Aug. 13, 1957 C. F. STONE 2,802,281

APPARATUS FOR SEASONING GREEN WOOD

Filed Jan. 27, 1955 2 Sheets-Sheet 1

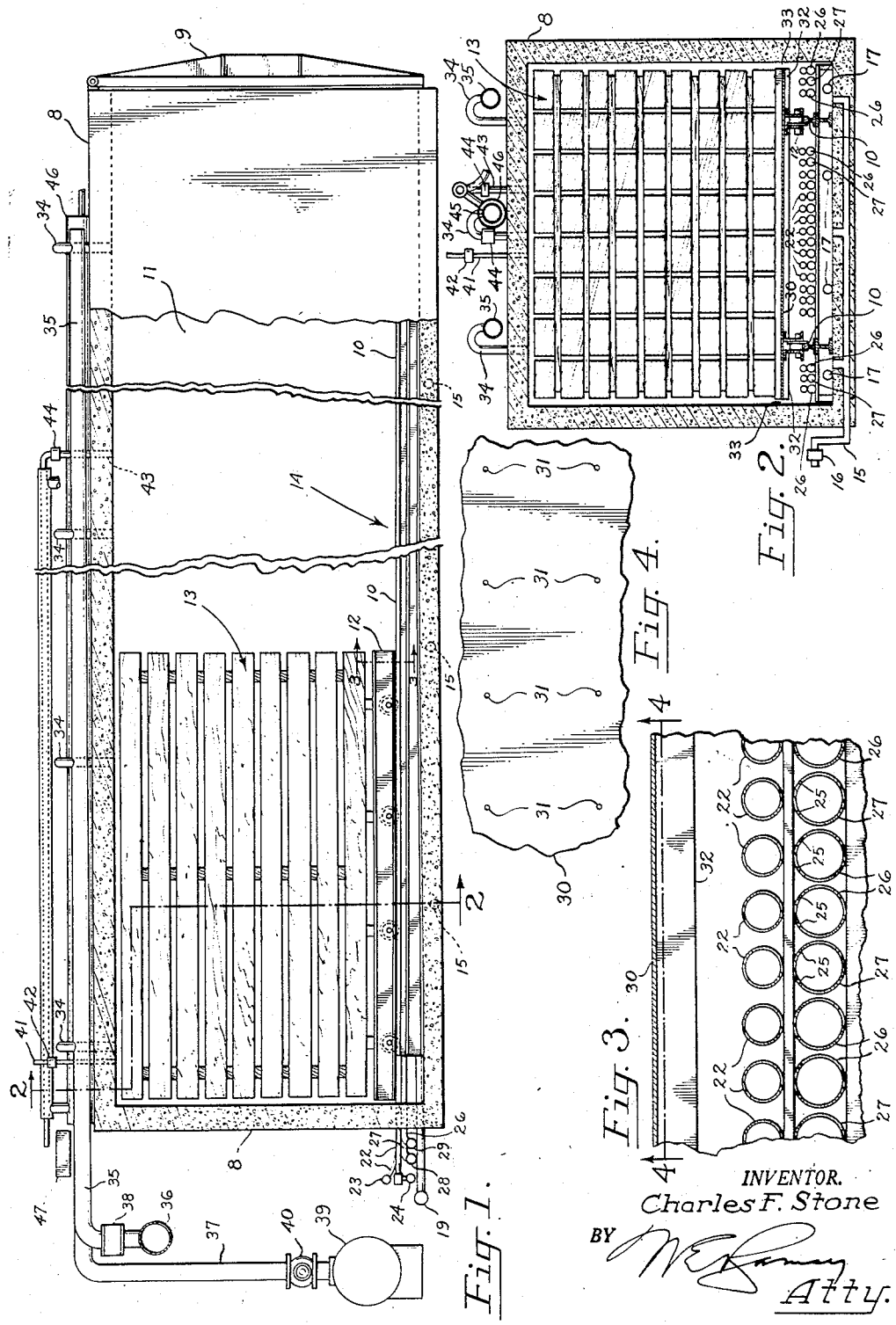


Fig. 1.

Fig. 2.

Fig. 4.

Fig. 3.

INVENTOR.
Charles F. Stone
BY
Atty.

Aug. 13, 1957 C. F. STONE 2,802,281

APPARATUS FOR SEASONING GREEN WOOD

Filed Jan. 27, 1955 2 Sheets-Sheet 2

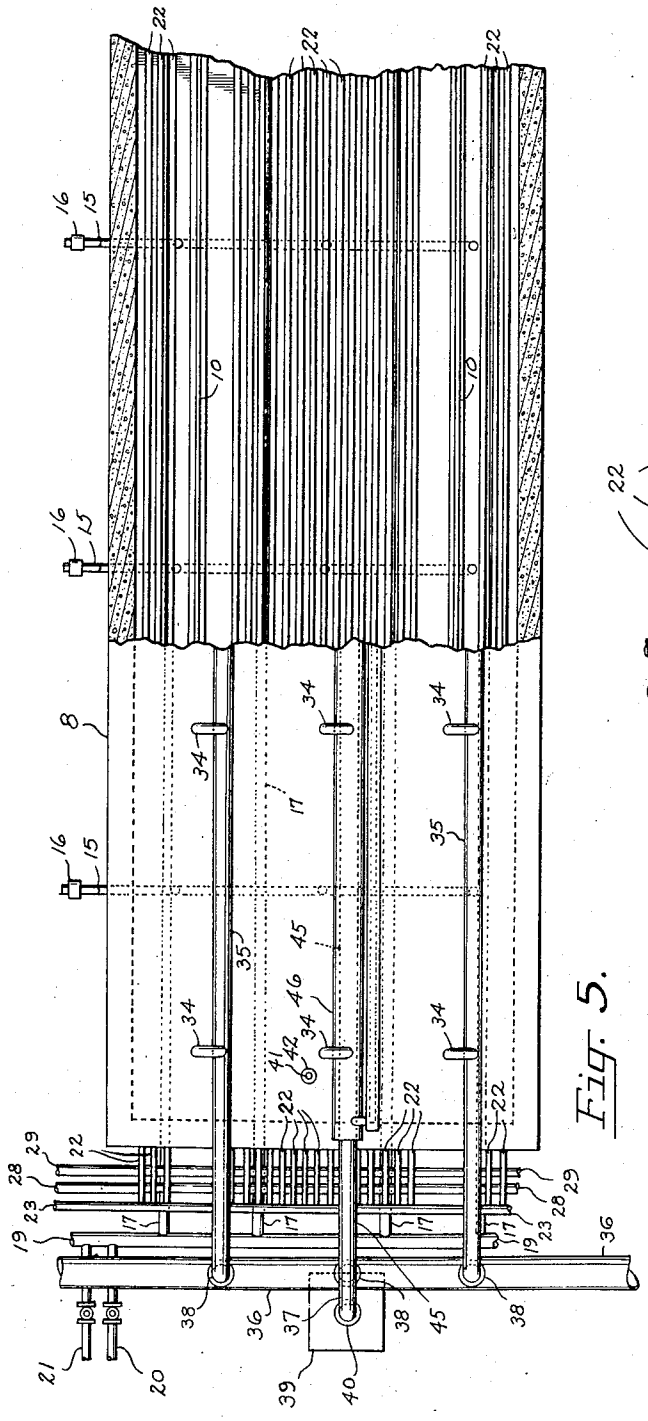


Fig. 5.

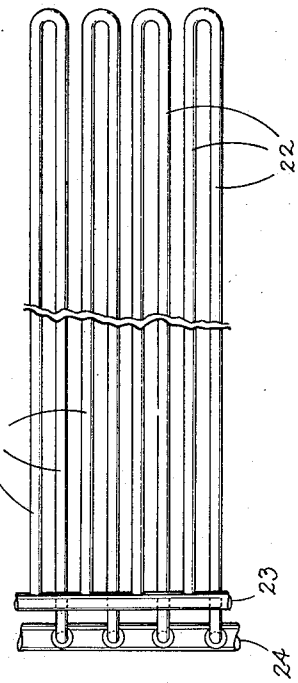


Fig. 7.

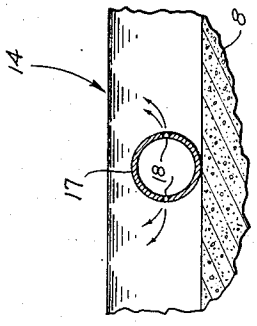


Fig. 6.

INVENTOR.
Charles F. Stone
BY
Atty.

United States Patent Office 2,802,281
Patented Aug. 13, 1957

2,802,281

APPARATUS FOR SEASONING GREEN WOOD

Charles F. Stone, Tillamook, Oreg.

Application January 27, 1955, Serial No. 484,535

8 Claims. (Cl. 34—73)

This invention relates to the rapid seasoning of green wood such as lumber in commercial quantities and, more particularly, to an apparatus for seasoning such wood in an atmosphere precisely controlled as to humidity, pressure, and temperature factors.

One object of my invention is to provide a method and apparatus for the rapid seasoning of green lumber in large quantities by employing elevated temperatures in an atmosphere of controlled humidity so as to eliminate end splitting, checking, cracking, case-hardening, and warping thereby limiting the downgrading and the resultant economic loss. In practice, I have limited this downgrade to less than two percent of each charge.

In many areas and with many wood species, air drying lumber on a commercial scale outdoors is not satisfactory. The main objections to this natural type of treatment or seasoning include the length of time required, up to 18 months with some species, and the problems presented in the storage and protection of large stocks of drying lumber. For these reasons, a substantial portion of the lumber industry, both in the United States and Canada, now practices kiln drying. Kiln drying itself, however, also presents serious problems and is not without limitations when practiced on a commercial scale. Thus, it is a common objective of substantially all modern kiln type seasoning methods to drive the water out by first changing it to a vapor and, thereafter, as this vapor comes to the surface of the wood, to evaporate or boil it off thereby allowing more water to come to the surface. With some wood species such as pine sapwood, few problems are presented, a less precise control is required, the boiling and evaporation are very rapid and the lumber thus is easily seasoned or dried. With other species such as spruce, redwood, or manzanita, however, inexact control or rapid drying are likely to produce excessive damage from splitting, checking, warping, and case hardening. With these more difficult woods the kiln drying process thus is more complex and must be more closely controlled if the percentage of down graded lumber produced is to be kept to a minimum. It is in the seasoning of these more difficult woods that the instant invention finds its most practical use, since one provision of the invention is a more delicate and a more fine control of humidity, pressure, and temperature conditions within the kiln.

In more detail, the instant invention is directed to a type of seasoning in which the lumber first is treated in a humid atmosphere alternately with hot wet steam at atmospheric pressure and with a partial vacuum. This preliminary steaming treatment serves to soften the wood and to remove objectionable constituents of the sap or moisture in the cells. After the initial steaming, the lumber is dehydrated by gradually increasing the temperature thereof in an atmosphere of progressively lower humidity. Finally, after a major portion of the moisture has been removed, a high vacuum is created so as to remove the remaining moisture down to a preselected level and the charge of wood then is cooled to atmospheric temperature. This entire process or method is continuous and the time consumed is minimal since I am enabled to exercise a precise control over both the temperature and the humidity during the practice of each step. In end result, I thus am enabled to season a charge of lumber with less or with no damage, thereby requiring a lower percentage of downgrading in spite of the fact that the total time consumed in seasoning each charge is less than heretofore has been thought possible in the lumber industry.

To the above ends, the apparatus portion of my invention includes a kiln having a horizontal floor and a hollow drying chamber of sufficient clear dimension to accommodate a single truck carrying the green lumber to be seasoned. Substantially the entire floor area of this drying chamber is covered by a water basin of shallow depth arranged to provide moisture to the atmosphere during a portion of each cycle. In addition, a drain maintains the water level within the basin at a preselected height and conduits supply water to and regulate the temperature of the water within the basin. This portion of my invention is of particular importance in controlling the humidity of the atmosphere which is within the chamber and in contact with the surface of the water in the basin. Accordingly, the provision of this apparatus and structure is one object of my invention.

In addition to the above structure, the seasoning apparatus includes both heating and vacuum means selectively for heating and creating a vacuum within the drying chamber. The heating means includes a bank of perforated air and steam pipes arranged adjacent the floor of the kiln but above the height of the water in the basin. Selectively, air or steam is directed vertically up through the chamber from these pipes past a second bank of heated, imperforate pipes so as to control the temperature within the kiln. At this point, an additional novel and important feature of my invention becomes evident. This particular structure is a dome or horizontal shield which overlies the banks of heating pipes beneath the stack of lumber and is provided with a large number of uniformly spaced apertures. The steam and air issuing from the pipes is trapped beneath this dome by virtue of the downturned peripheral margins which bound the outline of the dome. The heat, air, and steam are distributed uniformly throughout the charge of lumber by virtue of the vents which are defined by the many small and equispaced apertures. Further, to provide a structure which allows the interior walls of the kiln to be heated, the margins of this dome or shield are spaced slightly from the walls. Thus, when it is necessary to heat the walls to prevent excess condensation thereon, an increased amount of steam is discharged from the banks of pipes thereby filling the dome and causing a portion of the steam to spill about the edges of the kiln and rise along the surfaces of the walls. The provision of this structure is another of my inventive objects.

Since, of course, it is evident that the quality of the lumber produced by any seasoning or kiln drying method directly is related to the skill of and the control exercised by the operator, I provide two indicia mediums to help guide this operator. The first of these is a telltale exhaust vent and check valve means which opens through the roof of the kiln. Steam continuously issues from this vent to provide a visual indicia of the state of the atmosphere within the drying chamber. That is to say, in addi-

tion to the usual gauges, dials and the like, steam or the like issues from this exhaust vent continuously when the pressure within the kiln is at least atmospheric. The operator thus can judge from the height, color and appearance of the escaping steam or air what the condition is within the kiln. It is one object of my invention to provide such an indicia of the state of the atmosphere within the drying chamber of the kiln.

The second indicia mechanism provides a precise measurement of the amount of moisture within the atmosphere of the kiln during the seasoning process. This structure preferably takes the form of a conduit leading out of the drying chamber, past a check valve and through a condensing unit to a point of discharge and collection such as a measuring cup or pail. Thus, a portion of the steam or air within the kiln continuously is bled off through this conduit and the moisture therein is condensed and measured so the operator will have a more accurate indicia of the current status of the seasoning process when such is desired. Further, to provide an exact measurement, I proportion the dimensions of this conduit so that the amount of steam and moisture escaping therethrough is a preselected fractional portion of the total escape from the kiln. By a simple multiplication, this allows the operator to compute the total moisture escaping from the drying chamber. The provision of this structure also is one of my inventive objects.

Turning now to the process or method expression of the invention, I arrange a charge of green wood such as lumber in intimate contact with and within a controlled atmosphere and above and out of contact with a large continuous body of water, the temperature of which is subject to close control. The body of water is heated to an elevated temperature which may be below the boiling point and, while that temperature is maintained, the atmosphere within the kiln alternately is heated to a preselected elevated temperature (as with wet steam) and evacuated to the preselected vacuum. By utilizing the body of water, the humidity can be controlled with precision and accuracy throughout this steaming or preliminary phase of the method. Continuing, the temperature of the body of water then is reduced gradually at the same time that the humidity of the atmosphere is reduced and the temperature of the atmosphere is increased. This is the drying phase and it is followed by a final evacuation to a preselected high vacuum and a release of this vacuum by an introduction of cool dry air. In end result, I have found that this method allows a more exact and a more precise control of humidity, pressure, and temperature within a kiln. This, in turn, allows the practice of a more rapid seasoning cycle which, at the same time, is productive of less reject or downgraded lumber. Accordingly, the practice of the method allowing these results is an additional object of my invention.

These and other advantages and objects of my invention will become apparent during a consideration of the following detailed description, taken in conjunction with the accompanying drawings, wherein:

Fig. 1 is a foreshortened side view of the kiln with one of plural cars of lumber shown in place;

Fig. 2 is a cross section detail, taken substantially on the line **2—2** of Fig. 1, showing the drain for the water basin and the banks of heating pipes within the drying chamber;

Fig. 3 is a section detail view, taken substantially on the line **3—3** of Fig. 1, more particularly indicating the arrangement of the imperforate heating pipes and the perforated air and steam pipes which underlie the dome and emit air and steam to the kiln;

Fig. 4 is an enlarged detail view, taken substantially on the line **4—4** of Fig. 3, showing the vents or apertures which pierce the dome to allow uniform distribution of the steam and heat throughout the charge of lumber;

Fig. 5 is a top view of the kiln, partially broken away and shortened, showing the banks of pipes and exhaust conduits, together with the relationships thereof to a vacuum pump, multiple return pipes, manifolds, and the like;

Fig. 6 is an enlarged detail view of one of the perforated pipes located within the basin of water selectively to supply cold water or hot steam to the basin, thereby regulating the temperature of the water; and

Fig. 7 is a foreshortened detail view of the imperforate heating pipes which traverse the length of the kiln above the water basin within the drying chamber.

The instant invention has been developed for use on a large scale with large quantities of green lumber in the commercial lumber industry. To this end, it is contemplated that the single kiln illustrated in the drawings actually will be but one of many kilns arranged in a bank side by side and all conected to a common source of supply and exhaust. A discussion of the apparatus and the method with relation to a single kiln will, however, make evident the corresponding structure and practices with a bank or with multiple kilns.

To the above end, the kiln itself consists of a large tank-like structure **8** having a horizontal floor and roof and vertical side and end walls. One of these end walls is formed as a door **9** and tracks **10** traverse the length of the interior of the drying chamber **11** within the kiln. A wheeled truck or car **12** rides these tracks and is stacked with a charge or load of lumber **13**. As will be appreciated by those skilled in the lumber seasoning art, the walls of the kiln may be formed of reinforced concrete or steel boiler plate and the overall dimension may be an exemplary 116 feet in length so as to accommodate approximately seven of the trucks or cars **12**. In addition, the lumber **13** is arranged upon the car in conventional separated or spaced fashion so that all surfaces thereof are exposed to the atmosphere within the drying chamber **11**.

Referring to and comparing Figs. 1 and 2, a shallow water retention basin **14** covers substantially the entire area of the floor of the drying chamber within the kiln. This basin is of limited depth and multiple drain pipes **15** having check valves **16** which limit the water level within the basin to a preselected maximum. This fixes an optimum water depth and any increase in water level produced by extraction of water from the lumber must ascend the risers to the check valve **16** to escape. The risers produce a stand pipe effect and the water discharge will indicate to a large degree the moisture withdrawn from the lumber. To supply water to the basin, I provide a number of conduits **17** having apertures or vent openings **18** therein (see Fig. 6). As shown in Fig. 5, the conduits **17** are joined in common to a manifold **19**. Two valve controlled lines **20** and **21** selectively are operable to deliver either cold water or hot steam to the manifold **19** and thence via the pipes **17** and apertures **18** to the water within the basin. This allows a precise and an exact regulation of the temperature of the water and is an important feature of my invention since the humidity of the atmosphere within the kiln thereby is subject to a more precise control.

Returning now to Figs. 1, 2 and 3, either wet or dry steam and either hot or cool air may be supplied to the drying chamber **11** by apparatus now to be described. To this end, the heating structure includes a bank of imperforate steam pipes **22** which traverse the length of the kiln adjacent the floor therein. These pipes are arranged in loops as shown in Fig. 7, and steam is supplied through a header **23** and is evacuated through a condensate and steam return manifold **24**. By utilizing a boiler with a superheater, I am enabled to produce temperatures within the pipes **22** which vary over a wide range and which can exceed the boiling point of water through utilization of superheated steam.

As best shown in Fig. 3, a second bank of pipes is arranged beneath the heater pipes **22**. These pipes are of

similar configuration in that each is provided with plural ducts or venting apertures **25** in the form of nozzles directed against the heater pipes. In my preferred embodiment, there are twice as many air pipes as steam pipes in this group. To this end, the air pipes are identified by the reference numeral **26** and the steam pipes by the reference numeral **27**. Each of the steam pipes **27** is supplied from a manifold **28** and each of the air pipes from a manifold **29** as shown in Fig. 5. Appropriate air compressor and boiler facilities (not shown) are provided adjacent a central location to supply these manifolds, as will be appreciated.

In function, the pipes **26** and **27** coact with the heater pipes **22** to produce cool air, warm air, wet steam, or dry steam. By feeding cool dry air through the manifold **29** into the air pipes **26**, while the supply to the heater pipes **22** is closed off, cool dry air will be caused to issue up through the kiln via the apertures **25**. To obtain warm air within the kiln, heat may be supplied to the heater pipes **22** so that air issuing from the pipes **26** is warmed as it passes upwardly in the kiln. To aid this function, it will be noted that the vent-like apertures **25** within the air and steam pipes are arranged at an oblique disposition and are directed toward the heater pipes. This assures what may be termed a wiping contact of the air or steam with the heater pipes and is an efficient manner of warming a gas. Finally, a precise control of steam supplied to the kiln is effected both by regulating the wetness or the dryness of the steam which is supplied to the manifold **28** and by regulating the temperature within the heater pipes **22**. For example, saturated steam issued from the steam pipes **27** will be maintained at an elevated temperature during passage through the kiln simply by supplying heat to the heater pipes **22**.

To effect a precise and an exact control of the atmosphere within the drying chamber, it is essential that there be an even, uniform distribution and circulation of heat and steam upwardly through the kiln. To serve this function, I provide the novel vented dome structure which is shown in Figs. 2, 3 and 4. This dome includes a horizontal shield member **30** which is formed as a portion of each of the trucks **12**. When the kiln is completely filled with a charge, the domes or shields on each truck are in substantial end to end abutment and thus substantially the entire wall to wall area of the kiln is blanketed by this horizontal dome structure. In detail, each shield or dome **30** is pierced by a large plurality of small and uniformly spaced apertures or vents **31** (I prefer 1/16 inch vents on 3 inch centers). In addition, the peripheral margins of the shield are turned down as shown at **32** so as to provide a dome-like trap for the steam and heat issuing from the pipes **26** and **27**. For example, as steam issues from the pipes **27** past the heater pipes **22**, it is trapped beneath the dome and is caused to issue through the vent apertures **31** in a substantially uniform blanket. This assures a constant and a uniform circulation and distribution of steam throughout the lumber and from margin to margin of each charge.

As an additional feature, I space the margins **32** of the dome a slight distance from the walls of the kiln. This spacing is indicated at **33** in Fig. 2 and is of particular utility, once again, in providing a precise control of the humidity within the kiln. If, for example, temperature gauges in the walls indicate that the walls of the kiln are cooler than the atmosphere and that condensation thus may be forming thereon, an increased amount of steam is admitted to the kiln via the pipes **27**. This increased supply of steam is continued until it exceeds the capacity of the dome **30** causing a certain amount thereof to spill over the edges or margins **32** and rise through the kiln in direct wiping contact with the walls. This heats the walls and the process is continued until the temperature gauges indicate that the temperature has risen to the desired value. The steam supply then is cut back.

During each step of the drying cycle, of course, the atmosphere within the kiln must be maintained at a precise and an exact condition of temperature, pressure, and humidity for a selected length of time. Accordingly, it becomes necessary to supply steam or air continuously to the kiln and, at the same time, to remove or to allow the escape of an equivalent amount. I prefer to vent through the roof of the kiln so as to provide a circulation of the atmosphere. To this end, plural roof vents **34** are spaced equal distances along the length and breadth of the kiln. These vents are joined in common to longitudinal exhaust manifolds **35** and thence to both a master exhaust collection manifold **36** and a vacuum pump manifold **37**. A T-connection interconnects these latter two collection manifolds **36** and **37** and a check valve **38** is employed to assure a one way flow into but not out of the master exhaust manifold **36**. Further, as will be apparent, a motor driven vacuum pump **39** with a manual control valve **40** are connected serially to the vacuum manifold **37**. In function, the master exhaust collection manifold **36** is maintained at substantially atmospheric pressure and thus the drying chamber **11** of the kiln is open to atmospheric pressure except when the vacuum pump **39** is actuated. In the latter case, the check valve **38** closes and a subatmospheric pressure of preselected value may be created within the drying chamber.

To complete the apparatus, I provide two separate indicia structures. The first of these consists of a vent pipe **41** having a check valve **42** therein. This vent pipe is of small and of limited capacity and is open to the atmosphere within view of the operator of the kiln at all times except when the check valve **42** is closed as by a reduction of the pressure in the drying chamber. Thus, during a substantial portion of the drying cycle, steam is issuing from this vent pipe in a steady stream creating a plume in the air. By judging the height, color, and quality of this plume of steam, the operator thus is enabled to judge the conditions within the drying chamber and more precisely to effect a control of the drying cycle.

The second indicia mechanism consists of a single outlet pipe **43** which is arranged centrally of the roof of the kiln as shown in Fig. 1. This outlet also is restricted to one way flow by a check valve **44** located prior to the point of joinder with a heat exchange consisting of two concentric pipes **45** and **46**. The outer or jacket portion of this structure **46** carries cold water which is flowing to the boiler feed water supply and thus the steam escaping through the vent **43** down the length of the pipe **45** is condensed by a heat exchange principle as will be evident. At the far end of the pipe **45** (see Fig. 1), condensed moisture in the form of water drips from the pipe and is collected in a cup or pan **47**. By measuring the moisture thus collected, the operator is presented with an accurate indicia of the current status of the seasoning process. Further, to provide an even more exact measurement, I have proportioned the dimensions of this conduit to provide a preselected fractional portion of the total amount of steam which escapes from the kiln. For example, a typical installation may provide 562 times the area of the vent **43** in other vents **34**. In this case, the amount of moisture collected in the cup or pan **47** would be 1/562 the total amount of moisture escaping from the kiln. By simple multiplication, the operator thus is allowed to compute the total moisture which is escaping.

In use, the kiln illustrated is but one of many kilns arranged in a bank at a commercial lumber mill. To start a typical seasoning cycle, the door **9** is opened and the kiln is charged with seven truck loads of lumber as shown at **12**, **13** in Fig. 1. After charging, the door **9** is closed and the operator is provided with a check sheet and with accurate gauges and control mechanism. To illustrate an actual seasoning cycle, I have set out below in tabular form the temperatures and other factors as they varied during a twenty-four hour time sequence, utilizing a charge material which was one inch number two common spruce lumber.

Charge material.—1 inch No. 2 common spruce sitka

Time	Phase	Vacuum Inches of Mercury	Supply	Dry and Wet Bulb Readings, ° F.		Basin Water Temp., ° F.	Gauge Humidity, Percent
0800–1030	steaming	0	wet steam	211		200–205	
1030–1100		8					88
1100–1115	vacuum release	0	wet steam	211.5		200–205	90
1115–1215		0	do	211.5		200–205	90
1215–1245		16					
1245–1300	vacuum release	0	wet steam	211.5		200–205	88
1300–1400		0	mixed wet and dry steam.	212		200–205	88
1400–1445		23				200–205	
1445–1500	vacuum release	0	dry steam				88
1500–1800	drying	0	hot dry air	190	174	110–120	69
1800–2000		0	do	200	178	100–110	61
2000–2300		0	do	205	175	90–100	51
2300–0200		0	do	212	172	80–90	41
0200–0400	relieve surface stress.	0	mixed wet and dry steam.	213		80–90	81
0400–0500		24					
0500–0600	vacuum release	0	cool dry air	120		70	
0600–0800	cooling	0	do	100		70	

Moisture content 18%, no splits, checks, warps, etc.

In explanation of the above tabulation, the charge was completed and the door **9** closed at 8:00 a. m. For the next two and a half hours, the temperature gradually was increased to 211° F. by admitting wet steam through the pipes **27**. This temperature gradient must be gradual so as to bring each and every stick of lumber within the kiln to the same precise 211° F. temperature slowly and uniformly without damage. At the same time the water within the basin **14** was gradually raised to the indicated 200–205° F. temperature. Thus, a certain amount of moisture evaporated or escaped from the water basin into the atmosphere and the humidity was brought up to the high percentage shown in the table opposite the 1030 entry.

Beginning at 10:30 a. m., the steam was restricted and the vacuum pump **39** turned on so as to produce the indicated eight inch vacuum. From 11:00 until 11:15 a. m., the vacuum was released by slowly adding wet steam until a temperature of 211.5° F. was achieved. This temperature and the high humidity were maintained until 12:15 when, once again, a vacuum was created by actuating the vacuum pump **39** and diminishing the steam supply. After release of this vacuum between 12:45 and 1:00 p. m., a mixture of wet and dry steam was added to the kiln at a temperature of 212° F., while the basin water was maintained at 200–205° F. Between 2:00 and 2:45 p. m., a 23 inch vacuum was built up, followed by a slow release with dry steam between 2:45 and 3:00 p. m. At this point, the drying cycle itself was begun and the steaming cycle terminated.

To the above end, the supply of heat to the water basin **14** via the pipes **17** was cut down until the temperature of the water bath was brought down to approximately 110° F. For the next eleven hours, the temperature in the water basin gradually was reduced from the 110–120° F. range to a 80–90° F. range. At the same time, the temperature of the atmosphere within the drying chamber was increased from 190° to 213° F. as indicated by the dry bulb readings. This portion of the drying cycle, of course, was practiced by admitting hot dry air via the air pipes **26** and by carefully adjusting the temperature thereof. As shown by the comparative wet bulb and the gauge humidity figures in tabular outline, the humidity gradually was reduced to about 41% during this drying cycle. At this point, the drying of the lumber was complete. However, to relieve stresses and to prevent case-hardening, I have found that it is best to admit a mixture of wet and dry steam. This raises the humidity and the temperature, wets the surface of the lumber, and functions similar to annealing in metals. It is followed by a high vacuum equivalent to twenty-four inches of mercury. The cycle then is completed by gradually releasing the vacuum with cool dry air in the presence of a cool water basin and returning the temperature to a low value which may be slightly above that of the atmosphere over a three hour period of time.

In end result, the spruce was found to be in very good condition with no chips, warps, splits, or checks, and there was no sign of case-hardening. Utilizing deflection tests for strength and brittleness and nail tests for case-hardening or splits, it was found that spruce seasoned in this manner over a twenty-four hour period was superior to any known commercial method heretofore practiced. Conventionally, spruce treated in a kiln provides approximately six percent rejects or downgrades even with the most careful control. However, by utilizing the structure above set forth and by practicing the sequence above described, I have been able to reduce the rejects to less than two percent and to decrease the time substantially. Other species of wood and other dimensions of lumber will, of course, require variations in the length of time required to season the wood and in the precise sequence of the steps. However, with the one inch number two common spruce, it has been discovered that the moisture content of eighteen percent can be achieved in twenty-four hours with a minimum of damage.

Since, to the best of my knowledge, the use of a controlled temperature water basin such as **14** is new in the kiln art, a more detailed analysis of the function thereof is appropriate at this point. In the initial or steaming stages of the seasoning, it is essential that the atmosphere within the kiln be moist so as to prevent damage to the lumber. Thus, during this stage, I raise or maintain the temperature of the water in the basin to a point just below boiling (200–205° F. in the exemplary charge). This allows moisture to escape or evaporate from the surface of the water into the atmosphere and is of particular benefit in maintaining a constant, fixed humidity. Thus, it seemingly places the atmosphere and water in a state of equilibrium during the periods when steam is being admitted.

During the drying cycle, on the other hand, the temperature of the water in the basin **14** is decreased, step by step, as the temperature of the atmosphere is increased. As will be understood, the water thus becomes a long, wide cold surface to cause condensation of moisture from the air. As the moisture is removed from the lumber by the warm air, it is both vented to exhaust and picked up by condensation on the surface of the water. This process is amplified as the water temperature is reduced and the temperature of the atmosphere is increased thus being of substantial benefit to a more rapid seasoning cycle.

In practicing the method portion of my invention, I ar-

range a charge of green wood in intimate contact with and within a controlled atmosphere such as that provided by the drying chamber within the kiln illustrated. This charge is arranged above a large continuous body of water, the level and temperature of which are subject to close control, as explained with reference to the structure associated with the water basin **14**. Thereinafter, the body of water is heated to an elevated temperature but below the boiling point, as by supplying steam to the basin **14** via the pipes **17**. While maintaining that elevated temperature, the atmosphere within the kiln alternately is heated to a preselected elevated temperature at a preselected humidity and is evacuated to a preselected vacuum. This step can be practiced with the apparatus and structure disclosed above.

Continuing with the method, the temperature of the body of water is gradually reduced as is the humidity of the atmosphere, while the temperature of that atmosphere gradually is increased to a preselected maximum as shown in the tabular outline heretofore mentioned. Finally, the atmosphere surrounding the charge is evacuated to a high vacuum and then released followed by an introduction of cool dry air to complete the seasoning cycle. The benefits and advantages which flow from the practice of this method are similar to those which flow from the use of the disclosed structure and apparatus. Accordingly, they will not be repeated at this point.

In summary, it will be seen that I have provided both a method and an apparatus for the rapid seasoning of green lumber in large quantities. This method and apparatus employ elevated temperatures in an atmosphere of precisely controlled humidity so as to eliminate end splitting, checking, cracking, case-hardening, and warping thereby limiting the downgrading and the resultant economic loss to the lumber mill. In end result, this continuous method and the apparatus by which it is practiced allow a more exact and a more precise control of the three factors of humidity, pressure, and temperature within the kiln thereby allowing a more rapid and continuous seasoning cycle to be practiced. Commercially, this method and apparatus are of substantial importance both because of the saving in time costs and because of the production of less reject or downgraded lumber.

I claim:

1. An apparatus for the rapid seasoning of green lumber in commercial quantities, comprising a kiln having a horizontal floor and roof and vertical side and end walls enclosing a hollow drying chamber of sufficient clear dimension to accommodate a plurality of trucks loaded with lumber to be seasoned, a water retention basin covering the entire floor of said chamber intermediate said side and end walls, drain means including a stand pipe communicating with said basin to maintain the water level uniform therein to a point below the trucks and lumber, and independently operable heating and vacuum means selectively for heating and for creating a vacuum within said drying chamber to season the lumber in the presence of the water in said basin.

2. In a kiln for seasoning green wood, a sealed drying chamber having a horizontal floor of sufficient clear dimension to accommodate at least a single truck carrying wood to be seasoned, a shallow water retention basin covering substantially the entire area of the floor of said chamber, independently operable heating and vacuum means selectively for heating and for creating a vacuum within said drying chamber to season the wood therein, said heating means including a bank of perforated air and steam pipes arranged adjacent the floor of said kiln but above said basin selectively to direct air or steam vertically up past a second bank of heated imperforate pipes through said drying chamber, and a telltale exhaust vent means opening through said roof to provide a visual indicia of the condition of the atmosphere within said drying chamber.

3. An apparatus for seasoning green wood in an atmosphere of controlled humidity, pressure, and temperature, comprising a kiln having a horizontal floor within a drying chamber, basin means located within said chamber and extending over substantially the entire floor area thereof for controlling the humidity of the atmosphere therein, vacuum means for creating a vacuum within said drying chamber, steam supply and vented dome means arranged above said basin and substantially coextensive therewith to effect a uniform distribution of steam upwardly throughout said chamber, and means for extracting a preselected fractional portion of the atmosphere within said chamber and condensing and measuring the moisture therefrom as an indicia of the moisture content of said atmosphere, said means comprising a bleeder vent leading from said chamber, a condenser associated therewith, and a condensate collector adjacent said condenser to afford visual observation of the quantity of moisture produced in said chamber.

4. An apparatus for seasoning green wood in an atmosphere of controlled humidity, pressure, and temperature, comprising a kiln having a horizontal floor and roof and vertical side and end walls enclosing a hollow drying chamber, a water retention basin of shallow depth covering substantially the entire area of the floor of said chamber intermediate said side and end walls, conduit means for supplying water to and for regulating the temperature of water within said basin, said conduit means including a perforated section of pipe arranged within said basin selectively for supplying cold water or hot steam to the basin, independently operable steam and air heating means and vacuum means selectively for heating and for creating a vacuum within said drying chamber to season the wood therein, said heating means including a bank of perforated air and steam pipes arranged selectively to direct air or steam vertically up past a second bank of heated imperforate pipes through said drying chamber, vented dome means arranged above said heating means to collect and to effect a uniform distribution of air and steam upwardly through said chamber, and means for extracting a preselected fractional portion of the atmosphere within said chamber and condensing the moisture therefrom as an indicia of the moisture content of said atmosphere, said latter means including a conduit leading from said chamber past a check valve and through a condensing unit to a point of discharge and collection without said kiln, the dimension of said latter conduit bearing a preselected fractional relation to the total dimension of all venting structure from said kiln thereby allowing a precise calculation of the total moisture escaping.

5. A dry kiln comprising a chamber of substantially uniform horizontal cross section having a roof, a floor, side and end walls, a water basin occupying substantially the entire floor area, means arranged in said basin for supplying cool or hot fluids to vary the temperature of the water contained within said basin, a lumber storage compartment overlying said basin but spaced vertically therefrom, heating means including a series of fluid conduits in predetermined relation lying intermediate said basin and said lumber storage compartment, and means between the basin and said heating means for selectively directing different fluids of different temperatures, and for eliminating flow therethrough, to vary the quantity, temperature and moisture content of fluids flowing therefrom to the lumber storage compartment.

6. A dry kiln comprising a chamber of substantially uniform horizontal cross section having a roof, a floor, side and end walls, a water basin occupying substantially the entire floor area, means arranged in said basin for varying the temperature of the water contained within said basin, a lumber storage compartment overlying said basin but spaced vertically therefrom, heating means including a series of fluid conduits in predetermined relation lying intermediate said basin and said lumber storage compartment, said series of fluid conduits comprising

spaced imperforate heating pipes in overlying relation with perforate fluid discharge pipes, said fluid discharge pipes having orifices arranged in predetermined pattern to the overlying heating pipes to direct upwardly directed divergent jets about said overlying heating pipes, thereby to wipe about the exterior surfaces thereof and to effect good heat transfer therefrom, and means for selectively directing different fluids to said fluid discharge pipes, and for eliminating flow therethrough, to vary the quantity, temperature and moisture content of fluids flowing therefrom to the lumber storage compartment.

7. A dry kiln comprising a chamber of substantially uniform horizontal cross section having a roof, a floor, side and end walls, a water basin occupying substantially the entire floor area, means arranged in said basin for varying the temperature of the water contained within said basin, a lumber storage compartment overlying said basin but spaced vertically therefrom, heating means including a series of fluid conduits in predetermined relation lying intermediate said basin and said lumber storage compartment, said series of fluid conduits comprising spaced imperforate heating pipes in overlying relation with perforate fluid discharge pipes, said fluid discharge pipes having orifices arranged obliquely to the overlying heating pipes to direct upwardly directed divergent jets about said overlying heating pipes, thereby to wipe about the exterior surfaces thereof and to effect good heat transfer therefrom, and means for selectively directing different fluids to said fluid discharge pipes, and for eliminating flow therethrough, to vary the quantity, temperature and moisture content of fluids flowing therefrom to the lumber storage compartment.

8. A dry kiln comprising a chamber of substantially

uniform horizontal cross section having a roof, a floor, side and end walls, a water basin, means arranged in said basin for varying the temperature of the water contained within said basin, a lumber storage compartment overlying said basin but spaced vertically therefrom, heating means including a series of fluid conduits in predetermined relation lying intermediate said basin and said lumber storage compartment, means between the floor and said heating means for selectively directing different fluids, and for eliminating flow therethrough, to vary the quantity, temperature and moisture content of fluids flowing therefrom to the lumber storage compartment, a dome means overlying said fluid conduits and lying intermediate the latter and said lumber storage compartment, said dome means having a downturned peripheral flange to entrap and restrain fluids flowing upwardly from said basin and said fluid conduits, and the peripheral margins of said dome means being spaced from the walls of said container to release and direct flow of said upwardly flowing fluids along said walls to inhibit condensation of moisture thereon.

References Cited in the file of this patent

UNITED STATES PATENTS

1,125,862	McMullen	Jan. 19, 1915
1,166,819	Derby et al.	Jan. 4, 1916
1,490,569	Krick	Apr. 15, 1924
1,678,559	Devine	July 24, 1928
1,902,637	Grow	Mar. 21, 1933
2,073,423	Lacasse	Mar. 9, 1937
2,296,546	Toney	Sept. 22, 1942
2,363,715	Wells	Nov. 28, 1944