

PATENT SPECIFICATION

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(54) METHOD FOR EXPANDING ORGANIC SUBSTANCES

(71) We, AIRCO, INC., a Corporation organized under the laws of the State of New York, United States of America, of 85 Chestnut Ridge Road, Montvale, New Jersey 07645, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to a method for expanding organic substances.

In the course of preparing organic substances for consumption, it is commonly necessary to utilize such substances as filler materials. The natural or normally supplied condition of such substances, however, many times exhibit a bulk density which is considerably greater than the normally required densities of such substances. Therefore, in order to economically utilize many organic substances, it is necessary to expand these materials. Previously, the expansion in size of organic substances has been of modest proportions and has been constrained by the fracturing or shattering of the substances during expansion processes. Therefore, any expansion of organic substances must be such as to preserve the desired characteristics of the substance and yet must be of such an extent as to render the expansion process economical in terms of the ultimate utilization of the substances.

One organic substance commonly used as a filler material is tobacco. In the course of processing tobacco, it is common to dry tobacco for storage and curing. Although such drying action enables the prolonged storage of tobacco, a certain degree of shrinkage thereof also occurs. This shrinkage many times results in tobacco exhibiting a higher bulk density than is necessary in order to preserve smoking characteristics. In addition, the cutting or shredding of tobacco frequently results in producing hard, dense, particles which, in turn reflects a loss of tobacco filling capacity. Thus in order to efficiently utilize

tobacco as the same is normally supplied, it is desirable to effect as great an expansion as is possible. Again, during such expansion, shattering or otherwise deleteriously affecting the smoking characteristics of tobacco must be avoided.

Numerous techniques for expanding tobacco have been proposed. One such technique is described in U.S. Patent No. 1,789,435 and includes subjecting tobacco to a gas such as air, carbon dioxide, or steam at a pressure of approximately 20 p.s.i. for 45 minutes in order to achieve a volumetric expansion of tobacco between 5 and 15 percent. One obvious disadvantage of this technique is the relatively long dwell or residence time required in order to effect tobacco expansion. Another technique for expanding tobacco wherein vapors of volatile organic solvents are utilized in treating tobacco is described in U.S. Patent No. 3,683,937.

In addition to the foregoing techniques, it has also been proposed to impregnate tobacco with a suitable liquid chemically inert thereto and to effect an expansion by exposing tobacco to a stream of hot gases. This technique is generally described in U.S. Patent No. 3,524,452 which indicates that the foregoing process may be accomplished at ordinary ambient temperatures and pressure. Although the aforementioned liquid impregnating expansion process may result in increases in filling capacity, the substantial dwell times required for impregnation (75—90 minutes) severely limits the efficacy of this expansion process.

According to the present invention there is provided a method of expanding an organic substance comprising the step of pressurizing a vessel to a pressure within the range of 200—1070 p.s.i.a., immersing said substance in liquid carbon dioxide while maintaining said pressure within said vessel to thereby impregnate said substance with said liquid carbon dioxide, depressurizing said vessel to substantially atmospheric pressure, removing the impregnated substance from the vessel,

and heating said removed substance to cause expansion of said substance in size by at least 10%.

5 Expansion of organic substances, such as tobacco, may be accomplished by removing the impregnated substance from the vessel and subsequently subjecting this substance to a stream of heated gas.

10 The invention will be more clearly understood by reference to the following detailed description of an exemplary embodiment thereof in conjunction with the following drawings in which:

15 Fig. 1 is a diagrammatic view of an exemplary embodiment of apparatus for impregnating organic substances in a pressure vessel; and

20 Fig. 2 is a schematic diagram of apparatus for automating a process for expanding organic substances.

The exemplary method of expanding organic substances in accordance with the teachings of the present invention will become apparent from the following description. 25 Initially, a charge of the organic substance to be expanded is inserted into a suitable pressure vessel capable of withstanding internal pressures of approximately 1100 p.s.i.a. The organic substance may be retained within the vessel in any suitable manner and for example 30 may be retained in a single basket or in a plurality of basket-like shelves or levels. The vessel is then pressurized with carbon dioxide gas and is preferably maintained under a pressure of 400—1070, more preferably 400—550 p.s.i.a. However, it will be recognized 35 that it has been found that any pressure within the range of 200—1070 p.s.i.a. will be acceptable and the particular pressure selected will vary in accordance with the particular organic substance to be expanded.

40 Subsequent to the aforementioned pressurization of a vessel, liquid carbon dioxide at the approximate corresponding equilibrium temperature is introduced into the vessel at the pressure previously established therein thereby immersing the substance to be expanded 45 in liquid CO₂. The organic substance is maintained in the liquid for a "dwell" time ranging preferably between 1 minute and 1 hour depending upon the particular substance to be expanded. Upon expiration of this predetermined immersion or dwell period, the impregnated substance is removed from the vessel 50 and is heated such as for example, by being subjected to a hot stream of gas such as air, nitrogen, etc. Carbon dioxide is thus expelled from the organic substance resulting in a substance expanded in size from 10—100 percent or greater.

60 In order to increase the rate of expanding organic substances and to reduce the labor costs thereof, the aforescribed process may be substantially automated. This may be 65 achieved, for example, by providing a suit-

able pressure vessel with rapidly opening top and bottom doors and separately feeding each of a plurality of vessels with organic substances to be expanded. A conveniently disposed conveyor apparatus may be utilized to 70 automatically introduce the organic substances into pressure vessels through top doors and upon impregnation of the substances, bottom doors may be opened to permit the discharge of organic substances from the vessels. A further conveyor apparatus may be utilized to 75 transport impregnated substances to a heating device such as a hot air drum in which the substances are expanded and yet another conveyor apparatus may be disposed to receive 80 expanded organic substances from the heating device and transport the same to further manufacturing stations.

In removing impregnated substances from the pressure vessel, carbon dioxide residue gas 85 may be vented to the atmosphere or may be returned to a suitable container therefor. In addition, the liquid carbon dioxide in which the organic substances are immersed, may also be recycled to a suitable storage means. 90 In this manner, liquid carbon dioxide is available as an agent for impregnated further organic substances.

In accordance with the teachings of the present invention, the instant method of expanding organic materials has been found to be particularly effective as a result of im- 95 pregnating substances at elevated pressures. Unlike processes for expanding organic materials taught by the prior art, where treatment of organic substances in expansion processes is effected at substantially atmospheric pressures, the impregnation of such substances in accordance with the present invention is accomplished under elevated pressures such 100 as, for example, between 200—1070 p.s.i.a. Although precise theoretical explanations for the success of the process according to the present invention are not fully understood, experimental testing of the process has resulted in the uniform volumetric expansion of organic substances (such as tobacco) generally 105 between 50—100 percent.

Referring now to Fig. 1, illustrated therein is an exemplary embodiment of apparatus for 115 supplying a suitable impregnating agent to a pressure vessel in accordance with the teachings of the present invention. The aforementioned apparatus is generally comprised of pressure vessels 10, 17 and 25, pumps 13 and 120 22, heater 16 and suitable valves and interconnecting conduits. Pressure vessel 10 may take the form of a conventional tank for storing liquid carbon dioxide at a pressure of approximately 275 p.s.i.a. A conduit 11 is 125 coupled between an outlet of vessel 10 and is effective to supply liquid carbon dioxide therethrough to a valve 12 and pump 13. Valve 12 which may comprise a conventional on-off or an adjustable flow valve is provided 130

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in known manner to effect a control over the flow of liquid carbon dioxide at this pressure. Pump 13, which may comprise a conventional cryogenic pump effective to increase the pressure of a liquid flowing therethrough is provided to supply liquid carbon dioxide at, for example, a pressure of 515 p.s.i.a. A valve 14, which also may take the form of a conventional valve similar to valve 12 and a conventional check valve 36 are disposed in conduit 15 which in turn is effective to pass liquid carbon dioxide at the aforementioned pressure to a heater 16. Liquid carbon dioxide is passed from heater 16 to pressure vessel 17 and is maintained therein at a corresponding equilibrium temperature with carbon dioxide gas. It will be recognized that liquid carbon dioxide in vessel 10 is normally maintained at a temperature of -6°F and that the equilibrium temperature of carbon dioxide at 515 p.s.i.a. (the temperature within vessel 17) is approximately 33°F . Therefore, a heater 16, which may take the form of any conventional heating device suitable to raise the temperature of a cryogenic liquid from the former to the latter value, is provided to heat liquid carbon dioxide in conduit 15. In order to maintain the equilibrium temperature within vessel 17, a further heating device 18, which may comprise a conventional steam coil or electrical cable heating element is disposed about or in proximity to vessel 17 to maintain the aforementioned equilibrium temperature therein. Although pump 13, heater 16 and vessel 17 have been described as suitable for maintaining equilibrium conditions for carbon dioxide at approximately 515 p.s.i.a. within vessel 17, it will be realized that depending upon the particular organic substance to be expanded, other pressures such as for example 1070 p.s.i.a. may be necessary. In the latter instance, pump 13, heater 16 and vessel 17 will be formed of suitable elements for withstanding 1070 p.s.i.a. and for maintaining the corresponding equilibrium temperature therein. Pressure vessel 25 and vessel 17 are preferably designed to withstand pressures of at least 1100 p.s.i.a. Vessel 25 may be provided with a releasably secured top portion or door 26 and a suitable retaining means, which may comprise a basket-like member 27, is provided for holding organic substances within pressure vessel 25. A conduit 32 is connected between vessel 25 through valve 33 to the upper reaches of vessel 17. Valve 33 may comprise a conventional valve device suitable for selectively enabling the flow therethrough of carbon dioxide gas under a pressure within the range of approximately 200–1070 p.s.i.a. A further conduit 20 is coupled through valve 19 with the lower reaches of vessel 17 and is disposed in communication with conduit 21 and hence, the inlet side of pump 22. Valve 19 may comprise any standard commercially available valve device capable of selectively

permitting the passage of liquid carbon dioxide under pressures of approximately 515 p.s.i.a. therethrough. Pump 22 may comprise a conventional pump suitable for passing liquid carbon dioxide under elevated pressures through a suitable valve 23 and conduit 24 for introduction of such liquid into pressure vessel 25. Valve 23 may conveniently comprise a cryogenic valve similar in construction and operation, to valve device 19. It will be appreciated that pump 22 is effective to transfer liquid carbon dioxide under a pressure of approximately 515 p.s.i.a. into vessel 25 previously pressurized to approximately this pressure. A conduit 29 is coupled through a suitable valve 28 to an outlet of pressure vessel 25 and to conduit 21. As will be described in greater detail hereafter, liquid carbon dioxide remaining in vessel 25 upon the completion of the impregnation of organic substances therein may be returned to pressure vessel 17. In order to facilitate the aforementioned recycling of liquid carbon dioxide, a conduit 31 is selectively placed in communication through valve device 30 with the outlet of pump 22. Valve devices 28 and 30 may comprise conventional cryogenic valves similar to previously described valves 19 and 23, and valve 37 may take the form of a known check valve.

The operation of the exemplary embodiment of apparatus for expanding organic substances illustrated in Fig. 1 will now be described. Initially, all valves are closed with the exception of valves 12 and 14. Pump 13 is energized which in turn pumps liquid carbon dioxide from vessel 10 to heater 16 and vessel 17 with the pressure of such liquid being increased from 275 p.s.i.a. to approximately 515 p.s.i.a. In addition, the temperature of the liquid carbon dioxide so transmitted is increased to the equilibrium temperature thereof in vessel 17 which as aforesaid, is approximately 33°F . Upon introduction of a suitable amount of liquid carbon dioxide into vessel 17, valves 12 and 14 are closed and pump 13 is de-energized. Valve 33 is opened thereby introducing carbon dioxide gas into vessel 25 and pressurizing this vessel to approximately 515 p.s.i.a. Upon completion of this pressurization, valves 19 and 23 are opened and pump 22 is energized thereby transferring liquid carbon dioxide at a pressure of approximately 515 p.s.i.a. into vessel 25 and flooding or immersing the organic substances retained within basket 27. Valves 19 and 23 are then closed and the organic substances are impregnated for a predetermined "dwell" time. The dwell time may range from 1 min. to 1 hour depending on the particular organic substance to be impregnated. Upon termination of this time period, valve 33 is opened to permit the carbon dioxide gas in vessel 25 to equalize in pressure with vessel 17. Valves 28 and 30 are then opened and pump 22 is energized in order

to recycle liquid carbon dioxide within vessel 25 to vessel 17 thereby avoiding the wastage of significant amounts of this material. After the liquid is completely pumped from vessel 25, valves 28, 30 and 33 are closed and pump 22 is de-energized. Valves 34 and 35 are opened to vent carbon dioxide gas to atmosphere, or alternatively, suitable valve devices (not shown) are opened to release the carbon dioxide gas to a vapor recovery system.

Finally, top 26 of vessel 25 is opened, thereby enabling the removal of impregnated organic substances therefrom. Upon heating such substances for example by exposing the same to a stream of heated gases, the substances are expanded in size from 10-100 percent or greater. It will be appreciated that in subsequent cycles of the foregoing process, liquid carbon dioxide is only required to be supplied from vessel 10 to vessel 17 in amounts sufficient to maintain a suitable level of liquid CO₂ in vessel 17 with the amount supplied being approximately equal to the amount of carbon dioxide which is lost during such a cycle.

An exemplary embodiment of apparatus for automating the handling of organic substances to be expanded is illustrated in Fig. 2. The foregoing apparatus is generally comprised of conveyor means 35, 46 and 48, pressure vessels 37-39 and a heater means 47. Conveyor means 35 may comprise any conventional conveyor device preferably adapted to convey a plurality of organic substances spaced transversely thereacross. Each of pressure vessels 37-39 is provided with top portions 40-42 and bottom portions 43-45 respectively. Preferably, each top and bottom portion is disposed so as to be automatically actuated between either an open or closed position and any suitable means (not shown) for implementing this operation may be utilized. However, as the particular configuration of top and bottom portions of pressure vessels 37-39 and the actuating apparatus therefor forms no part of the present invention, further description thereof is unnecessary.

Conveyor means 46 which may comprise a conventional conveyor device, is preferably disposed so as to receive organic substances 36 discharged from each of pressure vessels 37-39 and is effective to transport such substances to a suitable heater means 47. Preferably, a suitable inlet of heater means 47 is disposed in a material receiving relationship beneath an end of conveyor 46 to enable the delivery of impregnated substances to heater means 47. Clearly, any suitable heating apparatus, such as a rotary hot air drum described in U.S. Patent No. 3,785,765 may be utilized as heating means 47. Finally, a suitable conveyor means 48, well known to those skilled in the art, is disposed to receive organic substances expanded within heater means 47 and

is effective to transport heated organic substances to subsequent manufacturing stations (not shown).

The operation of the exemplary embodiment of apparatus illustrated in Fig. 2 will now be described. Initially, conveyor means 35 is energized to transport organic substances 36 to an end thereof. The top portions 40-42 of corresponding pressure vessels 37-39 are opened in order to permit the insertion therein of organic substances 36 and upon such insertion, the aforementioned top portions are closed. The pressure vessels 37-39 are now pressurized with carbon dioxide gas and liquid carbon dioxide is introduced therein through conduits 24, 24a and 24b in a manner similar to the flooding of vessel 25 heretofore described in connection with apparatus illustrated in Fig. 1. Accordingly, organic substances 36 are immersed in liquid carbon dioxide for predetermined dwell times and at the expiration thereof liquid carbon dioxide is removed from pressure vessels 37-39 through appropriate conduits 28, 28a and 28b. The carbon dioxide residue gas is then removed from the pressure vessels 37-39 through appropriate outlets 50, 50a and 50b and is either vented to atmosphere or admitted to a vapor recovery system (not shown). Bottom portions 43-45 of vessels 37-39 are subsequently opened to enable the discharge of impregnated organic substances 36 on to conveyor means 46 and the transportation of such substances to heater means 47. In heater means 47, a stream of heated gases, such as hot air, is directed against impregnated organic substances 36. In addition, by utilizing a heater device such as a rotating hot air drum, or the like, an effective expansion of impregnated organic materials will be achieved although it will be understood that any suitable heater device may be utilized. The expanded organic substances are subsequently discharged from heater means 47 and are transported by conveyor means 48 to further manufacturing stations (not shown) as previously mentioned.

Although the exemplary embodiment illustrated in Fig. 2 contemplates the utilization of an impregnating agent such as liquid carbon dioxide maintained at a pressure of approximately 515 p.s.i.a. within pressure vessels 37-39, any suitable impregnating agent and consequently any suitable elevated pressure may be utilized in dependence upon the particular organic substance to be expanded. However, in the course of expanding organic substances such as tobacco, carbon dioxide maintained in an equilibrium condition under pressures ranging between 400-550 p.s.i.a. is preferred.

In effecting the impregnation of organic substances by, for example, the exemplary embodiment of apparatus illustrated in Fig. 1, the following steps and representative time

periods required therefor may be set forth as follows:

	Cycle Steps	Minutes
5	Insertion of organic substance into Processing Vessel	5
	Pressure Equalization of Pressure Vessel with CO ₂ Gas	1
	Filling of Pressure Vessel with Liquid CO ₂	2
10	Dwell Time of Substances in Liquid CO ₂	2
	Liquid and Gas Evacuation from Pressure Vessel	3
15	Discharge of Impregnated Substances and Closure of Top Portion	2
	Total Cycle Time	15

In the course of expanding organic substances in accordance with the teachings of the present invention, the following exemplary tests were conducted.

Example I

A charge of shredded tobacco was introduced into a pressure vessel which was pressurized by carbon dioxide gas to 525 p.s.i.a. Ten pounds of liquid carbon dioxide were introduced therein at an equilibrium temperature of 36°F and upon slight heating of the impregnated tobacco, "movement" of the tobacco leaves indicating excellent impregnation of the tobacco leaves with liquid carbon dioxide was noticed. The "movement" occurred from expulsion of carbon dioxide from tobacco shreds. Expansion in size of this shredded tobacco by at least 10% was observed.

Example II

A charge of shredded tobacco was immersed in liquid carbon dioxide under 515 p.s.i.a. for a dwell period of 10 minutes. The reactor vessel containing the impregnated tobacco was equalized with the carbon dioxide storage vessel by placing the gas space of each vessel in communication. Liquid carbon dioxide was drained from the reactor vessel and residue gas was subsequently blown to atmosphere. The impregnated tobacco was heat-treated with hot air and an expansion of the treated tobacco of approximately 100% was observed.

Example III

The experiment described in Example II was essentially repeated under non equilibrium conditions. The reactor vessel was completely isolated from the storage vessel after impregnating shredded tobacco with liquid tobacco under a pressure of approximately 515 p.s.i.a. As liquid carbon dioxide was drained from the reactor vessel, the pressure therein decreased and upon completion of such drainage

and blow-down of the residual carbon dioxide gas, the impregnated tobacco was observed to be covered with carbon dioxide "snow". The impregnated tobacco was then removed from the reaction vessel and heat-treated with hot air. Expansion of the tobacco of approximately 110—120% was visually observed.

Example IV

A charge of various dried food products which consisted of prunes, apricots, pears and raisins was introduced into a pressure vessel which was pressurized to 800 p.s.i.a. with CO₂ gas. Liquid carbon dioxide was introduced therein at a pressure of 850 p.s.i.a. and the foregoing substances were immersed for 30 minutes in the liquid CO₂.

The liquid carbon dioxide was removed to the atmosphere at the bottom of the vessel and the carbon dioxide gas was likewise vented. The impregnated substances were then heated in an air drier for approximately three minutes and the following expansions in size were obtained:

	Percent	
Apricots	20—100	
Plums	30	85
Raisins	20	
Pears	10	
Tea leaves	10	

WHAT WE CLAIM IS:—

1. A method of expanding an organic substance comprising the step of pressurizing a vessel to a pressure within the range of 200—1070 p.s.i.a., immersing said substance in liquid carbon dioxide while maintaining said pressure within said vessel to thereby impregnate said substance with said liquid carbon dioxide, depressurizing said vessel to substantially atmospheric pressure, removing the impregnated substance from the vessel, and heating said removed substance to cause expansion of said substance in size by at least 10%.
2. A method according to claim 1 wherein said substance is immersed in said liquid carbon dioxide for a dwell period between one minute and one hour.
3. A method according to claim 1 or 2 wherein said substance is tobacco which is immersed in liquid carbon dioxide at a pressure within the range of 400—1070 p.s.i.a.
4. A method according to any preceding claim, wherein said step of heating said impregnated substances includes subjecting said substance to a stream of heated gases.
5. A method according to any preceding claim, wherein said step of pressurizing said vessel comprises introducing carbon dioxide gas into said vessel under pressure.
6. A method according to claim 5, wherein said organic substances comprises tobacco and said CO₂ gas is introduced into said vessel at a pressure within the range of 400—550 p.s.i.a.



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periods required therefor may be set forth as follows:

	Cycle Steps	Minutes
5	Insertion of organic substance into Processing Vessel	5
	Pressure Equalization of Pressure Vessel with CO ₂ Gas	1
	Filling of Pressure Vessel with Liquid CO ₂	2
10	Dwell Time of Substances in Liquid CO ₂	2
	Liquid and Gas Evacuation from Pressure Vessel	3
15	Discharge of Impregnated Substances and Closure of Top Portion	2
	Total Cycle Time	15

20 In the course of expanding organic substances in accordance with the teachings of the present invention, the following exemplary tests were conducted.

Example I

25 A charge of shredded tobacco was introduced into a pressure vessel which was pressurized by carbon dioxide gas to 525 p.s.i.a. Ten pounds of liquid carbon dioxide were introduced therein at an equilibrium temperature of 36°F and upon slight heating of the impregnated tobacco, "movement" of the tobacco leaves indicating excellent impregnation of the tobacco leaves with liquid carbon dioxide was noticed. The "movement" occurred from expulsion of carbon dioxide from tobacco shreds. Expansion in size of this shredded tobacco by at least 10% was observed.

Example II

40 A charge of shredded tobacco was immersed in liquid carbon dioxide under 515 p.s.i.a. for a dwell period of 10 minutes. The reactor vessel containing the impregnated tobacco was equalized with the carbon dioxide storage vessel by placing the gas space of each vessel in communication. Liquid carbon dioxide was drained from the reactor vessel and residue gas was subsequently blown to atmosphere. The impregnated tobacco was heat-treated with hot air and an expansion of the treated tobacco of approximately 100% was observed.

Example III

50 The experiment described in Example II was essentially repeated under non equilibrium conditions. The reactor vessel was completely isolated from the storage vessel after impregnating shredded tobacco with liquid tobacco under a pressure of approximately 515 p.s.i.a. As liquid carbon dioxide was drained from the reactor vessel, the pressure therein decreased and upon completion of such drainage

and blow-down of the residual carbon dioxide gas, the impregnated tobacco was observed to be covered with carbon dioxide "snow". The impregnated tobacco was then removed from the reaction vessel and heat-treated with hot air. Expansion of the tobacco of approximately 110—120% was visually observed.

Example IV

A charge of various dried food products which consisted of prunes, apricots, pears and raisins was introduced into a pressure vessel which was pressurized to 800 p.s.i.a. with CO₂ gas. Liquid carbon dioxide was introduced therein at a pressure of 850 p.s.i.a. and the foregoing substances were immersed for 30 minutes in the liquid CO₂.

The liquid carbon dioxide was removed to the atmosphere at the bottom of the vessel and the carbon dioxide gas was likewise vented. The impregnated substances were then heated in an air drier for approximately three minutes and the following expansions in size were obtained:

	Percent
Apricots	20—100
Plums	30
Raisins	20
Pears	10
Tea leaves	10

WHAT WE CLAIM IS:—

1. A method of expanding an organic substance comprising the step of pressurizing a vessel to a pressure within the range of 200—1070 p.s.i.a., immersing said substance in liquid carbon dioxide while maintaining said pressure within said vessel to thereby impregnate said substance with said liquid carbon dioxide, depressurizing said vessel to substantially atmospheric pressure, removing the impregnated substance from the vessel, and heating said removed substance to cause expansion of said substance in size by at least 10%.

2. A method according to claim 1 wherein said substance is immersed in said liquid carbon dioxide for a dwell period between one minute and one hour.

3. A method according to claim 1 or 2 wherein said substance is tobacco which is immersed in liquid carbon dioxide at a pressure within the range of 400—1070 p.s.i.a.

4. A method according to any preceding claim, wherein said step of heating said impregnated substances includes subjecting said substance to a stream of heated gases.

5. A method according to any preceding claim, wherein said step of pressurizing said vessel comprises introducing carbon dioxide gas into said vessel under pressure.

6. A method according to claim 5, wherein said organic substances comprises tobacco and said CO₂ gas is introduced into said vessel at a pressure within the range of 400—550 p.s.i.a.

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5 7. A method according to Claim 5, wherein said organic substance comprises dried food products and said CO₂ gas is introduced into said vessel at a pressure within the range of 800—1070 p.s.i.a.

10 8. A method according to any preceding claim, additionally comprising the steps of extracting liquid carbon dioxide not retained by said substance from said vessel prior to depressurizing said vessel to substantially atmospheric pressure.

15 9. A method according to claim 8 additionally comprising the steps of providing a supply of said liquid carbon dioxide at said pressure in a storage vessel and recycling said liquid CO₂ extracted from said vessel to said storage vessel.

10. A method of expanding an organic substance in a vessel substantially as hereinbefore described with reference to the accompanying drawings. 20

11. A method of expanding an organic substance in a vessel substantially as hereinbefore described in Example 1, 2, 3, or 4.

12. An organic substance whenever expanded by the method of any of claims 1 to 11. 25

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