Feb. 24, 1959 L. W. ECKERT 2,874,796

METHOD OF FABRICATING A SOUND-ABSORBING UNIT FROM CELLULOSIC MATERIAL

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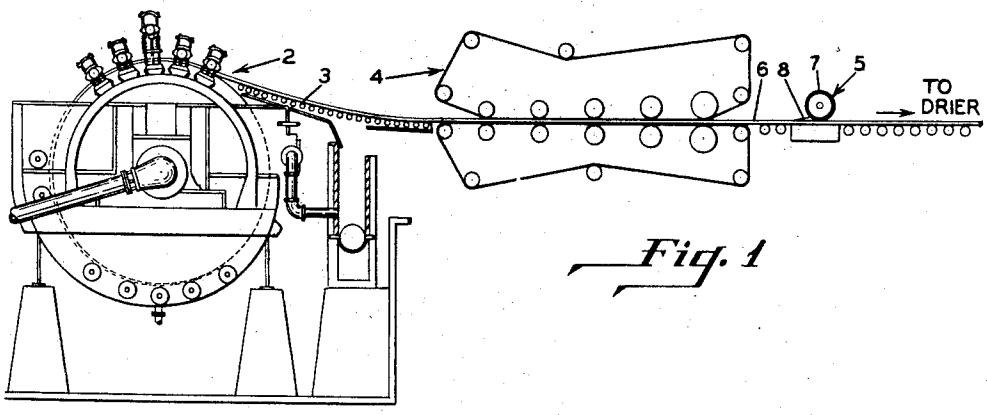


Fig. 1

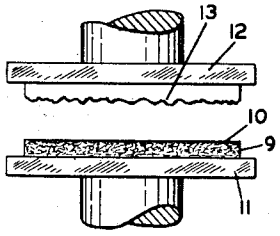


Fig. 2

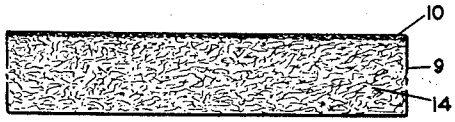


Fig. 3

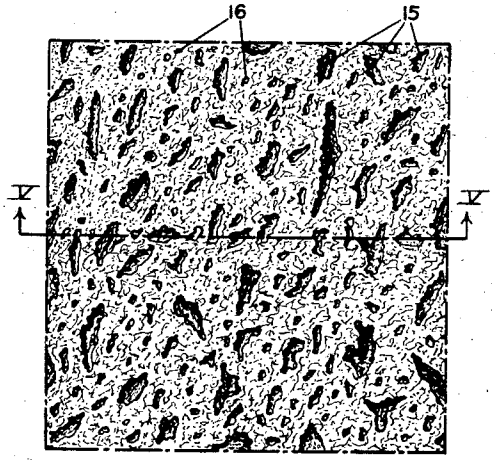


Fig. 4

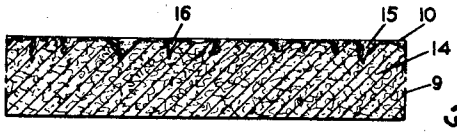


Fig. 5

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METHOD OF FABRICATING A SOUND-ABSORBING UNIT FROM CELLULOSIC MATERIAL

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7 Claims. (Cl. 181—33)

This invention relates to a method of fabricating a sound-absorbing unit from cellulosic material and is concerned more particularly with the fabrication of acoustical or sound-absorbing units from felted fibrous materials.

There are now in use acoustical units formed of nodulated mineral wool bound with a binder such as starch or the like. The product is frequently provided with a fissured surface to enhance the sound absorption and provide a decorative surface texture. The fissured surface may be formed in the manner disclosed in John D. Alexander Patent 2,717,538.

Attempts have been made heretofore to simulate this type of surface texture in felted wood fiber insulation products, but the wet web does not lend itself to fissuring by the Alexander process primarily because of the interfelted nature of the product. When attempts have been made to reduce the interfelting of the fibers to facilitate fissuring, the product does not possess sufficient wet strength to be delivered through the driers of a conventional fiberboard plant where this type of acoustical product logically would be produced.

An object of the present invention, therefore, is to provide a process for fabricating an interfelted fibrous sound-absorbing unit having artificial openings provided therein, such as fissures simulating the natural openings in stone of the travertine variety, the preliminary formation of which may be carried out on fiberboard forming and drying equipment now available in the industry.

While a surface texture effect in simulation of stone can be formed on fiberboard insulation by an embossing operation without shearing or tearing of the surface layer, the sound absorption of the textured product is not high principally because the embossing which is effected to provide the texture compresses the material in the indented areas; and few, if any, openings are provided for the entrance of sound waves into the porous interior of the fiberboard.

Another object of the invention, therefore, is to provide a process by which artificial openings will be sheared into the body of a fiberboard acoustical unit, extending from the normally exposed face of the board into the porous interior and improving materially the sound-absorbing efficiency of the product.

Where artificial openings are punched or otherwise formed in fiberboard acoustical units, it is desirable to provide clean, sharp edges defining the openings; for if the openings are formed by a displacement and disruption of the fibers instead of a shearing action, there is always a tendency for the fibers to return to their normal position and, where the openings are of relatively small size, the fibers upon such repositioning may tend to close the openings and reduce the sound-absorbing value of the product. This reorientation of the fibers occurs most frequently under conditions of high humidity.

A further object of the invention, therefore, is to provide a process which will effect shearing of the fibers

at the surface at least of the fiberboard and will minimize any tendency for the openings to be subsequently reduced in dimensions or actually substantially closed, particularly under conditions of high humidity.

Other objects of the invention will be clear from consideration of the following detailed description of the invention.

According to the invention, there is applied to the surface of a formed body of felted cellulosic fibers, such as the wood fibers or the like customarily used in fiberboard insulation manufacture, preferably while in wet condition, prior to drying, a solution of boric acid which penetrates into the body below the surface. The body is then heated to remove water therefrom and by the action of said boric acid on the felted fibers to condition them for shearing. Thereafter, artificial openings are formed in the body extending from said surface and penetrating into said body, the fissures being formed by shearing of said layer of boric acid conditioned fibers.

A preferred embodiment of the invention will be described in conjunction with the attached drawing in which:

Figure 1 is a diagrammatic view illustrating equipment useful in carrying out certain preliminary steps in the process of the invention;

Figure 2 is a diagrammatic view illustrating apparatus for forming a sheared, fissured pattern;

Figure 3 is a side elevation of a portion of a felted fibrous blank prior to fissuring:

Figure 4 is a top plan view of a portion of a fissured blank; and

Figure 5 is a sectional view taken along the line V—V of Figure 4.

The felted fibrous blank or body may be formed essentially from wood fibers. A wood fiberboard prepared as disclosed in Scott Patent 2,642,359 forms a suitable base or body for sound insulation purposes. As shown in Figure 1, the body may be formed on a conventional fiberboard making machine such as the Oliver machine designated by the numeral 2 in Figure 1. In this machine, a slurry of fibers suspended in water is deposited upon a rotating screen, and a continuous felted fibrous sheet is formed from which a portion of the water is extracted, the formed sheet being delivered over rolls 3 to a press section 4 which, in the diagram of Figure 1, is in the nature of a Downingtown press. In the Downingtown press, additional water is removed from the sheet, and it is consolidated to a desired thickness. The formed sheet is then delivered to a station 5 where the upper surface 6 of the formed fiberboard sheet in a wet condition has applied thereto by a coating roll 7 a quantity of treating material from a pool 8 disposed to the rear of the roll 7 in the direction of travel of the sheet through the machine.

The treating material consists essentially of a solution of boric acid. In order to assist in the control of the application of the treating material to the wet board, a thickening agent such as sodium alginate or the like may be combined with the boric acid solution.

In the preparation of a suitable treating material, the following ingredients are combined, all parts being given by weight:

Boric acid	8.00
Sodium alginate (Keltex sold by Kelco Co.)	0.25
Water	91.75

This provides an aqueous acid solution, the effective or active component of which consists essentially of boric acid.

In the preparation of the treating solution, the water is heated to about 140° F., and the powdered sodium alginate is stirred in for about 5 to 15 minutes until a

uniform distribution of it in the water has been obtained. Thereafter, the powdered boric acid is added, and the mixture is stirred for about 5 minutes. The solution is maintained at a temperature of about 140° F. in order to insure that the boric acid will remain in solution. If a quantity of boric acid greater than about 8% is to be incorporated, then the temperature of the solution should be maintained at a higher level in order to insure complete solution of the boric acid in the water.

The boric acid solution in heated condition is delivered behind the roll 7 in the pool 8; and the speed of movement of the fiberboard sheet through the machine, the viscosity of the solution, the size of the pool 8, and other variable factors affect the quantity of boric acid solution deposited onto the fiberboard and penetrating into the body thereof. Generally, a quantity equivalent to about 5 to 6 grams of boric acid per square foot of fiberboard surface (on a dry weight basis) is adequate for the purposes of the present invention. However, larger quantities may be employed without deleterious results, and somewhat smaller quantities may be used.

At the time the boric acid treating solution is applied, the wet board as delivered from the Downingtown press section 4 may contain about 65% to 75% by weight of water. The temperature of the board may be in the order of 100° F. The application of the heated boric acid solution to such a wet surface results in immediate interspertion of the boric acid treating solution and the water contained in the board, and a slight penetration of the boric acid solution into the body of the board occurs.

The surface treated board is then delivered to a conventional drier, and water is removed from the board and the boric acid conditions the fibers for shearing. In a typical drier installation, the first and middle zones may be heated to about 450° F. to 350° F. (from entrance to exit of each zone), and the exit zone may be similarly heated to about 370° F. to 260° F. It will be understood, of course, that until such time as substantially all of the water has been removed from the wet board, the temperature of the board will not exceed about 212° F.; and in the inner areas, the board temperature will be much lower. At completion of the drying operation, however, the board at the upper treated surface may be elevated to a temperature in the order of 220° F. to 250° F. This temperature is adequate to activate the boric acid and condition the fibers for shearing. The board drying temperatures and the duration of the drying time will vary with the thickness of the board, the quantity of water contained in the board at the time of delivery to the drier, the length of the drier zones, and other variable factors. The foregoing temperatures are illustrative only.

The boric acid solution prevents discoloration of the board surface and thus permits the use of higher drying and reaction temperatures than otherwise would be possible. This is more fully disclosed in my copending application, Serial No. 519,256, filed June 30, 1956, and entitled Method of Drying Water-Laid Fibrous Materials.

As shown in Figures 2 to 5, the blank may consist of a body 9 of interfelted fibers, preferably cellulosic fibers such as hard or soft wood, sugar cane, and other fibrous materials. A surface portion 10 of the board contains the dried residue of the heat reaction product of the boric acid solution and the cellulosic fibers. With a board ¾" thick, the penetration of the boric acid may be in the order of 1/16", and satisfactory results will be achieved. There is no critical limit to the depth of penetration of the boric acid treating solution, although for most purposes the thickness of the boric acid conditioning layer need not exceed about 1/16" to 1/8." Greater penetrations of the boric acid conditioning solution will enhance the shearing action of the fibers to greater depths but will, of course, necessitate the application of larger quantities of boric acid treating solution. This will increase the cost of the finished product due to the increased usage of boric acid and the requirement for a substantially longer drying time due to the presence of the additional water from the boric acid solution which must be removed.

As shown in Figure 2, the blank 9 may be supported upon the lower platen 11 of an embossing press, and the upper platen 12 of the press which carries an embossing plate 13 may be brought into engagement with the surface 10 of the blank 9 to shear artificial openings into the blank extending from the surface 10 thereof and penetrating substantially into the body 14 of the unit.

As shown in Figure 4, the artificial openings may be irregular in size, in shape, and in depth. As the embossing plate moves into engagement with the surface 10 (or the board is moved into engagement with the embossing surface in the event the platen 11 is raised rather than the platen 12 lowered), the conditioned fibers in the layer of treated material are actually sheared, leaving the severed ends of the fibers facing into the openings and thus enhancing the sound-absorbing value of the finished product.

In Figures 4 and 5, the fissures 15 have been indicated as of the general nature of the openings or crevices found in travertine marble. In addition, some rather small but relatively deep artificial openings have been provided, and these have been numbered 16. They serve to open further areas in the porous interior 14 of the body to the entrance of sound waves to thereby increase the sound-absorbing efficiency of the finished product.

The nature of the chemical action involved between the boric acid and the wood fibers is not known. There is, however, a definite conditioning action which occurs, and it may be both chemical and physical. The heat reaction product of the cellulosic fibers and the boric acid solution at the exposed upper surface of the board is readily susceptible to a shearing action; it appears that the fibers are embrittled and reduced in shear strength.

The concentration of the boric acid solution may be varied as desired. Generally, a concentration of 8% to 15% of boric acid in the treating solution will be found acceptable. With lower concentrations, more solution must be applied to obtain the desired quantity of boric acid for proper fiber conditioning, and this results in additional water which must be removed from the board in the driers. If more concentrated solutions than 15% boric acid are used, then the temperature necessary to maintain the boric acid in solution may be objectionably high. The total quantity of boric acid applied to the board may vary considerably; about 4 to 15 grams of boric acid per square foot of fiberboard surface (on a dry weight basis) is adequate for most purposes with a product such as the board of the Scott patent previously referred to.

Where a thickening agent is used, the sodium alginate is preferred, but other thickening agents such as carboxy methylcellulose, starch, and bentonite may be substituted therefor, as is well-known in the coating art. Generally, only a very small quantity of thickening agent will be used, in the order of 0.25% to 1.0% of the total weight of the treating solution.

The treating solution is preferably applied to the wet board prior to drying; and, for best results with the wood fiberboard of the example, the heating should be such that the treated fibers at the surface are subjected to the equivalent of a temperature in the order of at least 220° F. for a period of about one hour.

While Figures 4 and 5 show one style of shearing which may be used in the fabricating of acoustical units in accordance with the invention, it is obvious that other types of designs may be created. For instance, some or all of

the openings may be sheared by the use of punches, rotary cutters, dies, or other shearing elements which serve to sever the board. A very efficient insulation unit for sound absorption may be prepared by first shearing the fissures, as shown in Figures 4 and 5, with a unit as shown in Figure 2, and then providing smaller sized openings of greater depth with twist drills. Artificial openings may be sheared into the surface by the use of a sand-blasting unit operating through a stencil of the desired configuration. Various modifications will suggest themselves to those in the art; and all, or a portion, of the artificial openings may be formed by one or more of the various modes of shearing. The invention is not limited to any particular method of shearing the fibers.

I claim:

1. In a method of fabricating a fibrous sound-absorbing unit having artificial openings provided therein extending from a surface thereof and penetrating into the body of the unit, the steps comprising applying to a surface of a formed body of felted cellulosic fibrous material an acid solution the active component of which consists essentially of boric acid which penetrates into the body below said surface, heating the body to remove water therefrom and to elevate the fibers at the treated surface of the body which are wetted with said acid solution of boric acid to a minimum temperature of about 220° F. and by the action of said acid solution of boric acid on said fibers at the treated surface to condition said fibers for shearing, and thereafter forming artificial openings in said body extending from said surface and penetrating into said body by shearing of said layer of boric acid conditioned fibers.

2. In a method of fabricating a fibrous sound-absorbing unit, the steps of claim 1 in which the acid solution of boric acid is applied at the rate of about 4–15 grams per square foot of treated surface on a dry basis.

3. In a method of fabricating a fibrous sound-absorbing unit, the steps of claim 1 in which the boric acid solution is heated to a temperature in the order of 140° F. at the time of application.

4. In a method of fabricating a fibrous sound-absorbing unit in accordance with claim 1, the improvement which comprises adding to the boric acid solution a thickening agent which limits the penetration of the boric acid solution into the body of the fibrous material.

5. In a method of fabricating a fibrous sound-absorbing unit, the process of claim 1 in which the heating of the body is effected at a temperature in the order of 220° F. for a period of at least about one hour.

6. In a method of fabricating a fibrous sound-absorbing unit, the steps of claim 1 in which the acid solution of boric acid is applied to a formed body of cellulosic fibrous material which is in wet condition prior to drying.

7. In a method of fabricating a fibrous sound-absorbing unit, the steps of claim 1 in which the artificial openings are formed by moving a fissure-forming shearing surface into said body and mechanically shearing the fibers in said layer of boric acid conditioned fibers and continuing the application of mechanical shearng forces to said body until fissures of the desired depth and extent have been formed therein.

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