Aug. 7, 1945. A. ELMENDORF ET AL 2,381,269

PROCESS FOR MAKING THICK HARDBOARD

Filed Oct. 28, 1941 2 Sheets-Sheet 1

Fig. 1.

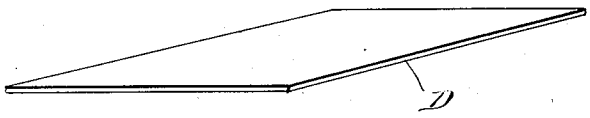


Fig. 2.

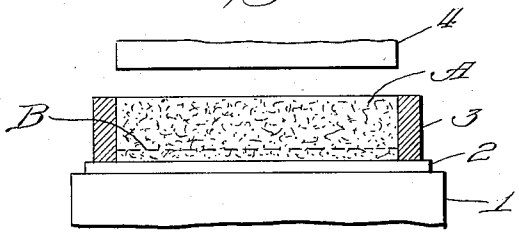
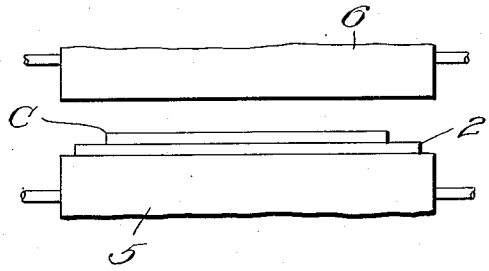


Fig. 3.



Inventors:
Armin Elmendorf and
Morris Lieff,
By Wm. F. Frendenreich, Atty.

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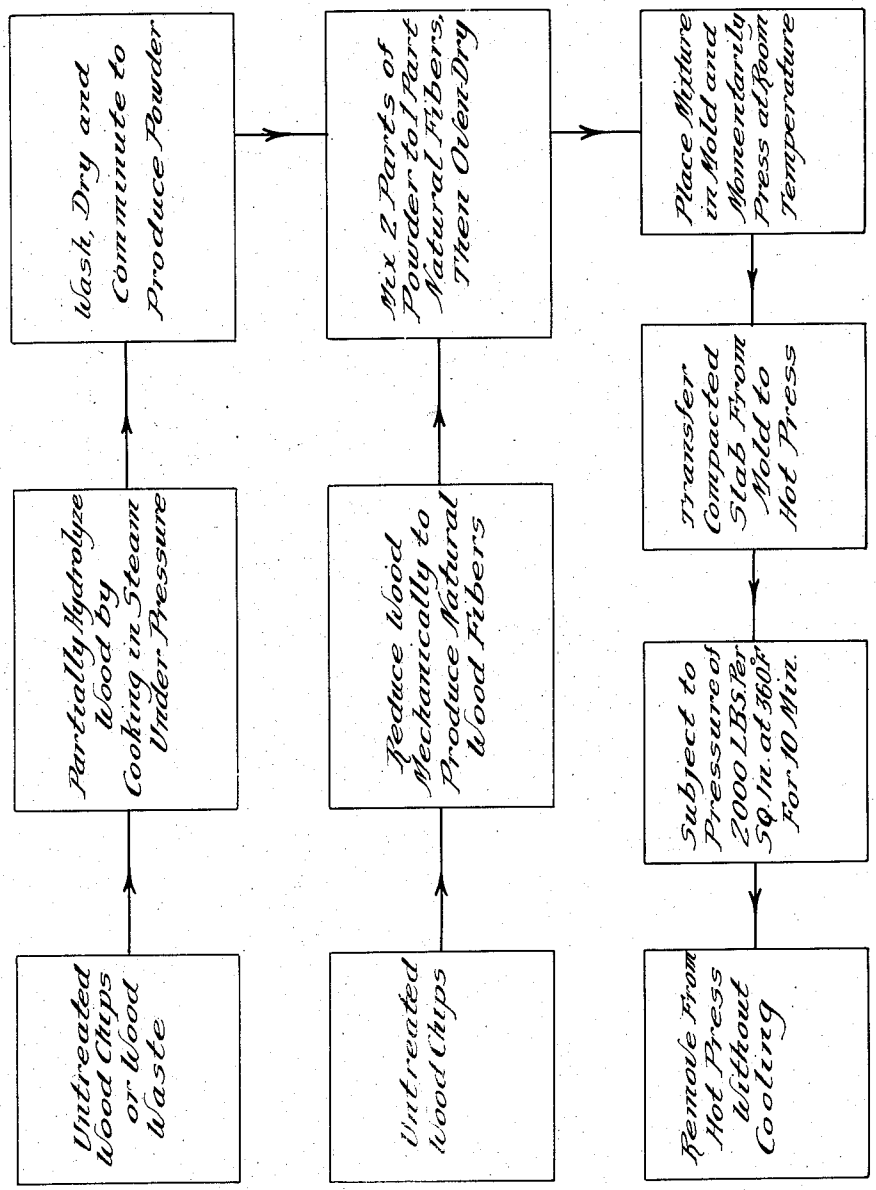


Fig. 1

Inventors:
Armin Elmendorf &
Morris Luff.
by Wm. F. Freudenreich, Atty.

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PROCESS FOR MAKING THICK HARDBOARD

Armin Elmendorf, Winnetka, and Morris Lieff, Chicago, Ill.

Application October 28, 1941, Serial No. 416,828

4 Claims. (Cl. 18—47.5)

Most commercial hardboard made of lignocellulose fibers as now manufactured is made by felting a thick mat of the fiber and then pressing the same between hot plates while the mat is still wet. Wire screens are used between the mat and the hot plates which permit the escape of the steam and gases generated.

In another process, binders are introduced in the form of oxidizing oils or pitches and the felted mat or board is first dried to oven dry condition and then pressed at an elevated temperature. In this process, the pressure is repeatedly released to permit the escape of the gases generated.

The limitations of the present commercial products are such that it is not feasible to make thick panels of wallboard size. Most panels of large size, i. e., four feet by twelve feet, are made only one-eighth of an inch thick. By increasing the amount of material being felted, somewhat thicker panels can be produced, but it seems to be beyond the realm of practicability to make hardboard beyond about one-fourth of an inch in thickness using felted boards. The primary object of the present invention is to make possible the production of large hardboard panels, for commercial uses, of substantially greater thicknesses than has heretofore been practicable without laminating.

Hardboard made of felted fiber readily separate into layers along the edges and they are easily split as by driving a nail into the edges. In order to be commercially useful, it is important that nails can be driven not only through the face of thick boards, but also into the edge. Hardboards made of felted fibers are not isotropic since they are readily cleaved into layers or strata parallel to the faces. Boards that are isotropic cannot be separated into layers as they have substantially the same strength in all directions. Nails can be driven into the edges as well as through the face near the edges, of isotropic boards, if they are sufficiently tough.

In carrying out our invention, we convert wood or woody material into natural fibers which contain substantially all of the original constituents of the wood, namely, the cellulose, hemicelluloses and lignin. These fibers may be in the form of the individual botanical fibers of which wood is composed or bundles of such fibers having substantially their original strength. As is well known, such natural fibers are usually from one-eighth inch to three-sixteenths inch long and are from one to two thousandths of an inch thick. Ligno-cellulose fibers of other vegetable origin such as cane, cornstalk, straw, etc., may also be used.

These natural wood or woody fibers can be obtained by any of the conventional methods used for producing fibers in the manufacture of ordinary wall boards, such as by grinding wood blocks, or in a defibrator machine which reduces wood chips to a fibrous state while being steamed to soften the same.

We have found that panels made solely of natural wood fibers when pressed oven dry at high pressures and at temperatures below about 450° F. are not converted into a satisfactory hardboard by this pressing procedure. Such pressed panels are very low in water-resistance, swell excessively in water, and have low strength. The modulus of rupture of such boards is generally only one thousand to three thousand pounds per square inch. By the use of certain oil and resin binders, a hardboard can be obtained at temperatures of about 450° F. if the press is repeatedly opened and closed to release the gases formed. At temperatures above 500° F., chemical decomposition sets in, causing disintegration of the wood structure.

In the presence of even a small percentage of moisture in the fibers, blistering and decomposition takes place at temperatures below 500° F., and sometimes even below 400° F.

A satisfactory hardboard must be hard, nailable, have adequate water resistance, and a modulus of rupture of at least five thousand pounds per square inch.

We have discovered that the desired end sought can be achieved by mixing with the natural fibers a fibrous powder of partially hydrolyzed wood, which can be obtained by several methods as by cooking wood chips in the presence of dilute acids, or by subjecting wood to steam under high pressure for several hours, or by other methods. The hydrolyzed wood is washed, dried, and, finally, comminuted to what may be termed a powdered form which, however, contains a large proportion of tiny fibers. The washing of the cooked material serves to remove the water soluble substances that were created through changes in the hemicellulosic substances in the wood during the cooking process. The fibrous powder may conveniently be manufactured from wood chips or wood waste. The wood chips may be obtained by the reduction of cordwood by the machinery usually employed in the paper industry, whereas the wood waste may consist of sawmill waste such as sawdust or shavings. In our preferred method, chips or other small bodies of wood are

placed in a cylinder where they are subjected to steam at a pressure of about one hundred seventy-five pounds per square inch for about two hours. When steam at a higher pressure is used, the time may be reduced and, conversely, if the steam pressure be lower, a longer cooking time is needed. After the cooked wood is blown from the cylinder and washed and dried, it is run through a hammer mill to reduce it to the form of a fine fibrous brown powder.

Both the powder and the natural wood fibers are oven-dried so that when they are mixed together, the resulting mixture is oven-dry. The natural wood fiber and the fibrous powder may be mixed in various proportions, within limits, one limit being that in which the ratio of the powder, by weight, to the fiber, is about four to one, whereas at the other limit the relations are reversed, being one part of powdered substance and four parts of the natural fiber.

The natural wood fibers and the hydrolyzed fibrous powder are preferably dried to oven-dry condition and thoroughly mixed as by means of a ball mill. Drying of each component may be done separately or they may be dried together after mixing, or after pressing at room conditions.

To produce a panel, a sufficient quantity of the oven-dry mixture is placed within a form, which may be simply a deep frame, the opening in which is as long and as wide as the desired panel; the quantity depending upon the thickness which the panel is to have. Preferably the frame is placed on a loose, rigid plate so that after the panel-forming material has been poured into the same, the filled form may be transferred to a powerful press where the contents of the form are momentarily subjected to a pressure of from one thousand pounds to three thousand pounds per square inch at room temperature. This pressure compresses the loose mass into a slab which is considerably thicker than the final product and which, when stripped from the frame, can be carried intact upon the loose supporting plate to a hot press. In other words, the momentary pressing of the loose mass not only compacts the same, but binds it into a self-supporting slab. In the hot press this slab is subjected to a pressure of from one thousand pounds to three thousand pounds per square inch, and a temperature lower than 400° F., for about ten minutes. We have found that with a temperature of from 350° F. to 360° F., and a pressure of two thousand pounds per square inch, applied for about ten minutes, there is obtained a very hard and strong board that does not blister upon opening the press, thereby making it unecessary to cool the press before opening it.

No form is needed to confine the rudimentary panel while in the hot press, because the material in the slab that is being further compacted does not flow. Therefore, by simply pressing the slab between smooth surfaces, namely the plate on which it lies and the under surface of the upper platen, there is obtained a panel of the same size as the slab. Furthermore, we have found that the fusion that takes place in the body of the panel is very uniform clear to the edges, so that very little trimming is needed to produce a final product of uniform structure throughout. Thus, there is so little waste of material as to be negligible.

A series of panels made of various proportions of gum fibrous powder prepared by cooking gum sawdust and shavings at one hundred seventy-five pound steam pressure for two hours, then washing, drying and comminuting to obtain an oven-dry fibrous powder, and oven-dry natural pine fibers made by the defibrator method, mixed in various proportions, and pressed at two thousand pounds per square inch for ten minutes at a temperature from 350° F. to 360° F. gave the following strength values when tested in bending as a simple beam:

Table

Ratio [1]	Modulus of rupture
	Lbs./in.²
1 to 0	10,500
4 to 1	10,400
2 to 1	8,500
1 to 1	6,500
1 to 2	6,200
0 to 1	1,900

[1] Partially hydrolyzed lignocellulose fibrous powder to natural lignocellulose fibers.

Thus, it is apparent that panels made from mixtures coming within the previously-mentioned limits all have a high modulus of rupture, this increasing as the ratio of the fibrous powder content to the natural fiber content increases. The board becomes too hard and brittle to permit nailing if the ratio of fibrous powder to natural fibers exceeds four to one, and nailing is imperative if the product is to have a wide, commercial use; and, below the other end of the scale or range, with more than four times as much of the fiber as there is of the powder, the strength and water resistance of the board are reduced to such an extent that the board is no longer a satisfactory commercial product. We believe that the preferred ratio is that of two parts of the fibrous powder to one quart of the natural fibers. A board made from such a mixture has a modulus of rupture of about eighty-five hundred pounds per square inch, nails can be driven through the same close to the edges, and, if soaked overnight in water at room temperature, will absorb only about fifteen percent of moisture. The modulus of rupture of this hardboard is almost double that of commercial hardboards now on the market. Even when the ratio of the fibrous powder to the natural fiber is one to two, the modulus of rupture is still above six thousand pounds per square inch. If desired, the water-resistance may be further improved by adding the usual waterproofing agents such as rosin size, petrolatum, drying oils, etc., either integrally, or on the surface of the pressed panel.

We have found that chemical pulps such as sulphite and soda pulp and natural occurring cellulose such as cotton do not produce satisfactory boards when used in place of the natural lignocellulose fibers. The resultant boards are both low in strength and water resistance.

We have found, furthermore, that wood flour, even though made of lignocellulose material, cannot be substituted for the natural fibers. Boards made of combinations of natural lignocellulose in the form of finely ground wood flour as used in the molding industry and partially hydrolyzed fibrous lignocellulose powder are not satisfactory, being low in strength and much too brittle to be nailed.

Boards may also be made of fibrous material containing a small percentage of moisture by pressing the pre-formed slab in the hot plate press at relatively low pressures such as one hun-

dred pounds per square inch until the slab is heated through, then opening the press slightly to permit the vapors to escape, and then pressing at the higher pressures cited to coalesce the fibers. In this procedure, the slab is dried in the press but it is less economical to dry the slabs in this way than by previously drying the fibers and powder. Repeated "breathing" of this kind is generally necessary to expel all moisture.

If the plates are cooled before releasing the pressure, the high pressure can be applied immediately without "breathing" even though the fibers contain a small percentage of moisture. In this case, slightly lower temperatures can be used to obtain strengths comparable to boards made of oven-dry mixtures. Boards can be made in the presence of one-half percent to twelve percent of moisture and temperatures ranging from 300° F. to 400° F., if the temperature of the press is dropped at least 25° before opening the press. When the moisture content lies in the upper range of the limits mentioned the temperature drop must be substantially greater than 25° before the press can be opened safely. This is especially true at the higher temperatures. Unless the press is cooled, blisters will be formed and even explosions take place upon opening the press.

The present invention is illustrated in part in the accompanying drawings, wherein Figure 1 is a perspective view of a large, thick, rectangular panel made in accordance with the present invention; Fig. 2 is a view partly in section and partly in elevation, illustrative of the step of effecting a preliminary compacting of the mixture which is to be converted into the finished board; Fig. 3 is a more or less diagrammatic view, showing an open, hot press into which the thick slab or rudimentary panel has been placed, preparatory to being transformed into a much thinner hardboard, and Fig. 4 is a diagram illustrating an entire series of steps for carrying out the process, beginning with untreated wood chips and ending with a completed panel.

In the drawings, 1 represents the lower platen of a press upon which there is located a form or mold comprising a flat metal plate 2 upon which rests a deep, rectangular frame 3. The upper member of the press is in the form of, or is provided with a plunger 4 which is adapted to fit slidably into the frame 3. The first step in the preparation of a hardboard panel is to deposit in the mold or form a sufficient mass of the oven-dry mixture A of natural wood fibers and the partially hydrolyzed woody substance in the form of a fibrous powder, heretofore described; the two constituents being mixed in any one of the desired proportions between the working limits of four parts of the fibrous powder to one part of the natural wood fibers and one part of the fibrous powder to four parts of the natural wood fibers. The press is then closed, with the work and the apparatus at room temperature, so that the plunger exerts a pressure of from one thousand pounds to three thousand pounds per square inch on the loose mixture, thereby compacting the same into the space lying below the dotted line B in Fig. 2. This operation may be done quickly, so that the mixture may remain under pressure for only an instant. The mixture is now in the form of a compacted slab whose edges are sharply defined by the sides of the form, and which has smooth top and bottom faces.

This slab, indicated at C in Fig. 3, is transferred to the lower platen 5 of a hot press, after the frame has been stripped off and while still resting on the plate 2. The hot press is then closed and the slab is subjected to a pressure of from one thousand pounds to three thousand pounds per square inch for about ten minutes. When the temperature of the work, during pressing, is kept below four hundred degrees F., the board does not blister upon opening the press while the latter remains hot; the most satisfactory temperature being around three hundred fifty degrees to three hundred sixty degrees, when a pressure of two thousand pounds per square inch is used.

At the end of the hot pressing operation, the product has the form of the board D of Fig. 1, being of the same length and width as the slab C, but only slightly over one-half the thickness and quite different in internal structure and in its properties. The board is very hard, has smooth faces, so that both sides may be exposed in situations where that is necessary in its final use; or, where only one face need be exposed, that may be either of the two faces. This distinguishes our board from the usual commercial type formed from felted materials pressed wet, which, because of their moisture content, must have at least one surface engaged with a piece of wire mesh to permit the escape of steam; the latter side having a rough indented surface which, in the use of the board, must always be concealed.

We claim:

1. The process of making a nailable hard board panel, which consists in converting untreated lignocellulose tissue to natural lignocellulose fibers which are substantially in the form of the original individual botanical fibers or bundles of such fibers of which the woody tissue is composed and having substantially their original strength, partially hydrolyzing other lignocellulose material and comminuting it to a powder, mixing said natural fibers with the hydrolyzed powder in proportions ranging between the limits of one part of natural fibers to four parts of said powder and four parts of natural fiber to one part of powder, oven-drying the mixture, placing the oven-dry mixture in a form, compressing the mixture at approximately room temperature and at a pressure of at least one thousand pounds per square inch, removing the slab thus produced from the form, and then subjecting the slab to a pressure of at least one thousand pounds per square inch and temperatures from 325° F. to 400° F. for from five to fifteen minutes.

2. The process of making a nailable hard board panel, which consists in converting untreated lignocellulose tissue to natural lignocellulose fibers which are substantially in the form of the original individual botanical fibers or bundles of such fibers of which the woody tissue is composed and having substantially their original strength, partially hydrolyzing other lignocellulose material and comminuting it to a powder, mixing the natural lignocellulose fibers with the hydrolyzed lignocellulose powder and then coalescing the mixture under heat and pressure.

3. A nailable hardboard product which consists of a mixture of natural lignocellulose fibers which are substantially in the form of the original individual botanical fibers or bundles of such fibers of which the woody tissue is composed and having substantially their original strength and partially hydrolyzed lignocellulose powder in proportions ranging between the limits of four parts of powder to one part of fiber and one part of powder to

four parts of fiber, coalesced under the influence of heat and pressure.

4. The process of making a nailable hardboard panel, which consists in converting untreated lignocellulose tissue to natural lignocellulose fibers which are substantially in the form of the original individual botanical fibers of which the woody tissue is composed and having substantially their original strength, partially hydrolyzing other lignocellulose material and comminuting it to a powder, mixing the natural lignocellulose fibers with the hydrolyzed lignocellulose powder in proportions ranging between the limits of one part of natural fibers to four parts of said powder and four parts of natural fiber to one part of powder, and then coalescing the mixture under heat and pressure.

ARMIN ELMENDORF.
MORRIS LIEFF.