Sept. 18, 1956 J. A. VAUGHAN 2,763,069

METHOD OF CONTROLLING AIR SEASONING OF WOOD

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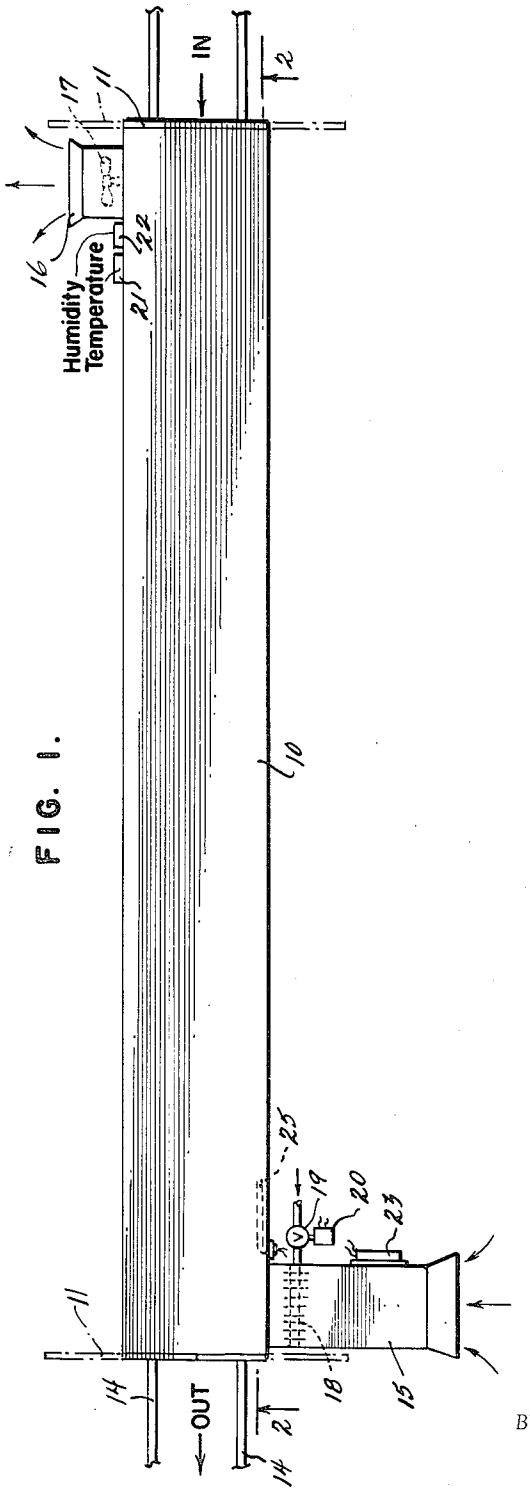


FIG. 1.

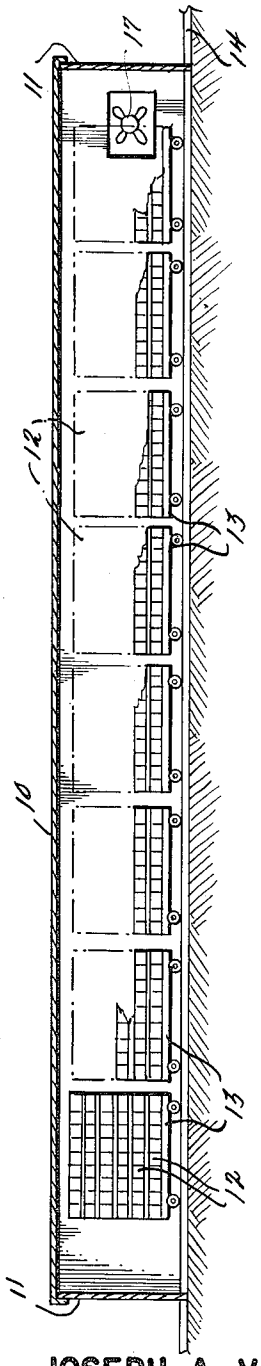


FIG. 2.

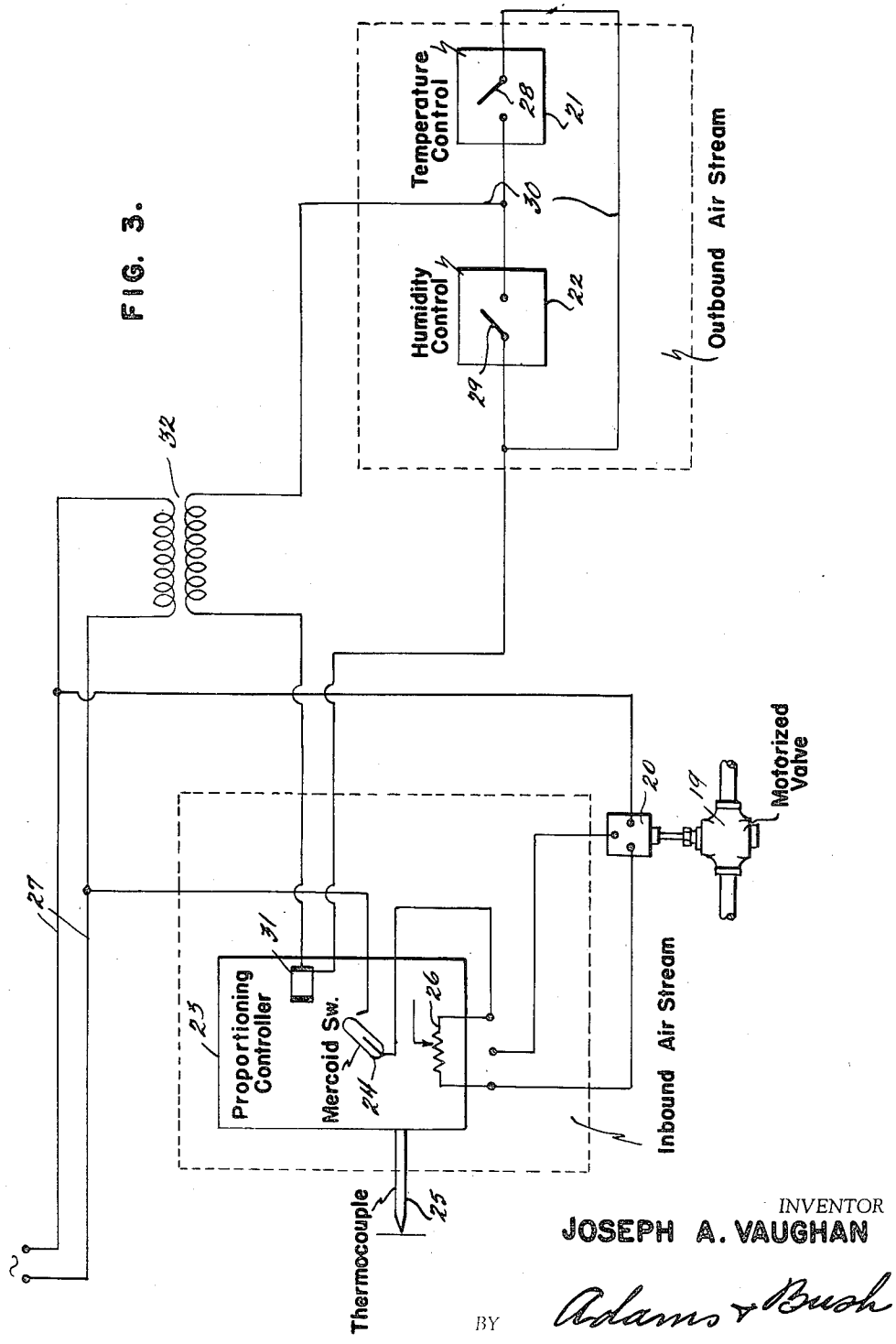
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FIG. 3.



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METHOD OF CONTROLLING AIR SEASONING OF WOOD

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3 Claims. (Cl. 34—28)

This invention relates to a method of air seasoning of wood, and more especially green, dimension timbers, such as poles, crossarms, piling, crossties and lumber, to reduce their moisture content to a point suitable for subsequent preservative treatment or to reduce their shipping weight.

One of the objects of the invention is to provide a new and economical method of air seasoning wood, as above set forth, to reduce the time required for drying to a fraction of the time usually required for seasoning in the open air, and to eliminate deterioration or degrade, due to abnormal checking, decay and the like. The idea is to speed up the drying time and to improve the quality of the dried wood.

A further and important object of the invention is to provide a method of drying wood with heated air at predetermined optimum and minimum temperatures and controlling the temperature of the air in response to varying amounts of water vapor coming from the wood being dried, whereby a charge of wood being dried creates its own ideal drying conditions.

A still further object of the invention is to provide a greatly improved method of drying wood, including the step of introducing successive charges or stacks of the wood into a long drying chamber or wind tunnel, circulating drying air through the stacks at predetermined optimum and minimum drying temperatures, and controlling the temperature of the air entering the load of wood to be dried in response to predetermined changes in the wet bulb and dry bulb temperatures of the air leaving the load of wood resulting from the adsorption of varying amounts of water vapor from the wood in the stacks.

Other aims and advantages of the invention will appear in the specification, when considered in connection with the accompanying drawings showing a simplified example of apparatus for practicing the method, wherein:

Fig. 1 is a plan view of long drying chamber which may be employed for practicing the method;

Fig. 2 is a vertical sectional view of the drying chamber shown in Fig. 1; and

Fig. 3 is a simplified wiring diagram of electrical control apparatus suitable for practicing the method.

The method most commonly employed for drying lumber and timber is that commonly known as air seasoning. This method consists of stacking the lumber or timber in the open under sheds in such a manner as to permit the natural circulation of air around the material. Depending upon atmospheric conditions and size of the pieces, various lengths of time will be required for the wood to be dried to a given moisture content. Although the equilibrium content which the wood may reach will be from 12% to 20%, depending upon atmospheric conditions, it is difficult to reach these figures in a reasonable length of time in any but such material as one inch and two inch stock. The time required to dry wood four inches or more in thickness may be such as to making holding the stocks for long periods impractical or uneconomical. Further, there is the constant danger of degrade by decay, checking and splitting. It is usual, therefore, to air season dimension stocks which are to be subsequently preservatively treated, to about 35% to 50% moisture. To reach these figures may require from 90 to 150 days for green pine, and 8 to 12 months for hardwoods, such as gum or oak. There is danger of decay during such long air drying periods.

In such items as furniture, flooring, interior trim, and other small pieces, it is necessary to dry stocks to a moisture content of about 6% to 8%. To reach these figures and also to avoid degrade during drying, carefully controlled artificial drying methods are employed. These methods usually employ conventional drying kilns.

In industries employing dimension timbers, such as poles, piling, crossties, railroad timbers, and the like, it is customary to dry the material by the air seasoning method, either for the purpose of reducing shipping weights, or, if the stock is to be treated with a preservative, to reduce the moisture content to a point where proper injection of the treating solution or preservative is possible.

In general, the wood preserving industry relies largely on air seasoning, because it has been considered to be the most economical method to employ. Kiln drying and other drying methods have been employed to obtain rapid moisture removal. These methods employ dry bulb temperatures ranging from about 160° F. to 220° F. and above. When dimension timbers, such as pine poles, are dried by some of these methods, it is often found that certain difficulties are encountered in the subsequent preservative treatment. These difficulties usual resolve themselves into erratic penetration of the preservative into the wood and sometimes fluid exudation or bleeding of the preservative from the wood after treatment.

Since the proper preservation of wood requires adequate depth of penetration and good distribution of the preservative throughout the treatable portion, the lack of either of these must be avoided. Further, the consumer of treated poles, crossarms, and the like, requires all possible cleanliness. Bleeding, therefore, is not to be tolerated in such items.

In order to avoid the disadvantages of air seasoning, as well as the difficulties which may be encountered in treating dimension timbers dried by other methods, I have contrived a method of drying, which I call Controlled Air Seasoning. In natural air seasoning, ideal conditions exist for only a short portion of each day. My method has for its object the rapid drying of wood under substantially constant conditions of ideal natural air seasoning. It reduces air seasoning time from one-ninth to one-fifteenth of that required by the natural method and, further, eliminates many disadvantages of air seasoning, as well as treatment difficulties encountered when artificial drying methods are employed.

These good results are accomplished, because my method removes water from the wood in such a manner as to avoid abrupt changes in the physical character of the wood, which changes, if abrupt, create strains and stresses in the wood and result in closure of intercellular openings, as well as checking, splitting, and other physical degrade.

Perfect drying of wood requires that the total moisture shall move simultaneously from all portions of the wood. My method of Controlled Air Seasoning approaches this ideal by controlling conditions, so that free water and water vapor moves more or less uniformly from all portions of the wood at the same time. This results in less checking than is normally experienced in air seasoning, and because the moisture distribution curve is flatter than that produced by high temperature drying methods, the

difficulties experienced by other drying methods are not experienced in Controlled Air Seasoning.

In accordance with this invention, a predetermined optimum amount of drying air is circulated at an optimum rate through stacks of the wood in a drying chamber in the form of a long tunnel and the temperature of the air is raised and maintained between predetermined limits and is controlled in response to both the dry bulb temperature and the humidity of the air stream leaving the load of wood. This is to say, the temperature of the air entering the load of wood is controlled by the psychrometric condition of the air leaving the load of wood, which varies in accordance with the amount of moisture absorbed from the wood by the air passing over it.

Referring to the illustrative apparatus for practicing the method, the drying tunnel is shown as being in the form of a long building **10** made of any suitable material and preferably well insulated. While the building may have two or more parallel tunnels to provide a multi-run unit, it is shown, for convenience, as having a single tunnel.

The volume of wood to be dried at one time and the air volume and velocity desired will to some extent control the length and cross section of the building or tunnel to be employed. For instance, if it is desired to dry a relatively large quantity of wood at one time and, further, it is desired to pass a relatively small volume of air per minute, per unit volume of wood, but the velocity of the air is to be relatively high, then a rather long dryer of small cross section will be required. For drying crossties, poles and the like, the tunnel should be about ten to twelve feet wide, eight to twelve feet high and three hundred to seven hundred fifty feet long, to permit successive charges or stacks of poles or other materials to be placed lengthwise in the tunnel.

The tunnel is shown as having suitable sliding doors **11** at its opposite ends and the charges or stacks **12** of material are conveniently loaded on carriages or trams **13** on tracks **14** running through the tunnel. The pieces in the stacks are suitably spaced to permit free passage or circulation of air in contact with all of them. The construction and arrangement are such that loaded trams of green material will be introduced into the tunnel in succession as the trams of dried material are removed, so that the drying process is substantially continuous. Any suitable means for moving the trams may be employed.

In accordance with this invention, drying air is introduced into the tunnel at one end, preferably through a large conduit **15**, and discharged from the other end through a conduit **16**. A fan **17** is shown as being arranged in the discharge conduit to cause induced draft of the drying air through the charge. However, if forced draft is desired, a fan may be placed in the inlet conduit **15**.

The inbound air may be heated by any suitable means employing the most economical fuel for that purpose. For the purpose of illustration, a steam heater **18** is shown in the air inlet conduit **15**. The supply of steam is controlled by a valve **19** operated by a motor **20** to regulate the temperature of the inbound air stream.

The control of the drying air to assure most economical operation, may be accomplished by employing any of several well known standard instruments responsive to the relative humidity and the temperature of the air leaving the load to operate a main control which, in turn, regulates the temperature of the air entering the load by the actuation of the motorized valve **19**. This operation is accomplished automatically by means of a temperature control **21** and a humidity control **22** adjacent to the outbound air end of the tunnel electrically connected to an electronic potentiometer controller **23** and the valve operating motor **20**. The controller **23** is preferably of the general type disclosed in U. S. Patents Nos. 2,423,540 and 2,518,332, and known as an "Electronik" controller. It will be understood that the temperature and humidity controls are well known types of instruments which require no detailed description.

Fig. 3 shows a schematic wiring diagram of the electrical instrument described in connection with Fig. 1. The electronic potentiometer controller **23** is there shown as having a manually adjustable or back-set mercoid switch **24**, and a thermo-couple **25** positioned in the air stream entering the load. It also includes a proportioning control **26**. The mercoid switch and the proportioning control are shown as being connected to a current feed line **27** and both of them are shown as being connected in circuit with the motor **20** which operates the motorized valve **19**. They are likewise connected by a low voltage circuit **30** and a relay **31** with the temperature and humidity controls **21** and **22** having switches **28** and **29**, which are connected in series with the mercoid switch **24** and the proportioning control **26**.

The operation of the control equipment may be explained as follows:

Through a series of relays and potentiometers (not shown) which are embodied in the main electronic controller **23**, the proportioning control element is set so that a maximum temperature of, say, 140° F. will not be exceeded. At the same time, the mercoid switch **24**, which is mechanically connected to an indicating hand (not shown) in the main control, is set to maintain a minimum temperature of, say, within the limits of 90° F. to 110° F. The circuits are such that the proportioning control **26** is thrown out of the circuit, due to opening of switches **28** and **29** simultaneously, as a result of rising temperature and falling humidity of air leaving the load. Now, as the temperature of the air entering the load falls to the minimum set temperature of 90° F., the mercoid switch **24**, which responds mechanically to the position of the indicating hand, will re-establish the circuit, thus energizing the proportioning motor **20**, so that the valve **19** opens and remains open until the minimum upper limit of, say, 110° F. (controlled by the preset condition of switch **24**) is reached, when the indicating hand again mechanically positions the mercoid switch **24**, so that it is then opened, resulting in the proportioning motor **20** operating to close the valve **19**, thus cutting off the heat source, which results in a drop in temperature of the air entering the load. When the minimum set temperature of 90° F. is again reached, the cycle is repeated and the temperature of the air entering the load is thus maintained between 90° F., and 110° F. as long as the switches **28** and **29** remain open.

The temperature control **21** and humidity control **22** are set for optimum air conditions leaving the load, say, 70% relative humidity and 80° F., respectively. As long as the air leaving the load is at a temperature below 80° F., the switch **28** will remain closed, thus maintaining the circuits through switch **24** and proportioning control element **26**, and the temperature of the air stream entering the load will remain at the maximum set condition. Also, as long as the air stream leaving the load is at a relative humidity above 70%, the switch **29** will remain closed and maintain the circuit through both the switch **24** and control element **26** in the main control **23** and the temperature of the air stream entering the load will likewise remain at the set maximum. Only when the air leaving the load is above 80° F. and its humidity is below 70%, will the switches **28** and **29** both be opened. When both of these switches are opened, the proportioning control element **26** will be de-energized, the motorized valve **19** will be closed, and the temperature of the air entering the load will be reduced until the set minimum temperature of 90° F. is reached. Then, the mercoid switch **24** will be closed and the off and on operation will take place, as described above.

In accordance with the present invention the optimum temperature of the drying air is determined so that each

cubic foot of air passing over the load will absorb from 2 to 5 grains of moisture and the charges of the wood are moved through the tunnel counter-current to the air stream. After the drying cycle is established the rate of moisture adsorption should become fairly constant at between 2.25 to 3.00 grains per cubic foot of air passing over the load and this rate is kept substantially constant as the charges or tram loads of wood are progressively and periodically moved through the tunnel and exposed to the air at a progressively higher temperature and corresponding lower humidity as they approach their discharge end of the tunnel, where the drying air is introduced. Incidentally, the controls are so adjusted that the air leaving the load has sufficient moisture absorbing capacity to assure the desired rate of drying as the charges of green material are introduced into the tunnel. In a tunnel of the type described, I have found that the drying air within the optimum temperature range of 90° F. to 140° F. should be introduced at the rate of 200 to 800 feet per minute through the load.

These conditions apply to the drying treatment of green material containing upward of 60% moisture (dry basis) and long experiments have demonstrated that degrade of the wood is reduced to a minimum when these conditions are met. Furthermore, I have succeeded in reducing the drying time to as little as one-tenth of that required for ordinary air seasoning in the open.

In practicing the method, I have found that, if the amount of water pickup, by the air passing over the load, falls below 0.5 grain per cubic foot of air, the air temperature should be reduced so as to coincide with the proper relation to the rate of flow of water from the wood. This will assure continuous flow of water from the wood at a rather uniform rate and will result in approximately constant water removal from all sections of the wood to be dried. It will thus be found that closure of cell openings is prevented or minimized, and difficulties in subsequent preservative treatment of the wood will be avoided.

The air stream is controlled in such a manner that air leaving the load will be assured of having sufficient remaining moisture-carrying capacity to guarantee no stagnation in the drying operation at that point.

The following are typical examples of my method, as applied to the drying of green wood for subsequent preservative treatment:

A charge of dimension timber, such as green pine crossties, etc., having a moisture content of from 60% to 90% (dry basis) is placed in the dryer by being stacked substantially uniformly on the trams. The stacking should be in the same manner as employed for conventional air seasoning. When the material to be dried is placed in the dryer and all doors or openings, other than the fan and heater openings, have been tightly closed, the fan is started and regulated to furnish air at a speed of approximately 400 feet per minute through the load.

The air heater is started and the outbound relative humidity controller is set so that the air stream leaving the load will be held to a maximum of approximately 70% relative humidity. The outbound temperature controller is set so that the air stream leaving the load is held at about 80° F.

Within a matter of a few hours, psychrometric readings taken in the air streams entering and leaving the load will reveal that moisture is being removed from the wood by the air. It will be found further that the relative humidity controller and the temperature controller in the outbound air stream are regulating the heat input in the air stream entering the load, so that the relative humidity of the air stream leaving the load remains practically constant at the set condition of 70% and its temperature is about 80° F. The trams are then moved progressively through the tunnel and discharged, one at a time, and loads of green poles are simultaneously introduced to make the drying process continuous.

The average pine at 80% moisture content contains 25.6 pounds of water per cubic foot and at 35% moisture contains 11.2 pounds of water per cubic foot. It is evident, therefore, that 14.4 pounds or 100,800 grains of water are to be removed per cubic foot of wood in the load. Now, if air is moving through the load at 4.43 cubic feet of air per minute per cubic foot of wood, and the air is absorbing an average of 2.25 grains of moisture per cubic foot per pass, then approximately 10 grains of moisture are being removed per cubic foot of wood per minute.

It has been shown that a total of 100,800 grains of moisture must be removed per cubic foot of wood. Therefore, 10,800 minutes or 168 hours will be required to dry the wood from 80% moisture to 35% moisture. This compares with several months of drying time in the open air, even during summer weather.

A concrete example of the method may be explained in connection with the drying treatment of green pine poles, say, about 30 feet long. The crossed poles are stacked on the trams in spaced layers with the butts and tips alternating in the successive layers to make the cross-section of each load substantially uniform from end to end.

It is first determined that, say, eight days of drying treatment will be required to dry the poles to 35% to 45% moisture content in a tunnel approximately 500 feet long. A full charge in a tunnel of this length will consist of 16 tram loads of the poles.

Upon starting the cycle of operation, two tram loads of the green poles are charged into the tunnel at the air outlet end every day, so that it takes eight days to complete the charge and dry the first two tram loads to the desired moisture content. This means that the loads of poles are advanced in the tunnel approximately 60 feet each day. The drying program is continued until all of the poles are dried, two tram loads being removed each day and two tram loads of green poles being added until the supply of green poles is dried.

Obviously, the invention is not restricted to the particular embodiment herein described.

What is claimed is:

1. In the method of air seasoning green wood having a known moisture content, wherein successive portable stacks of the wood are introduced into a long drying tunnel through one end and heated air is introduced into the opposite end of the tunnel and discharged at the stack inlet end, whereby the moving air stream's temperature progressively decreases and its humidity content increases as it absorbs moisture from the wood during its passage through the stacks and the stacks are moved counter-current to the stream of air through the tunnel as the drying progresses, the improvement which comprises maintaining the flow of air and progressive movement of the stacks through the tunnel at substantially constant predetermined rates; maintaining the dry bulb temperature of the inbound air at a substantially constant predetermined temperature by automatically controlling the heat input thereto in response to the temperature of the air; sensing the dry bulb temperature and relative humidity of the outbound air; and automatically reducing the heat input to the inbound air whenever the condition of the outbound air with respect to its dry bulb temperature exceeds a predetermined temperature and at the same time the condition of the outbound air with respect to its relative humidity falls below a predetermined relative humidity, until at least one of these predetermined conditions of the outbound air has been reestablished.

2. The method as set forth in claim 1, wherein said predetermined dry bulb temperature and said predetermined relative humidity of the outbound air are dependent upon the initial moisture content of the wood being dried and the desired degree of dryness of the finished product.

3. The method as set forth in claim 1, wherein the

green wood to be dried has an initial moisture content of from about 60% to about 90% dry basis and is dried to a final moisture content of about 35% dry basis and wherein the dry bulb temperature of the inbound air is normally maintained at about 140° F., and wherein the predetermined dry bulb temperature of the outbound air is about 80° F. and the predetermined relative humidity of the outbound air is about 70%.

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