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Johnson

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[54] **TOBACCO TREATMENT TO INCREASE VOLUME THEREOF**

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[52] **U.S. Cl.** ..... **131/140 P,** 131/17 R

[51] **Int. Cl.** **A24b 3/18,** A24b 15/00

[58] **Field of Search** 131/140–144; 99/81; 34/5

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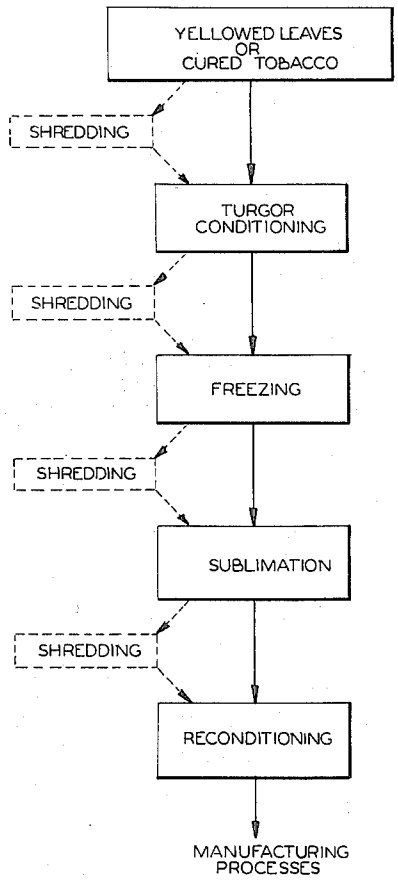
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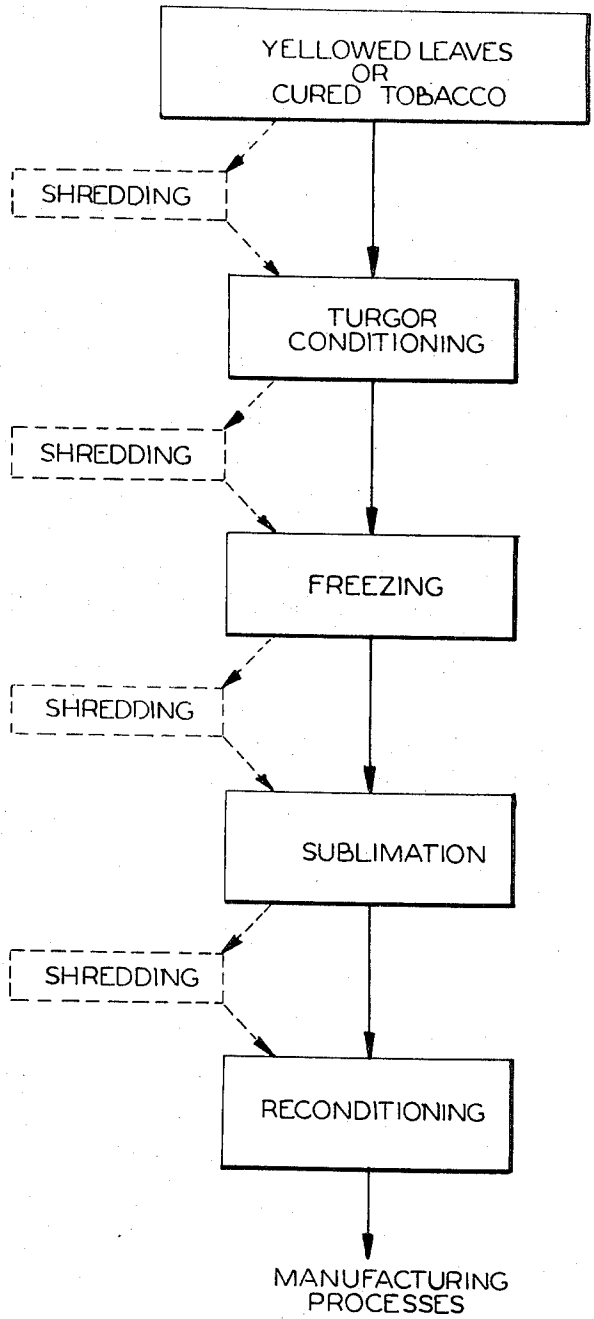
Attorney—Stowell & Stowell

[57] **ABSTRACT**

Substantial increases in the specific volume of tobacco and other improvements of the properties thereof may be obtained by bringing the tobacco before, during or after curing to a condition of high turgidity and subjecting the turgid tobacco to low pressure sublimation of the water content thereof from the frozen condition. The tobacco may be shredded at any stage of the process before or after the low pressure sublimation. The product typically has a specific volume at least twice that of air dried tobacco of the same moisture content.

4 Claims, 1 Drawing Figure





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TOBACCO TREATMENT TO INCREASE VOLUME THEREOF

This invention relates to a method of treating tobacco which comprises bringing tobacco prior to, during or after the completion of the curing process to a condition of high turgidity and removing the water content of the turgid tobacco by low pressure sublimation from the frozen condition whereby the specific volume (volume/weight) of the tobacco is substantially increased.

THE PRESENT ART OF PROCESSING TOBACCO

1. On-the-farm processing (tobacco curing)

The conventional methods of processing tobacco on the farm involve the timely removal of water from freshly harvested tobacco leaves utilizing air drying under conditions of either natural or forced ventilation.

Curing for bright-leaf tobacco (flue-curing) involves not only drying but a number of complex chemical and physical phenomena. To account for the changing leaf characteristics during curing, the process is separated into three phases: yellowing (coloring), color setting, and "killing-out" phases. During the yellowing phase, chlorophyll is oxidized, unmasking the yellow pigments already present with the leaf. Starch is converted into glucose, sucrose, and fructose, and these simple sugars are simultaneously oxidized in the respiration process. Complex protein molecules are broken down into less complex fractions of amino acid, amides, ammonia, etc. For the biochemical conversions to progress satisfactorily, a high percentage of cell sap must be retained by the leaf. Drying during yellowing is therefore restricted to relatively low rates so that 70–80 percent of the initial water in the leaf remains at the end of yellowing. Yellowing conditions are normally established with an air temperature between 90° and 110°F. at a relatively high humidity of 80–95 percent. The yellowing phase may require from 20–70 hours depending on the stalk position and leaf maturity at harvest.

The second phase, or color-setting phase, involves a gradual removal of moisture from the laminae of the tobacco sufficient to inhibit or arrest biochemical processes. A tobacco leaf is very responsive to temperature at this stage and undesirable oxidative processes may be enhanced when leaf temperatures are elevated within the range of 110° to 130°F. while leaf moisture content is high. The browning reaction (oxidation of o-diphenols) may proceed to undesirable levels under such conditions. To avoid this discoloration, leaf moisture is gradually removed while leaf temperatures are gradually elevated within this temperature range. The major portion of laminae moisture is removed during this period of 12–30 hours and color becomes stable, hence the designation "color-setting phase."

The unfavorable surface-to-volume ratio of midrib makes this portion of the leaf most difficult to dry. The last phase, or "killing-out" phase, is for the purpose of drying of the midrib to permit storage without deterioration. The environmental temperatures are gradually elevated to 170°F. to establish high rates of drying of midrib material. The drying time for this phase is on the order of 24 to 30 hours.

Equipment for curing may be either conventional tobacco barns or bulk-curing equipment. In the conventional curing method tobacco leaves are strung on sticks after harvest and placed on five to eight tiers (levels) within the structure. Temperature conditions

are established by means of natural or forced convection of air in connection with suitable heat exchangers located beneath the tobacco. Humidity is generally controlled by manual adjustment of ridge ventilators and foundation vent openings. The principles of curing are the same in bulk curing, however, the tobacco is packed tightly into racks or bales and placed on two tiers. Air is forced and circulated by means of a heating furnace. Proportioning the degree of intake or exhaust permits regulation of humidity conditions.

After curing, the tobacco is conditioned to around 15 percent moisture to enable handling without shattering. Farm preparation for market completes the operations on the farm.

2. Commercial processing by manufacturers

After sale by the farmer, tobacco moves through various operations in preparation for the cigarette manufacturing or other tobacco products. These include redrying and conditioning to uniform moisture levels, pressing into hogsheads for storage, aging, blending, reconditioning, shredding, etc. These operations are for the purpose of enhancing the potential qualities of the tobacco, assuring safe storage, and preparing the tobacco for a specific tobacco product.

3. Deficiencies of the existing processing methods

In both on-the-farm and commercial processing of tobacco, a number of deficiencies exist in attaining the most desirable manufacturing characteristics. Perhaps of greatest importance is the shrinkage which normally accompanies natural air drying during curing. As moisture is removed from tobacco during curing, the leaves wilt as plasmolysis proceeds within the cells. Progressive drying establishes forces of cell contraction and noticeable curling and wrinkling of the leaves. The midrib shrinks by several orders of magnitude to finally become a hard and dense portion which poses later problems to manufacturing due to its drastically different physical characteristics in comparison to laminae. Shrinkage during curing results in cured leaf having less than optimum properties from the standpoint of filling value. Larger amounts of tobacco are required than might be required by processes involving less shrinkage.

Other deficiencies in conventional farm processing are related to the necessity for elevated temperatures in drying. (1) There is always the hazard of oxidation of o-diphenols with its degrading discoloration during the color-setting phase. (2) Dry weight losses are increased for higher drying temperatures. Estimates up to 10 percent dry matter loss due to volatilization at elevated temperatures have been given. (3) Inactivation of enzymes is increased for higher process temperatures. This is perhaps important in view of the assumed desirability for aging tobacco, which is believed by many to be closely connected with enzymatic processes continuing over a period of time.

Deficiencies in commercial processing operations relate primarily to problems posed by non-homogeneity of laminae vs. midrib materials. Stemming operations and separate handling procedures are involved in attempts to reduce the inherent differences in product composition and physical properties and to contribute to more uniform and desirable tobacco products.

THE METHOD OF THE INVENTION

Sublimation drying of high moisture content tobacco prior to, during, or following the end of the curing pro-

cess provides a means for eliminating the above problems. In relation to the curing process for bright leaf tobacco, conditioning of the leaf to a high moisture state near the end of the coloring phase establishes maximum leaf volume prior to sublimation drying. The tobacco is then frozen, followed by sublimation drying under high vacuum conditions. This is followed by conditioning under natural air conditions to establish a moisture content sufficient to prevent damage in handling. This process prevents shrinkage which normally occurs during conventional processing, results in less dry matter losses, and minimizes oxidative discoloration and enzyme inactivation. The finished tobacco laminae exhibit a specific volume up to approximately 2.5 times that of comparable air-dried tobacco, while midrib material gives a specific volume up to approximately 4 to 4.5 times that of comparable air-dried midribs.

On the other hand, problems associated with low specific volume (related to filling value) or nonhomogeneity of laminae and midrib of tobacco cured conventionally may be solved by suitable conditioning of cured leaf to high moisture levels by imbibition of liquid water followed by sublimation drying. This process can increase the specific volume of cured laminae up to 2.25 times that of the original laminae while increasing the specific volume of midrib material by a factor up to 4.5. By monitoring the time or extent of moisture uptake, it is possible to produce laminae and midrib material having any desired level of specific volume within the specified ranges.

ILLUSTRATIVE EXAMPLES OF THE METHOD OF THE INVENTION

The following examples are illustrative of the method of the invention. The sequence of steps is shown in the accompanying drawing which is a generalized flow sheet of the method.

1. Processing of uncured tobacco

Tobacco leaves are harvested at maturity and yellowed at a dry bulb temperature of 90°–105°F. and a relative humidity between 80 and 95 percent. These conditions permit continuation of normal metabolic processes including chlorophyll oxidation, starch to sugar conversion, protein hydrolysis, and respiration. Tobacco leaves may be strung on sticks or suspended in racks as in the conventional yellowing process.

At or near the end of the coloring phase, the tobacco is conditioned to establish turgor within the cells for maximum volume. It may be possible, where yellowing conditions proceed in nearly saturated atmospheres, to omit this step if the tobacco has not wilted. Conditioning may be accomplished by establishing a humidity near 100 percent around the leaves, by placing butts in water, or by complete immersion of the leaf in water. The latter procedure is most rapid and will establish turgor within one to four hours depending on the extent of wilting at this point.

The material is then preferably shredded to permit more rapid drying. Shred widths may be of any size, however, the smaller the width, the more efficient the drying process. For convenience the leaf is shredded into ¼-inch strips. Shredding may be carried out at other stages of the processing or after the processing is completed.

The tobacco is then frozen, for example, to a temperature of −20°F. This may be accomplished by tray freezing in a freezing chamber for 1 or 2 hours or by more rapid freezing techniques using liquid nitrogen or other coolants, or the tobacco may be frozen by subjecting the wet tobacco to evaporative cooling at low pressures.

Drying is accomplished by placing the tray of frozen, shredded tobacco into a heated-shelf freeze dryer and establishing the proper drying conditions, the important consideration being to avoid thawing of the moisture content of the tobacco during the drying operation. For example, a vacuum is established to at least 100 microns, the heating platen is controlled at no higher than 5°F., and the condenser temperature is maintained at −50°F. or lower. Drying is complete under these conditions within 24 hours and material may be removed from the chamber.

Conditioning of the tobacco to a safe handling and storage moisture level may be accomplished using humidified air at temperatures of, for example, 70°F.

2. Processing of cured tobacco

Cured tobacco leaves must be conditioned to a state of turgor prior to sublimation drying. Conditioning is accomplished by imbibition of water during a suitable soak period. To effect most rapid moisture uptake the tobacco can be shredded; however, equally successful results may be achieved for intact laminae or midrib material. Because of the different rates of water imbibition for laminae in comparison with midribs, best results are obtained by treating each separately. Laminae imbibe rapidly and reach high moisture levels within 50 to 60 minutes whereas midribs require 4 to 5 hours.

After this step, the tobacco is frozen and freeze-dried under conditions similar to that for uncured tobacco, except that sublimation drying can be accomplished at higher platen temperatures up to 20°F.

Conditioning of the tobacco as before is accomplished with humidified air at 70°F. or above.

The following illustrative data were obtained by experimental tests as described:

Processing of Uncured Tobacco

Tobacco leaves of Coker 258 from the top third of the plant were harvested at maturity and strung on sticks for the coloring phase of the curing process. The tobacco was placed in a controlled environment test room at 95°F. dry bulb temperature and 85 percent relative humidity, to permit accomplishment of the coloring phase. During this phase, chlorophyll oxidizes and unmasks yellow pigments present in the leaf at harvest. Also important biochemical processes occur such as starch to sugar conversion, protein hydrolysis, and respiration.

After approximately 48 hours, the leaves were a rich yellow color, indicative of completion of the coloring phase. Measurements of leaf moisture content showed that the tobacco contained around 310 percent moisture on an oven-dry basis. Percent moisture on a dry basis is given as follows:

$$\% \text{ moisture} = \text{Wt. of water in material/Dry weight of material}$$

The yellow leaves were immersed in water at 76°F. for 2 hours. The moisture content (total leaf basis) of the tobacco increased to 525 percent. Generally the midrib moisture content is higher than that of laminae due to large zylem vessels; the value of 525 percent represents an intermediate value between laminae and midrib material.

The midribs were separated from laminae to permit separate determination of specific volume. The midribs were cut into short lengths of one-fourth inch and the laminae were shredded into ¼-inch strips.

To provide control samples for comparison, weighed samples of midribs and laminae were air dried in small trays. A drying temperature of 110°F. was provided for 24 hours followed by 170°F. air temperature for 10 hours. Under these drying conditions, shrinkage inevitably occurs.

In preparation for the freeze-drying process, weighed samples of laminae and midribs were frozen by intimate mixing with crushed dry ice (−109°F.). Samples were completely frozen to a brittle state within seconds for the shredded laminae and within one or two minutes for midrib material.

The frozen samples were transferred to pre-cooled shelves (platens) of a laboratory freeze dryer and the following conditions established: Shelf temperature, +5°F; pressure, 50 microns (0.05 mmHg); and condenser temperature, −68°F. These conditions were maintained for 24 hours. Samples were then removed and sealed immediately in moisture-proof containers.

Air-dried and freeze-dried samples were evaluated as near to the dry state as possible. A given sample was weighed to obtain the dry weight, ground in a Wiley mill to No. 20 mesh particle size, and sealed in a glass jar. Specific volume determinations were made by weighing small quantities of tobacco and measuring the volume after tamping in a graduated cylinder.

Results of the tests are given in Table I.

TABLE I

	Initial Weight (gm)	Dry Weight (gm)	Initial % Moisture (Calculated)	Specific Volume (cm^3/gm)	% Increase in Specific Volume
Laminae air-dried	50.0	10.41	380	3.2	—
freeze-dried	50.0	10.25	387	8.6	167
Midribs air-dried	54.79	5.56	885	2.33	—
freeze-dried	44.34	4.63	858	11.0	372

Processing of Cured Tobacco

Conventionally cured tobacco leaves of Coker 258 from the top third of the plant were selected to test the effectiveness of the moisture conditioning-freeze-drying process. Laminae and midribs were separated to permit separate determinations on each type of material.

As a control, weighed samples of laminae and midribs were oven-dried at 170°F. for 10 hours, reweighed, ground in a Wiley mill to a No. 20 mesh particle size, and evaluated for specific volume as described previously.

Preparation of laminae and midribs for the freeze drying process was as follows: A weighed sample of laminae was shredded and immersed in water at 76°F. for 1 hour. Studies on moisture uptake in cured laminae showed that high moisture levels could be obtained within a 1-hour soak period. The moisture level at this time was approximately 860 percent. The high moisture laminae was frozen in seconds by intimate mixing with crushed dry ice (−109°F.). The tobacco became brittle and broke into small pieces. Reduction of particle size as much as possible serves to increase the drying rate and thus shorten the total process time. Midribs were prepared by immersion in water at 76°F. for 5 hours. At this time the midribs had increased in moisture to 850 percent. They were then frozen by intimate mixing with dry ice and broken into approximately 1-inch lengths.

The high moisture frozen samples of laminae and midribs were transferred to pre-cooled shelves of a laboratory freeze dryer and the following conditions established: shelf temperature, +5°F.; pressure, 50 microns Hg; and condenser temperature, −68°F. These conditions were maintained for 24 hours; then the samples were removed and sealed immediately in moisture-proof containers. The samples were later weighed, ground in a Wiley mill to No. 20 mesh particle size, and determinations made for specific volume.

Results of the tests are given in Table II.

TABLE II

	Dry Weight (gm)	Volume (cm^3)	Specific Volume (cm^3/gm)	% Increased in Specific Volume
Laminae Control	5.0	20.0	4.0	—
Freeze-dried	5.0	45.0	9.0	125
Midribs Control	5.0	18.5	3.7	—
Freeze-dried	5.0	87.5	17.5	373

Substantial increases in the specific volume of tobacco may be obtained by vacuum sublimation of water from tobacco which has been conditioned to moisture contents less than the maximum obtainable and varying the moisture content at the time of vacuum sublimation provides a means of controlling over a wide range the final specific volume of the tobacco.

The method of the invention may be applied to all types of tobacco including fire-cured, dark air- and sun-cured tobaccos, and to Burley, Maryland, cigar filler, binder and wrapper tobaccos. It may be applied to freshly cut leaves or at any stage of the curing processes.

I claim:

1. A process for treating tobacco parts which comprises contacting tobacco parts which are sufficiently large so that they will not pass through a 16-mesh screen with water or water vapor for a period of time sufficient to increase the volume of said tobacco plant parts by at least 50 percent to form a water-containing expanded tobacco parts, freezing said water-containing expanded tobacco parts and freeze-drying the resulting frozen parts in a zone of reduced pressure.

2. A process for treating tobacco plant parts which comprises contacting tobacco parts which are sufficiently large so that they will not pass through a 16-mesh screen with water or water vapor for a period of time sufficient to substantially increase the volume of said tobacco parts to form water-containing expanded tobacco parts, freezing said water-containing expanded tobacco parts and freeze-drying the resulting frozen part in a zone of reduced pressure.

3. Tobacco produced by the process of claim 1.

4. Tobacco produced by the process of claim 2.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,785,385 Dated January 15, 1974

Inventor(s) William H. Johnson

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Claim 1, line 6 omit "a".

Claim 2, line 9, change "part" to--parts--.

Signed and sealed this 16th day of April 1974.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents