June 25, 1963 D. D. PEEBLES 3,095,149

CENTRIFUGAL ATOMIZER AND METHOD

Filed June 23, 1961

2 Sheets-Sheet 1

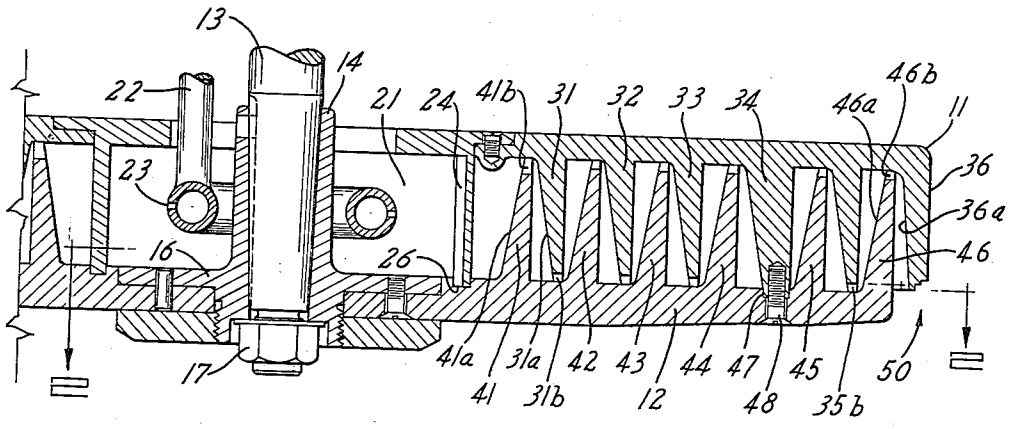


FIG_1_

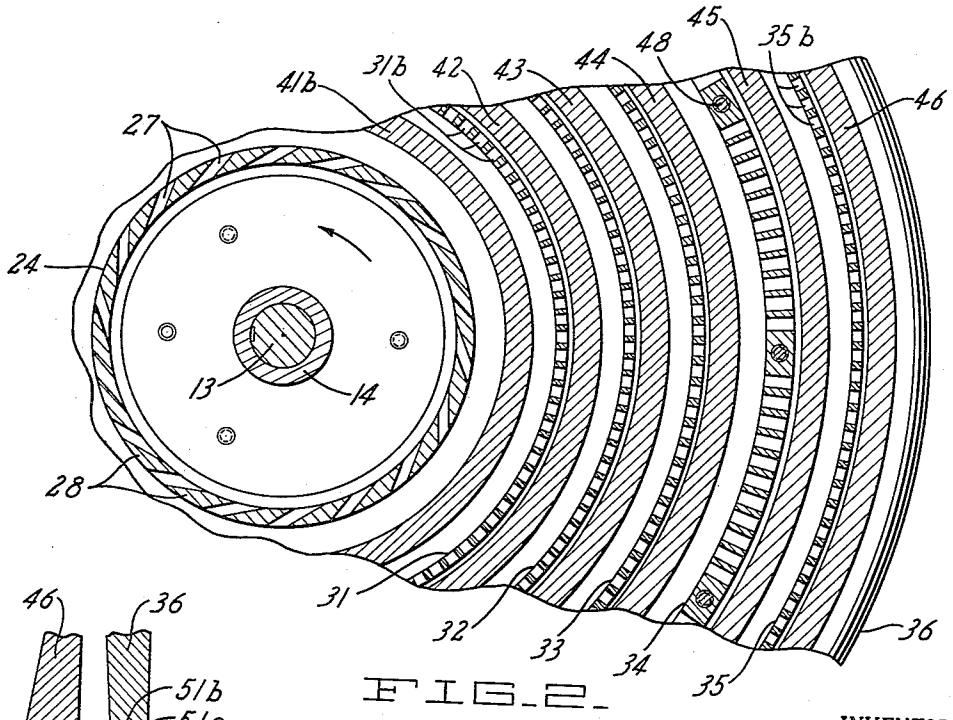


FIG_2_

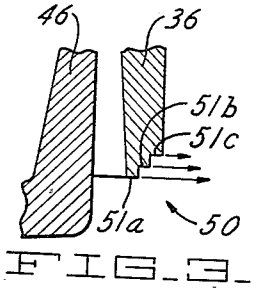


FIG_3_

INVENTOR.
David D. Peebles.

BY

Fleit and Swain
ATTORNEYS

June 25, 1963 D. D. PEEBLES 3,095,149

CENTRIFUGAL ATOMIZER AND METHOD

Filed June 23, 1961 2 Sheets-Sheet 2

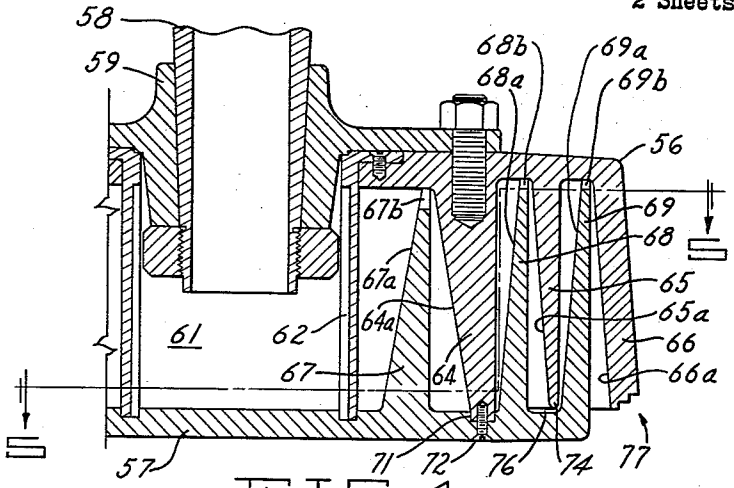


FIG_4_

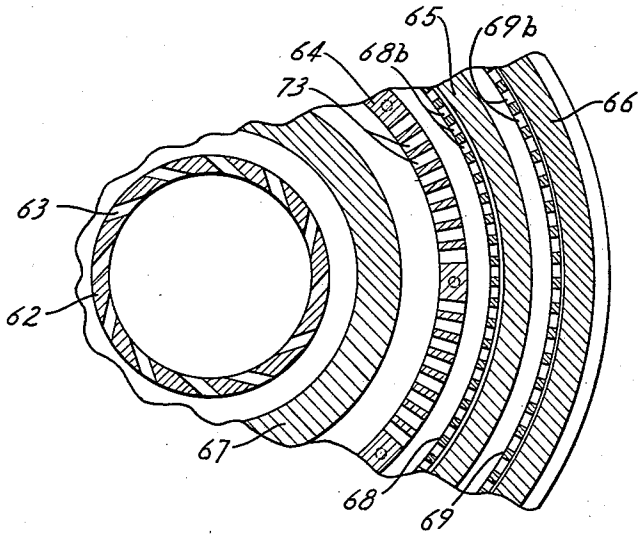


FIG_5_

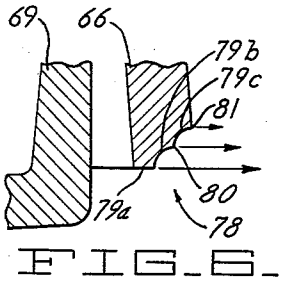


FIG_6_

INVENTOR.
David D. Peebles.

BY

Fleht and Jenner.
ATTORNEYS

United States Patent Office

3,095,149

Patented June 25, 1963

3,095,149

CENTRIFUGAL ATOMIZER AND METHOD

David D. Peebles, Davis, Calif., assignor to Foremost Dairies, Inc., San Francisco, Calif., a corporation of New York

Filed June 23, 1961, Ser. No. 119,153

6 Claims. (Cl. 239—224)

This invention relates generally to centrifugal atomizing devices such as are used in conjunction with spray dryers.

In the past, various types of centrifugal atomizer constructions have been employed, depending upon the character of the feed material with which they are used and the character of the atomization desired. One type which has been widely used in the spray drying of milk, employs a rotary head or basket provided with circumferentially spaced impact elements or bars upon its periphery (see for example, Peebles et al. 2,668,080). With atomizers of this general type, the feed material is delivered into the central portion of the head, and as it moves outwardly between the upper and lower plates, it is impacted and atomized. Such conventional centrifugal atomizers leave something to be desired with respect to their range of application to different fluid materials, the uniformity and size of the atomized droplets, and capacity for a given size and speed of rotation. The emphasis upon impacting action causes undue wear, thus necessitating frequent repairs. Also impacting action may produce undesirable effects upon the feed material, such as disintegration or breaking up of crystals and solids present.

Centrifugal atomizers have been constructed with interleaved annular walls (see for example, Patent 1,870,099) whereby the fluid feed moves in opposite axial directions over the inner peripheral surfaces of the walls, as it progresses outwardly. Finally, the material discharges over an annular lip at the outer periphery of the atomizer. The difficulty with such atomizers, as previously constructed, is that capacity has been limited and the atomization obtained does not have a degree of uniformity comparable to that obtained by the present invention.

In general, it is an object of the present invention to provide a centrifugal atomizer capable of effective and uniform atomization of a wide variety of feed materials, and also capable of high capacity compared to conventional constructions.

Another object of the invention is to provide a novel centrifugal atomizer which depends for its action upon the formation of a relatively thin uniform film of fluid feed material, which is discharged over annular lip means at the periphery of the atomizer, thereby providing relatively uniform and effective atomization.

Another object is to provide a centrifugal atomizer with special discharge lip means which promotes uniformity of atomization.

Another object of the invention is to provide a novel centrifugal atomizer which is characterized by a relatively small amount of wear, and therefore is capable of a long, useful life with a minimum amount of servicing.

Additional objects and features of the invention will appear from the following description in which the preferred embodiment has been set forth in detail in conjunction with the accompanying drawing.

Referring to the drawing:

FIGURE 1 is a side elevational view in section illustrating a centrifugal atomizer in accordance with the present invention.

FIGURE 2 is a cross sectional detail taken along the line 2—2 of FIGURE 1.

FIGURE 3 is a cross sectional detail on an enlarged scale showing the construction of the peripheral discharge means.

FIGURE 4 is a half-side elevational view in section showing another embodiment.

FIGURE 5 is a section taken along the line 5—5 of FIGURE 4.

FIGURE 6 is a detail like FIGURE 3 but showing another embodiment.

The atomizer illustrated in the drawing consists of a body formed of the separable plate-like members 11 and 12, which are mounted upon the rotating shaft 13. As is well known to those familiar with spray drying equipment, the shaft 13 may extend vertically through the top of the spray drying chamber for connection with suitable driving means. The body part 12 is shown provided with a hub 14 for attachment to the shaft. The flange 16 on the hub seats upon the lower body part 12, and is shown held in place by the nut 17.

The central space 21 within the body forms what may be termed a feed chamber. Feed materials are introduced into the chamber 21 by suitable means, such as the annular feed pipe 22, which is provided with a series of slots or openings 23. The outer periphery of the chamber 21 is defined by a substantially cylindrical wall 24, which may be integral with the member 11. The lower end of this wall is shown seated within the annular recess 26 formed in the member 12. A plurality of circumferentially spaced slots 27 and formed in the wall 24. These slots extend in generally tangential directions, as shown in FIGURE 2. The portions 28 between the slots 24 form in effect vanes which act upon the feed material to impart rotary motion, and particularly to impart energy in a radial direction.

A plurality of interleaved annular walls are disposed outwardly of the wall 24. Thus, concentric annular walls 31—36 are fixed to the body member 11, and the concentric annular walls 41—46 are carried by the body member 12. The inner peripheral surfaces 31*a*—36*a* of the walls 31—36 conform to truncated cones, and the cross sectional configuration as viewed in FIGURE 1 is such that the surfaces are disposed at a relatively small acute angle with respect to the axis of rotation. The inner peripheral surfaces 41*a*—46*a* of the walls 41—46 likewise conform to truncated cones, with substantially the same slope as the surfaces 31*a*—36*a*. The extremities of the walls 31—35 are in contact with the upper surface of the member 12, and are provided with circumferentially spaced slots 31*b*—35*b*. The extremity of wall 34 preferably is extended somewhat as shown in FIGURE 1, for seating within the annular groove recess 47. Screws 48 are shown for attaching these parts together. The walls 41—46 similarly have their extremities provided with the circumferentially spaced slots 41—46*b*.

The outermost wall 36 has an end portion 50 (FIGURE 3) constructed to form peripheral discharge means. Thus a plurality of concentric stepped annular surfaces 51*a*, 51*b* and 51*c* are formed. These surfaces are coincident with parallel planes that are at right angles to the axis of rotation. They form a series of surfaces from which films of material are discharged, as will be presently explained.

Operation of my centrifugal atomizer is as follows: Assuming that the atomizer is being rotated at a suitable speed (e.g. 7,800 r.p.m. for a head 20 inches in diameter), a fluid material such as milk is supplied to pipe 22 and to the feed well 21. This material is acted upon by the vanes 28 between the slots 27, and caused to flow through the slots 27, with tangential and radial velocity components. In general, the vanes 28, in conjunction with the slots 27, serve to effect relatively uniform annular distribution, to impart rotary energy and thus increase tangential velocity, and to exert a pumping action to de-

liver material outward from the feed well 21, thus aiding and securing a desired high operating capacity. The inner surface 41*a* receives the material passing through the slots 27, and the material flattens out on the surface 41*a* in the form of a flowing film. The upwardly flowing film on surface 41*a* passes through the slots 41*b*, and here rotary energy is again imparted to the material, whereby it is caused to rotate at the same tangential velocity as the studs which intervene between the slots 41*b*. In addition these slots serve to correct irregularities in film thickness and distribution and to present a uniform distribution of the material to surface 31*a*. Material discharging from the slots 41*b* is received upon the sloping surface 31*a* of the wall 31, with uniform distribution and without material splashing, and by virtue of centrifugal action the material again forms a film which flows downwardly to the extremity of wall 31, and through the slots 31*b*, which function in the same manner as slots 41*b*. As the material discharges from the slots 31*b*, it is received upon the surface 42*a* of wall 42, to form an upwardly flowing film. In the manner just described, the material progresses outwardly and passes successively through the slots on the ends of each annular wall. Ultimately the material is delivered upon the inner surface 36*a* of the outermost wall 36. The relatively thin and uniform (i.e. in thickness) downwardly flowing film formed on surface 36*a*, is delivered as a thin film flowing outwardly across the end surface 51*a* of this wall. According to my observation, the major part of this film is directly discharged from surface 51*a*, and is disintegrated into small droplets. A portion of the film tends to cling to the metal surface and flow upwardly to surface 51*b*, where it forms an outwardly flowing film, with most of such material discharging from the outer edge of this surface as atomized droplets. Here again some material clings to the surface of the metal and flows to the surface 50*c*, from which it is discharged.

In general, as the material passes from one annular wall to the next, the flowing film becomes progressively thinner and more uniform in thickness, whereby the film upon the surface 36*a* is optimum to form atomized droplets of the desired size. Furthermore as the material flows through the slots at the extremities of the several ribs, rotary energy is applied, thereby minimizing movement of the flowing film in a circumferential or tangential direction relative to the annular walls. It has been found that such circumferential movement, if it occurs to a substantial extent, interferes with the formation of the desired thin uniform film, and greatly reduces the capacity of the atomizer and uniformity of atomization. In other words, without means of the type described for progressively applying rotary velocity to the material, a damming action tends to occur which detracts from progressive formation of a thin and uniform film, and thus teds to cause lack of uniformity and fineness of atomization. Also it greatly reduces overall capacity for a given size atomizer and speed of rotation.

The peripheral discharge means 50 is a desirable feature which contributes to effective and efficient atomization. Without such means a substantial part of the material would flow upwardly on the outer surface of rib 36, thus interfering with uniform and effective atomization.

In the embodiment of FIGURES 4 and 5 the radial dimensioning has been reduced and the depth or vertical dimensioning increased. Also the number of annular walls has been reduced. Thus the upper one of the two plate-like members 56 and 57 is mounted on the vertical hollow shaft 58 by a flanged collar 59. Fluid material is fed downwardly through the shaft to the central feed chamber 61. Wall 62 corresponds to wall 24 of FIGURE 1 and is provided with circumferentially spaced slots 63 corresponding to slots 21. Body member 56 carries the annular walls 64, 65 and 66, and member 57 carries walls 67, 68 and 69. The inner peripheral surfaces 64*a*, 65*a* and 66*a* of the walls 64—66 conform to truncated cones.

The same is true of the peripheral surfaces 67*a*, 68*a* and 69*a* of ribs 67—69. The extremity of wall 67 engages the corresponding inner surface of member 56, and is provided with a plurality of circumferentially spaced slots 67*b*, corresponding to slots 41*b* of FIGURE 1. The extremity of wall 64 interfits a recess 71 in the member 57 and is secured thereto as by means of screw 72. Also this extremity is provided with circumferentially spaced slots 73 which function in a manner similar to the slots 34*a* in wall 34 of FIGURE 1.

The extremity of rib 68 engages the adjacent surface of member 56 and is provided with circumferential slots 68*b*.

The extremity of wall 65, indicated at 74, is rounded as viewed in section and terminates short of the adjacent surface of member 57, to provide the annular gap 76. The extremity of wall 69 contacts the inner surface of member 56 and is provided with circumferential slots 69*b*. The outermost wall 66 is provided with peripheral discharge means 77 formed like the discharge means 50 of FIGURE 3.

In general the embodiment of FIGURES 3 and 4 operates in the same manner as FIGURES 1 and 2. Material flows directly over the rounded surface 74 on the end of rib 65, to be discharged therefrom upon the surface 69*a* of gap 69. The peripheral discharge means 77 makes for discharge from a plurality of surfaces to insure effective and uniform atomization.

The discharge means 78 in FIGURE 6 is likewise formed as a series of steps, but with rounded or filleted surfaces 79*b* and 79*c*. Thus any portion of the film flowing across surfaces 79*a* which does not directly discharge therefrom, flows upwardly over curved surface 79*b* for discharge from edge 80. Any remaining material flowing upward over surface 79*c* discharges from edge 81.

In addition to the features pointed out above, my atomizer is characterized by the fact that wear is reduced to a minimum. This is attributed to the fact that the atomizer does not depend upon mechanical impacts for its action, and because relative movement in a rotary direction between the material and the surfaces contacted by the material is maintained at a minimum.

Experience has shown that the atomizer is applicable to a wide variety of fluid materials, including materials varying as to density, viscosity, or character of solids present. It will be evident that for different materials, modifications may be made to obtain the capacity, predetermined film thickness and the degree of atomization desired. For example, the atomizer may be operated at different speeds to obtain the desired atomizing action and capacity. Also the angle to which the inner surfaces of the rib are sloped may be adjusted in accordance with the flow characteristics of the feed.

This application is a continuation-in-part of my copending application Serial No. 749,757, filed July 21, 1958, now abandoned, entitled "Atomizer."

I claim:

1. In a centrifugal atomizer, a hollow body adapted to be secured to a rotating shaft and including axially spaced circular plate-like members, a series comprising two sets of concentric annular walls disposed within the body and between the plates, base portions of said walls being secured to said members with a first set of said annular walls secured to one member and a second set of said annular walls being secured to the other member and interleaved between the first set, the annular end portions of said walls, with the exception of the outermost wall, each serving to discharge material upon the inner peripheral surfaces of the next wall of the series surrounding the same, whereby material delivered to the inner peripheral surface of the innermost wall of the series is caused to progress outwardly and progressively from one annular wall to the next with movement of the material in opposite axial directions over the inner peripheral surfaces of the annular walls in the form of

progressively thinner flowing films, the outermost one of said walls comprising the outer peripheral wall of the atomizer, at least certain of the walls having circumferentially spaced slots in their extremities whereby the flowing film of fluid material passing through said slots has rotary energy imparted to the same to increase its tangential velocity.

2. An atomizer as in claim 1 in which a feed chamber is formed in the central portion of the body, the outer periphery of said feed chamber being defined by vanes for imparting rotary energy to the feed and for forcing the feed outwardly as a flowing film against the inner periphery of the innermost annular wall of the series.

3. An atomizer as in claim 2 in which said vanes are formed by a substantially cylindrical shaped member that is slotted to provide flow passages disposed in a general tangential direction.

4. In a centrifugal atomizer, axially spaced circular plate-like body members, means forming a centrally located feed chamber between said members, vanes extending between the members and separated by tangentially disposed passages and disposed to define the outer periphery of the feed chamber, a series of circular concentric walls carried by the plates and surrounding said feed well, alternate ones of said walls forming a first set that is attached to one of said members, the other second set of walls being attached to the other plate-like member, said walls providing inner conical shaped surfaces, slots formed in the extermities of at least certain of said walls, feed material delivered outwardly from the feed chamber being caused to flow as thin films successively over the inner surfaces of said walls in opposite axial directions, movement of feed material through said slots serving to impart rotary energy to increase its tangential velocity, the outermost one of said walls having an end surface over which material is discharged into the surrounding atmosphere as atomized particles.

5. An atomizer as in claim 4 in which said slots are formed in the extremities of all said walls except said outermost wall.

6. In a centrifugal atomizer, an annular body adapted to be rotated about a central axis, means forming a feed chamber in the central portion of the body for receiving fluid feed material, means in the body surrounding the feed chamber for forming the feed material into a thin

flowing film, an outer annular wall forming the outer periphery of the body and having one end portion thereof carried by the main part of the body, the inner surface of the annular wall conforming to a truncated cone that is divergent toward its other end portion and concentric with the axis of rotation, said last named means being disposed to deliver said film of feed material to said inner surface at said one end portion whereby such film flows over said surface to the other end portion of said annular wall for discharge, and discharge means formed on the other end portion of said annular wall to cause the fluid material of said film to be discharged outwardly as an atomized spray, said last means comprising an end discharge surface of substantial radial dimension formed on said other end portion and over which fluid material flowing from said truncated conical surface is discharged, the inner edge of said surface forming a corner junction with said truncated conical surface, and at least one additional outwardly extending annular discharge surface formed on said end portion, said additional discharge surface being stepped axially relative to the first discharge surface and of greater diameter, the outer periphery of the first end surface terminating in an abrupt edge from which atomized fluid feed material is discharged, there being an annular surface extending axially from said edge to the additional annular discharge surface, said additional discharge surface likewise having its outer periphery terminating in an abrupt edge, whereby any fluid material tending to flow from said first named abrupt edge over said last named annular surface is discharged over said additional discharge surface.

References Cited in the file of this patent

UNITED STATES PATENTS

581,206	Hewitt	Apr. 20, 1897
820,772	Elsenhans	May 15, 1906
1,870,099	Croan	Aug. 2, 1932
2,294,221	Bowen et al.	Aug. 25, 1942
2,920,830	Nyrop et al.	Jan. 12, 1960

FOREIGN PATENTS

61,430	Sweden	Nov. 4, 1924
114,604	Sweden	July 31, 1945
288,904	Great Britain	Apr. 19, 1928