

April 12, 1932.

G. D. HARRIS

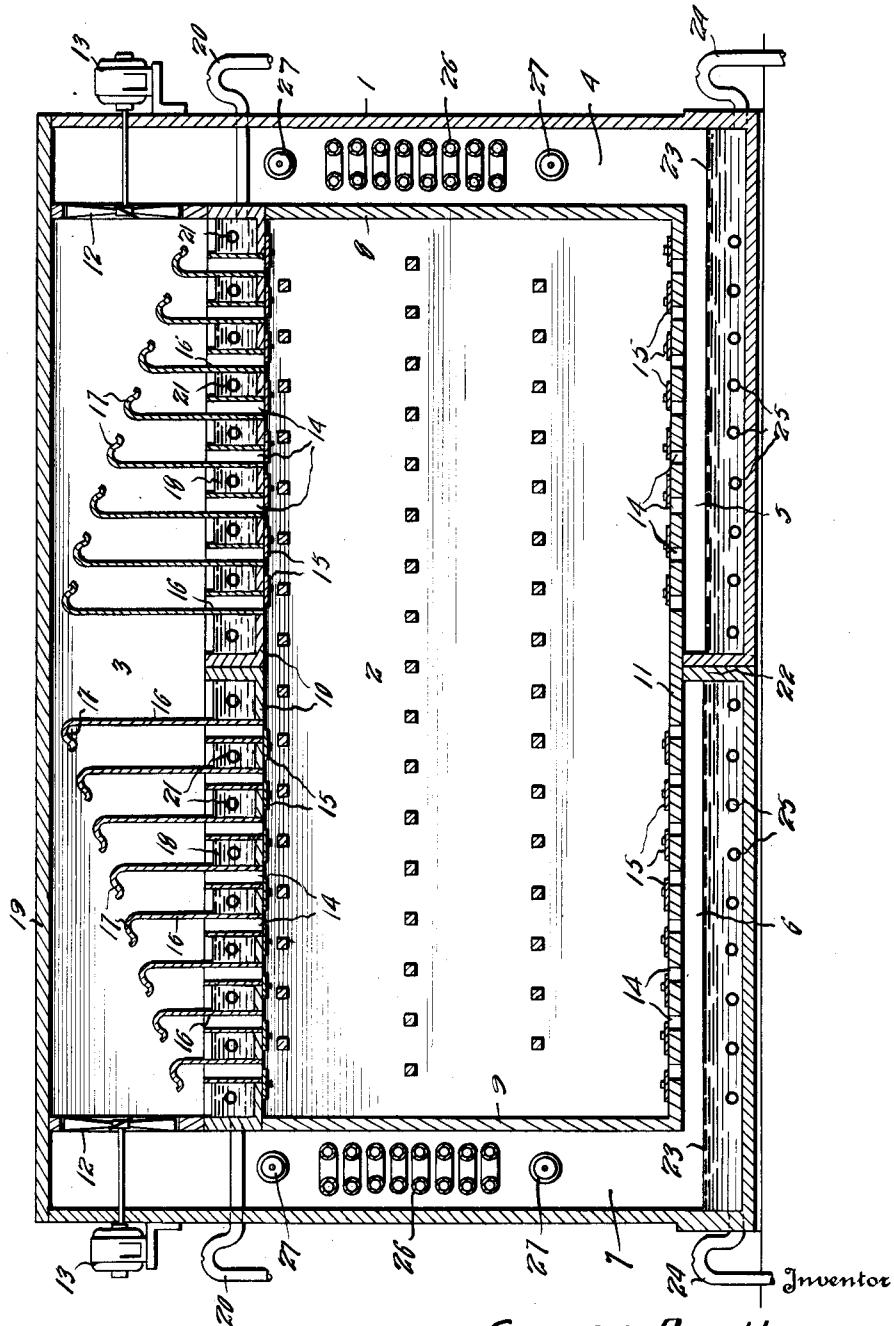
1,853,424

METHOD AND APPARATUS FOR TREATING MATERIAL

Filed March 4, 1930

4 Sheets-Sheet 1

FIG. 1.



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FIG 2

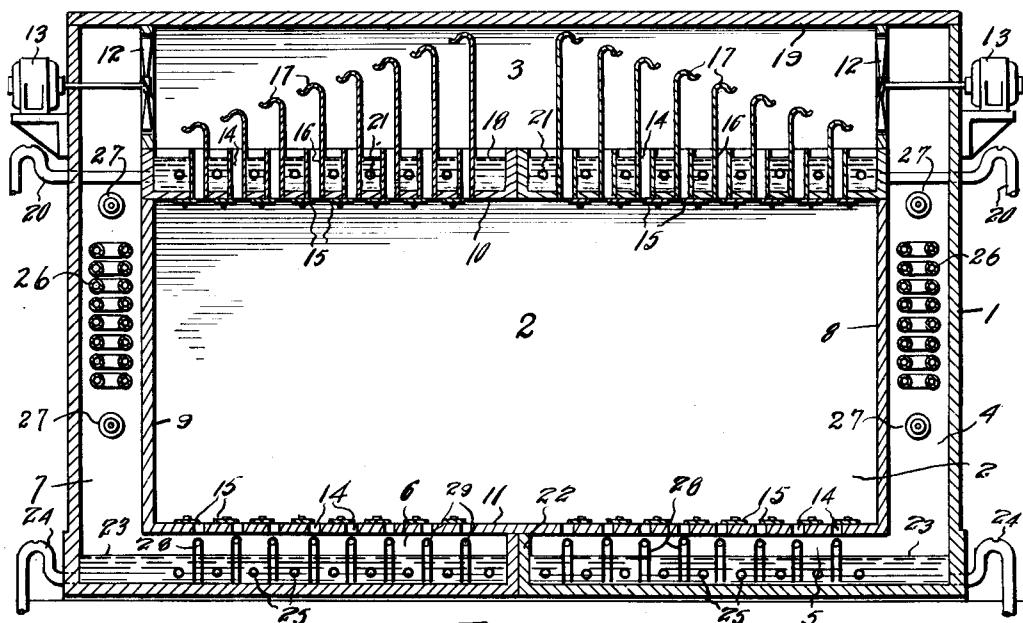
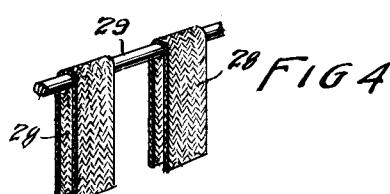
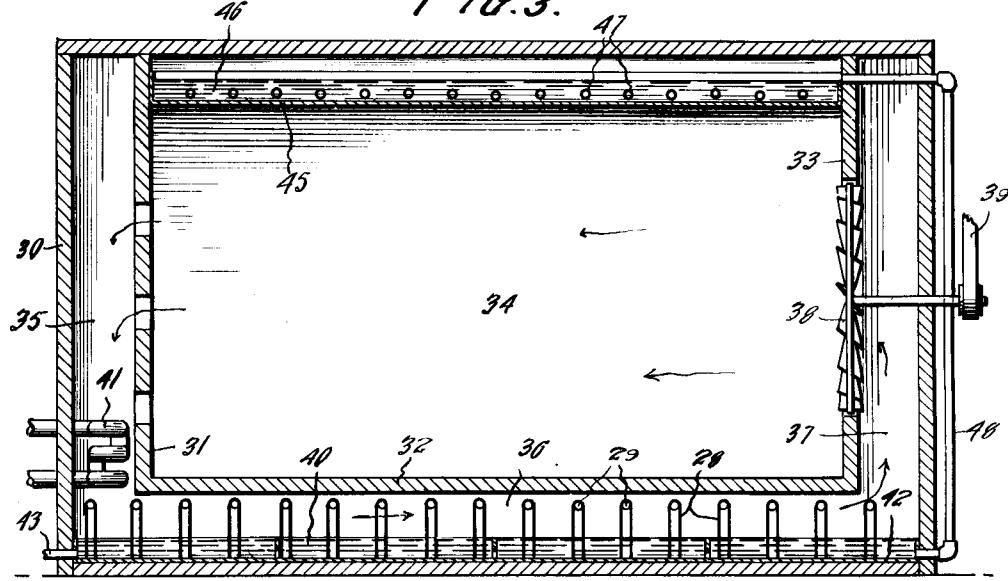


FIG. 3.



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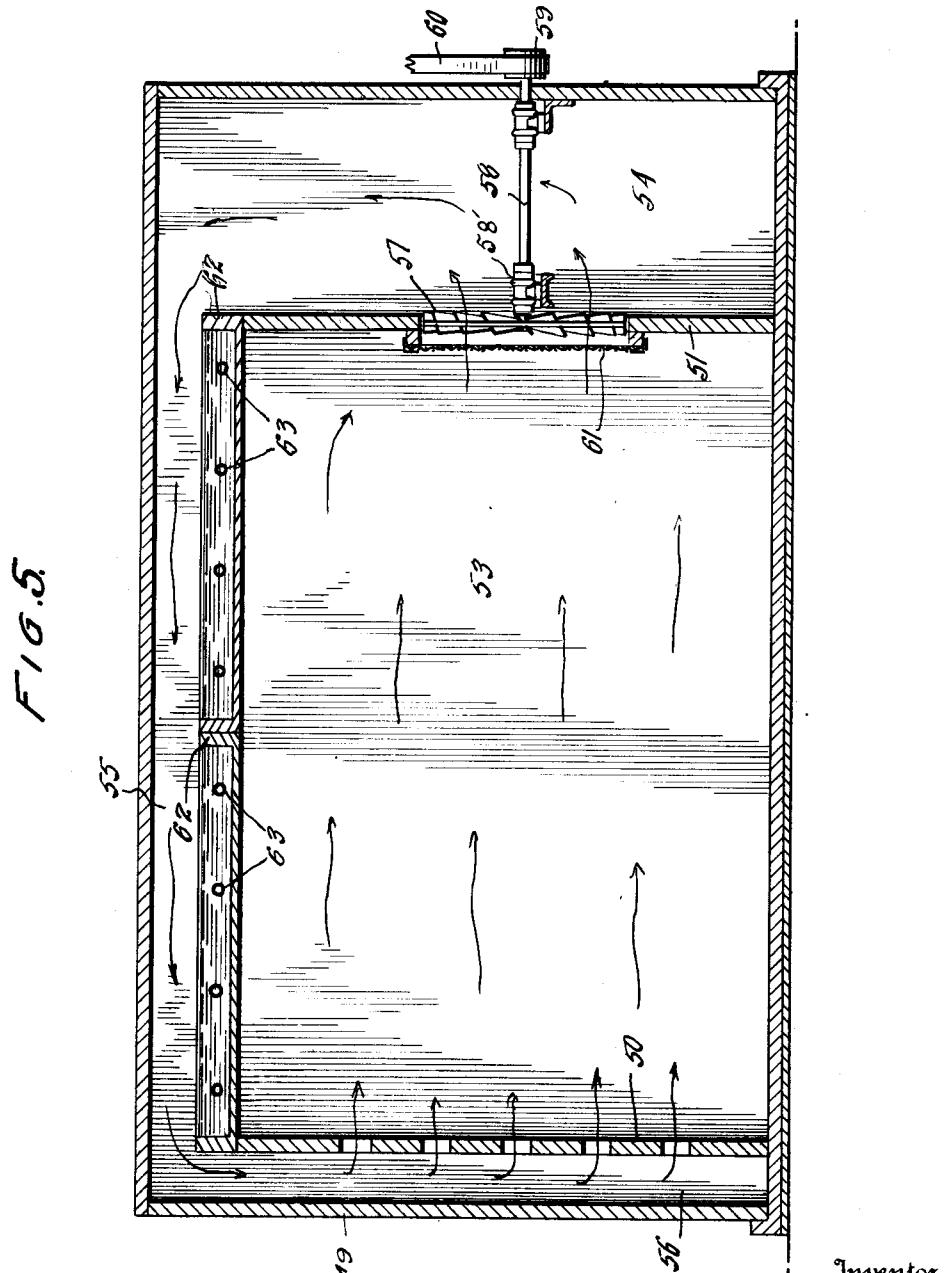
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METHOD AND APPARATUS FOR TREATING MATERIAL

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4 Sheets-Sheet 3



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## METHOD AND APPARATUS FOR TREATING MATERIAL

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FIG. 6.

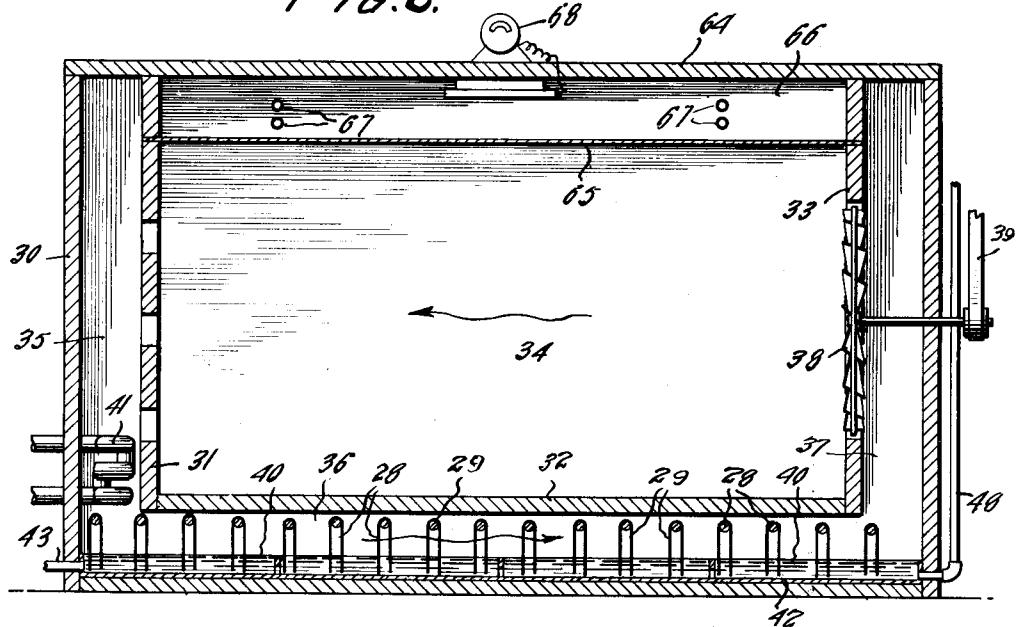
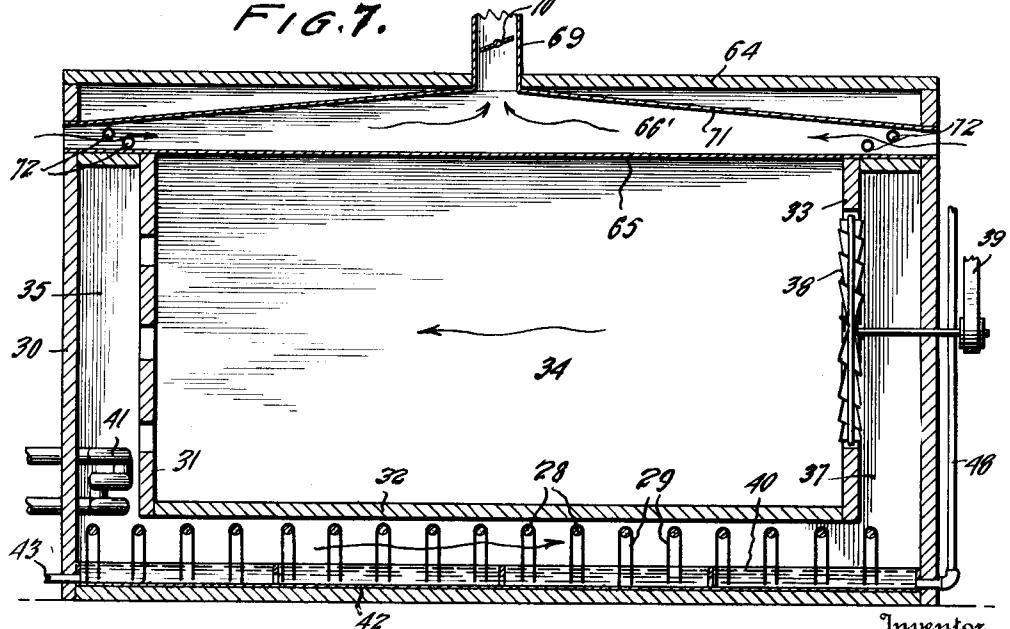


FIG. 7.



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## UNITED STATES PATENT OFFICE

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## METHOD AND APPARATUS FOR TREATING MATERIAL

Application filed March 4, 1930. Serial No. 433,157.

This invention relates in general to the conditioning of materials and more particularly has reference to processes and apparatus for conditioning air and other gases which are circulated in contact with the material to be treated.

This application is a continuation in part of my copending applications, Serial No. 81,606, filed January 15, 1926, Serial No. 10 322,432, filed November 28, 1928, and Serial No. 322,433, filed November 28, 1928.

In many industries in which materials are worked and otherwise treated to form them into finished articles, it has been found that 15 the workability of the material can be advantageously affected by subjecting the material to a conditioning process prior to subjecting it to any manipulation to form it into a finished article.

20 In certain processes heretofore used for conditioning various materials, the condition of the air or gas is modified by controlling its temperature and moisture content and then the so-conditioned air is circulated in 25 contact with the material to be treated. The material undergoing the conditioning treatment is usually placed in a products chamber through which the conditioned air is circulated, in such a manner that the moisture 30 contained in the conditioned air will be taken up by the material undergoing treatment. It has been found that when the products chamber is provided with a roof which is at its inner surface at a lower temperature than 35 that of the conditioned air, condensation will take place and form droplets of moisture on the roof which will drop onto the material being treated. While the above circumstance does not affect certain materials, nevertheless, other materials are affected in that 40 when finished, they contain spots where the condensed liquid has dropped thereon.

45 It will be appreciated that in the case of treating materials which should have an unspotted appearance when finished, the above disadvantage is undesirable. The present invention contemplates improvements in the conditioning processes and apparatus which will avoid the disadvantageous spotting of the material discussed above.

A major object of this invention is to devise a process and apparatus for treating materials with conditioned air or gases in which the material undergoing treatment will not be subjected to spotting.

55 Another object of this invention is to devise methods and apparatus for treating materials with conditioned air in which the upper wall of the material conditioning chamber is heated to prevent condensation forming 60 thereon.

65 Yet another object of this invention is to devise methods and apparatus for treating materials in which the air is conditioned in various manners and in which the moisture content of the conditioned air is prevented from condensing on surfaces where the presence of condensation might damage the material treated.

70 Still another object of this invention is to devise an apparatus for conditioning materials provided with a products chamber having means in contact with the upper wall thereof for heating the wall to prevent the moisture content of the conditioned air from 75 condensing on that wall.

80 A further object of this invention is to provide an apparatus for treating materials in which the material is subjected to conditioned air within a chamber, the upper wall of which is in contact with a tank containing heated fluid.

85 A still further object of this invention is to provide an apparatus for treating materials with conditioned air in which the chamber for conditioning the material has a humidifying tank positioned thereabove in heat exchange contact with the upper wall of said chamber.

90 With these and other objects in view, which may be incident to my improvements, the invention consists in the parts and combinations to be hereinafter set forth and claimed, with the understanding that the several necessary elements comprising my invention may be 95 varied in construction, proportions and arrangement without departing from the spirit and scope of the appended claims.

95 In accordance with the present invention, material is treated by subjecting it to a con-

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ditioned gas. The gas may be conditioned as to humidity in accordance with any of a number of processes and after conditioning, is then passed through a chamber in contact with the material to be treated. In order to prevent spotting of the material undergoing treatment, due to condensed liquids falling thereon, the temperature of the upper wall of the chamber containing the material to be treated, is maintained above the dew point of the conditioning gas. In order to maintain the temperature of the upper wall of the material conditioning chamber above that at which moisture condenses from the conditioning gas, the upper wall may be directly heated, or a body of heated water may be maintained in contact therewith. The body of heated water may be employed solely for controlling the temperature of the upper wall of the products chamber or the water may be used to humidify the conditioning gas.

In accordance with one process and the apparatus for carrying it out, water from the heated body of water maintained in contact with the upper wall of the material conditioning chamber may be continuously or intermittently withdrawn and supplied to a humidifying device maintained in the gas conditioning chamber.

30 In another form of the invention, the gas may be conditioned by bringing it in contact with the body of water maintained in heat exchange relation with the upper wall of the material conditioning chamber.

35 In a further modification of the invention, the condensation of moisture on the roof is prevented by circulating or maintaining a heated gas in contact with the exterior of the roof.

40 It will be appreciated that other types of conditioning apparatus may be modified so as to fall within the scope of the present invention.

In order to make my invention more clearly understood, I have shown in the accompanying drawings, means for carrying the same into practical effect without limiting the improvements in their useful applications to the particular constructions which, for the purpose of explanation, have been made the subject of illustration.

In the drawings:

Figure 1 is a somewhat diagrammatic representation of a material conditioning apparatus constructed in accordance with the present invention and which may be operated for effecting the process herein described.

Figure 2 is a view similar to Fig. 1, showing a material conditioning apparatus slightly modified.

Figure 3 is a diagrammatic representation of another form of material conditioning apparatus.

65 Figure 4 is a perspective detail view of the

wicks employed in the apparatus shown in Figures 2 and 3, 6 and 7.

Figure 5 is a form of the invention in which the body of heated liquid in heat exchange relation with the roof of the products chamber is employed directly to humidify the conditioning gas.

Figure 6 is a diagrammatic representation of a form of the invention in which the roof of the products chamber is heated by means of a heated fluid.

Figure 7 is an illustration of a further modified form of the invention in which the roof is heated by means of a heated gas.

In the drawings, there is shown an apparatus 1 for conditioning materials. This apparatus is divided by walls or partitions into a treating or products chamber 2 and air conditioning chambers 3, 4, 5, 6 and 7. The vertical partitions or walls 8 and 9 separate chamber 2 from the side conditioning chambers or ducts 4 and 7, respectively, and horizontal partitions 10 and 11 separate chamber 2 from the upper and lower conditioning chambers. Chamber 5 is in open communication with the side chamber or duct 4, and the lower chamber 6 is in open communication with the side chamber 7. Side chambers 4 and 7 communicate with the upper conditioning chamber 3 through openings, in which are positioned fans 12, driven by electric motors 13 or other suitable sources of power. The upper conditioning chamber communicates with the products chamber 2 through slots in the partition 10, and chambers 5 and 6 beneath partition 11 communicate with chamber 2 through similar slots in partition 11.

In order to secure an even distribution of air through the products chamber 2, slots 14 in the walls or partitions 10 and 11 are provided with adjustable closure members 15, which may be actuated to vary the size of the slot openings. It has been found that the size of the slot openings can be so regulated that air will flow through the products chamber in well-defined streams with practically no intermixing of the streams. This is very desirable since, when the air flows in well-defined streams without any cross circuiting, an even distribution is obtained and proper treatment of all of the materials will be effected.

Slots 14 in the upper partition 10 are fitted with tube-like members 16, with which are associated drip guard deflectors 17. The tube-like members 16 extend a predetermined distance above the partition 10 and cooperate with the partition 10 and walls 8 and 9 to form tank structures in which are contained bodies of water 18. The drip guard deflectors 17 extend above the tubes 16 varying distances, as is clearly shown in the drawings. These deflectors prevent any moisture which condenses on the upper wall 19 of the treat-

ing apparatus from dripping through the slots 14 onto the material contained in the products chamber 2.

The tank structures afforded by the several partitions 8, 9 and 10 and the tube structures 16 are provided with suitable overflow conduits 20, which serve to prevent water contained in the tanks from exceeding a predetermined level. Submerged in the bodies of water 18 are suitable heating elements 21, which may be in the form of coils through which hot fluids are circulated, or electrical heating elements may be employed. Water is supplied to the tanks above the slotted partition 10 by means of suitable supply conduits, (not shown), which preferably are fitted with valves controlled by automatic regulating devices, such as floats, positioned in the tank structures hereinbefore described.

With the construction just described, it will be appreciated that the water within the tank structure will be maintained at a substantially constant level, regardless of the quantity of water evaporated therefrom by the heating elements.

Chambers or ducts 5 and 6 beneath partition 11 are separated by the partition or separating wall 22. Each of these chambers is provided with a tank adapted to contain a body of water 23, which is prevented from exceeding a predetermined level by means of the overflow conduits 24. The bodies of water 23 are heated by means of heating elements 25, which are in the form of coils, through which are circulated hot fluids, or elements through which electric current is passed. Water is supplied to the lower tank structures by suitable supply conduits, (not shown), provided with automatically controlled valves for maintaining a predetermined level of water within the tanks.

It will be appreciated that after the vapors arising from the bodies of water diffuse into the air, the temperature of the air may be increased, so that it will be greater than is desired in the products chamber. In order to cool the air so that it will be at the proper temperature for treating the material in the products chamber, there are provided suitable cooling coils 26 in the side conditioning chambers 4 and 7. Water or other cooling media may be supplied to these coils through suitable conduits, (not shown), which are equipped with regulating valves. If desired, thermostatic control means may be provided in the products chamber 2, by means of which the valves positioned in the cool fluid supply conduits may be actuated. With such construction, the temperature of the air within the products chamber 2 can be automatically maintained at a predetermined value.

Certain material may be advantageously treated by circulating saturated air thereover, which contains entrained moisture.

Apparatus for introducing entrained water

in the air is shown in the drawings. In each of the compartments 4 and 7, there are positioned a plurality of spraying means 27 of any construction and size found suitable for the purpose. As shown, the sprays are positioned above and below the cooling coils, but I wish it to be clearly understood that the sprays may be located at any point found desirable, and that any number of them may be employed.

It is within the concept of the present invention to regulate the temperature of the water supplied to the spraying devices so that the temperature of the air may be properly maintained.

The structure herein described is particularly useful for surface wetting the material to be treated. When so used, the moisture is evenly deposited on the material.

The structure illustrated in Fig. 2 is of substantially the same construction as the apparatus shown in Fig. 1 and similar parts in each figure have been designated by corresponding reference numerals. As shown in Fig. 2, either wicks or submerged heaters 90 can be used singly or together. These wicks may be suspended from suitable racks 29 as shown in Fig. 4. While wicks have been shown in the lower conditioning chamber, it should be understood that they may also be employed in the upper humidifying chamber.

In the structure shown in Figures 1 and 2, the water in the tanks associated with the roofs of the products chambers, is maintained at a temperature equal to or above that at which moisture will condense from the conditioning gas.

By maintaining the temperature of the water in the tanks associated with the partitions 10 at a temperature equal to or above that at which moisture will condense from the conditioning gas, the hereinbefore pointed out disadvantage is avoided. By maintaining the temperature of the partition 10, either equal to or above that of the conditioning gas, due to the heat exchange between the heated body of water and the partition 10, there will be no condensate formed on the underside of the partition 10. It will be appreciated that as there is no condensate formed on the undersurface of the partition 10, there will be no possibility of the material, undergoing treatment becoming spotted as the result of condensate dripping from the roof of the products chamber.

In operation, material to be treated is placed in the products chamber 2, and the fans 12 are set in operation so that air will flow over the material in the desired direction. Air in chamber 1, in one direction of flow, will be drawn down through slots 14 in partition 11 over the bodies of water 23. These bodies of water may be heated at a constant rate or at a varying rate, dependent

upon the manner in which the structure is to be operated. Vapors generated by heating the bodies of water 23 arise and diffuse into the air which flows through ducts 5 and 6.

5 Mixtures of air and vapors flow up through ducts 4 and 7 over the cooling coils 26. The temperature of the cooling coils is maintained by a thermostat within the products chamber, or elsewhere, so that the air flowing over the coils will be at such a temperature that, after further treatment, it will be at the temperature desired for the products chamber. Before and/or after the cooling treatment, water from the spraying devices 10 may be dispersed into the air. This water is entrained in the air and is carried with the air over the material to be treated. The tempered air from the ducts 7 and 8, which is substantially saturated with moisture, is 15 then drawn upwardly by the fans 12 and is forced into chamber 3, where it meets with vapors arising from the bodies of water 18. Vapors arising from the bodies of water 18 will diffuse into the air in the chamber 3 to 20 further moisten the same. After this treatment, the air will be substantially saturated. The treated air will then flow down through the slots 14 over the material to be treated.

The temperature of the conditioning air 25 may, of course, be regulated by controlling the temperature of the cooling coils and the temperature of the water entrained in the air, and by regulation of the heating elements in the conditioning chambers.

30 As hereinbefore pointed out, the size of the slots 14 may be regulated by adjusting closures 15 so that the air will flow through the products chamber 2 in well-defined streams, so that material in all portions of the chamber will receive the proper treatment.

The present invention is applicable to other types of conditioning apparatus. In Fig. 3, there is shown a conditioning apparatus of the type set forth in my copending application Serial No. 81,606, filed January 15, 1926, modified in accordance with the present invention. As illustrated in the drawings, this apparatus comprises a casing 30 divided by walls or partitions 31, 32 and 33, into a products chamber 34 and air conditioning chambers 35, 36 and 37. Partition 31 is provided with a plurality of openings, through which the gas may pass in circulating through the chambers. A fan or blower 38 is mounted in an opening in the partition 33 and is actuated by the power drive 39 or any other suitable means.

In the lower air conditioning chamber 36 are positioned one or a plurality of water bodies 40 over which the gas is passed to humidify the same. A plurality of wicks 28 are supported on rods 29 and dip in the water body 40.

65 Water or other suitable liquid is supplied to the tank 42 in the chamber 36 in any de-

sired manner, and the rate of supply may be controlled to effect the most advantageous operation. An outlet 43 is provided, which may be equipped with a liquid level regulating device for maintaining a constant level 70 of liquid in the tanks 42.

In operation, the gas is heated to a predetermined temperature by the heating elements 41 in chamber 35, and is then passed to chamber 36, where it becomes saturated with moisture. From chamber 36, the gas is drawn by the fan or blower 38 and is forced through chamber 34 in contact with the material to be treated. 75

As hereinbefore mentioned, there is a tendency for the moisture which saturates the conditioning gas, to condense out upon contact of the conditioning gas with cold surfaces. For instance, if the upper wall 44 of the conditioning chamber were cold, globules 80 of liquid would form on the undersurface thereon, and when the globules obtain a weight sufficient to overcome the adhesion between the globules and the undersurface of the roof, the liquid would fall onto the material and spot it. 85

The present invention overcomes the above disadvantage by providing means for heating the upper wall 44 so as to prevent the condensation of moisture thereon. One method 90 of heating the upper wall is to place a tank 45 in heat exchange contact therewith, and to maintain a body of heated water in the tank. As is clearly shown in Fig. 3, tank 45 contains a body of water 46 which is connected 100 with suitable automatically controlled supply conduits, (not shown), so that a sufficient quantity of water will always be present in the tank to insure the proper operation of the apparatus. Suitable heating elements 47 are 105 submerged in the body of water 46 and are provided with automatically controlled mechanism for maintaining definite water temperatures. It will be readily understood that by maintaining a body of heated water in heat exchange relation with the upper wall 44, the wall will be maintained at a temperature substantially the same as that of the body of water, which temperature is equal or greater than that of the conditioning gas 110 will prevent condensate forming on the wall. 115

If found desirable, the heated water from the tank 45, can be withdrawn therefrom and passed through conduit 48 into the tank 42 at a rate which will compensate for the evaporation of liquid from the lower humidifying chamber. 120

If desired, apparatus such as shown in Figures 1 and 2 may be modified so as to operate with only the bodies of water in the upper portion of the apparatus. This type of apparatus is clearly shown in my copending applications Serial Nos. 322,432 and 322,433, filed November 28, 1929. Apparatus such as 125 set forth in the above mentioned copending

applications may be advantageously employed for conditioning certain materials. In this particular type of apparatus, it will be appreciated that there will be no condensation of the moisture from the conditioning gas formed on the undersurface of the roof of the products chamber. This form of apparatus employs the heated bodies of water maintained in contact with the roof of the

products chamber for two purposes, namely, to humidify the conditioning gas, and to prevent condensation of moisture contained in the conditioning gas on the undersurface of the roof of the products chamber.

In Fig. 5, there is shown a conditioning apparatus in which the means for heating the roof of the products chamber to prevent the condensation of moisture thereon also serves as the humidifier. As illustrated in

Fig. 5, this apparatus comprises a casing 49 divided by walls or partitions 50, 51 and 52 into a products chamber or compartment 53 and gas conditioning and circulating compartments 54, 55 and 56. Partition 50 is provided with a plurality of openings through which the conditioning gas may pass from the conditioning compartments into the products chamber 53. A fan or blower 57 is positioned for rotation in an

opening formed in partition 51. The fan may be carried by shaft 58 which is rotated by means of the pulley 59 and the power belt 60. Any suitable mounting for instance, the bearing bracket 58' may be provided. Of course, means other than those shown may be employed for rotating the fan.

As a feature of safety, a fan guard 61 formed of suitable grating or screening may be provided to protect workers who may enter the chamber 53, through doors (not shown) to place and remove material to be treated from the chamber.

Positioned on the roof 52 are one or more tanks 62 containing liquid and equipped with heating elements 63. As in the other modifications herein described, the heating elements may be of any desired construction and type, and may be operated in a manner most suitable for carrying out the treatment. It will be noted that the tank structure is arranged in heat conducting relation with the wall or roof 52, and consequently the roof will be at substantially the same temperature as the body of water or other liquid in the tank.

Water or other liquid may be supplied to the roof tank in accordance with the quantity evaporated. The supply may be controlled by automatic control valves (not shown) which cooperate with liquid level control valves (also not shown) to maintain a predetermined quantity of liquid in the tank structure.

In operation, the conditioning gas is circulated by means of the fan or blower over

the body of water or other liquid in the tank and through the products chamber 53. In passing over the heated liquid, the air or other gas will take up the vapor arising from the liquid and will carry the same into the products chamber where it will be assimilated by the material undergoing treatment.

Since the roof 52 is in thermal contact with the tank structure in which is contained heated liquid, and as the gas is conditioned both as to temperature and humidity by the heaters 63, the roof will be at a temperature approximately equal to that of the liquid and at a temperature higher than that of the conditioning gas, thus making impossible condensation of moisture thereon, and the disadvantages of having condensate form on the roof will be entirely avoided.

The present invention has been illustrated in the drawings as applied to several forms of conditioning apparatus, but I wish it to be clearly understood that the concept maintaining the temperature of the roof of the products chamber at a temperature equal to or greater than that of the conditioning gas may be applied to any type of material conditioning device, whether associated with a gas conditioning apparatus or not.

While in the foregoing disclosure, the upper wall of the several forms of conditioning apparatus have been heated by means of heated bodies of water, I wish it to be clearly understood that any other means for maintaining the temperature of the upper wall sufficiently high to prevent the condensation of moisture thereon may be employed. For instance, the upper wall may be heated by direct contact with heating elements or any other heating medium.

In Figures 6 and 7, I have shown a construction which differs from that described in the foregoing disclosure in that the temperature of the roof of the products chamber is maintained above that at which moisture from the gas will condense thereon, by means of a heated gas instead of heated liquid.

Fig. 6 shows an apparatus similar to that shown in Fig. 3, modified so that the roof may be heated by a gas instead of a liquid. Parts shown in Fig. 6 similar to those shown in Fig. 3 have been designated by corresponding reference numerals. This device differs from that illustrated in Fig. 3, in that the upper liquid tank is eliminated. The upper portion of the products chamber is partitioned by the wall or secondary roof 65, to form a chamber 66 between the same and the roof 64 of the treating apparatus. The partition 65 is preferably formed of metal or other material which is a fairly good conductor of heat.

It will be appreciated that if a hot fluid is in contact with partition 65, and its tem-

perature is sufficiently high, no moisture will condense on the interior surface of the partition or roof 65. This is accomplished in this form of the invention, by placing heating elements 67 in chamber 66 to heat the gas therein, which in turn heats the partition or roof 65.

To prevent the condensation of moisture on the roof 65, it is necessary to maintain the 10 temperature of the gas in the chamber 66 at or above the temperature of the gas in the products chamber. For instance, if the temperature of the conditioning gas is 95° F. in the treating chamber, the temperature of 15 the gas in the chamber 66 should be 95° F. or higher.

The temperature of the gas in the chamber 66 may be regulated by manually controlling the operation of the heating elements 67 or 20 it may be regulated by the automatic control device 68. In any event, the temperature is regulated so that condensation of moisture on the roof of the products chamber is prevented.

25 Another modification of the invention is shown in Fig. 7. This form of the invention is similar to that shown in Fig. 6, in that a gaseous fluid is employed as the medium for heating the roof of the products chamber. 30 The structure of Fig. 7 differs from Fig. 6, in that in Fig. 7, there is a flow of gas in contact with the roof of the products chamber.

As illustrated in Fig. 7, there is a compartment or chamber 66' formed above the roof 35 65. Chamber 66' is in communication with the atmosphere at the ends of the apparatus. The openings at the ends of the chamber 66' serve as inlets for the heating gas. An outlet conduit 69 is arranged at the upper portion 40 of the chamber, and is provided with a damper or valve 70 to control the outflow of gas from chamber 66'. To facilitate the flow of gas, the roof 71 of the chamber 66' is sloped from the inlets to the outlet 69.

45 Adjacent each inlet opening are heating elements 72, which heat the incoming air or other gas so that the fluid flowing in contact with the products chamber roof 65 will be at a temperature sufficiently high to prevent 50 condensation of moisture on the inner surface thereof.

The temperature of the gas may be controlled either by regulating the action of the heating element or by regulating the rate of 55 flow through the chamber 66' by operating the valve or damper 70. This may be effected manually or automatically. As shown in the drawings, the flow of gas through the compartment 66' is effected by thermosiphonic 60 action, but I wish it to be clearly understood that a blower or other type of gas forcing means may be employed to move the gas through the chamber 66'.

65 If found convenient or economical, the heated gas passing from chamber 66'

through conduit 69, may be used to advantage. For instance, the gas may be introduced in the conditioning apparatus and after humidification may be passed in the products chamber. The gas after passing from 70 the chamber 66' may be mixed with gas flowing in the treating apparatus or may be mixed with fresh gas as it is introduced into the treating apparatus. The heated gas from chamber 66' may be introduced into the conditioning compartments of the treating apparatus before the heating stage or between the heating stage and the humidifying stage. In this form of the invention, the temperature is regulated so that moisture will not 75 condense from the conditioning gas on the roof of the products chamber.

The present invention as hereinbefore set forth, is of decided advantage in that materials normally rendered valueless or of little 80 value when spotted, may now be treated with a conditioned gas without danger of spotting. The elimination of spotting of the material is highly desirable when the apparatus is used for treating fancy leather goods and 85 other materials which must have a pleasing finished appearance, or for treating materials, the quality of which would be detrimentally affected by spotting.

90 While I have shown and described the preferred embodiment of my invention, I wish 95 it to be understood that I do not confine myself to the precise details of construction herein set forth, by way of illustration, as it is apparent that many changes and variations may be made therein, by those skilled 100 in the art, without departing from the spirit of the invention, or exceeding the scope of the appended claims.

105 I claim:

1. A method of conditioning material comprising circulating a conditioning gas through a chamber containing the material, subjecting the gas to contact with a body of liquid positioned above the chamber, and heating the body of liquid to diffuse moisture into the gas and to prevent condensation of moisture on the upper portion of said chamber.

110 2. A method of conditioning material comprising circulating a conditioning gas through a chamber containing the material, subjecting the gas to contact with a body of water and heating a body of water in contact with the upper wall of the chamber to prevent condensation of vapor from the gas on the upper wall.

115 3. A method of conditioning material comprising circulating a conditioning gas through a chamber containing the material, heating a body of liquid in contact with the upper wall of said chamber to prevent condensation of vapor from the gas on the upper wall, passing heated water from said body to a humidifying zone and passing the gas into 120 125 130

contact with the heated water to humidify the gas.

4. A method of conditioning material comprising circulating a conditioning gas through a chamber containing the material, heating a body of liquid in contact with the upper wall of said chamber to prevent condensation of vapor from the gas on the upper wall, passing heated water from said body to a humidifying zone, heating the gas and passing it in contact with the heated water to humidify the gas. 70

5. A method of conditioning material comprising passing a conditioning gas in contact with a body of water, drawing the gas from contact with the body of water, forcing it through a products chamber, maintaining a body of heated water in contact with the upper wall of said products chamber, and with- 75

10 drawing water from said heated body to compensate for the water evaporated from the first body.

6. A method of conditioning material comprising heating a conditioning gas, passing it in contact with a body of water, drawing the gas from contact with the body of water, forcing it through a products chamber, maintaining a body of heated water in contact with the upper wall of said products chamber, and 80

15 withdrawing water from said heated body to compensate for the water evaporated from the first body.

7. A method of conditioning material comprising circulating a conditioning gas from a zone containing the material to be treated, over a body of water, over a second body of water, then passing the gas into the zone containing the material to be treated, heating said second body of water to a temperature 85

20 above that of the dew point of said conditioning gas and transferring the heat of said second body of water to the upper wall of the zone containing the material to be treated. 90

8. A method of conditioning material comprising circulating a conditioning gas through the chamber containing the material, subjecting the gas to contact with a body of water, subjecting the gas to contact with a second body of water positioned above the chamber, and heating said second body of water to facilitate the humidification of the gas and transferring heat from the second body of water to the upper wall of the chamber to prevent condensation of moisture on 95

25 the upper portion of said chamber. 100

9. A method of conditioning material comprising circulating a conditioning gas through a chamber containing the material, subjecting the gas to contact with a heated body of water, cooling the gas after humidification, and passing it in contact with a second body of heated water, the temperature to which said second body of water is heated being higher than that temperature at which 105

30 moisture will condense from a conditioning 110

gas and transferring heat from the second body of water to the roof of the chamber to prevent condensation of moisture on the roof of the chamber. 115

10. A method of conditioning material comprising circulating a conditioning gas through a chamber containing the material, subjecting the gas to contact with a heated body of water, cooling the gas after humidification and dispersing moisture therein, and passing it in contact with a second body of heated water, the temperature to which said second body of water is heated being higher than that temperature at which moisture will condense from a conditioning gas and conducting heat from the second body of water to the roof of the chamber containing the material to prevent the condensation of moisture on the roof of the chamber. 120

11. A conditioning apparatus comprising a chamber adapted to contain the material to be treated and a conditioning gas in contact therewith, a tank associated with the roof of said chamber, a heating coil positioned in said tank adapted to heat water therein so as to maintain the roof of the chamber at a temperature above that at which moisture will condense from the conditioning gas. 125

12. A conditioning apparatus comprising a products chamber, a plurality of gas-conditioning chambers arranged in parallel circuit with said products chamber, means for circulating the gas through said products chamber in parallel circuits through said conditioning chambers, means in said conditioning chambers for humidifying the gas, said means comprising a heated body of water maintained in heat exchange relation with the upper wall of the products chamber to prevent condensation of moisture thereon. 130

13. An apparatus for treating tobacco and similar materials comprising a products chamber having upper and lower slotted walls, conditioning chambers, a tank structure associated with the upper walls, a tank structure positioned beneath the lower wall, and means in the upper tank for heating water therein to prevent condensation on the upper wall thereof, and consequent spotting of the material to be treated. 135

14. An apparatus for treating tobacco and similar materials comprising a products chamber having upper and lower slotted walls, conditioning chambers, a tank structure associated with the upper walls, a tank structure positioned beneath the lower walls, means positioned in said conditioning chambers for cooling air circulated therethrough, and means in the upper tank for heating water therein to prevent condensation on the upper wall thereof and consequent spotting of the material to be treated. 140

15. An apparatus for treating tobacco and similar materials comprising a products chamber having upper and lower slotted 145

walls, conditioning chambers, a tank structure associated with the upper walls, a tank structure positioned beneath the lower wall, means positioned in said conditioning chambers for cooling air circulated therethrough, means associated with the cooling means for entraining water in the gas, and means in the upper tank for heating water therein to prevent condensation on the upper wall thereof and consequent spotting of the material to be treated.

16. An apparatus for conditioning material comprising a products chamber, an air heating chamber, a humidifying chamber, means for passing air through said chambers, and means associated with the roof of the products chamber for maintaining the wall at a temperature above the dew point of the air, said last mentioned means comprising a body of heated water.

17. An apparatus for conditioning material comprising a products chamber, an air heating chamber, a humidifying chamber, means for passing air through said chambers, and means associated with the roof of the products chamber for maintaining the wall at a temperature above the dew point of the air, said last mentioned means comprising a body of heated water, and means for conveying heated water from the body to the humidifying chamber.

18. An apparatus for conditioning material comprising a products chamber, an air conditioning chamber, a humidifying tank in the air conditioning chamber, means associated with the tank for increasing the effective area of water maintained therein, means for circulating air through said chambers, and means associated with the upper wall of the products chamber to prevent the formation of droplets of water thereon.

19. An apparatus for conditioning material comprising a products chamber, an air conditioning chamber, a humidifying tank in the air conditioning chamber, means associated with the tank for increasing the effective area of water maintained therein, means for circulating air through said chambers, a body of water associated with the upper wall of the products chamber, means for heating said water to transfer heat to the upper wall to prevent condensation of moisture thereon.

20. An apparatus for conditioning material comprising a products chamber, an air conditioning chamber, a humidifying tank in the air conditioning chamber, means associated with the tank for increasing the effective area of water maintained therein, means for circulating air through said chambers, a body of water associated with the upper wall of the products chamber, means for heating said water to transfer heat to the upper wall to prevent condensation of moisture thereon, and means for conducting water from said

heated body to the humidifying tank to compensate for water evaporated therefrom.

21. A conditioning apparatus comprising a chamber adapted to contain the material to be treated and a conditioning gas in contact therewith, a compartment associated with the roof of said chamber, adapted to contain a fluid therein, and means in said compartment for said fluid and temperature responsive means in the compartment for regulating the temperature of the fluid heating gas so as to prevent the condensation of moisture upon the roof of the chamber containing the material to be treated.

22. A conditioning apparatus comprising a chamber adapted to contain material to be treated and a conditioning gas in contact therewith, a compartment associated with the roof of said chamber, heating means positioned in said compartment adapted to heat gas therein, so as to maintain the roof of the chamber at a temperature above that at which moisture will condense from the conditioning gas.

23. A conditioning apparatus comprising a chamber adapted to contain material to be treated and a conditioning gas in contact therewith, a compartment associated with the roof of said chamber, said compartment being closed to communication with the chamber and having air inlets at the ends thereof, and an air outlet at the upper portion thereof, and means in said compartment for heating and circulating air therethrough.

24. A method of conditioning material comprising heating a body of gas, passing said gas in contact with moisture saturated elements, passing the humidified gas into a chamber containing material to be treated, heating a second body of gas, and passing it in contact with the roof of the chamber containing the material to be treated, and subsequently introducing said second body of gas after humidification into the chamber containing the material to be treated.

In testimony whereof I affix my signature.  
GORDON DON HARRIS.

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