

PATENT SPECIFICATION

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(54) METHOD AND APPARATUS FOR PRODUCING FIBROUS PRODUCTS HAVING INTEGRAL TONGUE AND GROOVE EDGES

(71) We, JOHNS-MANVILLE CORPORATION, a corporation organized under the laws of the State of New York, United States of America, of 22 East 40th Street, New York 16, State of New York, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to the manufacture of bonded fibrous products, and in particular to the forming and curing of loose masses of fibrous material, containing throughout uncured binder material, into coherent, permanently shaped, semi-rigid but resilient and flexible, or rigid fibrous products, typically of low density structures but of substantially increased densities and integrity as compared to the initial loose mass of fibrous material. Although the low density products of this invention are primarily designed for use in thermal insulation applications, the method is amenable to the manufacture of panels, tiles, sections, etc., for other or combined utilities such as decorative wall or ceiling construction units alone or of composite functions providing effective thermal and/or sound insulations.

One of the most common means of uniting and joining abutting sections of many construction materials, particularly wood and bonded low density fibrous units or sections such as wall or ceiling panels or tiles, consists of conventional tongue and groove edges for complementary mating of adjoining components. Typical means of forming conventional tongue and groove edges comprise cutting away or routing out of material with saws, knives, or other blade devices to effect this conventional joint substantially similar to the forming of tongue and grooved wood. However, because of the relatively low strength inherent in such low density and open material in typical bonded fibrous insulations which may range down to a density of about one

pound per cubic foot, the removal of substantial amounts of the material mass along the more vulnerable edges to form either a conventional tongue or groove structure further extensively weakens the already fragile edge portions. Moreover, because of the soft consistency and low strength of the initial material—loose mass of fibers containing uncured binder—it is usually necessary to complete the formation of the product including the substantial total cure of the binder to achieve maximum integrity prior to subjecting the product to such aggressive action as cutting away edge portions with saws or routers, thereby necessitating a second or subsequent independent operation in the manufacture following product formation and curing.

On the other hand, the prior art practice of unit molding of such low density bonded fibrous products such as wall or insulating panels, ceiling tiles, etc., wherein the same operation includes forming the edge portions with integral tongue and/or grooves of typical configuration has been confined to batch or single unit forming procedures of relatively slow and cumbersome production rates which are costly. Also, the imparting of typical tongue or groove configurations, particularly the latter type of joint, entails awkward and involved uses of mold forms and intricate molds and procedures, all of which significantly increase costs without enhancing the product characteristics or value. Other single unit molding operations entail the formation of a laminate composed of two, three, or more sections, superimposed in staggered arrangement to provide tongue and grooved edges. Such constructions are particularly susceptible to delamination or separation and, moreover, require the use of intermediate adhesives, increasing the density and decreasing thermal and acoustical efficiency while reducing resiliency and flexibility, as well as adding to costs.

In accordance with the invention, a method of forming tongue and groove edges in a

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fibrous product body made from a continuously moving loose mass of fibers containing binder, comprises cutting a marginal slit in a first longitudinal edge of the moving loose mass, compressing the moving loose mass to the desired thickness of the product body, further compressing the mass in an area adjacent the first longitudinal edge by applying a compressive force from within the marginal slit to expand the marginal slit into a groove, further compressing the mass in an area adjacent a second longitudinal edge located opposite the first longitudinal edge to a thickness less than the body of the product and shaping it so as to form a tongue complementary to the groove shaped in the first longitudinal edge, and causing or allowing curing or setting of the binder in the moving mass while the mass is thus compressed and shaped.

This invention will be more fully understood when reference is made to the following detailed description of the preferred embodiment of the invention, and the accompanying drawings, in which:

FIG. 1 is a schematic side view illustrating the steps and means thereof of this invention for producing fibrous products having integral tongue and groove edges;

FIG. 2 is a schematic top view of the procedure and means of FIG. 1, further illustrating the steps and arrangement of means of the invention;

FIG. 3 is an end view of the heated press taken on a plane along line 3—3 of FIGS. 1 and 2, looking into the entrance of the heated press and showing the tongue and groove forming mold units; and

FIG. 4 is a perspective view of a typical low density product of this invention illustrating the integrally molded tongue and groove longitudinal edges.

Referring to the drawings, there is schematically illustrated in FIG. 1, a manufacturing operation and means therefor for the production of semi-rigid, relatively low density insulating board, or the like products, from glass fibers and binder, having a generally rectangular transverse cross-sectional configuration from a mass of loose, random intermingled fibrous material containing the binder. As shown in FIG. 1, body 10 of a loose mass of glass fibers containing an uncured binder is carried by conveyor 11, or any appropriate transporting means, and continuously fed to the compressing, shaping and thermal setting means 12. An integral groove is formed in one side of the product between its major surfaces by cutting a marginal slit 13 in one longitudinal edge of the moving body 10 of the loose mass of glass fibers with a revolving circular knife 14, or other equivalent means such as a revolving saw or reciprocating knife or saw, extending along the length thereof and generally intermediate and parallel to the two major surfaces of the moving body 10. The depth

of the cut forming the marginal slit is such as to exceed the designed depth of the final groove. Upon cutting this marginal slit, it is preferred that the cut surfaces of the slit be heated to a temperature sufficient to substantially activate the binder in the immediate area and set the same to prevent fibrous material from tearing loose and breaking away during subsequent forming and curing operations, and thereby fouling or clogging the mold, disrupting the operation and/or the consistency of the product leaving voids or areas of under density. This expedient preliminary precuring of the cut surfaces of the marginal slit can be achieved by means of an appropriate heated plate 15, inserted into position within the slit 13, cut into the moving body 10 by revolving knife 14 whereby the cut surface of the slit comes into passing contact with the heated plate as the body moves to the compressing, shaping and thermal setting means 12.

Following cutting the marginal slit 13, and the preferred but optional curing of the cut internal surfaces of the slit, the body of loose mass of binder containing glass fibers enters the compacting, shaping, thermal setting means 12, comprising a pair of heated opposed platens 16 and 17, each having tapered portions 18 and 19, respectively, providing an entrance thereto and facilitating compression of the loose mass of unbonded fibers. The heated opposing platens 16 and 17 each comprise a broad surface of substantially flat plane 20 and 21, respectively, of sufficient area or length in relation to forming speed and product thickness to enable adequate heating through the low density body 10 of loose mass of glass fibers containing an uncured binder to substantially complete the cure of the uncured binder at least to the point of permanently fixing the imposed shape and density, and of such width as to accommodate the fiber mass and form the product dimension. Each platen 16 and 17 is provided with suitable heating means, not shown, such as electrical resistance heaters, induction coils, or internal steam conduits or other appropriate sources to produce adequate heat to effect the thermal activation and curing of the binder.

As the loose mass of glass fibers containing an uncured binder approaches and enters the compacting, shaping and thermal setting means 12, the two major surfaces of the fibrous body 10 are compressed upon entering the gradually tapered sections 18 and 19 of the spaced-apart, generally parallel opposing heating platens 16 and 17, respectively, to approximately the ultimate thickness and shape and density of the desired product, which, of course, is governed by the distance spaced between the substantially parallel platens 16 and 17. While thus compressed and conformed to shape, the moving body is permanently fixed to the imparted shape and density by the substantially simultaneous application of

heat which thermally activates and sets the heat curable binder.

In concert with the continuous compression, shaping and heat curing of the overall moving body 10 of loose mass of glass fibers containing uncured binder, a mold form 22, in combination with the means 12, is positioned generally intermediate the platens 16 and 17, and so as to penetrate the slit 13 cut in said one longitudinal edge of the body 10 to an extent at least to the depth of the desired edge groove in the ultimate product, and of a thickness to expand the slit 13 to the width of the groove of the desired ultimate product. The mold 22 is interposed within the marginal portion of the moving body 10 of fiber for a length preferably substantially corresponding to the length of the generally parallel section of platens 16 and 17, and at least for a duration sufficient for the curing of the binder of the fibers to permanently fix the edge groove. As an alternative to optional heated plate 15, mold form 22 may be independently heated to facilitate activation of the cure. However, the independent heating of the mold form 22 is not usually necessary since the heat transmitted from platens 16 and 17 normally more readily penetrates the reduced portions of the body forming the walls of the groove.

The opposite longitudinal edge of the body 10 of loose binder containing fiber is correspondingly provided with a complementary edged tongue with a forming mold which may be provided by continuing the sloped tapered sections 18 and 19 of platens 16 and 17, respectively, in a limited marginal area of these platens extending inwardly at least equivalent to the length of the tongue of the designed product and such as to effectively mate with the corresponding groove. The marginal continuations of platens 16 and 17 continue to approach each other to the point of providing secondary or minor spaced-apart platen mold surfaces 23 and 24, spaced a distance from each other, generally intermediate surfaces 20 and 21, approximately equivalent to the width of the tongue of the designed products and such as to effectively mate with the corresponding grooves. Optionally, to simplify the compressing and heating platen structure, the tongue-forming mold surfaces can be constructed of separate or a unitary cooperating pair of opposing mold faces, which are mechanically combined with primary consolidating, shaping, and heating platens 16 and 17.

Accordingly, as the body 10 of loose mass of glass fibres containing an uncured binder moves from conveyor 11, or other suitable transporting means, and following the cutting of a marginal slit 13, in passing contact through compressing, shaping and thermal setting platens 16 and 17, groove mold form 22 and tongue mold surfaces 23 and 24, in concerted cooperation with platens 16 and 17,

each respectively form a continuous groove 25 and continuous tongue 26 integral with the product, such as shown in board 27 of FIG. 4, extending along the longitudinal edge portions thereof, by further consolidating or densifying the material shown in areas 28 and 29 which increases the strength of these formerly vulnerable areas of reduced mass and thereby minimizing breakage.

This invention is particularly directed to the manufacture of insulating products comprising a loose random mass of glass fibers having densities of up to about 10 pounds per cubic foot but typically less than about 1 or 2 pounds per cubic foot, and containing dispersed throughout between about 3 and 25% by weight of resinous binder material such as a thermosetting resin of the phenol formaldehyde type, although the means of the invention are also applicable with the use of other curable binders. These very loose and low density masses of glass fibers containing an uncured binder can be formed by means of this invention into fibrous products for thermal insulating applications having relatively low densities of between about 0.5 to about 20.0 pounds per cubic foot and preferably of about 1 to 2 pounds up to about 8 pounds per cubic foot, of substantially any given transverse cross-section or configuration. In the lower density ranges, although the shape and density are permanently fixed, these products are nevertheless sufficiently flexible to be bent or folded and will return upon release to their original shape and density without damage.

As is frequently expedient in thermal insulations of low densities and thus often highly vapor permeable constructions, a vapor barrier 30 comprising metal foil or plastics sheet, etc., can be applied to or superimposed over the surface of the fibrous product of this invention and by extending the same from within the groove 25 across one surface and continuing out along the tongue 26. Thus the insulation section, when joined with like abutting units, forms a continuous vapor barrier with the cooperating tongue and groove joints conveniently forming a seal between the sections. To facilitate the sealing effect, it is preferred that the tongue 26 and cooperating groove 25 should be correspondingly tapered to enable a force fit which is easily achieved with the resilient compressible materials of this invention.

Although the invention has been described in relation to loose masses of fibrous material containing thermo-setting binders, i.e. curable binders, the invention is also applicable to loose masses of fibrous material containing thermoplastic binders in which case the product shape, density, etc., must be maintained through to cooling to fix the same which can be provided for by extending the molds beyond the heated area and preferably providing positive cooling means.

**WHAT WE CLAIM IS:—**

1. A method of forming tongue and groove edges in a fibrous product body made from a continuously moving loose mass of fibers containing binder comprises cutting a marginal slit in a first longitudinal edge of the moving loose mass, compressing the moving loose mass to the desired thickness of the product body, further compressing the mass in an area adjacent the first longitudinal edge by applying a compressive force from within the marginal slit to expand the marginal slit into a groove, further compressing the mass in an area adjacent a second longitudinal edge located opposite the first longitudinal edge to a thickness less than the body of the product and shaping it so as to form a tongue complementary to the groove shaped in the first longitudinal edge, and causing or allowing curing or setting of the binder in the moving mass while the mass is thus compressed and shaped.
2. A method of forming tongue and groove edges in a fibrous product body as claimed in Claim 1, wherein the binder is a thermosetting material and heat is applied to the surfaces of the marginal slit so as to surface cure the binder.
3. A method of forming tongue and groove edges in a fibrous product body as claimed in Claim 1 or 2, wherein the loose mass is a mass of glass fibers having a density up to 10 pcf and contains from 3—25% binder.
4. Apparatus for effecting the method

claimed in Claim 1, 2, or 3, wherein there are provided cutting means for cutting a marginal slit in a first longitudinal edge of the moving loose mass, means to compress the mass to the desired body thickness, means to set or cure the binder, groove-forming means which apply a compressive force to the mass from within the cut slit, and tongue-forming means which compress a second longitudinal edge located opposite the first longitudinal edge to a thickness less than the thickness of the body of the fibrous product.

5. A fibrous panel having a groove along one longitudinal edge and a complementary tongue along an opposite longitudinal edge of the panel, made by the method as claimed in any of Claims 1—3.

6. A fibrous panel as claimed in Claim 5, wherein the areas at the tongue and groove are of a greater density than that existing in other areas of the panel.

7. A method of forming tongue and groove edges in a fibrous product body substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

8. Apparatus substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

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