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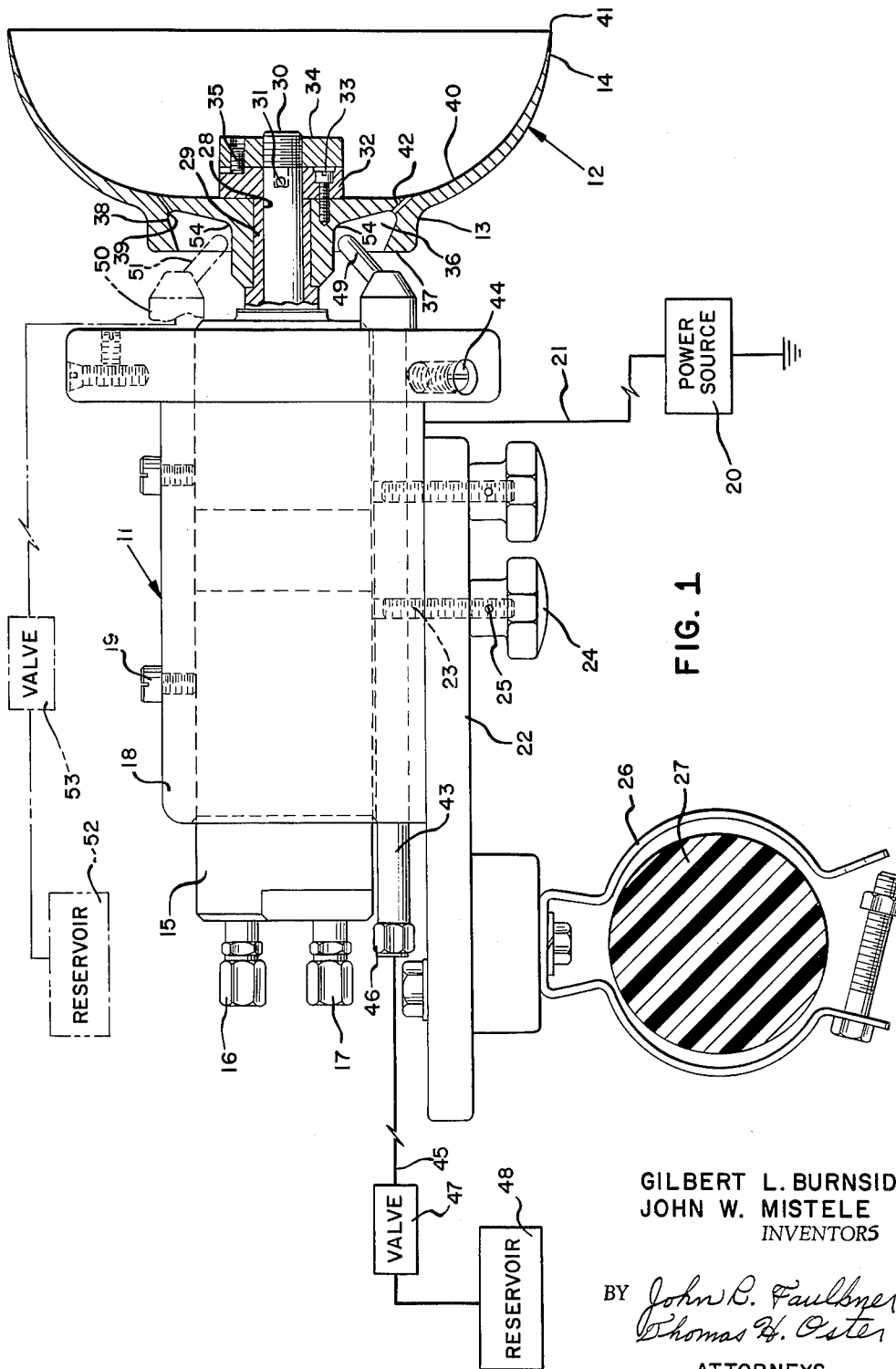
G. L. BURNSIDE ETAL

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ATOMIZING APPARATUS HAVING A LIQUID ACCUMULATION CAVITY

Filed June 11, 1964

2 Sheets-Sheet 1



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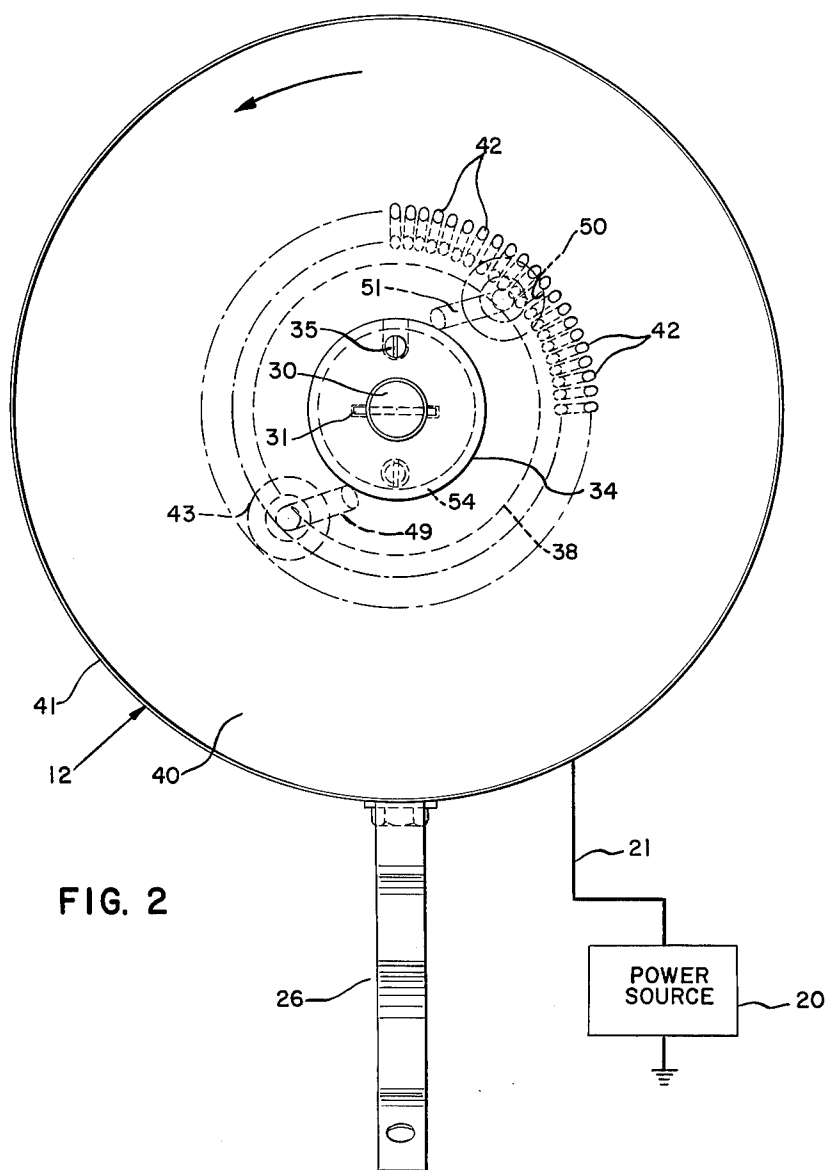
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ATOMIZING APPARATUS HAVING A LIQUID
ACCUMULATION CAVITY

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9 Claims. (Cl. 239—223)

This application is a continuation-in-part of copending application Serial No. 116,814, filed on June 13, 1961, and now abandoned.

This invention relates to a method and apparatus for comminuting liquid coating materials and for the electrostatic transportation of the comminuted particles for deposition on an article. It is particularly directed to the repetitious electrostatic painting of similar articles in which the paint is first atomized by centrifugal force and then, after receiving an electrical charge, transported to and deposited on the surface of an article to be painted.

The painting art has resorted to the use of rotating atomizing heads such as metallic cups or discs for the production of a charged mist or spray of paint. These metallic atomizing heads are rotated about their own axis, and paint is fed to the central portion of the head from whence it flows to the periphery of the head under the influence of centrifugal force. At the periphery, the paint may also be atomized electrostatically and, therefore, departs from the atomizing head in a direction which amounts to the vector sum of the centrifugal and electrostatic forces.

Present practices of delivering liquid coating materials such as paint to the center portion of an atomizing head require a conduit means extending through the inner shaft which supports the head as illustrated in U.S. Patent 2,759,763. Another type of atomizing head in the prior art is center fed through a nonrotating nozzle located in the center of a cup which is connected to a paint supply tube as depicted in U.S. Patent 2,922,584.

The method for center feeding paints to the atomizing surfaces or edges of atomizing devices used for electrostatic painting in the present state of the art has been found to be unsatisfactory as it is difficult to obtain uniform wetting of the atomizing surfaces or edge, especially at high speeds of rotation. Incomplete or uneven wetting results in "spitting" or nonuniform atomization of the paint. Also, liquid coating materials and cleaning solvents have a tendency to penetrate the bearings supporting the rotating atomizing head through the inherent clearances between rotating and nonrotating members. Seepage of coating materials such as red oxide primer, which is highly abrasive, results in extensive wear of bearing surfaces. Further, low viscosity solvents used for flushing liquid coating materials from the atomizing devices penetrate the bearings and seals due to the vibrations and centrifugal forces present in the operation of these atomizing devices. Seals such as O rings and gaskets are chemically attacked by the solvents that also dissolve and destroy the effectiveness of lubricants applied to moving parts.

The method and apparatus of this invention overcome the deficiency of the center feed atomizing devices by feeding the liquid coating material first to a cavity machined into the hub portion of the atomizing head where complete distribution of the coating material is effected. Then the coating material flows uniformly from the cavity through a plurality of passages to the feeding zone of the atomizing head from whence it continues to be distributed to the periphery of the head so as to wet the entire edge under the influence of the centrifugal and inertial forces. Actually, the cavity acts as a storage reservoir for the liquid coating material before it is

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forced out through the passages at a uniform rate and pressure to the feeding zone.

An object of this invention is to provide an atomizing device to be used for the commercial application of electrostatic paint coatings involving centrifugal atomization.

A further object of this invention is to provide an atomizing device in which the liquid coating material is fed from a cavity located in one surface of the atomizing head through passages to the periphery of the head where it is atomized.

A still further object is to provide a spraying device for electrostatic coating which is relatively free from breakdown and requires little or no maintenance.

Other objects and advantages of this apparatus will become more apparent as this description proceeds, particularly when considered in conjunction with the drawings in which:

FIGURE 1 is a side elevational view, partially in section, of the spraying apparatus of this invention; and,

FIGURE 2 is a front view of the atomizing head of the spraying apparatus of this invention.

In FIGURE 1 can be seen a spraying device 11 comprising an atomizing head 12 which may be in the form of a bell, cup, disc, or plate. The atomizing head 12, in this instance, has a tubular hub portion 13 on one end which is integrally formed with a cup-shaped body portion 14 on the other end. The cup-shaped body portion 14 is concentric and coaxial with the tubular hub portion 13.

The atomizing head 12 is rotated by a driving means, such as an air motor 15, which is supplied by compressed air through coupling 16. Spent air is exhausted from the air motor 15 through a second coupling 17. The air motor 15 is contained in a housing 18 by screws 19. The housing 18, the air motor 15, and its associated atomizing head 12, which are preferably constructed out of metal, are charged to a high potential by a voltage source 20 by means of conduit 21.

The housing 18 is attached to a support plate 22 by studs 23. Each stud 23 is locked to a handle 24 by a dowel pin 25. Manual rotation of the handle 24 adjusts the housing 18 and its contained spraying device 11 to assure that the atomizing head 12 is properly aligned with the surfaces of an article (not shown) to be coated. The support plate 22 is attached to a clamp 26 which permits the mounting of the spraying device 11 on a post 27. The post 27, which is usually manufactured from a dielectric material, may be installed in a spray booth or other enclosure.

The atomizing head 12 is provided with a bore 28 which is concentric with the axis of rotation of the atomizing head 12 and the air motor 15. A bushing 29 in the bore 28 receives shaft 30 of the air motor 15. The atomizing head 12 is driven by the shaft 30 through a pin 31 held in a drive plate 32. The drive plate 32 is secured to the atomizing head 12 by screws 33. To retain the atomizing head 12 on the shaft 30, a stop plate 34 is screwed onto the threaded end portion of the shaft 30. A set screw 35 locks the stop plate 34 to the drive plate 32 in order to retain the rotating atomizing head 12 on the shaft 30 during the operation of the spraying device 11.

The hub portion 13 of the atomizing head 12 has a concentric annular cavity 36 machined into its back surface 37. The internal peripheral and bottom surfaces of the cavity 36 are sloped to form a recessed continuous outer corner 38 at their junction. A continuous radius 39 is formed in the corner 38. The cup-shaped body portion 14 of the atomizing head 12 has an internal, concave-shaped feeding zone 40 terminating in a circular atomizing edge 41.

A plurality of passages 42 place the corner 38 of the cavity 36 in communication with the feeding zone 40 of the body portion 14 of the atomizing head 12. The passages 42 are sloped outwardly from the recessed outer corner 38 of the cavity 36. The cavity 36, as it is annular shaped, also has a continuous recessed inner corner 54.

An axially mounted liquid coating material delivery tube 43 is held in the housing 18 by a screw 44. The delivery tube 43 is supplied with a liquid coating material through a hose 45 connected to a coupling 46. A valve 47 installed in the hose 45 regulates the flow of the liquid coating material that may be fed from a reservoir 48 by a pump or by any other suitable means. A nozzle 49, which is attached to the front end of the delivery tube 43, feeds the liquid coating material to the inner corner 54 of the cavity 36 of the atomizing head 12.

As seen in FIGURE 2, the nozzle 49 is angled in order to feed the liquid coating material to the corner 54 of the cavity 36 in a counterclockwise direction. This is the same angular direction in which the atomizing head 12 is rotated (as designated by arrow). The passages 42, as best seen in FIGURE 2, are equally spaced to permit the uniform distribution of the liquid coating material from the feed tube 43 to the feeding zone 40 of the atomizing head 12. Experimentally, it has been determined that, for liquid coating materials such as automotive paints, the angular spacing of the passages 42 should not exceed 6°.

In the utilization of this apparatus for priming of sheet metal parts, eighty tubular passages, each of .062 inch diameter and placed 4½° apart, were found to be satisfactory.

In the application of the method and apparatus of this invention, liquid coating materials are fed to the cavity 36 while the atomizing head 12 is being rotated by the air motor 15. It is essential that the atomizing head 12 rotates rapidly to enable the paint to be atomized by centrifugal action. Rotating speeds of 1,200 to 5,000 r.p.m. have been found very satisfactory for a six-inch atomizing head 12 with a conventional liquid prime coating material. The rotational speed may be varied to accommodate such variables as paint viscosity, paint composition, and temperature. The high potential impressed on the atomizing head 12 and the steep electrostatic gradient immediately adjacent to the edge 41 of the atomizing head 12 charge the atomized particles of paint and permit their acceleration, transportation, and deposition by the electrostatic field existing between the atomizing head 12 and the article to be painted.

The liquid coating material flows from the reservoir 48 to fill the cavity 36 of the atomizing device 11 when valve 47 is opened. Then the coating material is forced outwardly from the cavity 36 through the passages 42 at a uniform rate and pressure to the feeding zone 40 by virtue of the centrifugal and inertial forces acting on it. The liquid coating material continues to flow to the peripheral edge 41, wetting the entire feeding zone 40 of the atomizing head 12 during its rotation. No liquids come into contact with the shaft 30 or the bushing 29 to cause seepage between the rotating and stationary members of the atomizing device 11.

It has been found that the provision for a large number of tubular passages 42 results in a more uniform distribution of liquid coating material on the entire surface of the feeding zone. This avoids what is commonly referred to as a "striping effect" or incomplete wetting of the surface of the cup. To assure that the flow of liquid coating material is effected through all passages at one time and at a uniform rate and pressure, it is essential that the liquid coating material has to be accumulated within the cavity to a certain depth prior to being distributed therefrom to the feeding zone. This is achieved by feeding the coating material to the inner corner 54 and by sizing the tubular passages 42 so that they initially impede the flow, thereby causing a backup of liquid coat-

ing material in the cavity 36 to establish a reservoir therein. The steady accumulation of liquid coating material in the cavity 36 will provide a sufficient pressure head due to the centrifugal and inertial forces acting thereon to force the liquid coating material through the passages 42 at a uniform pressure and rate to the feeding zone 40 to establish a flow balance between the nozzle 49 and the peripheral edge 41 at the speed of rotation of the atomizing head 12. The angling of the nozzle 49 further assures uniform distribution of the liquid coating material in the cavity 36, especially at high speeds of rotation.

The design of the atomizing device 11 of this invention permits the utilization of more than one delivery tube 43 to feed paint to the liquid receiving cavity 36 of the atomizing head 12. As can be seen in FIGURE 1, a second delivery tube 50 with its nozzle 51 (as shown in phantom lines), may be mounted around the periphery of the atomizing head 12. This second feed tube 50 may be connected to a second reservoir 52 and regulated by a valve 53 installed between the reservoir 52 and the atomizing device 11. Delivery tube 50 and other delivery tubes, if desired, may be installed in housing 18 similar to delivery tube 43.

The use of plurality of delivery tubes 43 and 50 permits the mixing of liquid coating materials of different colors or compositions by opening valves 47 and 53 simultaneously. Also, it is possible to switch from one color to a second color without requiring the flushing out of the various delivery tubes 43 and 50. An alternate arrangement can be effected to permit the instantaneous cleaning of the atomizing head 12 by connecting delivery tube 50 to the reservoir 52 filled with a solvent. Then, by opening valve 53, the atomizing head 12 is cleaned while paint may be retained in delivery tube 43, ready for painting, by keeping valve 47 closed.

We claim:

1. An apparatus for atomizing liquids comprising a rotatable atomizing head, driving means for rotatably supporting said atomizing head, said atomizing head comprising a cup-shaped body portion on one end integrally formed with a hub portion at the other end, said cup-shaped body portion having a concave feeding zone terminating in a continuous peripheral edge, an annular recessed liquid receiving cavity located in said hub portion, said liquid receiving cavity having a continuous recessed inner corner and a continuous recessed outer corner connected by a bottom surface, at least one conduit means extending into said cavity for introducing liquids to be atomized at the recessed inner corner of said liquid receiving cavity, and a plurality of passages leading from said recessed outer corner of said cavity to said feeding zone, each of said passages being of a size that causes said liquids to be accumulated in said cavity before being forced through said passages at a uniform pressure and rate to said entire feeding zone under the influence of centrifugal and inertial forces.

2. An apparatus for atomizing liquids comprising a rotatable atomizing head, means for rotatably supporting and driving said atomizing head in one direction, said atomizing head comprising a cup-shaped body portion on one end integrally formed with a hub portion at the other end, said cup-shaped body portion having a concave feeding zone terminating in a continuous peripheral edge, and an annular recessed receiving cavity located in said hub portion, said annular recessed receiving cavity having a continuous recessed inner corner and a continuous recessed outer corner connected by a bottom surface sloped outwardly and toward said one end of said atomizing head, a nozzle extending into said cavity for introducing liquids to be atomized to said atomizing head at the continuous recessed inner corner, said nozzle being angled in the same direction in which said atomizing head is rotated, and a plurality of tubular passages leading from said recessed outer corner to said feeding zone, each of said passages being of a size that causes said liquids to be ac-

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cumulated in said cavity before being forced through said passages at a uniform pressure and rate to said entire feeding zone under the influence of centrifugal and inertial forces.

3. An apparatus for atomizing liquids comprising a rotatable atomizing head, driving means for rotatably supporting said atomizing head, said atomizing head comprising a cup-shaped body portion on one end integrally formed with a hub portion on the other end, said cup-shaped body portion having a concave feeding zone terminating in a continuous peripheral edge, an annular recessed liquid receiving cavity located in said hub portion, said cavity having a continuous recessed inner corner and a continuous recessed outer corner connected by a bottom surface, at least one conduit means extending into said cavity for introducing liquids to be atomized at the recessed inner corner of said liquid receiving cavity, and a plurality of tubular passages leading from said recessed outer corner of said cavity to said feeding zone, each of said passages being of a size that causes said liquids to be accumulated in said cavity before being forced through said passages at a uniform pressure and rate to said entire feeding zone under the influence of centrifugal and inertial forces.

4. An apparatus for atomizing liquids comprising a rotatable atomizing head, driving means for rotatably supporting said atomizing head, an annular recessed liquid receiving cavity located on one side of said rotatable atomizing head, a liquid feeding zone located on the other side of said rotatable atomizing head, said liquid receiving cavity having a recessed inner corner and a recessed outer corner concentrically disposed with respect to said atomizing head, a plurality of nozzles angularly spaced from each other for introducing a plurality of liquids to be atomized at the recessed inner corner of said liquid receiving cavity, and means for selectively introducing liquids to be atomized into the liquid receiving cavity from said nozzles, and a plurality of passages leading from said recessed outer corner to said liquid feeding zone, each of said passages being of a size that causes said liquids to be accumulated in said cavity before being forced through said passages at a uniform pressure and rate to said entire feeding zone under the influence of centrifugal and inertial forces.

5. An apparatus for atomizing liquids comprising a rotatable atomizing head, driving means for rotatably supporting and driving said atomizing head in one direction, said atomizing head comprising a cup-shaped body portion on one end integrally formed with a hub portion on the other end lying on the same axis of rotation, said cup-shaped body portion having a concave feeding zone terminating in a continuous peripheral edge, an annular recessed liquid receiving cavity located in said hub portion, said annular liquid receiving cavity having a continuous recessed inner corner and a continuous recessed outer corner concentrically disposed with respect to the axis of rotation, said recessed inner corner and said recessed outer corner being connected by a bottom surface, the concave feeding zone of said cup-shaped body portion axially spaced outwardly from the bottom surface of said liquid receiving cavity, at least one conduit means extending into said cavity for introducing liquids to be atomized at the recessed inner corner of said liquid receiving cavity, and a plurality of diagonally extending tubular passages leading from the recessed outer corner of said liquid receiving cavity to said concave feeding zone, each of said passages being of a size that causes said liquids to be accumulated in said cavity before being forced through said passages at a uniform pressure and rate to said entire feeding zone under the influence of centrifugal and inertial forces.

6. The apparatus as described in claim 5 and which is further characterized in that said tubular passages are uniformly angularly spaced not more than 6° apart.

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7. The apparatus as described in claim 5 and which is further characterized in that said bottom surface of said cavity is sloped outwardly and forwardly towards the peripheral edge of said cup-shaped body portion of the atomizing head.

8. The apparatus as described in claim 5 and which is further characterized in that said nozzle is angled in the same direction in which said atomizing head is rotated.

9. A self-cleaning apparatus for atomizing liquid coating materials comprising a rotatable atomizing head, a shaft, means for rotating said shaft, a cup-shaped body portion on one end integrally formed with the hub portion on the other end lying on the same axis of rotation, said cup-shaped body portion having a concave feeding zone terminating in a continuous peripheral edge, an annular liquid receiving cavity in said hub portion defining a hub lying on the axis of rotation, said liquid receiving cavity being axially spaced from and positioned from the end opposite from said concave feeding zone, said liquid receiving cavity having a continuous recessed inner corner and a continuous recessed outer corner, an end portion of said shaft being non-rotatably received in said hub, at least one conduit means extending into said cavity for introducing liquids to be atomized at the recessed inner corner of said cavity, said atomizing head being rotated at a speed sufficient to cause said liquid coating material to flow from said recessed inner corner to said recessed outer corner and through said tubular passages to the peripheral edge of said atomizing head and to be atomized from said peripheral edge under the influence of centrifugal action, a second conduit means for introducing a liquid cleaning agent at the recessed inner corner of said liquid receiving cavity angularly spaced from said first conduit means, said atomizing head being rotated at a speed sufficient to cause said liquid cleaning agent to flow from said recessed inner corner to said recessed outer corner and from there through said tubular passages to said peripheral edge to clean the surface of said atomizing head previously in contact with said liquid coating material, and means for selectively introducing liquid cleaning agent and liquid coating material into said liquid receiving cavity through said first and said second conduit means, respectively, and a plurality of tubular passages placing said outer corner in communication with said concave feeding zone, each of said passages being of a size that causes said liquids to be accumulated in said cavity before being forced through said passages at a uniform pressure and rate to said entire feeding zone under the influence of centrifugal and inertial forces.

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