

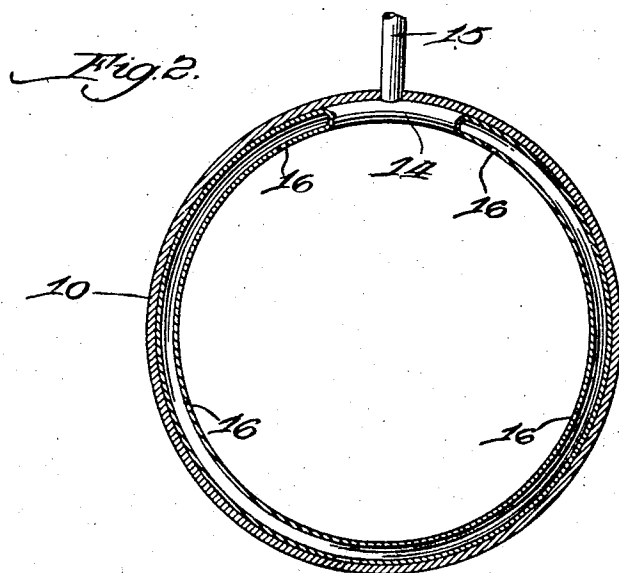
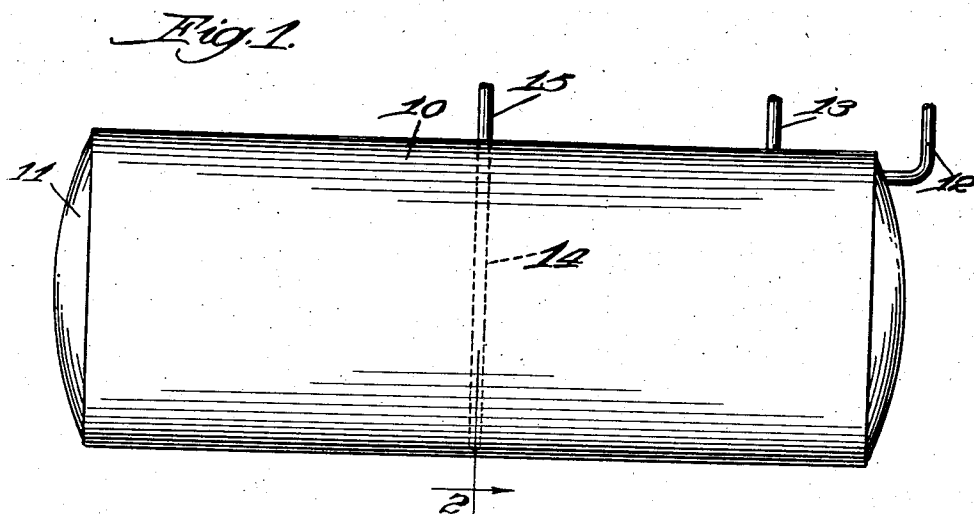
Oct. 15, 1940.

O. A. BAILEY

2,217,933

METHOD OF DISTRIBUTING FINE PARTICLES THROUGHOUT A BULK MATERIAL

Original Filed May 2, 1938



INVENTOR
Otterbein A. Bailey.
BY
Chilton, Wills, Davies, Hirschl & Dawson.
ATTORNEYS.

UNITED STATES PATENT OFFICE

2,217,933

METHOD OF DISTRIBUTING FINE PARTICLES THROUGHOUT A BULK MATERIAL

Otterbein A. Bailey, Chicago, Ill., assignor to The Guardite Corporation, a corporation of Illinois

Original application May 2, 1938, Serial No. 205,652. Divided and this application December 11, 1939, Serial No. 308,739

15 Claims. (Cl. 131-140)

This invention relates to a method of distributing fine particles throughout a bulk material, and more particularly to moistening tobacco.

Cases are frequently encountered where it is desired to impregnate an article with another substance and where it is impossible either to so subdivide the material to be impregnated as to permit it to be treated by the ordinary forms of contact application, or else where for some other reason treating in the usual fashions is impossible.

In steam-moistening organic products, the difficulty is also frequently encountered that the product cannot be heated above a particular temperature without damage. Inasmuch as the steam in condensing gives up its latent heat of vaporization to the product upon which it condenses, that product of necessity is correspondingly raised in temperature, that is, the product is raised in temperature in accordance with definite ratio of increase in temperature to increase in moisture content. The exact amount will, of course, depend upon the specific heat of the article and for most organic products will range between 20° F. and 40° F. for each per cent of water condensed.

It has now been discovered that if liquid water, preferably hot, is introduced into a vacuum under the proper conditions, that much more water may be introduced into the product undergoing treatment than would be possible with a corresponding temperature rise by steam alone. In other words it is possible to increase the moisture content of the product which is being steamed and whose temperature is, therefore, increasing, more than the increase in moisture content resulting from the condensation of steam for any given increase in temperature of the product. This is true even of articles in large bulk, such as tobacco in hogsheads.

The liquid water is subdivided into such minute liquid particles which will hereinafter be designated as a micromist, that the particles are able to penetrate the hogshead of tobacco without substantial interference.

In this manner, far more water may be introduced into the tobacco with a given rise in temperature than is possible to accomplish by the use of steam.

The same invention may be employed to impregnate other articles either with water or other liquid or solid material. For example, instead of using pure water, a micromist of a solution of sugar, for example, may be produced and used as an impregnant. Likewise, if desired, glycerine

may be incorporated with the water and it is possible in this manner to treat tobacco with the ordinary treating materials customarily employed for that purpose.

Instead of water, other volatile liquids may be employed, such as alcohol, or ether, or the like. It is generally preferred that a major part of the liquid remain unevaporated, but this is not essential to processes where the impregnating agent is dissolved or suspended in the volatile liquid.

The exact degree of fineness of the particles in the micromist has not been determined. Calculations based upon the residual heat of the particles indicate that they may be as little as 6 millimicrons or less in diameter.

With each particular liquid, the conditions under which a micromist will be produced will vary according to the vapor pressure, latent heat, specific heat, and surface tension thereof. With water, it is preferred to employ a vacuum of at least 27" and preferably of about 29.5" to commence with. However, by use of hotter water, it is possible to use correspondingly lower vacuums. For example, at a 29.5" vacuum, using 100° C. water, approximately 14.5% of the water would evaporate and the resulting steam would expand approximately 77,875 times compared to its original volume as water. The total expansion of a given droplet of water would therefore be in the neighborhood of 11,000 times. At 29" the expansion is about 5,000 times. However, if 57.5° C. water is employed with a 29.5" vacuum, the expansion also is about 5,000 times. Conversely, by using 150° C. water at a 28.5" vacuum or 200° C. water at a 28" vacuum, the expansion will be about 5,000 times.

At a 27" vacuum using 100° C. water, the expansion is only about 1,300 times based on the entire droplet.

The above calculations are made on the basis of the initial conditions. Obviously where the pressure rises, the results obtained will represent the summation of effects at the various pressures.

It is preferred that the expansion with water exceed 1,000 times based on the entire droplet in order to produce particles of the size required for impregnation of the type here covered. In practical operation the expansion should be at least 5,000 times at the outset.

In carrying out the process, the product should always be substantially completely freed from non-condensable gas before the impregnation step commences. Preferably, such operation is carried out following the procedure set forth in the Merriam and Wiles Patent 2,080,179, issued May

11, 1937, by evacuating to such an extent that water is boiled within the product to be impregnated and the resulting steam washes out all of the residual air.

5 In those instances where any substantial amount of impregnation is to be accomplished, the liquid employed should be one whose vapor will condense freely within the product to be impregnated, the latter acting as a condenser for such vapor. The condenser action of the material thus acts to create a positive stream of vapor to carry the micromist particles within the mass to be treated. Without such current or stream, a mere rise in pressure will result in extremely un-uniform distribution of particles throughout the mass.

10 In order to accomplish the condensing action, it is therefore desirable that when the micromist particles are produced by the explosion of a volatile liquid, that the temperature of the volatile liquid be considerably above any temperature attained by the product to be treated, because otherwise, unless artificial cooling or heating means are employed, the product will not act as a condenser.

25 Where tobacco is the material to be treated and water is the explosive agent, it is preferred that the temperature of the water be at least 212° F. and generally is even higher than that. Temperatures of 280° F. to 300° F. in the water may frequently be employed.

The invention is illustrated diagrammatically in the drawing in which:

35 Figure 1 is a diagrammatic side elevation of a vacuum tank 10 having a door 11, a line 12 leading to a suitable evacuating system, a line 13 for the introduction of steam and a ring structure 14 connected to a pipe 15 through which hot water may be introduced. The ring 14 is provided with a number of small orifices 16.

40 Figure 2 is a sectional elevation through the ring 14 and illustrates a typical position of the openings 16.

45 As an example of the process, Maryland tobacco in an ordinary hogshead container and having an initial temperature of 87° F. was subjected to an absolute pressure sufficient to reduce the temperature therein to approximately 82° F. (the absolute pressure being about $\frac{1}{2}$ "), and thereafter water at a temperature of about 260° F. and under a pressure of 40 lbs. of steam was introduced into the vacuum chamber until the temperature in the tobacco had risen to about 158° F. During this process the tobacco gained 55 6.14% of moisture.

The water was sprayed in in a stream approximately $\frac{3}{8}$ " in diameter. Other openings from $\frac{1}{8}$ " to $\frac{1}{4}$ " are satisfactory, but in general an opening of $\frac{1}{8}$ " to $\frac{1}{4}$ " is preferred. It is not necessary to atomize the water preliminarily to introduction into the chamber. In fact, in some instances the use of too fine a spray nozzle had a disadvantageous effect upon the spraying operation.

65 In another example of the invention, Kentucky Burley tobacco having a temperature of 90° F. was subjected to a vacuum sufficient to pull its temperature down to 80° F. in a period of about 15 minutes, and thereafter the product was subjected to steam combined with a spray of water above 212° F. until the temperature of the tobacco had reached approximately 166° F. This tobacco gained approximately 6.75% of moisture.

75 The condensation of the water or other liquid

within the product is a very important factor in the distribution of the moisture therein.

However, even where large quantities of water are condensed within the product, the distribution is not thoroughly uniform. It is uniform enough, however, that subsequently steaming the product, re-evacuating to cause evaporation of a part of the condensed steam and repetition of such cycle will uniformly distribute the moisture. The number of cycles to be employed depends upon a number of features. However, normally, from 1 to 2 cycles are enough, although in some cases as many as 5 may be employed.

The steam employed is preferably desuperheated in the usual manner at approximately the pressure in the chamber.

This application is a division of my co-pending application, Serial No. 205,652, filed May 2, 1938, which was a continuation-in-part of Serial No. 161,109, filed August 26, 1937.

The foregoing detailed description has been given for clearness of understanding only and no unnecessary limitations should be understood therefrom.

What I claim as new, and desire to secure by Letters Patent, is:

1. The method of moistening an organic product in large bulk which comprises removing substantially completely from the product non-condensable gas and replacing it with an atmosphere substantially completely of steam, and then introducing liquid water at a temperature of at least the normal boiling point thereof under higher steam pressure and in a micromist whereby the moisture content of the product is increased substantially uniformly throughout its bulk and the temperature of the product is increased, the increase in moisture content being greater than the increase in moisture content resulting from the condensation of steam on the product where steam alone is used with the same increase in temperature of the product.

2. The method of treating tobacco which comprises subjecting a hogshead of tobacco to a high vacuum, removing substantially completely from the tobacco while under the high vacuum all non-condensable gas and replacing it with an atmosphere substantially completely of steam and introducing hot water at a temperature of at least about 212° F. to the chamber in a stream while the absolute pressure is of the order of 0.5 to 1.5 inches of mercury, whereby a considerable proportion of the hot water flashes to steam and produces a micromist of the remaining water, and whereby the formation of steam so produced carries finely divided particles of liquid water within the hogshead of tobacco.

3. The method of treating tobacco in a large dense mass which comprises substantially removing all air from the tobacco and replacing the air with an atmosphere of steam under high vacuum, introducing liquid water at a temperature of at least about 212° F. to the vacuum and continuing the introduction of such water until the pressure upon the tobacco has materially risen.

4. The method of moistening an organic product in a large mass which comprises freeing the product from non-condensable gas under a vacuum, the absolute pressure being of the order of $\frac{1}{2}$ to $1\frac{1}{2}$ inches of mercury, introducing hot liquid water at a temperature of at least about 212° F. into the vacuum in a small stream, whereby some of the hot water flashes to steam and subdivides the unevaporated water into extremely fine particles, while simultaneously increasing the steam

pressure upon the product, whereby the steam, at its increased pressure penetrates the mass of organic product and carries the finely divided particles of liquid water thereinto, and thereby increases the moisture content of the product more than the increase in moisture content of the product if steam alone were used with the same increase in temperature of the product.

5. The method of impregnating a bulk product which comprises substantially completely removing all non-condensable gas from the product and replacing it with an atmosphere substantially completely of condensable gas under low absolute pressure, introducing a volatile liquid thereto at a temperature above its normal boiling point, whereby the liquid will spontaneously explode because of the immediate and instantaneous internal boiling of a substantial part thereof, whereby a micromist is produced, and condensing a portion of the evaporated liquid within the product, the movement of the gas into the product for condensation carrying with it and distributing throughout the product a large proportion of the micromist particles.

6. The method as set forth in claim 5, in which the volatile liquid is itself the impregnating agent and in which the temperature and vacuum are controlled so that the liquid does not completely evaporate.

7. The method as set forth in claim 5, in which the volatile liquid is a carrier for another material in it.

8. The method of impregnating a bulk product which comprises substantially completely removing therefrom all non-condensable gas and replacing it with an atmosphere substantially completely of a condensable gas under a low absolute pressure, introducing a volatile liquid thereto at a higher temperature than the then temperature of the product, the vacuum and the temperature of the liquid being so adjusted that the liquid will spontaneously explode because of the immediate and instantaneous internal boiling of a substantial part thereof, whereby a micromist is produced, and condensing a substantial portion of the evaporated liquid within the product, the movement of the gas into the product for condensation carrying with it and distributing throughout the product a large proportion of the micromist particles.

9. The method of moistening a porous bulk product which comprises removing substantially completely all non-condensable gas from the pores thereof and replacing it with an atmosphere substantially completely of steam under a

substantial vacuum in a chamber containing said product, introducing water to the chamber at a higher temperature than the then temperature of the product, the vacuum and temperature of the water being so adjusted that it will spontaneously explode because of the immediate and instantaneous internal boiling of a substantial part thereof, whereby a micromist is produced sufficiently fine to penetrate the pores of the product, and condensing a substantial portion of the steam so formed within the product, the movement of the steam into the product for condensation carrying with it and distributing throughout the product a large proportion of the micromist of liquid water.

10. The method as set forth in claim 9, in which the water is introduced at a temperature above 212° F.

11. The method of impregnating a bulk product which comprises substantially completely removing therefrom all non-condensable gas, introducing a volatile liquid thereto at a temperature above its normal boiling point, the vacuum and the temperature of the liquid being so adjusted that the liquid will spontaneously explode because of the immediate and instantaneous internal boiling of a substantial part thereof, whereby a micromist is produced, and condensing a substantial portion of the evaporated liquid within the product, the movement of the evaporated liquid into the product for condensation carrying with it and distributing throughout the product a large proportion of the micromist particles.

12. The method as set forth in claim 11, in which the liquid is water and it is introduced at a temperature above 212° F. to a vacuum below 29" of mercury.

13. The method of treating an organic product which comprises removing air therefrom to produce a condensable atmosphere substantially of steam thereabout, and introducing liquid water to the vacuum without substantial separate-addition of steam, whereby the water explodes and produces a micromist of liquid water and a carrier of steam under higher pressure, and the steam so produced carries remaining liquid water into the product.

14. The method as set forth in claim 13 in which the product is tobacco in bulk, and the liquid is water.

15. The method as set forth in claim 13 in which the product is tobacco and the liquid is water at at least about 212° F.