Oct. 18, 1966 D. D. PEEBLES 3,279,924

CONTACTING APPARATUS AND PROCESS FOR FORMING AGGREGATES

Filed Dec. 12, 1963 3 Sheets-Sheet 1

Fig. 1

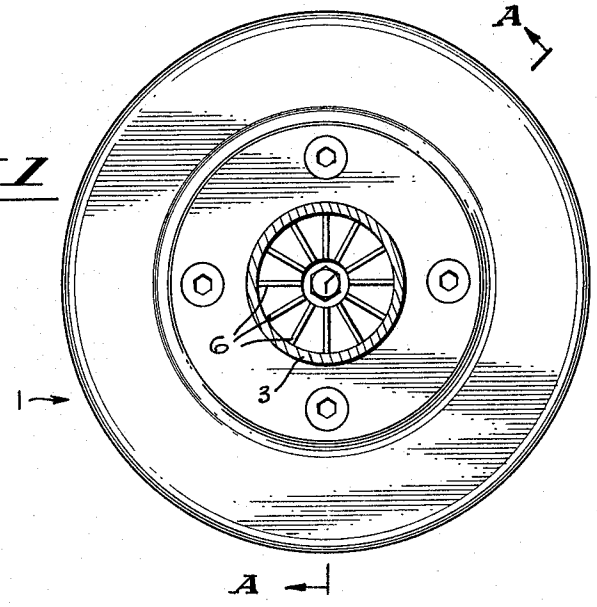
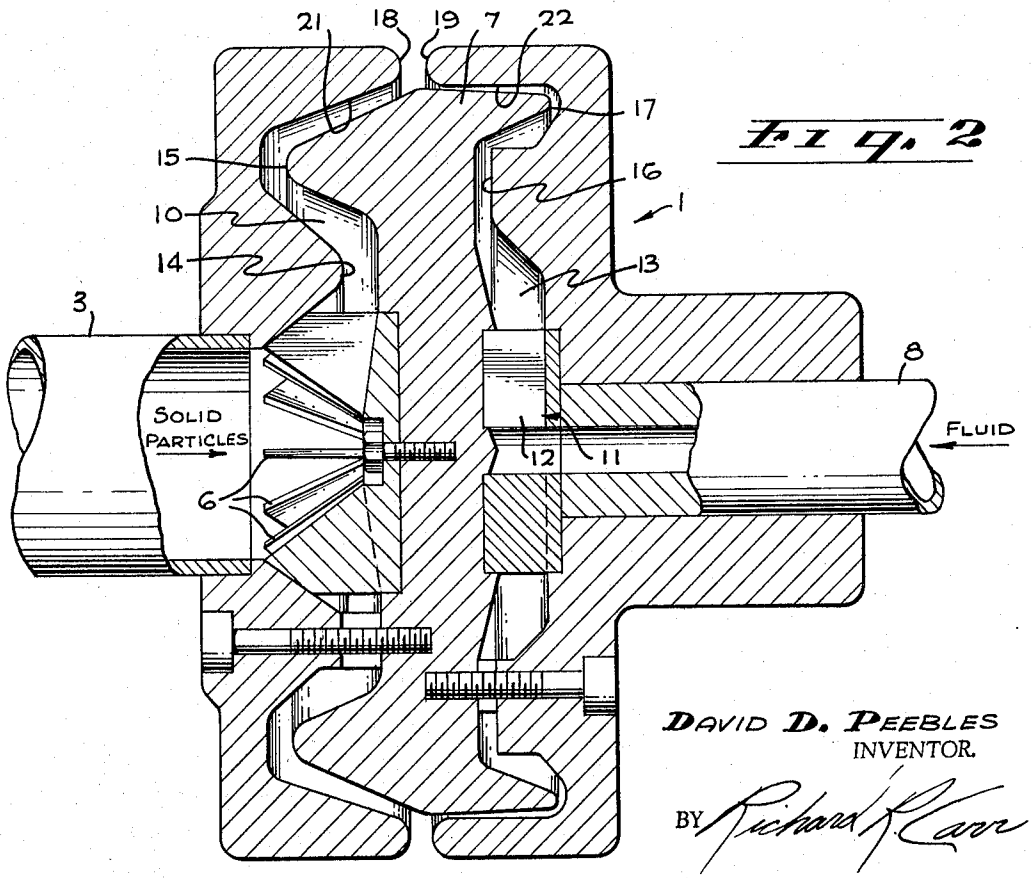


Fig. 2



DAVID D. PEEBLES
INVENTOR.

BY Richard K. Carr

ATTORNEY

Oct. 18, 1966 D. D. PEEBLES 3,279,924

CONTACTING APPARATUS AND PROCESS FOR FORMING AGGREGATES

Filed Dec. 12, 1963 3 Sheets-Sheet 2

Fig. 3

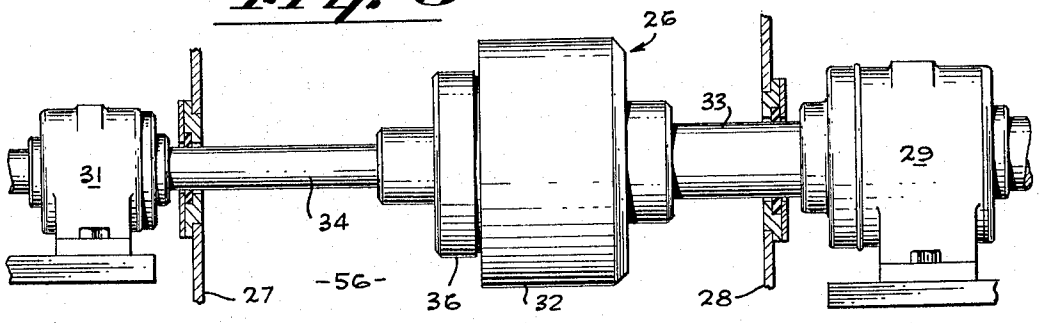
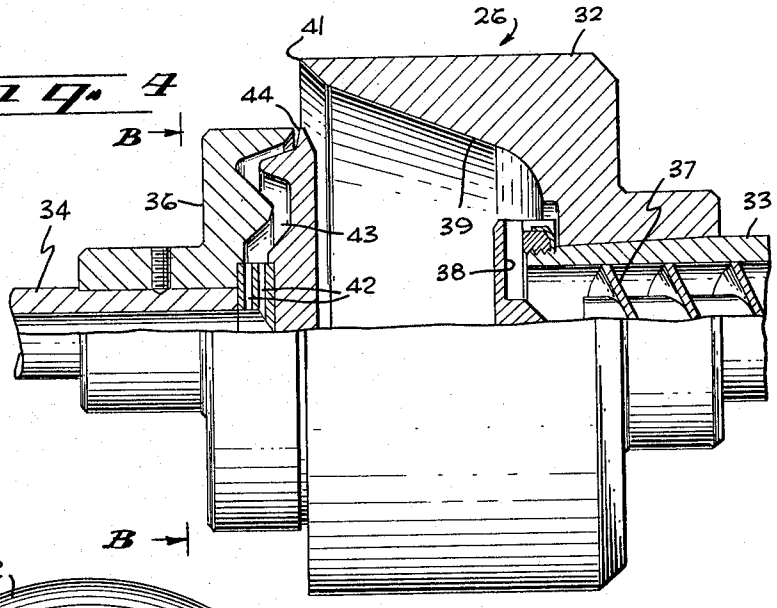


Fig. 4



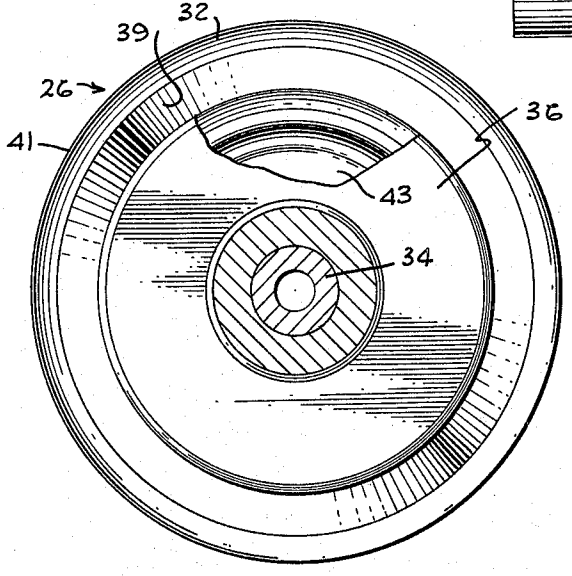


Fig. 5

DAVID D. PEEBLES
INVENTOR.

BY Richard K. Lee

ATTORNEY

Oct. 18, 1966 D. D. PEEBLES 3,279,924

CONTACTING APPARATUS AND PROCESS FOR FORMING AGGREGATES

Filed Dec. 12, 1963 3 Sheets-Sheet 3

Fig. 6

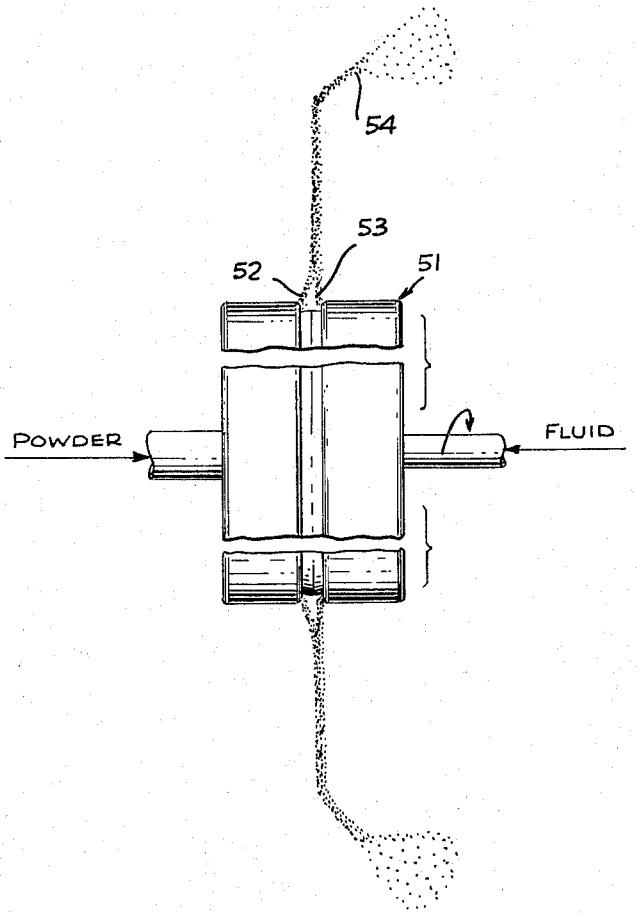
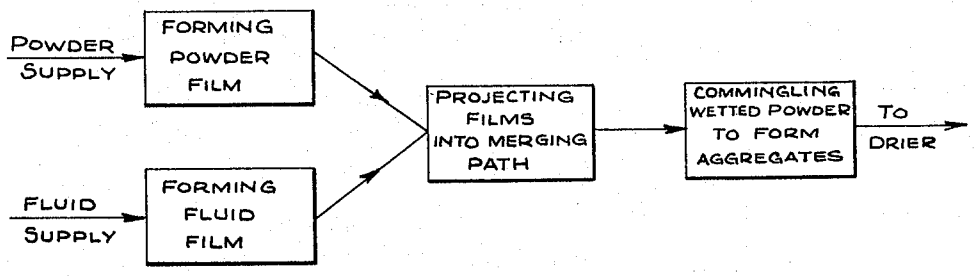


Fig. 7



DAVID D. PEEBLES
INVENTOR.

BY Richard R. Carr

ATTORNEY

United States Patent Office 3,279,924 Patented Oct. 18, 1966

3,279,924

CONTACTING APPARATUS AND PROCESS FOR FORMING AGGREGATES

David D. Peebles, Davis, Calif., assignor to Carnation Company, Los Angeles, Calif., a corporation of Delaware

Filed Dec. 12, 1963, Ser. No. 330,194
5 Claims. (Cl. 99—56)

This invention relates to a process and apparatus for contacting solid particles with a fluid. More specifically, it concerns a centrifugal wetting head for continuously contacting predetermined amounts of a liquid with a stream of solid particles so as to achieve uniform wetting of the solid particles. The invention also concerns a process for obtaining uniform coating of discrete solid particles with a fluid. Further, it concerns a process for obtaining more uniform aggregation of solid particles.

Processes for obtaining aggregated products, such as instantized milk powder, are well known in the art. In general, the aggregating process involves the steps of introducing predetermined quantities of powder and moisture into a contacting zone. First, the powder is wetted by the moisture to make the individual particles of powder sticky. Then, the particles are commingled to form random shaped and size aggregates of a size substantially larger than the individual particles of powder. Finally, the aggregates are dried to form a readily wettable product.

The efficiency of the aggregating process is largely dependent upon obtaining uniform surface wetting of the individual solid particles. The particles which are not wetted, or which are not wetted sufficiently, do not adhere together to form aggregates, and they appear as fines in the final product. An excess of fines make the aggregated product non-wettable and non-dispersible, and result in a poor product, or require addditional processing to remove the fines.

Many wetting procedures used in the prior art consisted of apparatus for creating a zone of dispersed moisture, often called a "fog." The solid particles are projected through the moisture zone and wetting is achieved by a random contact of solid particles with moisture droplets. In another type of prior art process, a liquid is sprayed into a falling stream of particles. While these systems produce aggregates, none of them achieve uniform wetting and reduction of fines achieved by this invention.

This invention utilizes different principles of wetting and does not depend solely upon random contact between fluid and solid parties. In this invention a stream of solid particles is projected at high velocity. Preferably, the particles are projected radially from a rotating head. The film of solid particles form a thin plane of substantially uniparticle thickness. A thin stream of finely atomized fluid, or preferably a liquid, is projected from an opening near the outlet for solid particles. The film of solid particles and the stream of finely atomized liquid are projected to intersect, and preferably merge, just after emission from the periphery of the rotating head.

The velocity of the individual particle creates an area of decreased pressure immediately behind the projected particle. The stream of liquid is projected so as to travel a path substantially coincident with the film of solid particles. In this manner, the present invention obtains the following three advantages: (1) Wetting of the solid particles is obtained by contact between the solid particles and liquid droplets as the streams intersect or merge. (2) The decreased pressure behind each solid particle tends to draw the finely dispersed liquid into contact with the solid particle; ideally, larger particles tend to draw more liquid than smaller particles because of the lesser pressure behind a larger particle. (3) The film of solid particles and the stream of finely dispersed liquid travel a substantially coincident or parallel contiguous path for a period of time permiting far greater intercontact between the liquid droplets and solid particles than can be achieved by passing moving particles through a stagnant zone of "fog" or by the point intersection of a stream of particles with a stream of liquid.

In addition to the above advantages, an objective of the invention is to provide a high capacity apparatus for uniformly coating solid particles with a liquid. Another important advantage is an aggregating process which may be carried out in significantly small apparatus. The reduction in the size of the apparatus increases plant capacity and significantly reduces installation cost since much of the apparatus eliminated is constructed of stainless steel. Yet, another objective is to provide a durable centrifugal wetting head for continuous use in processing a variety of powdered pellets or pulverized material. A further objective is to provide an improved process for uniformly wetting solid particles in an aggregating process, and specifically to achieve a high through-put of aggregating material while decreasing the percentage of fines in the final product. Other objectives will be apparent to those skilled in the art upon reading the following description of the invention.

These objectives and advantages are achieved through the use of a compound centrifugal wetting head which comprises: Inlet means for receiving solid particles and means for dispensing the solid particles into a thin film as the head rotates. Preferably, the means for dispensing the solid particles is a circuitous radial path which forms the solid particles into a thin film as they move radially. An inlet means for receiving fluid, and means for dispensing the fluid as a thin film. Preferably, means are provided for causing the fluid to travel a circuitous path and be spread into a thin film as it travels radially. At the terminus of each path, are means for directing the film of solid particles and the film of fluid into contiguous or substantially coincident paths.

In the process of the invention, uniform coating of discrete solid particles with a fluid is achieved, and the solid particles are commingled to form aggregates. First, the solid particles and the fluid are formed into thin films, and the films are projected into contiguous or substantially coincident paths. Preferably, the plane of the solid particles and that of the fluid merge or intersect to permit fluid and the solid particles to intimately mix while traveling a coincident path for a distance. The fluid uniformly coats the individual solid particles and the solid particles commingle to form aggregates.

FIGURE 1 is a plan view of the wetting head from the solid particle inlet side.

FIGURE 2 is a section through the wetting head along line A—A. This view shows in detail the internal construction of an embodiment of the head, and particularly illustrates the radial paths traveled by the solid particles and liquid.

FIGURES 3, 4 and 5 illustrate an alternative embodiment of the apparatus of the invention.

FIGURE 3 is a side view of the wetting head in a working position in the contacting chamber.

FIGURE 4 is a detailed partial section of an embodiment of the wetting head, again looking at it from the side.

FIGURE 5 is a section through the fluid inlet means of the wetting head along line B—B.

FIGURE 6 is a side view of a wetting head illustrating the trajectory of the powder and liquid.

FIGURE 7 is a schematic illustration of the preferred process.

Specifically referring to FIGURE 2, the solid particles (hereinafter called powder) enter the wetting head through conduit 3. Conduit 3 is not affixed to the head 1 and does not rotate with the head 1. As powder enters the head 1 through the stationary conduit 3, the rotating blades 6, which are rigidly attached to the internal dividing wall 7, disperse the powder radially and prevent the conduit 3 from becoming clogged.

Conduit 8 is used to receive liquid and to rotate the head. The conduit 8 is rigidly attached to the head 1. A motor (not shown) is attached to the conduit 8 to rotate the head 1. Liquid enters the head 1 through the conduit 8 and is directed radially through holes 12 in the ring 11.

The radial path 10 traveled by the powder is defined by alternating ridges 14 and 15 which mesh and thereby cause the powder to travel a circuitous or tortuous path and be spread into a thin film. At the terminous of the path 10 is a lip 18 from which the powder is projected. The trajectory of the particles of powder is determined by the slope or pitch of the wall 21. If the pitch of the wall 21 is steep, as is that of wall 22, the powder will be projected substantially perpendicular to the axis of rotation of the head. However, if the pitch of wall 21 is shallow, the powder will be projected at a slight angle from the plane of rotation of the head.

Liquid enters the path 13 through the holes 12 and moves radially along path 13. The alternating ridges 16 and 17 mesh, causing the liquid to travel a circuitous path and be spread into a thin film. The angle of the wall 22 determines the trajectory of the liquid after being projected from the lip 19.

The head operates as a compound centrifuge continuously dispensing powder and liquid radially, and spreading each into a thin film. Preferably, the powder and liquid are projected from lips positioned in close proximity so that the liquid and solid particles travel a contiguous or coincident path. Ideally, the trajectory of the powder and that of the liquid are arranged so that the film of projected powder and the film of projected liquid merge a short distance from the periphery of the head. It will be appreciated that with respect to the liquid, the rotation of the head will spread it into a thin film and will also atomize the thin film ito discrete liquid droplets when projected from the lip of the head.

FIGURES 3, 4 and 5 illustrate an alternative embodiment of the invention. The primary distinctions between the embodiment illustrated in FIGURES 1 and 2 and that illustrated in FIGURES 3, 4 and 5 are in the independent drive, and the means for spreading powder into a thin film. FIGURE 3 shows the wetting head 26 positioned in the contact chamber. Only a partial section of the contacting chambers 27 and 28 is shown. It will be appreciated that the contacting chamber 27 and 28 forms an enclosed housing around the head 26 with means for removing the wet powder or aggregates.

The head 26 is provided with separate motors 29 and 31. Each motor controls the speed of one section of the head. The independent rotation of each section of the head is best understood by referring to FIGURE 4. The right section of the head 32, here used for dispensing powder, is driven by motor 29 using conduit 33 as a drive shaft. The left section of the head 36 is independently driven by motor 31 using conduit 34 as a drive shaft. In this manner, the section of the head dispensing powder 32 can rotate at a different speed than the section of the head dispensing liquid 36. This feature adds flexibility to the head by permitting more or less liquid to be dispensed without changing the powder output. Independent rotation of each section of the head also permits finer atomization of liquid by increasing the revolutions per minute of section 36 without varying the revolutions per minute of section 32.

Referring again to FIGURE 4, powder is supplied to the head by screw conveyer 37. Conveyer 37 is provided with an independent motor (not shown). The powder is advanced through conduit 33, and is dispensed radially through holes 38 onto the inclined internal wall 39 of section 32. The centrifugal force produced by the rotation of section 32 causes the powder to move down the incline arc of the wall 39 to the lip 41 where it is projected radially. It should be noted that instead of using a circuitous path, as shown in FIGURE 2, to spread powder into a thin film, a combination of an inclined plane and centrifugal force are utilized. However, it will be appreciated that the principle involved is the same.

Liquid is supplied to section 36 through conduit 34. The liquid moves through holes 42, and radially along path 43. As previously described, the circuitous path traveled by the liquid spreads it into a thin film, and it is atomized when projected from the lip 44.

Preferably, the trajectory of the film of powder projected from the lip 41 and the trajectory of the liquid droplets from lip 44 should merge into a common path a short distance from the head. An added advantage of the embodiment shown in FIGURE 4 is that section 36 is not attached to section 32. Thus, the horizontal distance between the lips 44 and 41 may be varied, thereby changing the trajectory of the particles or the liquid. It should be appreciated that with respect to the powder, the important features reside in causing the powder to form a thin film which is projected at high speed. With respect to the liquid, it is important that a film of atomized liquid be projected to merge with the powder a short distance from the head. Preferably, the powder and dispersed liquid travel a coincident path for a substantial distance after merging. In this manner wetting of the powder takes place when the films merge; additional wetting is achieved through intercontact between liquid droplets as they travel a coincident path; and the decreased pressure behind each particle of powder tends to draw the finely dispersed liquid into contact as they travel a coincident path.

The velocity of the powder and liquid droplets when they leave the head is determined by the tangential velocity of the head, and the thickness of the film of powder will vary with the through-put, the radius of the head and the revolutions per minute of the head. The quantity of liquid emitted from the head may be varied by changing the back pressure in the conduit supplying liquid or the revolutions per minute of the head. The degree of atomization of the liquid droplets will, of course, vary with the revolutions per minute of the head. Under optimum conditions the film of powder projected from the head should be substantially uniparticle thickness, and in any event, the film of powder should be kept relatively thin by operating the head at high revolutions per minute or under through-put conditions which will maintain a thin film.

Preferably, the head is constructed of a rust resistant metal such as stainless steel or aluminum.

Now, referring to the process of the invention, it has been found that substantial improvements in the aggregating process for forming instantly wettable products can be achieved by spreading the powder into a thin film and projecting it into a merging or intersecting film of finely atomized fluid. Preferably, the merging films travel a coincident path for a substantial distance so that the powder is uniformly wetted by the fluid. The wetted particles of powder commingle to form uniform aggregates of a size substantially greater than the individual powder particles. By this method, it has been found that substantially fewer fines, i.e., unaggregated particles of powder, appear in the final product. Thus, the final product is more readily wettable and dispersible, and the reduction of fines decreases the amount of aggregated product which must be recycled or discarded.

Precursor powder or solid particles for use in the process means any pulverulent, granulated, pelleted or other particles capable of becoming self adherent and

forming aggregates when commingled. Illustrative examples of materials suitable for use in the process of this invention are: dried skim milk; whole milk powder; malted milk; lactose; milk-containing products such as chocolate milk; flour, flour-containing products such as baking mix and cake mixes; cereals; meals such as pancake mixes; non-viable yeast; sugars such as confectionery sugar, granulated sugar and brown sugar; coffee and combination of coffee with cream and/or sugar; egg whites; products containing carbohydrates such as corn syrup solids in a vegetable fat emulsion and combination of the above.

The fluid used in the process is preferably water. Controlled amounts of steam may be added, if desired. Other liquids, and liquids containing additives, may also be used. For example, water containing sugar in solution or flavoring agents in solution may be used.

Referring more specifically to the flow sheet shown on FIGURE 7, powder is formed into a thin film. Preferably, the film is substantially uniparticle thickness. In any event, the thickness of the film of powder should be controlled and kept near one particle thickness. Any apparatus may be used to form the thin film; but, the preferred apparatus utilizes centrifugal force to spread the powder into a thin radial film. An excellent apparatus for spreading the powder into a film is that illustrated in FIGURES 1–5 herein.

A fluid, for example water, is also formed into a thin stream or film. This is preferably accomplished by the apparatus shown in FIGURES 1–5 herein. It may be accomplished by other means such as forcing the water through an orifice under high pressure.

Next, the films of powder and water are projected into a merging, substantially parallel, planar path at high velocity. At the time the films of water and powder merge, the water should be atomized into discrete droplets. Preferably, atomization is effected using centrifugal force so that the water droplets can be projected into a radial path to merge with a radial film of powder.

To achieve the most uniform wetting, it is desirable that the powder and water droplets be projected into the merging path at high velocities. It will be appreciated that the particles and liquid are emitted at velocities far in excess of free fall emission. As previously explained, the velocity of the powder creates an area of decreased pressure immediately behind each particle, and this tends to draw water droplets, thereby aiding wetting. If a centrifugal head similar to that illustrated in FIGURES 1–5 herein is used, the velocity will be determined by the tangential velocity of the head. For example, when using a six (6) inch head of the type shown in FIGURE 2, it is advantageous to run the head above about 3,000 revolutions per minute, and for optimum results it is desirable to run the head in excess of about 5,000 revolutions per minute.

After the projected films of powder and water droplets merge, it is highly desirable that they travel a coincident path for a substantial distance to permit interplay between the powder and water droplets and to thoroughly wet the powder.

The wet powder particles become externally adhesive and they commingle to form aggregates of a size substantially larger than the individual particles of powder. Following formation of powder aggregates, the aggregates may be dried to the desired moisture content in a suitable drying apparatus, such as a tray dryer.

In aggregating milk, flour, or other heat or moisture sensitive materials, aggregation should be done under time, temperature and moisture conditions which will not deteriorate the aggregated product. These conditions are ascertainable by reference to well known prior art.

Referring to FIGURE 6, the figure illustrates the preferred apparatus for carrying out the process. The head **51** is of the type shown in FIGURE 2. FIGURE 6 specifically illustrates the trajectory of the powder and liquid, but does not show the first step of forming each into a thin film. In this case, the powder and liquid are projected in planes. The film of powder **52** arcs into and merges with the film of liquid **53** a short distance from the periphery of the head **51**. The two films then travel a coincident, or at least contiguous, path to about point **54**. By this time the powder is wetted and begins to form aggregates which fall by gravity, or on an air cushion, to the bottom of chamber **56** where they may be transported to a drier.

To further demonstrate the advantage of this invention, non fat, spray dried milk is aggregated by the process of this invention following the steps illustrated in FIGURE 7. Water is used to wet the milk particles, and the apparatus illustrated in FIGURE 2 is used. When compared with an aggregation technique such as that of United States Patent No. 2,835,586, it is found that the dried milk product aggregated by the process of this invention formed more uniform aggregates, and that the percentage of fines in the aggregate is reduced by as much as about 20%.

A good quality, all-purpose wheat flour of about 14% moisture content is aggregated using the process steps schematically shown in FIGURE 7. Water is used to wet the flour particles, and the apparatus shown in FIGURE 2 is used. In this case sufficient water is supplied to raise the total moisture content of the flour to between about 28% to about 32% in the contacting chamber. Following aggregation the product is tray dried to the original moisture content to about 14%. Examination of the aggregated product reveals the percentage of fines in the final product is reduced by about as much as about 20% when compared with a product aggregated by a process such as that of Canadian Patent No. 644,621.

With reference to the total moisture content of the product in the contacting zone, the operable limits will vary with the material being aggregated. The desirable total moisture content in the contacting chamber for the various products can be obtained by referring to well known prior art references. For example, in the case of milk, United States Patent No. 2,835,586 may be referred to; for flour, Canadian Patent No. 644,621 teaches suitable aggregating conditions; for coffee, United States Patent No. 2,897,084 may be consulted; for yeast, United States Patent No. 2,921,854 gives suitable conditions; for eggs, United States Patent No. 2,950,204 may be consulted; for sugar, Australian Patent No. 235,190 may be referred to. However, it should be appreciated that using the process of this invention makes more efficient use of the liquid and it is possible to use somewhat less water because of the uniform wetting achieved by the process. Further, it should be understood that the invention is not limited to the use of any particular moisture limitation so long as sufficient moisture is used to cause the powder to become sticky and self adherent.

While the invention has been illustrated with reference to particular preferred embodiments thereof, it should be understood that these are only illustrative. Accordingly, variations and modifications will occur to those skilled in the art, and it is intended that such variations and modifications which fall within the broad scope and spirit of the appended claims be included.

An additional feature of the present invention is that large quantities of air are not injected into the contacting chamber with the powder and moisture. The compound centrifugal head of the present invention may be enclosed in a contacting chamber. If desired, discharge of the aggregates from the chamber may be effected through a valve or appropriate means for regulating the influx of air from outside the chamber. Since only small quantities of air enter the chamber with the powder and liquid, the vapor pressure within the chamber will approach that of the wetted powder. Under these conditions the air does not compete with the powder for the moisture, and improved wetting of the powder results.

Having described the invention what is claimed is:

1. A method of aggregating an edible powder capable of becoming self adherent when wetted which comprises:

(a) Forming said powder and a fluid into a thin film by moving said powder and said fluid over separate irregular surfaces under centrifugal forces;

(b) Projecting said films at high velocity into a merging path on a trajectory to cause said particles of powder and moisture to move in intimate contact, whereby the powder particles are externally wetted;

(c) Commingling said powder particles to form aggregates of a size substantially greater than the initial powder particles.

2. The process of claim 1 wherein the powder is milk powder and the fluid is water.

3. The process of claim 1 wherein the powder is flour and the fluid is water.

4. The process of claim 1 wherein the powder is formed into a substantially uniparticle film.

5. The process of claim 4 wherein the aggregates formed by commingling powder are dried to about their original moisture content to form permanent aggregates which are readily dispersible in water.

References Cited by the Examiner

UNITED STATES PATENTS

2,835,586	5/1958	Peebles	99—56
2,893,871	7/1959	Griffen	99—56
2,946,086	7/1960	Mathews et al.	18—1
3,083,099	3/1963	Swanson et al.	99—56
3,114,930	12/1963	Oldham et al.	18—1

A. LOUIS MONACELL, *Primary Examiner.*

M. W. GREENSTEIN, *Assistant Examiner.*