STRUCTURAL PANEL AND METHOD OF PRODUCTION

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9 Claims

ABSTRACT OF THE DISCLOSURE

Method for improving the fiber surface smoothness and appearance of porous fibrous panels made of discontinuous glass fibers or the like, wherein the fibers are bonded to one another only at points of contact by hardened bonding material, with interstices between, which comprises, coating the surface fibers with additional liquid, hardenable material and then hardening the material in order to firm up or stiffen the surface fibers; and then dry grinding to remove fibers and thereby provide improved surface contour, while preserving the porosity of the panel. The product is a porous panel of improved surface finish and smoothness.

The invention overcomes prior art defects including off-ware due to indentations, stains and binder spots, light density spots, off-tolerance variations in thickness and weight, and poor bevels. Process efficiencies of 15-20% improvement over the prior art have been effected.

This application is a continuation-in-part of application Ser. No. 204,920 filed June 25, 1962, now abandoned and a continuation of Ser. No. 589,158, filed Sept. 28, 1966, now abandoned.

This invention relates to structural panels and to a method of production. More particularly, this invention relates to structural panels having improved surface finish, scuff resistance, and sharper and cleaner edges giving improved appearance; and, to an improved method of higher efficiency for producing such structural panels. Further, this invention relates to structural panels adapted for use as ceiling or wall coverings.

In the prior art one popular structural panel comprises a high density board-like mat of glass fibers bonded with a relatively heavy content of thermosetting resin, such as phenol formaldehyde. The board is beveled at the edges and provided with a surface finish such as paint for pleasant appearance.

However, this prior product and method have been characterized by several defects including off-ware due to indentations, stains or binder spots, light density spots, off-tolerance variations in thickness and weight, and poor bevels.

The stains which appear on the product are of such nature that they are not capable of detection at the end of the production line before packaging and shipment. Thus, they show up only after storage as the result of a slow build-up.

Also, the prior product has been too soft for sharp bevels. Thus, a relatively broad or dull bevel has been necessary to reduce bevel break-outs and defects.

It has also been found that soft spots appear in the exposed surface of the prior product; these contribute to poor binder saturation and resultant stains after storage.

The result is low production line efficiency because of rejects.

Accordingly, an important step forward in the art would be provided by an improved method of producing structural panels for ceilings or wall applications, having improved surface finish, better scuff resistance, finer bevels, and wherein the method provides efficiencies up to 25% greater than the prior art.

It is, accordingly, an important object of the present invention to provide an improved structural panel.

A further object is to provide an improved structural panel characterized by improved surface finish.

A still further object is to provide a novel structural panel of improved surface finish and high acoustical properties for use on ceilings or walls.

A still further object is to provide an improved structural panel characterized by sharper, cleaner bevels.

Another object is to provide a method for producing improved structural panels wherein production efficiencies up to 25% greater than the prior art are provided.

A still further object is to provide a method for producing acoustical panels for structural purposes, such as ceilings and walls, wherein a novel pre-finish treatment is used to improve the final finishing with greater production efficiencies.

Other objects of the invention will appear in the following description and appended claims, reference being had to the accompanying drawings forming part of this specification wherein like reference characters designate corresponding parts in the several views.

FIGURE 1 is a partial side elevational view of a production line for use in the present invention, showing the initial procedural steps;

FIGURE 2 is a continuation of FIGURE 1 showing the remaining procedural steps of the production operation;

FIGURE 3 is an enlarged fragmentary side elevational view showing one typical, but preferred, method of applying liquid binder for treating or saturating panels in accordance with the present invention;

FIGURE 4 is a perspective view of a panel made in accordance with the present invention;

FIGURE 5 is an enlarged fragmentary section view of a panel made according to the invention.

Before explaining the present invention in detail, it is to be understood that the invention is not limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawings, since the invention is capable of other embodiments and of being practiced in various ways. Also, it is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation.

In accordance with the present invention, an improved acoustical panel of high density and made of glass fibers bonded by a thermosetting resin is provided wherein the surface finish is of higher quality and the bevels are sharper and cleaner for improved appearance.

Further, in accordance with an important aspect of the method of the invention, structural panels are formed from a high density glass fiber board that is partially impregnated with thermosetting resin to provide an improved surface for finishing by sanding, cutting, beveling and painting operations. By so operating, greatly improved production efficiencies are provided.

Mat formation

According to FIGURE 1, staple glass fibers comprise a foundation component of the present products. These are made by forming a plurality of small streams of molten glass and attenuating the streams by means of a downwardly directed gas jet. The staple fibers so produced
fall downwardly and are drawn by suction to a movable chain to form a fibrous mat. Thus, a glass melting furnace 10 is provided with an elongated delivery forehearth 12, into the bottom wall 14 of which there are fitted one or more feeders or bushings 16. The bushings 16 comprise precious metal and are made up of generally rectangular shoe-box-like walls and bottom, being open at the top to receive molten glass flowing from the furnace. To the end walls, there are attached electrical terminals 18 to which electrical connections are made for passing electric current the length of the feeders 16 to provide proper glass feeding temperatures.

The bottom walls 20 are provided with rows of spaced tips or small delivery tubes 22 through which small streams 24 of molten glass issue downwardly by gravity. Gas fiber-forming heads or attenuators 26 are positioned beneath each of the bushings 16 and comprise spaced, parallel headers 28 containing appropriate apertures, not shown, but of conventional construction, adapted to produce jet-like attenuation streams as of steam or compressed air, fed thereto from the manifold tubes 30. Thus, as the molten glass streams 24 issue downwardly through the attenuators 26, the high speed jets of gas grip the streams and draw them out into very fine diameter fibers 32 of a length in the range from about one-fourth inch to about three inches. A forming hood 34 is positioned beneath the fiber-forming heads 26 and directs the fibers 32 downwardly. During the downward fall of the fibers 32, they are coated by sprays of aqueous thermosetting resin 36, produced from sprayheads 38 positioned in suitable apertures in the forming hood 34. The coated fibers 40 fall downwardly through the forming hood 34 to the upper flight 31 of an endless collecting chain 44. Chain 44 is supported by parallel and horizontally spaced rolls 46, at least one of which is driven for moving the upper flight 42 in the arrow 48 direction.

A suction box 50, having an outlet 52, connected to a suitable exhaust fan or gas pump, is interposed between the upper flight 42 and lower flight 54 of chain 44 to draw the coated fibers 40 downwardly onto the upper flight 42. This results in the formation of a loose mat 56 of gradually increasing thickness, achieving full thickness as or slightly before it exits from the forming hood 34 onto the upper flight 42.

As shown in FIGURE 1, the loose mat 56 passes in the arrow 48 direction to a curing oven 58, including an outer housing or shelf 60 mounted on supports 62 and having a suitable heat source such as gas burners or electric radiants contained therein to generate a sufficient temperature for curing the resin deposited by the sprays 36 to a dry condition. To support the mat 56 during movement through the oven 58, there is provided a lower chain or conveyor 63 having upper and lower flights 64 and 66 and being mounted on axially aligned, horizontally disposed and spaced support rolls 68. One or more of the support rolls 68 is power driven at a synchronized line speed for movement in the previously mentioned arrow 48 direction.

To control the thickness of the mat 56, an upper conveyor or chain 70 is provided in parallel cooperative relationship above the lower conveyor 63. The upper conveyor 70 includes a lower flight 72 and an upper flight 74 with support and moving power being provided by spaced rolls 76. The lower flight 72 is spaced an appropriate distance from upper flight 64 of lower chain 63 to provide a proper mat production thickness.

From the foregoing, it will be observed that as the loose, uncured mat 56 travels through the oven 58, it will emerge as a cured mat 78 from between the conveyors 63 and 70. This basic cured mat 78 is of relatively high density, by virtue of high resin content and compaction of the fibers. The mat 78 is, however, quite porous.

Further processing of the raw mat—inital sanding

As shown at the right end of FIGURE 1, the cured mat 78 passes between a support table 80 and a first dry sanding roll 82. The sanding roll 82 is effective to smooth the top surface of the cured mat 78, removing surface irregularities such as flight marks made by the chain 70, to produce an initially sanded board or mat 83.

Saturating impregnation

Following the initial sanding operation effected by roll 82, the sanded mat 83 passes to the upper flight 84 of a chain 86, supported on rolls 88, one or more of which is driven to drive the upper flight in synchronism with the remainder of the production line. Note the enlarged view of FIGURE 3 for details.

Between the upper flight 84 and the lower flight 90 there is provided a suction box 92 having a narrow inlet opening 94 for appropriate suction, and an outlet opening 96, connected to a conduit leading to a suitable fan or other gas pump.

An important aspect of the present invention resides in the application, by impregnation, of a second coat of resin prior to further processing. It is important that the coating of binder applied to the surface after the initial sanding be drawn into the board for very uniform distribution and fiber support. It will thus be apparent that the mat 83 is quite porous.

Accordingly, as shown at the left of FIGURE 2 and in greater detail in FIGURE 3, an elongated conduit 98 is positioned above the cured and sanded mat 83, spanning the width of the mat. The weir or conduit 98 is provided with a flow control slot 102 having a lower delivery edge 104 over which a liquid resin composition 106 can flow by gravity. In order to provide a sufficiently uniform distribution across the width of the mat, a foraminous material 108 such as screen, woven glass cloth or the like is provided to produce a uniform coating of downwardly flowing liquid material. To support the foraminous material 108, a bracket 110 is connected along the top of the conduit 98, spanning the slot 102, and providing a clamp portion at 112 above and adjacent to the delivery edge 104. One of the longitudinal edges of the rectangular foraminous member 108 is clamped at 112 so that the remainder of the member 108 falls into contacting relationship with the side of the conduit 98 below and adjacent to the delivery edge 104 to catch the overrunning liquid material 106 from the delivery edge 104 and distribute it as a uniform curtain 114, dropping downwardly onto the upper surface of board 83.

Note that the curtain 114 deposits on the upper surface of the board 83 slightly to the left of the suction throat 94 of the suction box 92. Thus, as the mat or board 83 passes over the inlet throat 94, the reduced pressure causes the material 114 to be drawn or driven uniformly into the mat, thus providing an impregnated mat 116.

The impregnated mat 116 passes to a second curing oven 118 that includes an outer shell 120, supported as at 122. As distinguished from the oven 58, previously described, which included both an upper conveyor 70 and a lower conveyor 63, the second oven 118 includes only a lower conveyor 124 having spaced support rolls 130, at least one of which is power driven in synchroniza-

Suitable heating means is provided in the oven 118 to cure the impregnated board 116 to bone-dry state, designated 132.
As shown in FIGURE 2, the cured and dry board 132 passes to a final sanding operation, wherein a backing table 134 cooperates with a sanding roll 136. The roll 136 is effective to reduce the thickness of the dry mat 132 to finished dimension.

From the sanding operation 136, 134, the finish sanded board 138 passes to one or more appropriate slitter saws 140. Following the saw 140, a knife 142, cooperating with support tables 144, finishes the cutting operation to provide panels of appropriate rectangular or square dimension.

From the knife 142, the blanks are beveled manually in an off-line bevel operation as at 145 and then returned to the upper flight 146 of a conveyer 148. While on the flight 146, the beveled panels pass beneath sprayheads 150 for application of paint, after which they pass through a drying oven 152. The oven 152 includes a housing 154 supported at 156 and containing heating means such as gas or electrically powered elements. A conveyer 158 spans the housing 154 and has upper and lower flights 160 and 162 supported on rolls 164 driven at production line speed. After emerging from oven 152, the finished blocks 166 pass along an inspection conveyer 168 and then to a packaging station indicated by the arrow 170.

Operation summary of the invention

From the foregoing description it will be noted that operation of the method of invention comprises an important step of applying a partial saturating or impregnating coating of resin to the cured and pre-sanded boards 83 and curing this impregnating resin to a dry state prior to finishing. By so operating, an improved base material is provided for the final sanding, beveling and application of a surface finish paint. Thus, the production of finished panels of unexpectedly superior surface finish is effected.

It is an important and unexpected aspect of the present invention that in contrast to analogous prior products, the bevels are sharper, cleaner and shorter, and are produced without damage, as was the experience of the prior art.

Finished panels of invention

By reference to FIGURE 4, it will be noted that the finished blocks 166 may be of generally square configuration in plan and are characterized by short, sharp, clean 45° bevels 172. As pointed out above, these bevels are possible in the present product by virtue of the improved internal structure and density of “body” of the boards from which made, and thus can be formed without break-outs at a high production rate. In order to avoid broken and crumbled edges, the prior art method required that the bevels be more flattened, thus of a 30° configuration, rather than a sharp, short 45° configuration provided by the present invention. Even by so operating, due to the relatively poor “body” of the prior products, rejects were relatively high because of beveling fractures.

Thus, it will be evident that improved structures of higher density, sharper contour lines and improved surface finish and appearance are provided in accordance with the present invention.

Extended scope of invention

While the foregoing disclosure has related to the use of a liquid impregnating composition containing phenol formaldehyde resin, this material is subject to some latitude of use within the broader scope of invention. Thus, both aqueous and alcoholic materials can be used. Because of the volatile nature of alcohol and the hazards of handling, water will generally be preferred. However, it has been found that the alcoholic resin when applied to the boards before painting, will tie down potential resin stains and prevent their showing through the final paint.

Within the broad scope of the invention, the saturating resin may be extended to other materials such as melamine-formaldehyde, urea-formaldehyde and similar thermosetting resins.

Use of fillers for production of wall panels

In an extension of the invention, fillers such as powdered bentonite, clays, chalk, silica and the like can be added to the impregnating resin for application to the boards, as shown at the left side of FIGURE 2 and in FIGURE 3. By so operating, products having superior scuff and abrasion resistance for wall panel application can be made. Such materials are harder and more resilient, but they also retain a substantial amount of acoustical efficiency for overall sound improvement.

An enlarged cross sectional view of such a product is provided by FIGURE 5 wherein it will be noted that the filler particles 174 have deposited in the upper layers of the fibers for surface support and greater resistance against impact. The resin is shown as dots 176 of lesser density that have been distributed generally uniformly through the remainder of the board.

When operating in accordance with this embodiment of the invention, it is believed that the high density of the board acts as a type of filter for the filler. Thus, the filler appears to be captured and retained in the upper layers while the binder penetrates more deeply. This will provide an excellent base for grinding and for subsequent finish application.

Paints useful for finishing in accordance with the present invention include the synthetic rubber base materials, the caseins, oils and the like. It has been found that the latex-type materials are easily applied and sufficiently economical that their use may be favored.

While the curtain coater 108 has been discussed with reference to the saturation of the boards 83, it is to be understood that application of the saturating curtain 114 also can be made by spray guns or rollers. However, when so operating, adjustment of the applicator to provide a uniform distribution throughout the mat is required and is coordinated with the action of the suction box 92.

The single sanding modification

The extended scope of invention would also encompass application of the saturating binder as by the faraminous screen 108 prior to entry of the loose, uncured mat into the oven 58. By so operating, the sanding can be entirely effected by the first sanding roll 82, the second roll 136 not being used. For certain types of products this will provide still greater economy of operation, although optimum properties are not provided as in the double sanding operation previously described.

Although glass fibers are preferred in the present invention, some latitude may be tolerated as where long, staple, relatively nonbrushy fibers can be produced from other mineral materials. In addition to the use of gas attenuated fibers, as shown in FIGURE 1, the same type of glass fiber from other forming operations also can be used, as from spinning plate and flame attenuation processes.

Summary and advantages

From the foregoing description, it will be evident that superior products are provided in accordance with the present invention, characterized by sharper bevels and superior surface finish. Also a method giving substantially improved production line efficiency in accordance with the invention, process efficiencies of 15–20% improvement over the prior art have been effected.

Another important advantage of the present invention resides in the fact that products of improved acoustical efficiency and scuff resistance are provided.

While 1 do not wish to be bound by any particular theory, it is believed that the saturation or impregnation in accordance with the invention provides an improved, more full-bodied surface, that is still porous, but that is
particularly effective for dry sanding to provide a finish receptive surface of superior performance.

Within the scope of the invention the term grinding can be construed to be actual fiber removal by either a sanding, grinding or abrading operation. This is clearly distinguishable from the teaching of the prior art relating to wet sanding for the mere removal of resin in the surface finishing of dense reinforced resin articles.

What is claimed is:

1. In a method of processing a stiff, porous, fibrous panel having an exposed, dry, fibrous, major surface and a porous, fibrous body section adjacent to said major surface, said panel consisting essentially of discontinuous, siliceous fibers in random array, bonded to one another at points of contact by hardened bonding material with interstices between the fibers, the steps of:
   - removing fibrous material by dry grinding from said major surface to remove irregularities,
   - coating the so-treated surface with additional hardenable material in liquid form to partially impregnate the surface fibers, and preserving the porosity of the fibrous major surface and of the fibrous body section and moving the coating material at least partially into the body section, and hardening the additional material to dry condition,
   - and then removing additional fibrous material from said major surface by dry grinding to impart to the surface a uniform fibrous, finished contour.

2. In a method of processing a stiff, porous, fibrous panel having a dry, fibrous major surface and a porous, fibrous body section adjacent to said major surface, said panel consisting essentially of discontinuous, siliceous fibers bonded to one another at points of contact by hardened bonding material with interstices between the fibers, the steps of:
   - coating the major surface with additional hardenable material in liquid form to partially impregnate the surface fibers, and preserving the porosity of the fibrous major surface and of the fibrous body section, and moving the coating material at least partially into the body section, and hardening the additional material to dry condition to render the surface stiffened,
   - and then removing fibrous material from said stiffened major surface by dry grinding to remove fiber irregularities.

3. The product produced by the method of claim 2.

4. A method for imparting a finished surface of desired contour to a stiff porous body of glass fibers interbonded by a hardened binding agent comprising:
   - coating the surface with a hardenable material in liquid form, moving the coating material at least partially into the body region under said surface, and hardening the additional material to a dry condition to impart additional hardness to said surface,
   - and then mechanically working said surface in dry condition to remove material and impart to the surface a uniform fibrous finished contour.

5. The method of claim 4 wherein the coating material is moved into the porous fibrous body region under the surface by drawing the material therein under the influence of a differential in gas pressure across said body region.

6. The method of claim 4 wherein the mechanical working of said surface to remove material is accomplished by dry grinding said surface.

7. A method for processing a stiff porous fibrous body having a dry porous surface comprising glass fibers in random array interbonded one to another by a bonding material with interstices between the fibers comprising:
   - mechanically working said porous fibrous surface in dry condition to remove surface irregularities,
   - coating the mechanically worked surface with hardenable material in liquid form and moving the coating material at least partially into the body region under said surface, and hardening the additional material to a dry condition,
   - and then again mechanically working said surface in dry condition to remove additional material to impart to the surface a uniform fibrous finished contour.

8. The method of claim 7 wherein the coating material is moved into the fibrous body region under the surface by drawing the material therein under the influence of a differential in gas pressure across said body region.

9. The method of claim 7 wherein both steps of mechanical working of said surface to remove material are accomplished by dry grinding said surface.

References Cited

UNITED STATES PATENTS
2,583,024 1/1952 Strabel 117—64
3,050,427 8/1962 Slatyer et al. 264—91

DONALL H. SYLVESTER, Primary Examiner.
ROBERT L. LINDSAY, Assistant Examiner.

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