G. H. BENJAMIN.

ART OF DRYING BODIES.

APPLICATION FILED NOV. 20, 1914.

1,225,212.

Patented May 8, 1917.

3 SHEETS—SHEET 1.

FIG. 1.

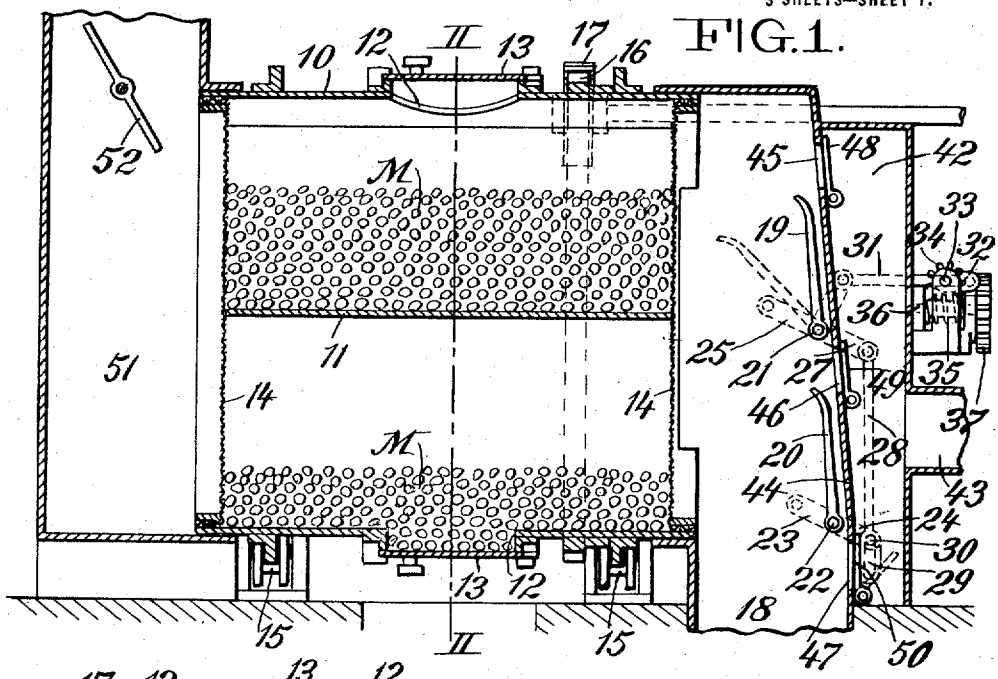


FIG. 2.

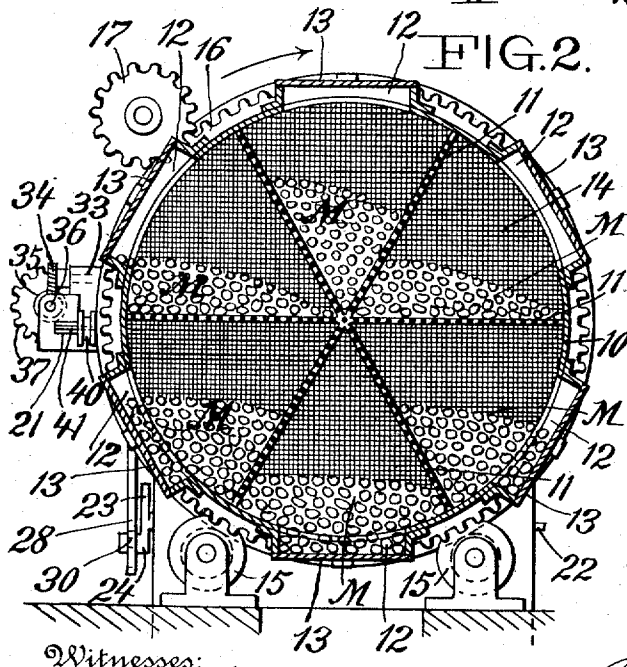
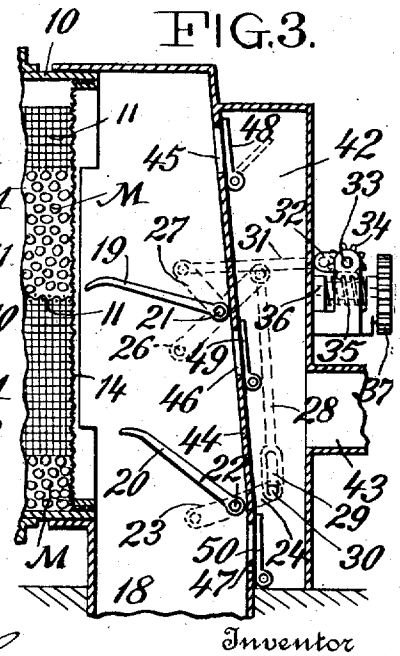


FIG. 3.



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3 SHEETS—SHEET 2.

FIG. 4.

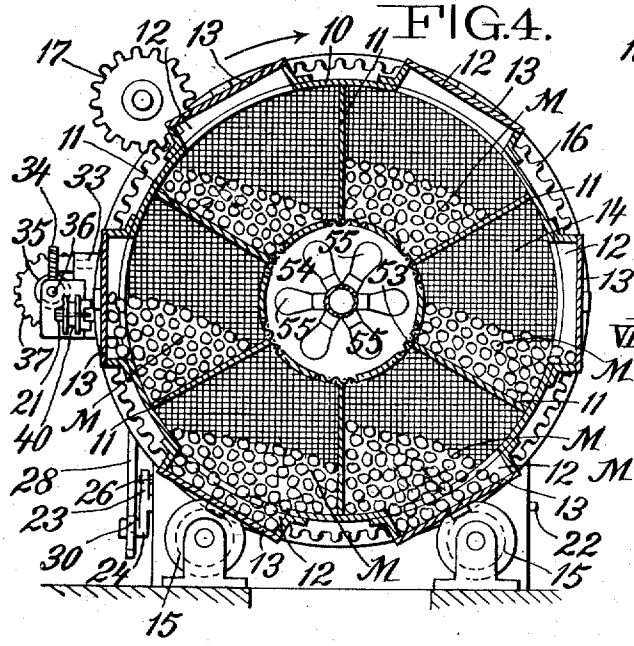


FIG. 5.

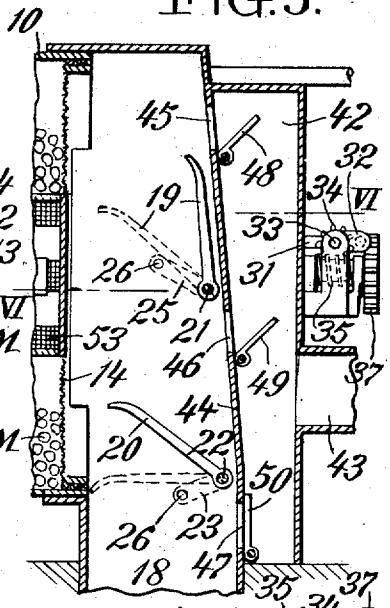
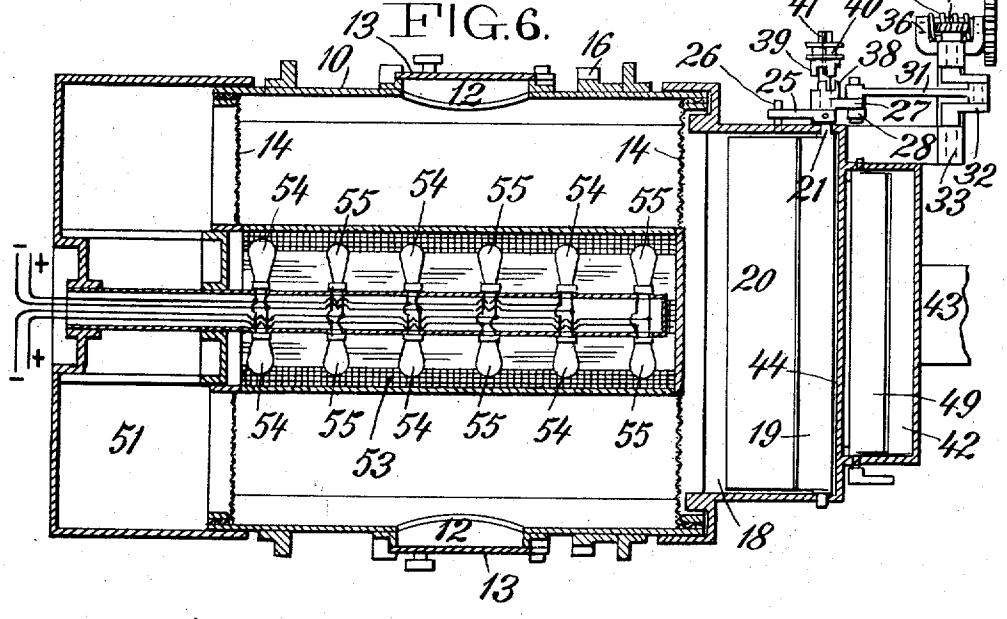


FIG. 6.



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3 SHEETS—SHEET 3.

1,225,212.

FIG. 7.

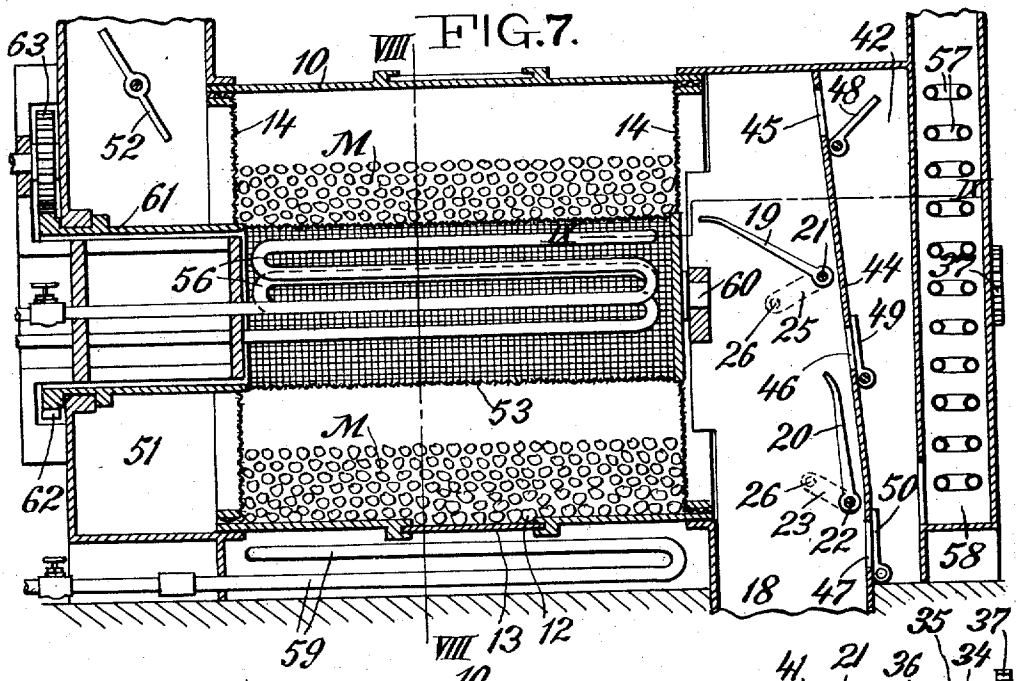


FIG. 8.

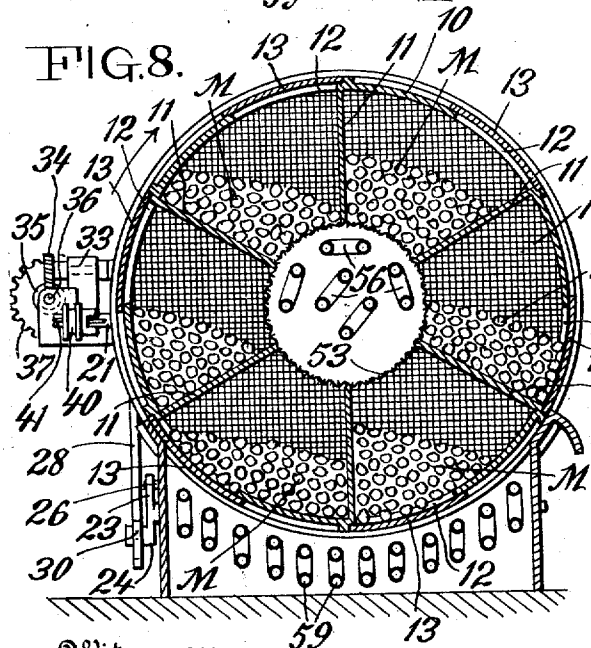
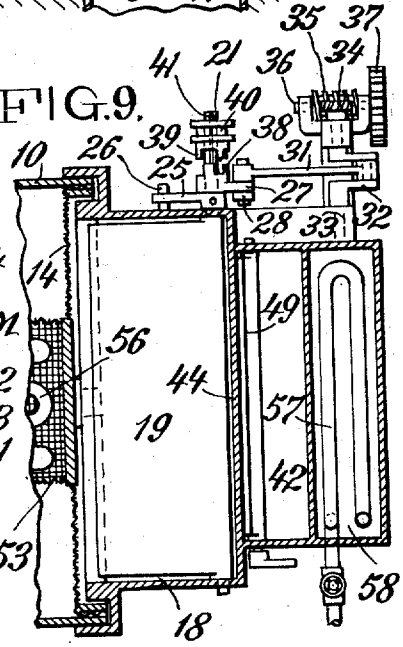


FIG. 9.



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UNITED STATES PATENT OFFICE.

GEORGE HILLARD BENJAMIN, OF NEW YORK, N. Y.

ART OF DRYING BODIES.

1,225,212. Specification of Letters Patent. Patented May 8, 1917.

Application filed November 20, 1914. Serial No. 873,108.

To all whom it may concern:

Be it known that I, GEORGE HILLARD BENJAMIN, a citizen of the United States, residing at New York city, in the county and State of New York, have invented certain new and useful Improvements in the Art of Drying Bodies, of which the following is a specification.

My invention relates to a method and apparatus for drying or otherwise treating bodies for the purpose of removing moisture and putting them into a condition which will permit of their storage without sensible deterioration for considerable periods.

My improved method is based upon the following conditions:

(A) If a cellular body containing moisture, is subjected to heat, the fluid within the cell walls of the body will be expanded, the expansion being proportional to the heat applied, and such expansion will create a pressure from within the cell walls outwardly, which will tend to expand the cell membrane, thereby making it thinner and causing an exudation of the fluid from the cells through the membrane of the body.

(B) If a cellular body, having moisture upon its surface, or containing fluid within its cell walls, is subjected to the action of air currents having a capacity for absorbing moisture, the effect of such air currents will be to absorb the external moisture and to set up an exosmotic exudation of the fluid within the cell walls, and further, by the rapid evaporation due to the passage of the air currents over the body, tend to chill the body and thereby lower the temperature of the body from the normal, or form a temperature at which exudation of the moisture within the cell walls will not take place.

My improved method, therefore, briefly stated, contemplates subjecting the body to a temperature sufficient to set up exudation and simultaneously subjecting the body to the action of air currents which will absorb the exuded moisture and at the same time aid the exudation of moisture from within the cell walls.

As supplementary to the action of the two forces above set forth, my invention also contemplates the use of a third force, *i. e.*, the effect of transmitted light. It is a well known fact that sunlight or electric light has a very great effect upon vegetation, and that such effect is observed in the growth of the plant, the coloring of the leaves and blossoms, the exudation of moisture from the plant, and the power of the plant to absorb carbon. I have described my process as mainly consisting of the application of the two forces, *i. e.*, the effect of heat and that of passing air currents, for with many materials to be treated, the application of these two forces will be sufficient, whereas with other bodies, the third force, *i. e.*, the electric light, is advantageous.

My invention also relates to the construction of the apparatus used for carrying the above described method into effect, and which I will describe for the purpose of illustrating how the method may be used. I wish it understood, however, that I do not in any wise limit myself to the particular forms of apparatus disclosed, as other apparatus may be used with great success.

The accompanying drawings illustrate apparatus which may be used for carrying my improved method into effect, in which Figure 1 is a vertical section of a dehydrating apparatus; Fig. 2 is a transverse section on the line II—II of Fig. 1. Fig. 3 is a vertical section of the portion of the dehydrating apparatus shown in Fig. 1 at the right, and showing the influence dampers in a different position from that of Fig. 1. Fig. 4 is a transverse section corresponding to Fig. 2 but showing a modification of my invention. Fig. 5 is a vertical section of the right hand end of the dehydrating apparatus corresponding to Fig. 3. Fig. 6 is a plan view taken through Figs. 4 and 5, substantially on the line VI—VI of Fig. 5. Fig. 7 is a vertical section of a modification of the dehydrating apparatus. Fig. 8 is a transverse section on the line VIII—VIII of Fig. 7. Fig. 9 is a horizontal section of the right hand end of Fig. 7 taken on the line IX—IX.

In the drawings, 10 represents a drum, divided into compartments by partitions 11, and having hand holes 12, with covers 13, through which hand holes the material to be dehydrated may be introduced into the compartments in the cavity of the drum. At the end of the drum are wire screens 14. The drum as a whole, is mounted upon roller bearings 15, and is provided on its exterior with a toothed wheel 16, which coöperates with a pinion 17 attached to any suitable source of power, and thus rotation of the drum be effected, as desired. At the right hand end of the drum is a hot air duct 18,

which is assumed to be connected to a source of air. Situated in the air duct at different levels, are influence dampers 19—20. Damper 19 is secured to a shaft 21, and damper 20 is secured to a shaft 22. To shaft 22 is secured arms 23 and 24, and to shaft 21 is secured an arm 25. The dampers 19—20 can be manually adjusted to the position shown in Figs. 1 and 7 by engagement of pins 26 with apertures formed in arms 23 and 25 and the wall of air duct 18.

Loosely mounted on shaft 21 is a bell-crank 27, one arm of which is pivoted to a rod 28, which arm is provided with a slot 29 engaging a pin 30 formed on the arm 24. The other arm of bell-crank 27 is connected by a rod 31 to a crank 32 which is secured to a shaft 33. To shaft 33 is secured a gear 34 which coöperates with a worm 35 on a shaft 36, said shaft having a gear 37 which may be connected to any suitable source of power. When the shaft 36 is rotated the loosely mounted bell-crank 27 and the slotted rod 28 will be moved without effect on the dampers 19—20. The hub of bell-crank 27 is provided with teeth 38, adapted for clutch engagement with teeth 39 found on a sliding collar 40. The collar 40 is adapted for engagement with a spline 41 formed on shaft 21. When pins 26 are removed from engagement with arms 23 and 25, and the collar 40 is moved into clutch engagement with bell-crank 27, movement of the bell-crank, caused by rotation of shaft 36, will be imparted to the influence dampers 19—20, causing said dampers to change their positions. For instance, in Fig. 1 both influence dampers are in a vertical position. Movement of crank 32 causes damper 19 to be moved to the position shown by dotted lines. The slot 29 formed in rod 28 permits this movement of damper 19, without affecting damper 20. Further, movement of crank 32 causes further movement of damper 19, and owing to the limited length of slot 29, causes movement of damper 20 to the position shown in Fig. 3. The operation of these dampers will be more fully set forth in describing the method.

Situated to the right of the air duct 18 is a flue 42, which may be connected through a pipe 43, to any suitable source of gas, for instance, sulfurous acid gas. Located in the wall 44 of air duct 18 are ports 45, 46, 47, controlled by valves 48, 49, 50. These valves are shown in different positions in the different figures, and their functions will hereinafter be described.

Situated at the left hand end of the drum 10, is an exhaust duct 51, and in this duct a controlling valve 52. The partitions 11 of the drum 10, I prefer to be perforated, as shown in Fig. 2 or formed of wire netting, as shown in Fig. 3. In Fig. 4 there is located within the drum 10, a drum formed of perforated metal or wire 53, and located within this drum, two series of electric lights 54—55. In Fig. 7 a steam coil 56 is used in place of the electric lights, and a steam coil 57 is located in a pipe 58 which corresponds to pipe 43 of Fig. 3. A third steam coil 59 is located under the drum. The drum is provided with extensions 60 and 61, which are journaled in bearings forming part of the walls of ducts 18 and 51. The extension 61 is provided with a gear wheel 62 which is in mesh with a driving pinion 63.

My method may be carried out as follows: Referring first to Fig. 1. The drum being at rest, the hand cover 13 is moved and the material to be treated introduced into one of the compartments between the partitions 11, at which time the cover is replaced and the drum rotated, the material being introduced into each compartment until the required amount of material to be treated has been introduced into the drum. The drum is then set in motion. The air currents entering by the air duct 18, pass through the drum and over the material in the drum (indicated by the letter M) and out of the drum through the air exhaust duct 51.

It will be understood from the description heretofore given, that the influence dampers 19—20 are constantly moving and changing their positions, whereby the air will be sent through all of the compartments, when the dampers are in the position shown in Fig. 1, and through the lower compartments, when the dampers are in the position shown in Fig. 3, and through the upper compartments, then reversing, the mechanism controlling the influence dampers being such that one influence damper follows the motion of the other, or precedes the motion of the other. As this feature has been made the subject of other applications and will be readily understood, it is not considered necessary to enter into any further description of the movement of the dampers.

In the apparatus shown in Figs. 1 to 3, the heating effects and dehydrating effects are due to introduced hot air through the air duct 18. The air is preferably dry air. When the machine is first started, the air currents lose a part of their heat through the material to be treated, and in the continued use of the apparatus, lose a part of their heat by reason of the evaporation of the moisture from the surface of the material being treated. This loss of temperature is one which it is difficult to regulate owing to the fact that the different materials contain different amounts of moisture. It is therefore generally necessary to make the temperature of the introduced air somewhat higher than the temperature required to produce the necessary exudation; for instance, if it is found that a body exudes moisture freely at 110°, it will be necessary to raise

the temperature of the air to 120°, thereby lowering the humidity of the air relative to its volume, as is well understood, in order to compensate for the losses above set forth.

To avoid this objection, the method is applied best through the apparatus shown in Figs. 4 to 9 inclusive. In the apparatus shown in these figures, the material is introduced as previously described, and the air then turned on through the air duct 18; the material M is heated to the exuding temperature by the action of the heat from the electric lights 53, or the steam coils 56, 59. Thus, when the air is turned on, at for instance a temperature of 110°, the material has already been brought to 110°, and in the further operation of the machine is maintained at 110° by the action of the electric lights or the steam coils. Thus the moisture absorbing value of the air introduced through the air duct 18 is maintained with the effect that the exudation of the moisture is more uniform, and further exudation may be maintained at lower temperatures, as is the case where the exudation is due to the heat and osmotic action of the introduced air currents.

In Fig. 8 of the drawings, the heat is applied internally and externally of the drum, which permits of somewhat better distribution. The drum is rotated as before stated. The rotation of the drum brings different surfaces of the material M into the air currents and also into the influence of the heat, thereby insuring that all particles of the body treated shall be both heated and subjected to the action of air. Further, by reason of the arrangement shown in Fig. 4, all of the material is brought into the influence of the electric light.

The precise action of the light upon vegetable bodies is not known. It is supposed that the rays act mechanically and thereby bring about motion which permits chemical reactions to take place, which, as before stated, influence the plant and the structure of the materials carried by the body. The time during which the material contained within the drum should be subjected to the action of heat, air currents and the like, will depend upon the character of the body treated; that is, its structure, the amount of moisture, character of ingredients, and the like. In practice it has been demonstrated that where a body will exude moisture freely at 110° temperature, exudation will continue during the time the temperature is maintained for a definite time, when it will cease. With some bodies the exudation which takes place at such a temperature will remove the required percentage of water, which ordinarily speaking must be such that the remaining water will not be sufficient to combine with the enzym present to set up fermentation or to produce mold (the percentage ranges from 5 to 20%) but sufficient to maintain the cell membranes of the body in a condition to permit endosmosis through the cell walls of the body when the body is subsequently immersed in water. If it is found that the body does not exude the required moisture at say 110° temperature, the temperature is then raised and continued until such time as the moisture has been reduced, as above stated. With certain bodies, the temperature must be kept low to avoid the volatilization of the essential oils. With other bodies, the temperature may be increased. With bodies in which the volatilization point is very low, it is sometimes desirable to heat them for a time at a temperature less than will effect volatilization, then drop the temperature, then bring it back to the original temperature, when it is found that exudation will again commence. By repeating the steps as before stated, the required percentage of moisture will be removed without volatilization. With other bodies, where it is desired to in effect polymerize the essential oils, the temperature, after the required exudation has taken place, may be rapidly raised, for instance to 220° or higher.

It will be understood that owing to the very great variety of materials which may be subjected to treatment, it is practically impossible to state any definite range of temperatures which must be employed. The purpose of the flue 42 is to allow the introduction of a gas or gases to the material in the drum during the dehydration treatment, or before or after or alternately with the dehydrating treatment, such gases passing into the air duct 18 through the openings 45, 46 and 47, controlled by valves 48, 49 and 50. These valves 48, 49 and 50 are individually adjustable to permit of the gases flowing into the air duct at different points whereby they may be directed by the influence dampers 19 and 20 through the different compartments, as previously pointed out. Thus I may use any gas, such for instance as sulfurous acid gas, as in the case of the treatment of hops, or I may use an aldehyde, where is is desired to produce chemical reaction with the oils or sugars present in the material treated, as in the case of tobacco, leather, etc.

I have given no description, in this specification, of the application of the method to particular bodies, as such treatment will be made the subject of separate applications some of which have already been filed, and others of which will be filed.

Having thus described my invention, I claim:

1. The method of partially dehydrating bodies, which consists in imparting motion

to the body and while in motion subjecting it to the action of air currents, independently applied heat, and electrically produced light for a sufficient time to remove at least 80% of the normal water content and produce color changes.

2. The method of treating cellular bodies to produce a partially dehydrated body, which consists in subjecting the body to the action of heated air currents, independently applied heat, and electrically produced light, the physical effects of the heat and light being regulated so as not to destroy the enzyms present in the body treated.

3. In a dehydrating apparatus, the combination of a rotary member, an air inlet, an air outlet, means for continuously altering the level at which the air is transmitted through the rotary member, and means for heating the rotary member.

4. In a dehydrating apparatus, the combination of a rotary member, an air inlet, an air outlet, means for continuously altering the level at which the air is transmitted through the rotary member, and means for heating and lighting the interior of the rotary member through the instrumentality of electric energy.

5. In a dehydrating apparatus, the combination of a rotary member open at both ends and divided into compartments by partitions, an air inlet located at one end, an air outlet located at the other end, a series of air deflecting dampers located in the air inlet, together with means for continuously varying the positions of the dampers.

6. In a dehydrating apparatus, the combination of a rotary member open at both ends and divided into compartments by partitions, an air inlet located at one end, an air outlet located at the other end, a series of air deflecting dampers located in the air inlet, means for continuously imparting motion to said dampers, together with means for heating the interior of the rotary member.

7. In a dehydrating apparatus, the combination of a rotary member open at both ends and divided into compartments by partitions, an air inlet located at one end, an air outlet located at the other end, a series of air deflecting dampers located in the air inlet, means for continuously imparting motion to said dampers, a source of electric energy, and a series of electric lights adapted to transmit light and heat into the interior of the rotary member.

8. In a dehydrating apparatus, the combination of a rotary member open at both ends and divided into compartments by partitions an air inlet located at one end, an air outlet located at the other end, a series of air deflecting dampers located in the air inlet, means for continuously imparting motion to said dampers, a gas inlet, and dampers located between the gas inlet and the air inlet.

9. In a dehydrating apparatus, the combination of a rotary member open at both ends and divided into compartments by partitions, wire screens at both ends, an air inlet located at one end, an air outlet located at the other end, a series of air deflecting dampers located in the air inlet, and means for continuously imparting motion to said dampers.

10. In a dehydrating apparatus, an annular rotary drying chamber having a perforated interior wall and a light radiating device inclosed by said interior wall.

11. In a dehydrating apparatus, an annular rotary drying chamber having a perforated interior wall, and an electrically energized light radiating device inclosed by said interior wall.

12. In a dehydrating apparatus, an annular rotary drying chamber, and an electrically energized combined light and heat radiating device inclosed by said annular chamber.

13. In a dehydrating apparatus, the combination of a rotary member, an air inlet, an air outlet, a controlling means for said air inlet adapted to cause the air to enter different portions of the said rotary member, and means whereby a gas may be caused to flow into different portions of said chamber according to the position of said controlling means.

In testimony whereof, I affix my signature, in the presence of two witnesses.

GEORGE HILLARD BENJAMIN.

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FRED R. WALTER.