Sept. 30, 1952 J. A. MONICK 2,612,266

COOLING OF SPRAYED PRODUCTS

Filed Oct. 11, 1945 2 SHEETS—SHEET 1

Fig. 1

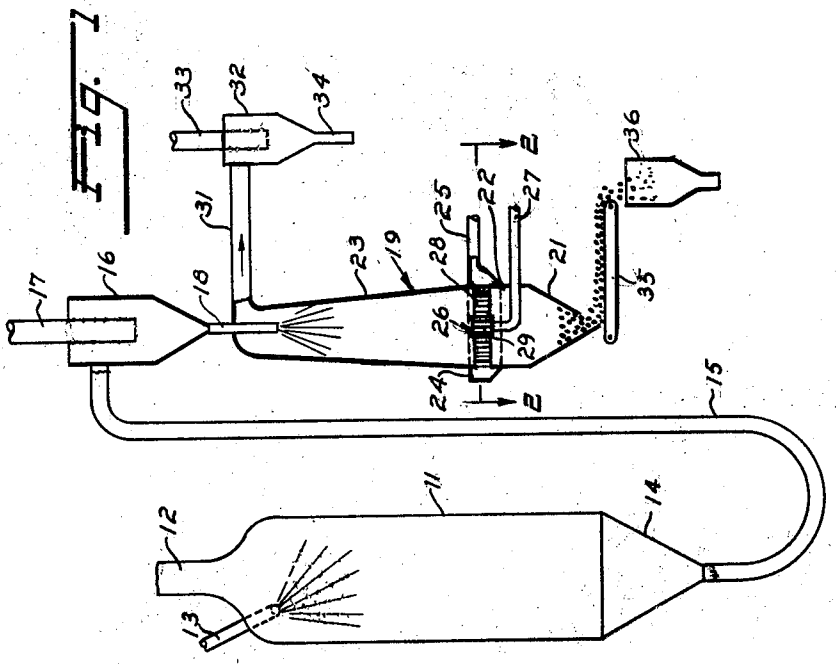
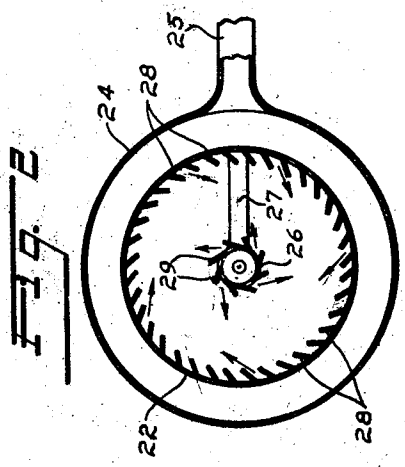


Fig. 2



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Fig. 4

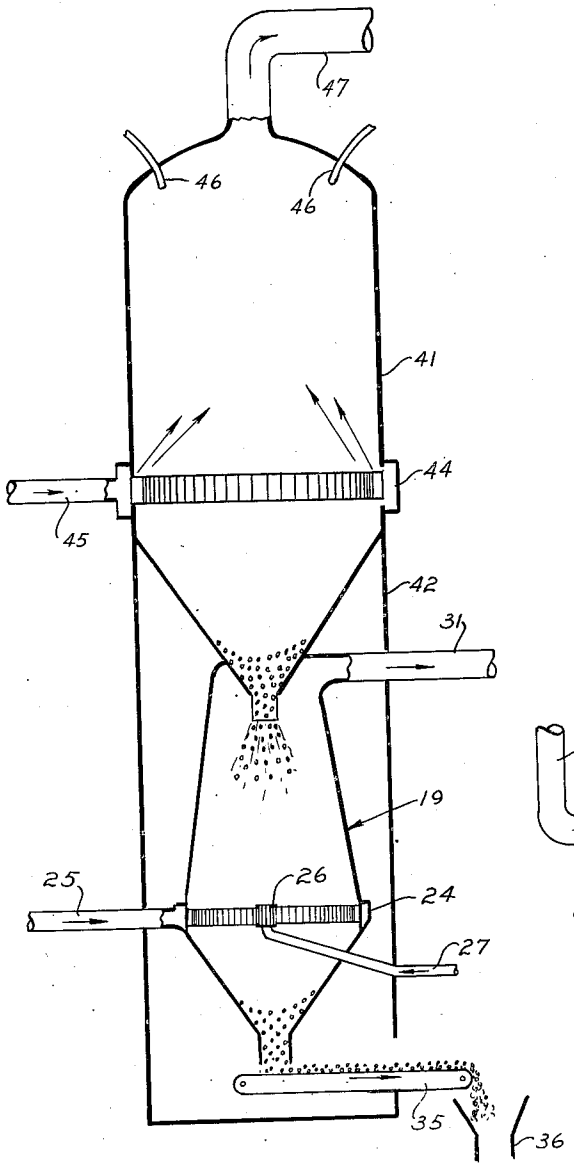
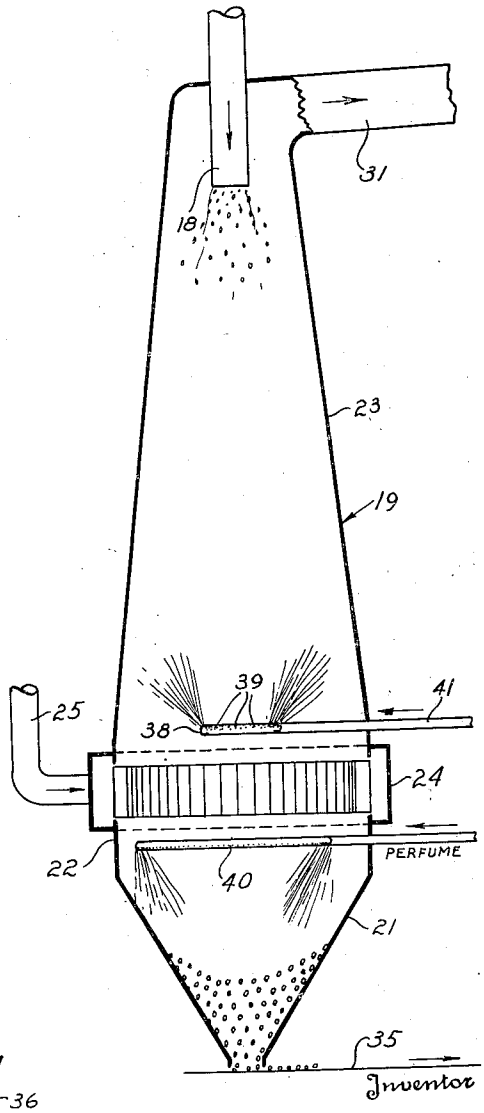


Fig. 3



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2,612,266

COOLING OF SPRAYED PRODUCTS

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2 Claims. (Cl. 209—139)

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This invention relates to the cooling of sprayed soap and like particles and is especially concerned with a process and apparatus for the cooling of solid particles which have been formed by spraying a liquid product into a gaseous heated medium, as for example soap particles made by the process known as the spray tower process. The term "soap" includes detergents and like solid substances used for cleaning.

According to presently used spray tower systems for making granulated, powdered and like particulate soap, liquid soap is introduced in the form of a spray and mingled together with blasts of hot air in a tower wherein droplets of liquid soap become individual solid particles and fall to the bottom of the tower in such form. In practice the entering liquid soap is about 240° F. while the heated air into which the liquid soap is sprayed is at about 460° F., these conditions prevailing at the top of the tower. At the bottom of the tower, the soap particles having been formed, the soap temperature is reduced to about 110° F. while the air temperature is only about 130° F.

Normally therefor soap particles at a temperature of about 110° F. are drawn out of the bottom of the spray tower and introduced into a cyclone separator which separates these particles from the air, the air being exhausted and the particles being dumped onto a conveyor belt which in turn delivers the still warm particles to a cooling device. The usual cooling device comprises a rotating drum through which the soap particles flow longitudinally, and at the same time the particles are exposed to a counterflow of cooling air through the drum. The interior of this cooling drum ordinarily contains spiral baffle blades for assuring that the soap particles move continuously therealong during rotation of the drum.

This type of cooling device has caused considerable difficulty in the past because the warm soap particles, still at a temperature of about 110° F. or slightly less, tend to cake behind the blades and build up a coating on the interior surface of the cooling drum. Accumulation of such soap particles eventually increases the weight of the cooling drum, thereby requiring more power to rotate it or cutting down its speed and therefore its efficiency. In practice it has often been found necessary to shut down the entire tower and process for a period of about one day every two weeks in order to manually loosen and remove the caked soap particles from the interior of the cooling drum. This shut-down not only holds up production, but it requires the

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labor of several men working for a full day to clean the drum which is of considerable size.

I have also found that the forced feed and tumbling about of the particles passing through the cooling drum results in crumbling and powdering of the particles, thereby producing fine dust which causes sneezing and like discomfort to the user of the product.

In solution of the above problem, I contemplate omission of the rotary cooling drum and substitution therefor of a mechanically stationary device which will reduce to a minimum physical handling of the soap particles during cooling and will adequately cool the soap particles to a temperature at which they may be safely packaged without the danger of caking. I accomplish this cooling in the preferred embodiment of the invention by producing a special counterflow of air relative to a stream of the relatively hot soap particles to be cooled, and I have found that in addition to providing very efficient cooling of the soap particles the operation removes small particles of a size which correspond to dust in the final product and which may cause sneezing to the user of the packaged soap.

With the above in mind, it is a major object of my invention to provide a novel stationary apparatus for cooling soap and like particles with minimum mechanical handling.

It is a further object of the invention to provide a novel manner of passing air or some other gaseous substance in counterflow relation to a stream of soap or like particles to be cooled whereby efficient cooling is obtained and whereby small dust particles which may cause sneezing of the eventual user of the packaged product are removed.

It is a further object of my invention to provide a special cooling tower for cooling discrete warm soap particles which is of special shape for maintaining substantially constant air velocity therethrough counter-current to the stream of soap particles and wherein the velocity of the cooling air is maintained in excess of the terminal settling velocity of desired size of small dust particles which it is desired to remove from the product.

It is a further object of the invention to provide a particulate soap cooling tower having novel arrangements for producing turbulence of air flow for efficiently reducing the temperature of the soap particles to a level where the product may be packaged without caking.

A further object of the invention is to provide a novel tower arrangement for cooling soap par-

ticles with minimum mechanical handling and wherein soap dust particles smaller than a given size are removed from the product, in which perfume is sprayed into the product following the cooling and dedusting operation and just prior to packaging, whereby considerable saving in the amount of perfume used is effected since the perfume is not volatilized as much by the cooler particles as it is in prior art arrangements wherein the perfume is usually incorporated into quite warm soap particles prior to cooling.

It is a further object of the invention to provide a novel combined soap particle making and cooling tower therein the still warm soap particles after manufacture in an upper spray tower section drop into a lower cooling tower section wherein they are subjected to the action of turbulent cooling air before leaving the tower and before being packaged.

Further objects of the invention will presently appear as the description proceeds in connection with the appended claims and the annexed drawings wherein:

Figure 1 is a flow diagram of an apparatus and process for making, cooling and packaging soap particles according to a preferred embodiment of the invention;

Figure 2 is a section through the cooling tower on line 2—2 of Figure 1 illustrating the counterflow of air which produces the turbulence in the cooling operation;

Figure 3 illustrates diagrammatically a further embodiment of the invention using a cooling tower having an internal air supply arrangement different from the cooling tower of Figure 1; and

Figure 4 is a combined flow diagram and substantially diagrammatic view of a combined spray tower and cooling tower according to a still further embodiment of the invention.

Referring now to Figure 1, the usual spray tower 11 is provided at its top with a hot air conduit 12 connected to a suitable source of pressurized heated air and a liquid soap spray nozzle 13, by which charges of hot air and sprayed liquid soap are continuously discharged and intimately mixed within the top of the tower. The droplets of liquid soap change to particulate form as they fall from the top to the bottom of the tower. The spray tower may be of the type disclosed in Uhl Patent No. 1,782,054 to which reference is made for more detail. Since this is a conventional spray tower process for making soap particles, it is not necessary to go into further detail in description of the same except to observe that by reason of the turbulent flow conditions existing within the tower it is apparent that frequent collision of soap particles with each other and the incomplete forming of certain particles will result in a product wherein many of the particles are of undesired small size, some even approaching the very small size which is now recognized as the dust that causes sneezing to the consumer when a package is opened.

The formed soap particles which are usually at a temperature of about 110° F. are collected in the conical shaped lower end 14 of the spray tower 11 and withdrawn therefrom through the conduit 15 to be discharged into the cyclone separator 16 which separates the particulate product from the hot air. The hot air is discharged from separator 16 through outlet conduit 17 and the product soap particles are discharged through conduit 18 into the special cooling tower 19 of the invention.

Cooling tower 19 may be regarded as essentially composed of three vertical sections, the lowest substantially frusto-conical downwardly converging section 21 wherein the side walls are disposed at an angle of between 30° to 45° to the vertical, a relatively short intermediate section 22 where the side walls are substantially vertical so that this portion of the tower is substantially cylindrical, and a longer upper upwardly converging section 23 in the shape of a truncated cone wherein the side walls are disposed not more than about 20° to the vertical.

Adjacent section 22, the tower is surrounded by an annular manifold 24 providing a pressurized chamber which is connected by a conduit 25 to a source of air pressure such as a suitable blower fan (not shown). Manifold 24 is provided with internal apertures so that it serves as an annular nozzle for discharging air into the tower. An auxiliary air supply is provided substantially centrally of the tower and at about the level of housing 24 in a form of radially open nozzle 26 supplied by a conduit 27 connected to a suitable source of air pressure. As illustrated best in Figure 2, the air entering tower 19 from a plurality of apertures in manifold 24 is so directed by suitable baffle plates or blades 28 as to create a generally circumferentially traveling air current which is substantially concentric with section 22. Similarly, nozzle 26 is provided with circumferential outlets and suitable directional baffle plates or blades 29 whereby the escaping air therefrom travels in a substantially circumferential swirling or spiral path which is counter current to the swirling motion of the air entering from manifold 24, so that within section 22 of tower 23 there is violent turbulence due to the interference of the two opposed swirling streams of air under pressure.

As illustrated in Figure 1, the upper end of tower 19 is connected by a conduit 31 to the suction end of a cyclone separator device 32 which separates air transversing conduit 31 from any small soap particles which have been picked up thereby and the separated small soap particles are delivered through a conduit 34 to a suitable remelt station (not shown) so that none of the product is wasted. The separated air is exhausted at 33. Due to the suction through conduit 31, the turbulent air stream within section 22 is drawn upwardly through the falling stream of warm soap particles.

As further illustrated in Figure 1, the cooled larger soap particles collect in the conical bottom section 21 of the cooling tower 19 from which they may drop onto a conveyor belt 35 or the like for removing them to a hopper 36 directly on the packaging machine.

According to the invention, the drop-in temperature of the air cooled soap particles by the time they arrive in lowest section 21 of cooling tower 19 is such that they do not tend to cake or agglomerate. There is a minimum of handling of the particulate soap prior to packaging so that the tendency to form further fine particles in the product is considerably reduced.

The size of cooling tower 19 is usually determined by the degree of cooling necessary to reduce the soap particles to desired temperature. For example, it is usually desired to reduce the temperature of the soap particles to at least about 90° F. prior to packaging. If the soap particles enter the cooling tower at a temperature of 110° F. and are to be discharged therefrom at 100° F. or less, it is necessary to consider the temperature of the entering cooling air in order to estimate

the amount of air required to effect the desired heat transfer. For a latitude in the neighborhood of New York city, the surrounding air temperature is rarely higher than 85° F. even in summer, so that withdrawing cooling air directly from the surrounding atmosphere into conduits 25 and 27 of my apparatus, and considering the specific heat of air to be 0.237 B. t. u. per pound per degree Fahrenheit, I have estimated that it would require a circulation of about thirteen thousand, three hundred cubic feet of air per minute to reduce the temperature of the soap particles from 110° F. to 90° F. even where the outer outside air temperature was 85° F. A cooling tower having a diameter of approximately ten feet would have to be about twenty-five feet in height to be satisfactory under such conditions. It is to be understood that these dimensions and calculations are exemplary only and in no way restrictive of the invention.

I have found that by utilizing the opposite swirling air supply arrangement illustrated in Figure 2 and with the upper end of the tower at reduced pressure due to its connection with the suction end of separator 32, adequate and efficient cooling of the falling soap particles is readily obtainable within the tower, and the cooling tower is continuous in operation since it is not subjected to such inherent operational defects as would require it to be shut down for cleaning like the prior art cooling drums.

In addition to adequately cooling the soap particles, my above described manner of creating a turbulent counterflow of air through the dropping soap particles removes therefrom all soap particles below a predetermined particle size and thereby removes from the product those small fines or dust particles which cause sneezing to the user of the final package. It is in connection with this removal of the very fine soap particles or dust from the product that the upper section 23 of the tower is advantageously shaped with a slight taper (up to about 20°), the purpose of this taper being to provide a gradually reducing cross section of the tower for producing a slightly increasing linear velocity of the flow of air toward the top of the tower. On tall towers this tapering may be unnecessary.

This air velocity is determined by calculating the settling or terminal velocity for the largest size fine particle when it is desired to remove from the product. It is well known that particles of very light weight when allowed to drop freely through a viscuous medium such as air do not fall according to the ordinary law of gravity. Some time after it starts to fall, each light particle of appreciable surface area reaches a settling velocity where the upwardly acting force of air resistance to its fall is equal to the gravitational force, and a further gain in speed is impossible at this point. The particle is then said to have attained terminal velocity.

In practicing the invention, I calculate the velocity of the upward flow of air in tower 19 which is high enough to just exceed the terminal velocity of the small particles of dust which I wish to remove from the product. This terminal velocity of small particles of dust may be calculated mathematically approximately by any the various available theoretical equations or laws of streamlined motion. This terminal velocity may be approximately calculated for example by Stokes' law for the speed of a particle falling in a viscuous medium, as described in Meston Patent No. 2,091,514 to which

reference is made for further detail. By such mathematical calculation and with knowledge of the approximate size of the particle to be withdrawn from the falling product, an approximate terminal velocity may be calculated sufficiently to proceed with the general design of the tower, although the nature of the material and the various types of air currents which may be employed in the tower may vary the actual value of the terminal settling velocity so that in many cases some actual experimentation is necessary to determine the actual required upward air velocity once the apparatus has been set up.

I have found that very satisfactory fine particle removal from the product is effected by the air velocity which was calculated as necessary for sufficiently reducing the temperature of the soap particles. In general when the upward air velocity is adequate for efficient particle cooling in a practically sized tower it is high enough to remove the dust particles. It will be appreciated that both the cooling operation and the removal of dust particles from the product may be varied by changing the temperature of entering cooling air, as well as by varying the shape of the cooling tower, the velocity of the entering air and the manner of creating turbulence in the intermediate section of the cooling tower.

Another manner of cooling the soap particles to desired temperature while at the same time removing dust and small particles therefrom is illustrated in Figure 3 wherein cooling tower 19 is provided with the same annular main cooling air discharge housing or mainfold 24 but the inner nozzle 26 has been replaced by an annular nozzle 38 having a plurality of upwardly facing small apertures 39, the conduit 41 leading to nozzle 38 being connected to a suitable source of compressed air or the like. Except for substitution of nozzle 38 for nozzle 26, the cooling tower of Figure 3 is exactly the same as in Figure 1, the arrangement of Figure 3 being used in some instances fragile particles are being handled and less turbulence of the air within the cooling tower is desired, and also where it is desired to create a more directional pressurized countercurrent to the stream of soap particles falling from the top of the tower. In the lowermost part of the tower in Figure 3 the soap particles may be sprayed from an annular multiapertured ring 40 with a suitable perfume. Since the soap particles are now free of dust and considerably cooled so that there is no vaporization of the perfume, this produces a saving in perfume which is an expensive ingredient.

Figure 4 illustrates a further embodiment of the invention wherein the cooling tower which may be similar to that illustrated at 19 in Figure 1 may be combined with a spray tower comprising the upper section 41 of an elongated tower 42 which extends about and encloses the cooling tower.

In this combined tower, the upper spray tower section 41 is substantially cylindrical and is provided adjacent its lower end with a substantially annular inlet ring nozzle 44 to which hot air under pressure is delivered inwardly and upwardly by a conduit 45 for intermingling with sprayed liquid soap entering through nozzles 46 at the top of the tower, a suitable conduit 47 being provided at the top of spray tower section 41 for exhausting the air which has been reduced in temperature during formation of the

soap particles. The warm soap particles at about 110° F. temperature collect in the lower generally conical portion of spray tower 41 and are funnelled into the top of cooling tower 19 so that the falling warm soap particles are immediately subjected to the swirling and countercurrent action of the up-flowing cooling and dedusting air stream from nozzles 24 and 26. In this manner the soap particles are cooled to at least about 90° F. for safe packaging, and the heated air containing the small particles of dust removed from the product is exhausted through conduit 31 as in Figure 1.

In this embodiment of the invention I have therefore combined in a single installation the conventional type spray tower with the cooling tower of my invention, thereby further eliminating mechanical handling of the soap particles between the spray tower and the cooling tower and reducing to a minimum mechanical handling of soap particles after they have been formed and prior to packaging, while at the same time insuring that their temperature is sufficiently low prior to packaging that there is no objectionable lumping or agglommeration of the particles in the package.

The conduit 31 as in Figure 1 is preferably connected to a waste bin wherein the discarded soap dust and particles are collected and remelted and used again for introduction through nozzle 46.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed and desired to be secured by United States Letters Patent is:

1. A cooling and classifying tower for treating hot, lightweight spray-dried particles which have been removed from a spray-drying tower while above a predetermined maximum packaging temperature comprising; means defining a vertically elongated chamber, the interior of which presents an unobstructed cooling passage having an inner wall of substantially circular cross-section; means at the top of said chamber for introducing said particles in a stream of air into the upper end of said passage at the axis thereof; an air outlet at the top of said chamber surrounding and above the point of introduction of said particles; a first annular air introduction nozzle around the periphery of said chamber adjacent the lower end thereof; baffle means in said nozzle for directing said air tangentially around said inner wall of the chamber in one direction; a second nozzle located at substantially the axis of said chamber and in the same horizontal plane as said first nozzle for introducing cooling air at a controlled velocity; a plurality of baffles in said second nozzle for directing the cooling air in the opposite direction around said chamber; suction means connecting with the top of the chamber for maintaining a pressure differential between the upper and lower ends of said chamber whereby the air travels turbulently upward and out of said outlet at the top of said chamber at a velocity sufficient to entrain certain of said particles; and a collecting compartment having a downwardly converging wall below said air introduction nozzles, the wall of the compartment merging with the inner wall of the chamber terminating in a product outlet through which the remaining cool particles are removed for packaging.

2. A process of treating small lightweight hot spray-dried particles containing organic detergents after they leave a spray-drying tower at a temperature above a predetermined maximum packaging temperature which comprises, entraining said particles in a fluid stream, introducing said stream carrying said particles vertically downwardly into the central portion of the upper end of a vertically elongated cooling zone through which the particles may freely fall, establishing two oppositely directed coplanar circular movements of cooling air substantially transverse to the path of the freely falling particles at a point below their introduction into said zone, causing said cooling air to flow upwardly counter to the path of said particles through said cooling zone at a velocity exceeding the terminal settling velocity of certain of said particles, removing the cooling air with said certain of said particles entrained therein at a point above the point of introduction of the particles into the cooling zone, and collecting the remainder of said particles below the level of introduction of said cooling air.

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