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METHOD AND APPARATUS FOR ATOMIZING LIQUIDS

Original Filed June 11, 1964 2 Sheets-Sheet 1

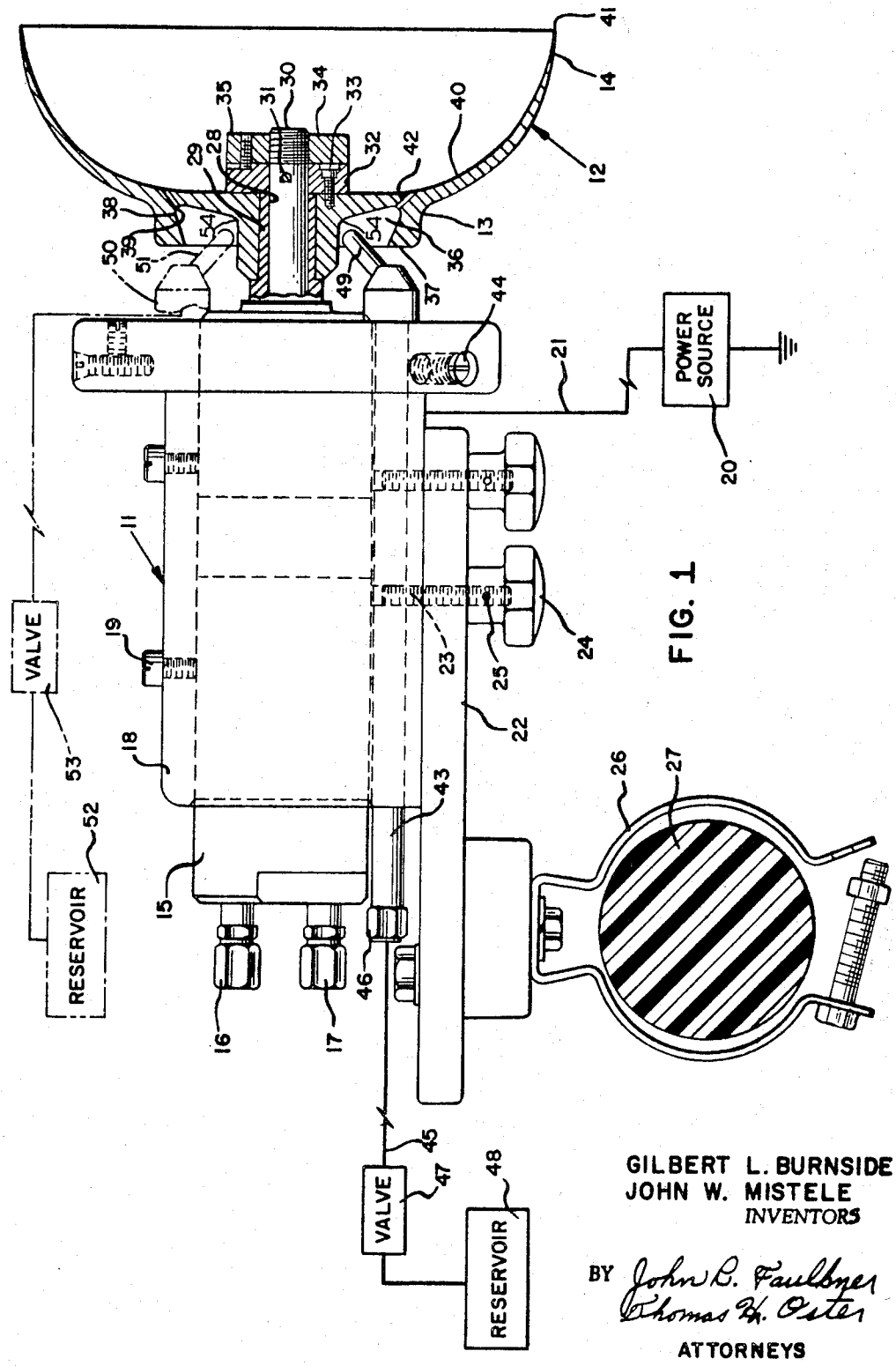


FIG. 1

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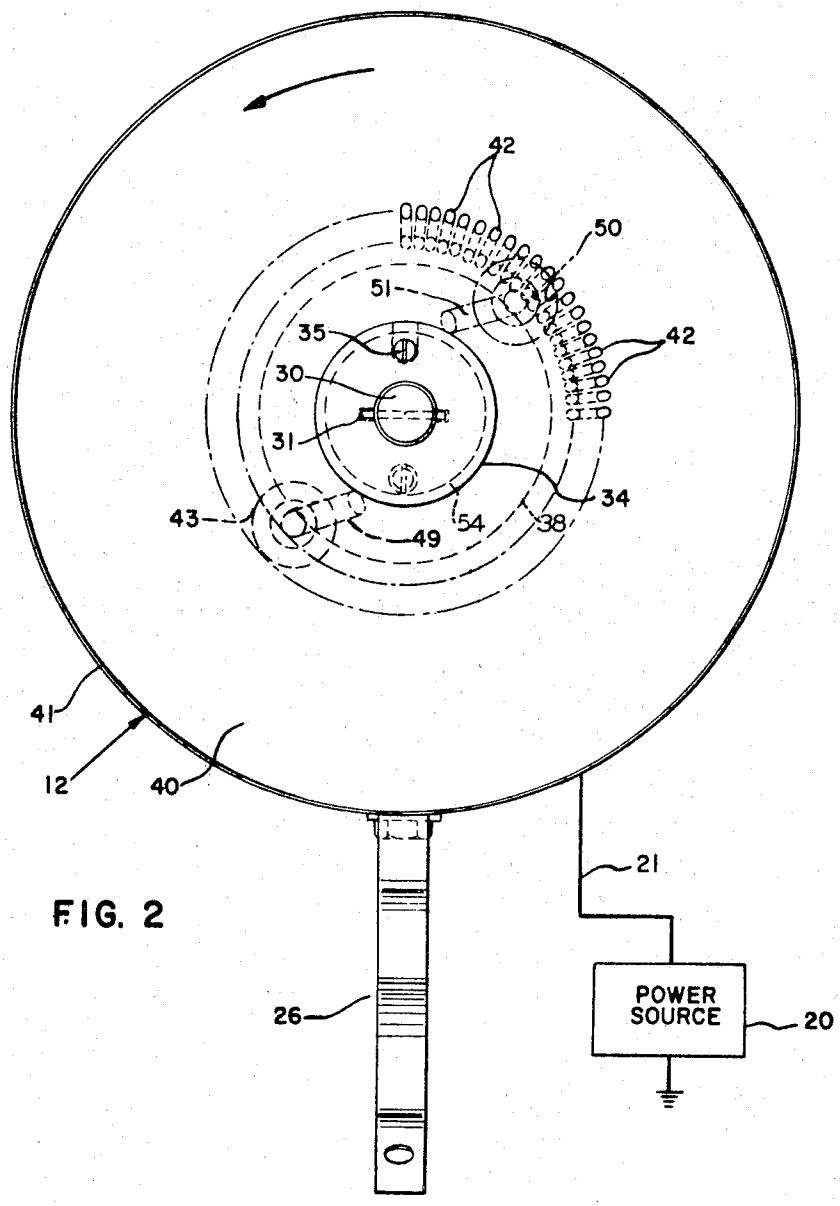


FIG. 2

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METHOD AND APPARATUS FOR ATOMIZING LIQUIDS

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Original application June 11, 1964, Ser. No. 375,425, now Patent No. 3,224,680, dated Dec. 21, 1965. Divided and this application June 4, 1965, Ser. No. 461,259

11 Claims. (Cl. 239—7)

This application is a division of our application Serial No. 375,425, filed June 11, 1964, now Patent No. 3,224,680.

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 is 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 non-rotating 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 attached 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 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 "stripping 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 coating 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 a 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. A method for atomizing at least one liquid with a rotatable atomizing head, said atomizing head having a recessed liquid receiving cavity located thereon and a feeding zone terminating in a peripheral edge which defines unrestricted circular exit means from said feeding zone and is located on the side of the atomizing head remote from but in communication with said liquid receiving cavity, said method comprising the steps of rotating said atomizing head, feeding liquid to said cavity, and restricting the flow of liquid from said cavity to said feeding zone to cause the accumulation of liquid in said cavity until a flow balance is established therebetween resulting in a uniform continuous flow of liquid to said feeding zone from said cavity at a given rate of liquid feed and speed of rotation for said atomizing head.

2. A method for atomizing liquid with a rotatable atomizing head, said atomizing head having a recessed liquid receiving cavity located thereon and a feeding zone terminating in a peripheral edge which defines unrestricted circular exit means from said feeding zone and is located on the side of the atomizing head remote from but in communication with said liquid receiving cavity, said method comprising the steps of rotating said atomizing head, feeding liquid to said cavity, and restricting the flow of liquid from said cavity to said feeding zone to cause the accumulation of liquid in said cavity to a certain depth until the head of said liquid accumulated therein will result in the distribution of liquid therefrom to said feeding zone at a uniform pressure and rate and from said feeding zone to said peripheral edge to place the flow in balance under the influence of centrifugal and inertial forces.

3. A method for atomizing liquids with a rotatable atomizing head, said atomizing head having a recessed liquid receiving cavity located thereon, a feeding zone terminating in a peripheral edge which defines unrestricted circular exit means from said feeding zone and is located on the side of the atomizing head remote from said liquid receiving cavity, and a plurality of passages placing the

feeding zone in communication with said liquid receiving cavity, said method comprising the steps of rotating said atomizing head, introducing liquids to said cavity, sizing said passages so as to impede the flow of liquids from said cavity to said feeding zone through said passages to cause the accumulation of liquids in said cavity until the head of said accumulated liquids therein brings about the distribution of liquids through said passages at a uniform pressure and rate to said feeding zone and from said feeding zone to said peripheral edge to place the flow in balance under the influence of centrifugal and inertial forces for an established rate of liquid feed and speed of rotation of said atomizing head.

4. A method for atomizing liquids with a rotatable atomizing head, said atomizing head having a recessed liquid receiving cavity located thereon, a feeding zone terminating in a peripheral edge which defines unrestricted circular exit means from said feeding zone and is located on the side of the atomizing head remote from said liquid receiving cavity, and a plurality of passages placing said feeding zone in communication with said liquid receiving cavity, said method comprising the steps of rotating said atomizing head, introducing liquids to said cavity at a point remote from said passages and restricting the flow of liquids by sizing of said passages so as to cause the accumulation of liquids in said cavity to a substantially uniform depth until the head of said accumulated liquids therein under the influence of centrifugal and inertial forces acting thereon will effect a flow of a uniform pressure and rate through said passages to said feeding zone to place the flow of liquids from said cavity to said peripheral edge in balance.

5. A method for atomizing a plurality of liquid coating materials with a rotatable atomizing head comprising the steps of rotating said atomizing head, actuating a means for sequentially introducing a first liquid coating material through a first conduit means and a second liquid coating material through a second conduit means to an annular recessed liquid receiving cavity located on one surface of said atomizing head, said atomizing head having a plurality of tubular passages to place a second surface remote from said one surface in communication with said liquid receiving cavity, said second surface terminating in a continuous peripheral edge which defines unrestricted circular exit means from said atomizing head for liquid introduced to said second surface from said liquid receiving cavity, and restricting the flow of each of said liquid coating materials by sizing said tubular passages so as to cause the accumulation of liquid coating material in said cavity until the head of said accumulated liquid coating material therein under the influence of centrifugal and inertial forces acting thereon will effect a flow at a uniform pressure and rate through said tubular passages to said second surface to place the flow of liquid coating material from said receiving cavity to said continuous peripheral edge in balance.

6. A method for atomizing at least one liquid with a rotatable atomizing head having a feeding zone on one side thereof, said feeding zone being essentially defined by a concave surface terminating in a peripheral edge which in turn defines unrestricted circular exit means from said feeding zone, an annular recessed liquid receiving cavity in a side opposite said feeding zone, a plurality of passageways interconnecting said annular cavity and said feeding zone, and providing means for fluid communication between a peripheral portion of said annular cavity and a plurality of sites on said concave surface substantially evenly spaced from each other and from said peripheral edge, and drive-and-support means positioned on said side opposite and concentric with the axis of rotation of said head, said method comprising the steps of introducing liquid into said cavity and rotating said atomizing head at a rate sufficient to generate centrifugal forces and distribute said liquid about said peripheral portion of said annular cavity and provide a uniform continuous flow of said liquid through said plurality of passageways to said plurality of sites and thence along said concave surface to said peripheral edge.

7. The method of claim 6 wherein said passages are sized so as to impede the flow of said liquid from said cavity to said feeding zone through said passages to cause accumulation of liquids in said cavity sufficient to provide a uniform liquid pressure within the several passages of said plurality of passages and a uniform rate of liquid flow at said sites into said feeding zone.

8. The method of claim 6 wherein the flow of liquid to said plurality of sites from said cavity proceeds substantially tangentially of said peripheral portion of said cavity.

9. The method of claim 6 wherein said liquid enters said feeding zone at a plurality of sites positioned intermediate the axis of rotation of said head and said peripheral edge.

10. The method of claim 9 wherein said liquid enters said feeding zone at sites positioned a distance from said axis of rotation substantially less than the distance between said sites and said peripheral edge.

11. The method of claim 9 wherein said liquid is introduced into said annular cavity in the angular direction of head rotation.

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