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J. F. WALSH

2,304,221

DRYING APPARATUS

Filed March 27, 1940

Fig. 1.

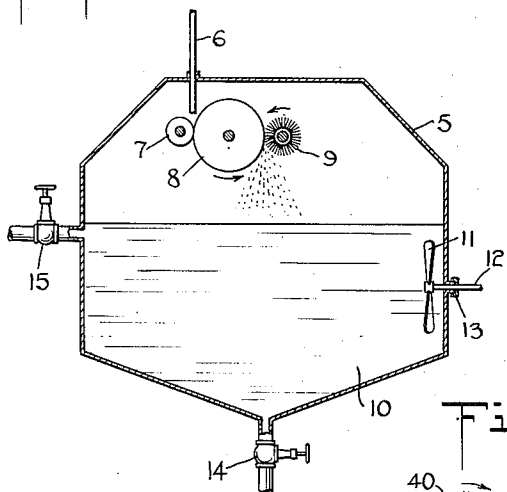


Fig. 2.

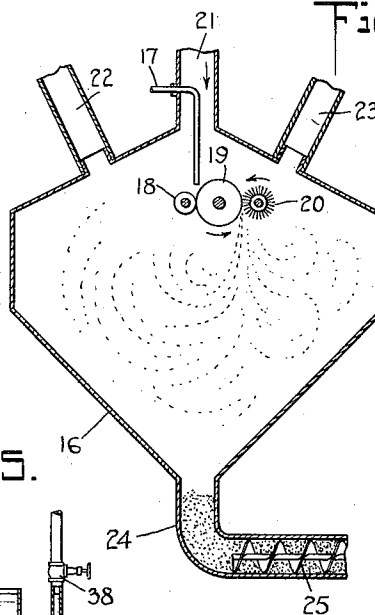


Fig. 3.

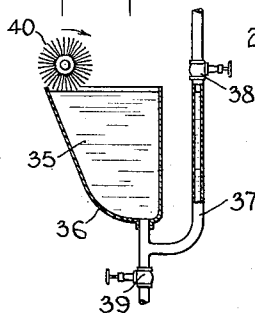


Fig. 4.

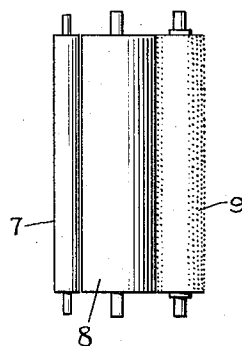
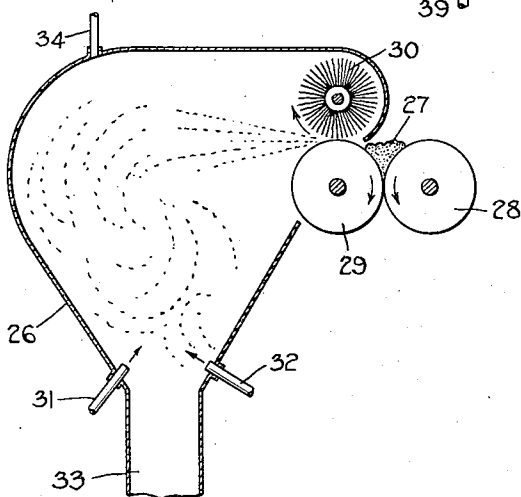


Fig. 5.



INVENTOR
James F. Walsh
BY *W. H. Lewis*
ATTORNEYS

UNITED STATES PATENT OFFICE

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DRYING APPARATUS

James F. Walsh, Tuckahoe, N. Y., assignor to
Celanese Corporation of America, a corporation
of Delaware

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5 Claims. (Cl. 83—91)

This invention relates to the production of finely divided, uniformly-sized particles of solids. It relates more particularly to the production of uniformly-sized particles of materials from solutions, dispersions and plastic masses containing organic derivative of cellulose and similar materials.

An object of this invention is to produce finely divided particles of materials in a controlled and substantially uniform size.

Another object of this invention is to produce said particles in a rapid and economic manner.

Other objects of this invention will appear hereinafter from the following detailed description.

In many industrial processes it is necessary that solid materials be obtained in a finely divided form. In some instances it is necessary that the solid particles be produced in a dry state from liquids containing said materials in solution and in others the solid particles may be first produced in a wet state by precipitation from their solutions followed by the filtration of the resulting slurries and the drying of the filtered material. In still other cases, it may be desired to reduce plastic or other compositions of matter to discrete particles. To accomplish these results various expedients have been employed. In some instances it has been customary to separate solid materials from solutions by spraying them under high pressure through a nozzle and removing the solvent by evaporation, or by spraying the solution into a coagulating or precipitating bath therefor. The disadvantage of these methods lies not only in that the adjustment of the nozzle is very fine and is easily clogged and therefore requires constant attention, but also in that the action of corrosive liquids will shorten the life of said nozzles. In addition, there is the ever-present possibility of leakage or failure of lines in a system under high pressure with injury to life and property. Where solid plastic masses are to be ground, the use of mills, etc., has the disadvantage that they are not continuous in operation and valuable time is consumed in charging and discharging the mills.

I have now discovered that the preparation of dried, finely divided materials from solutions or plastic masses thereof may be accomplished by controllably feeding the solutions or fluid masses of the material to be dried or precipitated to a surface, and positively removing said solutions or fluid masses from the surface by picking up the solutions on a second high speed rotating discontinuous surface and throwing or scattering it therefrom in the form of a finely divided spray.

Instead of feeding said solutions or fluid masses to a surface, they may also be removed in a finely divided form from a body of liquid maintained at constant level. When this method is utilized, the discontinuous surface, which is preferably a brush rotating at high speed, is adjusted so that the moving periphery thereof is in contact with the liquid to be divided only at the surface thereof. The rotating surface may, however, be adjusted so that it dips into the body of liquid to a greater extent where the viscosity of the liquid makes it desirable or possible. By suitably adjusting the brush and the level of the liquid in relation to the upper edge of the vessel in which it is contained, the spray may be thrown or scattered over the edge so that it may fall freely without returning to the body of the liquid. In order to dry said materials the spray may be allowed to fall in a heated chamber so that the solvent will be evaporated therefrom or, alternatively, the finely-divided spray may be allowed to fall into a precipitating or coagulating bath from which the solid material may be filtered and then dried in a powder form. Where the material is a plastic mass it may be fed to the surfaces in a molten or semi-molten form, and the spray thrown from the second surface may be allowed to fall through cooled air so that the liquid droplets will solidify and produce a finely divided powder in a form which is dry, non-agglomerating, and ready for immediate use.

Various means may be employed for removing the solution or fluid mass as a fine spray from a body of the same or from a surface to which it is fed. Among the most suitable means are brushes rotating at high speed in close proximity thereto. The bristles of said brushes may be made of metal or other strong flexible material which is inert toward the materials being treated or solvents and which will stand up under the physical strain, abrasion and flexing to which they are subjected. Other means may comprise a discontinuous surface such as a wire screening which catches the liquid and throws it off in finely divided form, or spring metal fingers on a roller which pick up the fluid and then strike a stationary object such as a bar. When released, the fingers will spring forward and snap the liquid therefrom in a fine spray. The spray may then be treated as described above to obtain the solid material.

The size of the particles obtained may be regulated by varying the diameter of the brush, the speed of rotation and the amount of fluid which is fed to the brush during a given interval of time.

Where a small amount of fluid is fed to a brush rotating at very high speed the resulting particles will be very small. Decreasing the speed of rotation of the brushes or increasing the amount of fluid fed to the brushes where their speed of rotation is held constant, will yield materials of increased particle size. Where it is undesirable to vary the speed of rotation of the brushes, an increase or decrease of the peripheral speed of the same can be obtained by increasing or decreasing the diameter of the brushes and this in turn will likewise affect the particle size. Brushes of any practical diameter may be used but I prefer brushes of from about 6 to about 12 inches in diameter. The speed of rotation may likewise be varied and I preferably use speeds of from about 500 to about 1500 revolutions per minute. It is evident that the arrangement of the bristles may also be varied depending on the viscosity and nature of the solution. The brush or other means should preferably be so arranged that the entire surface of the carrying roll may be swept. By suitable adjustment of the various factors discussed above, the particle size may be varied at will.

The surface, from which the rotating discontinuous surface, such as brush, picks up the fluid, may also be a rotating surface such as a cylindrical roll, or it may be a flat surface down which the fluid flows in a layer of appropriate thickness or it may be the top layer of a body of the fluid to be divided or precipitated. While either of these methods may be used, I prefer to use a rotating cylindrical carrying roll. The fluid may be fed by an adjustable feed pipe to the carrying roll from which it is then removed by the rotating brush. The thickness of the fluid layer may be controlled by another roll in close proximity to the carrying roll and the fluid may drop to the space between said moving rolls. When the fluid is permitted to flow down a surface, the thickness of the fluid layer may be varied by means of an adjustable doctor blade or other suitable controlling means.

Where the material which is to be broken down into small particles is a plastic mass such as a plasticized mass of an organic derivative of cellulose, it may be kept in a fluid plastic condition by using carrying and regulating rolls which are heated and which pick up said plastic compositions from milling type heated rolls. In some instances it may be desired to cool said rolls. These expedients may be accomplished by using hollow rolls through which steam, hot water or brine may be passed in accord with the result desired.

In order to illustrate my invention, several illustrative embodiments thereof are shown in the accompanying drawing, in which

Fig. 1 is a sectional view of an arrangement for finely dividing a solution and passing it to a precipitating or coagulating bath therefor,

Fig. 2 is a sectional view of an arrangement for finely dividing a solution to produce a dry powder;

Fig. 3 is a sectional view of an arrangement for finely dividing a plastic mass to obtain it in powder form,

Fig. 4 is a detail plan view of an arrangement of the control and varying rolls and brush, and

Fig. 5 is a sectional view of an arrangement for removing a liquid in finely divided form from a body of liquid. It is to be understood that the arrangement of Fig. 5 is contained in a suitably enclosed housing (not shown).

Like reference numerals designate similar parts throughout the several views.

In Fig. 1, showing one embodiment of my invention, 5 is an enclosed chamber, and 6 is a feed pipe for delivering a solution of the material to be obtained in finely divided form to the chamber 5. The solution from the feed pipe 6 drops down into the space formed by a feed control roll 7 and a carrying roll 8, the feed control roll 7 serving to spread the liquid uniformly over the surface of the carrying roll 8. In close proximity to said carrying roll 8 is a brush 9 revolving at high speed and adjusted so that it picks up the layer of liquid from the carrying roll 8. The motion of said brush 9 revolving at high speed is such that it throws the liquid downward in a fine spray where it falls into a precipitating bath 10 which is slowly agitated by means of a propeller 11 mounted on a shaft 12 and journaled in a liquid-tight sleeve 13. The precipitating bath in which the liquid falls precipitates the solute which settles to the bottom of the chamber, and the precipitate may be withdrawn through the valve 14. The precipitating bath may be replenished through valve 15 to keep the bath level constant. The slurry removed through valve 14 may be filtered and dried in any suitable manner and the acetic acid or other solvent in the liquid may be recovered in any suitable manner. While only one brush is shown in Fig. 1, it is also obvious that two may be used. The second brush and roll may be suitably disposed on the opposite side of control roll 7. A second feed pipe may be provided to form a symmetrical arrangement but this is not necessary.

In Fig. 2 is shown another embodiment of my invention. In this figure 16 indicates a chamber into which the solution of the material to be obtained in dry and finely divided form is delivered through a feed pipe 17. The solution is finely divided by means of a feed control roll 18, a carrying roll 19 and a brush 20 in the manner described above with relation to the apparatus illustrated by Fig. 1. Dry heated air is blown into the chamber 16 through an air inlet duct 21, serving to evaporate the solvent rapidly from the globules or droplets formed by the brush 20. The solute falls to the bottom of the chamber in dry powdered form and the solvent laden air leaves the chamber through ducts 22 and 23 and passed to a solvent recovery system where the solvent may be recovered. Any of the powdered material which is carried by the solvent laden air may be removed by a cyclone recovery or other suitable system prior to the delivery of the solvent-air mixture to the solvent recovery system. The main body of the dry, powdered material falls to the bottom outlet 24 of the chamber 16 and may be removed in any suitable manner, such as a revolving worm 25 or merely by gravity. If desired the hot air can be introduced through an opening at a lower part of the chamber instead of through the duct 21.

In Fig. 3 is shown a modification of the apparatus suitable for reducing plastic masses to a dry finely divided form. A thermoplastic composition 27 is converted or homogenized by the action of heated milling type rolls 28 and 29. When the proper degree of plasticity is reached a revolving wire brush 30 is brought into close proximity to the heated roll 29 and the plastic mass 27 on the roll in the form of a thin layer is removed therefrom in the form of small particles which are scattered into chamber 26. The finely divided plastic material is chilled and so-

lidified by the action of cold air entering the chamber 26 through ducts or pipes 31 and 32. The solidified powdered material falls to the base 33 of the chamber 26 and may be removed by gravity or by a worm arrangement 25 such as is shown in Fig. 2. The pipe 34 is an outlet for permitting the air in the chamber to escape. The powdered material is dry, non-agglomerating and in uniformly finely divided form.

In Fig. 5 is shown an arrangement for removing a liquid in finely divided form from a body of liquid. The body of liquid 35 is contained in a vessel 36. The liquid is fed through a pipe 37, the rate of feed being controlled by a valve 38. The vessel may be drained by a valve 39. A brush 40 is mounted in such a manner with relation to the body of liquid that upon rotation at a suitable speed it will pick up a portion of the liquid and disperse or scatter the same in the form of finely divided particles or a fine spray. The finely divided particles or spray thus obtained may be treated in the manner above described with particular reference to Fig. 1 and Fig. 2. The spray forming means shown in Fig. 5 may be contained within a chamber such as 5 in Fig. 1 or 16 in Fig. 2 or any other suitable housing depending on the nature of the liquid and the product desired.

My invention is particularly suitable for the precipitation of solutions of organic derivatives of cellulose and more particularly for the precipitation of solutions of cellulose acetate after acetylation and ageing. Where cellulose acetate is precipitated by pouring the solution into a large volume of water or by adding water to the solution, the cellulose acetate is precipitated in a stringy, fibrous form. When thus precipitated it is often difficult to thoroughly wash the cellulose acetate to remove all occluded acids. By my process, however, when the cellulose acetate is precipitated by allowing the finely-divided spray to fall into a bath of water, the solid particles of cellulose acetate are obtained in a finely-divided spheroidal form and because of the size, shape and structure of said particles the cellulose acetate may be readily washed free of all occluded acids, easily stabilized, dried and quickly dissolved to form the spinning dope.

It is to be understood that the foregoing detailed description and drawing are given merely by way of illustration and that many variations

may be made therein without departing from the spirit of my invention.

Having described my invention, what I desire to secure by Letters Patent is:

1. Process for reducing plastic masses to a finely divided form of substantially uniform particle size, which comprises forming a layer of plastic material on a surface and then brushing said layer while it is in a plastic condition from said surface in the form of particles of substantially uniform size into a chilling medium so as to cause said particles to solidify.

2. Process for reducing plastic masses to a finely divided form of substantially uniform particle size, which comprises forming a layer of thermoplastic material on a heated surface and then brushing said layer while it is in a warm, plastic condition from said surface in the form of particles of substantially uniform size into a chilling medium so as to cause said particles to solidify.

3. Process for reducing plastic masses to a finely divided form of substantially uniform particle size, which comprises forming a layer of thermoplastic material having a basis of cellulose acetate on a heated surface and then brushing said layer while it is in a warm, plastic condition from said surface in the form of particles of substantially uniform size into a chilling medium so as to cause said particles to solidify.

4. Process for reducing plastic masses to a finely divided form of substantially uniform particle size, which comprises converting a thermoplastic material on a heated surface and then brushing said converted material while it is in a warm, plastic condition from said surface in the form of particles of substantially uniform size into a chilling medium so as to cause said particles to solidify.

5. Process for reducing plastic masses to a finely divided form of substantially uniform particle size, which comprises converting a thermoplastic material having a basis of cellulose acetate on a heated surface and then brushing said converted material while it is in a warm plastic condition from said surface in the form of particles of substantially uniform size into a chilling medium so as to cause said particles to solidify.

JAMES F. WALSH.