United States Patent

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[54] ROTARY FLUID-SPRAYER
9 Claims, 5 Drawing Figs.

[52] U.S. Cl. 239/251, 239/252, 239/256
[51] Int. Cl. B05b 3/06
[50] Field of Search 239/251, 252, 256, 258, 261, 260, 246

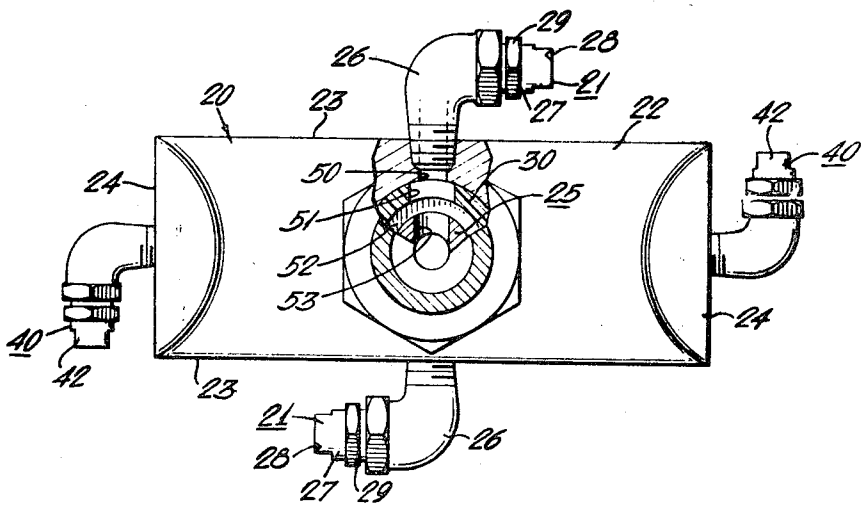
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ABSTRACT: A rotary spray head is disclosed for effecting a washing action on inside surfaces of enclosures or for washing dust from gas or air streams. The head comprises a body mounted for rotation on a spindle and driven by reaction forces created by the effluence of fluid from nozzles on the body. The rotational velocity of the body is controlled by means of control nozzles mounted on the body to issue fluid in a direction counter to the drive nozzles when a free ball mounted in a valve chamber is unseated by the action of centrifugal forces and fluid is discharged from the control nozzles. The rotational velocity of the body may be adjusted by varying the pressure of the fluid supplied to the head or by altering the dimensions of the nozzles and the ball.



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FIG. 1.

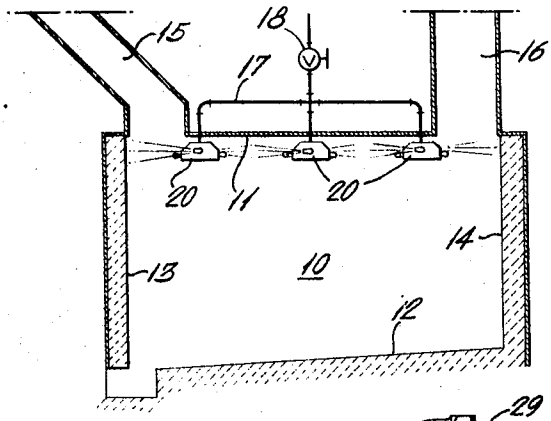


FIG. 2.

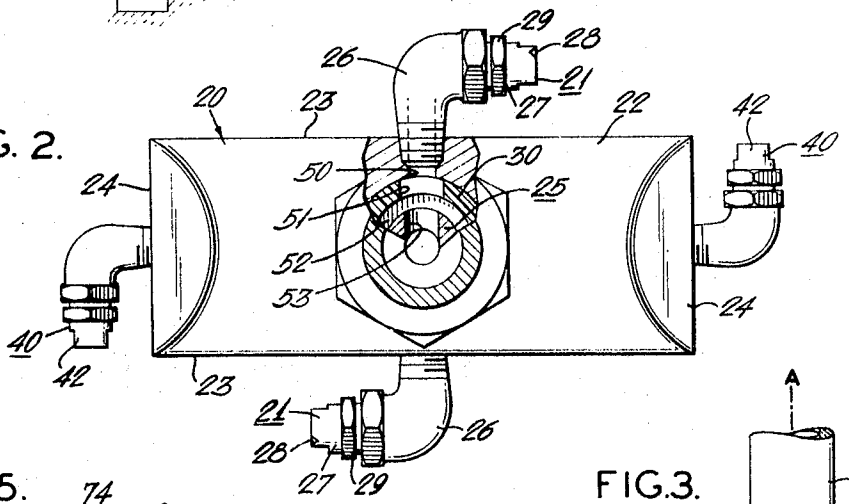


FIG. 5.

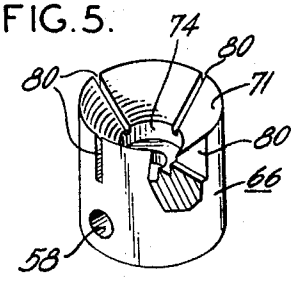


FIG. 3.

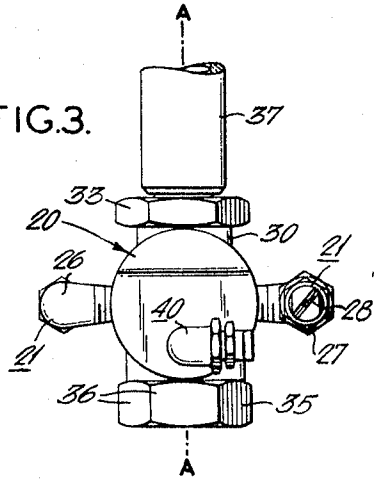


FIG. 4.

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ROTARY FLUID-SPRAYER

The present invention relates to fluid-handling apparatus and more particularly, the present invention relates to rotary spray heads for use in wetting ambient dust or effecting a washing action in enclosures.

At present, the inside surfaces of stock chests, starch cookers, tanks and like enclosures in paper manufacturing mills are periodically cleaned by means of pressurized water sprays directed thereagainst. Usually the sprays are directed manually by workmen positioned in and around the enclosures. Although effective, this method of cleaning is undesirable not only because it is an uneconomical use of labor but also because of the possibility of the workmen being injured by contact with the corrosive chemicals and atmospheres present inside the enclosures. Also, it presents a safety hazard since the workmen are usually clothed in cumbersome rain apparel and the floors on which they must work are slippery. Thus, apparatus which operates to effect a cleansing action without requiring manual sprayers is highly desirable.

A reaction-type rotary spray head is proposed for mounting in an enclosure to periodically cleanse its surfaces. However, unless the rotational velocity of the head is controlled, the fluid issuing therefrom tends to atomize or form an ineffective spray mist with a reduced impact and cleaning action on the surfaces. In addition, there is a tendency for a spray head in a stock chest or like enclosure to become coated with chemicals during periods between cleanings. When combined with a high coefficient of static friction between bearing surfaces, the reaction forces may be insufficient to break the spray head loose and initiate rotation. Thus, a rotary spray head having a controlled rotational velocity and high starting torque is desirable.

With the foregoing in mind, it is a primary object of the present invention to provide a novel rotary spray head for use in settling fine ambient-borne particles or for cleansing the inside surfaces of enclosures.

It is another object of the present invention to provide an improved fluid spraying head which rotates at a controlled velocity to provide an effective impact spray.

It is a further object of the present invention to provide a new reaction-type rotary spray head which develops a maximum of starting torque to enable it to be used satisfactorily in installations where there is a tendency for the spray head to become coated with foreign matter and locked in a fixed position when it is not operating.

Still another object of the present invention is to provide a unique rotary sprayer which effects a cleansing action without requiring manual labor.

As a still further object, the present invention provides a new rotary spray head which possesses self-cleaning features.

More specifically, the present invention provides a rotary spray head which is adapted to be mounted adjacent the surface of an enclosure for directing sprays of fluid against the interior surfaces to effect a cleansing action thereon. The spray head comprises a horizontally elongated body mounted for rotation on a hollow vertical spindle which is connected to a supply of fluid under pressure. First or power nozzle means is mounted on opposite sides of the body to issue fluid and impart rotation in one direction to the body, and second or control nozzle means is mounted on opposite ends of the body to issue fluid in an opposite direction for controlling the rotational velocity of the body within a predetermined limit. Passage means provides fluid communication between the nozzles and the hollow spindles, and fluid flow to the control nozzles is regulated by valve means having a free ball which is normally seated by gravity and the pressure of the fluid being sprayed but which is unseated by the action of centrifugal forces when the rotational velocity of the body exceeds the predetermined limit. The effluence of fluid from the drive nozzles on the sides of the body and the lack of such effluence from the control nozzles at startup results in maximum reaction forces and hence starting torque, being applied to the body.

These and other objects, features and advantages of the present invention should become apparent from the following description when taken in conjunction with the accompanying drawing in which:

FIG. 1 is a schematic diagram of an enclosure in which is mounted a series of rotary spray heads embodying the present invention;

FIG. 2 is a plan view of one of the spray heads illustrated in FIG. 1 with a portion broken away and sectioned to illustrate interior details thereof;

FIG. 3 is an end elevational view of the spray head illustrated in FIG. 2;

FIG. 4 is an enlarged side elevational view of the spray head of FIG. 2 with a portion broken away and sectioned to illustrate valve means for controlling its rotational velocity; and

FIG. 5 is a perspective view of the seating member which supports the ball portion of the valve means.

Referring now to the drawing, there is illustrated in FIG. 1 an enclosure or tank **10**, for example a starch cooker in a paper mill. The enclosure **10** has a ceiling **11**, a floor **12**, and sidewalls **13** and **14**, respectively. A chute **15** is provided in the top wall **11** for charging starch into the enclosure **10**, and a stack **16** is spaced horizontally from the chute **15** in the top wall **11** for venting fine starch particles, fumes and the like from the enclosure **10**.

In accordance with the present invention, a novel rotary spray head **20** is provided for periodically cleansing tanks like the one described above, for settling the fine particles which may be evolved, for example, when ingredients are charged into the tank, or for adding fluid to the ingredients in the tank during mixing. To this end, a series of rotary spray heads **20, 20** are mounted in the tank **10** adjacent its ceiling **11** with one spray head **20** being located adjacent the chute **15** and another spray head being located adjacent the stack **16**. The spray heads **20, 20** are rotated by fluid supplied thereto under pressure through piping **17** and a valve **18**. As will be more fully described hereinafter, the spray heads **20, 20** rotate and direct sprays of fluid against the interior surfaces of the enclosure **10** to effect a cleansing action when the valve **18** is opened or for settling the fine ambient-borne particles.

The spray head **20** is rotated by reaction forces created by the discharge of fluid therefrom. For this purpose, first nozzle means or power nozzles **21, 21** are provided on the body **22** of the spray head **20** to rotate the body **22** in the counterclockwise direction (FIG. 2). In the present instance, the body **22** is cylindrical, having sidewalls **23, 23** and endwalls **24, 24** and being mounted for rotation on a spindle **25**. As may be seen in FIG. 2 and 3, the power nozzles **21, 21** are mounted in the middle of the sidewalls **23, 23** and lie in a plane passing through the diameter of the body **22** and normal to its axis of rotation A. In the present instance, each power nozzle **21** comprises an elbow **26** having one end threaded into the body **22** and mounting an externally threaded orifice **27** in its other end. The elbows **26, 26** are disposed to cause fluid to flow in opposite directions from the orifices **27, 27** and to cause the lines of action of the flowing fluid issuing therefrom to be spaced outwardly from the axis A a sufficient distance to impart rotation to the body **22**.

In order to effect a spraying or washing action on the interior surfaces of the enclosure **10**, each orifice **27** has a transverse slot **28** (FIG. 3) which is inclined with respect to the axis A and which produces a fan-shaped spray of fluid when the body **25** rotates. In addition, wrench flats **29** are provided on each orifice **27** to facilitate its removal for cleaning purposes or to enable the orifice **27** to be replaced should it become desirable to alter the spray characteristics or to change the discharge flow rate of the power nozzles. It is also to be noted that, if desired, the lines of action of the fluid issuing from the power nozzles **21, 21** may be inclined upwardly or downwardly with respect to the plane of the nozzles to thereby direct streams of fluid against horizontally disposed surfaces adjacent to the spray head.

The body **22** is mounted for free rotation on its axis A when fluid issues from the power nozzles **21, 21**. To this end, a

sleeve 30 is mounted in a bore which extends transversely in the body 22 and which is coaxial with the axis A. The sleeve or bearing 30 protrudes a slight distance beyond the top of the body 22 and the protrusion is surrounded by a downwardly depending annular flange 32 on a packing nut 33 which is threaded onto external threads on the upper end of the spindle 25. Downward thrust loads between the body 22 and the spindle 25 are resisted by means of a peripheral flange 34 on the bottom of the sleeve 30, which flange 34 is mounted in a recess in the bottom of the body 22 to engage the upwardly facing surface of a head 35 on the bottom of the spindle 25. As may be seen in FIG. 4, wrench flats 36, 36 are provided on the head 35 so that upon rotation of the head 35 the spray head may be readily mounted to and dismounted from a vertically depending supply pipe 37. It is to be noted that the sleeve is preferably formed of a fluorinated hydrocarbon, for example tetrafluoroethylene, to minimize friction and to provide a bearing having satisfactory wear properties and performance in environments in which corrosive chemicals may be present. Also, it is preferable for the body 22 to be formed of a corrosion-resistant material, for example, Type 316 Stainless Steel.

As noted heretofore, a reaction-type spray head tends to rotate at a high velocity when fluid is supplied at a relatively high pressure. As a result, the fluid issuing from the spray head atomizes, forming an ineffective spray mist. Operation at lower pressures and velocities reduces the atomization tendency, thereby improving the effectiveness of the spray head.

In accordance with the present invention, a spray head is provided which operates satisfactorily at increased fluid pressures and with a minimum of fluid atomization. To this end, the rotational velocity of the body 22 is controlled by means of second or control nozzles 40, 40 which operate to counter the effect of the power nozzles 21, 21 by issuing fluid in a clockwise direction (FIG. 2). As may be seen in FIG. 2, the control nozzles 40, 40 are threaded into the endwalls 24, 24 of the body 22, and they are like the power nozzles 21, 21 with the exception that each control nozzle 40 has a through bore 41 in its orifice 42 rather than a slot 28. In order to prevent the fluid issuing from the control nozzles 40, 40 form interfering with the action of the power nozzles 21, 21 the control nozzles 40, 40 are disposed in a plane normal to the axis A but below the plane of the power nozzles 21, 21. Since the control nozzles 40, 40 are mounted on the endwalls 24, 24 of the elongated body 22, the lines of action of fluid issuing therefrom are spaced outwardly of the Axis A a distance greater than the corresponding spacing of the lines of action of the power nozzles 21, 21. As a result, the effect of the control nozzles 40, 40 in retarding the velocity of the body is maximized.

In order to supply fluid to the power nozzles 21, 21 and the control nozzles 40, 40, passage means is provided in the body 22 and spindle 25. As may be seen in FIG. 2, fluid is continuously supplied to each power nozzle 21 through a lateral port 50 which registers with an enlarged port 51 in the side of the sleeve 30. An annular groove 52 is provided in the spindle 25 to register with the port 51 in the sleeve, and a series of lateral ports 53 in the spindle 25 provides fluid communication between the interior of the spindle 25 and the groove 52. With this arrangement of passages, fluid is continuously flowed from the interior of the spindle 25, through the ports 53, the groove 52, and the port 51 to issue from the orifice 27 in the power nozzle 21.

A similar arrangement of passages is provided to supply fluid to the control nozzles 40, 40. As may be seen in FIG. 4, the control nozzle 40 is connected to lateral passages 55 and 56 which are interconnected through a chamber 57. One end of the passage 56 opens into an inlet 57*a* in the top of the chamber 57, and the other end of the passage 56 opens into a port 58 in the sleeve 30, the port 58 registering with the annular groove 52 in the spindle 25. A series of bores 60, 60 provide fluid communication between the groove 52 and the interior of the spindle 25. Thus, with this arrangement of passages, fluid flows outwardly through the bores 60, the groove 52, and port 58, through the passage 56, chamber 57, and passage 55 to issue from the orifice 42 of the control nozzle 40.

According to the present invention, the rotational velocity of the body 22 is controlled by causing fluid to issue from the control nozzles 40, 40 when the velocity is above a predetermined limit and by preventing fluid from issuing from the control nozzles 40, 40 when the velocity is below a predetermined limit. To this end, valve means is provided in the passage means supplying fluid to the control nozzles 40, 40. As may be seen in FIG. 4, the valve means comprises a valve member, in the present instance a ball 65, mounted for free movement into and out of engagement with an annular valve seat 75 mounted in a recess 74 surrounding an outlet 57*b* in the bottom of the chamber 57. In the illustrated embodiment, the chamber 57 is formed by a hole drilled upwardly from the bottom of the body 22, and its bottom is formed by a cylindrical valve seat support member 66 which is secured in the hole by means of an expandable split retaining ring 67. Fluid communication between the outlet 57*b* and the nozzle passage 55 is provided by means of an L-shaped passage 59 in the member 66, the passage 59 being aligned with the passage 55 by a pin 70 extending through the body 22 into engagement with the member 66.

The ball 65 is normally engaged with its seat 75 to block fluid flow to the control nozzle 40 when the body 22 is at rest or when it is rotating at a velocity below a predetermined limit. For this purpose, means is provided to permit gravity forces to act on the ball and to bias it into engagement with its seat. In the present instance, the biasing means includes an upwardly diverging conical wall 71 on the member 66, the wall 71 surrounding the outlet 57*b* and being coaxial therewith. As may be seen in broken lines in FIG. 4, the ball 65 is engaged against its seat 75 when the body 22 is at rest or rotating relatively slowly. However, as the rotational velocity of the body 22 increases, centrifugal forces acting outwardly on the ball 65 overcome the gravity forces and cause the ball 65 to be displaced leftward up the conical wall into the position illustrated in full lines in FIG. 3. As a result, the ball disengages its seat 75 exposing the outlet 57*b* and affording fluid flow to the control nozzles 40. Effluence of fluid from the control nozzles 40 reduces the rotational velocity of the body 22, causing the gravity forces on the ball 65 to overcome the centrifugal forces thereon and thereby enabling the ball 65 to return to its normally seated position.

It is to be noted that when the ball 65 is seated, fluid pressure on its top and the absence of pressure on its bottom would tend to maintain it in that position and thus require greater rotational velocities to unseat the ball than would be required if the pressure differential effect were minimized. In accordance with the present invention, however, means is provided to equalize the pressure on the top and bottom of the ball 65 to reduce the aforementioned undesirable effects of the pressure differential. For this purpose, a series of slots, in the present instance four slots 80, 80 are formed in circumferentially spaced relation in the conical wall 71. As may be seen in FIG. 5, the slots 80, 80 extend downwardly from the rim of the wall 71 and into the recess 74 above the valve seat 75 and below the bottom of the ball 65 (see FIG. 3). Thus, when the ball 65 is seated, the fluid pressure on its underside is equal to the pressure on its top, and because of the absence of fluid in the outlet 57*b*, only a small downward seating force is applied to the ball by virtue of the pressure differential. As a result, the ball 65 is responsive to relatively small changes in the rotational velocity of the body 22.

The spray head of the present invention possesses self-cleaning and lubricating features which enable it to be used satisfactorily with fluid carrying suspended solids. For this purpose, a slight clearance is provided between the sleeve 30 and the spindle 25 to enable fluid to leak both upwardly and downwardly therebetween. Because of its cylindrical shape, the fluid exiting from behind the packing nut 33 on the spindle 25 at the top of the body 22 flows downwardly across the sides of the body 22 and thereby effects a washing action on the

body 22. The thrust bearing surfaces formed between the head 35 of the spindle 25 and the bottom flange 34 on the sleeve are lubricated by fluid leaking outwardly therebetween. Also, the relatively quick movement of the ball 65 into and out of engagement with its seat 75 is such as to resist clogging.

It should be apparent that the rotational velocity range of the spray head for a predetermined fluid supply pressure may be varied by properly selecting the size of the control nozzles 40, 40 with respect to the power nozzles 21, 21. If the orifices in the control nozzle were substantially smaller than the corresponding orifices in the power nozzles, the velocity control range would be less than if the control nozzle orifices were substantially the same size or larger than the power nozzle orifices. In addition, other factors which enter into the design of the spray head are the size of the ball 65, the shape of the conical wall 71 in the support member 66, and the diameters of the fluid supply passages. Thus, by properly sizing these elements, the spray head of the present invention may be tailored to meet a wide range of service conditions and applications.

In view of the foregoing, it should be apparent that a rotary spray head which rotates at a controlled velocity has now been provided to direct relatively high-pressure streams of fluid against the interior surfaces of an enclosure for effecting an improved washing action thereon.

While a preferred embodiment of the present invention has been described in detail, various modifications, alterations or changes may be made without departing from the spirit or scope of the present invention as defined in the appended claims.

What I claim is:

1. A rotary fluid spray head comprising: a body, a hollow spindle mounting said body for rotation on an axis, first nozzle means mounted on said body for issuing fluid therefrom to impart rotary motion in one direction to said body, second nozzle means mounted on said body for issuing fluid in a direction substantially counter to said first-mentioned direction for retarding the rotary motion of said body, passage means providing fluid communication between said spindle and said first and second nozzle means, and valve means in said passage means for varying the flow of fluid through said second nozzle means in response to changes in the rotational velocity of said body on said axis.

2. A spray head according to claim 1 wherein said valve means includes a chamber in said body spaced outwardly from said axis, an inlet connecting said chamber to said spindle through said passage means and an outlet connecting said chamber to said second nozzle means through said passage means, means providing a valve seat around said outlet in said chamber, a valve element mounted in said chamber for displacement by centrifugal force outward of said axis, and means acting on said valve member to bias said member inwardly against said centrifugal force, so that seating and unseating of said valve member occurs in response to changes in the rotational velocity of the body.

3. A spray head according to claim 2 wherein said outlet is located in the bottom of said chamber, said valve member includes a ball, and said biasing means includes an upwardly diverging conical surface surrounding said outlet and engaging said ball, so that when the rotational velocity of the body is below a predetermined limit, the ball extends across the outlet to block fluid flow to the control nozzle, and when the rotational velocity exceeds the predetermined limit, the ball is displaced up the conical surface to expose the outlet and afford fluid flow to the control nozzle.

4. A spray head according to claim 3 wherein said inlet is located adjacent the top of said chamber, said valve seat means includes a recess surrounding said outlet and an annular seat mounted in said recess, said annular seat having a central aperture in registry with said outlet and being closely spaced from the bottom of said ball when said ball is engaged against said conical surface and extends across the aperture in said seat, and including a series of slots in said conical surface providing fluid communication between the top of said chamber and the space between said ball and said valve seat, so that fluid pressure is equalized on the top and bottom of the ball to increase the responsiveness of the valve means to changes in the rotational velocity of the body.

5. A spray head according to claim 1 wherein said second nozzle means is located outwardly of said axis a distance greater than the corresponding distance of said first nozzle means, so that reaction forces created by the effluence of fluid from the second nozzle means applies maximum torque to the body for retarding its rotational velocity.

6. A spray head according to claim 1 wherein said body is elongated and symmetrical in a direction transverse to its rotational axis and having opposite ends and sides, said first nozzle means including a pair of orifices carried by said sides for issuing fluid in substantially opposite directions with respect to said rotational axis to impart rotation to said body in said one direction, said second nozzle means including a pair of orifices carried in said ends for issuing fluid in substantially opposite directions with respect to said axis to impart rotation to said body counter to said one direction, said orifices in said first nozzle means having transverse slots inclined with respect to said rotational axis to cause fluid issuing therefrom to form a fan-shaped spray.

7. A spray head according to claim 1 wherein said body has a bore coaxial with said rotational axis, a sleeve mounted in said bore, said sleeve rotatably receiving said spindle, one end of said spindle having a head engaging axially against said sleeve and the other end of said spindle having external threads, and an internally threaded packing nut threadedly engaged on said external threads for limiting axial displacement of said body relative to said spindle.

8. A spray head according to claim 1 wherein first nozzle means is disposed in a plane normal to said rotational axis and said second nozzle means is disposed in a parallel plane spaced therefrom, said passage means including a series of lateral passages in said body in fluid communication with said first nozzle means and a like series of lateral passages in said body in fluid communication with said second nozzle means, a peripheral groove in said spindle in registry with said first-mentioned series and said second-mentioned series of lateral passages, and ports in said spindle providing fluid communication between said grooves and the interior of said spindle, so that fluid is continuously supplied to the nozzle means during rotation of the body.

9. A spray head according to claim 8 wherein said body is of stainless steel and said sleeve is of fluorinated hydrocarbon so that the body resists deterioration by corrosive fluids.