Dec. 5, 1961 S. L. McCORMICK, JR 3,011,543

SPRAY DRYER

Filed July 12, 1957

FIG. 1

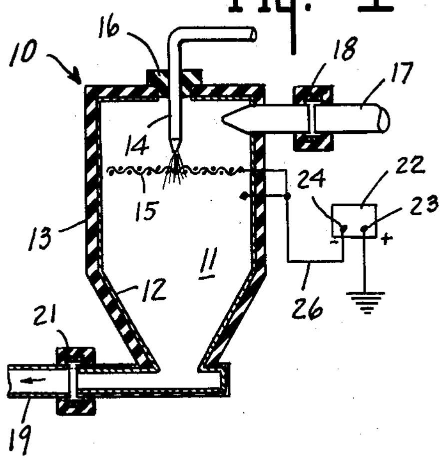


FIG. 2

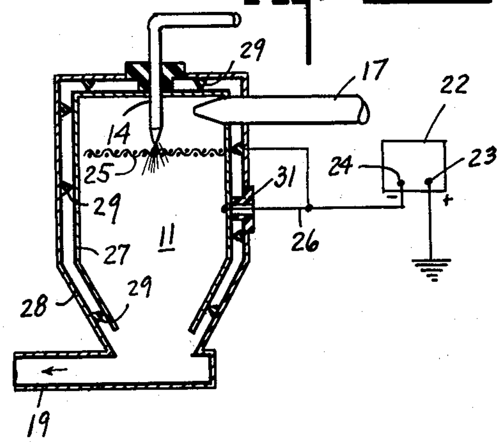
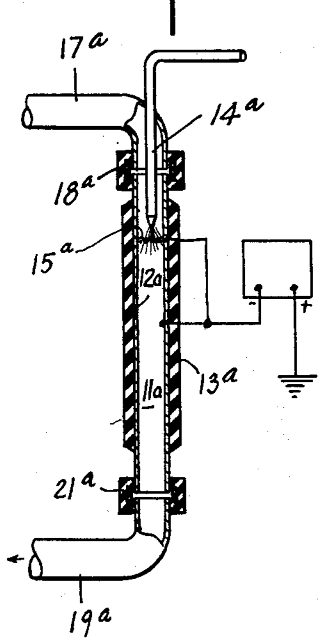


FIG. 3



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1

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SPRAY DRYER

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This invention relates generally to spray dryers, and in particular to such dryers having a means for restraining the particles from contacting the walls of the drying chamber.

Spray drying has been used with varying degrees of success in a wide variety of industries. It has been used to dry milk, soaps and detergents, pharmaceuticals, fine chemicals, organic and inorganic chemicals, rubber and synthetic latices, clay slips, and other products and materials as well.

In the soap and detergent industries, for example, spray drying is a major operation, and the dryers constitute a large percentage of the investment in modern detergent processing equipment, where the total production of spray dried products is several billion pounds per year. Milk is spray dried in quantities approaching a billion pounds annually, and the annual spray dried production of other foods, coffee, for example, runs into the hundreds of million pounds.

Spray drying presents several unique problems not encountered in certain other drying technics. Among these problems is the tendency of particles to adhere and accumulate during the drying operation to the surfaces of the drying chamber.

In many spray drying operations a portion of the dispersed particles or droplets strike the drying chamber walls either before or after they are completely dried, and adhere to the wall. The material adhering to the wall is thus exposed to the hot drying gas for relatively long periods of time and if the material being dried is heat sensitive, qualities such as taste, odor, biological activity and the like, are lost or impaired. Consequently the material that adheres represents a loss since it is inferior and cannot generally be used.

One attempt to overcome the above-mentioned problem provides for increasing the size of the drying chamber to afford more travel distance for the particles, and therefore more drying time before they can come in contact with the drying chamber walls. This arrangement, of course, adds to the prime cost of a dryer. An existent dryer can seldom be modified or converted economically in this manner.

A further attempt at solution of this problem involves increasing the degree of atomization resulting in smaller particles or droplets to be dried. This inherently leads to smaller product particle size with a tendency toward dustiness and decreased bulk density which may be undesirable. The temperatures of the drying gas may also be increased, resulting in an increased drying rate for droplets. However, thus increasing the drying temperature is obviously undesirable for the drying of heat sensitive material.

A further attempt at solution of the problem of adherence of the particles provides a mechanical device, such as a rotating chain which strikes the side walls of the drying chamber to dislodge material adhering to them. This arrangement is not completely successful since the chain will not strike all the surfaces of the drying chamber and since particles tend to collect on the chain and its supports. Since it is frequently desirable to dry materials whose final product specifications are such that no economical combination of the factors mentioned above, or others, will give a satisfactory product, the field of application for spray dryers is limited. It is usually necessary to test a new material to be spray dried on a substantial

2

pilot scale before success may be predicted. The present invention provides additional flexibility in the application of spray dryers so that almost any material which can be dispersed in a gas can be spray dried.

The primary object of this invention is to improve spray drying technics, particularly with respect to the problems connected with materials adhering to walls, which normally occurs. The accomplishment of this object makes possible the construction of spray dryers of more compact design and also gives increased flexibility in operating conditions.

In general the object of the present invention is accomplished by providing the dispersed particles with a unipolar electrical charge and impressing upon the drying chamber walls an electrical charge of the same polarity as that carried by the atomized particles.

A further object of the present invention is to provide a spray drying apparatus which can successfully spray dry materials which have a relatively high tendency to adhere to the drying chamber walls.

A further object of the present invention is to provide a spray drying apparatus in which drying gas having a relatively low inlet temperature may be used, thereby reducing heat exposure of the product.

A further object of the present invention is to provide a spray drying apparatus in which less atomization can be used to result in a product of relatively large particle size.

A further object of the present invention is to provide a spray drying apparatus in which the ratio of length to cross sectional width of the drying chamber may be much greater than that of conventional spray dryers.

A further object of the present invention is to provide a method for reducing the tendency of dispersed particles to contact the walls of the drying chamber of a spray drying apparatus.

The full nature of the invention will be understood from the accompanying drawings and the following description and claims:

FIG. 1 represents a schematic cross sectional illustration of an apparatus employing the present invention.

FIG. 2 is a view similar to FIG. 1, but illustrating a modified form of the invention.

FIG. 3 is a view similar to FIGS. 1 and 2, but illustrating a further modified form of the present invention.

Referring initially to FIG. 1, there is shown generally at **10** a tank or container providing a drying chamber **11**. The inner walls **12** of the chamber **11** are formed of electrically conductive material, such as steel, and the outer surface **13** of the tank is formed of an electrical insulating material, which may preferably also have thermal insulating properties. At the upper end of the drying chamber there is schematically shown a nozzle or other dispersing or atomizing device **14** for introducing into the chamber dispersed particles which are given a unipolar charge by passage through an ionizing grid **15** mounted adjacent the nozzle. An electrically non-conducting flange **16** serves to support the nozzle **14** and electrically insulates the chamber walls from the nozzle.

A drying gas inlet conduit **17** connects with the drying chamber adjacent the upper end thereof, and an electrical insulating sleeve or coupling **18** serves to electrically insulate the drying chamber walls from the conduit **17**. At the bottom of the drying chamber an outlet conduit **19** communicates with the drying chamber and an insulating coupling **21**, similar to coupling **18**, serves to electrically insulate the drying chamber walls from the conduit **19**.

A direct current source of electrical power is shown at **22** having its positive terminal **23** connected to ground and its negative terminal **24** electrically connected to the drying chamber walls and to the ionizing grid by means of wire **26**. It will be understood that this arrangement provides a means for impressing an electrostatic potential upon the drying chamber walls and the grid, and that while the grid and inner walls are illustrated as being at the same electrical potential, other connections with the power source may be made which will establish them at differing potentials. With the walls and grid connected as shown, the polarity of the charge on the drying chamber walls is negative and is of the same polarity as the charge imparted to the dispersed particles or droplets, by the grid as they are introduced into the drying chamber from the nozzle **14**.

In operation, the charged atomized particles are introduced into the chamber after passing through the grid, and heated drying gas enters the chamber from the duct **17**. Since the walls of the drying chamber are charged at the same polarity as the particles, they will be restrained from contact with the chamber walls. The spent drying gas containing the entrained dry product passes out of the drying chamber through the outlet duct or conduit **19**.

The modified form of the invention shown in FIG. 2 operates identically to that described with reference to FIG. 1, but differs somewhat in the construction of the container or tank. In this form of the apparatus an electrically conducting inner liner **27**, which may take the form of a screen, wire mesh or other electrostatically chargeable element, provides the drying chamber inner walls. This liner is supported and electrically insulated from the tank wall **28** by means of electrically insulating spacers **29**. Connection of the negative terminal of the power source **22** to the liner **27** is accomplished by wire **26** which passes through a non-conducting flange **31**. Wire **26** also serves to connect the power source to an ionizing grid **25** similar to the grid **15**.

The apparratus shown in FIG. 3 is a further modified form of the present invention in which the cross sectional dimension of the drying chamber **11***a* is greatly reduced as compared to this dimension of the drying chamber previously referred to. This spray drying apparatus includes a nozzle **14***a* for introducing into the drying chamber **11***a* dispersed particles given a unipolar electrical charge by the ionizing grid **15***a*. A drying gas inlet duct **17***a* is connected to the top of the cylindrical drying chamber. An outlet duct **19***a* is similarly connected to the bottom of the drying chamber. The inner surface **12***a* of the drying chamber is formed of electrical connecting material and is electrically insulated from the ducts **17***a* and **19***a* by means of the insulating couplings **18***a* and **21***a*, respectively. The outer surface of the drying chamber wall **13***a* is formed of electrical insulating material, which preferably also has thermal insulating properties. The drying chamber walls have impressed thereon a negative electrical charge which is the polarity of the charge given the particles introduced from the nozzle **14***a* by passage through the grid.

The operation of this form of the invention is identical to that previously described, but is illustrative of the reduction in size of the drying chamber which is made possible by the means for restraining the particles from contacting the drying chamber walls herein described.

While the invention has been disclosed and described in some detail in the drawings and foregoing description, they are to be considered as illustrative and not restrictive in character, as other modifications may readily suggest themselves by persons skilled in this art and within the broad scope of the invention, reference being had to the appended claims.

The invention claimed is:

1. A spray drying apparatus comprising a container forming a drying chamber, the inner surfaces of said container being electrically conductive and the outer surfaces being thermally and electrically insulating, and means for unipolarly electrically charging and introducing atomized particles to be dried within said container, a conduit communicating with said container and electrically insulated from the inner surfaces thereof for introducing a drying gas into the chamber, an outlet conduit extending from said container electrically insulated from the inner surface thereof and adapted to conduct dried particles and exhaust gas from the chamber, and electrical means for applying to the inner surfaces of said container an electrical charge of the same polarity as the charge carried by the atomized particles.

2. A spray drying apparatus comprising a container forming a drying chamber, the inner surfaces of said container being electrically conductive, means for creating a stream of unipolarly charged atomized particles to be dried within said container, said means comprising a nozzle and a charging grid positioned adjacent thereto, a conduit communicating with one end of said container and electrically insulated from the inner surfaces thereof for introducing a drying gas into the chamber, an outlet conduit extending from the other end of said container, said outlet conduit being electrically insulated from the inner surface of the container and adapted to conduct dried particles and exhaust gas therefrom, and electrical means for applying to the inner surfaces of said container and to said grid an electrical charge of the same polarity, whereby said atomized particles are provided a charge of the same polarity as the inner surfaces of said container.

3. A spray drying apparatus comprising an elongated container forming a drying chamber, the inner surfaces of said container being electrically conductive and the outer surfaces being electrically insulating, means for creating a stream of unipolarly charged atomized particles to be dried within said container at one end thereof, said means comprising a particle inlet nozzle and a charging grid positioned adjacent thereto, a conduit communicating with said container adjacent said one of its ends and electrically insulated therefrom for introducing a drying gas into said chamber, an outlet conduit extending from the other end of said container, said outlet conduit being electrically insulated from the inner surfaces of the container and adapted to conduct dried particles and exhaust gas therefrom, and electrical means having a connection to the inner surfaces of said container and to said grid for applying thereto an electrical charge of the same polarity, whereby said atomized particles are provided a charge of the same polarity as the inner surfaces of said container.

4. A spray drying apparatus comprising a container forming a drying chamber, said container including an outer shell and an inner liner supported thereby, said liner being electrically conductive and electrically insulated from the outer shell, means for unipolarly electrically charging and introducing atomized particles to be dried within the drying chamber bounded by said liner, a conduit communicating with said chamber and electrically insulated from said liner for introducing a drying gas into the chamber, an outlet conduit leading from said chamber electrically insulated from said liner adapted to conduct dried particles and exhaust gas from the chamber, and electrical means for applying to said liner an electrical charge of the same polarity as the charge carried by the atomized particles.

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