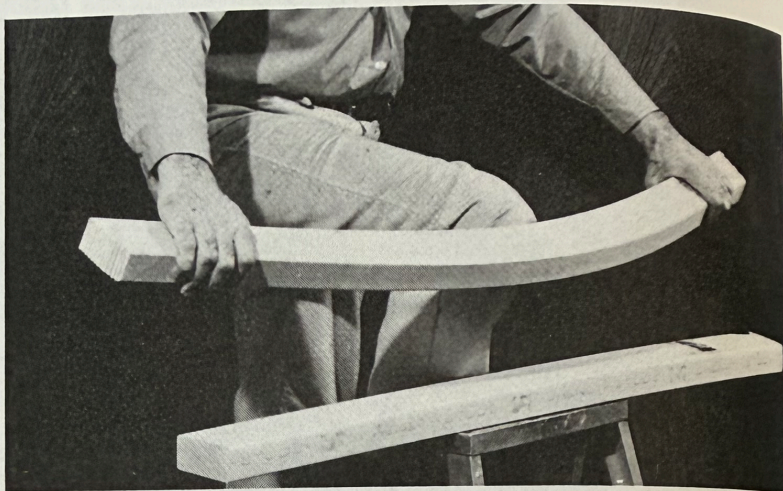


There are several useful techniques for bending wood with which you should become acquainted. They will enable you to expand the scope of your woodworking activities considerably. The methods include lamination, kerfing, and self-forming of skin plywood. Wood can also be bent by steaming, but this method is not covered here due to its difficulty of handling and the necessity for special equipment.

The wood-bending procedures shown are practical because they require no special equipment and are easily accomplished in the home workshop. The three methods are quite varied, each one being best-suited for a particular kind of application. The possibilities are almost unlimited.



It doesn't require too much muscle to bend a piece of heavy stock if you prepare it for the purpose.

Lamination

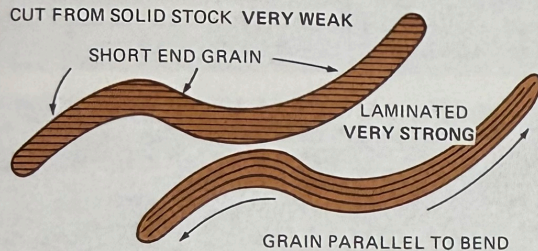
The curved chair frame illustrated is a good example of the advantage of bending wood to shape by the lamination method. Each of the curved side members are made from a relatively small board. To make these same parts by band sawing out of a solid board would be impractical and disadvantageous for several reasons. It would be virtually impossible to obtain a solid board of sufficient width. The alternative of edge-joining several boards to make a wide one would be a poor solution because it would result in a tremendous amount of cut-off waste and, more important, the cut out part would be very weak at the end grain portions that would occur in several places.

Bending wood by the lamination process simply involves cutting a board into a num-

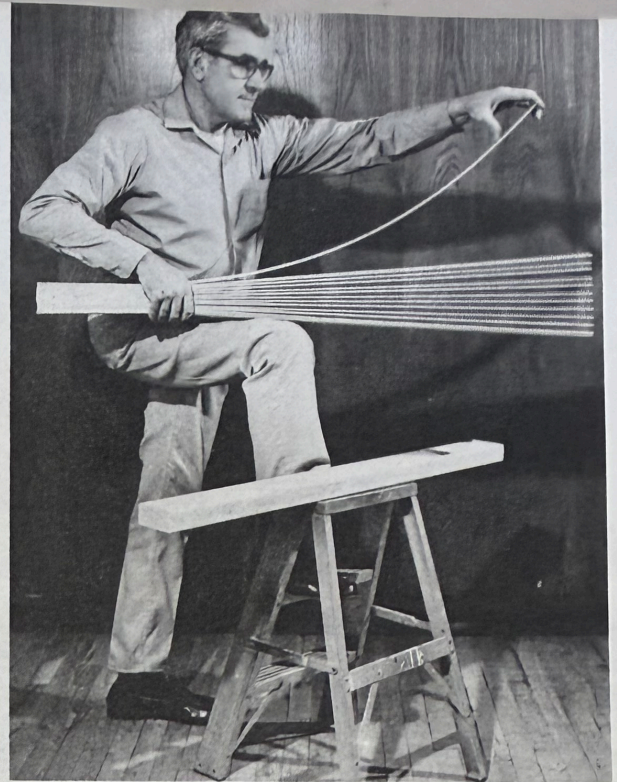
This chair was made with the bent lamination method which keeps material costs down and produces curved parts with high structural strength.



ber of thin, flexible strips, then gluing them back together again in a bent shape. The resultant curved piece has great strength primarily because the grain of the wood runs exactly parallel to the curve, thus there are no end grain portions along the contour. Also, it is actually stronger than the original board due to the stiffening effect of the glue layers and tensions caused by compression and expansion of the wood fibers along both sides of the individual strips.



Comparison of grain direction between a part cut from a solid board and a laminated one. Note weak end grain areas on the cut out piece.



The procedure is relatively simple: the wood is cut into thin flexible strips then reassembled with glue into a bent bundle in a form jig.

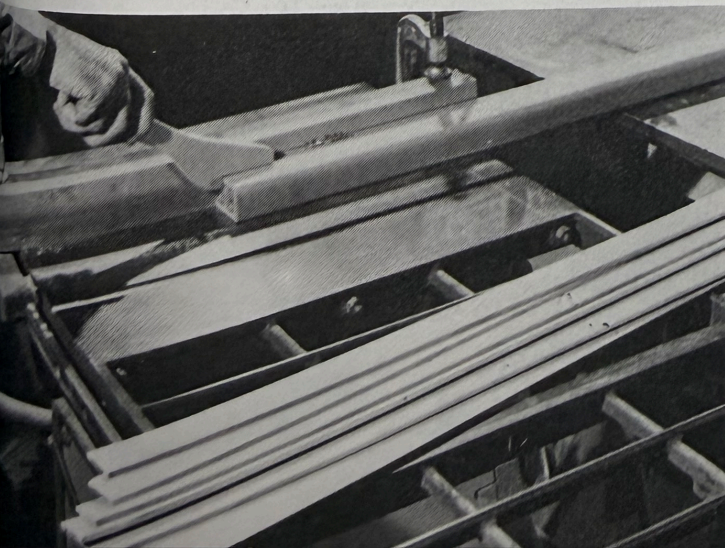
While both hardwoods and softwoods can be bent, hardwoods are better suited for the purpose. Ash, birch, elm, hickory, maple, oak, sweet gum, and walnut are the hardwoods commonly used. Among the softwoods, Douglas fir, redwood, southern yellow pine, and white cedar work best.

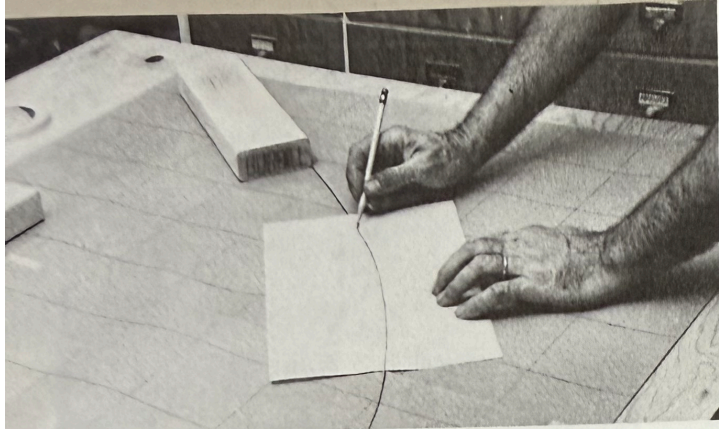
Slow-setting hide glue that has good gap-filling properties is suitable for laminating wood for interior projects. Resorcinol resin waterproof glue should be used for outdoor constructions.

LAMINATING PROCEDURES

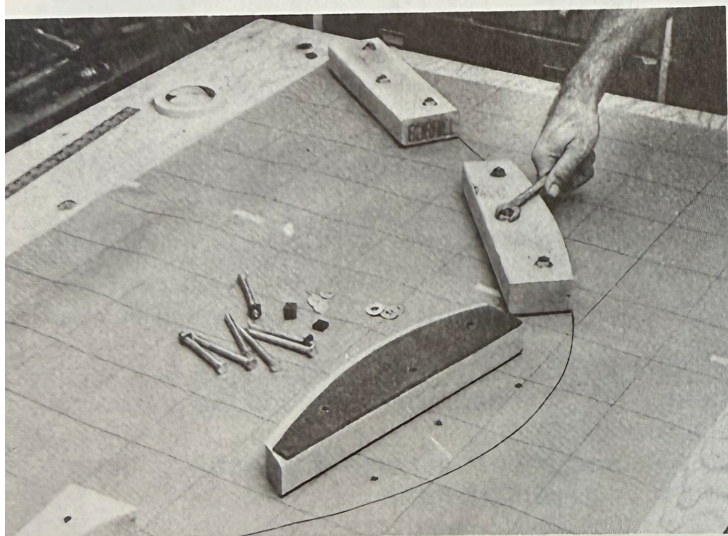
1 Thin strips $\frac{3}{32}$ " or smaller are ripped with a fairly smooth cutting blade. The stock should be straight grained, knot-free and without cracks or other flaws. Work from a single board when possible to maintain a continuous grain pattern if the piece is to be clear finished.

2 All strips should be kept in their original positions. This is important because grain characteristics vary throughout a board. Mis-matched grain could cause some difficulty in obtaining a close fitting bundle. Number each strip in sequence.



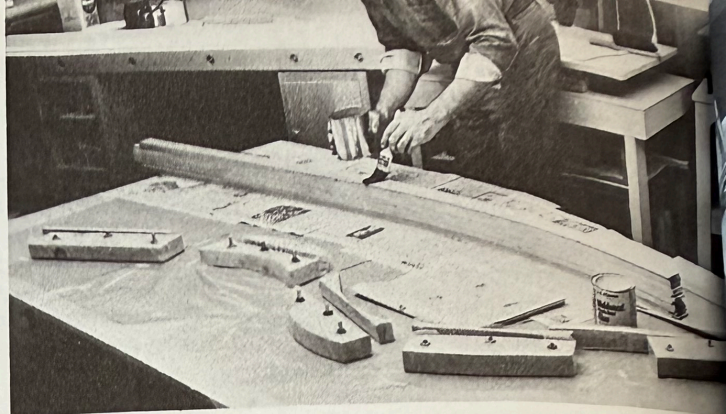
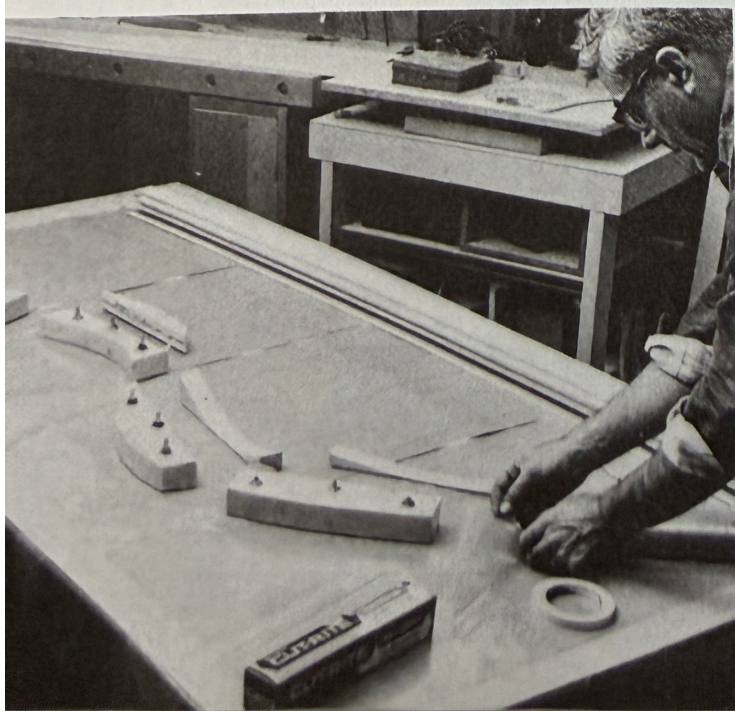


3 An outline of the desired curve is drawn full size on wrapping paper. Make tracings for forming blocks at key locations along the curve.

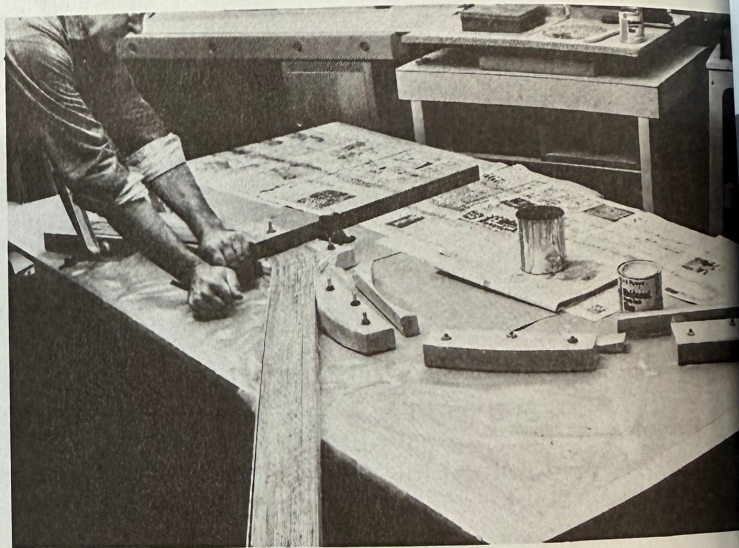


4 Forming blocks are cut from 2 x 4 lumber about 12 inches long. Locate the curve through the blocks so that sufficient cut-off remains to produce a matching clamping block. Bolt the main formers into the work surface. The dark piece is a $\frac{1}{8}$ " hardboard spacer.

5 Wax paper is used to line the contact surface of each block and the work table to prevent glue run-off from sticking the work to the jig and table. The recessed hardboard spacers serve only to permit the wax paper to be tucked in neatly.

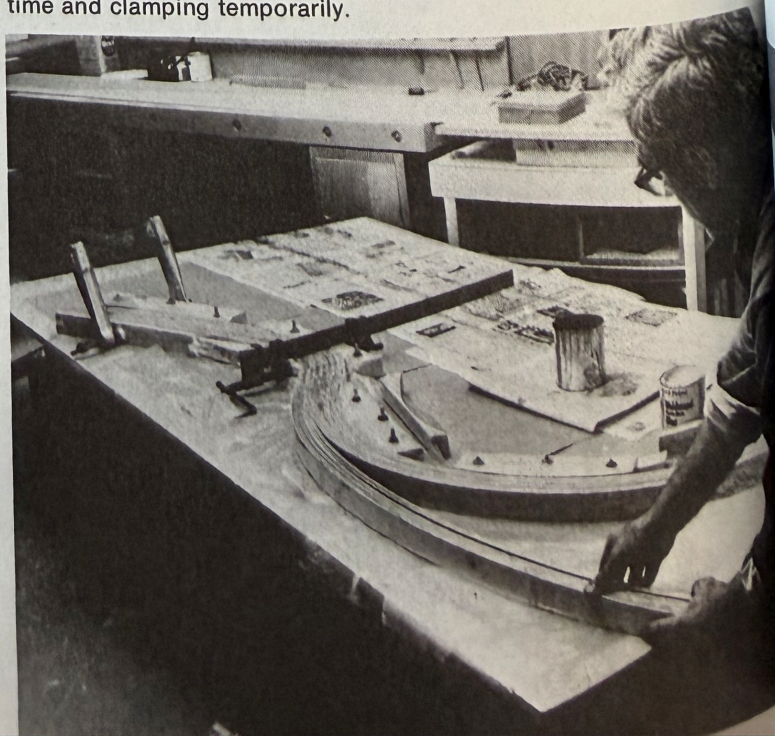


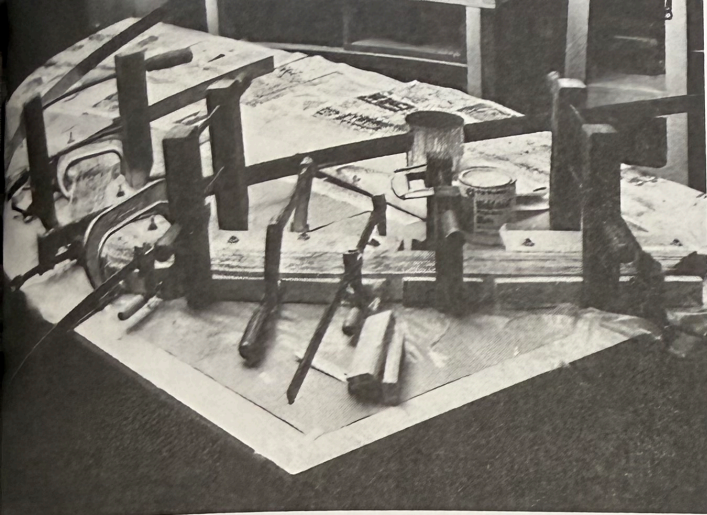
6 Glue is applied to both surfaces of each strip in full coats and the strips stacked one atop the other until all have been coated. Glue should by no means be of the quick setting type — plenty of assembly time is needed.



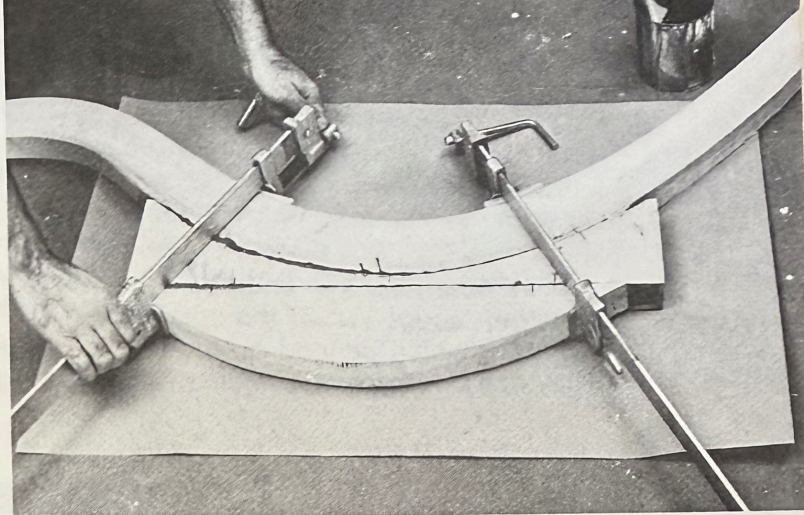
7 Clamping starts at one end and progresses towards the other. Note the clamping block behind the former. This is put into place before the clamp is applied.

8 A thick bundle like this requires some help when making the return curve (assistant is out of view). Lessened leverage at this stage necessitates bending only several pieces at a time and clamping temporarily.

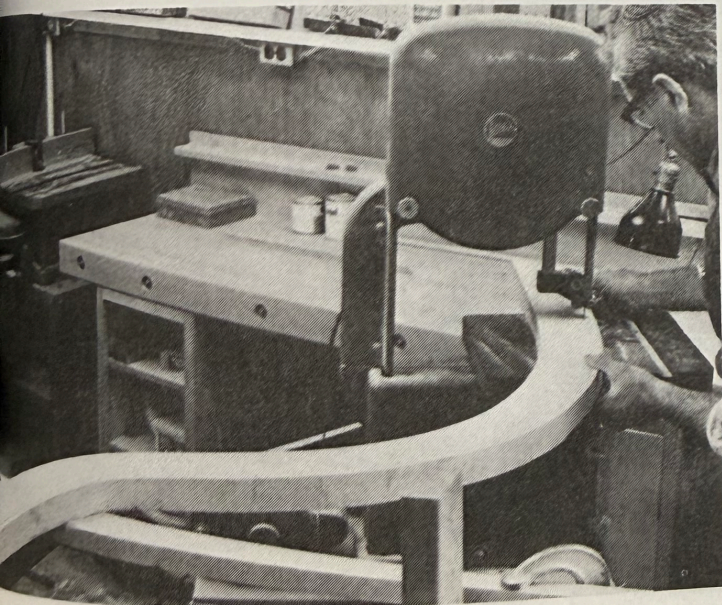




9 Clamps should not be spared for a job of this size. Work remains clamped for twice the usual time to allow the glue to dry thoroughly and to gain full strength.

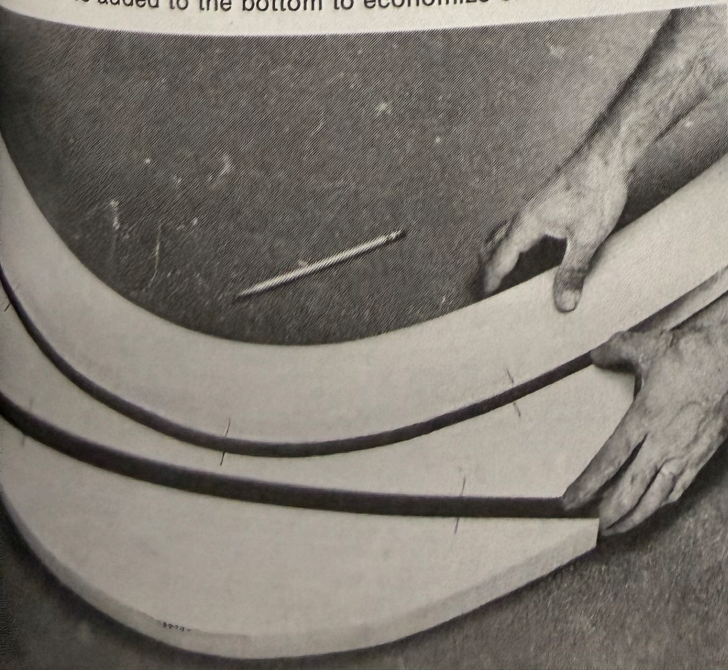


12 One nail is used at the end of each of the added-on pieces to prevent slipping. They're driven in only part way to facilitate later removal.



10 After removing excess surface glue with a belt sander the piece is band sawed to the precise shape. The lamination should be made oversize to allow for trimming.

11 Small sections need not be laminated. Note how the cut-off is added to the bottom to economize on lumber.



13 Final touches include rounding with spokeshave and sanding surfaces smooth.

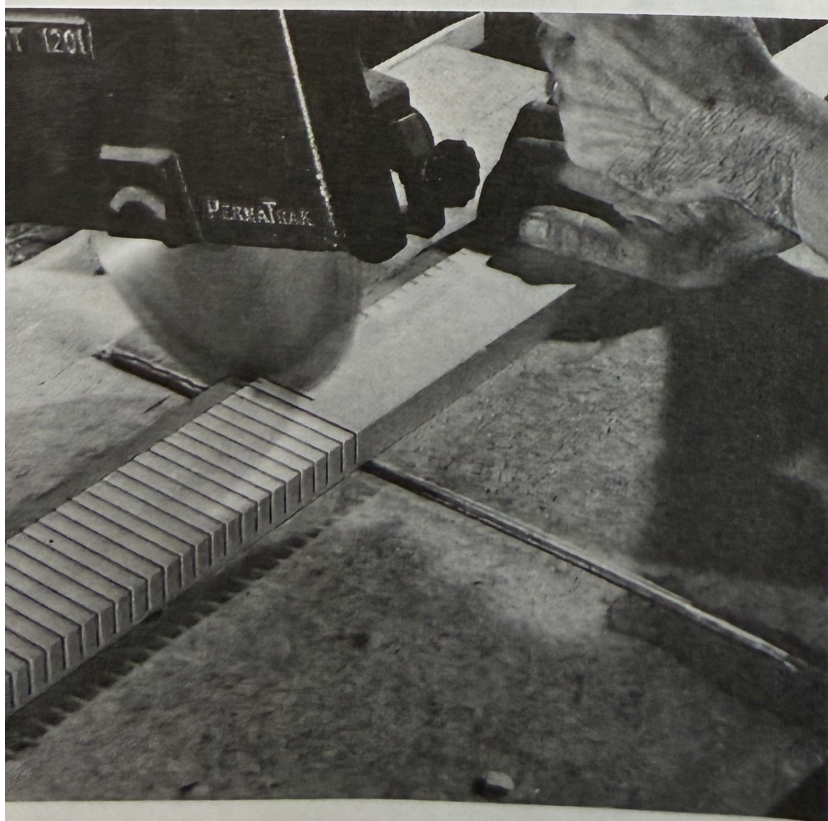
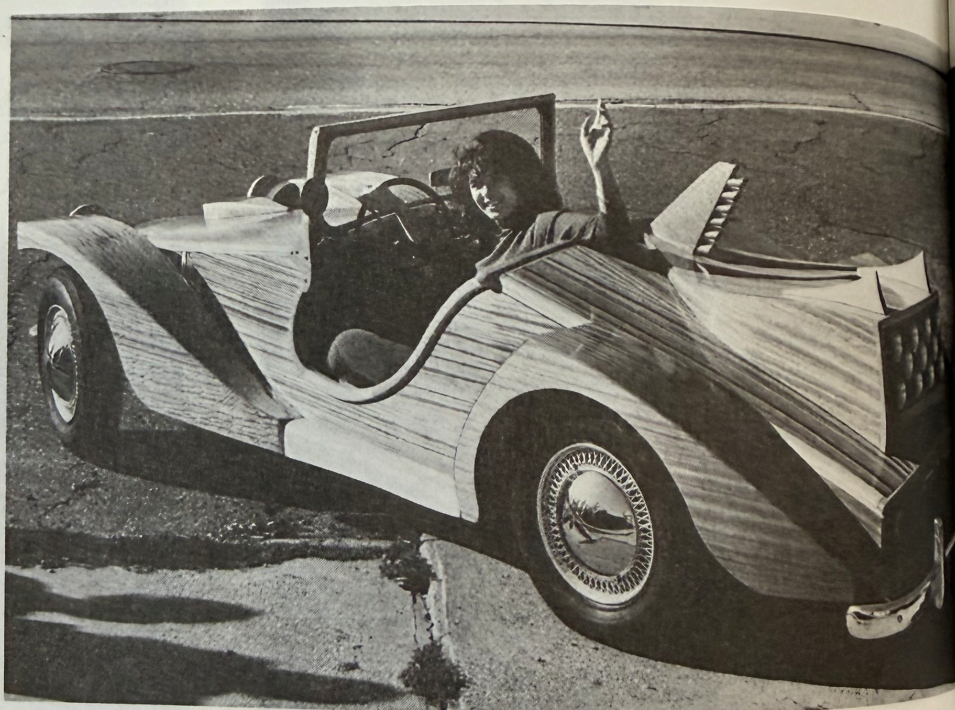
14 Cross members are joined with strong doweled lap joints.



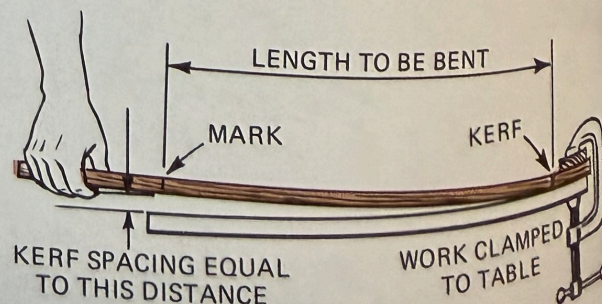
KERFING

A solid board can be rendered quite flexible by sawing into it a series of kerfs close together to within about $\frac{1}{16}$ " of the outside surface. The spacing between kerfs and their depth are variables which depend on the kind of wood used and the complexity of the bend desired. They can be closely approximated by making a simple measurement as shown in the diagram.

The graceful sweeping curves of this all-wood construction are its main attraction. It illustrates what can be done by means of the kerf bending method.



Kerfing (deep saw cuts) is done across the grain. The depth of the grooves and the spacing between them control the degree of bend that can be obtained.



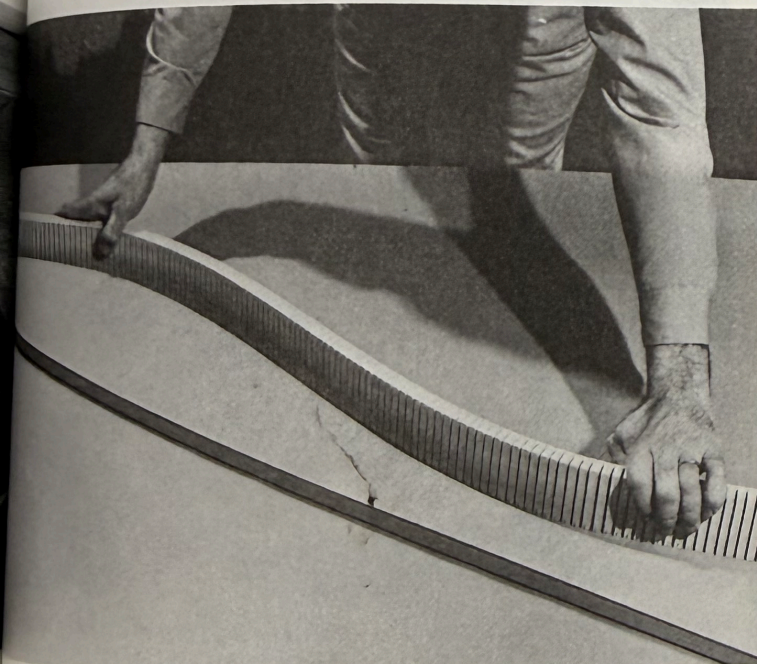
To determine spacing distance between kerfs: Make one test kerf, bend the wood until the kerf closes then measure the distance from the mark to the table. This dimension is what the spacing should be.

When a wide board (about 1') is to be bent, it is advisable to make an actual test on a narrow strip of the same material. This will fairly well reflect how a wider piece will react.

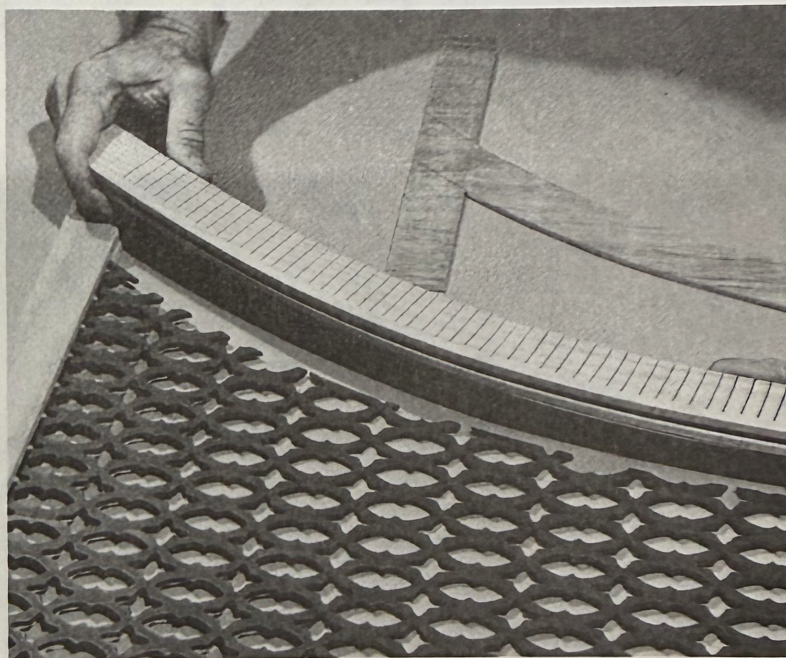
Kerfs need not be equally spaced. If the curve required includes small and large bends, the spacing can vary accordingly: the closer the spacing, the sharper the bend.

If the piece is to be free standing, it may be strengthened by filling the kerf spaces with thick glue or wood putty forced into the grooves prior to bending. Another means for stiffening the piece is by gluing on a facing or backing of thin flexible plywood.

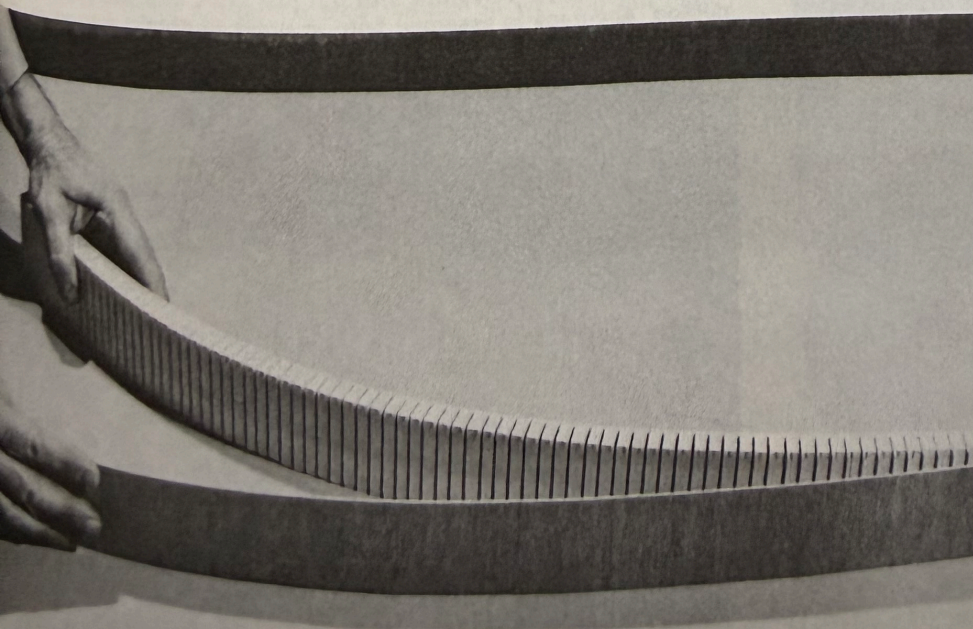
The kerfing method is useful for forming the aprons on circular or round cornered tables, curved drawer fronts, and varied projects of a diverse nature.



A kerfed board bends quite readily but has little strength until it is supported as it will be against this solid member. A mixture of fine sawdust and glue worked into the grooves will add rigidity.



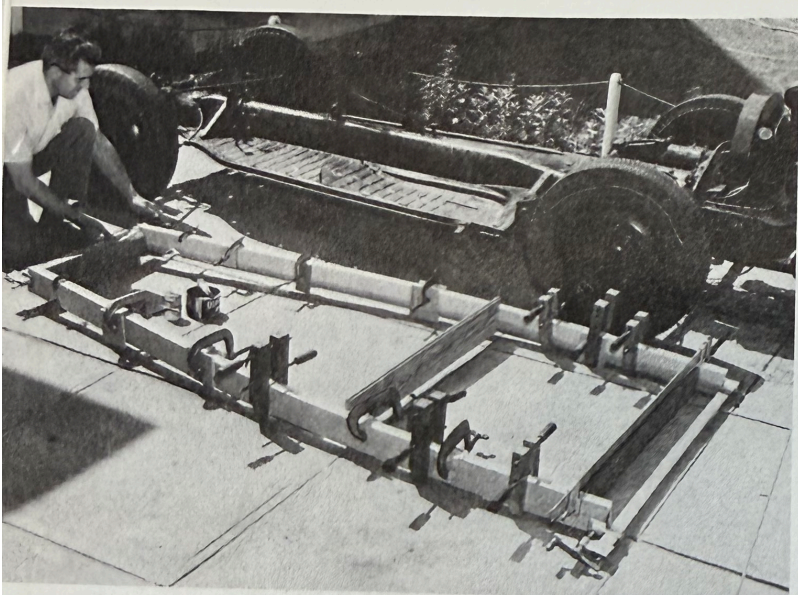
Ready made grooved oak molding used for installing hardboard filigree panels can be kerfed to permit edgewise bends. This approach makes possible novel curved installations. Kerfs must be very thin, made with a band or jig saw. Glue filler plus a thin plywood facing on the rear surface make it sufficiently strong.



Another method of reinforcing the strip is by gluing on a thin layer of flexible plywood.

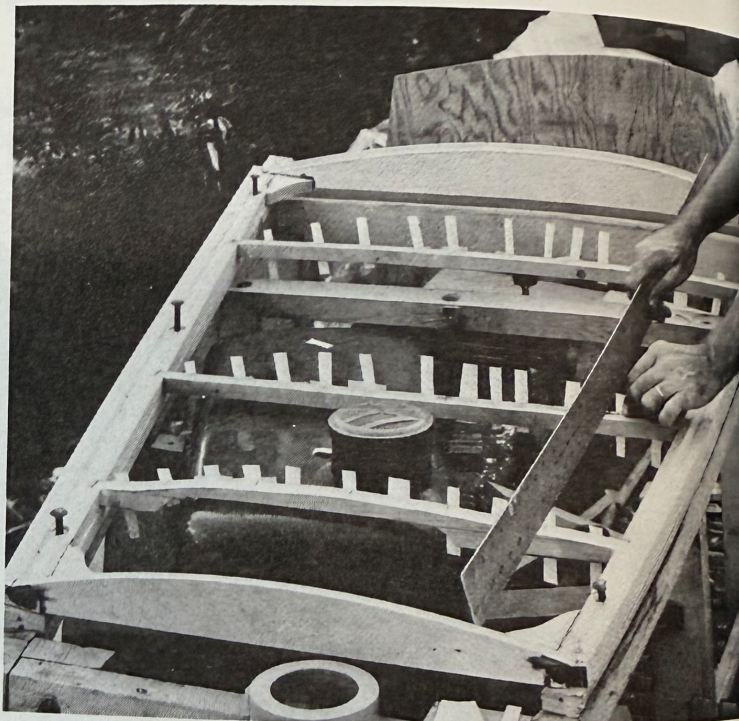
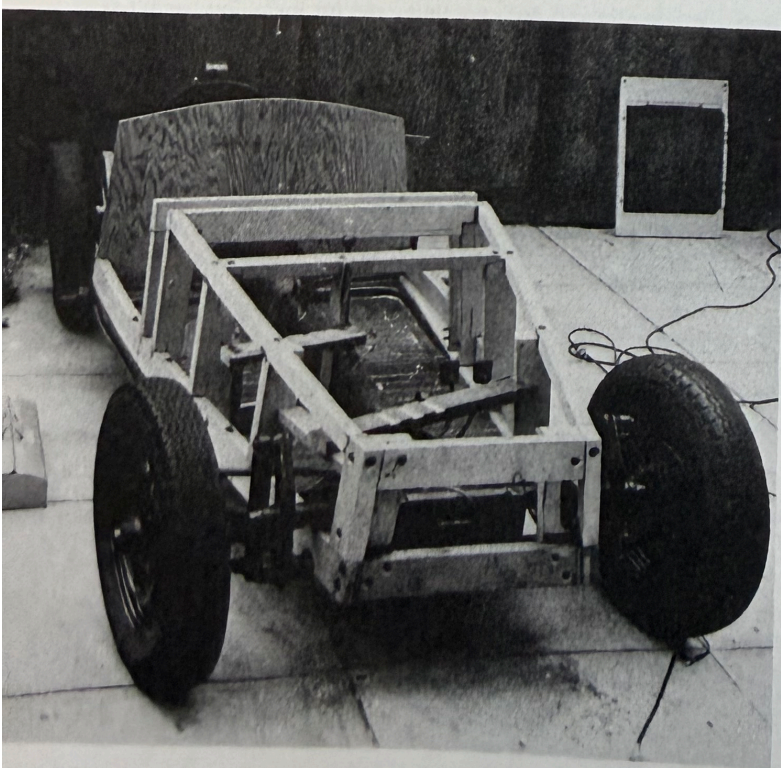
A KERF-BENT PROJECT

Due to the unusual nature of the workshop-built car body shown on page 390, some of the key points of its construction are shown. The intent is not to induce you to build your own (although it is a lot of fun), but it is felt that some of the related procedures of construction may prove useful to you in other projects.



1 The job starts off with a laminated bend: doubled up 1" x 6" boards glued and clamped while in a curved position will form the basic frame. A temporary stringer bows the sides.

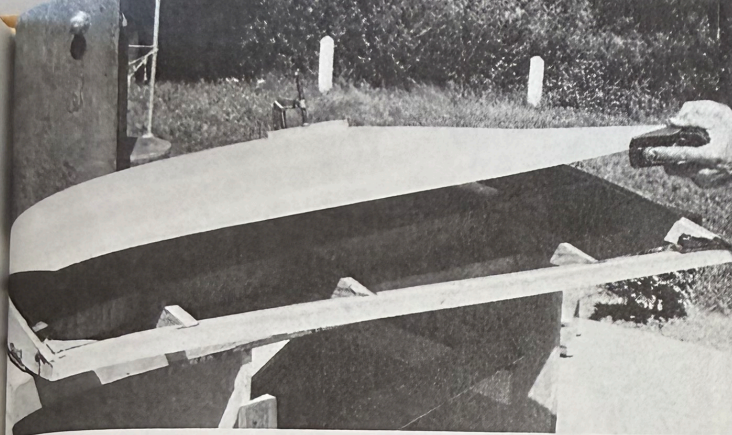
2 Waterproof glue, lag screws and nuts and bolts are used to make a sturdy frame.



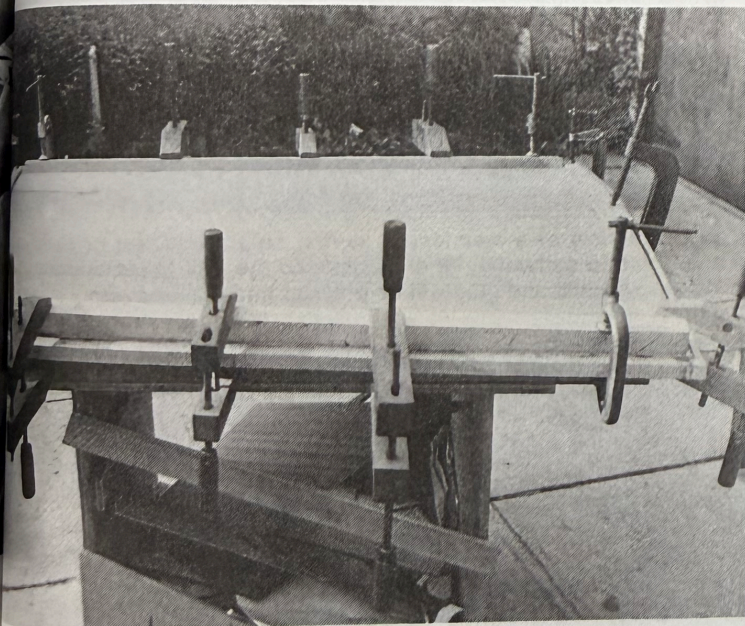
3 A straightedge and paper tabs solve a tricky problem. Paper tabs are taped to temporary sticks to obtain outline shape for ribs. Papers are moved up to ruler's bottom edge then taped. Sticks are then lifted out, and the outline formed by the papers is transferred to wood panels and then cut out.

4 Ribs with varied curvature turn out just right with the paper tab method. Accuracy is essential here in order to obtain a good glue contact surface overall.



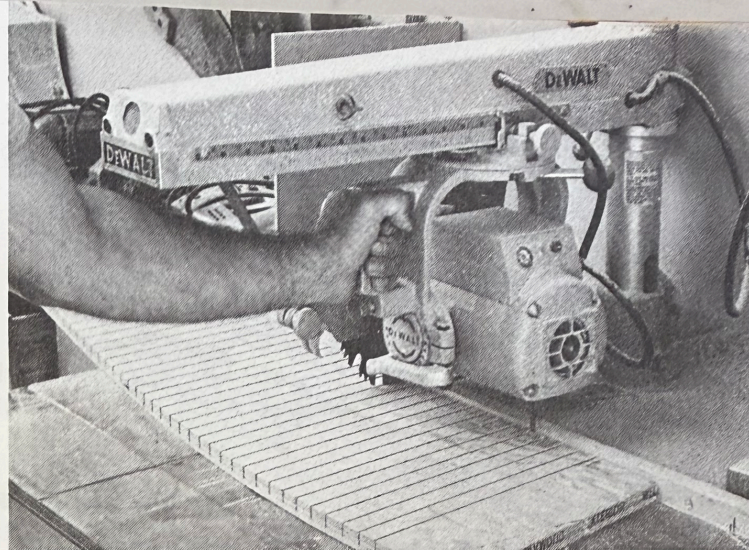


5 Plywood hood panel is set into rabbet and clamped. A block plane is used to make final adjustments for a perfect fit.

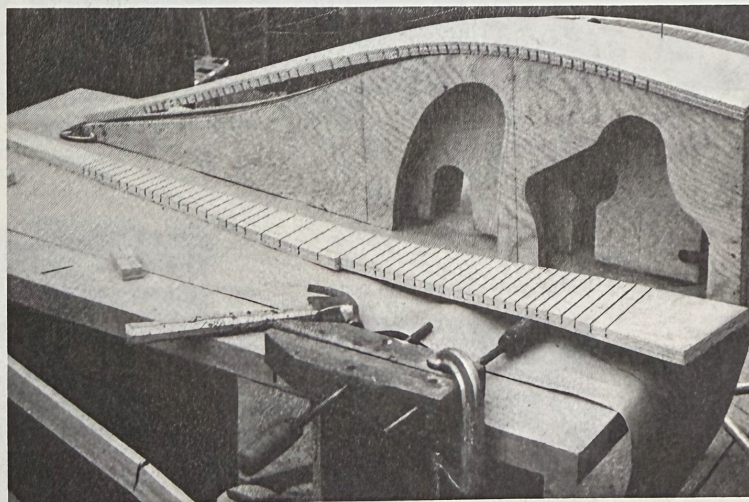


6 Protective wood strips help to distribute the clamping pressure evenly. The number of clamps is not excessive. They're needed because the skin in this case is $\frac{5}{16}$ " thick. This is quite heavy for a dry, self forming bend without kerfs.

7 Cardboard mock-up can be most helpful in working out basic design details.



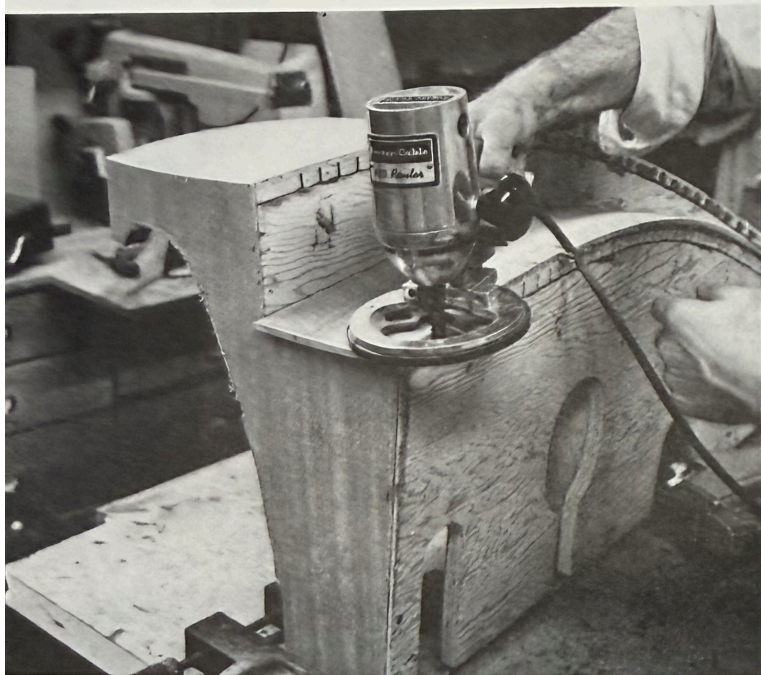
8 Kerfing one of the fender sections. The depth of the grooves can be deepened with a second pass if the part doesn't bend sufficiently on the first try.



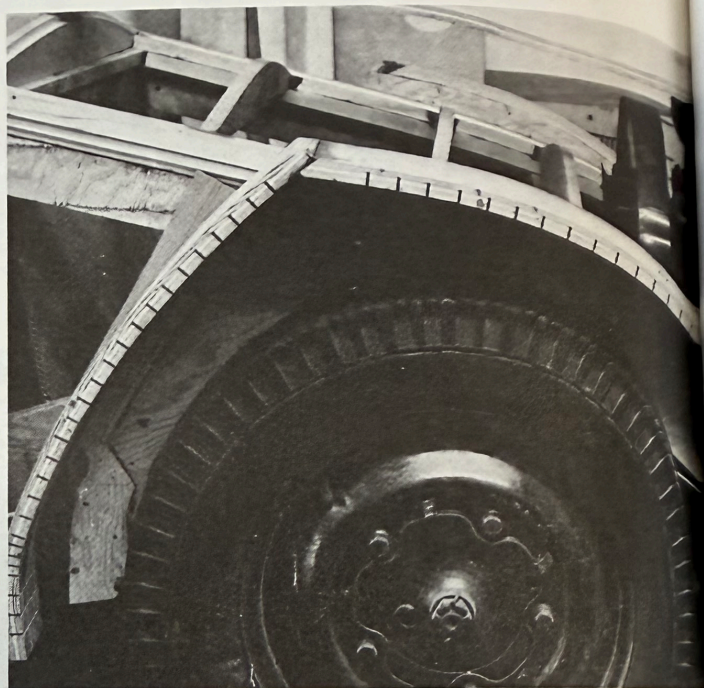
9 Note how the kerf spacing has been varied so that the board is not weakened unnecessarily where only a moderate bend will be required.

10 Sufficient clamp pressure is essential for this kind of a glue-up. Skin being glued to the kerfed section is $\frac{1}{4}$ " marine grade mahogany veneer plywood. Waterproof glue but no nails or screws were used on any of the surfacing veneers.





11 Veneer plywood is glued on beyond edges of project sides, then trimmed flush with the router.



12 Detail view of a rear fender kerfing before addition of skirt and plywood surfacing. When completed the unit is remarkably strong. Sawdust and glue will be pressed into the grooves.

Detail view of engine housing shows another kerf-bent section. Kerfing offers unlimited design possibilities.

