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METHOD FOR PRODUCING FIBROUS PRODUCTS HAVING INTEGRAL TONGUE AND GROOVE EDGES

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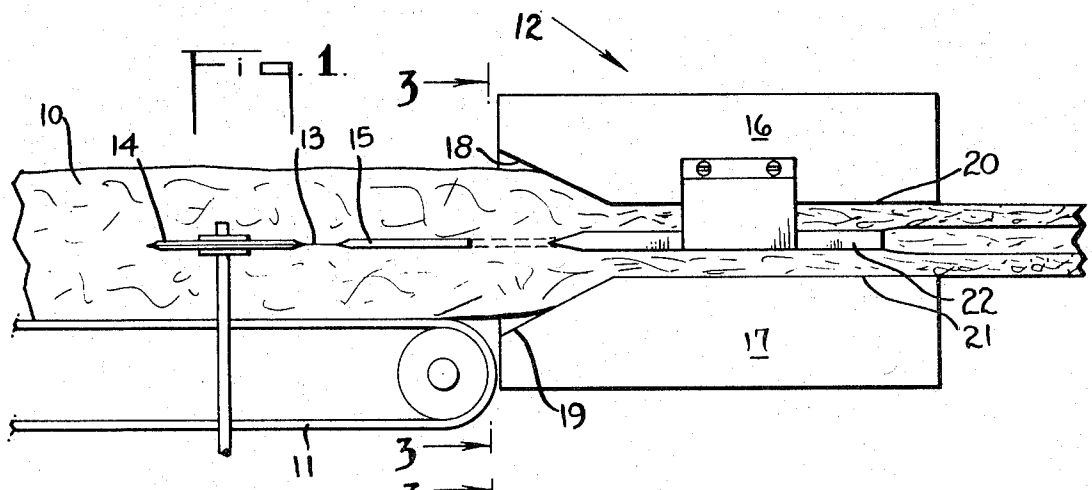
Fig. 1.



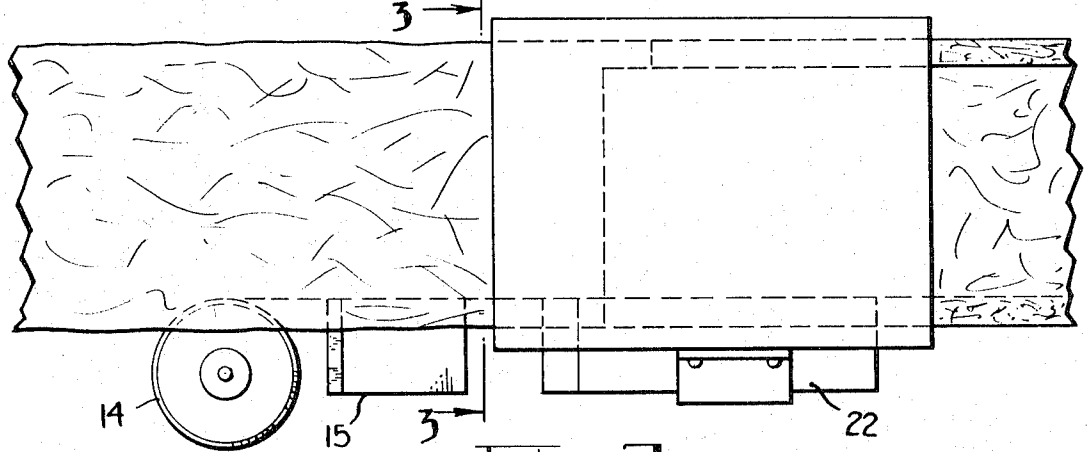




Fig. 2.

Fig. 3.

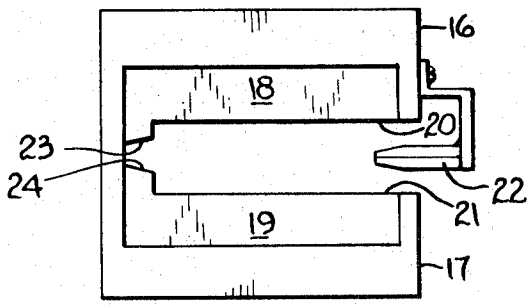
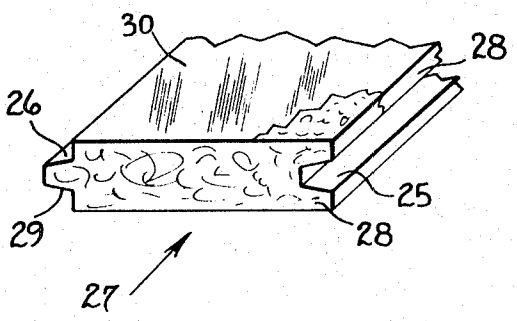



Fig. 4.

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# METHOD FOR PRODUCING FIBROUS PRODUCTS HAVING INTEGRAL TONGUE AND GROOVE EDGES

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## ABSTRACT OF THE DISCLOSURE

Method of consolidating, shaping and fixing the consolidated density and shape of a body of loose mass of fibers containing binders throughout to produce products of fixed configuration and density, which includes the concerted forming of integral tongue and/or groove longitudinal edges for effective complementary uniting of components with a like adjacent component, and the resulting tongue and/or groove fibrous product.

## BACKGROUND OF THE INVENTION

This invention relates to the manufacture of bonded fibrous products, and in particular to the forming and curing of loose mases of fibrous material, containing throughout thermally activable 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 over the initial loose mass of fibrous material. While this invention is primarily concerned with the manufacture of products from glass fibers, the means thereof are also applicable to the formation of products from fibrous materials of other compositions for sources of a substantially stiff and resilient nature including common inorganic fibers such as rock, mineral, or slag wools and related siliceous fibers, and even organic fibers exhibiting sufficiently stiff resilient characteristics such as relatively coarse wood fibers. 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 lumber 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 lumber. 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 about one pound density 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 fragible edge portions. Moreover, because of the soft consistency and low strength of the initial material—loose fibers containing unactivated 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 tile, 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.

## SUMMARY OF THE INVENTION

This invention comprises a combination of sequential steps or forming operations, and a combination of means for carrying out the same, which enables the effective manufacture on an economical continuous basis of relatively low density, semi-rigid but flexible, or rigid shapes of permanently bonded fibrous products having integrally formed therein typical tongue and/or grooved edges of increased density and in turn strength and durability. Specifically the invention constitutes a continuous method of forming low density fibrous products such as insulation sections or wall and ceiling finishing panels by consolidating and shaping a body of a loose mass of fibers containing binder and fixing the consolidation or density and shape imparted thereto by curing the binder while substantially simultaneously therewith or during the foregoing continuous operation additionally forming typical tongue and/or groove structures continuing along one or both longitudinal edges of the product.

It is the principal objective of this invention to provide an improved and economical method for the consolidation and shaping of a body of loose mass of fibers containing binder throughout and permanetly fixing the consolidation and shape including integral tongue and/or groove structures of typical configurations and increased strength and resistance to breakage over the balance of the product body extending along the longitudinal edges thereof.

## BRIEF DESCRIPTION OF THE DRAWINGS

This invention will be more fully understood and further objects and advantages thereof will become apparent 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/or 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.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

In this invention a semi-rigid but resilient and flexible, or rigid, relatively low density, bonded fibrous product suitable for thermal or sound insulation utility, or for panel or tile finishing application, is formed by continuously passing a moving body of loose mass of fiber containing binder throughout, through compressing and heating means comprising a cooperating pair of spaced-apart opposing, smooth surface, heated platens which compress and form the two major surfaces of the body of loose mass of fiber to the approximate shape or thickness and density of the designed final product while heating the compressed and/or shaped mass sufficiently to set the binder content therein and permanently fix the imparted consolidation or density, thickness and shape. The invention additionally constitutes in combination with the foregoing continuous operation of forming by consolidation and shaping and thus securing the binder to fix the consolidated density and shape, and substantially simultaneous therewith, the forming of integral tongue or groove longitudinal edges extending the length of the continuously formed product.

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 or other equivalent stiffly resilient fibers and thermally activatable binder, having a generally rectangular transverse cross-sectional configuration from a body of loose, random intermingled mass of fibrous material containing the binder throughout. As shown in FIG. 1, body **10** of a loose mass or bed of binder containing fibrous material, such as common glass fibers produced as disclosed in U.S. Letters Pat. No. 3,129,084 to Labino, 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 loose mass of 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 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 fibers containing binder to substantially complete the cure of the thermally activatable 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 dimensions. 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 body of loose mass of fiber containing 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 binder containing fiber, 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 the margin 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 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 binder containing fiber 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 re-

spectively forms 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.

Optionally products of this invention may be produced with both longitudinal edges each having a grooved marginal area as shown **25** or with both edges each provided with a tongue as shown in **26** to cooperate with independent appropriately corresponding mounting frames or means.

This invention is particularly directed to the manufacture of insulating products from resin binder containing fibrous materials compirsing 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% 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 thermoplastic or other thermally activatable binders. However, with a thermoplastic binder, 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/or with cooling means. These very loose and low density masses of resin containing glass fiber materials 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. And in the lower density ranges, although the shape and density are permanently fixed, these products are nevertheless sufficiently flexible to be bent or folded to conform to conditions, and will return upon release to 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 plastic 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. And 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.

It will be understood that the foregoing details are given for purpose of illustration, and not restriction, and that variations within the spirit of the invention are to be included within the scope of the appended claims.

What I claim is:

**1.** Method of forming permanently shaped and bonded low density fibrous products of generally rectangular transverse cross-sectional configuration having two major surfaces and two opposite longitudinal edges extending the length thereof with integral tongue and groove formed therein, comprising:

(a) cutting a slit into one longitudinal edge of a moving body of loose mass of fibers containing binder throughout along the length thereof and substantially intermediate and parallel to the two major surfaces of the body;

(b) thereafter compressing the thus cut moving body of loose mass of fibers containing binder throughout on its two major surfaces to consolidate and shape the same and heating the thus compressed and shaped moving body to cure the binder and fix permanently the imparted shape and compressed density in the body of loose mass of fibers and binder throughout;

(c) substantially simultaneously with said compressing of the two major surfaces of the moving body to consolidate and shape the body and with said heating to cure the binder and fix permanently the imparted shape and compressed density in the body of fibers and binder throughout, further compressing an area about the slit cut into the longitudinal edge of the moving body of fibers containing binder throughout and along the length thereof by applying a compressive force from within said cut slit directed opposite to the compressing applied to each major surface, and thereby expanding the said cut slit in one longitudinal edge of the said moving body into a fixed permanent opening providing a marginal edge groove extending along the length of one longitudinal edge of the said compressed and shaped body of mass of fibers and binder and thereby further densifying the said shaped body of mass of fibers and binder along an area of the marginal edge groove; and

(d) substantially commensurate with said compressing of the two major surfaces of the moving body to consolidate and shape the body and with said heating to cure the binder and fix permanently the imparted shape and compressed density in the body of fibers and binder throughout, further compressing a marginal portion of the longitudinal edge opposite the edge with the said cut slit of the moving body of fibers containing binder throughout in opposing directions corresponding to the compression applied upon each of the two major surfaces of the moving body of fibers containing binder throughout and further consolidating said marginal portion along the longitudinal edge of the body of fibers and binder to a thickness substantially corresponding to the width of the fixed opening forming the groove in the opposite longitudinal edge and thereby providing a complementary edge tongue and further densifying the said shaped body of mass of fibers and binder along an area of said marginal portion.

**2.** The method of claim **1**, including applying heat within the slit cut into one of said longitudinal edges of the moving body of the loose mass of fibers containing binder throughout and initiating the cure of the binder in an area about the slit.

**3.** Method of forming permanently shaped and bonded low density fibrous products of generally rectangular transverse cross-sectional configurations having two major surfaces and two opposing longitudinal edges extending the length thereof with integral tongue and groove formed therein; comprising:

(a) cutting a slit into one longitudinal edge of a moving body of loose mass of fibers containing binder throughout along the length thereof and substantially intermediate and parallel to the two major surfaces of the body;

(b) thereafter compressing the thus cut moving body of loose mass of fibers containing binder throughout on its two major surfaces to consolidate and shape the same and heating the thus compressed and shaped moving body to cure the binder and fix permanently the imparted shape and compressed density in the body of loose mass of fibers and binder throughout; and

(c) substantially simultaneously with said compressing of the two major surfaces of the moving body to consolidate and shape the body and with said heating to cure the binder and fix permanently the shape and compressed density in the body of fibers and binder throughout, further compressing an area about the slit cut into the longitudinal edge of the moving body of fibers containing binder throughout and along

the length thereof by applying a compressing force from within said cut slit directed opposite to the compressing applied to each major surface, and thereby expanding the cut slit in one longitudinal edge of the said moving body into a fixed permanent opening providing a marginal edge groove extending along the length of one longitudinal edge of the said compressed and shaped body of the mass of fibers and binder and thereby further densifying the said shaped body of mass of fibers and binder along an area of the marginal edge groove.

**4.** The method of claim **3**, including applying heat within the slit cut into one of said longitudinal edges along the moving body of loose mass of fibers containing binder throughout and initiating the cure of the binder in an area about the slit.

**5.** The method of claim **1** wherein the moving body of loose mass of fibers containing binders throughout comprises mineral fibers with between about 3 to 25% by



weight thereof of resin binder material in a density of less than about 10 pounds per cubic foot and which is consolidated to a shaped product of a density of about 0.5 to 20 pounds per cubic foot.

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