April 9, 1968 LE ROY S. DE MART ET AL 3,377,026

RETRACTABLE CLEANING MECHANISM FOR BOILERS AND OTHER HEAT EXCHANGERS

Filed Jan. 24, 1966

2 Sheets-Sheet 1

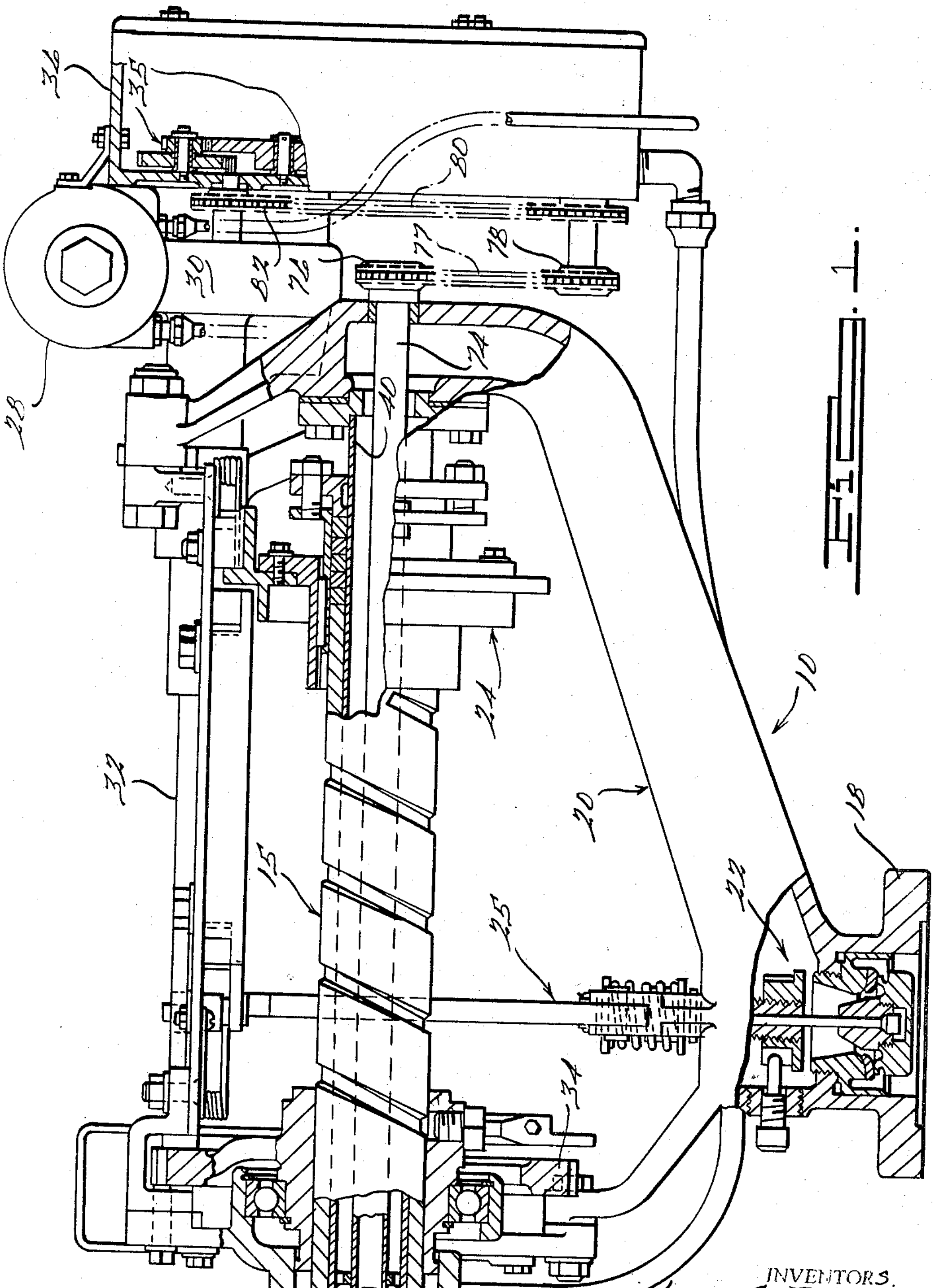

FIG. 1

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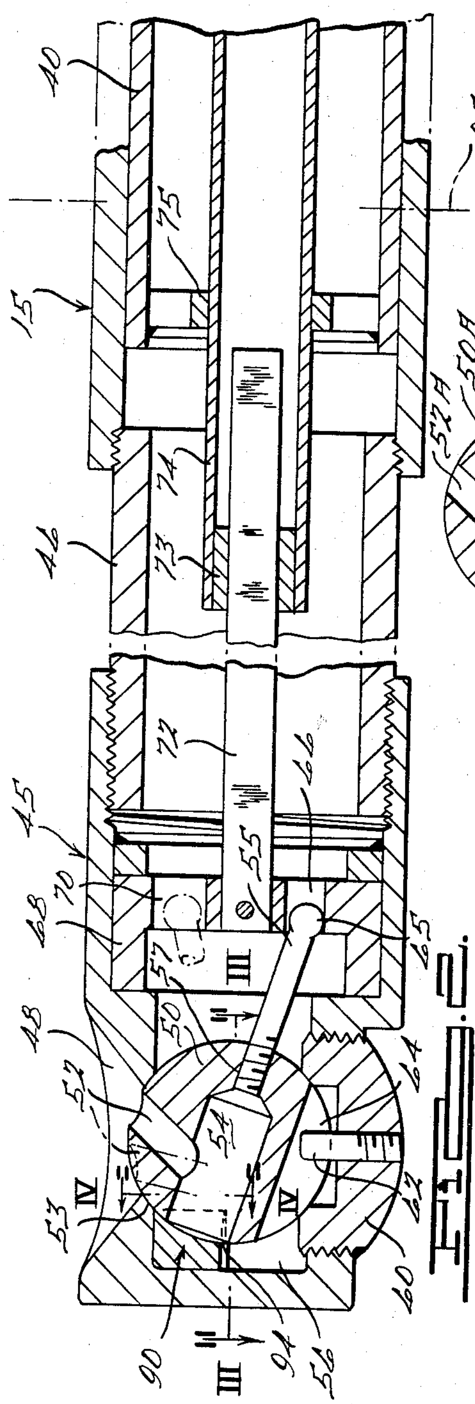

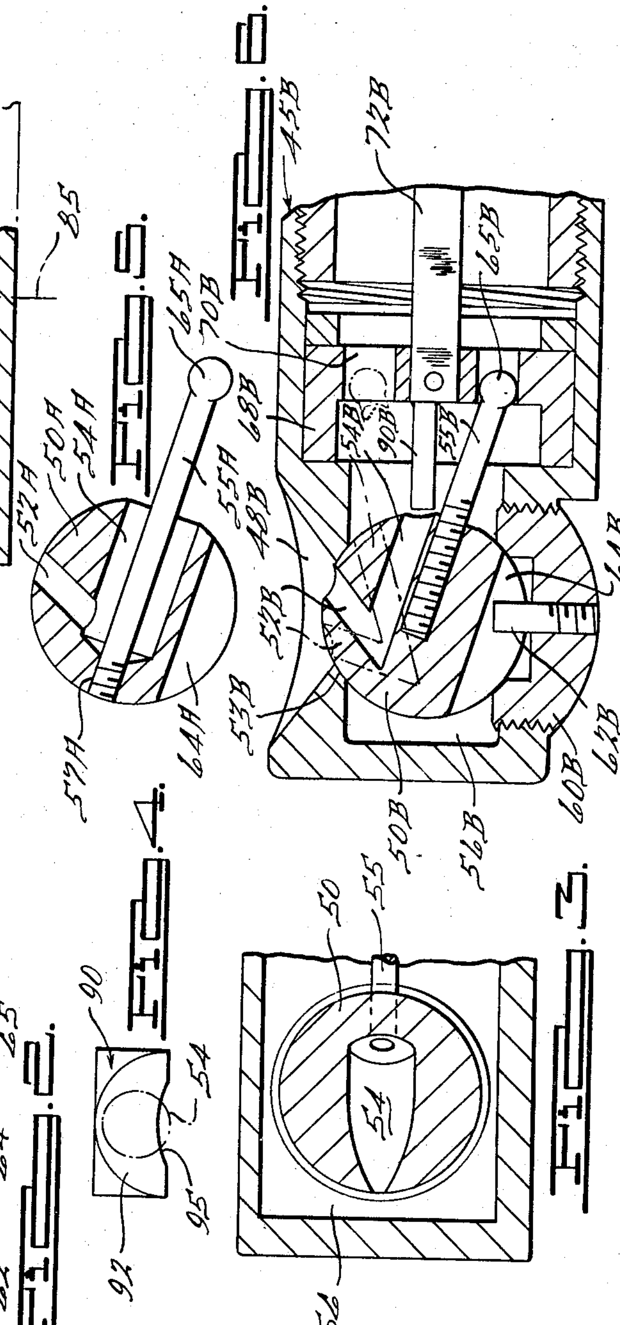

FIG. 2.

FIG. 3.

FIG. 4.

FIG. 5.

FIG. 6.

FIG. 7.

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RETRACTABLE CLEANING MECHANISM FOR BOILERS AND OTHER HEAT EXCHANGERS

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ABSTRACT OF THE DISCLOSURE

A device for projecting liquid against the surfaces of a heat exchanger to dislodge fouling material is disclosed in a preferred mechanism which includes a lance tube constructed and actuatable similarly to a known type of short retracting soot blower, and as having a ball type nozzle rockable by means of a stem which sweeps a conic path so that the path of movement of the jet from the nozzle has components both lengthwise of and rotational about the axis of the lance tube, the jet being thereby projectable against a water wall surface so as to impinge the same at varying distances from the axis, and a valving portion being disclosed which during oscillation of the nozzle, obstructs to a varying degree the access of fluid to the nozzle to thereby throttle the flow of liquid to a degree which varies in relation to the angularity of the nozzle.

The purpose of this abstract is to enable the Patent Office and the public generally and especially the scientist, engineer or practitioner in the art who is not familiar with patent or legal terms or phraseology to determine quickly from a cursory inspection the nature and essence of the technical disclosure of the application. The abstract is neither intended to define the invention of the application, which of course is measured by the claims, nor is it intended to be limiting as to the scope of the invention in any way.

This invention relates to apparatus for the treatment of heat exchanging surfaces and particularly to improved means for projecting liquid against highly heated surfaces, such as the water wall tubes in the radiant sections of large steam boilers while the boiler is operating.

An important object of the invention is to provide an improved liquid projecting mechanism having a nozzled lance tube which is extensible, during its operative cycles, into the zone of radiant heating and which between cycles is retracted to a protected low-temperature position, the operative pattern of liquid discharge being such that a substantial area of a radiant generating surface is subjectable to the impingement of a liquid jet from a uniquely arranged nozzle and actuating mechanism assembly which applies to the heated surfaces a washing and/or treating liquid having a predetermined volumetric dispersion.

In the cleaning and treatment of such highly heated metallic surfaces as the radiant steam generating surfaces of large public utility boilers, water and aqueous solutions are sometimes advantageously employed. Two mutually inconsistent considerations which are involved in the use of aqueous solutions on highly heated metal surfaces are, on the one hand, the serious consequences which might result from thermal shock, if undue chilling should be caused by too much water; and, on the other hand, the requirement for effective cleaning and treatment which necessitates a substantial rate of discharge of the liquid.

It has been found possible to effectively utilize water and aqueous solutions in the indicated environment and in spite of the conflicting considerations mentioned, if the

discharge rate and pattern are controlled with the accuracy made possible by the present invention.

An important object of the invention is to provide a simple, reliable and relatively inexpensive structure which accomplishes the purposes above indicated.

Another important object of the invention is to provide an improved liquid projecting device of the indicated character which is interchangeable with a standardized and conventional type of soot blower, so that if conditions develop during operation of a boiler making it impossible to clean properly a given area by means of a conventional soot blower already in place, a liquid projector constructed in accordance with the present invention can be substituted for the soot blower, or the soot blower itself can be modified to incorporate the invention, in a quick and simple manner and without modifying the boiler setting or supporting parts.

Another object is to provide an improved device of the indicated character which is arranged to discharge a concentrated jet of liquid from a nozzle which, during operation, is located relatively close to the water wall or generating surface, and which simultaneously rotates around a fixed axis perpendicular to the wall and at the same time changes its angularity to such axis, so as to sweep a sinuously modified circular path which enables effective coverage of a large area and wherein the rate of liquid discharge is automatically varied in a predetermined relationship to the angularity and effective radial reach of the jet, whereby the density of application of the liquid discharge is accurately controllable over the treated area.

Other objects and advantages will be apparent upon consideration of the present disclosure in its entirety.

In the drawing:

FIGURE 1 is a view partly in side elevation and partly in longitudinal section, and partly broken away, showing a preferred embodiment of the invention;

FIGURE 2 is a longitudinal diametric section of the nozzle portion on a larger scale;

FIGURE 3 is a horizontal sectional plan view taken substantially on the line III—III of FIGURE 2, and looking in the direction of the arrows;

FIGURE 4 is an elevational view of the flow-modulating valving block, the rest of the mechanism being omitted but looking in the direction indicated by the line and arrows IV—IV of FIGURE 2;

FIGURE 5 is a vertical sectional elevational view of a ball element of modified construction, and

FIGURE 6 is a fragmentary longitudinal diametric section of a nozzle construction illustrating another modification of the invention.

Referring now to the drawing, reference character **10** designates generally a blower assembly of the short retracting type and the general construction of which is well known in the art. Ordinarily such blowers are constructed and arranged in such manner that the lance tube, **15**, is supplied with cleaning fluid from a source of steam or air, which is discharged from the lance tube through a suitably orificed nozzle (not shown) rigidly attached to and forming a continuation of the lance tube.

Detailed description of many of the components which are presently well known will not be required. The blower, as is usual, is provided with a hollow gooseneck body **20** having a bottom inlet flange **18** by which it is attached to supporting pipe structure and through which fluid is supplied to its gooseneck by way of a blow valve assembly generally designated **22**. In the operation of this invention, the flange **18** may be connected to a source of water or of an aqueous solution (not shown) under pressure, rather than to a source of steam or air.

The blow valve assembly is actuatable, to start and stop the supply of fluid, by a cam assembly **24** which is effective to open the valve through the agency of the trigger element **25** when the lance tube is in the projected position, the cam **24** being designed to maintain the valve open through either the entire or any desired portion of the rotation of the lance tube which occurs while it is in the projected position, as will be understood.

As is also common, the projection, rotation and retraction of the lance tube may be powered from a suitable prime mover or motor, illustrated as an air motor **28**. The motor, through a gear reducer assembly **30**, shaft **32** and gearing **34** projects and rotates and then retracts the lance tube **15** at desired times.

The motor also drives through gearing **35** control components (not shown) contained in a control box **36** mounted on the rear of the unit and which, in known manner, regulate the number of blowing revolutions and transmit a signal to a master controller or the like (not shown), to shut down the blower unit after the lance tube has returned to the retracted position and the operating cycle of the blower is completed.

It will be noted that the gooseneck **20** discharges directly into the stationary feed tube **40**, in the conventional manner, and as is usual with blowers of this general construction, such fluid is fed from the open forward end of the feed tube into the interior of the lance tube **15** for discharge from the latter via suitable orifice means.

In practicing the present invention, however, instead of a simple nozzle rigidly secured to the outer end of the lance tube, the conventional fixed-orifice nozzle is replaced by a special hollow nozzle assembly **44** best illustrated in FIGURES 3–5. The body **45** of such nozzle may be connected to the lance tube **15** by nipple **46**. On one side near its outer end the nozzle body **45** is provided with a conically outwardly flaring opening **48** communicating and aligned with an internal ball socket which rockably retains a ball **50** having a discharge orifice passage **52** which is directed outwardly through the opening **48**. Orifice passage **52** communicates with a diametric ball inlet feed passage **54** which opens toward the front of the ball, but is closed at the rear by the stem of the radial ball-actuating pin **55**. As shown in FIGURE 2 passage **54** forms a counterbored forward extension of a reduced and tapped rear section **57** into which the conformably threaded stem of pin **55** is screwed. At its forward end feed passage **54** opens into the hollow front chamber portion **56** of the hollow interior of the nozzle body. Forward chamber portion **56** communicates, through open passage portions which extend around the sides of the ball, with the rear inner portions of the nozzle body, which in turn is open and communicates via nipple **46** and lance tube **15** with the feed tube **40**.

The ball **50** is seated against a socket portion **53** surrounding the opening **48**, so that fluid can only be discharged through the ball and its orifice **52**. The socket assembly for retaining the ball is completed upon the rear side of the ball by a similarly concentrically socketed screw-in plug portion **60**, the plug portion **60** being of sufficient size so that the opening therefor will pass the ball to admit it during assembly and permit its removal in event of any necessary disassembly for servicing. A keying pin **62** projects axially from the interior of the plug and radially of the ball into a slot **64** in the lower peripheral portion of the ball, slot **64** being oriented longitudinally in substantially coplanar relation with respect to the axis of the structure and with respect to a diameter of the ball.

The actuating pin **55** projects rearwardly from the ball **50** and at its rear extremity carries a small ball portion **65** rockably fitted in a longitudinally extending eccentrically positioned hole **66** formed in a disc **68** mounted in the nozzle for rotation about the axis of the latter. Longitudinal openings **70** in disc **68** permit free flow of fluid past the disc.

Disc **68** is fast upon a squared shaft **72** axially positioned and rotatable in the nozzle to rotatively drive the

disc **68**. Shaft **72** telescopes with but is rotatively driveable by a tubular shaft **74** rotatably supported in the feed tube **40** as in the spider bearing support **75** which, as will be seen, also permits free flow of fluid forwardly through the feed tube. Shaft **74** extends rotatably through and from the rear of the gooseneck **20** and carries fast upon its rear extremity a driving sprocket **76**, rotatably driveable as by chain and sprocket means which include a driving chain **77**, double idler sprocket assembly **78** and drive chain **80** which is in turn driveable by a sprocket **82** driveable by the timing gearing **35** of the control assembly powered from the motor **28**.

The drive means just described drives the disc **68** at a different and preferably substantially higher speed than the rate of nozzle rotation, which rate is ordinarily quite slow (e.g.: 3 r.p.m.). The differential rotation between the disc **68** and the nozzle body **45** oscillates the ball **50** in such manner as to change the angularity of the discharge orifice, **52** and the discharge therefrom, with respect to the axis of the assembly. It will be seen that a similar action would occur if the shaft **74** were simply held against rotation, instead of being positively driven from the motor as described, but by reason of the fact that the rotation of the lance tube is relatively slow, the sinuous component thereby imparted to the jet would be of a wavelength so long that the area covered by the jet would not be increased as greatly. By rotating the disc **68** at a substantial relative speed, however, a sinuous component of relatively short wavelength is imparted to the jet from the orifice **52**.

It will be seen that the jet is directed angularly rearwardly toward the surface to be cleaned, which is diagrammatically indicated by the line **85**, and that when the orifice is rocked inwardly to its inner limit to the low angle position in which it is shown in full lines in FIGURE 2, the jet impinges upon the water wall close to the axis, while when the disc **68** is turned with respect to the nozzle body through an angle of 180° from the position shown, the angle of the jet orifice **52** to the axis is increased to the high angle position shown in dotted lines, and the jet is thereby projected to an area of impingement farther from the blower.

The squared shaft **72** slides in a squared drive bearing **73** fast in the hollow shaft **74** during projection and retraction of the lance tube.

As indicated above, it is desirable to control very accurately the amount of the liquid projected into the boiler and against the hot surfaces to be cleaned, in order to prevent undue thermal shock, while yet providing a volume sufficient to effectively clean the surfaces. If the same rate of discharge were permitted with the jet orifice discharging in its low angle position shown in full lines in FIGURE 2 as when in the positions of higher angularity, the liquid impingement rate per unit area served would be non-uniform, and might be too high for safety at the low angle and too low for effective cleaning at the high angle.

In order to control the rate of discharge in such manner as to achieve a substantially uniform effective impingement rate per unit area served, in all positions, a stationary valving or throttling block **90** is fitted in the outer end of the nozzle body **45** and is so contoured and positioned as partially to overlie and obstruct the open front end of inlet passage **54**, to thereby restrict the inflow of liquid thereto to varying degree as the ball **50** is rocked. On its side facing the ball, the block **90** is provided with an area **92** of spherically concave contour and which bears wipingly against the surface of the ball surrounding the open front end of passage **54** in all areas at the bottom, where, when the ball is in the low angle position, the opening is relatively small as indicated at **94** in FIGURE 2. As the ball is rocked to move the orifice **52** outwardly to greater angularity, the forward extremity of passage **54** moves downwardly and the effective size of the inlet opening into passage **54** at the position **94** increases, to provide increased flow, thereby compensating for the greater effective radius and reach of the jet and providing greater flow in proportion to increased area of treatment. The discharge rate will be seen to vary constantly in proportion to the angularity of the jet.

The lower edge **95** of the block which coacts with the front opening of passage **54** to define the effective orifice may be contoured in a desired manner, as indicated in FIGURE 4, to graduate the change of flow rate in the manner desired. It will be appreciated in this regard that in addition to changes in the effective radius at which the jet is working, the temperature in the zone of installation, and consequently, the rate of evaporation of the projected liquid, the rate of flow of the gases of combustion, and other factors, may cause the engineer in charge of the installation to consider it advisable to vary the contour of the edge **95**, and thereby the rate of throttling, depending upon the conditions in the served zone.

All of the principal components of the invention except for the nozzle assembly **45** and the mechanism for oscillating the ball **50** may be the standard components of a conventional short retracting soot blower. It will be understood that where proper cleaning is obtainable with a conventional soot blower, utilizing steam or air as the cleaning medium, this is usually to be preferred over injecting water at a number of positions. Where an unusually difficult cleaning or slag-formation problem is encountered, however, which may arise at any time due to a change of fuel or other cause, a soot blower modified in accordance with the principles of the present invention can be installed or substituted, at the troublesome location, and can also be operated under the control of the same master controller, but fed from a water or aqueous solution pressure supply to the inlet connection **18**.

FIGURE 5 illustrates another construction incorporating a modified ball **50A** corresponding generally to and which is substitutable for the ball **50** of the first embodiment. The fluid inlet **54A** of the ball opens to the rear so that the fluid enters the ball while flowing forwardly without reversing its direction. The pressure drop occasioned the changing flow direction required with the first embodiment where the fluid enters the ball is thus largely eliminated. As shown in FIGURE 5, the inlet passage **54A** of the ball is of relatively large size and concentric with the actuating pin **55A**, which corresponds to the pin **55** of the first embodiment, its actuating ball **65A** being adapted to fit into the actuating disc orifice **66** of a nozzle assembly such as that shown in FIGURE 2 and to be actuated thereby so that the jet from the discharge passage **52A** of the ball will be similarly actuated. It will be noted that the inlet or feed passage **54A** can be conveniently formed as a counterbored section of a concentrically drilled and counterbored passage extending entirely through the ball, the base section **57A** of such passage being reduced and tapped to receive and retain the threaded forward end of pin **55A** which closes the forward end of the passage.

FIGURE 6 illustrates a further modification wherein parts corresponding to those of the first embodiment are again denoted by reference characters which are similar but in this instance differentiated by the suffix B. In this embodiment the actuating pin **55B** is also positioned radially with respect to the ball and again the ball is adapted to be actuated in like fashion and to discharge its jet in a like pattern from the passage **52B**. The inlet passage portion **54B** of the ball is offset from a radius in an upward direction, however, as illustrated in the drawing, and opens rearwardly. The open rearwardly directed mouth of inlet passage **54B** preferably lies as close to a radius as mechanical considerations will permit.

A pin portion **90B** is supported by and extends forwardly from, and parallel to the axis of, squared shaft **72** to a position close to the surface of the ball **55B**. Although shown as slightly offset from the axis, pin **90B** is also variable in position, and also in cross section, within limits, as desired flow considerations may dictate, but its forward or valving end will in any event lie closer to the common axis defined by the cone of the orbit of pin **55B** and the shaft axis than does the center of the eccentric orbit described by the mouth of inlet **54B**. Thus when the ball **65B** is in the illustrated position, corresponding to minimum throw of the discharge jet, the forward end of pin **90B** closely overlaps and partially blocks the mouth of the fluid inlet passage **54B** of the ball. As the ball is rocked to the other extreme position, the mouth of passage **54B** moves away from pin **90B**. The inlet passage is thus graduatedly throttled and unthrottled as the mouth of passage **54B** moves toward and away from pin **90B**, respectively.

While it will be apparent that the preferred embodiments of the invention disclosed are well calculated to fulfill the objects above stated, it will be appreciated that the invention is susceptible to modification, variation and change without departing from the proper scope or fair meaning of the subjoined claims.

We claim:

1. In a fluid discharge mechanism, nozzle body rotatable about a predetermined axis, a jet member mounted in said body and rockable therein to different angular positions with respect to said axis, means for so rocking said jet member with respect to said body and axis during such rotation of the body, said member having a discharge orifice therein providing intercommunication between the interior and the exterior of the body for discharging fluid therefrom at varying angles to said axis during rotation of the body, said nozzle body being a generally tubular, hollow member having an open rear end adapted to be attached to and supplied with liquid from a rotatable liquid supply conduit, said means for rocking the jet member including an element projectable into the body through such open rear end, and means responsive to rocking of the jet member for variably throttling liquid flow therethrough.

2. A mechanism as defined in claim **1** wherein said jet member has an inlet orifice-defining portion opening within the body and rockable with said member and communicating with said discharge orifice, said throttling means including a valving part within the body partially blocking said inlet orifice-defining portion, the jet member being rockable relatively to said portion.

3. A mechanism as defined in claim **2** wherein said body is closed at its forward end, the inlet orifice-defining portion opening forwardly toward but being spaced from such forward end, and the valving part being fixed in the forward end of the body.

4. In a fluid discharge mechanism, a nozzle body rotatable about a predetermined axis, a jet member mounted in said body and rockable therein to different angular positions with respect to said axis, means for so rocking said jet member with respect to said body and axis during such rotation of the body, said member having a discharge orifice therein providing intercommunication between the interior and the exterior of the body for discharging fluid therefrom at varying angles to said axis during rotation of the body, said nozzle body being a generally tubular, hollow member closed at its forward end and at its rear end open and adapted for attachment to a rotatable and axially movable lance tube for movement as a unit therewith and to be supplied with fluid therethrough, said means for rocking the jet member comprising a shaft including telescopic sections interkeyed against rotation with respect to each other and extending through said lance tube in an axial direction and into the open rear end of the body and mechanically connected to the jet member to rock the latter in response to differential rotation between the shaft and body, the jet member having an inlet opening directed forwardly in the body and communicating with said discharge orifice and also communicating with the open rear end of the body, and a stationary valving portion in the body partially blocking said inlet opening.

5. In a fluid discharge mechanism, a nozzle body rotatable about a predetermined axis, a jet member mounted in said body and rockable therein to different angular positions with respect to said axis, means for so rocking said jet member with respect to said body and axis during such rotation of the body, said member having a discharge orifice therein providing intercommunication between the interior and the exterior of the body for discharging fluid therefrom at varying angles to said axis during rotation of the body, a lance tube supporting and forming a rearward continuation of said body and adapted to supply liquid thereto, said means for rocking the jet member including a shaft extending through the lance tube in an axial direction, said jet member having an inlet mouth opening into the nozzle body, said means for rocking the jet member comprising a driving portion rotatable in the nozzle body and a stem connecting the driving portion to the jet member, and means in the body held against rocking with the jet member and partially blocking said mouth in at least some positions of rocking movement of the jet member.

6. In a fluid discharge mechanism, a nozzle body rotatable about a predetermined axis, a jet member mounted in said body and rockable therein to different angular positions with respect to said axis, means for so rocking said jet member with respect to said body and axis during such rotation of the body, said member having a discharge orifice therein providing intercommunication between the interior and the exterior of the body for discharging fluid therefrom at varying angles to said axis during rotation of the body, a lance tube supporting and forming a rearward continuation of said body and adapted to supply liquid

thereto, said means for rocking the jet member including a shaft extending through the lance tube in an axial direction, said jet member being universally rockable about a point, and means for so rocking said member including a stem and means actuatable by said shaft for turning the stem in a conic path, the apex of the cone defined by said path being centered on said point.

7. A mechanism as defined in claim **6** wherein the shaft and cone are coaxial, the wall of the cone converging in a direction away from one end of the shaft to an apex spaced from the end of the shaft, said jet member having an inlet mouth opening in a direction toward the base of the cone and movable in an eccentric orbit toward and from the axis, and means for variably throttling said inlet including a blocking element extending into the cone from the base to a position closer to the axis then said mouth and which overlaps and lies close to said mouth in at least a part of the orbit of the latter.

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