

UNITED STATES PATENT OFFICE

2,215,246

CONSOLIDATED FIBER PRODUCT

Joseph W. Gill, Elmhurst, Ill., assignor to United States Gypsum Company, Chicago, Ill., a corporation of Illinois

No Drawing. Application July 3, 1935,
Serial No. 29,735

3 Claims. (Cl. 92—55)

The present invention relates to a pressed board product and the process of its manufacture.

The primary object of the invention is the production of a hard, dense, coherent article of synthetic lumber, usually in the form of boards or slabs which may be used for building purposes, interior decoration, panel boards, and the like.

One of the objects of the invention is the production of a board composed substantially of cellulosic fibers or cellulosic and ligneous fibers in admixture with each other together with a comparatively small amount of a binder such as vegetable or animal fatty-acid pitch, preferably with a sizing material, in conjunction with auxiliary binders formed as a result of partial pyrolytic decomposition of the cellulosic or ligneous fibers.

A further object of the invention is to produce synthetic lumber by a process which involves the fibrillation of a ligneous substance such as wood, or various plants, either by a mechanical or a chemical process, preferably the former, followed by the reassembly of the resulting fibers into a coherent mat or slab after the incorporation with the fibers of a relatively small amount of a vegetable or animal fatty-acid pitch. After the incorporation of these materials, the board may be subjected to heat and pressure within definite ranges, as will be more completely enumerated hereinbelow, whereby it will be consolidated into a hard, dense, coherent, water-resistant product.

The present process involves the formation from the ligneous and cellulosic material of autogenously-formed binders resulting from the pyrolytic decomposition of the ligneous material and its associated cellulosic complexes. The decomposition products then probably combine with each other by condensation and polymerization, with the formation of resin-like binders which supplement the natural binders contained in the material. The presence of the fatty-acid pitch further acts to bind the material closely together while at the same time endowing it with properties of toughness, resilience, and high water resistance.

The fatty-acid pitch preferably employed may be a by-product of the manufacture of soap. Thus when fats or oils are saponified or hydrolytically split so as to produce glycerol, fatty acids form one product and glycerol the other. The fatty acids are then distilled, usually under a vacuum. The dark residue remaining in the still used for this purpose constitutes the pitch,

which is capable of hardening when subjected to elevated temperatures, particularly in the presence of oxygen.

The size used upon the fibers may consist of the ordinary rosin size used in the form of a rosin soap, or may be a resin which is capable of saponification or emulsification, although it is understood that other waterproofing materials in the nature of waxes such as paraffin wax, carnauba wax, ceresin wax, ozocerite wax, montan wax, and the like, may be used.

Broadly speaking, the present process comprises the fibrillation of ligneous material, although this does not exclude the use of fibers which have been chemically liberated from wood. Wood that has been merely mechanically fibrillated forms the preferred embodiment of the invention. Assuming that the manufacture is to proceed on the basis of the use of ground wood, which is usually ground in the presence of water by means of the usual pulp stones, the resulting pulp suspension is run into a suitable tank provided with an agitator, and while therein is treated with a sizing material such, for example, as rosin size in an amount approximately 1% to 2% of the weight of the fibers. There is also run into the tank up to 10% of a vegetable or animal fatty-acid pitch as, for example, stearin pitch, cotton-seed oil fatty-acid pitch, corn oil fatty-acid pitch, or the like. Due to its viscosity and immiscibility in water it is preferable to add the pitch in the form of an emulsion so that it will be uniformly dispersed among the fibers. A solvent for the pitch is preferably added to the pitch to facilitate its emulsification. After the pitch and fibers have been mixed in the said tank, a sufficient quantity of a precipitant such as alum or aluminum sulfate is added to decompose the rosin soap size, with the formation—in the usual manner—of an insoluble precipitate which deposits itself upon the fibers. The pitch that has been added to the mixture also is deposited on the fibers. The resultant suspension of treated fibers is now transferred to a suitable board-forming machine such as a Fourdrinier or Oliver board former, or other mechanical equivalent device, upon which it is formed into a wet mat. This mat is then slightly compacted by being passed between squeeze rollers, all in the manner well known in this art, whereupon the resultant damp mats are transferred to a drier wherein they are dried, with the removal of all or substantially all of the moisture therein contained. The pitch, by reason of the temperature used on the drier (250–350° F.), becomes somewhat hard-

ened. It is generally desirable subsequently to store the dry boards for a few days, more or less, in order to further increase the hardening of the pitch. In place of the rosin size, or conjointly therewith, there may also be used a small percentage, say 2%, of the aforementioned paraffin or waxes, these being incorporated preferably in either finely divided or emulsified form, although their use in the form of saponification products or soaps is not to be excluded. The amount of pitch used varies approximately between 1% and 10% and is in the preferred embodiment present in an amount approximating 5%.

Assuming for the purposes of the present description that a board having two plane flat surfaces is to be made, the board formed as hereinabove described is first thoroughly relieved of all the therein-contained vaporizable matter or moisture, and the board is then placed between heated surfaces such, for example, as the platens of a hydraulic press, whereupon impacting pressure is applied to said boards of up to 3000 pounds per square inch for a period of from one minute up to one hour within a temperature range of from 400° F. to a temperature short of the point of active development of carbon for the materials. The ignition point of wood is about 527° F. As a result of the applied pressure there is brought about a consolidation of the board while at the same time the heat tends to decompose the cellulosic and ligneous constituents thereof, with the autogenous formation of resinous and tarry condensation products which act as auxiliary binders and serve to bind the fibers of the board together into a strong and coherent mass.

If the board mats have been stored for some time, they will then contain hygroscopic moisture which they have picked up from the atmosphere. Boards containing such moisture can be pressed if there be interposed between at least one surface thereof and the heated platens some foraminous material such as a screen, in order to permit the escape of moisture which is converted into steam because of the heat imparted to the mats by their contact with the surfaces of the platens. It is preferred, however, to use only moisture-free boards for the final pressing operation.

In order to prevent possible difficulties resulting from the adhesion of the boards to the platens of the press, it is preferable to interpose between the boards and the platens heat-conducting caul plates of oxidized metal, or sheets coated with enamel or a glass-like composition. In stating the temperatures used in the present process, it is understood that these temperatures are measured at the surface of the metallic heat-conducting bodies that are in contact with the boards. Of course, if the platens themselves are of oxidized metal or are coated with enamel or other glass-like composition, such intermediate sheets may then be dispensed with. At any rate, the temperatures mentioned are the temperatures in contact with the board and not the temperatures of the interior of the platens themselves.

As a specific embodiment of the present invention, it may be stated that if a board or mat sized with rosin and containing a fatty-acid pitch is to be pressed, the temperature is above 400° F., but below the point of active carbon formation, preferably between 445° F. and 455° F.

Instead of forming the board wet, it is possible to proceed by first producing dry fibrated wood, as by grinding the same. The thus produced fibers are then mechanically mixed with a small amount of the above-mentioned pitchy substances

to form fibers having these substances adhering thereto. The thus treated fibers are then stored, either hot or cold, to allow the added materials to harden somewhat. Thereupon the fibers are mechanically made into a mat, as by blowing them with an air current onto a foraminous surface while applying suction to the latter. If the fibers have absorbed any moisture, the mat is preferably dried and then laid onto the platens or the oxidized or enameled caul plates, and pressed in the manner already described.

The pressing time depends, of course, upon the temperature and the pressure used. It may be stated, as a general rule, that as the temperature increases the time may safely be decreased, so that near the upper end of the temperature range stated the pressing time may be a matter of but a few minutes, while at the lower end it may extend very much longer.

A somewhat similar effect is noticed in the case of pressures, and as a general rule the higher the pressure the shorter may be the pressing time, although it is not to be understood that the relationship of the pressure to the time is the same as that of the temperature to the time.

One of the advantages in interposing an oxidized metal caul plate or an enameled or glass-lined caul plate between the boards being pressed and the platens is that such plates require little or no greasing or oiling, as they are naturally endowed with a tendency to obviate the sticking of the boards. This greatly simplifies manipulation and greatly facilitates rapid and economical manufacturing operations.

In carrying the present invention into commercial practice, it has been found that there are distinct advantages in applying the impacting pressures in distinct stages or intervals, the pressure being either the same at each period or different in each of the periods, as will presently be explained. In any event, there is preferably a release of pressure between the individual impactions. For example, mats having pitch incorporated therein, completely relieved of their moisture, are placed on caul plates and the assembly inserted between the platens of a hydraulic press. The temperature as measured at the surface of these platens may be, for example, between 445° F. and 455° F. The press is then preferably operated so as to bring the platens into contact with the boards, but without the application of any substantial pressure, for the purpose of heating the surface of the boards to about the temperature of the platens. This usually takes from 1 to 3 minutes, although it may be varied considerably. During this time, which can conveniently be termed the "toasting period," the board surface will have acquired a temperature sufficiently high so as to prevent the adhesion of the boards to the caul plates. Although it is preferable to employ the toasting step, particularly when the temperature employed is in the upper portion of the range, the process may be carried out under certain conditions without the use of this toasting. However, even if the toasting is not absolutely necessary, no harm can result from its use.

After the platens have been brought into contact with the boards for this toasting step, or urged thereagainst under considerable pressure for a short period of time, the pressure is released and the platens are preferably separated from the surfaces of the boards. This separation may be merely momentary or may extend for a few minutes. It has been found that in

certain cases the ultimate strength of the board is increased when the platens are held separated from the board for a few minutes. The pressure is then applied for a period of about two to

three minutes, whereupon it is gradually released and the platens allowed to lift slightly off the boards for the purpose of permitting the escape of the accumulated gases and vapors. A bluish acrid smoke will generally be seen to rise from the boards and pass out between the platens. The pressure may then be applied for a further period of about two to three minutes, whereupon it is again released in the same manner as already described. At the more elevated temperatures it will be found that the pressing of the board is now completed, while, with temperatures around 450° F. and below, it may be desirable to again apply pressure for another period of about two or three minutes, after which the pressure is released and the press opened. Thereupon the boards are quickly removed from the press and immediately subjected to a strong blast of air, preferably but not necessarily heated, to remove as much as possible of the smoke and gases from the freshly formed boards. This is done in order to remove the somewhat acrid odor which would otherwise characterize the boards. The boards may then be passed through a passageway in which they are subjected to a blast or current of cool air in order to relieve them of heat and allow them to become adjusted to normal atmospheric conditions without warping.

The boards may also, if desired, be placed in a suitable oven in which they are subjected to a baking operation at about 300° F. for a period of from two to six hours. This is particularly advantageous when the boards have been stored before pressing for only a relatively short time, so that the pre-oxidation of the pitch has not proceeded to the same extent as when they have been stored. The baking further modifies the pitch so as to increase its resistance to solvent. The strength of the boards is also enhanced by the baking.

As previously pointed out, the time of pressing may generally be shortened as the temperature is increased. On the other hand, as the thickness of the board increases the time of pressing is preferably extended. Thus, in forming $\frac{1}{8}$ " board at a temperature of 445° to 455° F., the total pressing time, including the toasting, may be about 7 or 8 minutes. This, however, may be shortened or lengthened according to whether the pressure employed is comparatively high or is in the lower range. As the thickness of the board increases, the time may be increased so that for $\frac{3}{8}$ " board around 10 minutes has been found satisfactory, and for $\frac{1}{4}$ " hard board about 14 minutes. If the temperature is only slightly above 400° F., the time of pressing may be extended to one-half or in some instances up to one hour or more.

In the pressing cycle the pressure may be changed during the various times that it is applied. Thus, for each subsequent application of pressure, the same may be increased or in certain instances remain constant or decreased. The important feature, however, is to release the pressure on the board at intervals during the pressing. In fact, a fairly high pressure may be applied, and after the same is released the board may be treated, as during the toasting step, with a very slight application of pressure, and thereafter, after total release of pressure, a high

pressure may be applied again. All of this obviously is subject to considerable variations, the particular examples being given for purposes of illustration only.

The boards produced by the present process have a high modulus of rupture, have low water absorption and a pleasing and smooth, polished surface. The fibers therein are consolidated together and coalesced by the production of autogenously-produced resins and tarry condensation products which result from the heating of the therein-contained cellulosic complexes, lignins, and the like. The inherent bonding powers of these autogenously-produced binders are further enhanced by the simultaneous presence of the pitches, which tend to plasticize and toughen the autogenously-produced binders. It will be noted that the amount of rosin size and pitches is relatively small, and unless the temperatures were within the range given these pitches and sizes would by themselves be insufficient to produce a board having the same degree of strength and water resistance. It is, therefore, the cooperation of the autogenously-formed binders with the fatty-acid pitches and size which mutually contribute to the high degree of water resistance, lack of water absorption and final strength of the products made in accordance with the present invention.

Applicant is aware of the fact that waxes, oils and sizes have been used in the past for the purpose of enhancing the water resistance of fibrous products, but he is not aware that the autogenous development of resins and condensation products conjointly with the use of fatty-acid pitches or resins has ever been used before, and he considers this as a distinct step in advance and as forming one of the essential elements of his present invention.

In the above formula the fatty-acid pitch is a substance that is derived from the residues remaining after the distillation of fatty acids, as, for example, those obtained from cottonseed oil or from animal stearin. These fatty-acid pitches are dark brown to black substances having many of the characteristics of ordinary coal-tar pitch but with the distinction that they are capable of becoming substantially insoluble in organic solvents and become solid and substantially infusible when subjected to temperatures of from 250° to 300° F.

The fatty-acid pitches may be of any desired origin, such as cotton stearin pitch, cottonseed fatty-acid pitch, stearin pitch, or cottonseed-oil foots pitch. All of these are now available as commercial products at a low cost, and for this reason the cost of carrying out the present invention is very low, so that it presents great commercial advantages.

The products obtained are a pleasing light-brown to chocolate-brown color, and, because of their high modulus of rupture, lend themselves to many industrial uses. Thus, they may be employed as table tops, wall panels, packing cases, backing for signs, partitioning, paneling, and for general cabinet work. Due to their high water resistance, they may also be employed in certain types of outside work.

In carrying out this invention as previously described, various types of fibers may be used, such as wood, cane, and vegetable, and the term "lignocellulosic fibers," as used in the claims, is intended to cover such fibers.

I claim:

1. The process of producing a consolidated

fiber product which comprises precipitating a fatty-acid pitch onto wood fiber while in suspension in a liquid containing a fatty-acid pitch emulsion, forming the fiber into a coherent but relatively loose mat, allowing the pitch to become oxidized by access of air at ordinary atmospheric temperature, compressing the resulting product at a pressure not exceeding about 3000 pounds per square inch and a temperature of at least 400° F., but one short of the point of the development of carbon and then subjecting the same to an oxidizing bake at about 300° F. for a time sufficient to further harden the pitch.

2. The process of producing a consolidated fiber product which comprises precipitating a fatty-acid pitch onto wood fiber while in suspension in a liquid containing a fatty-acid pitch emulsion, forming the fiber into a coherent but relatively loose mat, compressing the mat at a pressure not exceeding about 3000 pounds per

square inch and a temperature of at least 400° F., but one short of the point of the development of carbon, and then subjecting the same to an oxidizing bake at about 300° F. for a time sufficient to harden the pitch.

3. The process of producing a consolidated fiber product which comprises precipitating a fatty-acid pitch onto wood fiber while in suspension in a liquid containing a fatty acid pitch emulsion, forming the fiber into a coherent damp but relatively loose mat, drying said mat so that the pitch therein becomes somewhat hardened, compressing the resulting product at a pressure not exceeding about 3000 pounds per square inch and at a temperature of at least 400° F., but one short of the point of the development of carbon, and then subjecting the same to an oxidizing bake at about 300° F. for a time sufficient to further harden the pitch.

JOSEPH W. GILL. 20