

March 22, 1927.

1,621,855

F. A. SECORD

APPARATUS FOR DRYING

Original Filed Oct. 30, 1919 2 Sheets-Sheet 1

Fig. 1.

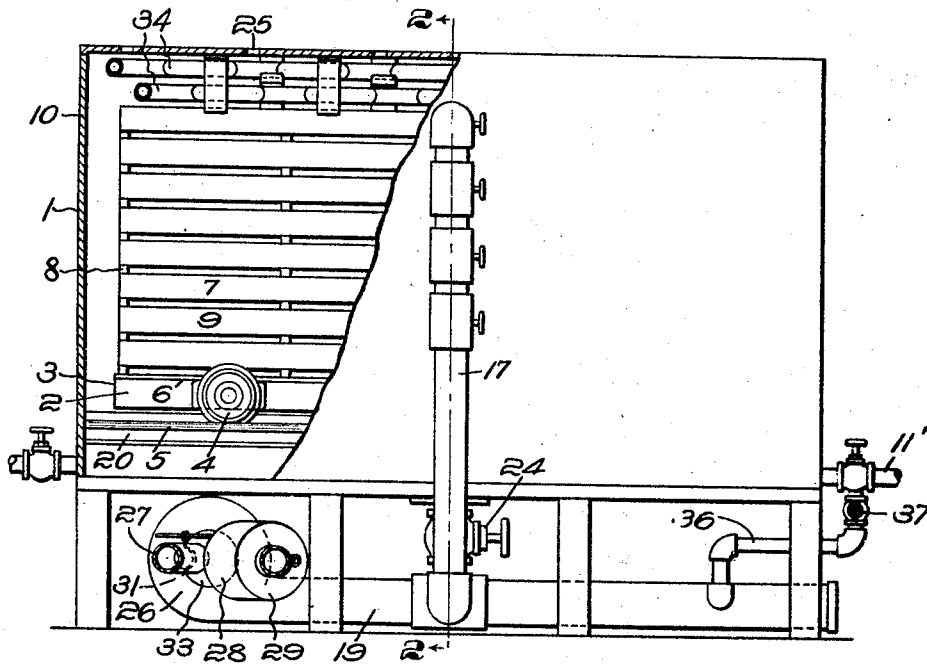
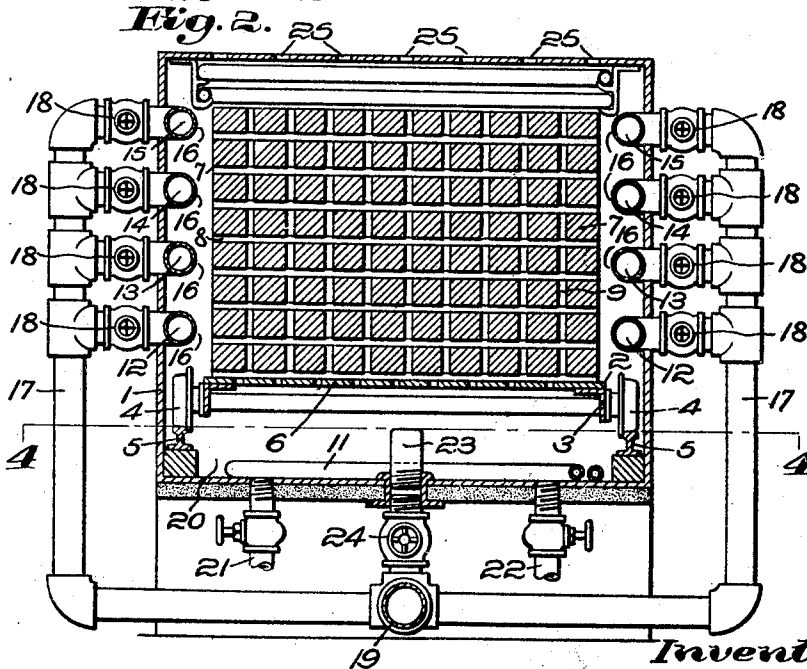


Fig. 2.



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Fig. 3.

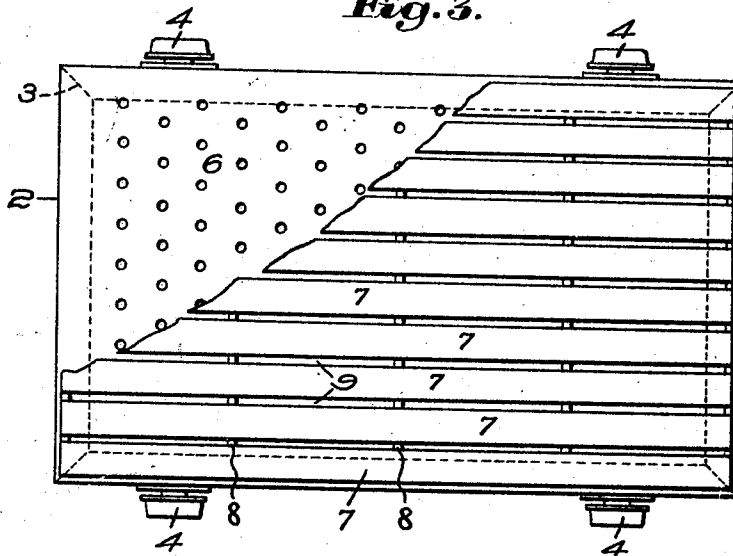
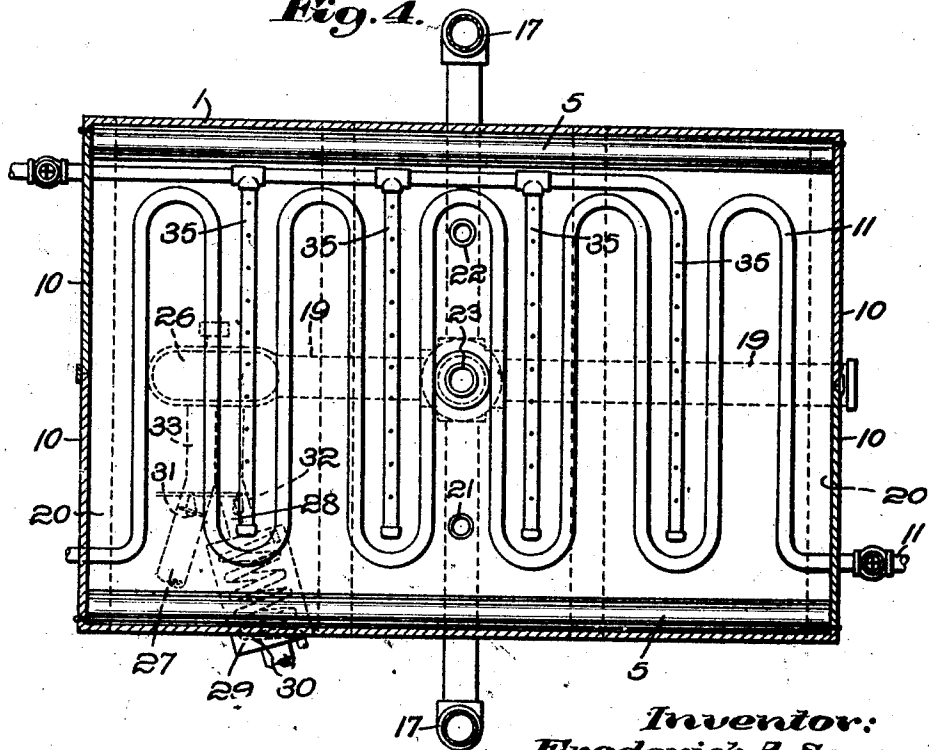


Fig. 4.



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UNITED STATES PATENT OFFICE.

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APPARATUS FOR DRYING.

Application filed October 30, 1919, Serial No. 334,478. Renewed August 12, 1926.

This invention relates to an improved drying apparatus. An object of the invention is to produce an apparatus that will materially shorten the amount of time required for drying materials, such for example, as lumber and the like, without subjecting the same to actions or conditions likely to produce waste such as by checking.

The invention will be best understood by referring to the accompanying drawings, which disclose merely for purposes of illustration one embodiment of an apparatus embodying this invention, the scope of the said invention being more particularly pointed out in the appended claims.

In the drawings:—

Fig. 1 is a side elevation partly in section of the drying apparatus;

Fig. 2 is a transverse section of the same taken on the line 2—2 of Fig. 1;

Fig. 3 is a detail plan of the carrier means for transmitting the material to be dried into the drying casing and for supporting the same during the drying operations, and

Fig. 4 is a detail plan section taken on the line 4—4 of Fig. 2 illustrating the water container which also contains the pipes for moistening and for heating the materials to be dried.

The methods heretofore employed in drying various materials and particularly lumber have necessitated the extension of the drying operations over a very long period of time and also have resulted in a large percentage of waste due to many reasons but principally to the fact that the outer surfaces of the lumber became dry much quicker than the interior, thereby causing an uneven shrinkage and consequent checking of said outer surfaces. Furthermore the contraction of the outer surfaces of the lumber results in the closing of the pores to such an extent as greatly to retard the completion of the drying operations. Such defects were largely due to the subjecting of the materials to forced currents of air of high temperature which carry the moisture away from the outer surfaces thereof faster than the moisture can be transmitted by capillary attraction from the interior to replace that carried away by the drying medium.

The present invention contemplates the production and maintenance of certain ranges of temperature between the material that is being dried and the drying medium so as to maintain a more perfect equilibrium

between the vaporizing of the moisture upon the surface of the material and the transmission of moisture from the interior portions of the material by capillary attraction, thereby avoiding the unequal contraction and the inevitable closing of the outer pores of said material. In the present example, therefore, means are provided for transmitting heat of a desired temperature to the material to be dried, and then in surrounding said material by or in subjecting it to the action of a drying medium, preferably of a lower temperature than that of said material, in order that the moisture at the surface of said material may be rapidly vaporized and removed. It is well known to those skilled in the art that moisture-laden materials when subjected to sudden temperatures will retain, due to the moisture therein, a temperature a number of degrees below that of the heat-supplying means, but as said moisture is gradually removed from said material the temperature thereof will more nearly approach the temperature of its heat-supplying source. In view of this gradual change in the temperature of the material, it is desirable that the range between the surrounding drying medium and the heat supplying medium be maintained substantially uniform, and that the temperature of said drying medium be increased from time to time in accordance with the changes in temperature of said material, and for this purpose means have been provided for increasing the temperature from time to time of the drying medium, which is admitted to and surrounds the material that is being dried.

For producing the above results, I have, as will be seen by referring to the drawings, provided a casing 1 of any suitable design or construction capable of enclosing the material that is to be dried. Although the said casing may be of any suitable length and contain various sections, that illustrating the present example embodies only one section, which is of a sufficient length to contain a suitable carrier 2, herein consisting of a frame 3 provided with wheels 4 arranged to roll along tracks 5, 5, which extend longitudinally of the casing 1. The carrier 2 is herein shown as comprising a perforated top 6 upon which the material to be dried is piled in such a manner as to permit a circulation of air around the greater portion of the various articles that are mounted there-

on. For example, in Fig. 2 the carrier is loaded with strips 7 of lumber arranged in layers, and each layer is separated from its supporting layer by separators or what are commonly known as sticking 8 in the manner ordinarily used in piling lumber. The various tiers of said lumber are separated from each other by vertical spaces 9, thus permitting the drying medium to circulate freely amongst the various sticks composing the load upon said carrier. A carrier such as described, together with its load, is then rolled into the casing 1 and said casing is then closed up by means of suitable doors 10, 10 arranged at opposite ends thereof or wherever desired, and the material mounted upon said carrier is then heated to a desired temperature, which temperature may be varied according to conditions and to the nature of the material. As an example, however, let it be assumed that the temperature of the material is to be approximately 140°, this, however, being given merely as an example and not for purposes of limitation—and the preferred method of heating said material being by radiation and transmission, that is, arranged beneath the carrier I have provided a coil or coils 11, preferably steam pipe, which are heated to the desired temperature and the heat transmitted through the material of the carrier and through the perforations in the top thereof to said material. As the material to be dried is in the present state substantially filled with moisture, a temperature considerably higher than that required for the material will be necessary in said coil in order to produce the desired results; but as said moisture is removed by the process hereinafter described, the temperature of said material will gradually increase until it more nearly approaches the temperature of the coil, which state will not occur until the lumber is practically dry. By arranging the heating coils 11 close up to the bottom of the carrier, the heat will be imparted to said carrier and be transmitted therefrom throughout the several layers of lumber piled thereon, although naturally the temperature of the various layers will gradually decrease toward the top of the load. When the desired temperature has been reached, at least in the lower layers, the present method contemplates the supplying of a drying medium with as little pressure as possible to said casing. Obviously, as the lower layers of the material upon said carrier become dry or approach a completely dried state, such layers will absorb a greater amount of the heat and thus be able to transmit more of said heat to the layers thereabove. It is desirable that the drying medium that is admitted to the chamber containing said material be admitted at points where it will contact with the lower or hot-ter layers of material, and for this purpose the casing is divided into zones, each zone having its own drying medium supplying means consisting, in the present example, of pipes 12, 13, 14 and 15 respectively. These pipes, being in the present example four in number, may of course be increased or diminished in size and number according to circumstances and to the dimensions of the casing. The pipes referred to are herein shown as duplicated upon opposite sides of the casing and correspond in length with the section of the casing within which they are located, that is, they are made substantially the length of the carrier 2, but should a number of carriers be arranged in the casing, each carrier would have its independent supply pipes. The pipes 12, 13, 14 and 15 have suitable discharge orifices 16 adapted to direct the drying medium against the material therebeneath. Each of said supply pipes is herein shown as communicating with a header 17 through suitable valves 18, whereby the supply of drying fluid to each of said pipes may be cut off. The header 17 extends downwardly, and is connected with a supply pipe 19, through which the drying medium is conducted from any suitable source not shown, said supply pipe being arranged in the present example centrally of said casing so that a uniform supply will be provided for each side of the casing. The coils 11 that are disposed beneath the carrier 2 are preferably arranged within what is herein designated as a watertight container 20, having suitable water supplying and discharging pipes 21 and 22 respectively, whereby the said container may be flooded as hereinafter described. The container 20 also has connection through a pipe 23 with the supply pipe 19, and a valve 24 is arranged in this pipe to regulate communication with said supply pipe. The various pipes 12, 13, 14, 15, 19 and 23 are, as heretofore stated, for the purpose of conducting the drying medium to various parts of the casing, and it is desirable that this drying medium be maintained at a lower temperature than the material that is being dried, so as to produce the vaporization of the moisture upon the surface of said material. For example, if the material in the lower layer or layers upon the carrier is approximately 140° temperature, the drying medium may be supplied to said casing at a temperature approximating 70° or thereabouts, although it is distinctly to be understood that this range is given merely as an example, and not for purposes of limitation. However, upon being delivered to the casing, said drying medium being cooler than the material, will tend to settle and as it contacts with the warmer moisture covered surfaces of the material all of the moisture upon said surfaces will immediately take the form

of vapor, and being warmer than the drying medium will impart more or less heat thereto. Furthermore said drying medium as it approaches the heated area at the bottom of the casing will accumulate still more heat and thereby be forced upward by the incoming cooler currents, and will discharge through openings 25 arranged at the top of the casing. As hereinbefore stated, it is desirable that the drying medium be admitted to said drying chamber with as little pressure as possible in order not to carry away the moisture faster than the same can be drawn by capillary attraction to the outer surfaces of the material, therefore the pressure of said drying medium is very slight, only sufficient to carry it into said chamber where the difference in temperature between the same and that of the material and air therein will tend to cause said drying medium to settle to the bottom until it has become sufficiently heated by the advanced temperature of the material to cause it to change its course and move to the top of said casing, where it will be discharged through the openings 25. To provide the desired force necessary to deliver the drying medium from its source to said casing, I have herein provided a blower 26 arranged at any suitable point in the supply pipe 19, the speed of said blower being varied to increase or diminish the pressure or force of said drying medium. I have previously stated that the temperature of the material within the casing that is being dried increases as the moisture therein is removed, the presence of moisture in said material having a tendency to depress or lower the temperature, and as said moisture decreases in volume, the temperature increases in direct proportion. Obviously, therefore, where it is desirable to maintain a uniform range of temperature between the material and the drying medium, means must be provided for increasing from time to time the temperature of said drying medium. I have, therefore, in the present example provided means for accomplishing this result, said means consisting of a conductor 27, which may be connected with any suitable source capable of supplying a drying medium preferably of relatively low temperature because it is more convenient to start with a low rather than high temperature. For example, where the drying medium is to be air, as it preferably is in the present case, said conductor 27 may be connected with a suitable refrigerating plant or it may be connected directly with the atmosphere where the temperature of the atmosphere is below that required to accomplish the desired results.

Uniting with said conductor 27 is a conductor 28, which I have herein shown as connected with a chamber 29 within which are arranged coils 30, preferably of steam

pipe, whereby the air which is conveyed through said chamber 29 and through said conductor 28 may be heated to the desired temperature. The conductors 27 and 28 are provided with suitable dampers 31 and 32 respectively, whereby the desired proportions of hot and cold air may be provided in the conductor 33 connecting said conductors 27 and 28 with the blower 26. By these or other suitable means, a suitably tempered drying medium may be supplied to the casing, wherein is the material to be dried, and this drying medium may be constantly varied in temperature as the drying operations progress and thus a predetermined range of temperatures may be maintained between said material and said drying medium.

The arrangement of the casing and of the top plate 6 of the carrier, also the construction of the carrier are such as to confine most of the heat supplied by the coils 11 within the space beneath said carrier, so that the heat therefrom, instead of being circulated upwardly through the casing, will be transmitted through the material surrounding said carrier to the several layers thereon. Naturally then the lower layer will, as heretofore stated, be of a much higher temperature than the successive layers thereon, and as the moisture is removed from the lower layers, said layers become more nearly the temperature of the said coils and will, in consequence thereof, radiate more heat to the succeeding layers. In the present example, by providing the perforations in the top plate 6, some of the heated medium will be permitted to circulate upwardly through the spaces provided between the various layers of the material, and thus assist somewhat in the drying of the upper layers, and the air thus permitted to escape from the chamber at the bottom of said carrier will increase the temperature of the drying medium as it is admitted to the drying chamber and assist in changing the course of said drying medium, thereby increasing the carrying capacity thereof.

Obviously, the drying of the material upon the carrier where the same is of a considerable height may be greatly increased by providing the various zones, hereinbefore referred to, which correspond to the variations in temperature of the layers of material upon said carrier, with supplying means whereby the temperature of the drying medium to said several zones may be varied in temperature. Naturally, however, this will involve considerable expense because of the fact that each of said zones will have to be connected with independent temperature adjusting means similar to the conductors 27, 28 and coils 30. It is, however, within the scope and purpose of the invention to provide each of the pipes 12, 13, 14 and 15 with temperature varying means as hereinbefore

described, but in order to simplify the present example, only one of said temperature regulating devices is shown, and this in connection with the main supply pipe 19.

Where only one of such means is provided, it will be most practical to begin the drying of the several layers upon the carrier at the bottom and proceed upward layer by layer or by groups of layers until the entire load is dry enough to be removed from the casing. In carrying out this feature of the invention, I preferably shut off communication between all of the pipes except the lower pipes 12, the valves 18 for all pipes except the pipes 12, and the valve 24 being closed during the first step of the drying process, at which time the drying medium which is being admitted through said pipe 12 is assumed to be about 70° in temperature, while the temperature of the material that is being dried approximates 140°; these temperatures being given merely for an example, as it will be obvious that they may be varied according to the character of the material that is to be dried. With the material filled with moisture and heated to 140° it will be obvious that the temperature of the heating devices or coils 11 will be considerably higher owing to the fact that the moisture in the material has a substantial cooling effect, but as this moisture is removed through vaporization by the subjection of the material to the action of the cooler drying medium, which is now being admitted through the pipe 12, the temperature of said material will gradually be increased until it approaches the temperature of the heating coils 11 which are constantly transmitting heat to the said material. Upon the removal of all of the moisture from the lower layers of the material, these layers will more readily transmit the heat from said coils through the layers of material next thereabove, and when these conditions are reached, communication between the lowermost pipes 12 will be cut off from the supply pipe 17 and communication between the next upper pipes 13 be opened by opening the valve 18 therefor. Naturally the temperature of the second or next upper layers of material will be less than those at the bottom due to their distance from the source of the heat, namely, the coils 11, and in order that the desired range of temperature be maintained at this point, adjustment of the dampers 31 and 32 will now be necessary. When the drying of the material within the next zone, that is, that area controlled by the second set of pipes 13, is completed, communication between said pipes is shut off and the next upper series will be opened and the operation repeated, and so on until the entire stack of material has been dried.

It is within the scope and purpose of the invention to increase the temperature of the

coils 11 rather than to decrease in the desired proportions the drying medium as it is being conducted to the several tiers of pipes 12, 13, 14 and 15, the main object being to maintain a predetermined difference in the temperatures of the material and the drying medium throughout the entire operation. As the air which constitutes the drying medium becomes laden with moisture from the material and is carried upward by its increased temperature due to the contact thereof with the heat arising from the coils 11, as well as from its acquisition of moisture, it will pass to the upper regions of the casing and escape through the openings 25 therein.

It is desirable to maintain the various temperatures hereinbefore described comparatively low in order that the lumber be not exposed to excessive heat so as to cause an unequal expansion between the outer and partially dried areas and the inner moist areas. It is, however, a well-known fact that the lower the temperature of the air, the lower will be the moisture carrying capacity thereof. For example, assume that air at 70° will carry about eight grains of moisture to the cubic foot, while air at 180° will carry about one hundred and sixty-six grains to the cubic foot. It would seem, therefore, that the higher the temperature the more rapid would be the drying of the material. Such, however, is not the case, for where excessive heat is allowed to contact with the outer surface of the wood or other materials that are being dried, said outer areas will be dried so rapidly that the process of drawing the moisture from the interior by capillary attraction will not keep pace with the removal of moisture from the outer surfaces. This results in an unequal contraction of the pores of said outer areas, thus greatly retarding the drying process and often producing checks in the material; whereas a much slower removal of moisture from the exterior will maintain the drying forces in equilibrium, that is, the moisture will be removed from the outside no faster than will the process of withdrawing the moisture from the interior by capillary attraction take place. In order to speed up the drying of the material without causing said results to take place, I have provided in the upper part of the casing a coil 34 preferably of steam pipe, which may be maintained at an exceedingly high temperature, much higher, if desired, than that of the coils 11, and as the natural tendency of heated medium is to rise rather than settle, that heated by said coils 34 will pass upwardly through the openings 25, provided said openings are large enough, and out of the said casing and in so doing the circulation of fluid within the casing will be increased and so will its temperature, and the temperature of the moisture laden air which

is passing upwardly from the material toward the top of the casing will likewise be increased by heat from said coils and the moisture carrying capacity thereof will be correspondingly increased. The hot air or fluid surrounding said coils 34 will form, as it were, a blanket at the top of the casing which assists in directing the relatively cooler air entering through the several pipes 12, 13, 14 and 15 downwardly against the material, and this air by contact with the heated material will, as previously stated, acquire heat which will cause it to rise to the zone occupied by the coils 34 where added impetus will be given thereto to carry it out of the casing. Said moisture-laden currents of air in rising will, upon entering the zone of said coils 34, be materially expanded and thus insure the carrying off of said moisture from the casing without permitting condensation to form upon the upper wall thereof.

I have illustrated the casing 1 as of a length suitable for receiving only one carrier. It will, however, be evident that the length of the casing may be varied either by increasing or decreasing the same and the drying units varied to correspond with the length of said casings without departing from the scope and purpose of this invention.

Very often material will be brought to the casing for drying which has been exposed more or less to the atmosphere, and has acquired a comparatively dry outer surface, the pores of which have become contracted and consequently the process of drawing the moisture from the interior by capillary attraction will be materially retarded. It is, therefore, desirable to treat such material so that the best results may be obtained from the process hereinbefore described, and one method of treating such material is to provide a coating of moisture upon the surface thereof. I have, therefore, for this purpose provided the watertight container 20, into which water may be admitted, or as herein shown, the entire casing is made water-tight so that it may be filled with water if desired, and in connection with this I also provide a series of perforated steam pipes 35, 35 interspersed among the various loops of the coils 11, whereupon when steam is turned on vapor will rise from said container when that only is filled with water or where the entire casing is filled the water therein will be heated to the desired degree, thus softening and moistening the surface of the material to be dried. This coating of moisture also causes the pores of the material to expand and thereby start the process of removing the moisture from the interior to the exterior by capillary attraction. After sufficient moisture has been deposited upon the exterior of the

material the steam may be shut off, the water drained and heat transmitted to the material from the coils 11, after which the process hereinbefore described may be carried out.

There are occasions when the material that is to be dried is at a higher temperature than desired for beginning the steps of the herein described process, it being necessary to reduce the temperature thereof, and for accomplishing this result I have, as stated, provided a connection between the container 20 and the main supply pipe 19, whereby air of a predetermined or desired temperature may be admitted to the said container and be transmitted through the plate 6 to the material resting thereon. It will also be obvious that the latter instrumentalities may be utilized to convey the necessary amount of heat to the bottom of the pile of material in place of the steam pipes 11, all of which variations are within the scope and purpose of the invention.

It has been stated that a certain range of temperatures is maintained between the drying medium and the material to be dried, for the purpose of preventing too rapid drying and thus causing the checking or warping of material, and this is particularly the case in the drying of lumber. It should, however, be understood that the method of drying is not limited to the maintenance of this range of temperature throughout the drying operation, for such a range may be increased at intervals when all danger of warping or checking of the material is past, for example, in the drying of lumber the starting of the process might be with the temperatures not very far apart, say 20°, and thus maintained until a certain amount of moisture, 10%, for example, has been removed, after which danger of checking being past, the range may be increased either gradually or very abruptly, as desired, according to the nature or character of the material.

Obviously numerous other variations in the manner of supplying heat to the material may be made as well as in the manner of heating the drying medium, as for example, in certain instances the steam may be admitted directly to the casing through the perforated pipes 35, 35 without admitting any water or liquid of any kind into the casing or permitting steam to pass upwardly through the openings in the perforated plate 6 and into contact with the material upon the carrier.

It is also within the scope and purpose of the invention to supply steam to the various pipes 12, 13, 14 and 15. To accomplish this result I have provided a connection between the pipe 19 and the steam supply pipe 11', as shown in Figs. 1 and 4, which connection consists of a pipe 36 which pipe is provided with a valve 37 whereby communication may be cut off when desired.

When the entire casing is to be flooded or filled with the solution for treating the material to be dried, it is desirable that the numerous supply pipes be closed so as to prevent the solution from flowing back into the supply pipe 19 and to accomplish this result the valves 18 and 24 may be closed, said valves being arranged in such relation to their respective pipes that the desired result may be obtained.

The results produced by the above process are the material reduction in time of drying lumber or like substances, and the elimination of checking, twisting and warping thereof, also the lumber so dried will not be as brittle as wood dried by other processes, and in addition the material so dried will be ready for immediate use.

Although I have described the above operations in connection with the drying of lumber or like substances, it is distinctly to be understood that within the scope and purpose of the invention, other materials such as grains, fruits, clay products, peat, and practically all substances requiring drying may be treated with equal success.

While I have herein shown and described merely for illustrative purposes one specific embodiment of my invention, and have disclosed and discussed in detail the construction and arrangement incidental to such disclosure, it is to be distinctly understood that the invention is limited neither to the mere details or relative arrangement of the parts nor to the specific application herein shown, but that extensive variations from the illustrations may be made without departing from the principles thereof.

Claims.

1. A drying apparatus having, in combination, a casing for the material to be dried, means to transmit heat to said material, means to supply to said casing a drying medium having a relatively lower temperature than said material to effect the vaporization of moisture on said material and means to increase the temperature of said moisture-laden medium above the critical zone of the drying operations to facilitate the removal of said moisture from said casing.

2. A drying apparatus having, in combination, a casing for the material to be dried, means to transmit heat to the material within said casing, means to supply to said casing a drying medium having a relatively lower temperature than said material to effect vaporization of the moisture on said material, and means to maintain a predetermined range of temperatures between said drying medium and said material.

3. A drying apparatus having means to transmit heat to the material to be dried and means to subject said material substantially at the same time to the action of a drying medium having a relatively lower tempera-

ture than said material, to effect vaporization of the moisture upon said material.

4. A drying apparatus having means to transmit heat to the material to be dried, means to subject said material to the action of a drying medium having a relatively lower temperature than said material, and means to maintain a predetermined range of temperatures between said drying medium and at predetermined sections of said material.

5. A drying apparatus having means to transmit heat to the material to be dried, means to subject said material during said heating operation to the action of a drying medium having a relatively lower temperature than said material, and means to increase or diminish the differences in temperatures between said drying medium and said material.

6. A drying apparatus having, in combination, a casing for the material to be dried, means to transmit heat to the material within said casing, means to supply a drying medium to said casing, means to regulate the temperature of said drying medium and means arranged at the top of said casing to increase the temperature of the drying medium to facilitate the discharge thereof from said casing.

7. A drying apparatus having, in combination, a casing for the material to be dried, means disposed at the bottom of said casing to transmit heat to the material, means for supplying a drying medium at a point above said heating means, means to temper said drying medium and means disposed adjacent to the top of said casing adapted to impart heat to said drying medium to facilitate the removal thereof from said casing.

8. A drying apparatus having, in combination, a casing for the material to be dried, means to supply moisture to the surface of said material, means to transmit heat to said material, means for supplying a drying medium to said casing at a point above said heating means and means to temper the drying medium prior to its admittance to said casing.

9. A drying apparatus having, in combination, a casing for the material to be dried, means to supply moisture to the surface of said material, means to transmit heat to said material, means for supplying a drying medium to said casing at a point above said heating means and means to temper the drying medium subsequent to its admittance to said casing and to facilitate the discharge of said drying medium from said casing.

10. A drying apparatus having, in combination, a casing for the material to be dried, a carrier adapted to be moved into said casing and to support said material therein, means arranged beneath said carrier to transmit heat to the material supported

thereon, means to supply a drying medium to said casing from a point substantially above said material heating means, and means to temper said drying medium prior to its admittance into said casing.

11. A drying apparatus having, in combination, a casing having a plurality of openings at the top thereof, a carrier for conveying the material, to be dried to and from said casing, means arranged in said casing beneath said carrier to transmit heat to the material thereon, means to supply a drying medium to said casing at a point substantially above said heating means, means to regulate the temperature of said drying medium and means arranged in said casing above the entering point of said drying medium adapted to increase and facilitate the discharge of said drying medium from said casing through the openings at the top thereof.

12. A drying apparatus having, in combination, means to support the material to be dried, means arranged beneath said material to transmit heat thereto, and means to direct an exteriorly tempered drying medium having a relatively lower temperature than said material, upon said material to effect vaporization of the moisture thereon.

13. A drying apparatus having, in combination, a carrier for the material to be dried, means to transmit heat to the material on said carrier and means to supply a drying medium having a relatively lower temperature than said material at points progressing upwardly with respect to said material to effect the vaporization of moisture on said material.

14. In a drying apparatus, the combination of a casing adapted to contain liquid, a carrier for conveying the material to be dried to and from said casing, and means to treat predetermined sections of the material supported by said carrier.

15. In a drying apparatus, the combination of a casing adapted to contain liquid, a carrier for conveying the material to be dried to and from said casing, means to supply liquid to said casing, means to temper the liquid while in said casing, means to remove the liquid from said casing, and means to supply tempered air to the material supported by said carrier.

16. In a drying apparatus, a liquid-tight casing, a carrier having a perforated bottom for supporting the material to be dried, means to supply liquid to said casing to immerse the material therein and heating means arranged in said casing to temper said liquid.

17. In a drying apparatus, a liquid-tight casing, means to supply liquid to said casing,

a plurality of air supply pipes connected at different levels with said casing, and means to close said air supply pipes to prevent the discharge of liquid from said casing.

18. In a drying apparatus, a casing and a pipe connected with said casing for supplying either a highly tempered drying medium or a low tempered drying medium through said pipe to said casing.

19. In a drying apparatus, the combination of a casing, a plurality of air pipes connected at predetermined levels with said casing for severally supplying a drying medium thereto, and means exteriorly of said casing to regulate the temperature of the air supplied to said pipes.

20. In a drying apparatus, the combination of a casing and a series of air pipe lines extending along the sides of said casing at predetermined intervals apart to supply relatively low tempered air to said casing, and means to temper said air prior to its delivery to said casing.

21. A drying apparatus having in combination, a casing for the material to be dried, means to transmit heat from the bottom of said casing upwardly through the material, means for supplying a drying medium to said material from a point above said heating means, means to temper said drying medium, and means disposed adjacent the top of said casing to impart heat to said drying medium and to facilitate the removal thereof from said casing.

22. In a drying apparatus, the combination of a casing, a carrier for conveying the material to be dried to and from said casing, and means to supply a heating medium to said casing either in the form of heated air, or steam or water.

23. In a drying apparatus the combination of a casing provided with a drying chamber and means to provide a fluid from a mixture of selected portions of hot and relatively cold fluids and to supply the tempered fluid to a plurality of zones in said drying chamber.

24. In a drying apparatus, the combination of a casing having a drying chamber, means to transmit heat to the material within said chamber, means to supply a drying medium to said chamber and means to provide a restricted discharge of the heated moisture-laden drying medium from the top of said chamber to assist in depressing the incoming drying medium to the lower parts of said chamber.

In testimony whereof, I have signed my name to this specification.

FREDERICK A. SECORD.