

SOME METHODS OF GLUING LIGHT LAMINATED OR PLYWOOD CURVED SHAPES FROM VENEER

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SOME METHODS OF GLUING

LIGHT LAMINATED OR PLYWOOD CURVED SHAPES FROM VENEER

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Curved products of light plywood and laminated wood can be produced by simultaneously gluing and forming strips or sheets of veneer to the desired shape. Plywood seats, angles, and tubing; laminated ribs for small boats; and numerous boat and aircraft parts, such as plywood hatch covers, laminated fuselage rings, wing-tip bows, and molded plywood shells, are only a few of the many uses to which the process of gluing veneer to curved shapes is adapted.

The basic principles of gluing practices that are essential to the gluing of flat laminated or plywood products are equally applicable to the gluing of curved members. Information relative to general gluing practices is available in other publications prepared at the Forest Products Laboratory.¹

The purpose of this report is to present a brief summary of some of the methods used in gluing laminated or plywood members of single curvature, and to illustrate these methods by means of sketches. Since the application of adequate and uniform gluing pressure is the principal special problem involved in the gluing of curved shapes, suitable methods for applying pressure to members with various degrees of curvature are presented. These methods only illustrate correct principles. It is not intended here to provide detailed instructions relative to the application or to the numerous possible variations of each method.

Forming Members of Slight to Moderate Curvature

If the curvature is only slight or moderate (laminations or plies bent through an angle of less than about 120°), the easiest way to apply gluing pressure is by means of a pair of solid forms (fig. 1, A and B). When loaded, such forms can be laid in screw or hydraulic presses and pressure applied just as in gluing flat stock. If many small curved items of the same design are to be made, it may be convenient to prepare a series of nested forms and use them superimposed upon each other in a press.

Whether heat should be employed to cure the glue depends upon the curing characteristics of the particular glue used and, in some cases, upon the economy of quick removal from the forms. Some glues require the application of heat for the full development of strength and durability. Others cure by

¹U. S. Dept. Agr. Bul. 1500, "The Gluing of Wood," 1929.

²Forest Products Laboratory Report No. 1340, "Control of Conditions in Gluing," 1941.

cold pressing at ordinary room temperature, although their rate of setting may be accelerated by the application of heat, and the pressure period consequently shortened.

The curing of curved members in forms (fig. 1, A) may be accomplished by heating to the desired temperature in a humidity-controlled chamber. Under properly selected and controlled conditions this method of heating avoids dimensional changes due to the drying of wood during the curing period.

The use of electric strip heaters to accelerate the setting of some glues on relatively thin members is illustrated in figure 1, B. A piece of thin, high-carbon steel 0.005 to 0.010 inch thick is attached to the inside surfaces of both forms. A sheet of felt or heat-resistant rubber on one form may be used to compensate for slight inaccuracies in the fit of parts. The strip heater must be uniform in cross section to facilitate uniform heating. The electrical energy necessary to produce the desired temperature in the strip heater will depend on several variables, such as size, shape, and construction of forms, but a power consumption of about 1-1/2 watts per square inch of heater strip has been found to be generally applicable. The use of less than 30 volts is advisable for the safety of the operators. Power can be supplied by a step-down transformer in series with a variable voltage transformer or by a welding machine. The jig is loaded and pressure applied before the power is turned on.

Forming Members of Considerable Curvature

Members having considerable curvature (laminations or plies bent through more than about 120° but less than 360°) are normally made by the methods shown in figure 2. Methods 2, A and 2, B show the use of clamps to provide pressure on rigid mating forms. Figure 2, A shows the sectional form on the outside, and 2, B shows the sections on the inside of the assembly. In either method the clamping should start at the midpoint of the member and progress toward the ends.

A male form provided with a metal tension band as illustrated in 2, C may be used provided the curvature is approximately circular. Since the pressure is inversely proportional to the radius of curvature, it will be high at points of small radius and low at points of large radius in elliptical or slightly oval shaped members. On a flat portion of an otherwise curved member, the pressure from a tension band would be zero. Assuming that the width of the work corresponds to that of the strap, the radial gluing pressure on circular shapes in pounds per square inch is equal to the tension per inch of width of the strap (in pounds) divided by the radius of the circle (in inches).

If the member deviates slightly from a circular shape in places, it is difficult to use tension bands alone, because the pressure may then be too low on the straighter portions. One method of meeting this difficulty is to use a fire hose under the tension band. The hose is closed at one end and connected to an air or water pressure supply at the other. In this method the laminations are spread with glue and laid in place, and the tension band

is tightened. Air or water under pressure is then admitted into the hose. If the shape deviates greatly from a circular shape or if there are straight portions, it may be necessary to interpose filler blocks between the hose and the tension band as shown in figure 2, D, since the band tends to assume a circular shape with fluid pressure in the hose. It is apparent that the setting of resin glues could be accelerated if hot water or steam were used in the hose.

In methods 2, E and 2, F the pressure is applied through a rubber bag by a fluid, such as air, steam, or water. Figure 2, E shows the use of a male form or mold, around which the material is wrapped. The whole assembly is then enclosed in a loose-fitting bag and subjected to pressure. The bag and its contents should be placed in a pressure tank or autoclave to provide both adequate pressure and heat to set the glue. This method is commonly known as "bag molding."

In 2, F the material is inserted inside of a metal form and, after ends have been attached and sealed, the pressure is applied by means of inflating a rubber bag. The form may be steam, electrically, or electrostatically heated, or the bag may be inflated with steam or hot water to cure the glue. If elevated temperature is required, the glue may be cured in methods 2, A and 2, B by strip heaters, as illustrated in figure 1, B or by heating in a chamber.

Forming Complete Rings or Cylinders

When the laminated or plywood member is a complete ring or cylinder, the manufacturing difficulties are considerably increased. One method consists in using a continuous lamination wound spirally around a form with the gluing pressure applied by tension of the lamination alone or aided by belt pressure. This method is illustrated in figure 3, A on a closed member of circular shape. Application of this method requires that the laminations first be spliced end to end by means of glued scarf joints until a sufficient length is provided to form the complete ring. It would be possible in some cases to manufacture much the same product by laminating the rings in half sections and later joining pairs of half sections with glued scarf joints. Any heating required to cure the glue may be accomplished by placing the assembly in a heated chamber.

The use of fluid pressure to form completely closed rings or cylinders is shown in methods 3, B and 3, C. These methods are identical to 2, E and 2, F except that the laminations are either continuous or have the joints in individual laminations staggered. Successful use of either method 3, B or 3, C depends upon careful fitting and placing of the first lamination in intimate contact with the form and drawing succeeding laminations together into position. Any looseness will result in defective glue joints.

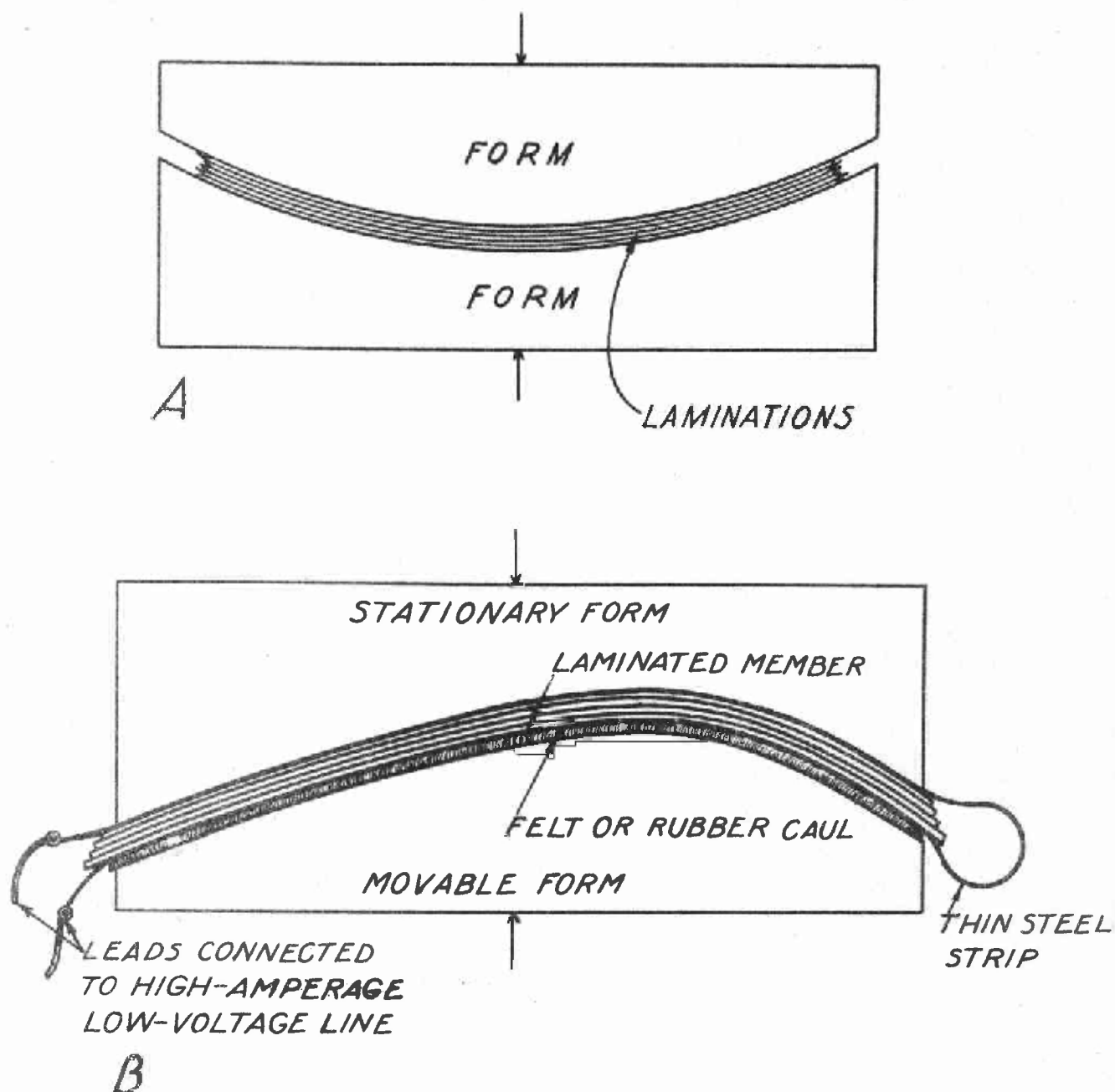


Figure 1.--Methods for gluing members of slight to moderate curvature.
 A, Gluing with forms only. B, Gluing with forms and an electric strip heater.

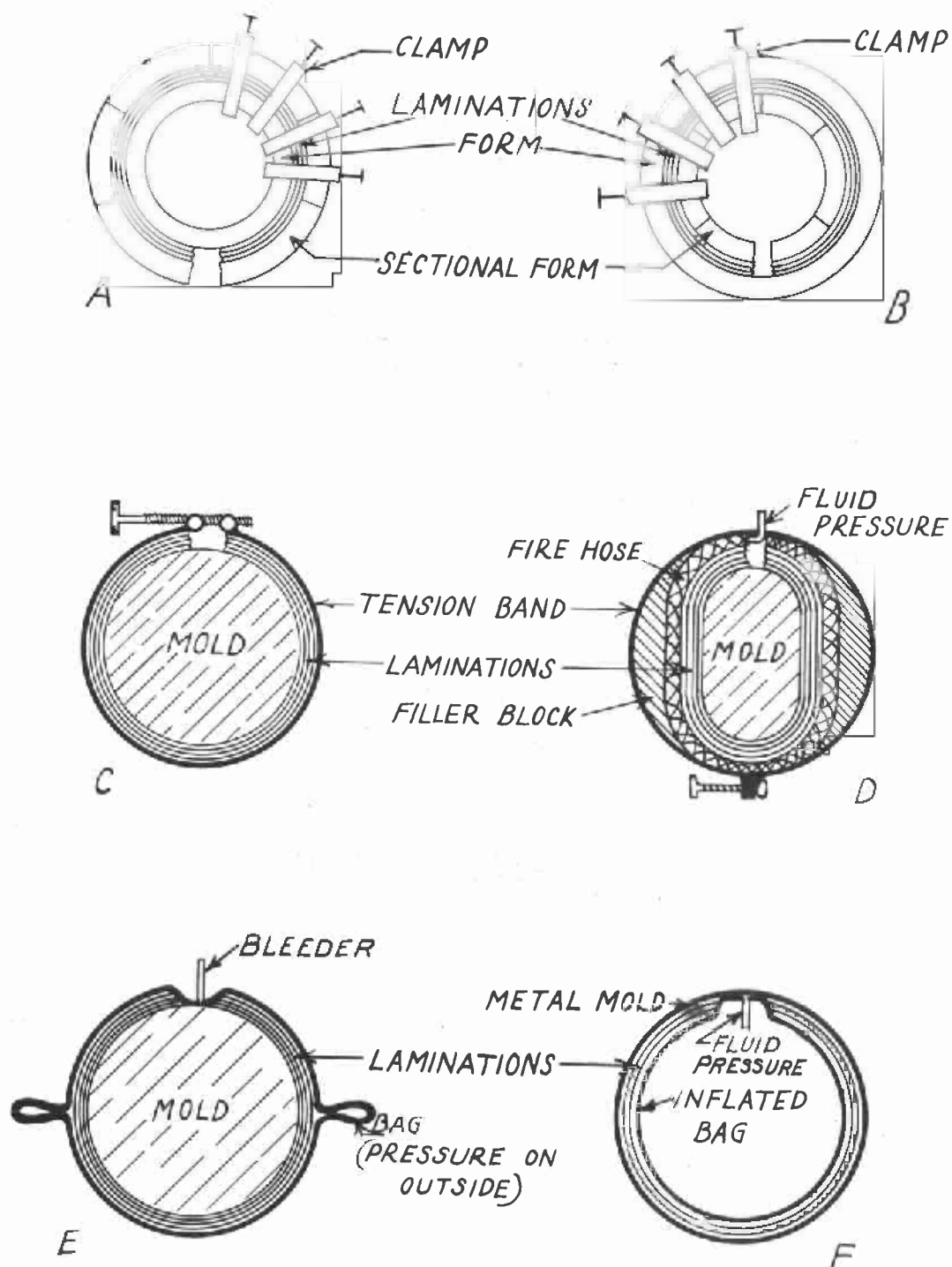


Figure 2.--Methods for gluing members of considerable curvature. A, Gluing with hand clamp pressure (form on inside). B, Gluing with hand clamp pressure (form on outside). C, Gluing with tension band pressure. D, Gluing with tension band and fluid pressure. E, Bag gluing (bag deflated). F, Bag gluing (bag inflated).

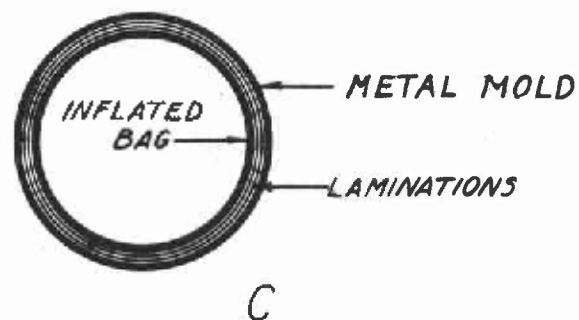
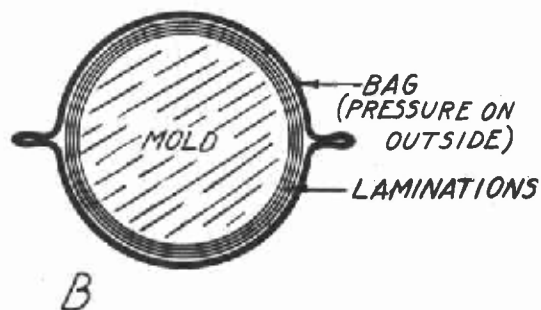
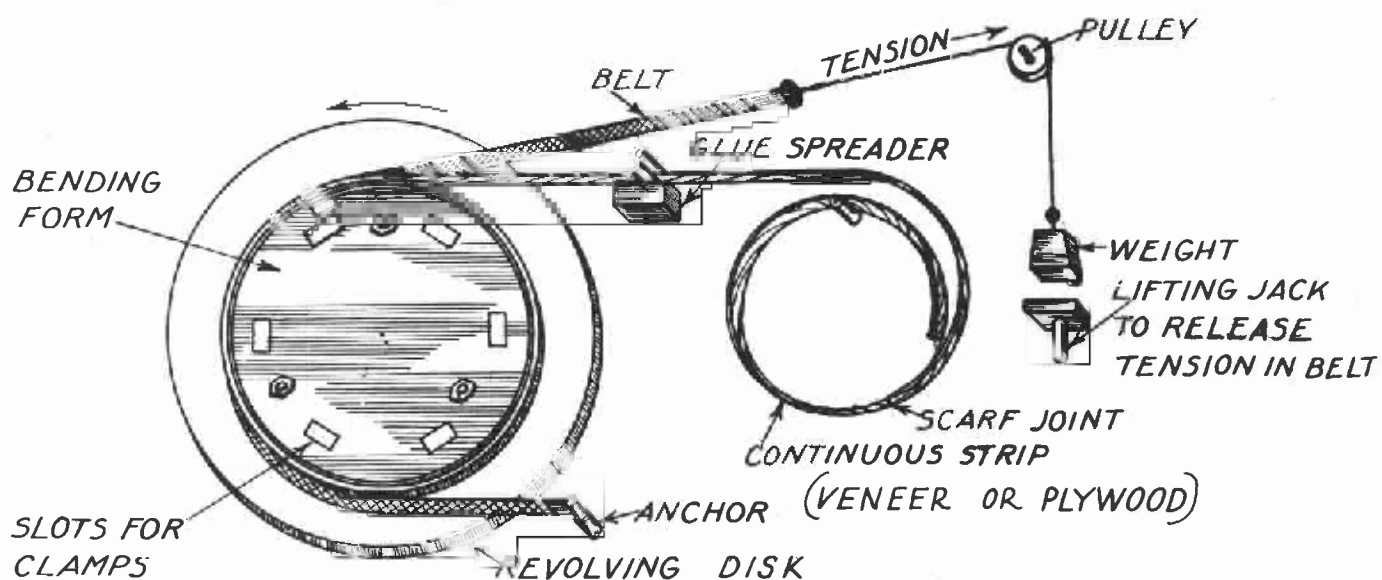


Figure 3.--Methods for gluing complete rings or cylinders. A, Gluing with winding and tension band pressure. B, Bag gluing (bag deflated). C, Bag gluing (bag inflated).