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METHOD AND APPARATUS FOR PREPARING FIBROUS MATERIAL IN BOARD
OR SHEET FORM TO ENABLE DEFORMATION THEREOF, ESPECIALLY
BENDING THEREOF INTO CORNERS
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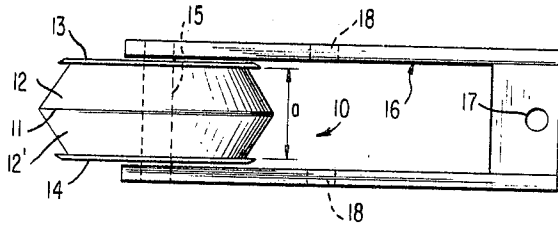


FIG. 1

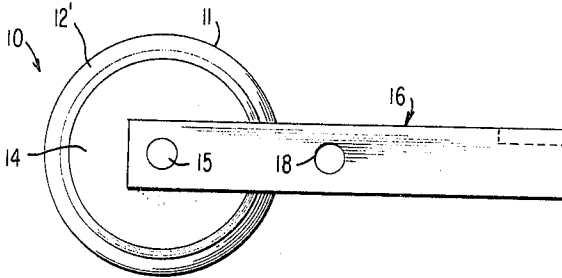


FIG. 2

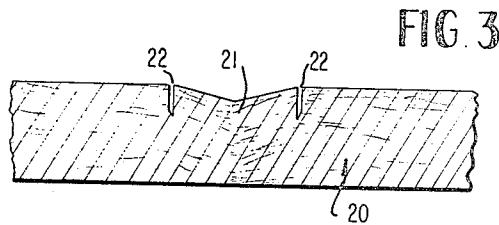


FIG. 3

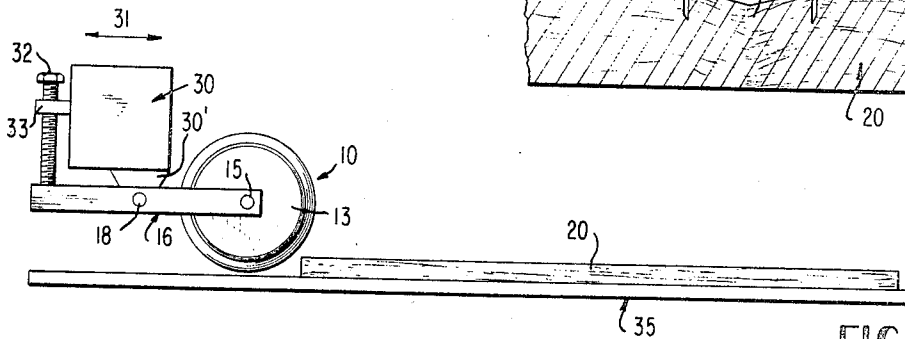


FIG. 4

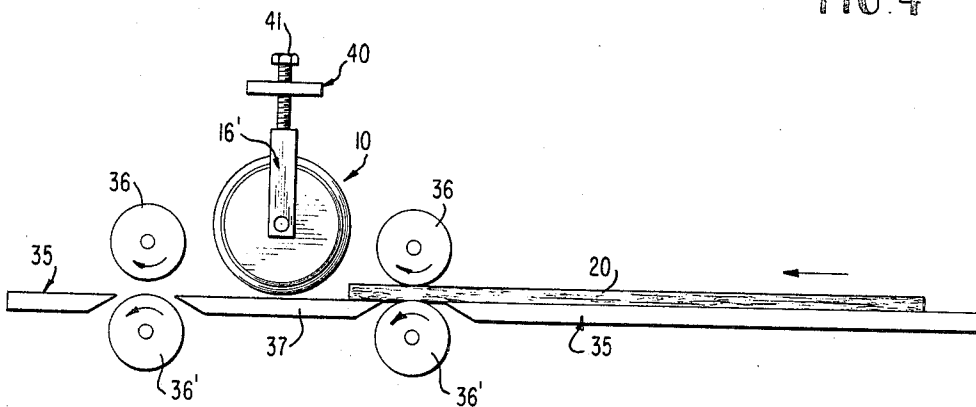


FIG. 5

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METHOD AND APPARATUS FOR PREPARING FIBROUS MATERIAL IN BOARD OR SHEET FORM TO ENABLE DEFORMATION THEREOF, ESPECIALLY BENDING THEREOF INTO CORNERS

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22 Claims

ABSTRACT OF THE DISCLOSURE

Thick, lightweight insulating boards, made of fibrous material held together by a binder, are relatively stiff; yet, by the present invention they may be readily bent to 90° corners so as to form ducts for heating and air conditioning. Pairs of spaced apart cuts in one surface delineate widths of inside corner areas to be crushed, preferably by rollers, which taper to their greatest depth at the center of a corner to be so bent.

The present invention relates to a method and apparatus to facilitate bending of fibrous material into corners, and more particularly, to a method and apparatus for preparing a specific section of a sheet or board of fibrous material in such a way as to enable deformation by bending along a predetermined line in a regular and orderly fashion.

Materials essentially consisting of loose masses of fibers bound together with an adhesive such as a thermosetting plastic compound as well as of plastic foams have found numerous applications. They are available in the form of sheets or boards with the fibers consisting of glass, wood, mineral, cellulose, rubber and other synthetic plastic materials. Air forms the largest percentage of the entire volume of such sheets or boards of fibrous material held together by the binder; the inclusion of such air, on the other hand, contributes to the thermal and acoustical properties as well as to the light weight thereof. Hence, the fiber boards of the aforementioned type come in various thicknesses and construction depending on the particular applications, such as duct boards, roof insulation boards, thermoinsulating material and acoustical materials. The fiberglass materials figure prominently among the materials used for the aforementioned purposes though numerous foamed plastic products are also known for use in those applications. These boards have to be deformed in conformity with the desired final product, for example, duct boards are normally bent to form four corners to thereby provide a square or rectangular duct. In the following text, reference to "fibrous material boards," "fiber boards" or "insulation boards" is to be understood to encompass all of the aforementioned materials as well as constructions including boards and sheets of various thicknesses.

The method used heretofore and continued to be used at present to form a corner bend in such boards is to remove a V-shaped section of the material along the line at which the bend is desired. The amount of removal is dependent on the given material of the board which, in turn, controls the depth of the V cut. The width of the V-cut is normally dependent on the degree of bend necessary, i.e., on the radius of curvature of the bend to be realized. The procedure normally followed nowadays is to make the angle and/or the width of the cut slightly less than the required bend so as to allow the joint to close firmly and to enhance the stiffness of the corner by the inherent resiliency of the material. Nevertheless, even following the last-mentioned precautions reinforcing the joint, the prior art method entails numerous significant disadvantages which will be described more fully hereinafter.

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Normally, the tools used to remove the "V-shaped section" from such boards fall into two basic categories:

(1) A cut is made along each leg of the V and the thus cut section is thereafter lifted out, i.e., is physically removed. The cuts can be made by means of a knife, a rotating saw blade, or a prefabricated tool which makes both cuts at the same time.

(2) A rotary, high-speed, router-type tool which is pre-shaped to the desired V configuration, removes the material as a result of continuous, high-speed rotation; an exhaust or vacuum unit then collects and deposits the resultant dust in a receptacle.

The attendant disadvantages in the prior art methods of making corner bends in insulation boards by the known methods indicated above are as follows:

(1) The various tools described, such as knives, rotating saw blades, router-type tools, and the like are subjected to excessive wear on the blades thereof. In each case, the material involved to be cut or removed is extremely abrasive, particularly when utilizing fiberglass consisting of spun glass fibers. The sharp edge necessary to produce a clean cut is very short-lived and requires time-consuming and cumbersome sharpening at short intervals.

(2) The scrap material produced by the knife or rotary saw cuts must be lifted and removed from the board. While this may be a relatively small labor increment by itself, it becomes a significant item as could be readily demonstrated by a convention time and motion study. The scrap removed by the high-speed, router-type of cut is deposited in a receptacle by a vacuum or exhaust unit; however, this waste must later on be removed into bags or other containers for ultimate disposal. Furthermore, any amount of inefficiency in the exhaust system allows the minute particles that the router produces to become airborne and create a definite housekeeping hazard.

(3) The ultimate disposal of scrap from either type of V cut is a further involved problem as

- (a) such scrap, though light in weight cannot be easily compacted;
- (b) its fibrous nature makes it uncomfortable to handle;
- (c) its fire-resistant qualities preclude burning thereof;
- (d) it is space-consuming for the reasons outlined above.

(4) When a bend is completed in the insulation board along the V-shaped cut obtained by the prior art methods, the end result is a butt joint. This is the weakest type of joint. Consequently, in some types of fabrication, it is necessary to spread an adhesive along the entire joint to ensure the proper structural strength, representing an additional operation that is both costly and time-consuming.

The aim and object of the present invention is to prepare fibers or insulation boards in such a manner as to enable corner bends to be made which entail none of the disadvantages mentioned above and at the same time produce definite and significant advantages of their own.

The present invention essentially consists in a method for preparing a fibrous material in board or sheet form, in which the loose fibers are bound together by an adhesive binder compound, in order to facilitate the subsequent binding deformation thereof, which comprises the steps of delineating the width of the material to be deformed by perforating or cutting the surface thereof on only one side by means of relatively shallow cuts and crushing the binder and some of the fibers of the material within the area defined by said cuts, preferably in such a manner that the degree of crushing increases substantially progressively from both of the cuts toward the center of the treated area.

The result of the method in accordance with the present invention is a section in the insulation board in which

the relative hardness and resistance to flexion thereof has been greatly reduced. It now becomes possible to make the required bend without removing any of the material.

In one preferred embodiment, the present invention utilizes a tool in the form of a round roller which is provided with a larger diameter at the midpoint than at either end and by the presence of beveled surfaces and which is flanked at each end by an edge-sharpened disk. This tool is used by pressing it into the surface of the insulation board, describing a path across the board along a predetermined line as a result of relative movement between the roller and the board. The effect on the insulation board is the crushing of the binder and of the fibers within an area lying directly below the roller. At the same time, the edge-sharpened disks perforate the surface thereby delineating the width of the deformed area and producing a straight, regular edge.

The edge-sharpened disks provided at each end of the roller may be formed integral with or may be separate from the roller but mounted on the same shaft as the latter.

In the alternative, straight, nonrotating blades flanking the roller may also be used which may be mounted as described above in connection with the disks.

However, according to a modified method in accordance with the present invention, the shallow cuts delineating the width of the board to be used for the bend may be made prior to the time the crushing roller contacts the insulation material by means of either a rotary blade or a straight blade.

Since the action according to the present invention is rolling and crushing with a relatively blunt tool, no wear factor on the blades is involved, thus assuring long life of the tools.

Additionally, there is no waste or scrap to be removed or handled in any manner whatsoever by the method in accordance with the present invention, whence labor is saved and the problem of disposition of the scrap is eliminated.

Furthermore, no problem of airborne dust can arise from the present invention.

In addition to the foregoing advantages, the present invention also entails certain other advantages. Although the binders of the fiber boards are crushed within the predetermined area of the board by the method in accordance with the present invention, many of the fibers remain interlocked and interlaced with the adjoining undeformed areas. This mass retains a degree of strength as contrasted to a complete absence of the fibers when utilizing the prior art method of cutting V-shaped grooves. When the action of bending is completed according to the present invention, the compression of the crushed area then assumes the density and hardness of material on either side of the bend. The end result is a joint as strong, if not stronger, than the material surrounding it by following the method in accordance with the present invention. In the case of a fiber glass air-duct system such a bend produces a more rigid duct and allows more latitude in design specifications.

Accordingly, it is an object of the present invention to provide a method and apparatus for preparing fiber boards to be deformed by bending which eliminate, by extremely simple means, the aforementioned shortcomings and drawbacks encountered in the prior art.

Another object of the present invention resides in a method and apparatus for preparing fiber boards to permit bending of corners which eliminate the relatively high wear and tear on the tools when following the prior art methods.

A further important object of the present invention resides in a method and apparatus for making bends in fiber boards which obviate completely the need for either physical removal of scrap material and/or disposal thereof.

Still another object of the present invention resides in a method and apparatus for making bends in fiber boards

which greatly simplify the operation and results in significant savings in labor and tools, thereby decreasing the cost of manufacture.

Still a further object of the present invention resides in a method and apparatus for making bends in fiber boards and the like which dispense with exhaust systems necessary with the use of the prior art high-speed rotary cutting devices.

Another object of the present invention resides in a method and apparatus for making bends in fiber boards which produce no scrap whatsoever and therewith eliminates the problem of health hazards due to the possible presence of minute particles.

A further object of the present invention is a fiber board product having one or several corners, such as ducts or the like which are characterized by joints that are as strong, if not stronger, than the surrounding material, not to mention straightness and regularity of the bends.

A still further object of the present invention is a duct system, for example, as used in air duct systems made from fiber board material, particularly of fiberglass which excels by greater rigidity than attainable heretofore, thus allowing greater latitude in design specifications.

These and further objects, features and advantages of the present invention will become more obvious from the following description when taken in connection with the accompanying drawing which shows, for purposes of illustration only, several embodiments in accordance with the present invention, and wherein:

FIGURE 1 is a top plan view on one embodiment of a roller tool in accordance with the present invention, mounted in a tool holder;

FIGURE 2 is a side elevational view of the roller tool and tool holder of FIGURE 1;

FIGURE 3 is a partial cross-sectional view through an insulation board, indicating the crushed area and lateral perforations obtained by the method in accordance with the present invention;

FIGURE 4 is a schematic illustration of the use of the tool in accordance with the present invention mounted on a movable work bar which travels over a stationary table on which is laid a piece of insulation board; and

FIGURE 5 is a schematic illustration of a modified embodiment in accordance with the present invention utilizing a tool in a fixed position with the insulation board movable relative to the tool by the action of feed rollers.

Referring now to the drawing wherein like reference numerals are used throughout the various views, and more particularly to FIGURES 1 and 2, reference numeral 10 generally designates therein a forming roller in accordance with the present invention. The roller 10 has its largest diameter at the midpoint thereof, i.e., at the intersection 11 of the two beveled surfaces 12 and 12'. The specific angle subtended by the beveled surfaces 12 and 12' depends on the material of the board and its thickness. Similarly, the width *a* of the roller is determined by the particular product and its thickness, as well known to any person skilled in the art.

Two edge-sharpened-disks 13 and 14 are disposed adjacent the roller 10. They may be suitably secured to the sides of the roller 10 by any conventional means. The roller 10 and disks 13, 14 are rotatably mounted by means of a shaft 15 in a suitable tool holder or roller support, generally designated by reference numeral 16. If so desired, any suitable bearings or anti-friction bearings may be interposed to facilitate the rolling action.

FIGURE 3 indicates a portion of a fiber board generally designated by reference numeral 20 which has been subjected to a preparatory action in accordance with the method of the present invention. As can be readily seen from FIGURE 3, the area 21 intermediate the two side

cuts or perforations 22 is crushed by the rolling action of the roller 10 of FIGURES 1 and 2. The surface cuts 22 which are relatively shallow, are produced by means of the disks 13 and 14. The function of the cuts 22 is to delineate the area under the roller 10 and to cut or perforate the surface directly adjacent to the roller. This assures a straight, regular line at the inside of the bend.

Aperture 17 and apertures 18 provided in the tool holder or roller support 16 may be used for securing the same either to a fixed member or to a travelling work support.

FIGURE 4 illustrates one embodiment in which the roller 10 and roller support 16 is suitably secured to a movable travelling work bar generally designated by reference numeral 30 which may be of any conventional construction and is shown therefor only schematically. Double arrow 31 indicates the direction of movement of the work bar 30. The work support 16 is pivotally secured to the travelling work bar 30 by appropriate pivot pins inserted into bores 18 of the support 16 which engage in appropriately positioned bores provided in bracket-like extensions 30' rigidly secured to the travelling work bar 30. By adjusting the screw 32 threadably mounted in the lug 33 rigid with the work bar 30, the height of the axis of rotation of the roller 30 may be varied, it being assumed that the travelling work bar 30 travels along a straight line that maintains constant the relative location of the axis of the roller 10 with respect to the fiber board 20. In the embodiment of FIGURE 4, the fiber board 20 is suitably held or secured on a relatively fixed part, such as the table 35.

While in the embodiment of FIGURE 4, the roller 10 together with the roller support 16 and travelling work bar 30 was movable relative to the table 35. FIGURES 1, 2, and 5 illustrate embodiments in which the roller 10 and roller support 16 or 16' are relatively fixed. In FIGURE 5, the roller support 16' is mounted on a relatively fixed part 40 of any conventional construction by means of the adjusting screw 41 to adjust again the height relative to the fiber board.

In the embodiment of FIGURE 5, reference numeral 35 again designates a fixed table. The fiber board 20 is displaced longitudinally by feed rollers 36 and 36'. These rollers are driven at constant peripheral speed from any conventional means (not shown). Reference numeral 37 designates a stationary platen to support the fiber board 20 while it is subjected to the crushing and cutting action of the tool.

Whereas the roller tool 10 in FIGURES 2, 4, and 5 is shown in the form of an idler, the roller can also be driven by any suitable means. In that case, a rotating tool 10 could replace one of the drive rollers 36 of FIGURE 5 without affecting the operation of the device.

It is readily apparent that the tool of FIGURES 2, 4 and 5, in the form of an idler can be readily installed on existing equipment in the place of the presently used V-blade cutting tools, involving only a simple and direct conversion.

Furthermore, the means for imparting relative motion between the roller 10 and the fiber board 20 may be modified in any known manner according to the numerous mechanisms available in the prior art for such purpose, it being immaterial for the method of the present invention whether the tool is moved either manually or automatically relative to the board 20 whereby the board 20 may be held stationary or the tool is held stationary while the board is moved relative thereto.

For example, for purposes of making ducts from spun fiberglass boards, it may be desirable to mount four tools consisting of four roller tools 10 as illustrated in FIGURES 1 and 2 and of a further tool, preparing the end of the board for closure, on a common work bar, means being provided to adjustably secure the tools on the common work bar to permit adjustment of their relative spacing in the axial direction of the work bar in order to per-

mit the manufacture of ducts of different dimensions and configurations, i.e., ducts having different height to width ratios. The travelling work bar itself may be slidably guided on a fixed support, such as appropriate rails, for example, by the interposition of suitable rollers or other antifriction means, whereby the rails may be mounted laterally on the fixed table support. The width of the table may therefore be made to correspond to a standardized width of fiber board. If so desired, the fixed table, the rails, and the travelling work bar may be mounted on a truck or trailer so that the entire assembly becomes mobile. At the place of installation, it is only necessary to place standard-size fiber boards that may be carried along in the truck or trailer, on the table and to thereafter move the travelling work bar across the length of the board. The fiber board is then ready to be bent into a four-cornered duct. In one case, using a fiberglass board material of one inch thickness, a roller was used having a width of 1½ inches with about a 60° angle formed on surfaces 12 and 12' as illustrated in FIGURE 1.

The foregoing clearly indicates that the particular apparatus and installation for realizing the method in accordance with the present invention is susceptible of numerous modifications as known to a person skilled in the art. However, regardless of the details of the arrangement, the method in accordance with the present invention provides significant advantages; namely,

- (1) No material is removed from the fiber board;
- (2) The roller, because of its peculiar shape, deforms the material and changes its density in such a way as to permit the board to be bent along a prescribed, regular line;
- (3) The very shallow cuts made in the surface of the material delineate and contain the section to be deformed by the roller;
- (4) No female dies are necessary since the fiber board is prepared only on one side;
- (5) The crushing action in accordance with the present invention does not materially alter visibly the shape of the section but instead crushes the binder adhesive compounds within that section and alters its physical properties so that a bend can be made at that point in the board;
- (6) The problem of scrap disposal is completely eliminated by the present invention;
- (7) A stronger, more rigid bend is produced by the present invention.

While I have shown and described several embodiments in accordance with the present invention, it is understood that the same is not limited thereto but is susceptible of numerous changes and modifications as known to a person skilled in the art. For example, instead of the edge-sharpened disks 13 and 14 laterally secured to the roller 10, angular cutting blades may be used travelling ahead of the crushing roller 10. The advantage of an angular blade over a rotary blade is that a straight blade cut is effective on materials of varying density and composition.

Furthermore, the present invention is applicable to fiber boards of all fibrous materials including conventional foam plastic products. With the latter, a heated roller will perform the same basic function.

I claim:

1. A method for preparing fibrous material in board or sheet form in which the fibers are bound together by an adhesive binder, to facilitate the subsequent bending deformation thereof into a predetermined shape, comprising the steps of first delineating the width of the fibrous material to be deformed by slightly perforating the surface on one side thereof, with spaced apart perforations whose spacing corresponds to such delineated width, and thereafter crushing the binder within the area of the delineating perforations.

2. The method according to claim 1, wherein the step of crushing the material within the width of said perforations is realized in such a manner that the degree of crush-

ing increases substantially progressively from the perforations toward the center of said width.

3. The method according to claim 1, further comprising the step of holding said fibrous material relatively stationary while moving relative thereto during the delineating and crushing operations.

4. A method for manufacturing insulating ducts and the like from boards essentially consisting of fibers held together by a binder without the need for physically removing any material, comprising the steps of preparing a board prior to deformation thereof including making two shallow cuts in the surface on one side thereof to delineate each area for subsequent bending deformation, then crushing the binder within each area, the degree of crushing varying within each area from a minimum near the two respective cuts to a maximum intermediate the same, whereby to reduce the relative stiffness of the board within such area, and thereafter deforming the board within each area to form a bend of predetermined shape.

5. The method according to claim 4, wherein the maximum is located approximately midway between two respective cuts.

6. An apparatus for preparing fiber boards to enable bending thereof, comprising support means for supporting the fiber boards, tool means including first means for making two relatively shallow cuts in the fiber board supported on said support means to delineate the area of subsequent deformation and second means for crushing the binder of the fiber board within each such area, and means for moving said tool means relative to a relatively fixed fiber board.

7. The apparatus according to claim 6, wherein said tool means includes roller means constituting said second means, said roller means having its largest diameter approximately midpoint thereof formed by the intersection of two inclined surfaces.

8. The apparatus according to claim 7, wherein said first means is constituted by cutting disk means arranged laterally of the roller means.

9. The apparatus according to claim 7, wherein said first means is constituted by straight, nonrotating blades.

10. The apparatus according to claim 9, wherein said non-rotating blades flank said roller means.

11. The apparatus according to claim 9, wherein said blades are disposed ahead of said roller means.

12. A work tool for perparing fiber boards to enable bending of the boards into predetermined shape comprising a roller structure, means for rotatably supporting said roller structure about the axis thereof, the diametric dimension of said roller structure increasing from both lateral ends in the direction toward the center, and cutting means operatively connected to said roller structure so as to be relatively fixed thereto, said cutting means being so located relative to said roller structure as to define the width of the latter by said cutting means.

13. The tool according to claim 12, wherein said cutting means are edge-sharpened disks located on both sides of said roller structure.

14. The tool according to claim 13, wherein the inclined surfaces of said roller structure constitute beveled surfaces with the maximum diametric dimension being

located about midpoint of the axial length of said roller structure.

15. The tool according to claim 12, wherein said cutting means are constituted by straight cutting blades.

16. A duct-like structure made from fiber board essentially consisting of loose fibers held together by a binder, which board is deformed into predetermined shape by bending at the corners thereof, characterized in that within each area of deformation thereof, the binder is crushed to reduce the stiffness of the material while the area of deformation is delineated by relatively shallow surface cuts in the fiber board on one side thereof.

17. The structure according to claim 16, wherein said cuts are relatively straight.

18. The structure according to claim 17, wherein the binder is crushed to a greater extent within the center of each area of deformation than along the sides thereof.

19. The product according to claim 16, wherein the binder is crushed to an increasing extent from each side of a respective area delineated by corresponding cuts toward the center of such area.

20. A method for perparing fibrous material in board or sheet of the type in which loose fibers are bound together by an adhesive compound, to facilitate the subsequent bending deformation thereof into a predetermined shape, comprising the steps of delineating the width of the fibrous material to be deformed by making a pair of relatively shallow cuts, on one side thereof, to produce substantially straight edges defining said width, and crushing the binder within the area of the delineating cuts to an extent which increases from a minimum near said cuts to a maximum intermediate said cuts.

21. The method according to claim 20, wherein the extent and degrees of crushing varies progressively over said width.

22. An apparatus for preparing fiber boards to enable bending thereof, comprising support means for supporting the fiber boards, tool means being fixed and including tool support means, means for adjusting the height of said tool means relative to said tool support means, first means for making two relatively shallow cuts in the fiber board supported on said support means to delineate the area of subsequent deformation and second means for crushing the binder of the fiber board within each such area, and means for moving said fiber board relative to said fixed tool means, said tool means relative to a relatively fixed fiber board.

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