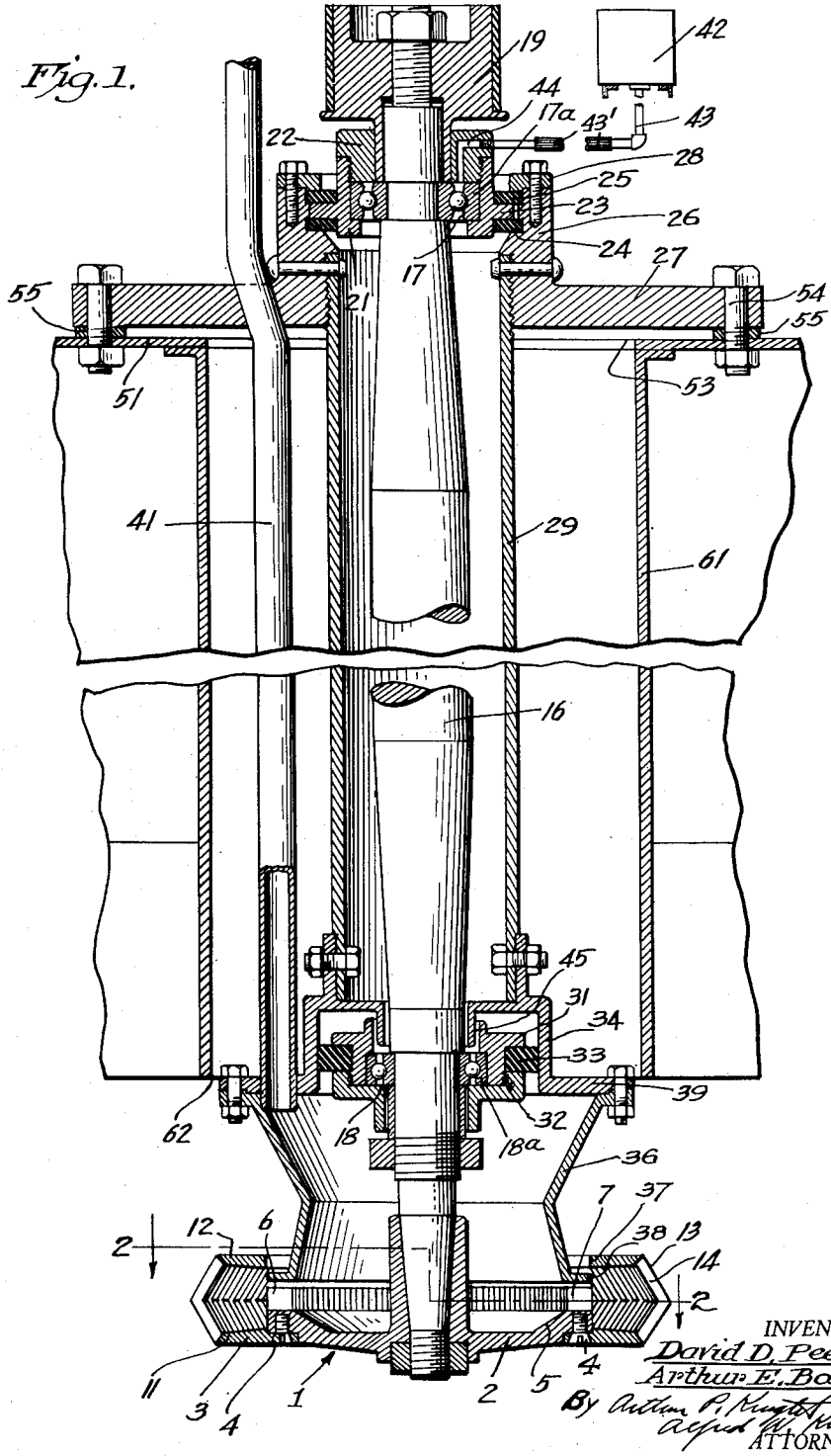
Dec. 12, 1933. D. D. PEEBLES ET AL 1,939,364

CENTRIFUGAL ATOMIZER

Filed April 4, 1931 3 Sheets-Sheet 1

Fig. 1.



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CENTRIFUGAL ATOMIZER

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Fig. 2.

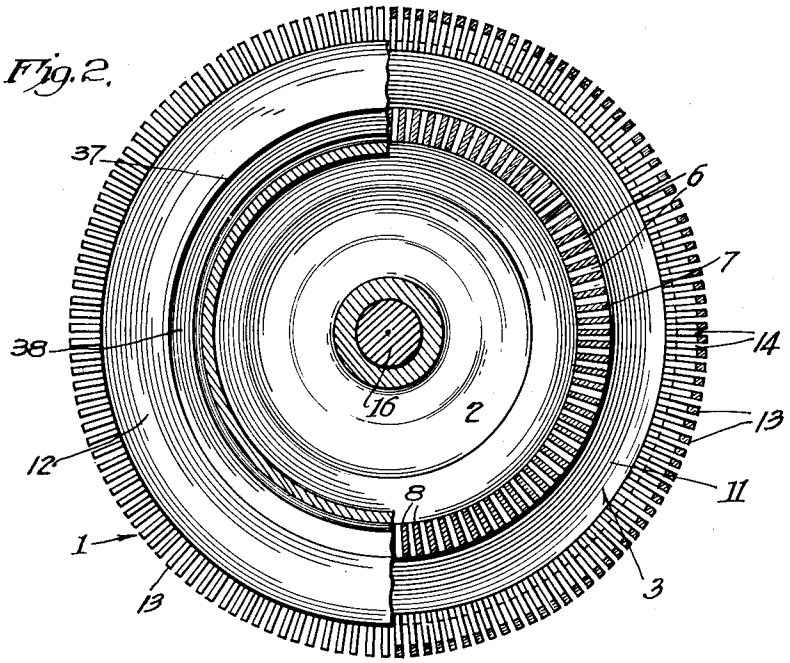


Fig. 3.

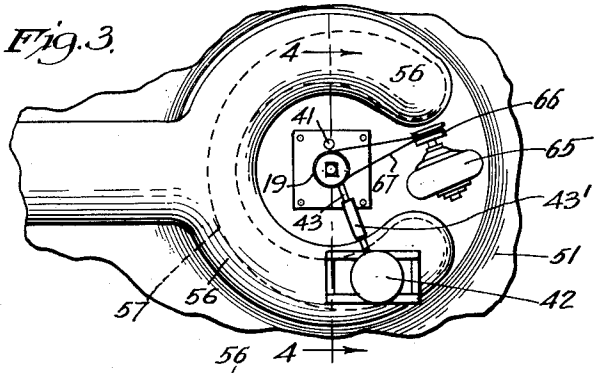
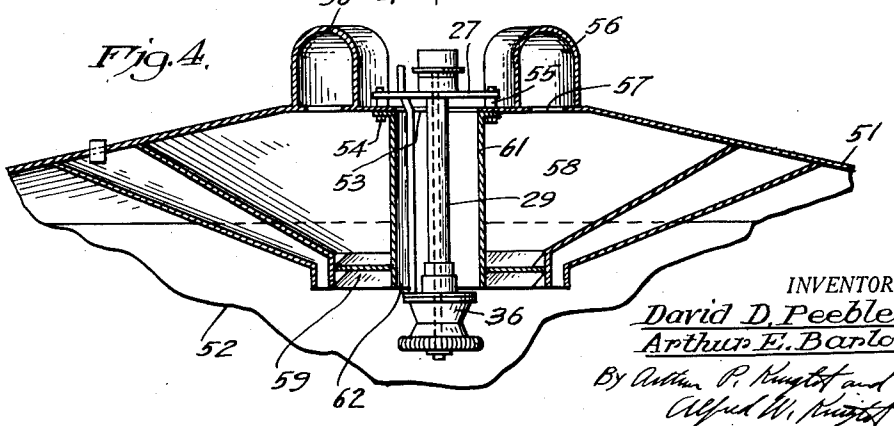


Fig. 4.



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Fig. 5.

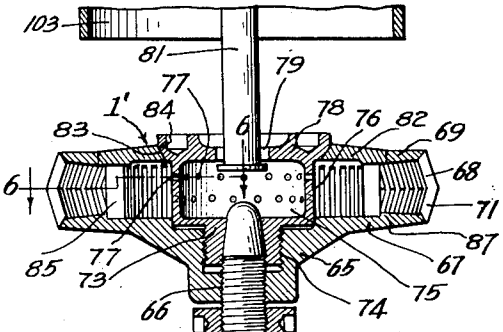


Fig. 6.

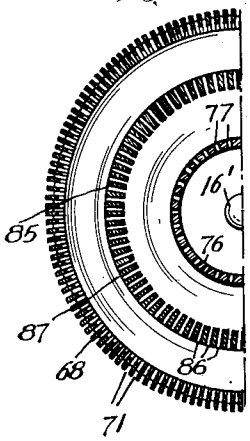
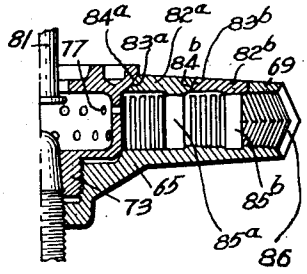


Fig. 7.



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UNITED STATES PATENT OFFICE

1,939,364

CENTRIFUGAL ATOMIZER

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Application April 4, 1931. Serial No. 527,730

3 Claims. (Cl. 299—63)

This invention relates to apparatus for atomizing liquids or spraying the same in finely divided condition by the action of centrifugal force.

The principal object of the invention is to provide a centrifugal atomizing device having a high capacity and adapted to subdivide liquid supplied thereto into particles of uniform minute size and to project such particles outwardly therefrom in finely divided condition and at a uniform rate.

A particular object of the invention is to provide a centrifugal atomizer adapted to handle a larger volume of material than the forms of centrifugal atomizer now in common use.

Another object of the invention is to cause all of the particles discharged from the atomizer to be of substantially uniform size and extremely finely divided, and to prevent the discharge from the atomizer of any relatively large particles or bodies of material in unatomized condition.

A further object of the invention is to provide an apparatus in which a single rotary atomizing device is provided with means adapted to progressively subdivide liquid material, in a plurality of stages, into particles of smaller and smaller size, in such manner that each stage operates on particles of smaller size than the preceding stage and is thus capable of uniformly subdividing such particles into still smaller particles.

A further object of the invention, at least in certain embodiments thereof, is to permit air or gaseous medium to enter the interior of the rotary atomizing device and to be discharged therefrom along with the liquid material and assist in the subdivision or atomization of such liquid material.

The centrifugal atomizer of this invention may be used for the spraying or subdivision of liquid for a wide variety of purposes, for example in spray drying materials, in wet scrubbing or washing operations, for humidification of air or other gases, or in spray burning of liquid fuels.

The term "liquid" as used herein is understood to include any pure liquid or solution, or any emulsion or suspension of liquids or solids in a liquid medium, or any other mixture having a sufficient liquid content to permit the material to flow readily under the action of centrifugal force.

The centrifugal atomizer of this invention comprises essentially a rotatably mounted rotary atomizing device having a central portion providing a material-receiving space, and a plurality of apertured annular rings disposed concentrically about said material-receiving space, the innermost of said annular apertured rings being disposed in position to receive material moving outwardly by centrifugal force from said material-receiving space, and the respective annular rings being spaced apart radially and so positioned with respect to one another that each ring outside the innermost ring receives material thrown outwardly by centrifugal force from the apertures of the next inner ring, whereby the material delivered into said central material-receiving space is caused to move outwardly by centrifugal force through the apertures of the innermost ring and to be thrown outwardly by centrifugal force from the outer ends of said apertures to the next outer annular ring and so on, thus progressively subdividing the material into particles of increasingly smaller size and finally causing the same to be thrown outwardly in an extremely fine state of division from the edges of the apertures of the outermost ring. The apertures of each annular ring are preferably formed as slots extending in planes parallel to the axis of rotation and substantially radially, which slots are of relatively small circumferential width and are of any suitable axial depth and radial length, and are preferably as closely spaced together as is consistent with maintenance of proper mechanical strength in said rings. The material-receiving central portion of the rotary member is preferably so designed as to partially confine liquid material delivered thereto and cause a layer or bed of such material of appreciable thickness to be maintained therein, which prevents occurrence of any appreciable de-watering action and separation of any solid constituents, such as would tend to occur during the movement of the material outwardly to said innermost annular ring if the material were permitted to move in a thin film. The confining means surrounding the central material-receiving space is preferably so formed as to permit outflow of material from the layer or bed thus maintained, under the action of centrifugal force, at a position opposite the middle portions of the slots in the annular rings, and such slots are preferably substantially symmetrically disposed with respect to the position at which such material is so discharged from said space.

The apparatus also includes, of course, suitable driving means such as an electric motor or steam turbine for rotating said atomizing de-

vice at sufficient speed to develop in the liquid material the centrifugal force necessary for effecting the above described operation. The atomizing device is preferably mounted on a driving spindle to which said driving means is operatively connected, and said driving spindle is preferably mounted on bearings provided with resilient aperiodic cushioning means for absorbing vibrations and preventing the development of any periodic vibration or oscillation of said spindle, so that the rotation of said spindle and the atomizing device carried thereby is at all times smooth and substantially vibrationless.

Liquid feed means are also provided for delivering liquid material to said central material receiving space, and shield means are preferably provided for effectively preventing splashing of liquid material from said material receiving space or any discharge of material therefrom otherwise than outwardly through said apertured rings.

The accompanying drawings illustrate embodiments of the invention and referring thereto:

Fig. 1 is a vertical section of a centrifugal atomizer according to our invention provided with driving means located above the rotary atomizing device.

Fig. 2 is a horizontal section of the atomizing device on line 2—2 in Fig. 1.

Fig. 3 is a partial plan view of a desiccating apparatus or the like, provided with a centrifugal atomizer such as shown in Figs. 1 and 2.

Fig. 4 is a vertical section on line 4—4 in Fig. 3.

Fig. 5 is a vertical section of another form of centrifugal atomizer, in which the driving means are located below the rotary atomizing device.

Fig. 6 is a partial horizontal section on line 6—6 in Fig. 5.

Fig. 7 is a partial vertical section of a form of rotary atomizing device similar to that shown in Fig. 5, but provided with a larger number of concentric apertured rings.

The apparatus shown in Figs. 1 and 2 comprises a rotary atomizing device 1 which consists of a central material-receiving portion 2 and an outer member 3 secured in any suitable manner to the central portion 2 as by means of screws 4. The upper face of the central material-receiving portion 2 is of general concave or bowl-shaped construction having its outer portion sloping upwardly and outwardly as indicated at 5 and terminating at the bottom edges of a plurality of closely spaced narrow slots 6 in an annular ring 7 at the outer edge of said central portion. The slots 6 preferably extend substantially vertically and radially through said ring and are preferably formed as straight slots having the side walls of each slot parallel to one another. Said slots may be of any suitable width and spacing, but it is preferable to use slots of relatively small circumferential width spaced as close together as is consistent with maintenance of proper mechanical strength and rigidity of the vanes or ribs 8 which remain therebetween. For example, good results have been obtained by making these slots approximately one-sixteenth inch wide and spaced approximately one-eighth inch apart at their inner ends. In general, the width of the slots should be less than the spacing between the slots, as is the case when these measurements are as above stated. The ring 7 may be of any suitable dimensions so as to provide slots having any desired radial length and axial depth.

The outer member 3 is shown as comprising top and bottom ring-shaped walls 11 and 12 respectively and an outwardly bowed or V-shaped outer wall or ring 13 extending therebetween, all of said portions being preferably formed integrally with one another. The walls 11 and 12 extend transversely with respect to the axis of the device, above and below the space between the inner and outer apertured rings, and act to confine liquid material moving outwardly by centrifugal action and cause all such material discharged through the inner ring to be also delivered through the outer ring. The outer ring 13 preferably slopes outwardly from both the upper and lower walls to a horizontal plane substantially midway therebetween. Said outer ring is of any suitable axial height and radial thickness and is provided with a plurality of closely spaced narrow straight slots or apertures 14, the side walls of each slot being preferably parallel to one another. These latter slots or apertures are also preferably of small circumferential width and spaced quite closely together, with the width of the slots less than the spacing therebetween. For example, good results have been obtained by making these slots also approximately one-sixteenth inch wide and spaced slightly less than one-eighth inch apart at their inner ends. The slots 14 also preferably extend substantially vertically and radially through ring 13.

The above described rotary atomizing device may be provided with any suitable rotatable supporting and driving means. For example, said atomizing device is shown secured to the lower end of a driving shaft or spindle 16 which is rotatably mounted in upper and lower bearings 17 and 18 and is provided at its upper end with a driving pulley 19. Each of said bearings preferably consists of a ball bearing, as shown, and the outer or fixed portion of each bearing is also preferably mounted on the main supporting structure by resilient cushioning means. For example, the outer or fixed member 17*a* of the upper bearing is shown as clamped between threadedly connected collars 21 and 22, and collar 21 is provided with a flange 23 secured between cushioning rings 24 and 25 of rubber or other resilient material. Said cushioning means are in turn mounted and held in position on a flange 26 on the main supporting plate 27 by means of clamping ring 28. A pipe or tube 29 is also secured to supporting plate 27 and extends down around driving spindle 16 and serves to support the lower bearing 18. The outer or fixed member 18*a* of said lower bearing is clamped between threadedly connected collars 31 and 32, between which is also held a cushioning ring 33 of rubber or other resilient material whose outer face bears against the inner face of a supporting fitting 34 secured to the lower end of pipe 29.

The pulley 19 at the upper end of the atomizer shaft may be driven in any suitable manner, for example by means of an electric motor 65 having a pulley 66 operatively connected to pulley 19 by means of belt 67. The speed of motor 65, and the relative sizes of pulleys 19 and 66, are such as to rotate shaft 16 and atomizer 1 at the desired speed.

Suitable means are also provided for feeding liquid material onto the central portion 2 of the atomizing device and for preventing splashing of such material therefrom. For this purpose there is provided a collar 36 surrounding the driving spindle 16 and having its lower portion projecting through the central opening 37 of the

upper ring 12 of the outer member of the atomizer and provided with an outwardly projecting annular flange or shield member 38. The outside diameter of said flange or shield member is preferably only slightly less than that of the opening 37, so that said shield member may be inserted through said opening, while the lower portion of collar 36 and shield member 38 serve to effectively prevent splashing of liquid material from the central portion of the atomizer out through said opening. The shield member 38 is preferably disposed with its lower face spaced only slightly above the top of the inner ring 7 of the atomizer, which insures that substantially all of the material is confined and caused to pass outwardly through the slots or apertures 6 in said inner ring. The collar 36 may be mounted on an outwardly extending flange 39 on supporting fitting 34. The liquid material feed means is shown as further comprising a feed pipe 41 extending through the main supporting plate 27, down alongside the pipe 29, and through flange 39 into the interior of collar 36.

Suitable means are also preferably provided for supplying oil or other lubricant to the upper and lower bearings 17 and 18. Such means are shown as comprising a suitable oil receptacle 42 from which oil is fed by gravity through feed pipe 43 to an oil passage 44 in collar 22, which delivers oil directly to the upper bearing. The pipe 43 is preferably provided with a flexible section 43', such as a copper tube connection, so as to permit free movement of the rotating assembly on the resilient bearing supports 24, 25 and 33, independently of the oil supply system. A portion of such oil passes on down around the spindle and inside pipe 29, and the fitting 34 is shown as provided with a flange 45 for causing such oil to be directed onto the lower bearing 18. It will be understood that any suitable means may be provided for indicating and controlling the rate of feed of oil from receptacle 42 from feed line 43.

It will be understood that the above described atomizer may be utilized in connection with various types of apparatus in which it is desired to introduce liquid material in atomized condition, but for purposes of illustration the atomizer is shown as mounted in a spray drying or desiccating apparatus. The top wall of the drying chamber is partially shown at 51 in Figs. 3 and 4 and the side wall thereof is partially shown at 52 in Fig. 4.

The top wall 51 is provided with a central opening 53, and the supporting plate 27 of the atomizer is mounted around said opening as by means of bolts 54 provided with spacing washers 55 which serve to space plate 27 from the top wall 51. The atomizer extends down within the drying chamber to any suitable position, and heated air, hot combustion gases or other suitable drying medium is delivered to position around the atomizing device. Such drying medium may be delivered through a branched conduit 56 and through an opening 57 in the top wall into an annular distribution chamber 58 and thence between helically inclined radial vanes 59 into the upper portion of the drying chamber around the periphery of the outer ring 3 of the atomizing device. A conduit or pipe 61 preferably extends centrally within the annular distributing chamber 58 and around the atomizer shaft housing pipe 29, said pipe 61 communicating at its upper end with the opening 53 in the top wall and having its lower end spaced somewhat from the periphery of flange 39 as at 62, so as to permit inward flow of cool air around the atomizer shaft housing pipe and material feed collar 36.

In the operation of the above described apparatus, the atomizer is set in rotation at suitable speed, by operation of the driving means such as electric motor 65, and the liquid material to be atomized is delivered through pipe 41 and through collar 36 onto the central material-receiving portion 2 of the atomizing device. The centrifugal force imparted to such material by rapid rotation of the atomizing device causes such material to be thrown or forced outwardly, but the inclination of the sloping portion 5 is sufficient to partially confine the material and cause a layer or bed of liquid material to be retained in the central portion of the atomizing device, such material continually overflowing from such layer or bed and being caused to move outwardly through the apertures or slots 6 of the inner ring 7. The liquid is thus divided into a multiplicity of small streams. As these streams reach the outer edges of the respective slots or apertures they are thrown outwardly therefrom at high velocity and are thus further subdivided into small droplets or particles. These droplets enter the slots or apertures of the outer ring and are picked up by the vanes of this outer ring. These droplets or particles are again caused by centrifugal action to move outwardly through the slots 14 and are again thrown or projected by centrifugal force from the outer edges of the latter slots and are thus further subdivided or atomized to a state of very fine division. It is not desired to restrict the invention to any particular theory of operation of this apparatus, but the performance thereof in actual operation has demonstrated its ability to effectively atomize liquid material delivered therethrough at high capacity and to uniformly atomize this material in the form of a very finely divided mist or spray. It is believed that the atomizing effect is due not only to progressive subdivision of the liquid material in passing through the plurality of slotted or apertured rings, but also to the frictional effect of the air or other medium surrounding the atomizer which tends to sheer off the liquid material as it reaches the outer edge of the slots or apertures in the outer ring and thus causes such material to be thrown outwardly in the form of very minute droplets.

In the above described apparatus there is an opportunity for air admitted through pipe 61 and annular space 62 to be drawn into the atomizer, between upper wall 12 of the atomizer and flange 38 of collar 36, and to be forced outwardly, by centrifugal force, through the apertures of the outer ring, and it is believed that this outward passage of the air through said apertures and discharge thereof from the periphery of the device together with the liquid material also assists in the atomization or breaking up of the liquid material.

The atomizer is preferably rotated at high velocity, for example 5,000 to 15,000 revolutions per minute, or higher, and it has been found that, at such speeds of rotation, if the spindle bearings are rigidly mounted there is a tendency to development of periodic vibrations or oscillations of the rotary assembly. The mounting of the bearings on supports comprising resilient aperiodic material, as at 24, 25 and 33 prevents the development of such periodic vibrations, and causes the atomizer to run smoothly even at high

velocity, which not only reduces wear on the bearings and the operating mechanism, but also improves the efficiency and uniformity of operation.

When the atomizer is used in connection with spray drying apparatus of the above described type, the atomized liquid material projected from the periphery of the atomizer is subjected to heating and evaporation by the gaseous drying medium introduced at suitable temperature between the inclined vanes 59. The relatively low temperature air drawn in between pipes 29 and 61 and through the annular space 62 serves both to cool the atomizer shaft and bearings and also to cool the atomizer 36 and the rotary atomizing device. The continual inflow of this relatively cool air through space 62 also serves to maintain a positive movement of gas from this point and from the region adjacent and above the atomizing device outwardly into the drying chamber and thus eliminate the tendency for creation of reduced pressure at this point and formation of eddy currents which might tend to carry particles of dried or partially dried material into contact with these parts, thereby preventing deposition or building up of dried or partially dried material therefrom. This air also acts, as above described, to assist in the atomization of the liquid material.

In the apparatus shown in Figs. 5 and 6, the rotary atomizing device 1' is mounted at the upper end of driving shaft or spindle 16', and driving pulley 19' is mounted on the lower end of said shaft or spindle. The rotary atomizing device is shown in this case as comprising a main portion 65 threadedly mounted on shaft 16' as at 66 and having an outwardly extending portion 67 serving as a lower confining wall for the liquid material. The member 65 is also provided with an outer wall or ring 68 extending upwardly at the periphery of the wall portion 67, and with a transverse upper wall portion 69 formed as a ring projecting inwardly from the top of the outer wall 68. The outer wall or ring 68 is preferably shaped similarly to the ring 13 above described and is provided with a multiplicity of closed spaced narrow slots or apertures 71 similar to the slots 14.

A central member 73 is threadedly mounted in a central recess 74 in member 65 and is provided with a material-receiving chamber 75 whose side wall 76 is provided with a plurality of suitably spaced and shaped openings or perforations 77. The perforations 77 are shown as arranged in two horizontal rows one above the other and are shown as staggered in the respective rows. The member 73 is also preferably provided with a top wall 78 substantially inclosing chamber 75 but provided with a central opening 79, through which extends feed pipe 81 for delivering liquid material into said chamber. The flanged lower end of pipe 81 preferably extends slightly below the top wall 78 and is preferably of only slightly less diameter than the opening 79 so that it, together with top wall 78 serves to confine the liquid material in chamber 75 and prevent splashing of material therefrom and cause all of the material to be delivered from said chamber through the perforations 77.

An intermediate member 82 is interposed between the upper portion of central member 73 and the upper confining wall 69, the member 82 also serving as an upper confining wall and having an upwardly and outwardly flared inner face 83 engaging a similarly inclined outer face 84 on member 73, whereby screwing of member 73 into recess 74 serves to hold the intermediate member 82 in position. Said intermediate member is also provided with a depending ring 85 concentrically disposed between wall 76 and the outer ring 71 and provided with a multiplicity of closely spaced vertically extending narrow radial slots 86. The lower edge of ring 85 bears against the lower wall 67 and inside shoulder 87 thereon, so that said lower wall and the upper walls 69 and 82 serve as before to confine the liquid material and cause the same to be thrown outwardly by centrifugal force wholly through the apertured rings 85 and 68.

The driving spindle 16' is provided as before with upper and lower ball bearings 88 and 89. The upper bearing 88 is mounted on the upper end of a supporting tube 91 while the lower bearing is mounted in a supporting housing 92, and the supporting members 91 and 92 are both secured to a member 93 whose outer edge portion 94 is clamped between cushioning members 95 formed as before of rubber or other resilient aperiodic material. Said cushioning members are retained by clamping collar 96 mounted on ring 97 which is in turn secured to a main supporting member 98.

An outer pipe 99 is shown as connected to supporting member 98 and extending upwardly around the supporting tube 91 for conducting relatively cool air or other gas around the driving spindle and to a position directly beneath the rotary atomizing device 1', said air or other gas being admitted to pipe 99 through the small space 101 provided between members 97 and 98 by means of spacing lugs 102 on member 97. If desired, relatively cool air or other gas may also be delivered, through an upper pipe 103, around the feed pipe 81 and to a position directly above the rotary atomizing device.

An oil supply pipe 104 is shown as extending through the member 93 and up through the annular space between tube 91 and pipe 99 and communicating with an oil passage 105 leading to the upper bearing 88. The lower bearing 89 may be separately lubricated if desired, but in the construction shown such lower bearing is lubricated by means of oil running down by gravity from the upper bearing, inside the supporting tube 91. The oil supply pipe 104 may be connected to any suitable oil supply means, not shown, and the connection thereof preferably includes a flexible connecting member such as a section of copper tube or the like indicated at 106 so as to permit free movement of the spindle supporting assembly on the cushioning means 95 above mentioned.

The operation of this form of the invention is substantially the same as above described, with the exception that the liquid material delivered through pipe 81 collects in chamber 75 and must first pass through the perforations 77, whence it is thrown outwardly by centrifugal force and caused to pass successively through the apertured rings 85 and 68. The material is thus progressively subdivided in passing through the perforations 77, apertures 86 and apertures 71, and is projected in atomized condition from the periphery of the outer ring 68. The manner in which this atomization is effected is substantially the same as in the form of the invention first described.

In both of the above-described forms of atomizer the liquid material delivered to the central material-receiving space is partially con-

fined or restrained against outward movement due to centrifugal force, by the upwardly inclined shoulder 5 in the first form and by the wall 76 in the second form, and is thus caused to collect therein to a certain extent and form a layer or bed of material of sufficient thickness to prevent objectionable de-watering, such as would occur if a material were caused to spread outwardly in an extremely thin film. From this space the material is discharged outwardly, over the upper edge of shoulder 5 or through perforations 77, at a position substantially opposite the middle portions of the slots in the successive annular rings. As the centrifugal force exerted on the outwardly moving material at the high speed of rotation of the atomizer is many times greater than the force of gravity, the material moves outwardly substantially in a horizontal zone at the level of the discharge thereof from the central material-receiving space, and in order that the outwardly moving material may be caused to strike squarely against the successive slotted rings and pass therethrough in as uniform a manner as possible throughout the entire height of the slots, said slots are preferably disposed, as shown, substantially symmetrically with respect to this horizontal zone in which the material is discharged.

In Fig. 7 there is shown a half section of a form of rotary atomizing device which is substantially the same as that shown in Figs. 5 and 6, with the exception that two intermediate members 82*a* and 82*b* are provided between the upper portion of the inner member 73 and the upper wall 69 of the main member 65. Said intermediate members are provided with upwardly and outwardly flared inner faces 83*a* and 83*b* engaged by similarly flared faces 84*a* and 84*b* on the central member 73 and member 82*a* respectively, so that the central member 73 serves as before to retain both of said intermediate members in position. The members 82*a* and 82*b* are provided with depending apertured rings 85*a* and 85*b* respectively, while the main member 65 is provided as before with an outer apertured ring 86. The operation of this form of atomizing device is substantially the same as above described, with the exception that the additional apertured ring provides an additional stage of atomization for the liquid material.

We claim:—

1. A centrifugal atomizer comprising a rotary atomizing device provided with a central material-receiving space and with a plurality of spaced concentric rings surrounding said space, each of said rings having a plurality of vertically elongated slots extending substantially radially therethrough and of relatively small circumferential width, the slots of all of said rings having their middle portions disposed substantially in a common horizontal plane, said atomizer having top and bottom walls serving to confine material delivered to said material-receiving space and positively direct all of such material outwardly, under the action of centrifugal force, through the slots in the several rings, said top wall extending from the innermost to the outermost of said rings but having an opening for introduction of material to said material-receiving space within said innermost ring, and said bottom wall extending from the center of the atomizer to the outermost ring.

2. A centrifugal atomizer comprising a rotary atomizing device having a central portion defining a material-receiving space and adapted to partially confine liquid material delivered thereto during rotation of such device and cause such material to be discharged outwardly therefrom by centrifugal force at a level somewhat above the bottom of said space, said atomizing device being also provided with a plurality of spaced concentric rings surrounding said space and each provided with a plurality of closely spaced vertically elongated slots extending radially therethrough and of relatively small circumferential width, the slots of the innermost of said rings being positioned to receive material discharged from said material-receiving space, and the slots of the successive rings being disposed substantially at the same level as those of the preceding ring, means for delivering liquid material to said material-receiving space, and means for rotating said atomizing device.

3. In a centrifugal atomizer, a rotary member mounted for rotation about a vertical axis and provided with a central material-receiving space and with a plurality of spaced concentric rings surrounding said material-receiving space, each of said rings having a plurality of closely spaced vertically elongated straight slots extending substantially radially therethrough and of small circumferential width, the side walls of each slot comprising extended plane surfaces parallel to one another and providing sharp edges for discharge of liquid material at the peripheral surface of each of said rings, the slots of the innermost of said rings being positioned to receive material from said material-receiving space and the slots of all of the rings being disposed substantially symmetrically with respect to a common horizontal plane.

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