

[54] **APPARATUS FOR TURGOR
CONDITIONING TOBACCO**

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[51] Int. Cl. **A24b 03/18**

[58] Field of Search .. 53/112 R; 131/133, 134, 136,
131/140-144

[56] **References Cited**

UNITED STATES PATENTS

2,267,900 12/1941 Doyle 131/133 A

FOREIGN PATENTS OR APPLICATIONS

1,878,358 8/1963 Germany 131/133 A

193,608 1/1938 Switzerland 131/133 A

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[57] **ABSTRACT**

Tobacco is shredded or strip form is turgor conditioned prior to sublimation drying to produce tobacco of high specific volume with minimal alteration of the chemical characteristics and intercellular structure of the tobacco by establishing a high vacuum around the tobacco to remove rapidly air and water vapor from within the cells and intercellular spaces of the tobacco, supplying liquid water to the evacuated tobacco and raising the ambient pressure to drive the water into the cells and intercellular spaces of the tobacco. Apparatus for carrying out the method includes sealable containers for tobacco, means for evacuating the container, means for introducing water into the evacuated containers and means for pressurizing the container to or above atmospheric pressure. The containers are disposed on a conveyor and brought into sealing engagement with a closure member which is connected to the evacuating means and the water and pressure supply. The actuation of the various means in the sealing means is brought about by a sequence timer in the system.

1 Claim, 5 Drawing Figures

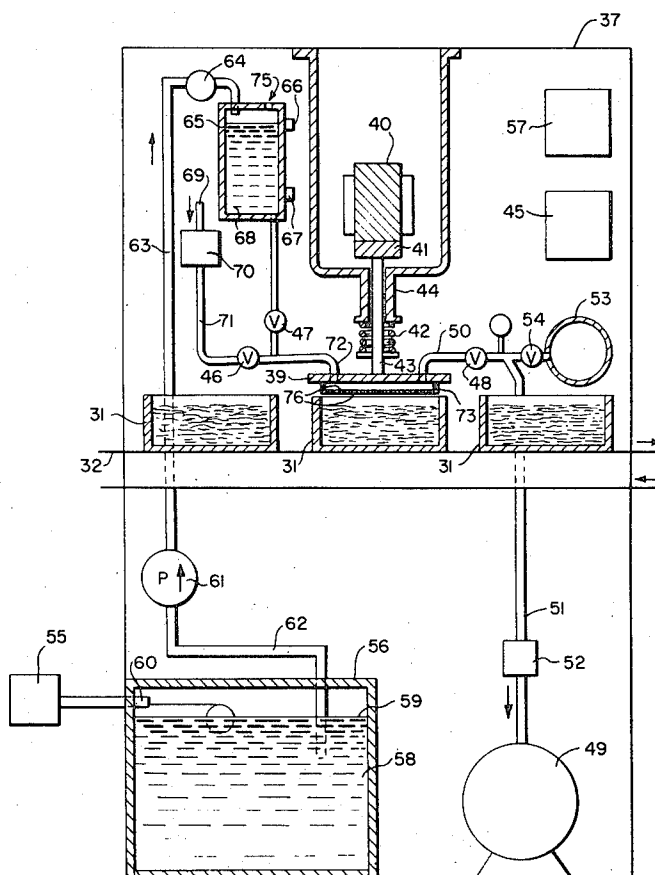


FIG. 1.

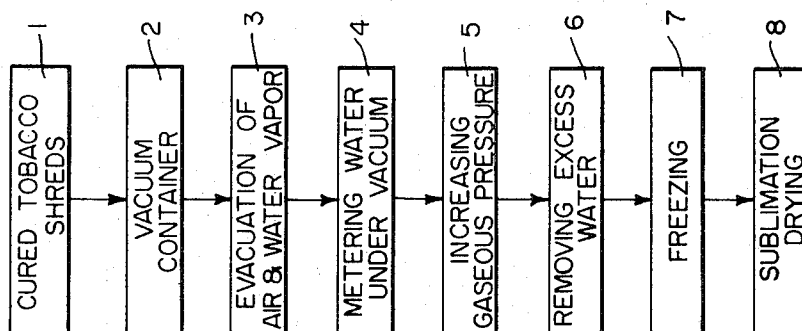
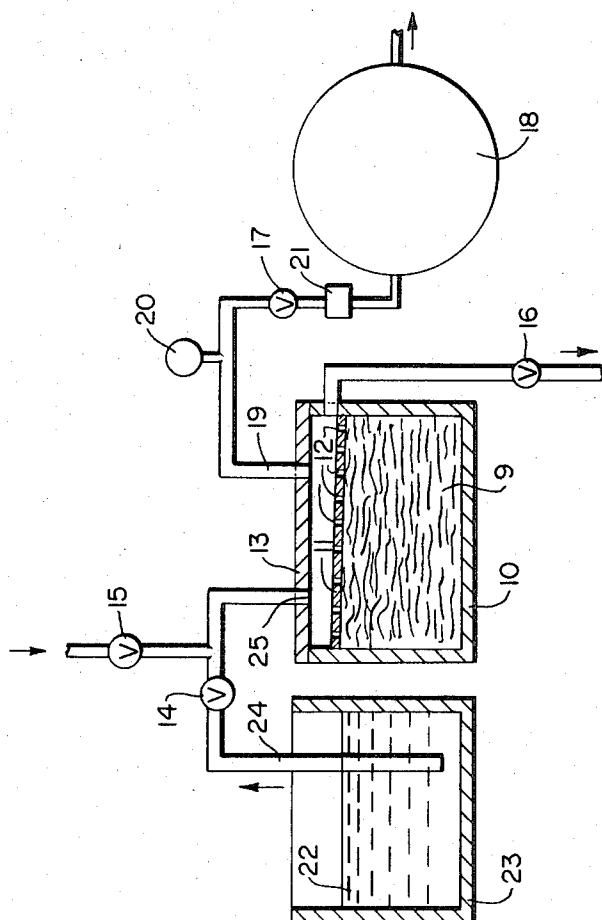
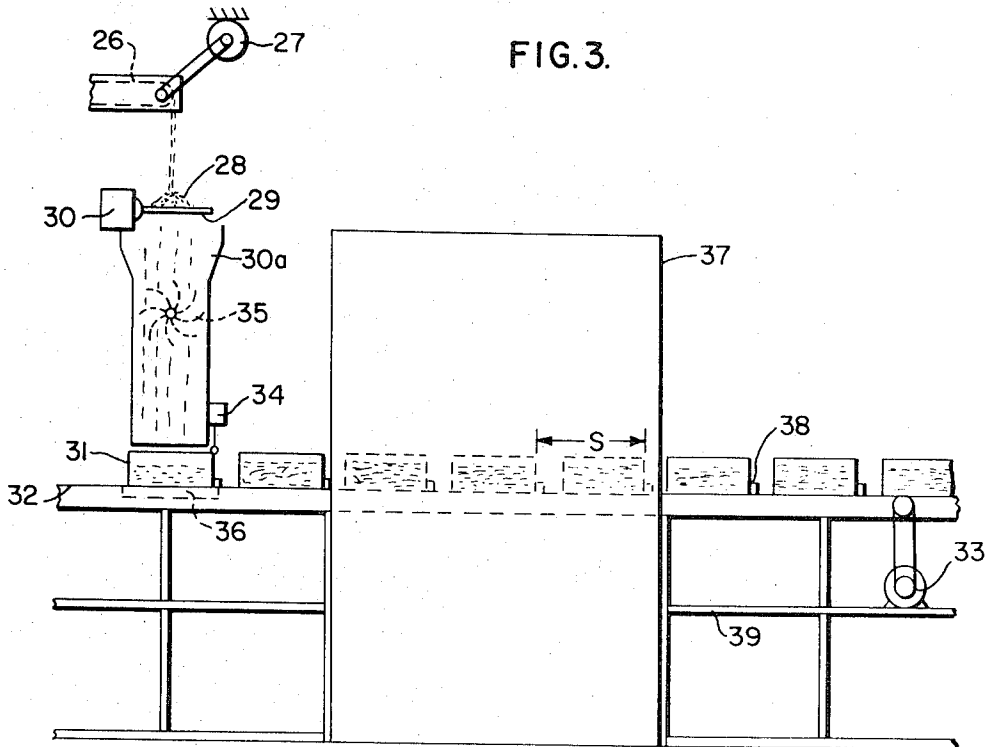
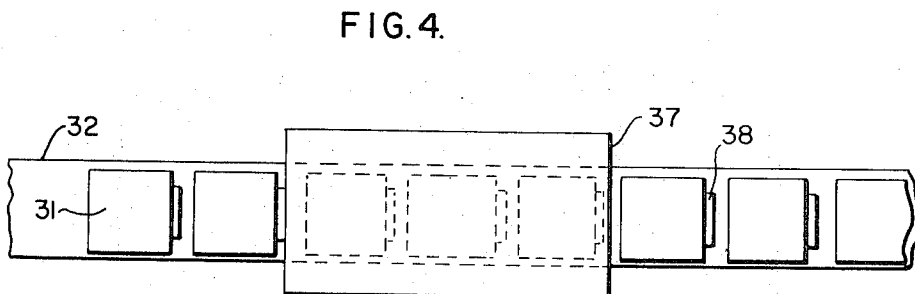


FIG. 2.





APPARATUS FOR TURGOR CONDITIONING TOBACCO

This is a division, of application Ser. No. 14,060, filed Feb. 24, 1970, now U.S. Pat. No. 3,710,803.

This invention relates to a apparatus for achieving rapid turgor conditioning of tobacco prior to sublimation drying with minimal effects on the chemical characteristics and intercellular structure of the tobacco. The method employed involves establishing a high vacuum around tobacco leaf in shredded or strip form to remove air and water vapor from within the cells and intercellular spaces of the tobacco; supplying liquid water to the evacuated tobacco to completely cover and surround the tobacco and raising the ambient pressure to drive the water rapidly into the cells and intercellular spaces of the tobacco through the cut edges and epidermal openings of the shreds or strips to establish turgor and maximum volume of the tobacco. Excess water is then removed from the turgor conditioned tobacco by sublimation at reduced pressures. Any desired additives such as flavoring and humectant substances may be incorporated in the tobacco by admixing them in the water introduced into the evacuated tobacco. The novel apparatus for practicing the method provides for automatic sequencing of the steps thereof with minimal handling of the tobacco.

In my patent application, Ser. No. 707,064 of Feb. 21, 1968 on "Treatment of Tobacco," a method of processing is disclosed whereby the specific volume of tobacco laminae may be increased by a factor up to 2.7/1 by sublimation drying from a state of turgor. Tobacco may be processed either during curing, at a timely point following metabolic processes of the coloring phase, or following the curing process utilizing tobacco in a relatively dry state. The major advantages of this new method of processing are that a given quantity of tobacco will yield a larger number of cigarette; tar, nicotine and other compounds of the smoke may be systematically reduced in proportion to the amount of processed material utilized; and chemical and physical properties of the tobacco are improved.

The previously described method of turgor conditioning of cured tobacco involves immersion of the lamina or midrib material in water to establish high moisture levels of about 800 percent (dry basis) for lamina and up to 1,000 percent or higher for midrib material. Cured tobacco lamina, which normally contains 12-25 percent moisture, is immersed in water for about 30 to 60 minutes for strips about 1 inch wide. On the other hand, intact midribs in 1 inch lengths require up to 3 hours or more to achieve maximum expansion, due to their more impermeable nature. Shredding of either lamina or midrib material into fine, cigarette-size shreds reduces the time requirement by about 50 percent; however the time for complete expansion is still excessive for rapid processing. During moisture uptake, the tobacco not only "fills up" with water but also expands by nature of imbibitional forces to develop turgor pressure and maximum volume.

A disadvantage of this method of turgor conditioning, in addition to excessive time involved, is the problem of solute transfer from the tobacco to the water and later surface deposition on the tobacco during drying. Tobacco contains up to 20 to 30 percent sugar which tends to dissolve along with other soluble compounds and to diffuse into the surrounding water. After

the tobacco has been frozen, freeze-dried and conditioned to a safe handling moisture level of around 12-20 percent, it tends to exhibit a slightly sticky or gummy characteristic due to translocated solutes. This characteristic poses additional problems to mechanical handling of the processed tobacco, as for example in the manufacture of cigarettes. The tendency of shreds or strips to adhere to each other or to containing or conveying surfaces prevents normal free-flowing characteristics important in tobacco processing operations.

Another problem associated with the method of turgor conditioning is the difficulty in obtaining uniform distribution of water throughout the shreds, resulting in non-uniform moisture uptake. Water does not penetrate uniformly throughout the fine shreds, thereby trapping air pockets at various locations throughout the bed. Agitation and shaking of the container holding the tobacco shreds and water, or pressing the tobacco within the water, help to eliminate trapped air; however, agitation also appears to increase solute transfer. Elimination of this difficulty accordingly is desirable.

The method herein disclosed essentially eliminates these problems by minimizing turgor conditioning time and providing uniform and rapid moisture uptake. Within seconds, the tobacco can be turgor conditioned, uniformly and systematically. The method thereby lends itself to automatic sequencing of events for continuous-flow operation.

It is therefore an object to provide an apparatus for rapid turgor conditioning of tobacco in shred or strip form from moisture levels of about 12-20 percent to up to 800 to 1,000 percent (dry basis).

Another object is to provide a turgor conditioning apparatus for tobacco which minimize the operating time and consequently reduce solute transfer from the tobacco to the surrounding water.

Another object is to provide a turgor conditioning apparatus for tobacco which gives uniform moisture distribution and uptake.

A further objective is to provide a turgor conditioning apparatus for automatic, continuous-flow operation.

These and other objects and advantages will become evident in the following description of the method and apparatus of the invention which will be more particularly described with reference to the accompanying drawings in which

FIG. 1 is a flow chart of the sequence of steps involved in the rapid turgor conditioning and subsequent sublimation drying of the invention;

FIG. 2 is a partial vertical sectional view, partly diagrammatic, which illustrates the essential components involved in the turgor conditioning method of the invention;

FIG. 3 is a partial vertical view, partly diagrammatic, of apparatus for automatic continuous-flow operation of turgor conditioning;

FIG. 4 is a plan view of a portion of the apparatus of FIG. 3.

FIG. 5 is a vertical sectional view of the turgor conditioning compartment of the apparatus of FIG. 3, illustrating the layout of specific components and control units.

Referring now to FIGS. 1 and 2, the essential steps of the method may be illustrated. FIG. 1 shows the sequence of steps, with turgor conditioning preceding the

sublimation drying process; whereas, FIG. 2 illustrates a suitable apparatus.

The invention will be more particularly described as applied to the turgor conditioning of shredded cured tobacco.

Cured tobacco shreds (1, FIG. 1), preferably of cigarette-size of about 1 mm in width, are prepared for processing. Shredding to the size which is to be used for cigarette manufacturing gives the advantages of more rapid and uniform turgor conditioning and sublimation drying, longer final shred length, and greater net increase in filling value. The latter two advantages result from the fact that shredding following either turgor conditioning or sublimation drying reduces shred length and by compressive action, reduces the gain achieved by the method. Tobacco at this stage is generally at room temperature of about 25° C or higher and at a moisture content of about 12 to 25 percent (dry basis). Moisture content should be sufficiently high to prevent breakage in handling operations preparatory to turgor conditioning.

The next step is filling of the tobacco container (2, FIG. 1) which holds the tobacco during the entire turgor conditioning treatment. It is desirable that the shreds be distributed uniformly within the container, to provide uniform expansion during turgor conditioning and to provide a uniform material for subsequent freezing and sublimation drying stages.

The container is then sealed and evacuated of air and water vapor (3, FIG. 1) to an absolute pressure of about 25 to 50 mm Hg. Within about 30 seconds the vacuum evacuates the enclosed container and removes the majority of air from within intercellular spaces and cells of the tobacco shreds. Furthermore, the moisture within the tobacco rapidly evaporates to give a dry material at low pressure throughout.

The next step is metering of water into the container (4, FIG. 1) which holds the tobacco shreds under reduced pressure. The partial vacuum draws water at atmospheric pressure into the container, without the necessity of external pumping action. The temperature of the water is preferably maintained at about 0° to about 25° C. Liquid water is added to the extent of turgor conditioning required but in such a manner as to completely cover the shreds. For moderate increase in specific volume, five to seven parts of water by weight are added for each part of tobacco. For maximum increase in specific volume, water is added to provide a moisture content in the tobacco up to about 1,000 percent (dry basis). This means that for one unit of dry tobacco, about 10 units of water by weight are added. Slight increases in moisture uptake, and consequently specific volume, may be obtained with moisture addition exceeding the 10/1 ratio of liquid to dry tobacco weights; however, the shreds have practically reached maximum turgor and maximum expansion at 1,000 percent and increases above this level are insufficient to warrant the additional costs in sublimation drying for the additional water. During the period of adding water, it is necessary to provide means for preventing flotation of tobacco shreds, since the density of the shreds is less than that of water. Since all air has been removed from between shreds, water moves freely to uniformly surround the shreds; however, the water does not move freely into the tobacco at this stage due to the low pressure within the container.

The next step of increasing the pressure above the tobacco-water mixture (5, FIG. 1) serves to establish a driving force which forces the water through cut edges and epidermal openings of the shreds and, within seconds, thereby completely fills the voids within the tobacco shreds. The cells further expand by imbibition within seconds to establish turgor and maximum volume, assuming that ample water has been provided. Ambient atmospheric pressure has been found adequate in providing the driving force in treating shredded tobacco. Within about 10 seconds, the voids within the shreds are filled and the density of the shreds containing water equals or exceeds that of water such that the shreds no longer tend to float. Within the subsequent time interval of about 30 seconds, complete expansion has occurred due to imbibition. The gaseous pressure in this step may be increased to atmospheric pressure within about 2 seconds with excellent results; although, slower rates of pressure increase may be employed with equally good results. Any gaseous fluid may be used to provide the driving force and pressures above ambient will also give satisfactory and rapid moisture uptake by the shreds. For greatest simplicity and economy, air at atmospheric pressure is preferably utilized.

The above step essentially completes the turgor conditioning method. In the event excess water is provided, this is preferably drained (6, FIG. 1) from the container prior to freezing (7, FIG. 1) and sublimation drying (8, FIG. 1). This reduces time and energy requirements in both freezing and sublimation drying.

By the method of this invention, all steps of turgor conditioning may be completed within about 1 minute, thereby reducing time of treatment by 30 minutes or more. This method minimizes solute transfer and gives more uniform moisture distribution and uptake than the prior method involving simple immersion.

Referring now to FIG. 2, there is shown therein a simple apparatus for the method. Shredded tobacco 9 is shown located uniformly in a container 10 in preparation for turgor conditioning. A hold-down screen 11 is located above the shreds to prevent flotation while allowing movement of fluids through the screen through openings 12. A vacuum cap 13 provides an air-tight seal and cover for the container 10 and permits control of vacuum, water and air. In operation, valves 14, 15, and 16 are first closed and valve 17 is opened. The vacuum pump evacuates the container 10 of air and water vapor as previously discussed. The air is drawn through the line 19 which is connected to the vacuum cap 13. The pressure gage 20 gives a ready indication of the pressure within container 10. A moisture trap of suitable condenser 21 removes water vapor from the air stream to prevent contamination of the vacuum pump. Within 30 seconds, at an absolute pressure of up to about 25 mm Hg., the container has been evacuated and the intercellular spaces and cells of the tobacco shreds are essentially free of air and water. Preferably as high a vacuum as possible should be used during this step to maximize the rate and extent of expansion. For example at an absolute pressure of 25 mm Hg., about 3 to 4 percent of the original air content is left; whereas at 0.05 mm pressure, only about 0.1 percent is left. Valve 17 is now closed, while valve 14 is opened to admit water 22 from container 23. The water is forced by atmospheric pressure through the tube 24 and on through the vacuum cap 13 at the opening 25. The

water penetrates the hold-down screen 11 and moves immediately and uniformly throughout and covers the tobacco shreds. A calibrated amount of water is admitted then valve 14 is closed. The space above the screen 11 is still at high vacuum and valve 15 is now opened to admit air at atmospheric pressure which moves immediately to the container 10. The air pressure above the tobacco-water mixture forces the water within about 10 seconds into the tobacco shreds. Further expansion takes place within about 20 seconds due to imbibition to establish turgor within the cells. If excess water has been provided, this may be drained readily by opening valve 16. The tobacco is now ready for rapid freezing and sublimation drying.

Tests were conducted to evaluate the method using bright-leaf tobacco. In a first series of tests, tobacco shreds of about 1 mm width were immersed in water and the time for settling observed. At least 10 to 15 minutes were found necessary with normal procedures before settling occurred. As pointed out earlier, the dry shreds float; and as they fill with water and expand, the flotation tendency decreases. Similarly, samples were placed inside a glass vacuum flask and submitted to the vacuum turgor conditioning treatment. Within seconds, the shreds showed visible swelling and settled immediately, indicating success of the method.

Other tests were conducted to compare the specific volume (vol/wt) of samples processed by vacuum turgor conditioning with samples processed by immersion turgor conditioning procedures. Bright leaf tobacco (*Nicotiana tabacum* L.) was shredded 1 mm wide and at a moisture content of about 15 percent (dry basis). Two samples were vacuum turgor conditioned by the method disclosed and immediately frozen within 5 minutes, using dry ice. Two comparable samples were turgor conditioned by immersion only with a water to dry tobacco weight ratio of 10/1. This provided ample water for maximum expansion. The tobacco was allowed to imbibe the water over a time period of at least 30 minutes prior to freezing as in normal procedures. All samples were sublimation dried and evaluated in the dry state for specific volume. Following grinding in a Wiley mill, measured weights were poured into a graduated cylinder, tapped to equilibrium and volume determined. The results are given below in comparison with check samples:

Sample	Specific Volume (cm ³ /gm)	
		Avg.
Vacuum Turgor Conditioned (1)	14.2	
Vacuum Turgor Conditioned (2)	12.4	13.3
Immersion Turgor Conditioned (1)	10.6	
Immersion Turgor Conditioned (2)	11.4	11.0
Check (1)	2.9	
	2.8	2.85

The tests show that the vacuum turgor conditioning method is a superior method for obtaining maximum increase in specific volume. Since water can move freely and uniformly among the fine shreds, uniform moisture uptake throughout the container results. Furthermore, free movement of water into the shreds gives greater expansion than when entrapped air remains within cellular or intercellular spaces.

FIGS. 3, 4, 5 and 6 illustrate apparatus for automatic turgor conditioning of tobacco. The following description represents a preferred equipment and means for achieving proper sequencing of events and systematic turgor conditioning; however it is to be understood that

modifications in layout, component selection, etc. may be made within the scope of the invention.

FIG. 3 is a vertical view of apparatus, partly diagrammatic, which illustrates continuous-flow operation including automatic filling of tobacco containers in preparation for turgor conditioning. FIG. 4 gives a top view. Shredded tobacco 28 is supplied to a weighing platform 29 of an automatic weigh device 30 by means of the conveyor 26 driven by the electric motor 27. The automatic weigh device 30 controls the on-off operation of the motor 27 to deposit the proper weight of tobacco on the platform 29 prior to dumping it into the container 31. In operation, the conveyor belt 32 is driven intermittently by motor 33 to position the tobacco containers 31 exactly beneath the hopper 30a for filling. When the container 31 approaches the correct position, a limit switch 34 causes the automatic weigh device to trip, thereby dumping the tobacco. In falling through the hopper 30a, the tobacco is tossed and distributed evenly by the rotary agitator 35, and within seconds the tobacco is located uniformly in container 31. After tripping, the weighing platform 29 returns to its horizontal position and conveyor 26 supplies tobacco in preparation for the next container. The speed of conveyor 26 is such that the proper weight of tobacco is supplied within the time interval that container 31 is in position beneath hopper 30a. To further assure uniformity of shreds within the container 31, a vibrator 36 located beneath container 31 provides gentle vibration during filling.

The automatic weighing equipment, hopper, and tobacco feed supply conveyor can be assembled from readily available commercial items. The sizes and capacities can be modified to provide the proper weight of shredded tobacco to the tobacco containers.

The intermittent operation of conveyor 32 permits station filling of containers 31 and also permits the use of stationary vacuum turgor conditioning equipment. This equipment is located within the turgor conditioning compartment 37 shown in FIG. 3. As shown in FIG. 3, the automatic conveyor 32 moves the containers to the right, intermittently moving the distance S to position each container to tobacco at the exact position (station) for either filling or turgor conditioning. The containers are stationary for a time period during these operations. This dwell-type conveyor is controlled by means of (1) a precision timer which actuates the motor 33 at the proper time and (2) a limit switch 34 which stops the conveyor when the container reaches the proper position. The containers 31 are spaced uniformly along conveyor 32 at known locations defined by the stops 38 attached to the conveyor.

The automatic dwell conveyor may be fabricated from standard, commercially available conveyor assemblies with a suitable electric drive motor 33 and control devices. Angle-iron framework 39 may be utilized to support and properly position the conveyor 32.

In FIG. 5 there is shown a vertical sectional view of the turgor conditioning compartment 37, illustrating the layout of specific components and control units. Tobacco containers 31 are shown located on the conveyor 32, positioned with one container located in position in the center for turgor conditioning. It should be noted that since the containers are subjected to high vacuum, they should be of sturdy construction designed to prevent collapse. Preferably they should be of a corrosion resistant material such as stainless steel or

aluminum. The key element in the entire apparatus is the vacuum cap 39 which is designed to evacuate the containers 31 as well as provide water and air in later steps. The cap is of sturdy construction, preferably stainless steel, capable of withstanding high vacuum and repeated operations. In operation an electromagnet 40 lifts the vacuum cap 39 by its attractive pull on the vertical cylinder 43 and head 41, attached to the vacuum cap 39. The head 41 must be of magnetic material such as iron or steel. The vacuum cap 39 is lowered and pressed tightly to the top of the container 31 by the spring 42, whenever the electromagnet is de-energized. Motion of the vertical cylinder 43 is governed by the guide assembly 44 to assure exact positioning during raising and lowering. Operation of the cap, both raising and lowering, is controlled by means of the electric timer 45.

Located generally to the right and bottom of FIG. 5 is the vacuum system which connects to the vacuum cap 39. Whenever the cap 39 is lowered and evacuation is called for, valves 46 and 47 are closed and valves 48 and 54 are opened. The vacuum pump 49 evacuates the center tobacco container 31 of air and water vapor by means of the vacuum line 50 connected to the vacuum cap 39. The air moves directly through the vacuum line 51, the water condenser 52, and on to the pump 49. The vacuum chamber 53 permits a shorter evacuation time, since on opening valves 48 and 54, the pressure is almost instantly reduced to an intermediate pressure below atmospheric. Valve 54 is then closed with continued pumping on the tobacco container. After the evacuation step has been completed, valve 48 is closed and valve 54 is now opened to be pumped down to a low absolute pressure in preparation for the next cycle. All of the valves 46, 47, 48 and 54 are of the electrical solenoid type, or other suitable type for automatic operation, and are controlled by means of the electric timer 45.

Located generally to the left and bottom of FIG. 5 is the water and air supply system. Whenever the vacuum cap 39 is in the lowered position and air or water is called for, valve 48 is closed and either valve 46 or 47 is opened by means of the electric timer 45. Water from a suitable supply 55 furnishes clean water to the water tank 56 in which the water temperature is thermostatically controlled by means of the regulator 57 in conjunction with a suitable sensing element placed in the water 58. The water lever 59 in the tank is regulated by the float valve assembly 60 on the intake water line. Water is drawn from the tank 56 by means of the metering pump 61 through the water line 62 and is forced through water line 63, through the line filter 64 and into the water metering container 65. The metering pump 61 is energized by means of the electric timer 45 to fill the metering container 65 during the time that valve 47 is closed. Water level within the container 65 is further controlled within limits established by means of level switches 66 and 67, to provide a metered amount of water to each tobacco container 31. In operation, the pump 61 supplies water to the metering container 65 until the water 68 reaches the level of the upper level switch 66. Then the switch 66 de-energizes the pump 61. Air is displaced from the metering container 65 by means of the air port 75. When water for turgor conditioning is called for, the valve 47 opens to admit water to the tobacco container 31, located beneath the vacuum cap 39. When the water level of the

water 68 reaches the lower level switch 67, the valve 47 is closed by action of the switch 67. In this manner, a metered amount of water is added for turgor conditioning to establish the desired weight ratio of water to tobacco.

The air supply system of FIG. 5 admits air at atmospheric pressure or above through the inlet air line 69, through the air filter 70, and on to the vacuum cap 39 through air lines 71 and 72, whenever the solenoid valve 46 is opened. The opening and closing of this valve is governed by the electric timer 45.

A hold-down screen 73 prevents flotation of the tobacco shreds 74 during turgor conditioning. The screen 73 is attached directly to the bottom of the vacuum cap 39 and is designed to permit free movement of air and water through the screen by means of perforations 76. Also the screen 73 is designed in relation to the container 31 to define the proper volume beneath the screen and within the container 31 for a given amount of tobacco plus water. Thus, in operation with the vacuum cap lowered, water enters and passes through the screen 73 and completely covers the shreds and screen prior to uptake by the tobacco. Upon admitting air, the tobacco then absorbs approximately the total amount of water with no excess, thereby eliminating the necessity for draining the container.

The operation of the turgor conditioning equipment located in compartment 37 is synchronous with the automatic filling of tobacco containers, with the cyclical operation governed by limit switches and the electric timer 45. This timer controls the on-off operation of multiple devices and guarantees the proper sequencing of events. The following table illustrates the operation throughout a complete cycle of events:

Event Schedule	Control Device	Time (Sec)
0. Initial conditions: Main switch, vacuum pump, water temperature control, and electric timer energized; power to all control devices; tobacco container 31 filled, beneath vacuum cap 39, and at end of turgor conditioning cycle ready to advance to next position.		0
1. Electromagnet 40 energized, lifting vacuum cap 39	Timer 45	0-1
2. Conveyor belt motor 33 energized, moving containers the distance, S, along the flow line.	Timer 45	1-6
3. Conveyor belt motor 33 de-energized, with tobacco containers positioned for filling or turgor conditioning	Limit Switch 34	6
4. Weigh platform 29 dumps tobacco into hopper 30a and returns to horizontal position.	Limit Switch 34	6
5. Conveyor motor 27 energized, to supply weigh platform 29 with shredded tobacco.	Weigh Device 30	7-40
6. Electromagnet 40 de-energized, lowering vacuum cap 39.	Timer 45	7-8
7. Solenoid air valves 48 and 54 energized to evacuate the container 31 of air and water vapor.	Timer 45	10-40
8. Solenoid valve 54 closed to permit faster evacuation of container 31.	Timer 45	15
9. Water pump 61 energized to fill metering container 65.	Timer 45	0-40

10. Water pump 61 de-energized.
 11. Solenoid valve 48 closed
 12. Solenoid valve 54 opened to evacuate chamber 53.
 13. Water solenoid valve 47 opened to admit metered amount of water to tobacco container.
 14. Solenoid valve 47 closed
 15. Air solenoid valve 46 opened, admitting air to tobacco container 31.
 1. Electromagnet 40 energized lifting vacuum cap 39.
 2. Conveyor belt motor 33 energized, moving containers the distance, S, along the flow line.
 3. Continue cycle.

Level Switch 66	35
Timer 45	40
Timer 45	40-60
Timer 45	42-55
Level Switch 67	54
Timer 45	55-60
Timer 45	60-61
Timer 45	61-66

The apparatus specifically illustrated and discussed above involves the use of individual containers for holding the tobacco which are capable of withstanding internal and external pressures. Instead of using such containers the tobacco may be placed on trays which are inserted by hand or mechanically into a sealable vacuum-pressure chamber. After sealing the chamber, vacuum is established, liquid water is introduced into the chamber through ports, the chamber is pressurized to atmospheric or above, the pressure is equalized to ambient pressure and the trays are removed.

At the end of the turgor conditioning, the tobacco at high moisture content is subject to solute transfer to any free water in contact with the tobacco until it is frozen. For this reason it is desirable that the turgorized tobacco be subjected quickly to a rapid freezing operation. This can be effectively accomplished by contacting the turgorized tobacco with a low temperature refrigerant liquid, such as Du Pont Freon, by spraying or immersion. Liquid nitrogen or carbon dioxide may also be used for quickly freezing the turgorized tobacco. In addition to reducing solute transfer, rapid freezing also further reduces damage to the tobacco leaf structure by ice crystal formation as finer crystals are formed at the faster freezing rates.

The method of the invention has been described above with particular reference to the turgor conditioning of tobacco leaf in the shredded form for the purpose of illustrating the principles of the invention. When the tobacco, either cured or uncured, is treated in the form of strips, for example, up to two or three inches in width, certain modifications of the procedure are desirable because of the much smaller relative area of cut edges in the strips than in the shredded tobacco which tends to reduce the rate of imbibition of liquid water into the tobacco. This reduction in imbibition rate can be overcome by using one or more of several modifications of the procedure.

The amount of imbibing area in the strip tobacco can be increased by perforating the strips, for example, by passing them under or between perforating rolls carrying an array of perforating needles in the peripheral surface thereof. The perforations may be spaced, for example, 0.25 to 0.50 inch apart. This provides additional passages for water movement thus accelerating infiltration of liquid water while maintaining satisfactory structural integrity. The perforations also serve to increase the drying rate during the subsequent sublimation process.

The strip tobacco may also be subjected to multiple

water imbibition cycles up to three or four times. In each cycle additional water moves into the strips to establish high moisture levels. It is necessary to drain unimbibed water after each cycle prior to re-establishing vacuum conditions.

A positive superatmospheric pressure up to 50 psi gauge may be applied to the tobacco when immersed in liquid water after the evacuation step to provide a greater driving force for more rapid water movement through stomatal and other openings in the leaf.

A short soak time up to about ten minutes at the end of the turgor conditioning process and prior to freezing may be provided to allow further imbibitional water movement and cell expansion.

It will be noted that in all of the forms of the method of the invention, agitation or other mechanical manipulation of the tobacco in the presence of liquid water is avoided in order to maintain to the fullest extent the structural integrity of the tobacco.

In order to minimize loss of water-soluble extractives from the tobacco, it is desirable that contact of the tobacco with excess liquid water during the turgor conditioning be at as low a temperature and for as short a time as possible. To this end, liquid water preferably is supplied to the evacuated tobacco at a temperature of about 32°-35° F., the time of contact of the liquid water with the tobacco before draining excess water is reduced to about 10 seconds, drainage time is reduced to about 5 seconds, preferably with the tobacco mat oriented vertically with respect to the plane of the leaf portions in the mat, which will result in a drainage of about 70 percent of the excess water. Operating under these conditions with a turgor conditioning ratio of water added to the evacuated tobacco of about 3 to 1 by weight, about 50 percent of the total added water will be drained off leaving in contact with the tobacco sufficient water, including the water of higher extractive content, for the tobacco to continue substantially complete imbibition and expansion during a ten minute period with the tobacco mat returned to horizontal orientation with respect to the plane of the leaf portions in the mat and with a loss of water-soluble extractives not exceeding about 2 to 3 percent. This procedure, furthermore, provides a rather porous tobacco mat particularly suitable for vacuum freezing, in addition to other rapid freezing techniques.

If a greater degree of removal of water-soluble extractives is desired, this can be accomplished by appropriately extending the time of contact of liquid water with the tobacco prior to draining the excess water or by extending the drainage period, or both.

I claim:

1. Apparatus for the rapid turgor conditioning of cured tobacco comprising a plurality of sealable containers for shredded tobacco, a closure member for said containers including connections to evacuation means, to liquid water supply means and to pressurizing means, conveyor means for moving said containers into sealing engagement with said closure member, and sequencing timer means for successively actuating the connections of said closure member when in sealing engagement with a container to said evacuation means, said liquid water supply means and said pressurizing means.

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