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TREATING WOOD AND WOOD PRODUCTS

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Fig. 2.

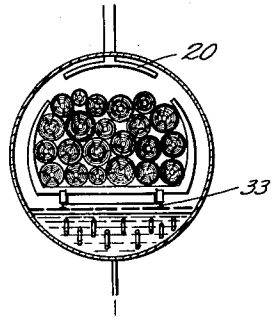


Fig. 1.

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TREATING WOOD AND WOOD PRODUCTS

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4 Claims. (Cl. 34—37)

This invention relates to the drying of wood such as green or partially seasoned timber as well as wood products.

The industry has long been confronted with the difficulties attendant upon low temperature processes which are at best objectionably time consuming. Because of the general acceptance of the idea that high temperatures could not be satisfactorily used, efforts to improve the drying of wood have proceeded toward rendering low temperature processes more efficient. As a result such processes, at the present time, are very expensive and the best properties of the dried products are not made fully available. I have discovered a process which (*a*) operates at high temperature without injury to the wood, (*b*) markedly reduces the time required to complete drying and (*c*) enables a more acceptable product to be obtained.

The principal object of the invention is to obtain by such a process an improved product suitable, for example, as railroad tie, telephone pole, or structural lumber stock, which is free from (1) checking and warping, (2) charring, (3) "case hardening" and (4) which has the strength of the fibres substantially unimpaired.

Checking is denoted by the presence of cracks or longitudinal fissures in the dry wood. It is principally due to the fact that water is removed from the outside layers so rapidly that they undergo substantial tangential contraction, thereby setting up uneven stresses which result in severe checking or warping. This objection is particularly present in direct air heating of the wood. It also frequently occurs when steam dried green timber is treated with a preservative such as creosote. Checks formed during the air drying operation are called "seasoning" checks while those produced when steam dried and air dried timber are treated with a preservative such as creosote are called "burst" checks, these latter being caused largely by the incomplete drying of timber.

Charring is caused when the timber is heated in the presence of air or other oxidizing influences at a high temperature. For this reason, kiln drying and air drying are conducted at a low temperature. Charring does not occur when the timber is dried by steaming due to the presence of the moisture.

Lowering of fibre strength is recognized as a serious fault met with when timber is dried by steaming. It is preferably traceable to the hydrolyzing action of the moisture upon the lignin of the middle lamella and of the cellulose of the cell walls resulting in partial breakdown of the fibre with corresponding lowering of strength. This loss of fibre strength probably does not occur in the case of kiln dried or air dried timber.

Kiln dried timber develops a condition known as "case hardening," which interferes with satisfactory preservative treatment of the dried timber. Apparently, this is occasioned by collapse of cell walls caused by strains set up by rapid drying whereby the passages through which the preservative must travel are more or less blocked and satisfactory penetration cannot be obtained.

An equally important object of the invention is to dry timber in a manner which will avoid the aforesaid objections and, at the same time, provide a process which is faster, thoroughly reliable, and more efficient and economical than conventional practice.

Air drying as well known is frequently a matter of months and entails the risk of loss of timber by decay before it is sufficiently seasoned; kiln drying usually requires a minimum of 72 hours, while steam drying in a closed chamber at the usual maximum commercially used temperature of 260° F. consumes 8 to 24 hours, depending upon the size and condition of the timber. I have found that the timber is more satisfactorily dried by the present invention and depending on the diameter of the pieces within 2 to 8 hours at high temperatures, that is, substantially above 260° F. and as high as 450° F. or more. This affords a substantial saving in operating and equipment costs and, moreover, markedly reduces timber inventory, i. e., it is possible to carry much smaller timber stocks since the necessity for air drying is overcome.

As regards the efficiency of the present invention, as one example, using the steaming process, the average moisture removal is usually about 6 lbs. per cubic foot. With the present invention and in the relatively shorter time period above described, I am able to remove in the case of recently felled green timber as 30 lbs. or more per cubic foot which is in the neighborhood of 100% based on the oven-dry weight of the wood.

Completeness of drying which is an important feature of this invention has many advantages. For instance, checking and warping, charring, case hardening and loss of fibre strength which are the principal objections to present processes are reduced or avoided, but, moreover, complete drying permits uniform distribution and penetration of subsequently applied preservative where such treatment is resorted to; lack of uni-

form distribution of preservative is considered to be one of the chief causes of objectionable exudation of preservative called "bleeding" during service life of the treated product; also by drying timber completely before treatment, loss of preservative through the mechanism known as "water interchange" is prevented; the more completely dried timber has its electric conductivity reduced to a minimum which is considered desirable for poles to be used in power and telephone lines; the reduced moisture content of the wood correspondingly reduces the weight whereby savings in freight costs are effected, and thoroughly dried timber has greater receptivity for and capacity to permanently retain protective coatings such as paints.

The foregoing explains the problems which are encountered in drying timber and the principal qualifications required for a satisfactory product. The industry has constantly sought to improve the methods of drying of timber, but the three processes above mentioned notwithstanding their well recognized objections are now used almost exclusively.

It has been proposed to dry timber in a closed chamber and in the presence of an inert atmosphere such as hydrocarbon vapors. In one instance, it was suggested that the treatment take place in the presence of moisture. This is impractical because moisture will induce hydrolysis and corresponding loss of strength in the wood under temperatures high enough to shorten the drying time. In another case, it is recommended that the hydrocarbon vapors admixed with air be used as the drying medium and the vapors drawn off. Such practice would not decrease the drying time because temperatures low enough to avoid charring of necessity would have to be used. This procedure and somewhat similar procedures, moreover, do not afford a reliable control and there is no assurance either that excessive moisture concentration will not result to promote hydrolysis or that there will be a proper quantitative replacement of moisture by hydrocarbon to prevent checking.

I have discovered that high temperature drying of timber is efficiently conducted by treating the same in a closed chamber provided with means for continuously removing moisture under critical conditions, namely, (1) in the presence of a saturated atmosphere of an inert gas preferably a hydrocarbon gas, which is (2) devoid of moisture (has a relative humidity of approximately 0.0) and oxidizing influences whereby there is no opportunity for hydrolysis or charring to take place, at (3) a high temperature promoting the rapid drying above described, and (4) under a low pressure whereby the moisture is rapidly vaporized and carried off immediately from the system. The pressure is substantially constant and is of the order of about one atmosphere.

It will be observed that the conditions above set forth are extremely simple to control and unskilled labor may operate the process reliably to give a uniform product. Moreover, a substantial saving in fuel costs is possible.

By a saturated atmosphere, I mean one which is substantially devoid of moisture and oxidizing influences and is composed substantially entirely of vapors of the hydrocarbon, the hydrocarbon being maintained at its boiling point or at least the boiling point of the lower fractions, i. e., the hydrocarbon atmosphere is a vapor in equilibrium with its liquid phase at its boiling point whereby the temperature of the atmosphere or vapor phase is at all times substantially equal to the boiling point of the liquid phase at the pressure prevailing in the drying chamber. This condition of equilibrium of a saturated atmosphere is maintained substantially constant throughout the process and insures that a constant low pressure will always be present.

By reason of the use of a saturated atmosphere, I am able to satisfy the other conditions and obtain a substantially completely dried product practically free from the objections above related and in a markedly shorter time period.

The use of a constant low pressure has the additional advantages that it substantially reduces any danger of explosion, and particularly, the combination of a high temperature and a low pressure is advantageous since it permits use of high boiling inexpensive hydrocarbons and eliminates any difficulties incident to the use of pressures.

In addition to the aforementioned features of the invention, I provide a continuous process for reutilizing the inert heating medium, small amounts of which are removed in the course of the immediate, i. e., substantially instantaneous dissipation of moisture from the treating chamber. For instance, the vapors of the drying medium are condensed and separated from the moisture and flow by gravity back to the treating chamber continuously where, because of their relatively low specific heat and high vapor pressure, vaporization immediately takes place which insures maintenance of constant conditions of saturation, temperature and pressure of the treating atmosphere. In another instance, the inert moisture ladened vapors are condensed and separated from the moisture and then conveyed to the treating fluid supply which is preferably located within the treating chamber and provided with heating means for accomplishing distillation of the treating fluid. By reason of this step of continuously recovering and redistillation of used inert medium, substantial savings in fuel and material are effected, the operation in each case being substantially automatic.

Also, in some cases, I impress partial vacuum on the heating chamber to accelerate vaporization of the moisture and lessen the resultant drying time, it being appreciated that the vacuum will lower the boiling point of both the moisture in the wood and the hydrocarbon. In such cases, the high temperatures which I employ may be maintained and a higher boiling treating medium provided which in many cases is obtainable at low cost. Where vacuum is used, it is to be understood that a saturated atmosphere is maintained and preferably the vacuum pressure is held constant throughout a treatment.

Before explaining in detail the present invention, 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 drawing since the invention is capable of other embodiments and of being practiced or carried out 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 the drawing,

Figure 1 is a diagrammatic illustration of one apparatus for carrying out the invention; and

Figure 2 is a section on the line 2—2 of Figure 1.

As one example of carrying out the invention, round green (recently felled) pole timber T suitable for telephone poles, is disposed in the closed chamber or retort 10. This retort is provided with hinged ends 11 and 12 and at its bottom is formed to produce a suitable receptacle 13 for receiving and retaining a liquid treating medium or supply M which in the present case will be a suitable hydrocarbon such as creosote.

The chamber at its top is provided with an outlet indicated at 14 which leads to a condenser 15 preferably a reflux condenser and which latter is in communication with another condenser 16 which likewise may be a reflux condenser of the bubble cap type. Means for impressing a vacuum on the condenser system is provided as shown at 17 i. e., the pipe 17 may be connected to a suitable exhausting apparatus (not shown) and means for separating the liquid condensates is shown at 18, the line 19 indicating a pipe for returning the liquid treating medium back to the supply M in the chamber 10 and a line 19' discharging the water to waste.

Referring to Figures 1 and 2, a vapor collecting header 20 is preferably extended throughout the length of the treating chamber at the top thereof for collecting vapors and discharging them through the outlet 14 to the condenser system.

The treating liquid is distilled by any suitable heating instrumentality preferably, however, in the form of heat transfer coils 21 immersed in the supply M and heated by any suitable circulating medium.

The purpose of the dual condenser system affords opportunity for either a liquid phase or a vapor phase separation of the moisture or both.

The vapor phase separation is to be preferred, and operates as will now be described. Column 15 is maintained at a temperature of 100° C. or slightly more which causes practically complete condensation and immediate return of the hydrocarbon to the treating chamber 10 by gravity through the pipe 22 and outlet 14. The water vapor passing from condenser 15 into condenser 16 through pipe 23 contains some steam-distilled hydrocarbon so that to recover this it is necessary to condense all vapors in this column 16, the hydrocarbon liquid being separated in the separator 18 and thence being returned to the supply M in the chamber 10 through line 19.

The liquid phase separation is accomplished by complete condensation of all vapors in column 15, a trap being provided for the condensate in this column by closing the valve 23' in the line 22 whereby the condensate is retained in the column below the opening 24 and is conveyed to the separator 18 upon opening the valve 25 in the line 26. The operation thereafter is the same as heretofore described.

In certain cases, where the hydrocarbon is miscible or partly so with the water, a vapor phase separation as described before takes place in the column 15. The water vapor containing some steam-distilled hydrocarbon then is caused to pass through line 27 by closing valve 28 and opening valve 28' into the bottom of the column 16 where it is separated by bubble cap or similar fractionation.

Lines 29 and 30 serve to connect the columns with the vacuum or exhaust source associated with the outlet 17 or the open air. The exhaust may be used in conjunction with any of the previously described methods of separation to evacuate from either column or both of them simultaneously.

It is to be understood that the operation of the condenser system is continuous and practically automatic and at low pressure.

A foam-breaking plate or foam-breaking coil 31 is provided over the receptacle 13 to prevent foam from reaching the timber if liquid droplets of water should drop from the wood into the liquid M at the initiation of the process.

It will be noted that the poles are supported by the usual trams 32 which travel over suitable tracks 33 to permit introduction and removal of the poles from the chamber 10 in the customary manner.

The supply M may, in some cases, be located outside of the treating chamber 10 and the medium distilled and conveyed to and introduced into the treating chamber 10 in any suitable manner such as will provide a saturated atmosphere completely filling the chamber 10 at all times. With such an arrangement, the distilled vapors will be maintained at the required temperature during travel to the treating chamber 10 so as to be introduced thereto at a temperature and pressure to permit carrying out the process in accordance with the critical conditions heretofore recited.

After the timber has been placed in the chamber 10, distillation of the treating medium takes place. The treating medium may be introduced to the receptacle 13 at elevated temperature, e. g., just below its boiling point or it may be preliminarily heated in the vessel 13 to a temperature below its boiling point before the introduction of the timber. This enables the distillation of the treating medium to quickly take place. In some cases, of course, it may be desirable to initiate the heating and distillation of the cold heating medium in the presence of the timber but such procedure is not preferred because it lengthens the time period required to make the run and particularly the period during which the system is being brought up to the boiling point of the conditioning liquid might allow a heated atmosphere of moisture and air to be in contact with the wood with the detrimental results mentioned previously such as charring, hydrolysis and checking.

In the case of most creosotes, the lightest fractions distill at about 338° F. and form a satisfactory heating medium, but a higher temperature may be impressed on the creosote to distill off any of the higher fractions. In such latter case, the lower fractions should be removed from the condensing system until fractions distilling at the temperature at which it is desired to maintain the heating of the timber are distilling.

Conditions are quickly reached at which the chamber is entirely filled with hydrocarbon vapors at the required drying temperature and in equilibrium with the liquid phase in the supply M. At this point, the chamber is substantially free of moisture (except for that being continuously evaporated from the wood which is substantially instantaneously removed by the header 20 and outlet 14) as well as oxidizing influences. The pressure at this time is of the order of about one atmosphere; the relative humidity is substantially zero. The aforesaid conditions are continuously maintained constant throughout

the treatment, the moisture being flashed off due to the substantial difference in boiling points between the hydrocarbon liquid and the moisture.

The treatment is continued until the timber is completely dried or dried to meet specified requirements and likewise the action of the condenser system heretofore described is continuously operative.

In the case of poles of the size and character of those above-mentioned, complete drying is effected by my process, as explained, in about two hours. Not only is the dried product free of the objections to be found in products dried in accordance with conventional processes, but the time period in which complete drying is effected compares very favorably with the best that can be accomplished with present practice. For instance, the best drying which could be obtained with the steaming process would require at least eight to ten hours. Moreover, whereas the present invention completely dries the lumber, this is impossible with steaming. For example, the present invention in a two-hour period will remove substantially thirty pounds or more of water per cubic foot or about 100% based on the oven dried weight of the timber. In the steaming process the best average removal of moisture which would be obtained is about 6 lbs. per cubic foot notwithstanding that the drying period is five or six times longer. Moreover, prolongation of the steaming period will not result in the appreciable removal of further moisture. Kiln drying processes naturally require even longer time periods to produce complete drying, for instance, a minimum of 72 hours, which is prohibitive. Air drying obviously is so long and dependent upon so many circumstances that no reasonable comparison can be made except to indicate that after several months the product still would not be as completely dried as poles treated in accordance with this invention.

When the treatment is completed, the timber is removed. Should further processing be desired, as for instance, recovery of light distillates that have been retained by the wood, and/or impregnation with a preservative or treatment with other chemicals, the timber is permitted to remain in the chamber and when such processing is resorted to, liquid in the supply M is drained off. To remove the distillates, a vacuum is then impressed on the chamber 10 to withdraw from the wood and recover a substantial proportion of the treating medium which is condensed therein. This recovered portion is then returned to the liquid and since it is composed of the desirable lighter fractions, these are restored to the treating medium so that the same does not become unduly depleted of such fractions.

After this recovery step of the residual distillate from the wood, which is usually not wholly complete, it may be desirable to further impregnate the wood with liquid preservative under pressure. In such cases it is best to utilize the same creosote from which light fractions have distilled into the wood, as the preservative agent. In this way it is possible to leave in the wood preservative that contains substantially the same ratio of light and heavy fractions that is present in wood that has been air dried and impregnated with creosote having the usual characteristics required.

The impregnation step is carried out by filling the chamber 10 with this preservative and thereupon impressing a pressure upon the liquid. This pressure is sufficient to cause the liquid to penetrate the wood.

By reason of the completeness of the drying of the timber and the fact that it is already wetted with the preservative, i. e., the lighter residual fractions, it is possible to conduct the pressure preservative step or steps with much greater rapidity than heretofore. Consequently, several pressure preservative steps may be resorted to without excessive cost.

The impregnation of the wood with preservative which may of course take place in any suitable way is characterized by substantially complete freedom from "burst" checking as heretofore experienced in connection with steam dried wood and with complete absence of any evidence of "case hardening" as experienced with kiln dried wood.

While I have referred to using a preserving liquid similar to the liquid from which the vapor used for drying is distilled, it is to be understood that other preservatives may be employed. It will be appreciated, however, that there are decided advantages to be gained by using the same liquid for drying as for preservation.

Suitable compounds, all of which are characterized by a boiling point above substantially the boiling point of water and a melting point not greater than substantially 60° C. for accomplishing the drying in accordance with this invention may be selected from the following:

Aliphatic, naphthenic, or aromatic compounds whether saturated or unsaturated, chain or cyclic, and any of their homologues that might be suitable for this procedure such as alcohols, ethers, amines, acids, aldehydes, ketones, esters, halides, cyanides, sulphides, polyhydric alcohols, anhydrides such as phthalic and nitro compounds.

As examples:

n-Decane
n-Decyl alcohols
n-Decyl ethers
n-Decyl amines
n-Decyl esters
n-Decyl halides
n-Decanoic acids
n-Decyl ketones
n-Decyl aldehydes
n-Decyl cyanides
n-Decyl sulphides

Preferred examples of suitable mediums are creosote, petroleum distillates, coal tar, wood tar or wood distillates, and the following:

Phenols
Creosols
Xylenols

High boiling acids

Oleic

High boiling alcohols

Amyl
Isobutyl
Diethylene glycol
Glycerol

Aldehydes

Benzaldehyde
Croton aldehyde
Furfural

High boiling amines

Aniline
Dimethyl aniline
Mono-di-tri-ethanolamines
Pyridines
Quinolines

High boiling esters

Amyl acetate
Butyl acetate
Butyl lactate
Diamylphthalate
Dibutylphthalate
Glycol monoethyl ether acetate
Isopropyl lactate
Octyl acetate

High boiling ethers

Diamyl ether
Diethylene glycol monoethyl ether

Halides

Chlorobenzenes
Chlorinated phenols
Nitrochlorobenzenes
Nitrobenzenes
Ortho-dichlorobenzenes
Ortho-nitrochlorobenzenes
Ortho-nitro toluenes
Paradichloro benzenes

Hydrocarbons

Toluenes
Benzenes
Mesitylenes
Cumenes

Ketones

Benzophenone

In some cases, inorganic salts are added, e. g., chlorides and sulphates such as zinc sulphate or zinc chloride or mixtures of the same to modify the vapor pressure of the solution.

In cases in which the drying treatment is to be followed by preservative treatment with aqueous salt solutions, the conditioning liquid used, namely, the drying medium should be a high boiling alcohol or some similar polar substance such as alcohols, ethers, acids and esters as above mentioned.

Also, in cases where it is desirable that the dried timber not be impregnated with any preservative but be produced virtually free of any treating medium the conditioning liquid used for drying should be one which is substantially completely recoverable or which will be lost during periods of storage of the wood, for example, any of the liquids meeting these requirements and as mentioned above.

In some cases, where it is desired to color the wood or wood products, this may be done by leaving in the wood or wood products a residuum of a compound which imparts the desired color. For instance, by using as the drying medium a dye coupling constituent such as naphthals or quinones and a dye forming constituent such as diazonium compounds included in the wood or wood products before drying, the two couple during the drying operation and the reaction product remains in the wood or wood products after drying to color the same. The diazonium may be applied by dipping the timber in a solution of the same before the timber is subjected to drying.

While I have referred herein particularly to hydrocarbon drying mediums, it is to be understood that saturated atmospheres of inorganic gaseous drying mediums such as carbon dioxide and nitrogen may be employed but are not preferred. In this connection, an inert atmosphere comprising a mixture of these two gases may be employed, but likewise is not preferred. In such cases, it is necessary to utilize intermittent momentary periods of high pressure. The purpose of this is to drive the inert gas having a high temperature into the timber or wood products. On release of the pressure, entrained water is brought out of the wood in order to keep the distribution of moisture in the timber uniform during drying to prevent excessive checking. It is also necessary to circulate these gases very rapidly through condensing apparatus in order to keep the atmosphere substantially free of moisture, this being done during relatively longer alternate periods of low pressure and assuring the substantially instantaneous removal of moisture from the chamber **10**. In this connection, in some cases, mixtures of hydrocarbon gases with inorganic gases may be used, but this is not preferred.

The drying process described above may be utilized for producing moisture-free or moisture-free and impregnated wood products such as sawdust, wood flour, or wood in any other similar physical state and also wood pulp, disintegrated wood, and wood fibres, as well as the fibres employed for making plastic materials produced from wood and as described, for example, in the United States Patents Nos. 1,923,756 and 1,932,255. In connection with the latter, the drying medium will be a substance necessary to impregnate the material for plasticizing the same. Amines such as aniline and aldehydes such as furfural are useful.

Drying in accordance with this invention may be conducted at a low temperature, but this is not preferred because, as heretofore stated, the industry demands rapid drying which can only be obtained at high temperature.

In some cases, the wood and wood products may be rapidly dried in accordance with this invention at a low temperature in the presence of a suitable vacuum. Such process is not preferred but may be desirable from the standpoint of expense. It is not as rapid as when drying is carried out in accordance with this invention at a high temperature with vacuum.

In referring in the claims to wood and wood products, therefore, I intend to include not only green timber and partially seasoned timber, but as well products derived from wood, some of which have just been above mentioned.

In referring in the claims to an inert atmosphere, I mean the drying mediums of the order of those referred to above which are either beneficial to the wood and wood products or do not affect or injure the same. That is to say, the mediums referred to herein either do not chemically react with the wood or chemically react with the wood in a beneficial manner and are considered to be comprehended within the term "inert," whereas steaming, as explained, affects or injures the wood by reason of the hydrolysis which takes place, and hence steam is not inert.

I claim:

1. The process of drying wood and wood products by distilling the water from the wood and wood products comprising placing the wood or wood products in a closed drying chamber, supplying to said chamber for drying the wood or wood products therein, the vapor phase of a com-

pound selected from a group consisting of aliphatic, naphthenic and aromatic compounds having a melting point not greater than substantially 60° C. and a boiling point above that of water at atmospheric pressure and inert to the wood or wood products, maintaining the vapor phase in said drying chamber substantially at a temperature equal to the boiling point of its liquid phase at the pressure in the drying chamber during substantially the entire drying operation, and continuously drawing off the distilled water vapor from the drying chamber.

2. The process of drying wood and wood products by distilling the water from the wood or wood products comprising placing the wood or wood products in a closed chamber, supplying to said chamber for drying the wood or wood products therein the vapor phase of an organic liquid selected from a group consisting of coal tar fractions and petroleum fractions obtained from distillation of crude petroleum and coal tar, said organic liquid being substantially free from solid phase at temperatures above 60° C. and having a boiling point above that of water at atmospheric pressure and being inert to the wood or wood products, maintaining the vapor in said drying chamber at a temperature substantially equal to the boiling point of the liquid at the pressure in the drying chamber during substantially the entire drying operation, and continuously drawing off the distilled water vapor from the drying chamber.

3. The process in accordance with claim 2 wherein the liquid is a creosote fraction.

4. The process in accordance with claim 1 wherein the compound is a wood preserving impregnant.

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