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METHOD OF MAKING A CELLULAR STRUCTURAL PANEL AND PRODUCT

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2 Sheets-Sheet 1

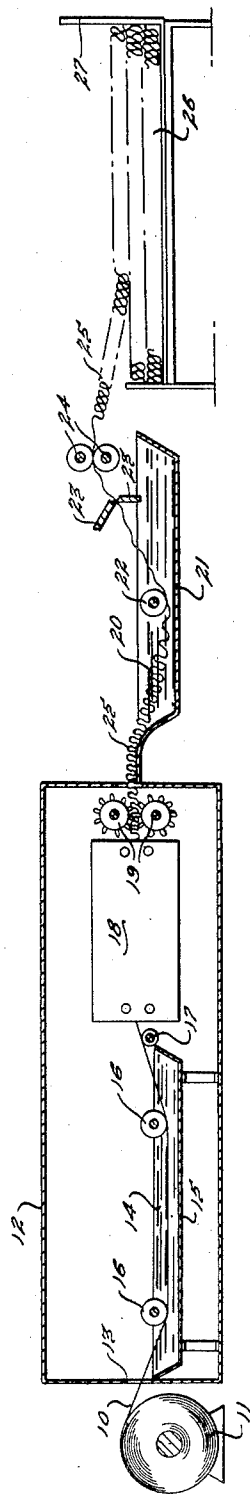


FIG. 1.

FIG. 2.

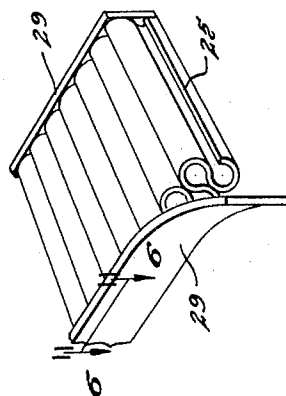
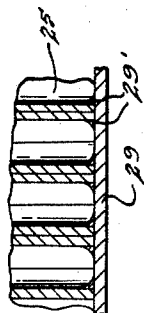


FIG. 4.

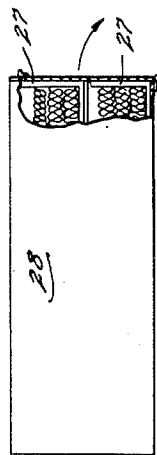


FIG. 5.

FIG. 6.

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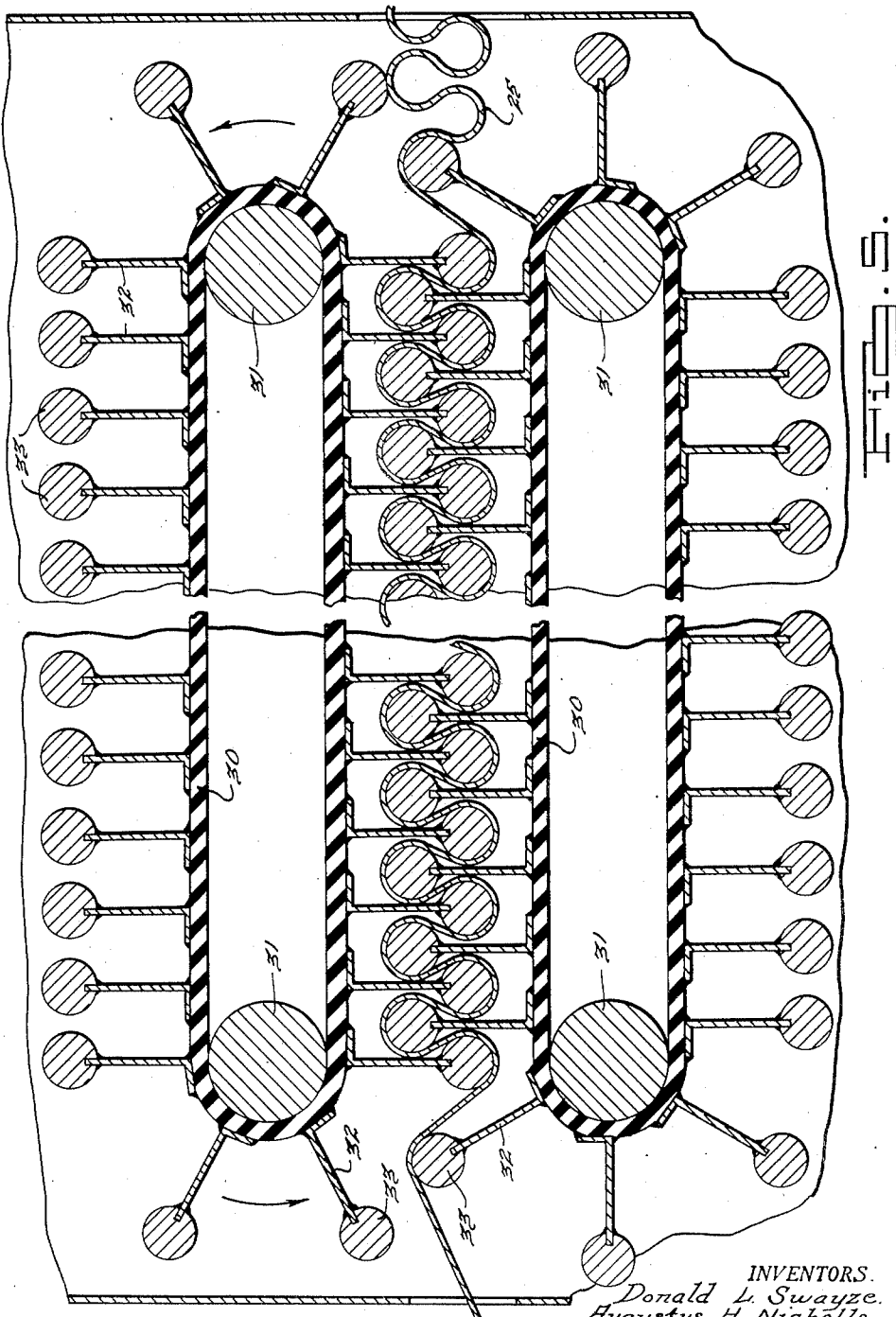
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METHOD OF MAKING A CELLULAR STRUCTURAL PANEL AND PRODUCT

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3 Claims. (Cl. 154—33.05)

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This invention relates to improvements in the manufacture of a cellular-like structural body and is particularly adapted to the formation of such body from flat or sheet stock. The invention in its broader aspects may be employed with equal facility in imparting a sinuous contour to a body of material in which successive portions of sheet stock, for example, are respectively disposed in two parallel planes.

An object of the invention is the provision of an improved method for so imparting a sinuous or cellular-like contour to a body of material in sheet stock, for example, that the same will be at least temporarily retained to contour and thereafter more permanently setting the stock in its contoured form.

More particularly the invention provides an improved method for manufacture of a structural cellular-like body by the practice of which the strength characteristics of the material are increased subsequent to the aforesaid contouring and, as a further feature, such increasing of the strength characteristics may include the permanent securing together of adjacent cell-forming walls.

A relatively light-weight, low-cost structural panel, for example, can be manufactured according to the invention from a fibrous material by increasing the normally low strength characteristics through contouring as indicated above and suitably impregnating the same, for example, with a heat setting resinous material and the latter can be further utilized to adhere together successive adjacent portions of the contoured material and to attach to the latter additional components of the panel.

A further object of the invention is the provision of a method of manufacture according to the above by which the contouring and impregnating are performed in a sequence of operations which avoids the difficulties of contouring a body of material having applied thereto an adhesive agent.

In carrying out the improved method utilizing a fibrous material having an inherent resiliency sufficient that the material will return to a normal contour, except when decisively creased and the fibers fractured, the fibrous material in flat, sheet stock can be rendered resiliently inert, then contoured as desired, the normal inherent resiliency restored, and thereafter the material impregnated with a strengthening agent having adhesive properties. These operations can be performed as successive steps in a continuous process of manufacture.

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The fibrous material can be rendered resiliently inert by causing the same to absorb a sufficient moisture content whereupon contouring may be mechanically performed without fracture of the fibers to impart to the stock a plurality of successive cell-forming walls, for example, having a radius of curvature, and when so contoured sufficient of the moisture content is evaporated to restore a substantial degree of resiliency to the material such that the same when stressed will tend to return to the contour imparted thereto.

The material may be further advanced without loss of contour in a continuous process to impregnate the same with a heat-setting resinous solution which, when set, permanently establishes the contour, strengthens the fibrous material, and may be utilized to adhere together successive adjacent cell-forming walls. If desired, the resinous solution may be utilized to adhere a facing panel to the cellular-like body.

Other objects and advantages of the invention will be more apparent from the following description taken in connection with the accompanying drawings illustrating apparatus for carrying out the invention and a typical resulting product.

Fig. 1 is a side elevational view showing apparatus for continuously performing the various steps of the invention;

Fig. 2 is a view in side elevation of an oven for curing the cellular-like body produced by the Fig. 1 apparatus;

Fig. 3 is a perspective view of the product after oven curing;

Fig. 4 is a view similar to Fig. 3 but showing the addition of a facing panel to the cellular-like body;

Fig. 5 is a side elevational view in section illustrating the contouring mechanism of Fig. 1;

Fig. 6 is an enlarged, fragmentary sectional view taken as indicated by the line 6—6 of Fig. 4.

Referring to the drawings, the invention is illustrated and described in connection with the method of manufacturing a cellular-like body from a fibrous sheet material 10, for example, paper or linen. To facilitate operation, the material 10 may be fed from a rotatably mounted roll as indicated at 14 into a furnace 12 through a suitable inlet opening 13. The furnace 12 contains a water bath indicated at 14 provided by a suitable tray 15. The fibrous sheet material 10 passes under spaced rolls 16 for immersion in the bath 14, the exposure time of the material to the water bath being sufficient

to fully wet the fibers of the material and render the same resiliently inert, the dip time, of course, varying with the rate of absorption of the material. If desired, the bath may include a wetting agent to improve and speed absorption.

From the bath 14 the material 10 so wetted and resiliently inert is fed over a support roller 17 into a contour-forming apparatus, generally indicated at 18 in Fig. 1, and more specifically shown in Fig. 5. The rate of travel of the material through the apparatus 18 and the temperature maintained in the oven 12 are so relatively predetermined that the absorbed moisture content of the material is sufficiently evaporated to dry the material and restore to the same a degree of resiliency such that it will tend to retain the contour imparted thereto by apparatus 18 during movement through the associated apparatus which is adapted for the performance of subsequent operations.

The material 10 is withdrawn from the apparatus 18 by a pair of gears 19 provided with rubber teeth, the material passing between the gears and being fed therefrom into a bath indicated at 20 contained in a suitable tray or tank 21, the material passing beneath a roller 22 for immersion in the bath. The solution of this bath is applied to the material to impart strength thereto and further may serve to adhere together adjacent cell walls. The bath 20 may be a heat-setting resinous solution, having adhesive properties, as more particularly hereinafter set forth. As the material emerges from the bath, it passes between a pair of rubber squeegees 23 which remove excess solution on the surface of the material 10 and the absorbed content of the bath 20 is further controlled by passing the material 10 between a pair of pressure rolls 24 adjusted to exert a given pressure sufficient to remove any excess solution from the material. While the tensile stress on the material 10 incident to passing the same between the squeegees 23 and rolls 24 tend to straighten the same, nevertheless the material has sufficient resiliency to return to the contour imparted thereto at 18 upon relief from such stress.

The material as it emerges from the oven 12 and rolls 24 has a plurality of successive cell-forming walls 25 and as indicated at 26 may be stacked in layers in a receptacle 27. The latter may serve as a mold in that the adjacent cell-forming walls of each layer are brought into surface contact therein and one or more of the molds then placed in an oven 28 as shown in Fig. 2 wherein the solution applied in the bath is cured, set, or solidified and adjacent cell walls adhered together by the solution incident to the curing, setting, or solidifying. In this respect the walls of the mold may be suitably coated or insulated from the cellular body to prevent a bonding of the latter thereto.

Referring to Fig. 5, the apparatus 18 includes a pair of endless belts 30, of rubber or a similar material, arranged one above the other, and each is moved by a pair of rollers 31. Each belt 30 has secured thereto a plurality of arms 32, each of which carries a circular rod 33 having a length equal to the width of the sheet stock 10 to be operated on. The upper belt 30 rotates in a counterclockwise direction and the lower belt in a clockwise direction as indicated by the arrows and the arms and rods are so arranged that the material 10 is first engaged by a rod 33 of the lower belt and then by an arm 32 of the upper belt to thereby partially loop successive portions

of the material about respective alternate rods of the belts, the loop provided by a rod of one belt being between adjacent arms of the other belt, and the thickness of the arms being relatively small so that the loops of each plane are in relatively close proximity.

Each loop is formed as the belts and rods begin their travel in a horizontal path from left to right, as viewed in Fig. 5, and are retained in looped form during such travel. Thus, the material enters the apparatus 18 impregnated with moisture sufficient to render the same resiliently inert for forming and during travel in the aforesaid horizontal path the time thereof and the temperature of the oven are so relatively predetermined as to evaporate the absorbed moisture so that upon release from the forming rods 33 the material is dried sufficiently to restore resiliency thereto.

Referring to the bath 20, the content thereof should have the characteristics of impregnating the material 10, increasing the strength of such material and also adhering together the adjacent walls. Preferably the bath is a solution containing a heat hardening or setting resin, for example, a thermosetting phenolic resin, in a suitable solvent although in the broader aspects the invention is not to be limited to the particular solution employed for impregnation and for this purpose a solution of starch, dextrine, casein, silicate, or thermoplastic resin may be employed.

One or more layers 26 of the material may have applied over each open end of the cells a facing skin 29 of some high strength, lightweight material such as plywood, aluminum, steel, metal alloys, cardboard, or the like, and for this application a surface of the latter may have applied thereto a coating of a fillet-forming cement, for example, a modified polyester cement, and such surface brought into contact with the ends of the cell walls. The surface of the end face of each such wall may be relatively slight and hence a fillet-forming adhesive or cement is desirable to increase the bonded area. The fillets formed by the use of such cement are indicated at 29' (see Fig. 6). The assembly of the cellular body and the end panels or skins 29 is subjected to pressure and heat to cure or set the fillet-forming adhesive. A structure so formed can be employed as a structural panel, particularly where high strength and low weight characteristics are requisite. While the crests of the cell-forming walls are arranged co-planar in Fig. 4, nevertheless this relative arrangement may be otherwise varied, for example, to give the body a generally arcuate contour, in which event portions of the adjacent cell-forming walls 29 may be spaced apart while other portions thereof would abut and be secured together.

Although but one specific embodiment of the invention has herein been shown and described, it will be understood that various changes in the size, shape, and arrangement of parts may be made without departing from the spirit of the invention.

We claim:

1. A structural panel including a cellular intermediate body comprising a plurality of adjacent cellular units each having a pair of rows of nested, integrally formed, mutually supporting cells, the cells of each of said units extending depthwise of the panel and each cellular unit consisting of and being formed from a single continuous sheet of resin impregnated paper having successively adjacent portions reverseiy con-

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voluted in figure 8 conformation providing the walls of said cells, the external surfaces of the walls of adjacent cells of at least one of the rows of each unit and the walls of the cells of adjacent units being adhered together and a facing skin of sheet-like high strength, lightweight structural material disposed adjacent and adhered to the end edges of said continuous sheets of resin impregnated paper at the ends of the walls of said cells.

2. A structural panel including a cellular intermediate body comprising a cellular unit having a pair of rows of mutually supporting cells, said unit consisting of resin impregnated sheet paper stock successively adjacent portions of which are reversely contoured to a configuration to provide the walls of said cells, the cell forming walls of one row being integral and arranged in staggered relationship with the cell-forming walls of the other row, the external surface of the adjacent cell forming walls of at least one of said rows being adhered together, and facing skins of sheet-like high strength, lightweight structural material one arranged over each end of the cells of said unit and adhered to the cell-forming walls at each end thereof.

3. The method of making a structural panel including laterally spaced facing skins of high strength, lightweight structural material and a cellular body of paper therebetween, which comprises moisture impregnating sheet paper stock, looping successive portions of the moisture impregnated sheet paper stock about a first row of forming members and about a second row of forming members arranged alternatively with the members of the first row to thereby respectively

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form integrally continuous first and second rows of cell-forming walls, heating the stock when the same is looped about said forming members to remove the moisture content thereof and set said walls in cell formation, removing said cell-forming walls from said forming members, pressing the adjacent cell-forming walls of each row into mutually supporting contact one with the other, treating the cell forming walls with means for rigidifying and adhering the same together, arranging a facing skin one over each end of the cells and adhering the same to cell-forming walls at each end thereof.

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