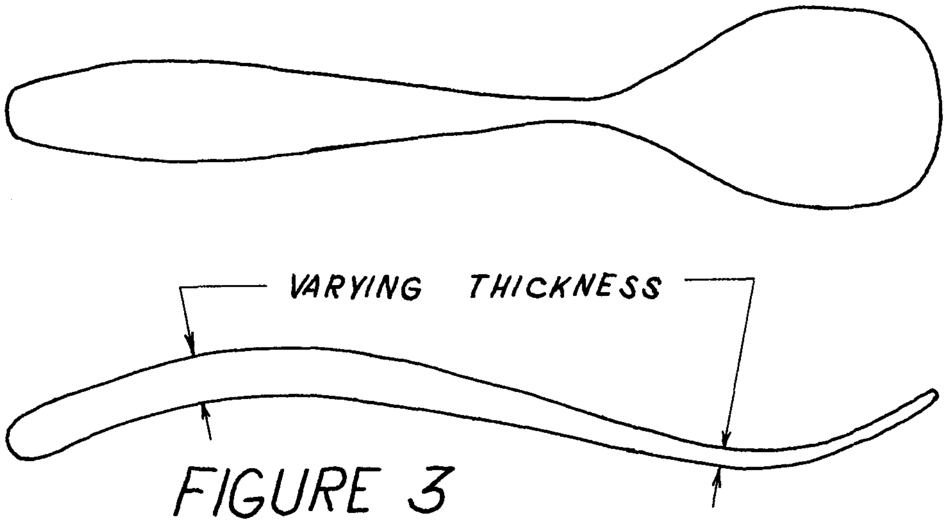
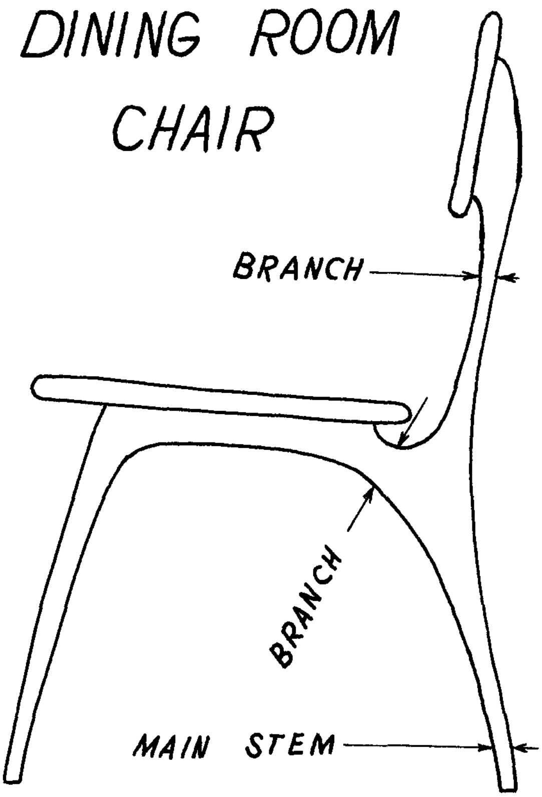


FIGURE 3

DINING ROOM CHAIR



THE TOTAL THICKNESS OF THE TWO BRANCHES IS GREATER THAN THE THICKNESS OF THE MAIN STEM

FIGURE 4

SCULPTURING A STANDARD LAMINATE

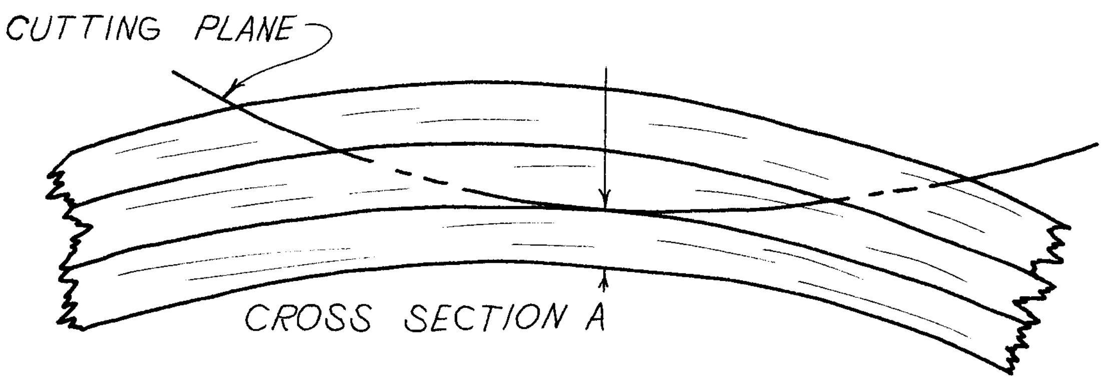


FIGURE 5

SCULPTURING THIS LAMINATE HAS REDUCED THE THICKNESS AT CROSS SECTION A TO ONE LAMINA. NOW THE LAMINATE IS NO STRONGER AT CROSS SECTION A THAN A SOLID PIECE OF WOOD THE SAME SIZE.

The second or aesthetic reason for not wanting to cut across the glue lines is significant for furniture or other projects in which appearance is important. When cutting across an object at an acute angle, a wider cross section is exposed than if the cut were at right angles to the thickness of the object. (See Figure 6, page 14.) The more acute the angle formed between the glue line and the cutting plane, the greater the cross section shown. Even when cutting across something as thin as a glue line, the cross section becomes quite wide, noticeable, and objectionable when the angle is acute.

An answer of "yes" to questions one and two makes the woodworker dependent on the process of lamination for the solution to his woodworking problem. If the answer to the last question is also in the affirmative, standard lamination will not work and some variation is necessary. Laminating wood components of varying individual thickness is that variation. The process increases the strength of the laminate and makes it unnecessary to cut across the glue lines.

COMPARATIVE GLUE LINES

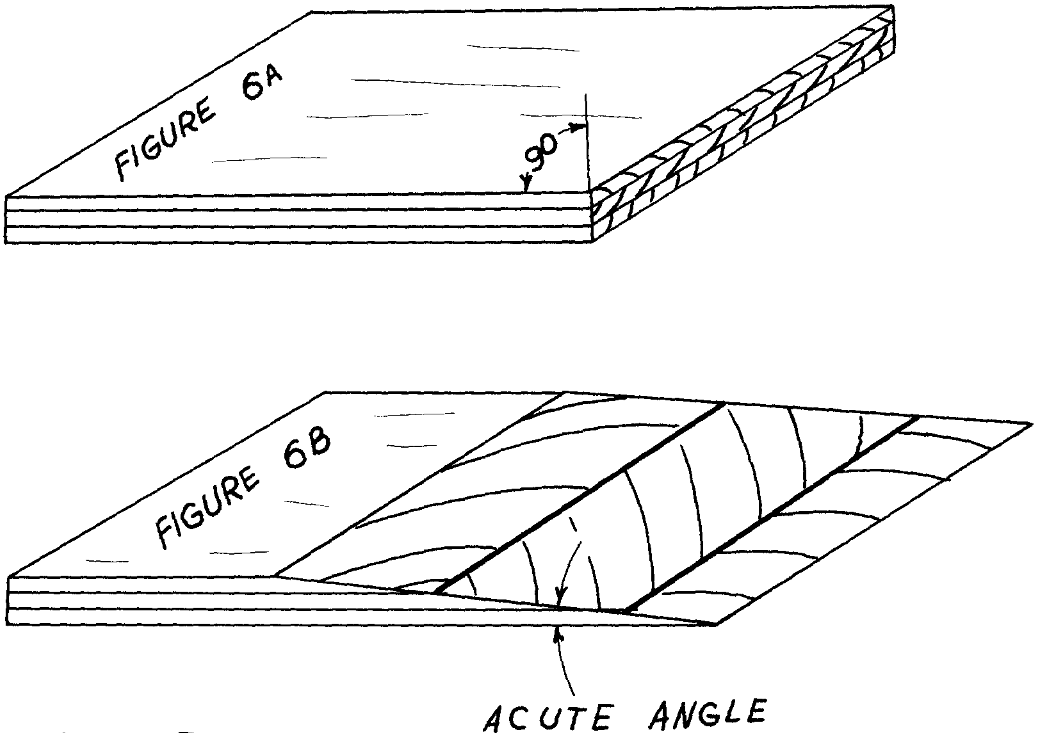


FIGURE 6

FIGURE 6A SHOWS THE END CUT AT 90° TO THE FACE. NOTICE THAT THE GLUE LINES APPEAR NO WIDER ON THE END THAN ON THE EDGE. FIGURE 6B HAS BEEN CUT AT AN ACUTE ANGLE. THIS HAS CAUSED THE LAMINAE AND GLUE LINES TO APPEAR WIDER ON THE END THAN ON THE EDGE. THE MORE ACUTE THE ANGLE THE WIDER AND MORE UNSIGHTLY THESE GLUE LINES BECOME.

CHAPTER V

THE TECHNIQUE

The technique of laminating wood components of varying individual thickness is a little more involved than the more conventional type of laminating but certainly within the skills of the average woodworker. The technique can be outlined as seen below.

A. Layout

1. Draw the pattern of the piece full size on paper.
2. Determine how many laminae will be needed to bend the sharpest curve. (Ordinarily, laminae of maximum thickness should be used to reduce the total number, make gluing easier, and reduce distortion (2:40). There is no way of determining this thickness except by trial of sample pieces (5:36-37). Some projects will require a large number of laminae, but for sake of illustration the writer will use two in these directions.)
3. Divide the layout into as many equal parts as there will be laminae. In other words, draw in the glue line so that both laminae

are the same thickness at each cross section. (See Figure 7, page 17.)

4. Along this glue line, step off equal spaces. Points a half inch apart are usually adequate unless the curve is extreme; then they will have to be closer.

B. Making the laminae

To shape the individual laminae by hand is slow and tedious, so it is suggested that a shaping block and the thickness planer be used. A piece of clear pine or other easily-worked wood may be used. It should be at least as thick as the thickest part of the lamina plus one inch. The shaping block should be a little wider and a little longer than the lamina. (Plan to make laminae a little wider and longer than the finished piece.)

1. Run the shaping block through the thickness planer once to make sure it is of uniform thickness. The edges should be square to the face.
2. Square lines across the edge of the shaping block at the same intervals as used in stepping off the layout. (See Figure 8, page 17.)

SALAD SPOON
(LAYOUT)

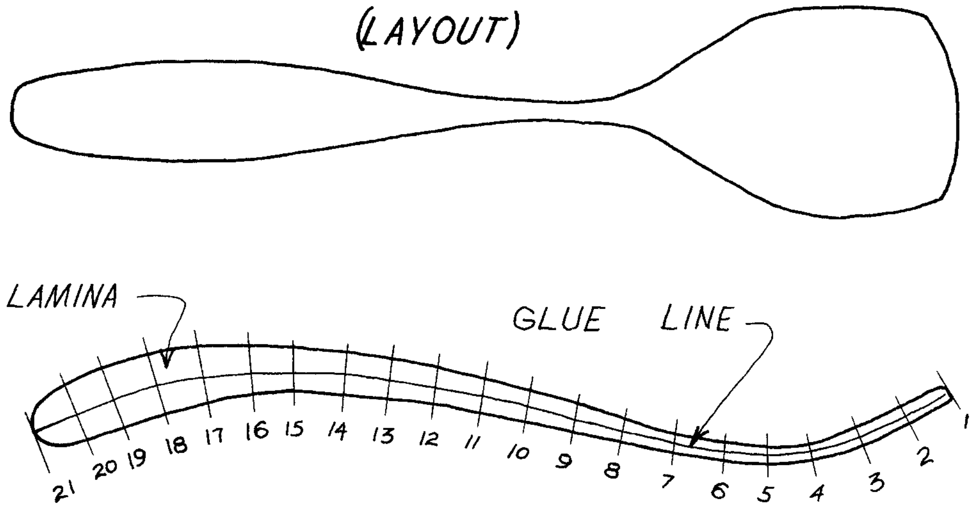


FIGURE 7

FIGURE 7 SHOWS THE TOP AND FRONT VIEWS OF A SALAD SPOON MADE FROM TWO LAMINAE. THE GLUE LINE HAS BEEN STEPPED OFF INTO EQUAL PARTS.

SHAPING BLOCK

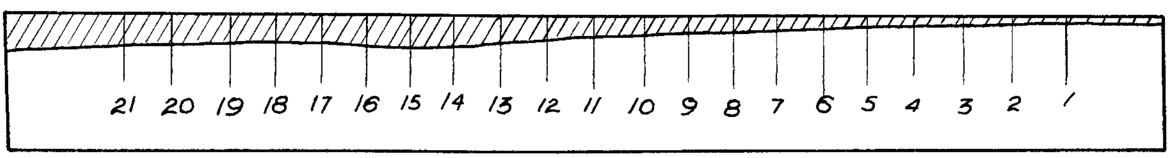


FIGURE 8

FIGURE 8 SHOWS A FRONT VIEW OF THE SHAPING BLOCK. LINES HAVE BEEN SQUARED ACROSS THE EDGE AT THE SAME INTERVALS AS ON THE FRONT VIEW OF THE SPOON LAYOUT. THE THICKNESS OF A SINGLE LAMINA HAS BEEN TRANSFERRED TO THE SHAPING BLOCK. REMOVE THE CROSS HATCHED SECTION WHICH REPRESENTS THE SHAPE OF THE LAMINA.

3. Measure the thickness of the individual lamina at each station on the layout and mark those measurements at the corresponding stations on the shaping block.
4. Join these marks with a faired line.
5. Remove the wood that represents the lamina. This must be done with extreme care to keep this curved plane at right angles to the edges of the shaping block.
6. Cut the blanks from which the individual laminae will be made. These blanks should be surfaced on one face and should be a little thicker, wider, and longer than the finished part. To conserve material, these pieces may be tapered to the approximate shape of the finished laminae.
7. With the surfaced face of the blank against the top or curved surface of the shaping block, run the two pieces through the thickness planer. The pressure rolls of the planer will force the blank down against the curved surface of the shaping block. As the two pieces pass under the cutter head, it removes wood and shapes the lamina. (See Figure 9, page 19.)

SHAPING THE LAMINA

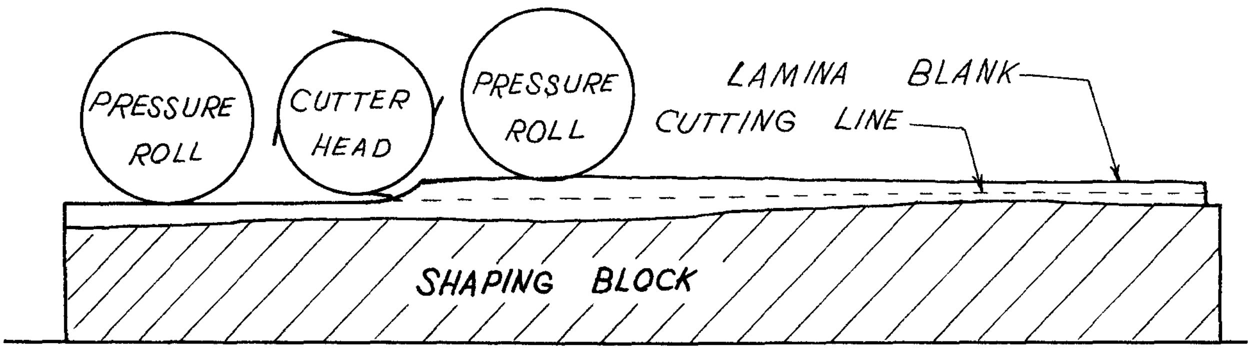


FIGURE 9

FIGURE 9 SHOWS THE SHAPING BLOCK AND THE LAMINA BLANK IN THE THICKNESS PLANER. THE PRESSURE ROLLS OF THE PLANER FORCE THE BLANK DOWN AGAINST THE CURVED SURFACE OF THE SHAPING BLOCK. THE CUTTER HEAD REMOVES WOOD AND SHAPES THE LAMINA.

C. Gluing

Gluing the finished laminae together to make the laminate is a step that requires consideration and care in choice of glue and clamping method.

1. Consider the glue to be used. There are many from which to choose.

   a. Assembly time should be sufficient so that when pressure is applied to the laminate the glue will be wet enough for the contiguous faces to slide against one another (6:2-3).

   b. Creep is a term used in the laminating industry. It refers to the slipping of one face against the other after the glue has dried. Creep should be avoided. Some glues are flexible enough after drying that they permit creep (1:14). When this happens, the laminate tends to straighten or spring back. This is a characteristic of polyvinyl glue and should be avoided.

   c. The degree of water resistance should be considered. If the glue need only be water resistant, then urea resin, or plastic resin glues are very good (1:14, 2:30-31). When a waterproof glue is required, resorcinol resin glues are recommended (2:30-31).

2. Clamping may be done by various methods. The piece being glued will dictate to some degree the type of clamping method to use.

    a. It is important to choose a method which insures that laminae are held in correct position.

    b. Uniform pressure must be applied throughout the glue line until the glue is dry.

    The inexperienced woodworker may wish to refer to Wood Laminating by J. Hugh Capron (2:35-49) for detailed information on clamping.

CHAPTER VI

CONCLUSION

This paper has shown that the process of lamination has been known for centuries but did not become important or widely used until the development of modern glues. It was pointed out that lamination has the advantage of allowing extreme bends in wood. It produces pieces that are stronger than solid wood. It makes possible acquiring finished pieces larger than would be feasible using solid wood. It was found that there are also disadvantages to this process. It is somewhat expensive and requires equipment and skills not always available. Pieces laminated by the conventional method cannot be tapered or sculptured without cutting across glue lines.

The latter part of this paper was devoted to a description of the procedure involved in doing this new type of lamination. This was included to help the reader understand the process and to promote the use of laminating components of varying individual thickness. Readers have seen in the preceding pages that laminating components of varying individual thickness possesses all the advantages of standard lamination. It enables the woodworker to make pieces with extreme bends. The resulting pieces have strength superior to pieces of solid wood the same size.

In addition these pieces are less likely to check or split than solid wood and will hold fastenings better. The process allows better utilization of wood and makes possible building up pieces larger than can be made from solid wood. Not only does laminating components of varying individual thickness retain the advantages of the standard lamination, it also overcomes the major disadvantage allowing the craftsman to taper or sculpture the laminate without cutting across glue lines. This fact improves the strength and and appearance of the laminate.

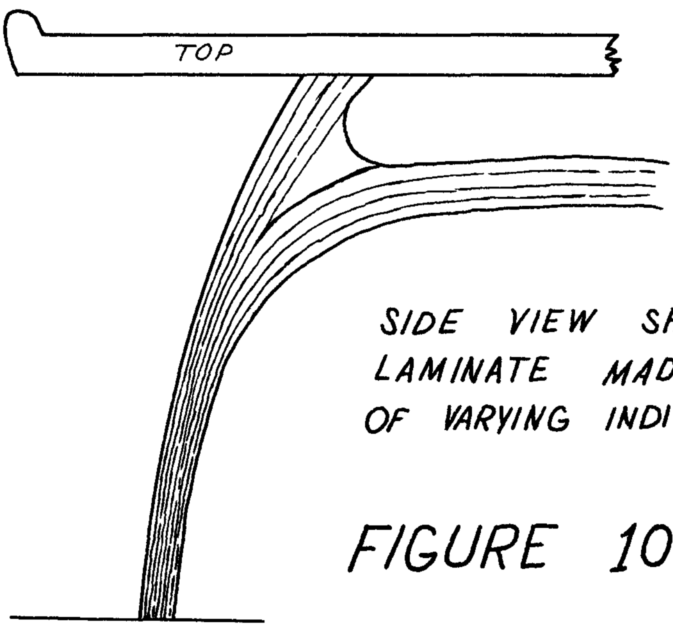
Therefore the writer would hope that this process of laminating components of varying thickness might lead to some advances in the field of lamination.

CHAPTER VII

POSSIBLE USES

The process of laminating wood components of varying individual thickness has cut another of the designer's restraints. It allows more freedom of imagination. This process might be used to construct the following articles: structural beams, salad sets, trout nets, tennis rackets, baseball bats, lamps, boat ribs, stools, chairs, table legs, and unlimited other furniture parts. A few of these are seen in sketches on the following pages.

TABLE LEG



SIDE VIEW SHOWING BRANCHING LAMINATE MADE FROM LAMINAE OF VARYING INDIVIDUAL THICKNESS

FIGURE 10

TABLE LEG

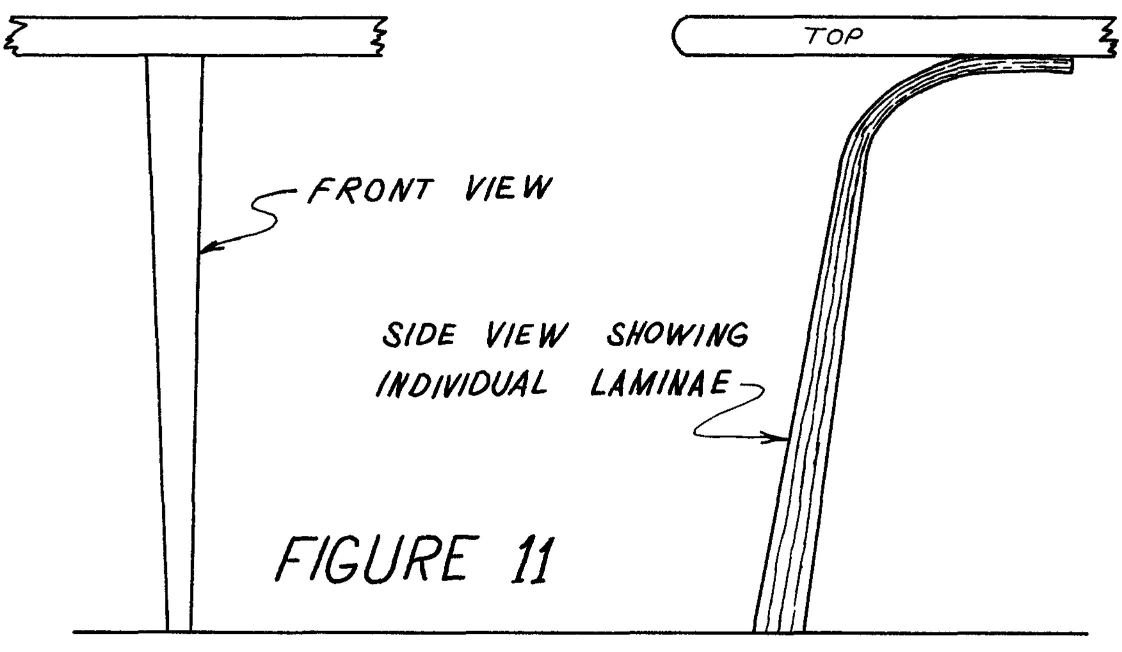


FIGURE 11

TROUT NET

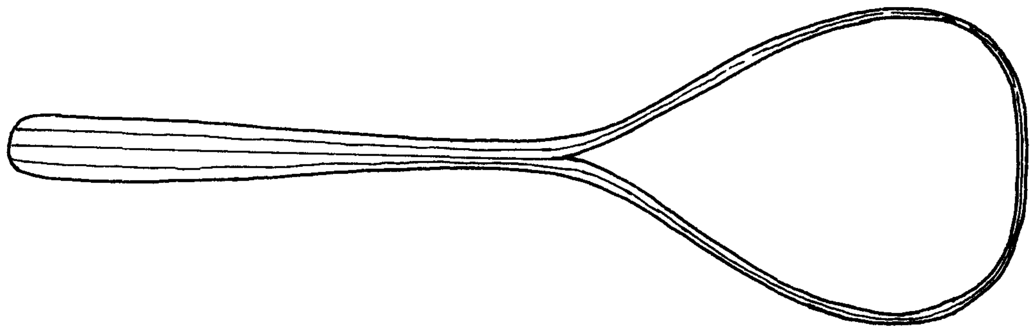
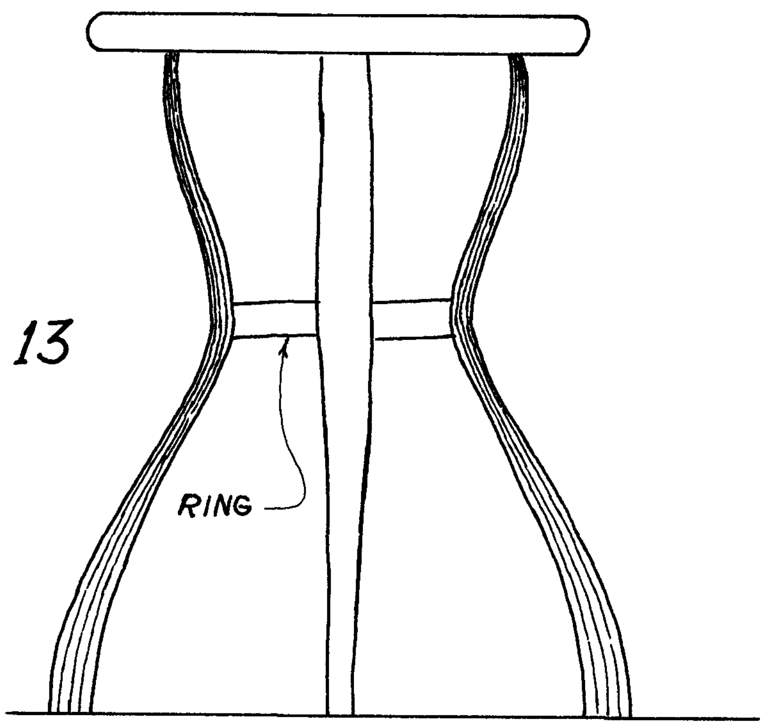


FIGURE 12

STOOL

FIGURE 13



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