Sept 10, 1957 R. M. BOEHM ET AL 2,805,946

PROCESS FOR MAKING CONSOLIDATED LIGNOCELLULOSE HARDBOARD CONTAINING RE-ADDED FINES

Filed Dec. 1, 1949 2 Sheets-Sheet 1

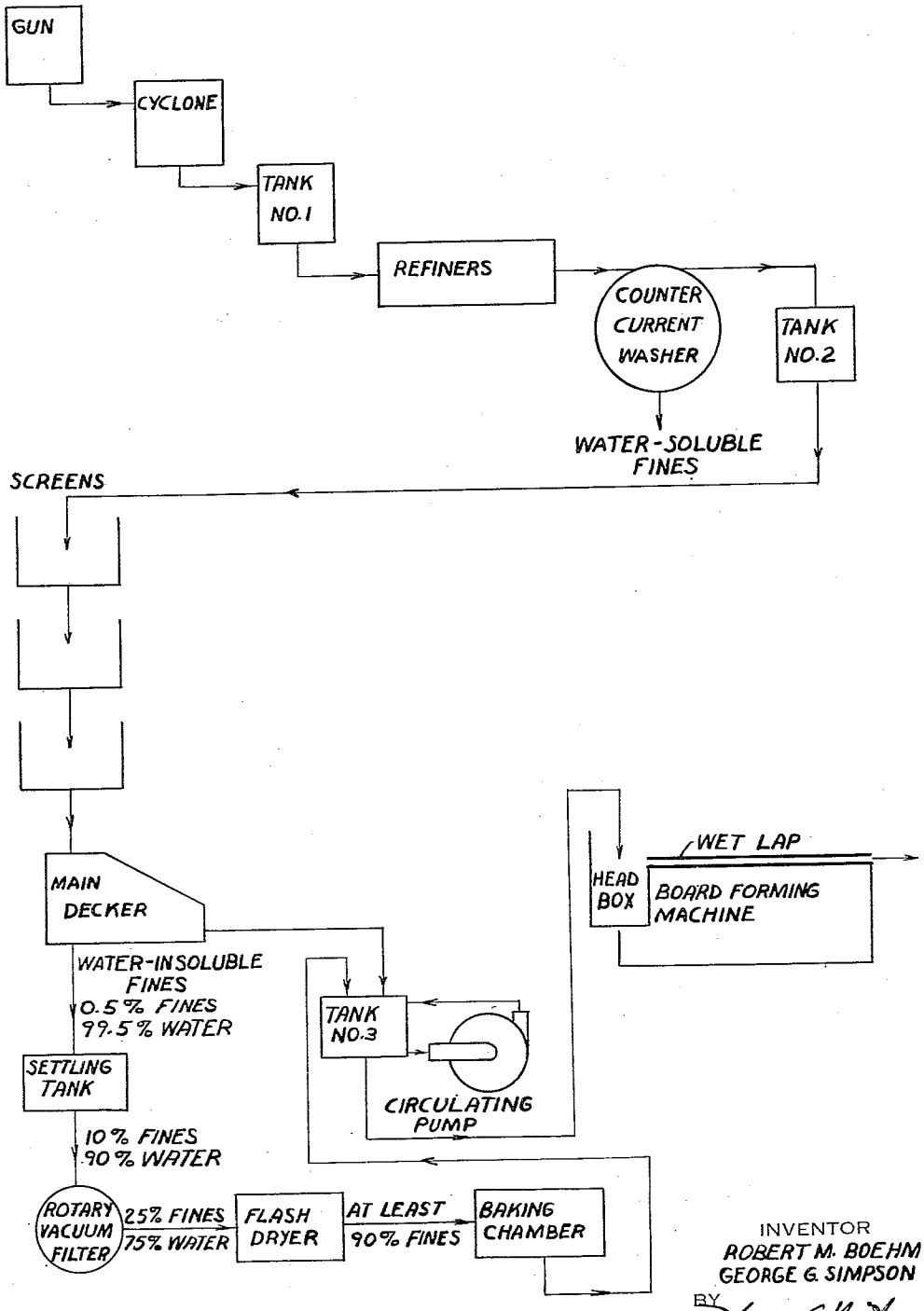


FIG. 1.

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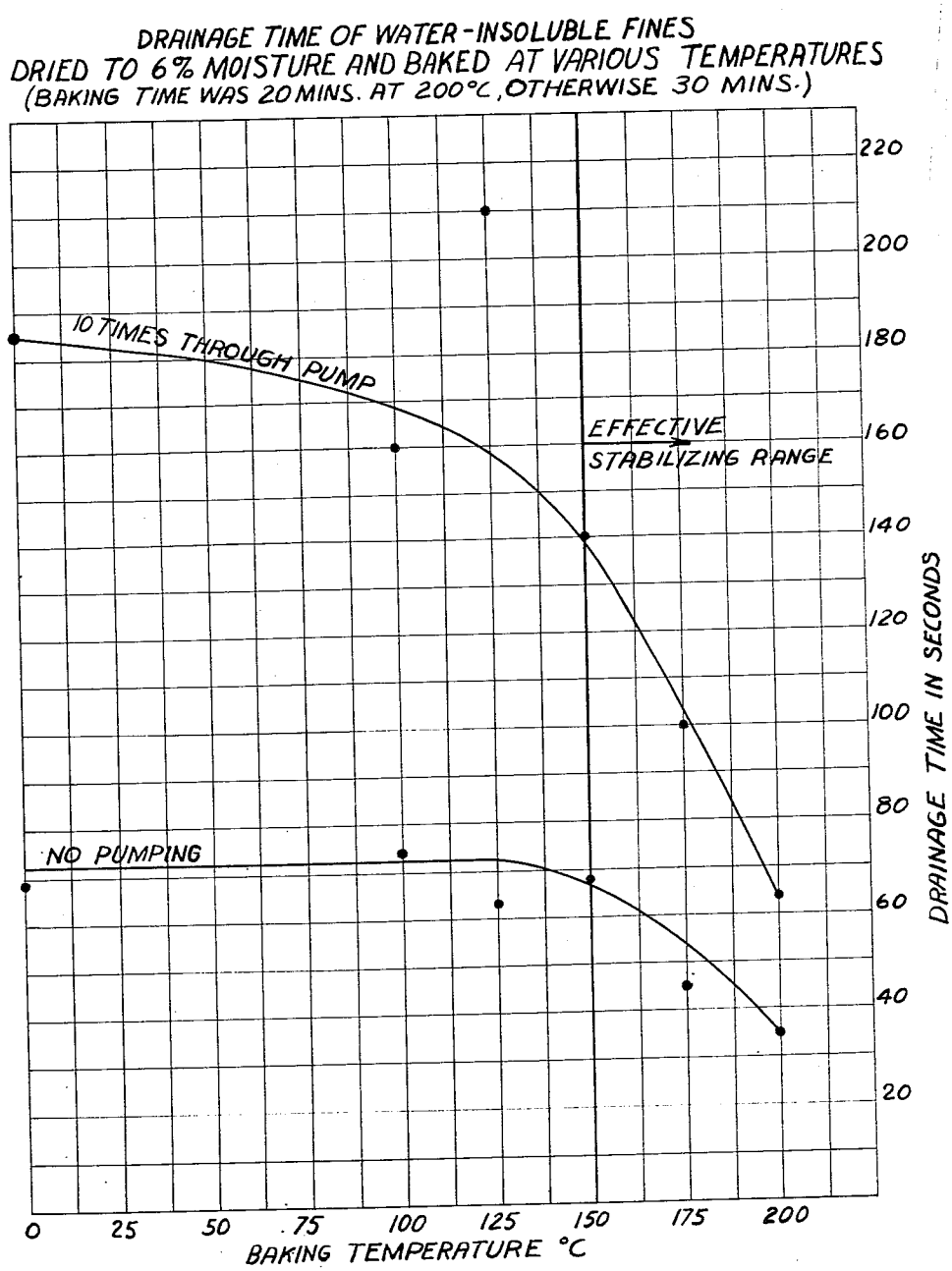


FIG. 2.

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PROCESS FOR MAKING CONSOLIDATED LIGNOCELLULOSE HARDBOARD CONTAINING READDED FINES

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3 Claims. (Cl. 92—1)

This invention relates to a process of making lignocellulose fiber products and more particularly to a process of making sheet products or boards from lignocellulose material in which process a portion of material heretofore found unsuitable for use in making boards is rendered usable and is used in board manufacture.

In the manufacture of boards from lignocellulose fiber made by the gun explosion process, the chamber of a gun, as for example the gun of the U. S. Patent 1,824,221, is filled with wood chips for example, steam at high pressure is supplied and after a short interval, the chips are disintegrated into fiber by explosive discharge to substantially atmospheric pressure. The fiber is refined, washed, screened and then continuously formed into a wet lap from which the boards are made by drying, accompanied or followed by hot pressing.

The exploded fiber from the gun contains a fraction consisting of extremely fine solids, part of which is fibrous and part is non-fibrous. This fraction is insoluble in water, high in lignin content, and amounts to about 7% of the fiber normally used in making boards. It is referred to herein as water-insoluble fines. For reasons stated below it has been found necessary to remove these fines from the board-making material by washing in order to produce acceptable boards. The present invention relates to the avoidance of the loss of this material and of this substantial percentage of board production by providing a treatment for the removed water-insoluble fines which enables their return to and use in the board-making process. The exploded fiber from the gun also contains another fraction which is water-soluble. This water-soluble material is believed to be produced by hydrolysis in the gun. This water-soluble material when retained in the fiber makes the boards less water-resistant and so it has been wholly or partly removed by washing and not returned. This previous practice of reducing or removing water solubles is continued unaffected by the present invention.

For a long time it has been known in the art that it would be desirable to use the water-insoluble fines along with the regular stock furnish in making boards. Although many efforts have been made to thus use these fines, each time the efforts failed because of serious difficulties. The fraction is gelatinous in nature and in the presence of water, particularly if stirred, as when pumped and so forth, it forms a gel-like structure. In the presence of fiber this material mats the fiber together and greatly slows down the drainage of water therefrom during dewatering of the wet lap. Since the board-making process is continuous, the wet lap fiber must be drained to the desired moisture content within a given time. Insufficient drainage of the wet lap causes the following difficulties:

1. Wet lap is difficult to handle.
2. Wet lap formation defects produced which result in boards of irregular surface.
3. Wet laps blow out of press.
4. Boards blister during hot pressing.
5. Boards have water spots.

6. Boards stick to press.

A typical analysis of the water-insoluble fines is as follows:

TABLE 1

Constituents:	Parts by weight
Lignin	47.4
Cellulose (Cross and Bevan)	39.8
Waxes	7.3
Hemicelluloses	4.1
Ash	1.4
	100.0

While the amount of water-insoluble fines will vary slightly with the gun conditions, the nature of the fines remains substantially unchanged.

A typical screen analysis of the water-insoluble fines dried to a moisture content of 4.8% according to Example I hereinafter is as follows:

TABLE 2

U. S. Screen No.:	Percent retained on screen
40	2.6
60	13.7
80	15.7
100	11.7
140	14.5
200	10.1
270	17.7
Through 270	13.9
	99.9

An object of this invention is to provide an improved process of making lignocellulose fibrous products. A further object is to provide an improved process of making boards from hydrolyzed lignocellulose material. A still further object is to provide a process of making boards from hydrolyzed lignocellulose material in which process a portion of the hydrolyzed lignocellulose materials heretofore found unsuitable for use in board making is rendered usable and is used in making boards and increased production obtained. A more particular object is to overcome the difficulties experienced in the art as set forth hereinbefore. Other objects will be apparent from the description of this invention given hereinafter.

It has been found according to the present invention that these objects are accomplished and difficulties overcome by carrying out the process which comprises hydrolyzing and distintegrating lignocellulose material to form coarse fibers and fines, said fines including a water-insoluble fraction, forming an aqueous slurry of the hydrolyzed and disintegrated material, removing the fines from the slurry, substantially de-watering the fines, heating the fines to a moisture content not in excess of about 10% by weight thereof on a dry basis, returning the fines to and re-slurrying same with the remainder of the hydrolyzed and disintegrated lignocellulose material, and finally making consolidated articles from the resulting slurry by forming into the desired shape and hot pressing. Preferably the heat drying of the fines is followed by a step of baking said fines prior to returning same to the system.

Figure 1 of the accompanying drawing shows a flow sheet of the preferred embodiment of this invention, the drawing being used to assist in understanding the invention.

Describing the invention with reference to Figure 1, wood of trees or woody materials of corn stalks, cane, and other vegetable growths are first fibrated. One method of fibrating comprises charging the closed chamber (e. g. a gun as set forth in U. S. Patent 1,824,221) with relatively small wood chips or other woody ma-

terials, subjecting the chips to a pressure of about 200–1200 pounds per square inch and a temperature of about 200° C.–300° C. for approximately 30 minutes to 5 seconds, respectively, in the presence of steam, and discharging the material from the gun through a constricted discharge means therein (e. g. a valve) into the cyclone which is preferably at atmospheric pressure, thereby exploding the wood chips. The gun treatment serves to disintegrate and also to hydrolyze the lignocellulose material. The gun conditions may be varied so as to be suited to change in kind of wood, size of chips (preferably up to about 1 inch long), water content of the chips (preferably about 25%), extent of desired steam treatment, and the like.

The material discharged from the gun includes relatively coarse fiber, bundles of fiber, and finely divided water-insoluble material (referred to herein as fines), and water-soluble material. The cyclone serves to break up the bundles of fiber and check the forward velocity of the discharge. The discharge from the gun next is passed into tank No. 1 in which an aqueous slurry is prepared of approximately 4% fiber consistency. This slurry is passed through the battery of refiners in order to further refine the fiber. The water-solubles are removed from the slurry by the counter-current washer. Next the resulting slurry is passed into tank No. 2 and adjusted to a fiber consistency of about 3.5%. This slurry is passed through the series of screens for removal of very coarse fractions of the fiber. Then the slurry is passed over the main decker, which removes substantially all of the fines. Next the slurry is passed to tank No. 3, adjusted to a fiber consistency of about 2.5% and sizing material is added to the slurry. The resulting slurry is passed into the headbox from which point the screen of the modified Fourdrinier type board-forming machine picks the slurry up and forms it into a wet lap. The fiber consistency of the wet lap is increased on the machine from about 2.5% to about 40% by drainage of water through the screen and passage of the wet lap through rolls. The wet lap is cut into the desired lengths and dried accompanied or followed by hot pressing. The coarse fiber removed by the screens is further refined and returned for use (not shown).

Heretofore efforts to add the fines back to the system have failed because the fines, not being dried or baked, increased the wet lap drainage time on the Fourdrinier machine far beyond any time which could be tolerated, and insufficient drainage was detrimental in the ways which have been stated.

The fines come through the main decker as a slurry of approximately 0.5% fines and 99.5% water. These fines are decanted in the settling tank (e. g. a Dorr type settling tank) to about 10% fines and 90% water. This slurry is thickened to approximately 25% fines and 75% water. A rotary vacuum type filter, e. g., gives excellent results. The resulting filter cake is dried to a moisture content of not in excess of about 10%. Preferably the type of dryer used is one which rapidly dries the fines as they are passed through a heated medium while the fines are in a finely divided state, e. g. a flash dryer. The flash dryer manufactured by Combustion Engineering Company, Inc., Raymond Pulverizer Division of Chicago, gives very good results.

These dried fines without further heat treatment may be added back to the system by introducing into tank No. 3, provided the local circulating pump on tank No. 3 is not used. If the circulating pump is used, wet lap drainage trouble is encountered. While good boards have been made by adding these dried fines back to the system, the process is not as satisfactory as desired because the circulating pump on No. 3 tank is prevented from serving its function of keeping the slurry well mixed. Furthermore if there is a shut-down of the operation for making repairs or other reasons, the fines are apt to swell up into a gel-like substance and prevent proper drainage of the wet lap. It is unsatisfactory to add the dried fines further along in the system because then they do not become properly mixed with the stock furnish. Instead of a circulating pump, any device may be used which keeps the slurry well mixed.

Another feature of this invention is the elimination of the difficulties mentioned in the foregoing paragraph. It was found that these difficulties, including the need for turning off the circulating pump on tank number 3, could be eliminated by baking the dried fines at about 150° C.–200° C. for approximately 30 minutes. The baking treatment appears to harden and set the particles of the fines. The baked fines differ from the unbaked fines in that water drains therefrom more rapidly and in that they are far less affected in the direction of jelling and the like than unbaked dried fines by standing in water or even agitating in water. This is shown in Examples IV and V and in Figure 2 of the drawing.

Thus the fines dried to a moisture content of not in excess of 10% may be used in the system, but it is preferred to so dry the fines and then to bake them in order to reduce and stabilize their effect on increasing the time required to properly drain water from the wet lap.

The following examples, wherein quantities are by weight on a dry basis, illustrate specific embodiments of this invention.

Example I

Filter cake material (filtered fines) of 72.4% moisture was dried to 4.2% moisture by subjecting to a temperature of 97° F.–120° F. for about 26 seconds in a Raymond flash dryer. The rate of feed to the dryer was 2800 pounds per hour. Good boards were obtained by adding 15% of this dried material to the board-forming material or stock furnish in tank No. 3 with the circulating pump turned off. While the fines increased slightly the time required for the stock to drain properly in forming the wet lap, the drainage time was below the acceptable maximum.

Example II

Filter cake material was dried to 6% moisture in the manner set forth in Example I except that the feed to the dryer was 3000 pounds per hour. Good boards were obtained by adding 20% of the dried filter material to tank No. 3 with the circulating pump turned off. Drainage was substantially as in Example I.

Example III

Filter cake material was dried to 2% moisture as in Example I except that the feed to the dryer was 2500 pounds per hour. Good boards were obtained without operating difficulties by adding 15% of the dried filter material to tank No. 3 with the circulating pump turned off. Drainage was faster than in Examples I and II. With the circulating pump running the drainage time increased to a point beyond the acceptable maximum and this caused operating difficulties.

Example IV

Filter cake material was dried to 6% moisture as in Example II and divided into several portions and baked in a circulating oven under various conditions. After baking, the material was made up to a 3% slurry of baked material in water at 70° C. Some of this slurry was diluted with water at 70° C. to a 1% consistency and tested for drainage. Another portion of the 3% slurry was passed 10 times through circulating pump running at 3420 R. P. M., diluted with water as above to a 1% consistency, and then tested for drainage. The drainage tester consisted of a 11.9 centimeter Buchner funnel telescoped over the end of and attached to a 10.7 centimeter inside diameter glass tube. The glass tube was graduated in 500 milliliter sections. The funnel contained a wire screen (30 x 28 mesh, wire of 12 mils

diameter) upon which the end of the glass tube rested. A stopper was inserted in the neck of the funnel. In making the drainage test, 3000 milliliters of the 1% slurry was put in the tube and the stopper removed from the funnel. The drainage time consisted of the time required for the water to drain through the screen and pass out the funnel. The drainage time was reckoned from the instant the stopper was removed until the flow of water from the funnel changed from a continuous stream to droplets. As a comparison, drainage tests were made under the same conditions on undried filter cake material and on dried but unbaked filter cake material.

The data is summarized in the following table and represented graphically in Figure 2 of the drawing.

Sample	Baking Conditions		Drainage Time	
	Time, Mins.	Oven Temp., ° C.	No Pumping	10 times through pump, secs.
Undried filter material (blank).	----------	----------	over 15 hrs.	----------
Dried filter material (blank).	----------	----------	69 secs.	185
Dried and baked filter material.	30	100	74 secs.	160
Do.	30	125	63 secs.	210
Do.	30	150	67 secs.	140
Do.	30	175	45 secs.	100
Do.	20	200	36 secs.	67

As will be seen from Figure 2, improved drainage and effective stabilization of the drainage begins with the baking conditions of 150° C. at 30 minutes.

Example V

Filter cake material was dried to 6% moisture as in Example II, followed by baking in a steam-tube rotary dryer under the following conditions and drainage test made on the resulting material as in Example IV.

Sample	Baking Conditions		Drainage time, seconds	
	Time, Mins.	Steam Temp., ° C.	No Pumping	10 times through pump
Dried filter material (blank).	----------	----------	58	223
Dried and baked filter material.	75	180	35	75

The foregoing examples are illustrative only and are not to be used to determine the scope of this invention.

While drying by means of a dryer based on the principle of a flash dryer is preferred, any type drying which employs the application of heat is applicable so long as the moisture content of the fines is reduced to at least 10%. Drying other than by application of heat (e. g. drying with unheated air) is not suitable with this invention. The baking may be done by any conventional apparatus with which suitable baking conditions can be maintained. In addition to baking by means of a circulating oven and a stream-tube rotary dryer exemplified herein, other means of heat such as for example high frequency units and infrared lamps may be employed.

The baking conditions may be varied depending on the particular circumstances. For example, the baking time would be less with high frequency heating than with a gas or electric oven. The time and temperature of baking vary inversely, so that longer times with lower temperatures as well as shorter times with higher temperatures than those set forth in the examples may be employed. However, for a temperature below about 125° C. the time required is impractical. On the other hand the temperature should not exceed about 250° C. even for a short time in order to avoid decomposing the fines.

Several important advantages of making boards according to the present invention over conventional methods include the following:

1. Firmer wet laps which facilitate drying the wet laps at lower temperatures and which decreases the breakage of wet laps.

2. Substantial saving in wood required for production of any given quantity of boards which saving amounts to approximately the percent of fines added back to the system. Over 90% of the fines added back to the system is retained in the finished boards.

3. There is also a reduction of sizing material used to about one-half that required in conventional methods. (The fines carry with them some of the size initially used in the system.)

As many apparently widely different embodiments of this invention may be made without departing from the spirit and scope thereof, it is to be understood that the invention is not to be limited to the specific embodiments thereof except as defined in the appended claims.

We claim:

1. Process of making consolidated fibrous lignocellulose hardboard containing re-added fines material and wherein the lap drainage is greatly improved which comprises hydrolyzing and disintegrating lignocellulose material to form hydrolyzed fiber containing fines, forming an aqueous slurry of the hydrolyzed and disintegrated material, removing the fines from the slurry, partially de-watering the fines, heating the fines to a moisture content of about 6% by weight thereof on a dry basis, baking the fines at a temperature of at least 150° C., until said fines become hardened and have lost their tendency to gel in aqueous media, the baking time being at least about 30 minutes at 150° C., returning the resulting fines to the remainder of the hydrolyzed and disintegrated lignocellulose material and re-slurrying the mixture, felting the mixture into a lap whereupon greatly improved drainage of water is obtained as compared with the drainage of a similar lap containing untreated fines material, and thereafter consolidating the lap into a hardboard under heat and pressure.

2. Process of making consolidated fibrous lignocellulose hardboard containing re-added fines material and wherein the lap drainage is greatly improved which comprises removing from an aqueous slurry of thermally hydrolyzed lignocellulose fiber the fines resulting from the hydrolysis treatment, rapidly drying the fines to a particle size such that substantially all thereof passes through a screen having 40 meshes to the inch, said fines subsequent to drying containing not more than about 6% of moisture, baking the fines at a temperature of about 150° C.–200° C. for about 30–20 minutes respectively, returning the dried fines to the remainder of the hydrolyzed fiber and re-slurrying the mixture, felting the mixture into a lap whereupon greatly improved drainage of water is obtained as compared with the drainage of a similar lap containing untreated fines material, and thereafter consolidating the lap into a hardboard under heat and pressure.

3. Process of making consolidated fibrous lignocellulose hardboard containing re-added fines material and wherein the lap drainage is greatly improved which comprises removing from an aqueous slurry of thermally hydrolyzed lignocellulose fiber the fines resulting from the hydrolysis treatment, partially de-watering the fines, rapidly drying the de-watered fines to a moisture content of about 6% by weight thereof on a dry basis, baking the dried fines at a temperature of at least 150° C. until said fines become hardened and have lost their tendency to gel in aqeous media, the baking time being at least about 30 minutes at 150° C., slurrying together in water the baked fines with hydrolyzed and disintegrated lignocellulose material, felting the mixture into a lap whereupon

greatly improved drainage of water is obtained as compared with the drainage of a similar lap containing untreated fines material, and thereafter consolidating the lap into a hardboard under heat and pressure.

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