June 29, 1937. J. F. COBB 2,085,634

DRY KILN

Filed April 15, 1932 3 Sheets-Sheet 1

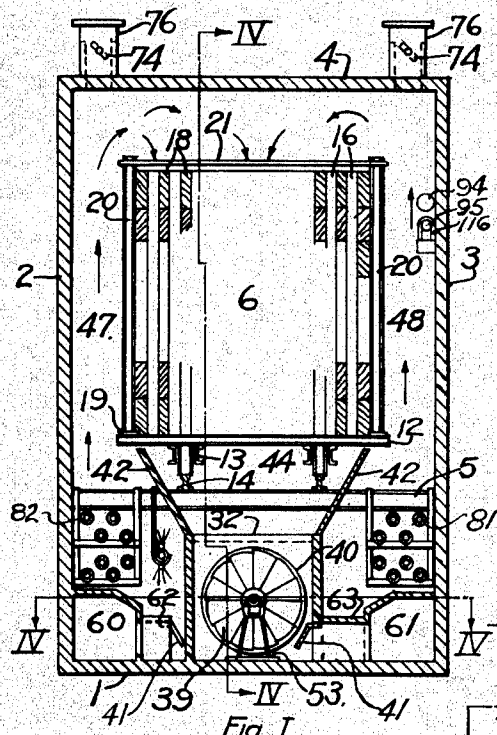


Fig I

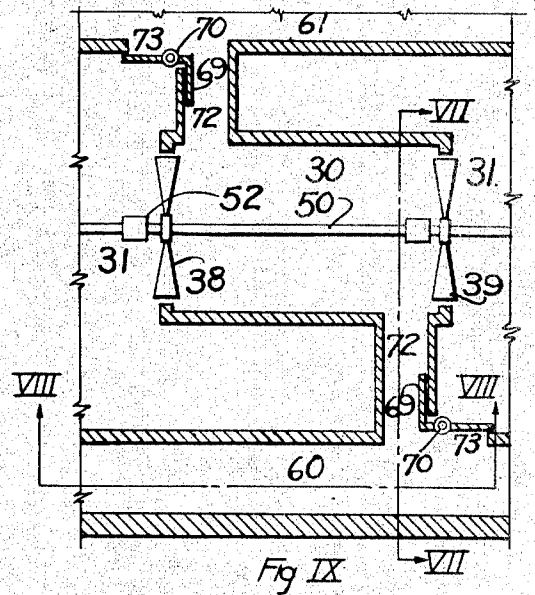


Fig IX

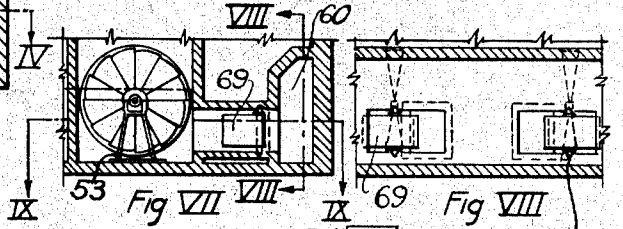


Fig VII Fig VIII

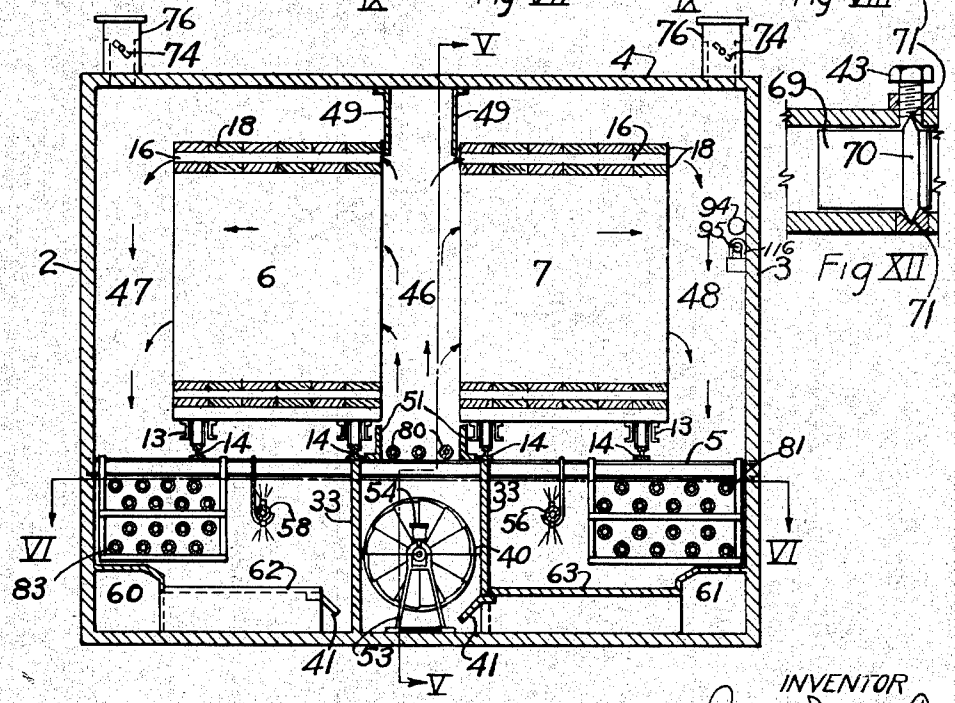


Fig II

Fig XII

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DRY KILN

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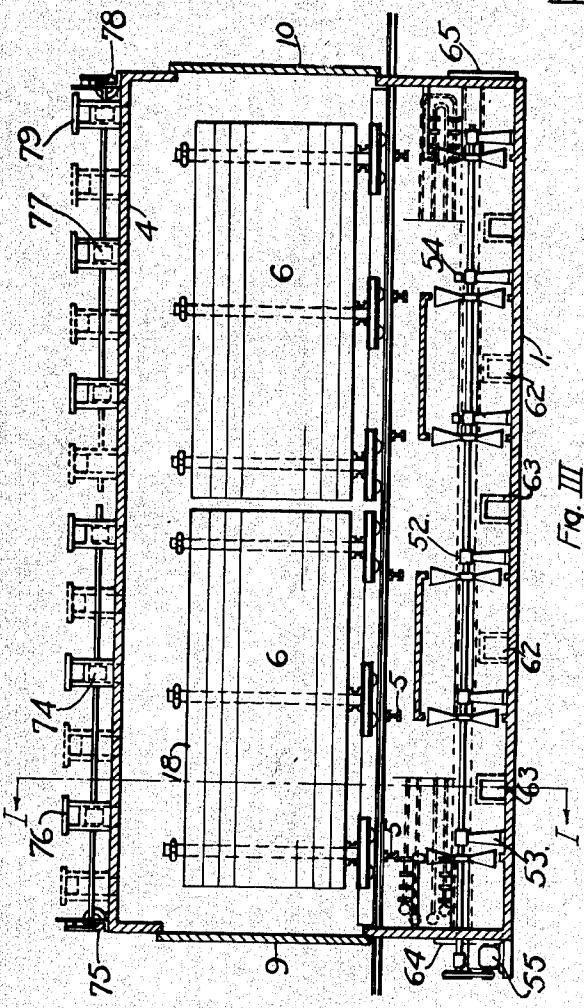


Fig. III

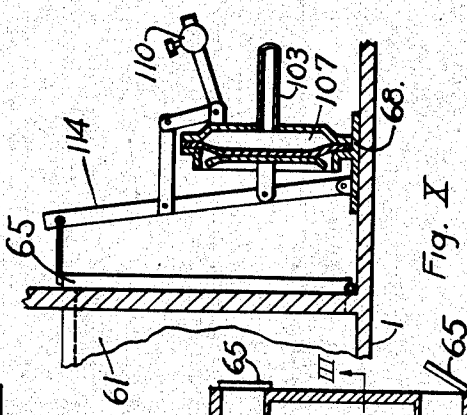


Fig. V

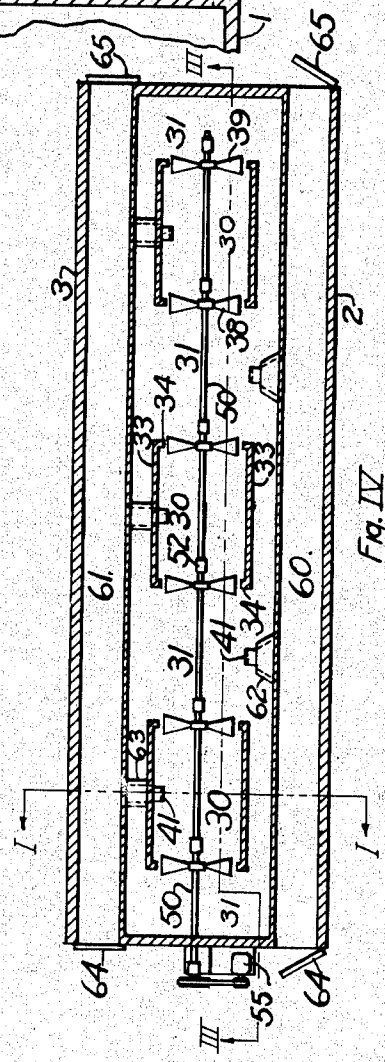


Fig. IV

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DRY KILN

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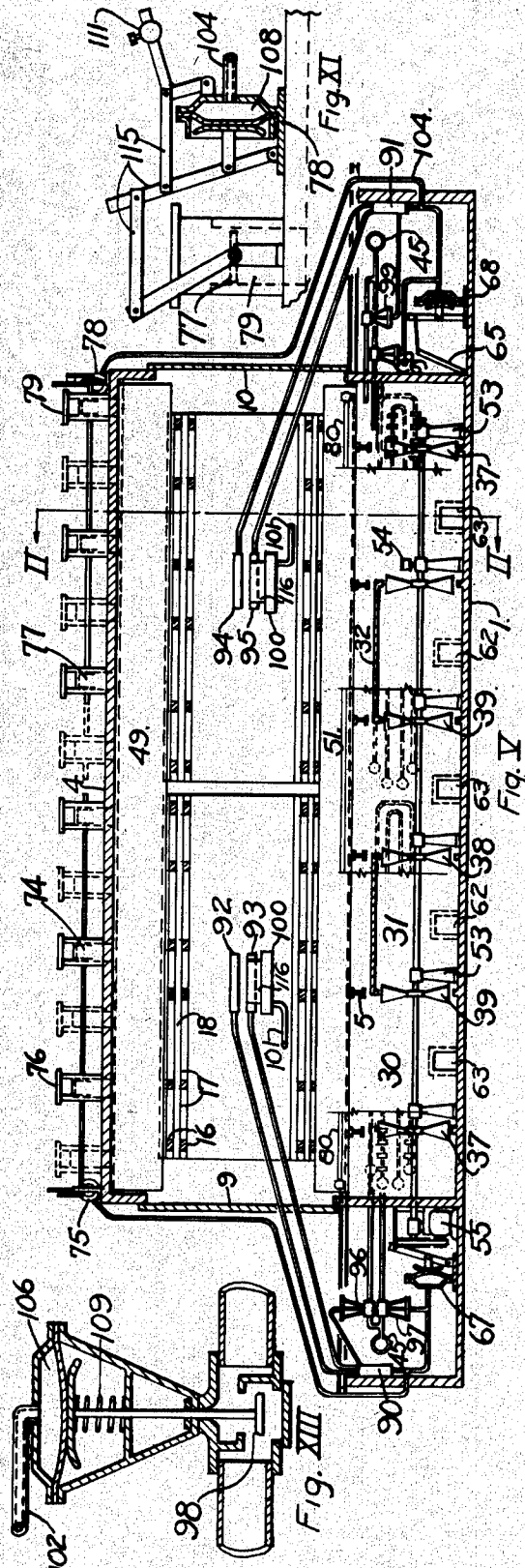


Fig. V

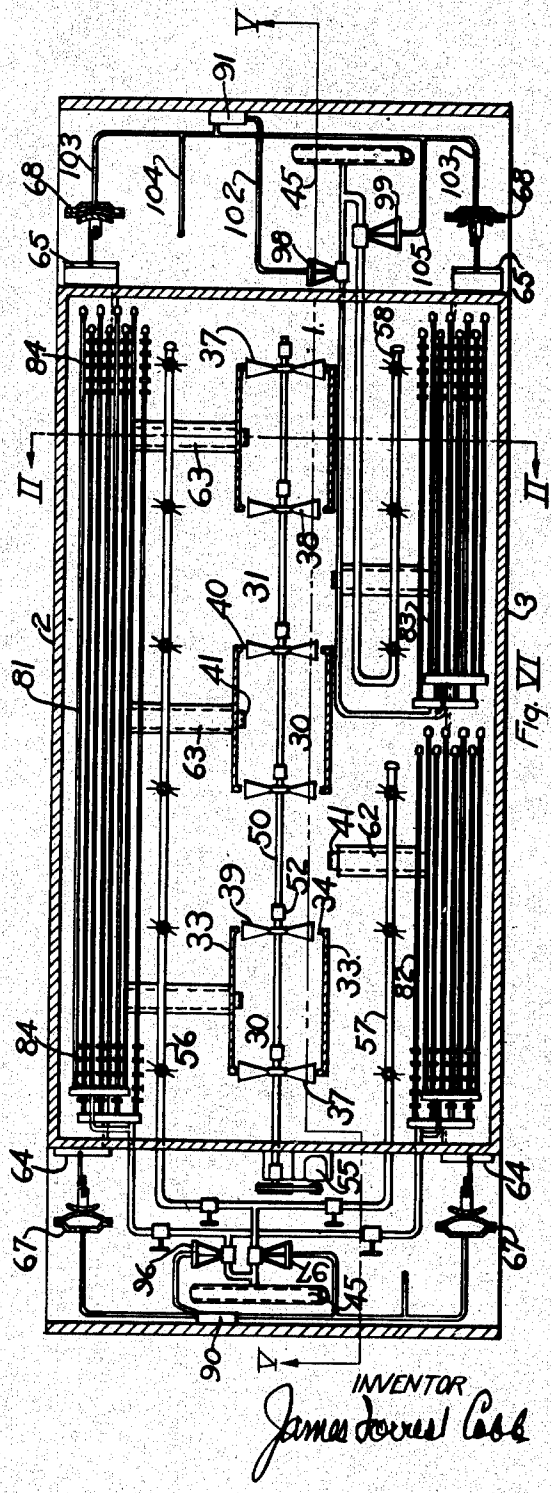


Fig. VI

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Patented June 29, 1937 2,085,634

UNITED STATES PATENT OFFICE

2,085,634

DRY KILN

James Forrest Cobb, Portland, Oreg., assignor to Moore Dry Kiln Company of Oregon, a corporation

Application April 15, 1932, Serial No. 605,403

13 Claims. (Cl. 34—46)

My invention relates to improvements in dry kilns and particularly kilns of the internal fan type in which the circulation of the atmosphere within the kiln is effected substantially transversely across stock loads stacked therein, by means of the rotation of power driven rotary fans operatively mounted within the kiln in pairs, either above, below, or at one side of the material to be dried.

An object of my invention is to provide a novel air circulating system within a kiln.

Another object of my invention is to provide within a kiln, spaced compartment air circulating units, each open on one of its sides and having paired fans operatively mounted, one in each of its two ends, which fans may effect intake of kiln atmosphere at the two ends of the unit and discharge of kiln atmosphere from one of its sides in one stream when the fans are rotating in one direction, and effect intake of kiln atmosphere at one side of the unit and discharge of kiln atmosphere from the two ends of the unit in two streams when the fans are rotating in the opposite direction.

Another object of my invention is to provide a novel fresh air and ventilating system for a dry kiln.

Another object of my invention is to provide automatic control of fresh air intake into the kiln regardless of the direction of air circulation within the kiln.

Another object of my invention is to provide a novel means of taking in fresh air from two fresh air conduits into the kiln to the suction side of the fan system from two sides of the kiln in either direction of fan rotation.

Another object of my invention is to effect a novel method of and inter-related apparatus for kiln control, in a kiln in which stocks of different initial moisture content dried at the different ends of the kiln respectively control the drying process, to bring the stocks to a substantially uniform moisture content in the same length of time.

Another object of my invention is to provide a novel heating system for a charge kiln in which stock of different moisture content, at different ends respectively of the kiln may be dried to the same final moisture content during the same drying period.

Another object of my invention is to effect a uniform application of heat substantially the full length of a kiln containing stock varying in initial moisture content, and to effect additional heat and/or humidity and ventilation in sections of the kiln containing higher moisture content stock to provide uniform drying.

Another object of my invention is to provide within a kiln a transverse circulation with means for effecting a greater volume of air circulation at the ends adjacent to the doors of the kiln without providing longitudinal circulation.

Another object of my invention is to effect extra heating of the air at the ends adjacent to the doors of the kiln to compensate for heat losses there, without producing longitudinal circulation within the kiln.

What constitutes my invention will be hereinafter specified in detail and succinctly defined in the appended claims. In the accompanying drawings wherein my invention is illustrated in the present preferred form of embodiment,

Figure I is a transverse vertical section of a single track kiln embodying my invention.

Figure II is a transverse vertical section of a double track kiln showing a modified circulating system to that shown in Figure I.

Figure III is a longitudinal vertical section taken along the line III—III of Figure I.

Figure IV is a plan view taken along the line IV—IV of Figure I.

Figure V is a longitudinal vertical section partially diagrammatic taken along the line V—V of Figure II.

Figure VI is a plan view partially diagrammatic of a two track kiln taken along the line VI—VI of Figure II.

Figure VII is partial transverse vertical section of a modified form of fresh air duct system of that shown in Figures I and IV.

Figure VIII is a partial longitudinal vertical section taken along the line VIII—VIII of Figure VII.

Figure IX is a partial plan view taken along the line IX—IX of Figure VII.

Figure X is a detailed cross section of a motor lever employed in Figures V and VI for operating fresh air doors.

Figure XI is cross section of motor lever with mechanism for operating ventilator dampers.

Figure XII is a vertical section through the pin of an automatic right angle damper for a fresh air port and duct, illustrated in Figure IX.

Figure XIII is cross section of a preferred form of diaphragm valve which controls the steam supply to the heating and spray pipes within the kiln.

Referring to the numerals on the drawings—1 indicates the floor, 2 and 3 the side walls, and 4 the roof of the kiln.

The kiln is equipped with doors 9 and 10, one of which is preferably at each end of the kiln.

Stock loads 6 and 7 are supported by bunks 12, which are carried on trucks 13, which roll on tracks 14 extending through the kiln. The tracks are carried on suitable supports comprising preferably beams 5, which are supported by the side walls 2 and 3 of the kiln and which also may be supported by the fan duct side walls 33, as shown in Figure II.

The stock loads 6 and 7 are preferably stacked having stickers 16 between layers of material to be dried, providing interstices 17 open for transverse circulation across the stock loads between the layers 18. The stock, when lumber, for example, is preferably stacked edge to edge between stickers on the stock loads either flat or edgewise.

Figure I illustrates the embodiment of my invention employing edge piling of lumber. The bunks 12 preferably have stake pockets 19, at each of their ends, having a recess for the insertion of I-beam or other stakes 20, which support the side tiers 18 of lumber. I preferably provide a binder 21 extending transversely across the top of the load, holding the top ends of the stakes 20 in position. The binders 21 may be of any well-known type, such as, rigid binders, spring binders, etc., well known in the art. Two trucks 13, one bunk 12, two stakes 20, and one binder 21 are assembled as a unit. Several units are assembled in a series to receive an edge stacked stock load of lumber, and these units may be spaced as desired, each stock load having at least two units and preferably more.

Figure II illustrates the embodiment of my invention employing flat stacking in a double track kiln. The stock loads 6 and 7 are disposed on longitudinal tracks extending through the kiln substantially parallel to and on opposite sides of a centrally disposed air circulating system, which likewise extends substantially the full length of the kiln in such a position that it may circulate the kiln atmosphere upward or downward if overhead fans are used, into the space between the stock loads 6 and 7, then across them in opposite directions, and then back to the air circulating system in continuous recirculation. The fan duct system comprises spaced compartment air circulating units of the same general design in Figures I and II for edge and flat piling.

The kilns may be of the single or double track type, as illustrated respectively in Figures I and II. It is understood, however, that kiln buildings may be constructed with any preferable number of tracks for which my invention may be operably adapted.

The drawings illustrate kilns in which the air circulating system is located below the tracks. It is understood, however, that the kilns may be in effect inverted and the air circulating system may be disposed above the stock loads. In this case the tracks would preferably be supported by the floor, instead of on I-beams 5.

A distinctive feature of my invention is to be found in the air circulating system of the apparatus. The air circulating system comprises spaced compartment air circulating units 30, each of which is open on one of its sides. The top side is open in kilns having the air circulating system below the stock loads. Between each two adjacent spaced compartments 30 is a covered passageway 31, open on two sides and having a passageway cover 32. This cover connects the compartment units 30 preferably substantially at their top edges, when the fan system is below the stock loads.

The compartment units 30 are made up of compartment side walls 33 and end walls 34 resting on the floor 1, when the fan system is below the stock loads. The compartments' end walls 34 are apertured respectively for the accommodation of right hand and left hand rotary fans 38 and 39 respectively, which are preferably housed by the fan housings 40, which may form a part of and connect with the side walls 33. In case the compartment walls are curved, or having a shape other than rectangular in horizontal cross section, the purposes and effects of the parts corresponding to the parts named would be the same.

Connecting with the top edges of the compartment side walls 33 and 34, and of the passageway cover 32, are the baffle plates 42, which may be upstanding or inclined and may extend substantially the full length of the kiln as illustrated in Figure I. These baffle plates 42 are not indispensable as in cases where the side wall 33 extend up to rail level to make substantial closure between the side walls 33 and the corner of the stock loads, as in Figure II, providing open means of communication between the compartment units 30 and the corridor 46 which has a plurality of outlets through stock loads forming the sides of the corridor as in Figure II. The baffles 42 in Figure I, or 51 in Figure II may be used if desired to effect more complete closure between the side walls 33 and the corners of the stock loads.

I preferably provide the baffle plates 42, however, in edge piling embodiments of my invention as illustrated in Figure I, to provide the plenum chamber 44 between the openings of the compartments 30 and the stock loads. These baffle plates 42 extend from the side wall 33 of the compartments and from the side edges of the passageway cover 32 upwardly, for example in Figure I, to form substantial closure with the side corners of the stock loads 6.

In flat piling embodiments of my invention, as illustrated in Figure II, the air circulating system is disposed between and below the stock loads. It is understood, however, that this circulating system may be disposed in a similar position in single track kilns in which each stock load is partially divided by a central flue, similar to the corridor 46 between the stock loads 6 and 7 in Figure II, for example. It is immaterial whether or not two stock loads 6 and 7 are stacked with the corridor 46 between them, or whether one stock load is partially divided by central flue corresponding to 46, and preferably covered at the top with a cover plate corresponding to the ceiling baffles 49.

In the edge piling embodiments of my invention, as shown in Figure I, I preferably provide corridors 47 and 48 on opposite sides respectively of the stock loads 6, between the stock load and the side walls of the kiln.

In the flat piling embodiment of my kiln I preferably provide corridors 46 medially and extending longitudinally within the kiln, and corridors 47 and 48 at the sides between the stock loads and the side walls of the kiln. In Figures I and II the corridors 47 and 48 are shown to extend from the ceiling to the floor of the kiln and to connect at their lower portions with the passageways 31, for example in Figures I and II. In Figure II the corridor 46 extends from the top of the stock load to the bottom of the compartments 30 of the air circulating system, but corridor 46 in Figure II may be considered to cor-

respond to the plenum chamber 44 in Figure I; in fact, the corridor 46 in Figure II is a plenum chamber and serves substantially the same purpose as the plenum chamber 44 in Figure I.

The fans 38 and 39 are preferably right and left hand having blades respectively set at different angles, and opposed in the direction of their discharge, mounted in pairs on a common shaft 50 carried on bearings 52, mounted on bearing stands 53, supported by the floor 1 of the kiln when the air circulating system is below the stock loads. The bearings may be supplied with lubricant through the oil cups 54 for example. The fan shaft 50 is driven preferably by any suitable driving means, such as for example, an electric motor 55.

An essential feature of my invention consists in the design of the air circulating system and the air circulation therefrom. The discharge of the kiln atmosphere from the compartments 30 and 31 in the two directions respectively of rotation of the fans, is in two counteracting currents moving substantially vertically from each compartment 30 into the plenum chamber 44 or 46 in one direction of fan rotation, and in counteracting currents from two adjacent compartments 30, in the passageway 31 where they move substantially laterally in different directions from the passageways 31 in the reverse direction of fan rotation. In each direction of fan rotation the kiln atmosphere passes across the stock loads and back to the fans, in continuous recirculation.

Attention is called to the method of admitting fresh air into the kiln. The fresh air conduits 60 and 61 on opposite sides of the kiln are provided with fresh air ducts 62 and 63 respectively. The fresh air conduits are preferably provided with end doors 64 and 65, which may be opened or closed to supply fresh air to the conduits 60 and 61 and through the air ducts 62 and 63 into the kiln chamber. I also preferably provide louvers, or dampers 41 which may be disposed in the fresh air ducts 62 and 63. These dampers or louvers may be individually or collectively adjustable by any suitable means to control the amount of open area in the fresh air ducts 62 and 63 between the conduits 60 and 61 and the kiln chamber.

It is understood that the air circulation within the kiln is reversible and it is intended, in one form of embodiment of my invention, illustrated in Figures I and IV, to use one of the fresh air conduits 60 or 61 for each direction of rotation of the fans, thus when the fans are discharging atmosphere upwardly from the compartments 30, as in Figure IV, for example, the fresh air conduit 60 and the fresh air duct 62 are employed for the intake of fresh air into the kiln chamber. When the fans are rotating in the reverse direction to discharge kiln atmosphere laterally through the passageways 31, at the sides of the stock loads 6, for example, in Figures I and IV, the fresh air conduit 61 and the fresh air ducts 63 are employed and air is intaken from the conduit 61 through the air ducts 63 into the compartment 30, the air being discharged from the compartment 30 into the passageway 31, and then laterally and upwardly at the sides of the stock loads 6. The duct 63 may be used with any design of duct system to take in fresh air from a conduit adjacent to a closed side of the suction compartment.

In Figures VII, VIII, and IX I illustrate another form of fresh air system. This system provides for intake of fresh air into the kiln chamber from the outside through both of the fresh air conduits 60 and 61 simultaneously in either direction of fan rotation. In these figures I also illustrate automatic means for making available fresh air to the suction side of the fans from both conduits 60 and 61 in either direction of fan rotation. This may be accomplished by employing right angle dampers 69 pivotally attached to pins 70, mounted in bearings 71. In Figure XII the top bearing 71 is shown adjustable. These right angle dampers 69 are preferably very freely mounted so that the dampers may have free movement through an arc of substantially 90°, as illustrated in Figure IX, to open the air duct 72 and to close the air port 73 when the fans are blowing from the compartments 30 into the passageway 31 due to the influence of suction and pressure respectively in the compartments 30 and the passageway 31, for example.

I preferably provide this system of fresh air control when a large volume of fresh air is required in the kiln, and when it is desired to utilize both fresh air conduits 60 and 61 simultaneously. This automatic damper may be used in connection with only one conduit 60 or 61 if desired and the other conduit may be omitted.

I preferably provide ventilator dampers 74 and 77 in ventilator stacks 76 and 79 respectively in the roof of the kiln. The ventilators are of any well-known and preferred type, which may control the amount of atmosphere outlet from the kiln independent of its fresh air supply. Automatic means of operating the ventilator dampers 74 and 77 comprising motor levers 75 and 78 respectively, which are controlled by the wet bulb temperature within the kiln, as by any well known type of controller 90 and 91 respectively.

I preferably provide any suitable and preferred system of humidifying the atmosphere of the kiln. For example, moisture may be introduced into the kiln by the steam sprays 56, 57, and 58. The spray 56 is on one side extending substantially the full length of the kiln, and the sprays 57 and 58 are on another side, each extending substantially one half the length of the kiln. Automatic means of operating the sprays 56 and 57, and 58 comprising diaphragm valves 97 and 99 respectively, which may be controlled by the wet bulb temperature within the kiln as by any well known type of controller 90 and 91 respectively.

I preferably provide doors 64 and 65 for the fresh air conduits 60 and 61 at the two ends respectively of the kiln. These doors may be opened and closed by the controllers 90 and 91, respectively, of any well known type which are actuated by fluctuations of temperature within the kiln as caused by the fluctuations of the drying rate of the stock. For example, the motor levers 67 and 68 which control the fresh air doors 64 and 65 respectively at opposite ends of the kiln in Figure VI, may be actuated to close the fresh air conduit doors 64 and 65, for example, when the wet bulb temperature within the kiln at the wet bulbs 93 and 95 respectively, falls below the set point. They may actuate the motor levers 67 and 68 respectively to open the fresh air doors 64 and 65 respectively, for example, when the wet bulb temperature within the kiln exceeds the set point of the controller.

The operation of the fresh air doors may be simultaneous with the operation of the ventilators when automatic ventilation control is employed. Both fresh air doors and ventilators may also be operated simultaneously with the

operation of the steam sprays—that is, when the steam sprays are turned on at either end of the kiln, the fresh air doors and ventilators at that end are closed, and when the humidifying sprays are turned off the fresh air doors and ventilators may be opened. This may be accomplished by employing diaphragm valves 97 and 98 oppositely acting to motor levers 67 and 75, and 68 and 76 respectively. That is, the diaphragm valves preferably open with air pressure from the controllers 90 and 91, and the motor levers close the ventilators and fresh air doors when air pressure is on them.

Fresh air and ventilation are utilized when the wet bulb temperature within the kiln exceeds the set point. It is understood that the fresh air and ventilators may be operated independently or together, also operated independently of the steam sprays or simultaneously with the steam sprays if desired.

I preferably provide heating systems on two sides of the circulating system. An important feature of my invention is in the control of heat within the kiln chamber. In my application Serial #492,026, I employ means for creating uniform temperature and drying conditions by creating longitudinal circulation in two independent circuits from the center toward the ends of the kiln in one direction of fan rotation and vice versa in the opposite direction of fan rotation. In my present invention I employ transverse circulation without substantial longitudinal air movement. More uniform heat distribution provided by my present invention is accomplished by the employment of separate heat control and substantially uniform drying at each of the two ends of the kiln, regardless of the differences in moisture content of the stock at the two ends of the kiln.

I preferably provide individual heating systems 81, 82, and 83 supplied with steam from an outside source through the pipe 45. Heating systems 82 and 83 are for supplementary use and are at the two ends respectively of the kiln, separately controlled by any well-known type of automatic controllers 90 and 91 respectively, each having thermostatic dry and wet bulbs within the kiln. For example, the controller 90 has dry and wet bulbs 92 and 93 respectively, and the controller 91 has dry and wet bulbs 94 and 95 respectively. The dry bulbs 92 and 94 control the temperature within the kiln at the two ends respectively, and actuate the controllers to open the diaphragm valves 96 and 98 by air pressure when the temperature within the kiln at the two ends respectively drops below the set point as may be caused by a slowing up of the drying of the stock. The wet bulbs are preferably kept wet by water boxes 100, with wicks 110 and a water supply through the pipes 101 supplied with water from a source not illustrated. In some cases I employ heating pipes 80 between the stock loads as illustrated for example in Figure II, in addition to the pipes described above. The pipes 80 are preferably individually controlled at the two ends of the kiln.

The heating system 81 preferably extends the full length of the kiln. It is in the path of air circulation of the fans and a substantially uniform heat distribution is effected substantially the full length of the kiln. The uniformly distributed heating system and/or air circulating system effect uniform heating conditions within the kiln substantially its full length when the initial moisture content of the stock is substantially uniform. This is rarely the case as stock usually varies in initial moisture content. It is, therefore, advantageous to employ a separately controlled heating system and/or humidifying and ventilating systems at each end of the kiln in addition to the uniformly distributed heating and air circulating systems, to provide extra heat, and/or moisture and ventilating capacity to dry the faster drying higher moisture content stock in the same length of time as the slower drying lower moisture content stock. In addition I preferably employ a separately controlled heating system at each end of the kiln, but when this is done other units of the heating system may extend the full length of the kiln, as, for example, the heating unit 81. This unit may be supplied with steam and controlled by hand or by the diaphragm valve 96 or 98 which supplies the heating system at either end of the kiln. The individually controlled heating systems at the two ends of the kiln are supplementary and must be of sufficient capacity to permit carrying the desired temperature in the end of the kiln to which it is located as required by the varying moisture content of the stock therein. The separately controlled heating systems at the two ends of the kiln permit a uniformity of drying not possible without it.

In my invention I preferably employ a strictly transverse circulation of kiln atmosphere, discharged from the opposed right and left hand fans and recirculated in a direction substantially transverse to the longitudinal axis of the kiln. Air is discharged in either direction of fan rotation in counteracting currents and it is normal for these currents to spread between adjacent compartments so as to cover the space between fans and provide a uniform flow of air circulation transversely within the kiln and across the stock therein, in either direction of fan rotation. However, it is an important feature of my invention that each pair of fans substantially recirculates the air within its influence so long as the air remains within the kiln, without effecting longitudinal air movement within the kiln proper from any one fan substantially beyond the median line between fans in each circuit of air circulation. Because the fans are of substantially uniform volume and are rotated at the same R. P. M., there is no tendency for the air to move longitudinally within the kiln, which is essential in connection with my invention.

An essential feature is also the sectional control of drying conditions which is preferably independent at the two ends of the kiln, regardless of the amount of water contained within and to be evaporated from the stock at the two ends of the kiln. The circulating system, the heating system, the humidifying system, the fresh air system and the ventilating system is each designed to provide adequate circulation, heat, humidification, fresh air and ventilation respectively in each section of the kiln in which it is located. This inter-related sectional control of these systems provides a uniformity of drying that is not possible without it.

By means of the independently controlled systems I am able to control the drying independent of variations in the amount of moisture to be evaporated at the two ends of the kiln. I employ a well known type of temperature and humidity recorder controller which controls the dry bulb temperature by turning on and off a supply of steam through diaphragm valves, for example, to the heating pipes, which valves are actuated by the dry bulb thermostat. This controller also controls the wet bulb temperature by means of the wet bulb thermostat which may actuate dia-

phragm valves supplying steam spray into the kiln, and also actuate motor levers controlling fresh air ducts and ventilators at the different ends of the kiln. I am able to maintain drying conditions at the two ends of the kiln which will substantially uniformly dry stock varying in initial moisture content at the two ends respectively of the kiln in the same period of time substantially without overdrying stock at one end, or underlying the stock at the other end.

The controllers may be of any well-known type, preferably of the two pen type controlling both dry and wet bulb temperatures. They preferably employ an auxiliary air supply to actuate the diaphragm valves and motor levers. These instruments are commonly used on dry kilns and are known as temperature and humidity recorder controllers. I preferably employ controllers which are constructed so that when either the dry or wet bulb temperature within the kiln at the position of the thermostatic bulbs reaches the set temperature an air valve within the instrument is opened to supply air from the auxiliary source to the diaphragm valves, to the motor levers, or both. Any well-known type of automatic controller may be employed, however, so long as it may be used to control the dry and wet bulb temperatures within the kiln as above described.

The diaphragm valves may be of any well known design, such for example, as illustrated in Figure XIII, which may be opened with air pressure through the air pipe 102 or 105 to supply steam to the heating pipes within the kiln, or to the humidifying sprays. The Figure XIII illustrates the design of diaphragm valves 96, 97, 98, and 99.

The motor levers actuating the fresh air conduit doors or the ventilators may be of any well-known type, for example, such as shown in Figure X and Figure XI. They are shown as closing the fresh air doors and ventilators by air pressure supplied through the pipes 103 and 104 respectively. Figure X and Figure XI illustrate the design of motor lever indicated at 67, 68, 75, and 78.

When the air supply is cut off of the diaphragm valves shown in Figure XIII or the motor levers shown in Figure X and Figure XI the air pressure in the pipes 102 and 103, 104 or 105 respectively, and in the diaphragm chambers 106 and 107, or 108 respectively, escapes through an air leak in the instrument which is normally provided for this purpose, allowing the springs 109 and the counterweights 110 or 111, for example, to close the valve Figure XIII, and open the fresh air doors 65, or the ventilators 79 respectively. The numbers above given to the air lines, are shown at one end of the kiln, but it is understood that the operation of similar pipes connecting diaphragm valves 96 and 97, and the motor levers 67 and 75 with the controller 90 at the opposite end of the kiln, would be substantially the same.

Bearing in mind that the air circulation is strictly transverse within the kiln, in either direction of air circulation, the atmosphere passes across the stock and across the thermostatic bulb of the controller at each end, once in each circuit of its movement. If the drying rate of the stock at that end is high, the heat required for evaporation of moisture is greater and the temperature loss of the air is greater. Thus the thermostatic bulb 92, for example, at that end actuates the controller 90 to open the heat diaphragm valve 96 on the supply line to the heating pipes at that end, to raise the temperature. In this way the condition of the lumber controls the separate heating system at the end of the kiln at which it is located. If the temperature of the air rises too high, due to less heat being used for evaporation of moisture from the stock than is supplied to the pipes, the heat is automatically cut off of the said heating pipes at that end. Similarly, if the moisture content of the kiln atmosphere at one end is raised above the set point of the controller, caused by a wet condition of the stock being dried, the wet bulb 93, for example, transmits this condition to the controller 90, and the diaphragm motor 75 controlling the vents, and/or the diaphragm motor 67 controlling the fresh air conduit doors at that end, opens them to reduce the humidity, or if the wet bulb temperature drops by the slow drying of the stock, the vents and air ports at that end are closed and the steam sprays 56 or 57 are opened by diaphragm valves 96 described above.

I preferably provide fans of larger diameter or having a greater angle of blade, at the ends of the kiln. The first fan 37 at either end of the kiln, as illustrated in Figures V or VI, preferably has a larger capacity and produces a greater volume of air circulation at the ends of the kiln in either direction of fan rotation. This greater volume of air circulation is needed to overcome the cooling effect of the doors caused by lack of proper insulation and heat losses through and around them. A greater volume of air circulation, greater amount of heating surface 84 at the ends of the kiln, or both may be employed to accomplish the extra heating of the air at the ends of the kiln.

In overhead fan kilns the fresh air conduits are not required. Fresh air ducts through the roof on the two sides of the air circulating system may be employed to serve the same purpose, as well as the purpose of ventilation and may be automatically controlled in like manner.

Attention is called to the direction of air flow within the kiln. When the fans are rotating in one direction air is exhausted from the compartments 30 and discharged into the passageways 31 in counteracting currents, and out the two sides of each of the passageways. The discharged atmosphere passes across the heating pipes and upwardly at the sides of the kiln and into the interstices of the stock loads, across the stock load and into the plenum chamber 44, and then again into the compartments 30, for example, in Figure I, in continuous recirculation.

In the opposite direction of fan rotation air is discharged vertically from the passageways 31 in counteracting currents into the compartments 30, and then moves through the plenum chamber 44 or 46, across the stock loads 6, or 6 and 7, into the plenum chambers 47 and 48, and across the heating pipes, through two sides of the passageways 31 into the compartments 30 in continuous recirculation. In the latter direction of air circulation fresh air may be admitted through the air conduits 60 and the air duct 62 into the passageways 31. When the air is being circulated in the former direction air may be taken in through the conduit 61 and the air duct 63 into the compartment 30, and thence recirculated within the kiln.

Baffles may be provided at any suitable location for directing air across the stock loads, for example, floor baffles 51 and ceiling baffles 49 are employed.

The arrows wherever shown in the drawings

illustrate one direction of air circulation within the kiln.

It is understood that this invention is not limited to the exact design and form illustrated and described. Modifications of the structures and methods herein described and equivalents are self-evident to those skilled in the art; therefore, it is to be understood that the invention includes within its scope what ever changes fairly come within either the terms or the spirit of the appended claims.

Having described my invention, what I claim is:

1. In a dry kiln, the combination of an air circulating system comprising spaced compartment air circulating units, each closed on a plurality of sides and open on one of its sides, paired substantially equal capacity fans, one right hand and one left hand, operatively mounted in the two ends respectively of each of said units, a fresh air supply duct to the suction side of each pair of fans in either direction of rotation of said fans, one duct extending through one of the closed sides of said unit, whereby the fans may discharge conditioned atmosphere in opposing currents substantially transversely through the said open side in one direction of their rotation, and discharge conditioned air out the ends respectively in the opposite direction of their rotation, a current from one compartment unit being opposed by a current from an adjacent compartment unit.

2. In a dry kiln, a rotary fan operatively mounted in a fan duct defining wall therein, separating suction and air delivery sides of said fan, a fresh air conduit within said kiln and communicating with the outside of the kiln, a duct and an adjacent port communicating with said conduit, and with the suction and air delivery sides respectively of said fan when it is rotating in one direction, a damper operatively mounted to automatically open said port and close said duct by suction and pressure from said fan, and to automatically close said port and open said duct when the fan is rotating in the opposite direction, whereby air is intaken to the suction side of said fan through said conduit in either direction of fan rotation.

3. In a dry kiln having therein stock varying in initial moisture content, a substantially uniformly distributed transverse air circulating means therein, a heating means extending substantially the full length of the kiln for supplying a substantially uniform amount of heat the full length of the kiln, individual heating systems at each end of the kiln, a controller at each end for the individual heating systems, each controller having a thermostat in the path of the transverse air circulation adjacent to the stock loads at its respective end, whereby variation of the temperature from a predetermined amount at each end, effected by the drying rate of the stock adjacent thereto, controls the heat supplied respectively to said heating systems.

4. In a dry kiln adapted for having stock loads therein, a door at one end thereof, a distributed air circulation system for effecting transverse circulation therein, said air circulation system comprising a larger capacity fan at the end thereof adjacent to said door, a heating system in said kiln disposed in the path of transverse air circulation, extra extended surface radiation on said heating system adjacent to said door, said radiation being in the path of air delivered by said larger capacity fan, whereby the same temperature and drying rate of the stock may be maintained adjacent to the door, as in the remainder of the kiln.

5. In a dry kiln adapted for having stock loads therein and having a door at one end thereof, a distributed air circulation system comprising fans, for effecting transverse circulation therein, said air circulation system comprising a fan of larger capacity at the end thereof adjacent to said door than fans remote from said door, a heating system extending substantially the full length of the kiln, a separate heating system at each end, said heating system disposed in the path of transverse circulation from said fan, control means having a thermostat in the path of air circulation at each end of the kiln, for each separate heating system whereby the extra air circulation adjacent to said door across said heating systems makes the latter more effective, adjacent to the door, than in the remainder of the kiln.

6. The method of drying stock varying in initial moisture content in a dry kiln, which consists of expending substantially the same amount of heat units to the air substantially the full length of the kiln to give it a predetermined temperature, of circulating the uniformly heated air transversely across said stock in the different sections longitudinally in the kiln, of determining the temperature of the air after it passes across the stock as a gage of the drying rate of the stock at the different sections, and of supplying additional heat to the air in such section which is low in temperature to compensate for the loss of heat below the said predetermined temperature, which loss was effected by a faster drying rate of stock in that section.

7. In a dry kiln, an air circulating compartment unit therein, open on one of its sides, substantially equal capacity right and left hand fans in its two ends respectively, an individual air duct communicating with the outside of the kiln and with the interior of said unit, heating means on each of two sides of said unit whereby upon rotation of the fans in one direction fresh air is induced into the unit and mixed with the kiln atmosphere, sucked into its open side and the mixture discharged out the two ends of said unit in opposite directions across both of said heating means.

8. In a dry kiln a fan operatively mounted therein, a suction and an air delivery side for said fan, two fresh air conduits communicating with the outside of the kiln and each disposed on a different side of the kiln, a fresh air duct and port leading from each of said conduits, said ducts communicating with the suction side of said fan and said ports communicating with the air delivery side of said fan when the fan is rotating in one direction, two automatic substantially right angle dampers, one pivotably mounted on each side of said fan between said duct and said port whereby said port is automatically opened and said duct is automatically closed when the fan is rotating in one direction and said port is automatically closed and said duct is automatically opened, when the fan is rotating in the opposite direction.

9. In a dry kiln a rotary fan operatively mounted therein, a fresh air conduit within and communicating with the outside of the kiln, a fresh air duct and a port communicating with the suction and air delivery sides respectively of said fan, an automatic damper substantially shaped as a right angle plate pivotably mounted to automatically open said port and close said

duct when the fan is rotating in one direction, and to automatically close said port and open said duct when the fan is rotating in the opposite direction.

10. In a dry kiln having therein stock varying in moisture content, a substantially uniformly distributed transverse air circulating means therein, a humidifying means extending substantially the full length of the kiln for supplying a substantially uniform amount of humidity the full length of the kiln, an individual humidifying system at each end of the kiln, a controller at each end for the individual humidifying systems, each controller having a thermostat in the path of the transverse air circulation adjacent to the stock loads at its respective end, whereby variation of the wet bulb temperature from a predetermined amount at each end, effected by the drying rate of the stock adjacent thereto, controls steam supplied respectively to said humidifying systems.

11. In a dry kiln having therein stock varying in moisture content, a substantially uniformly distributed transverse air circulation means therein, a heating means extending substantially the full length of the kiln for supplying heat substantially the full length of the kiln, an individual heating system at each end of the kiln, an individual ventilating system at each end of the kiln, a dry bulb controller at each end for the individual heating systems and a wet bulb controller at each end for the individual ventilating systems, each controller having a thermostat in the path of the transverse air circulation adjacent to the stock load at its respective end, whereby variation of the wet and dry bulb temperatures from predetermined amounts at each end, effected by the drying rate of the stock adjacent thereto, controls respectively the ventilation, and heat supplied to the heating system at each end.

12. In a dry kiln, a reversible fan operatively mounted in a fan duct therein, a fresh air conduit therein communicating with the outside of the kiln, a fresh air duct and an adjacent port communicating respectively with the suction and air delivery sides of said fan, and an angle damper pivotably mounted in said fresh air duct and port for alternately permitting the intake of fresh air through said duct and said port, depending upon the direction of rotation of said fan.

13. In a dry kiln having therein stock varying in moisture content, a substantially uniformly distributed transverse air circulating means therein, a steam spray extending substantially the full length of the kiln for supplying heat and moisture the full length of the kiln, a wet bulb temperature control having a thermostatic bulb in said kiln for said spray, an individual heating means at each end of the kiln, and a dry bulb temperature controller at each end of the kiln for the individual heating means, each dry bulb controller having a thermostat in the path of transverse air circulation adjacent to the stock loads at its respective end.

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