US 20040250837A1

(19) **United States**

(12) **Patent Application Publication**

(10) **Pub. No.: US 2004/0250837 A1**

(43) **Pub. Date: Dec. 16, 2004**

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(54) **WARE WASH MACHINE WITH FLUIDIC OSCILLATOR NOZZLES**

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(21) Appl. No.: **10/837,362**

(22) Filed: **May 1, 2004**

Related U.S. Application Data

(60) Provisional application No. 60/478,380, filed on Jun. 13, 2003.

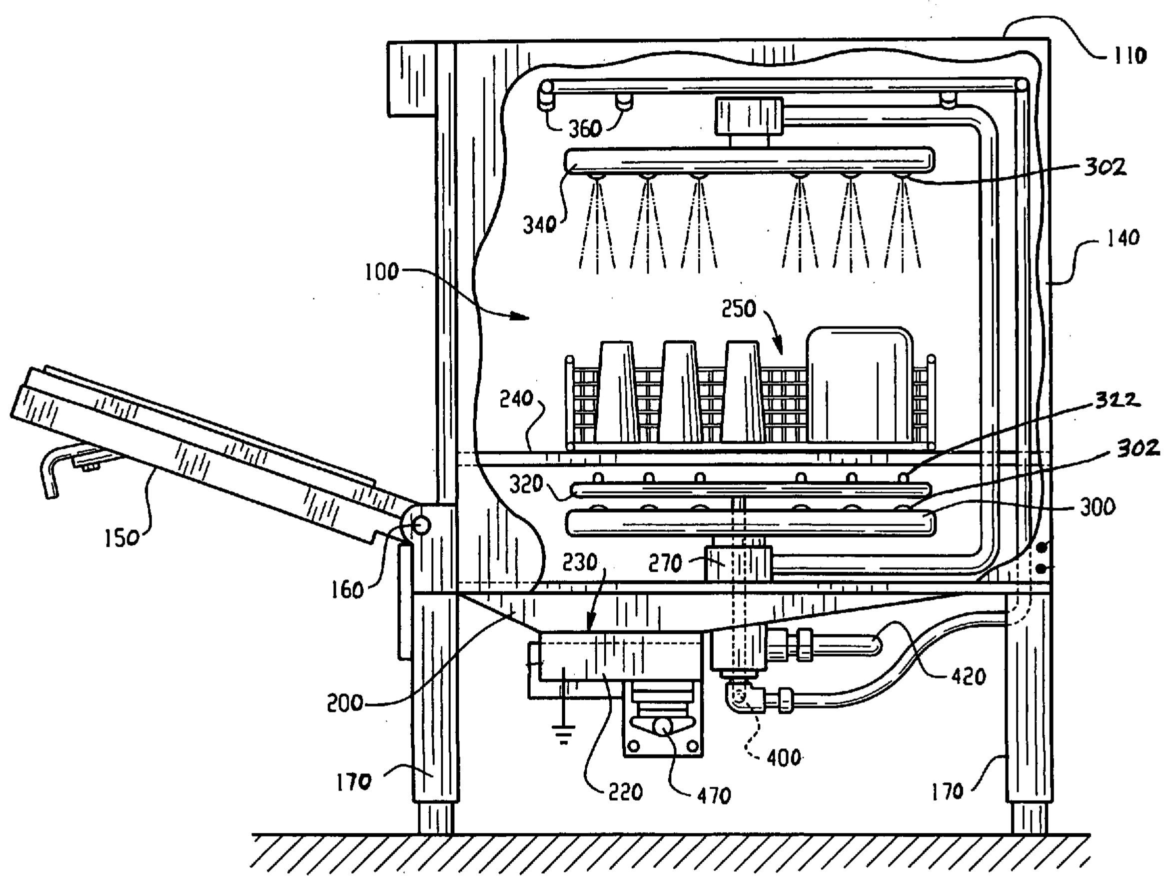
Publication Classification

(51) **Int. Cl.**[7] **B08B 3/02**

(52) **U.S. Cl.** .... **134/25.2**; 134/32; 134/26; 134/94.1; 134/64 R; 134/198; 134/122 R

(57) **ABSTRACT**

A ware wash machine includes one or more fluidic oscillator nozzles (or other variable stream orientation nozzles) used in connection with the dispensing of wash liquid, rinse liquid, sanitizing liquid and/or gaseous fluids onto wares being cleaned and/or dried and/or heated within the machine.



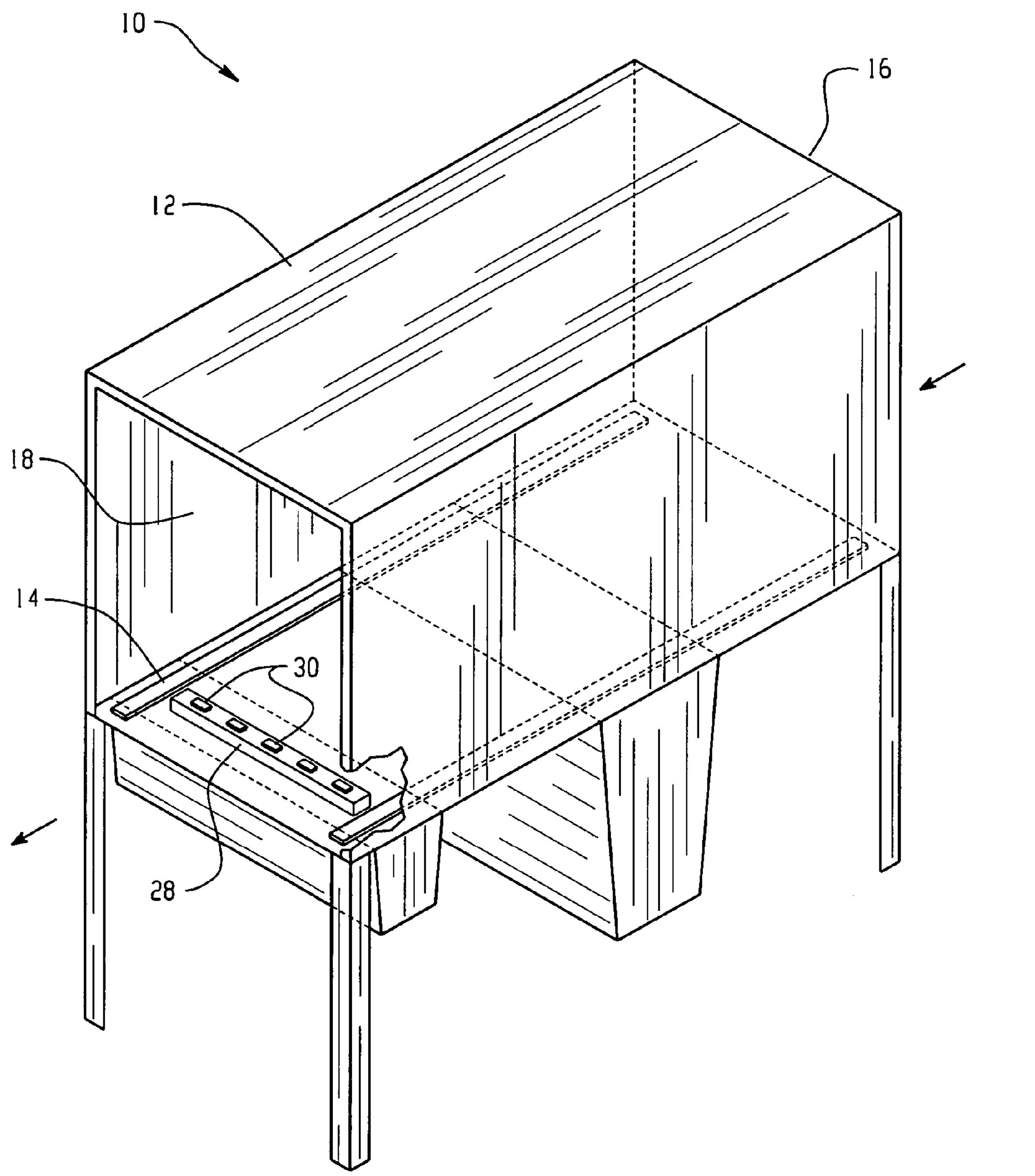


Fig. 1

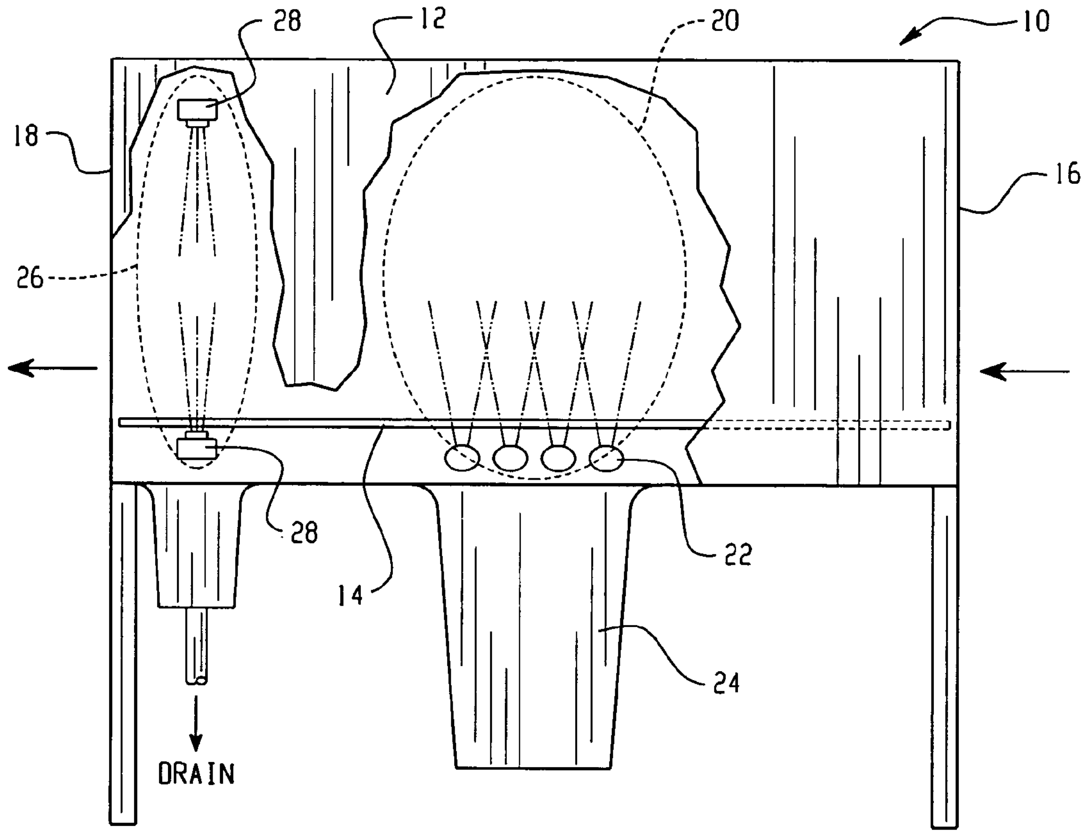


Fig. 2

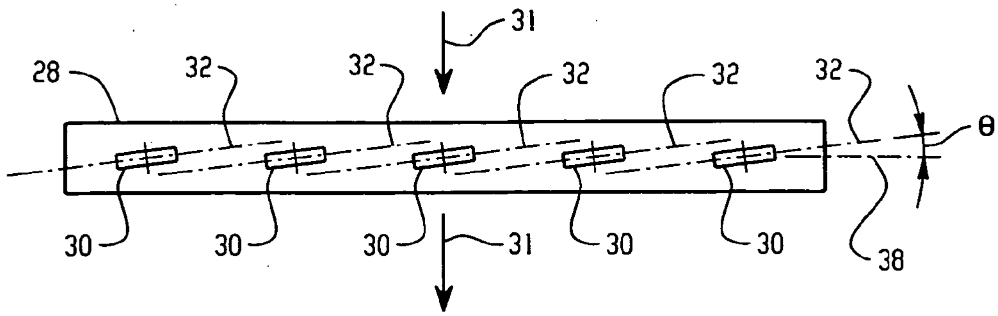


Fig. 3

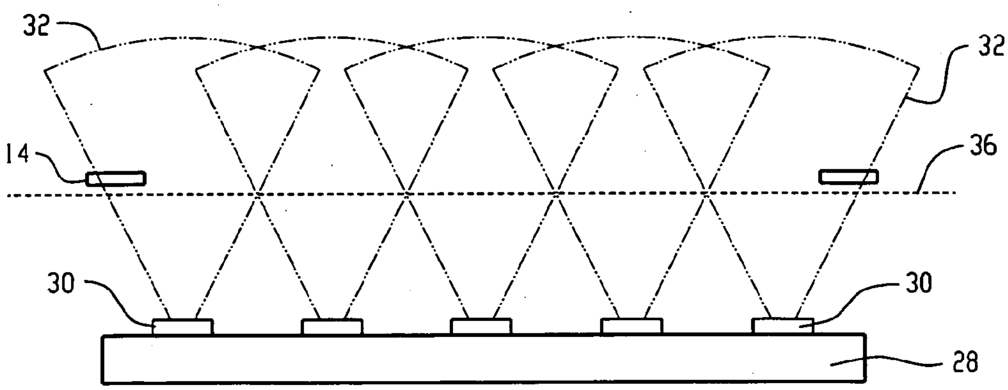


Fig. 4

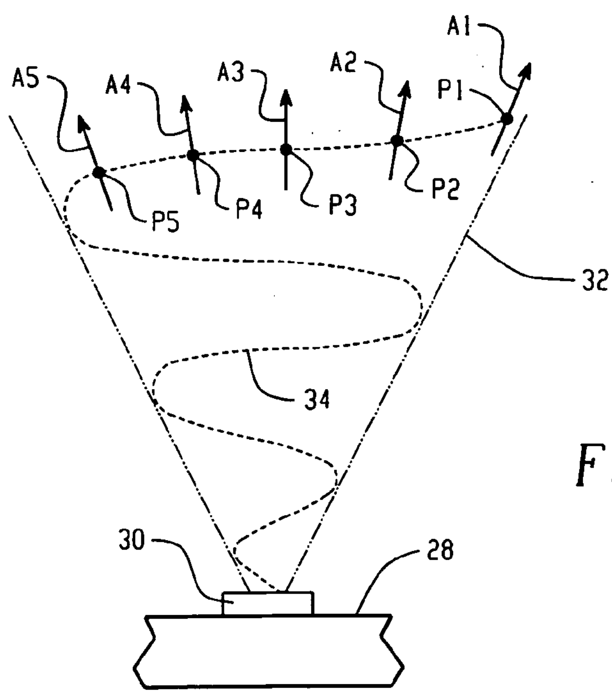


Fig. 5

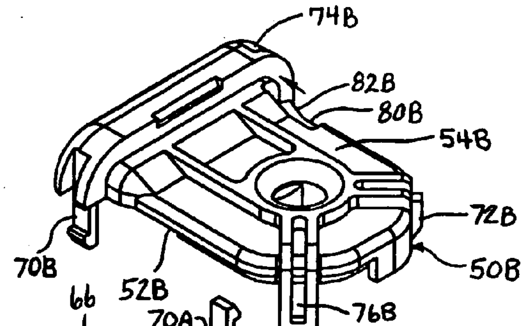


Fig. 8

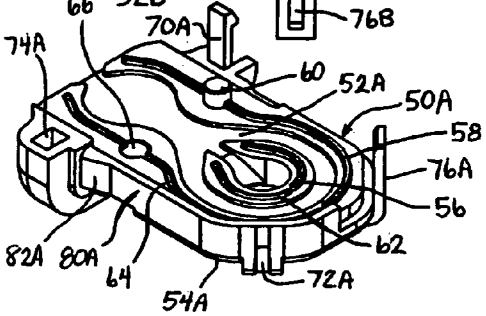


Fig. 7

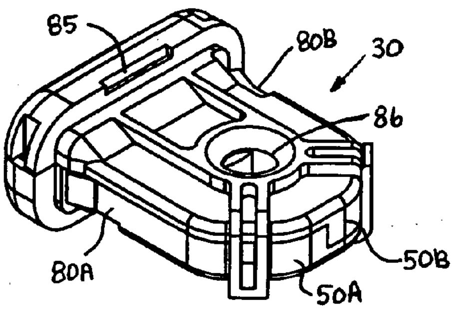


Fig. 6

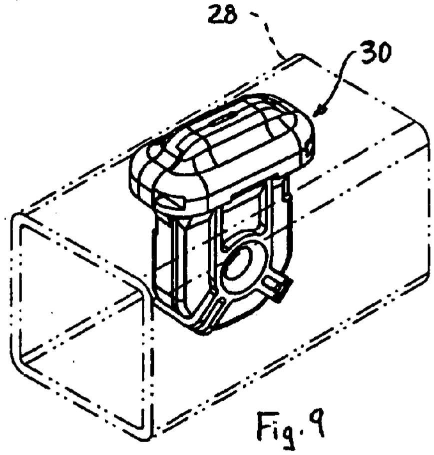


Fig. 9

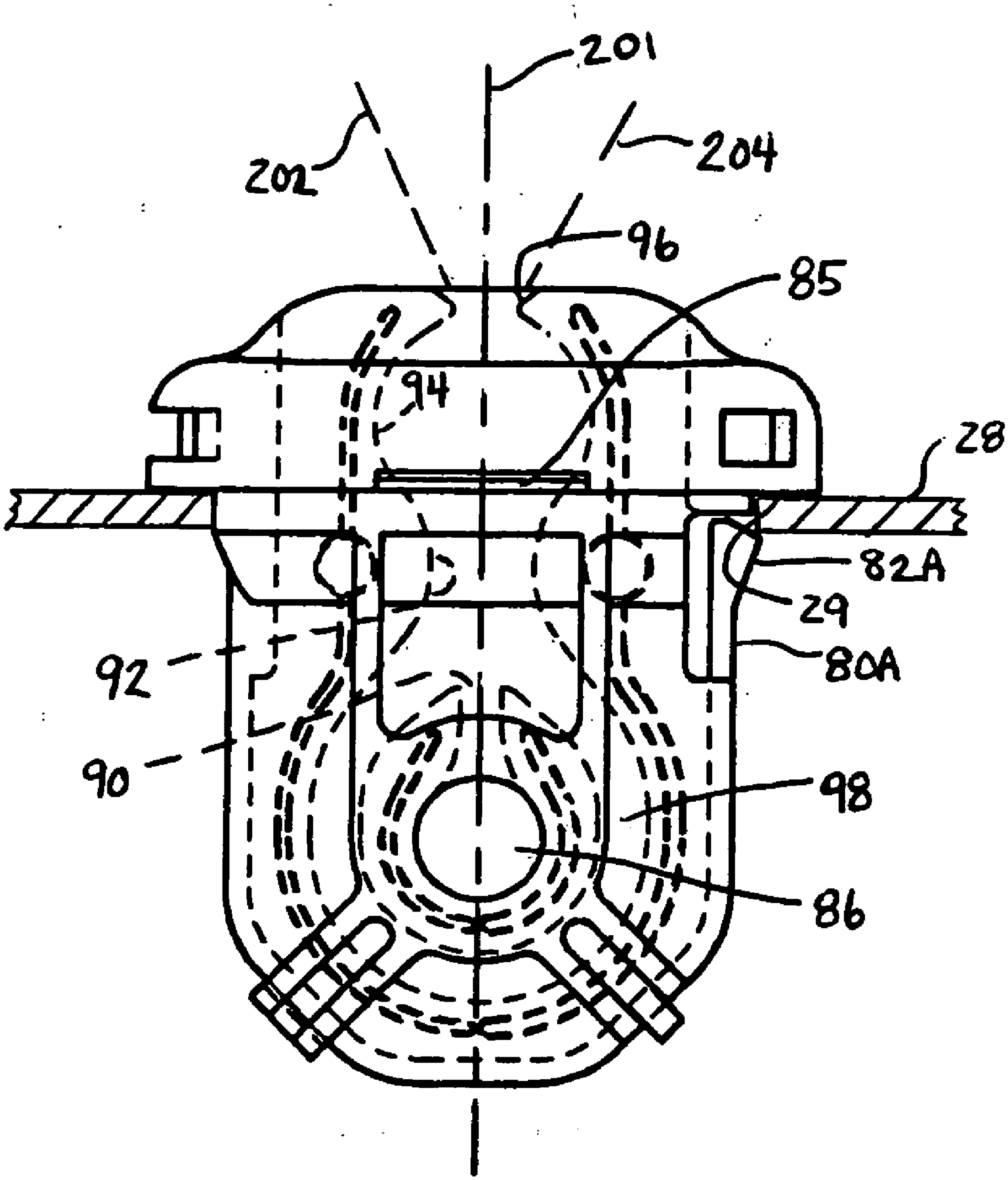


Fig. 10

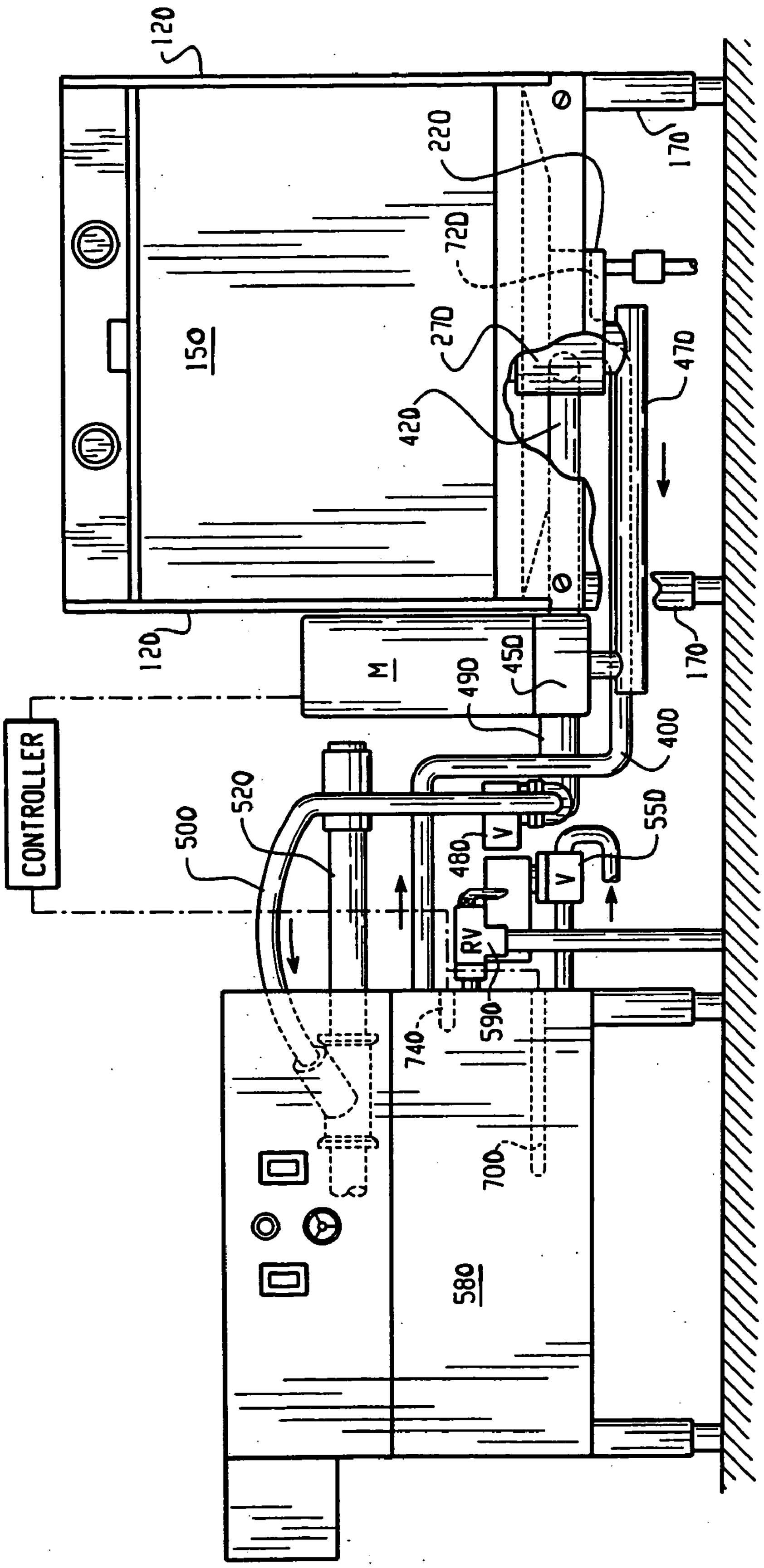

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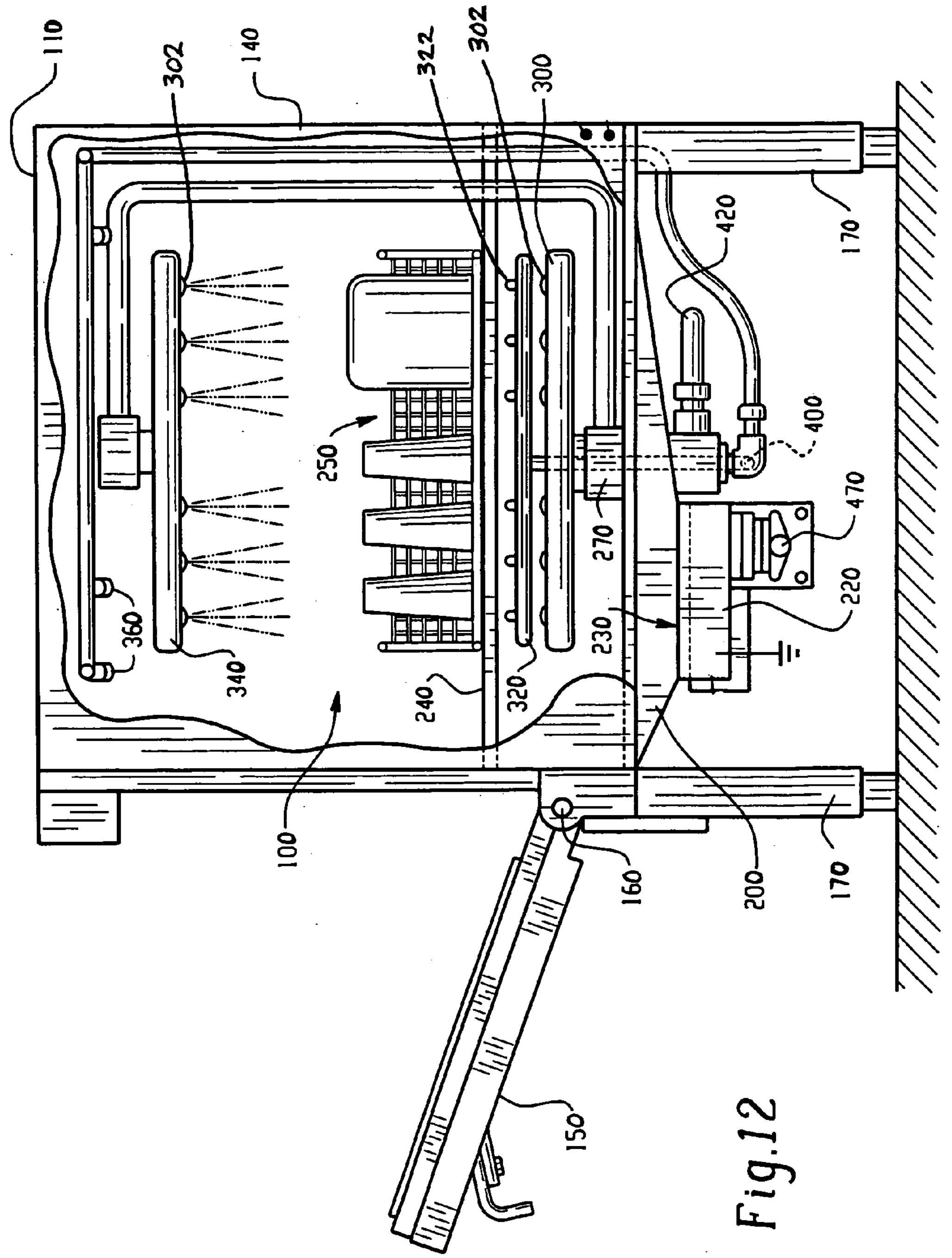
Fig. 11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150

Fig.12

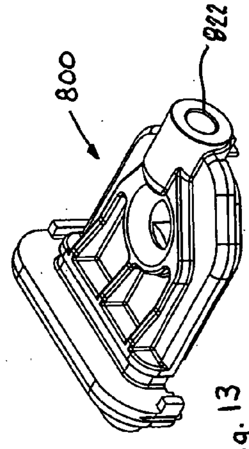

Fig. 13

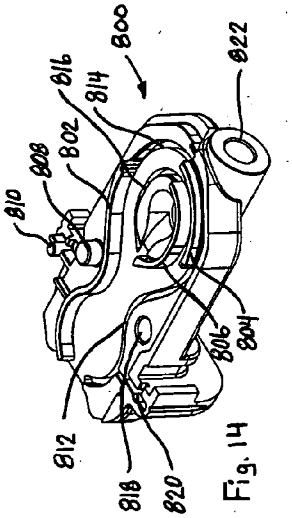

Fig. 14

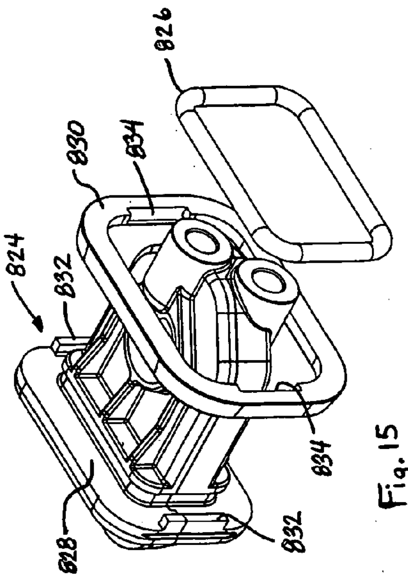

Fig. 15

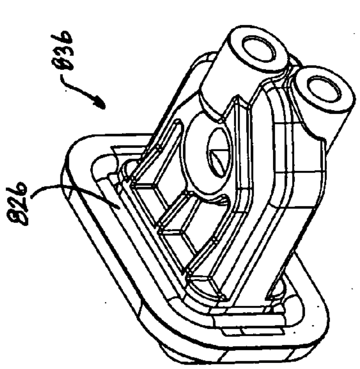

Fig. 16

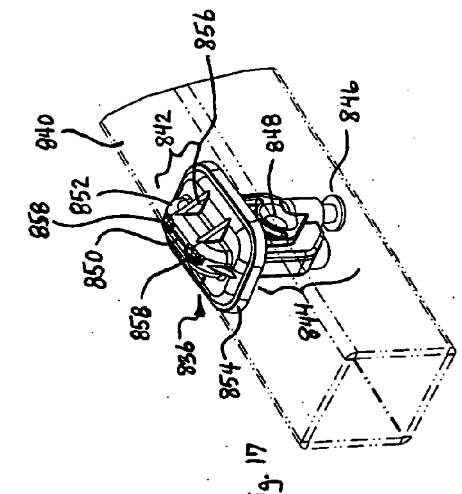

Fig. 17

WARE WASH MACHINE WITH FLUIDIC OSCILLATOR NOZZLES

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of U.S. provisional application Ser. No. 60/478,380, filed Jun. 3, 2003, the entirety of which is incorporated herein by reference.

TECHNICAL FIELD

[0002] The present application relates generally to machines used to wash kitchen wares such as dishes, glasses, utensils and pots and pans, and more particularly to a ware wash machine that makes effective use of one or more fluidic oscillator nozzles (or other variable stream orientation nozzles as defined below) in one or more areas of the machine.

BACKGROUND

[0003] It is known to provide varying types of ware wash machines. Two of the most common types of commercial machines are the single rack-type box unit and the conveyor-type unit. The former may include a single chamber into which a rack of soiled ware can be placed. Within the chamber, the entire cleaning process, typically including washing, rinsing and drying is performed on the rack. Multiple racks must be washed sequentially, with each rack being completely cleaned before the next can be operated upon. A conveyor-type machine, on the other hand, includes a conveyor for carrying individual items or entire racks of ware through multiple stations within the machine housing. A different operation may be carried out at each station, such as washing, rinsing, or drying. Thus, multiple items or racks of ware can be placed on the conveyor and moved continuously through the machine so that, for example, while one item or rack is being rinsed, a preceding item or rack can be dried. One difficulty encountered in the construction of such machines, regardless of type, is balancing effective washing and rinsing with the goal of limiting the amount of liquid, detergents, rinse agents and sanitizers used for such washing and rinsing.

SUMMARY

[0004] In a ware wash machine one or more fluidic oscillator nozzles or other variable stream orientation nozzles (defined below) are used for outputting one or more of a rinse liquid, a wash liquid, and a drying or heating gas such as air (heated or unheated) or steam.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] **FIG. 1** is a perspective view of one embodiment of a conveyor-type unit;

[0006] **FIG. 2** is a side elevation of the unit of **FIG. 1**;

[0007] **FIGS. 3 and 4** shows one embodiment of a rinse arm;

[0008] **FIG. 5** depicts an oscillating output stream of a fluidic oscillator nozzle;

[0009] **FIG. 6-10** illustrate one embodiment of a fluidic oscillator nozzle;

[0010] **FIGS. 11-12** illustrate one embodiment of an undercounter ware wash box-type unit; and

[0011] **FIGS. 13-17** illustrate another embodiment of a fluidic oscillator nozzle.

DETAILED DESCRIPTION

[0012] Referring to **FIGS. 1 and 2**, a conveyor-type unit **10** includes a housing **12** with a conveyor **14** extending therethrough. The conveyor **14** may be formed by spaced apart belts or a dog-type system as described in U.S. Pat. No. 6,559,607. Other types of conveyor systems could also be used, including conveyors pre-formed with structures for receiving and supporting individual wares. Whatever the construction of the conveyor, the region generally above the conveyor represents a ware receiving area within the housing **12**.

[0013] The unit **10** includes an entry side **16** and an exit side **18**. A wash section **20** within the housing includes one or more wash arms **22** for directing wash liquid or other wash media onto wares traveling along the conveyor **14**. The wash liquid may be recirculated by a suitable pump through a wash liquid tank **24** located beneath the wash section to receive the wash liquid as it falls from the wares. The tank **24** may typically include an overflow drain as well as a manual or automatic drain mechanism to enable draining of the entire tank **24**. In the illustrated embodiment the wash arms **22** are located beneath the conveyor **14** to direct wash liquid upward onto the wares. Other locations for the wash arms **22** are possible, including toward the top of the housing and on the sides of the housing. A rinse section **26** located downstream of the wash section **20** includes rinse arms **28** that direct rinse liquid onto wares traveling along the conveyor **14**. In the illustrated embodiment, an upper rinse arm directs rinse liquid downward onto the wares and a lower rinse arm directs rinse liquid upward onto the wares. Other locations for the rinse arms are possible, such as toward the sides of the housing.

[0014] Referring now to the exemplary rinse arm **28** shown in **FIG. 3**, the arm includes a plurality of fluidic oscillator nozzles **30** positioned thereon for outputting respective streams of rinse liquid. A fluidic oscillator nozzle is generally any nozzle that outputs an oscillating stream of fluid, meaning that the direction of the output stream of fluid varies in an oscillatory manner as will be described in greater detail below. In the case of liquids, the stream of liquid is typically made up of a series of drops of the liquid being output. The resulting fan-shape **32** covered by the sweep of the output stream of each nozzle is best seen in **FIG. 4**, with the output stream **34** at a given moment in time reflected in **FIG. 5**. Arrows A1-A5 reflect the instantaneous direction of different points or drops (P1-P5) of the stream output by the port at respectively different times, A1 representing instantaneous direction for point or drop P1 of the stream output at an earliest point in time, A2 representing instantaneous direction for point or drop P2 output at a later time and so on. The illustrated arm **28** includes five nozzles **30**, but the number could vary considerably. In one example the lower rinse arm **28** includes six nozzles **30** and the upper rinse arm includes five nozzles. The illustrated rinse arm has an axis that extends substantially perpendicular to the direction of the conveyor, but it is recognized that variations on this orientation are possible.

[0015] In the illustrated embodiment, the rinse arm **28** in a direction across a conveying direction (arrows **31** of **FIG. 3** and into or out of the page in **FIG. 4**) of the ware conveyor **14** and the fluidic oscillator nozzles **30** are located to assure that rinse liquid covers an entire lateral area of the conveyor. In particular, where the rinse arm is a lower rinse arm, the fan-shaped lateral coverage of the streams overlaps at a location/height **36** that is just below the level of the conveyor **14**. Further, in the illustrated embodiment each of the plurality of fluidic oscillator nozzles **30** is oriented to prevent its output oscillating stream from interfering with oscillating streams output by adjacent fluidic oscillator nozzles. In one example this result is achieved by orienting each nozzle **30** to output its oscillating stream such that oscillating movement of ejected liquid occurs at an angle θ relative to a longitudinal axis **38** of the rinse arm **28**. In other words, the sweep of the nozzles is skewed to prevent the interference while still assuring complete coverage across the width of the conveyor. In one example, the angle θ may be in the range of about two to ten degrees, but variations are possible, including angles from zero to ninety degrees. Further, it is recognized that constructions in which adjacent fluid streams interfere with each other are possible.

[0016] Fanjet nozzles output water in a spread pattern, with drops simultaneously output in multiple directions within the spread, rather than outputting a stream of drops with changing instantaneous direction as fluidic oscillator nozzles do. Fluidic oscillator nozzles can provide an advantage of larger output drop size (in the case of liquids) for a given flow rate than commonly used fanjet nozzles having the same flow rate, providing better washing or rinsing and also reducing heat loss to the air. In one example, fluidic oscillators outputs rinse liquid with an average drop size at least twenty-five percent greater than that output by a typical fanjet nozzle having the same flow rate. It is contemplated that the nozzles will typically be fed by a relatively constant pressure fluid, but a pulsing output from the nozzles could be produced, as by using a liquid manifold having an associated variable pressure mechanism to vary the pressure within the liquid manifold in a pulsed manner.

[0017] One embodiment of a fluidic oscillator nozzle **30** of the rinse arm **28** is shown in **FIGS. 6-10**. The nozzle **30** includes a first nozzle side part **50**A, a second nozzle side part **50**B constructed separate from the first nozzle side part **50**A and connected to the first nozzle side part to form a functioning, complete fluidic oscillator nozzle **30**, wherein the first nozzle side part **50**A and second nozzle side part **50**B are identical in shape and configuration. Each nozzle side part may be of unitary, molded plastic construction, with a Polyvinylidene Fluoride (PVDF) homopolymer representing one acceptable material. It is also recognized that other plastics could be used, or the nozzle could be constructed of other materials including, by way of example, metallic materials or ceramics. Further, rather than being molded, other construction techniques for the nozzle side parts could be used including, by way of example, machining, etching, forming and EDM.

[0018] The nozzle side parts **50**A and **50**B have respective internal sides **52**A and **52**B and respective external sides **54**A and **54**B. The internal sides have identical protrusions (e.g., curved ridge **56**, curved ridge **58** and post **60**) and identical recesses (e.g., curved recess **62**, curved recess **64** and post receiving aperture **66**). In final construction, the first nozzle side part **50** is arranged in mirror image orientation relative to and adjacent the second nozzle side part **52** such that the protrusions of the first nozzle side part frictionally engage into the recesses of the second nozzle side part and the protrusions of the second nozzle side part frictionally engage into the recesses of the first nozzle side part. Such engagement aids in holding the side parts together and also performs a sealing function for the cavity formed internal of the nozzle **30**.

[0019] Both the first nozzle side part **50** and the second nozzle side part **52** include at least one exterior mating finger (e.g., flexible fingers **70**A, **70**B and rigid fingers **72**A, **72**B) and at least one exterior mating opening (e.g., fixed openings **74**A, **74**B and movable openings **76**A, **76**B). In final construction the first nozzle side part **50** is arranged in mirror image orientation relative to and adjacent the second nozzle side part **52** such that the exterior mating finger(s) of the first nozzle side part engage the exterior mating opening(s) of the second nozzle side part and the exterior mating finger(s) of the second nozzle side part engages the exterior mating opening(s) of the first nozzle side part.

[0020] The nozzle may also include at least two flexible fingers **80**A and **80**B to facilitate snap-fit insertion of the nozzle into an appropriately sized and shaped opening **29** of the rinse arm, such fingers including respective surfaces **82**A, **82**B ramped to engage an opening during insertion to flex the fingers to an insertion position (e.g., inward toward the nozzle body), and the fingers returning to a holding position (**FIG. 10**) after insertion. The protruding part of the nozzle **30** includes a notch **85** to receive a tool (such as a screwdriver) to enable removal of the nozzle from the opening as by a prying operation. In one example, the protruding part of the nozzle may protrude no more than about 0.4 inches in order to reduce the potential for nozzle breakage, but variations on this distance are possible. In alternative embodiments, the nozzle may include exterior threads to facilitated engagement with the opening in the opening **29**. In the case of metal nozzles, they could be welded to the rinse arm or other manifold. The use of fasteners is also contemplated.

[0021] While the foregoing nozzle description primarily contemplates a nozzle in which the identical side parts are snap-fit together, it is recognized that other connection techniques could be used. For example, connection by one of an adhesive, one or more fasteners, a welding operation, such as ultrasonic welding for plastics, or a brazing operation (for metals) might be used. Further, while the foregoing nozzle description primarily contemplates first and second nozzle side parts constructed separately, they could be constructed together (e.g., as in a clamshell-type configuration including a connecting hinge could be provided between a single molded plastic piece including the two side parts, enabling the side parts to be folded against each other and connected together, as by any suitable technique previously mentioned, to form the internal cavity of the nozzle). Still further, a one piece nozzle construction could also be used. For example, an investment cast one-piece nozzle could be used.

[0022] Referring again to **FIG. 10**, a description of the internal cavity of the illustrated nozzle is provided. The nozzle includes openings **86** on opposite sides (e.g., each side part is formed with an opening that will lead to the internal cavity when the side parts are connected). In particular, the openings lead to an orifice **90**. The size of the orifice **90** in combination with the pressure of the fluid delivered thereto controls the flow rate of the nozzle **30**. The fluid stream exiting the orifice **90** is directed towards a throat **92** that opens to a body portion **94** having an associated exit port **96** through which the fluid stream is output from the nozzle **30**. A feedback loop **98** located adjacent the orifice **90** provides a changing pressure differential to vary the direction of the output fluid stream in an oscillating manner. In particular, the fluid stream output from the orifice **90** tends to attach to one sidewall of the throat **92** and as a result of the "Coanda Effect" follows that wall through the body portion **94**. When the fluid stream attaches to one sidewall it tends to create a low pressure condition on the same side of the feedback loop **98** due to the high speed flow near that side of the feedback loop **98**. As a result, fluid is drawn around the feedback loop toward the low pressure region and toggles the fluid stream exiting the orifice **90** toward the opposite sidewall of the throat **92**. These conditions repeat and the fluid stream exiting the orifice **90** repeatedly moves back and forth attaching to the two opposed sidewalls and thus oscillating its direction when output from the port **96** as best seen in **FIG. 5**. The angular orientation or instantaneous direction of the output stream with respect to an axis **201** of the nozzle varies over time. In particular, in the illustrated embodiment the output stream oscillates back and forth relative to a plane extending in and out of the page in **FIG. 10**, where the illustrated nozzle axis **201** lies in the plane. The two extremes of oscillation are represented at **202** and **204**. For ease of reference the illustrated nozzle axis **201** is defined by a line passing though the center point of the nozzle port **96** and the center point of the orifice **90**. However, the angular orientation or instantaneous direction of the output stream can be said to vary relative to any nozzle axis defined by a line passing through any two spaced apart points on the nozzle, where the relative position between the two spaced apart points does not change.

[**0023**] Varying degrees of oscillation can be achieved by modifying the nozzle configuration. Oscillating frequency is also affected by fluid pressure and medium (e.g., gas or liquid). Further, the shape and orientation of the feedback loop provided within the nozzle could vary significantly.

[**0024**] It is recognized that the foregoing nozzle construction is one of many possible fluidic oscillator nozzle constructions that could be used. Further, while the typical fluidic oscillator nozzle construction provides an output stream that, more or less, moves back and forth in two-dimensions along a plane, it is contemplated that other fluidic oscillator nozzle constructions could be used where the oscillation occurs in three dimensions. Further, it is also recognized that nozzle constructions in which the output stream technically does not "oscillate" are possible, such as an output stream that moves in one direction to produce a helical or cylindrical output, an expanding helical or cone-shaped output or an output stream having an orientation that varies randomly/chaotically relative to the axis of the nozzle. As used herein the terminology "variable stream orientation nozzle" is intended to encompass any and all such nozzle constructions that output a stream of fluid with an instantaneous direction that varies over time relative to a nozzle axis, regardless of whether the variance is regular, random, oscillating or non-oscillating.

[**0025**] The wash arms **22** could also include fluidic oscillator nozzles or other variable stream orientation nozzles positioned therein to direct wash fluid onto the wares. It is generally contemplated that the wash arm nozzles would be constructed to produce a higher flow rate than the rinse arm nozzles, but variations are possible, including the use of identical nozzles for both rinse and wash.

[**0026**] While the foregoing embodiment of the conveyor-type ware wash machine contemplates a single wash section **20** and a single rinse section **26**, it is recognized that conveyor-type machines having multiple wash sections and/or multiple rinse sections could be provided. It is further contemplated that other sections could be provided within the machine, such as an upstream pre-wash section using one or more variable stream orientation nozzles to output a pre-wash liquid to remove larger food materials from wares or to output steam, a downstream sanitizing section using one or more variable stream orientation nozzles to output a sanitizing liquid, a downstream drying section using one or more variable stream orientation nozzles to output air (heated or unheated) or some other gas for drying, or a downstream heating section in which heated air or steam is output by one or more variable stream orientation nozzles to heat the wares for sanitizing purposes.

[**0027**] Moreover, use of fluidic oscillator nozzles in undercounter and other box units is also contemplated. For example, referring to **FIGS. 11 and 12**, an exemplary undercounter unit is shown and includes a washing/rinsing chamber **100** that is defined by a cabinet, housing usually formed of stainless steel panels and components, and including a top wall **110**, side walls **120** and rear wall **140**, and a front facing door **150**, hinged at its lower end, as indicated at **160**. The chamber **100** is vented to ambient pressure through labyrinth seals (not shown) near the top wall. The cabinet is supported upon legs **170** which provide the clearance for the underside of the machine to permit cleaning beneath it as may be required by various-local sanitation codes. At the bottom of the chamber, as part of the sloping bottom wall **200** of the cabinet, is a relatively small sump **220** that may have a removable strainer cover **230**.

[**0028**] Above the bottom wall, rails **240** provide support for standard ware racks **250**, loaded with ware to be washed and sanitized, which are loaded and unloaded through the front door. The rack **250** may be a rolling rack intended to remain with the unit or may be a mobile rack intended to be removed entirely when the wares are removed. A coaxial fitting **270** is supported on the lower wall **200**, centrally of the chamber, and this fitting in turn provides support for a lower wash arm **300** and lower rinse arm **320**, each being rotational as is common. An upper wash arm **340** and upper rinse spray heads **360** are supported from the top wall of the chamber. The wash arms **300** and **340** may include suitable fluidic oscillator nozzles **302** (or other variable stream orientation nozzles) incorporated therein (e.g., as in the manner previously described with respect to **FIG. 9** or any other suitable manner). Likewise rinse arm **320** may include suitable fluidic oscillator nozzles **322** (or other variable stream orientation nozzles), and the spray heads **360** may include suitable fluidic oscillator nozzles (or other variable stream orientation nozzles).

[**0029**] The fresh hot rinse water supply line **400** extends from a source of hot water and is connected to the rinse arm

320 and rinse spray heads **360**. The wash water supply line **420** is connected to the upper and lower wash arms **340** and **300**, and receives wash water from a pump **450** mounted to one side of and exterior of the cabinet. The pump in turn is supplied from an outlet pipe **470** that extends from sump **220** and returns or recirculates the wash water sprayed over the ware in the rack during the wash segment of the machine cycle. Thus, during the wash portion of an operating cycle, pump **450** functions as a recirculating pump means.

[**0030**] A solenoid operated drain valve **480** is connected by a branch or drain pipe **490** to the wash water supply line **420** immediately downstream of the outlet of pump **450**, and this valve when open allows flow of the pump discharge to a drain line **500** that may be connected into a suitable kitchen drain system **520**, according to the applicable code regulations. In many kitchens in newer fast food restaurants the drain system may be considerably above the floor, thus the pumped discharge from the dishwasher is a desired feature in those installations. Also, when the drain valve is open, the path of least resistance to the pump output is through drain valve **480**, and flow through the recirculating wash plumbing quickly diminishes due to back pressure created at the nozzles of the wash arms. At this time the pump **450** functions as a drain pump means. During the normal cycle of operations of this machine, drain valve **480** is opened once each cycle of operation, after the wash segment and before the rinse segment of the cycle.

[**0031**] A solenoid-operated fill valve **550** is connected, in the embodiment shown, to control the supply of fresh water to a booster heater tank **580**, which is a displacement type heater tank having its inlet connected to receive water through fill valve **550**, and its outlet connected to the fresh rinse water supply line **400**. The booster heater has a heating element **700** and has the usual pressure relief valve **590** which will divert hot water through an overflow pipe in the event the tank pressure exceeds a predetermined value. While the illustrated booster heater tank **580** and pump **450** are shown alongside the main dishwasher housing, it is recognized that embodiments in which the pump **450** and booster are provided internal to the main housing, such as beneath the wash chamber, are within the contemplated scope of the various inventions described herein.

[**0032**] Also, a low capacity (e.g. 500 W) heater **720** may be located in or on the sump **220**. Such a heater may be, for example, a wire or similar heating strip embodied in an elastomeric pad that can be adhered to the exterior of the sump to heat water in the machine by conduction, if necessary. The heater **720** may alternatively be provided internally.

[**0033**] The undercounter unit of **FIGS. 11 and 12** could also incorporate one or more variable stream orientation nozzles that output a gaseous fluid, such as air (heated or unheated) or steam, and it is recognized that numerous variations on undercounter units or other box units are possible.

[**0034**] Referring now to **FIGS. 13-17**, an alternative embodiment of a fluidic oscillator nozzle and its installation in a rinse or wash arm is shown. **FIGS. 13 and 14** represent identical nozzle halves **800** oriented on the page in a manner that permits them to be fitted together to form a functional nozzle. The internal side of each nozzle half **800** includes protrusions (e.g., curved protrusions **802**, **804** and **806**, and posts **808** and **810**) that mate with corresponding recesses (e.g., curved recesses **812**, **814** and **816** and cylindrical openings **818** and **820**) on the other nozzle half in a friction fit manner to aid in holding the two nozzle halves together in assembled form. An ultrasonic welding process, solvent welding process or heat and pressure welding process may also be used to more permanently connect the nozzle halves together. Screws or other fasteners could also be used in addition to or in place of the welding and/or friction fit. Each nozzle half **800** also includes a boss **822**, which can be used for connecting the nozzle in a wash or rinse arm as described in further detail below. Notably, the orifice, throat, body portion, output port and feedback loop of the nozzle created by combined nozzle halves **800** are all primarily defined by the curved protrusions **802**, **804** and **806**.

[**0035**] As shown in **FIG. 15**, nozzle halves **800** combine to form a functional nozzle **824**. A gasket/seal **826** may be provided for location against surface **828** of the nozzle, with gasket housing **830** provided to limit the outward movement of the gasket **826**. Protrusions **832** of the nozzle **824** are sized for frictionally fitting in recesses **834** of the gasket housing **830** to hold the components together in the nozzle assembly form **836** shown in **FIG. 16**.

[**0036**] Nozzle assembly **836** is shown mounted in exemplary wash or rinse arm **840** in **FIG. 17**, with portion **842** of the assembly protruding from the arm **840** and with portion **844** internal to the arm **840**. A screw **846** is positioned through an opening in the bottom of the arm and threaded into boss **822** to secure the nozzle assembly **836**, with the screw tightened sufficiently to cause the gasket **826** to form a seal against the top of the arm **840**. Fluid under pressure within the arm **840** flows into inlet opening **848** of the nozzle and is ejected from exit port or orifice **850** in an oscillating manner as previously described. Notably, exit port **850** is located near the top of an upwardly projecting nozzle head **852** of the nozzle assembly, where nozzle head **852** is surrounded by a mounting flange **854** having an underside adjacent the top surface of arm **840**. Ribs **856**, which may be molded with the nozzle, are disposed at multiple locations around the nozzle head **852** and provide increased stiffness to aid in keeping the nozzle head from breaking or bending if impacted by wares or anything else within the ware wash machine. The ribs can also aid in keeping the nozzle part flat during molding and when the nozzle halves **800** are welded together. Nozzle port guards **858**, illustrated in the form of projecting bumps, are disposed on opposite sides of the nozzle port **850**. The port guards **858** project above the nozzle port **850** so that the port guards **858** are in position to be impacted before the nozzle port **850**. In the event the arm **840** is removed from a warewash machine for cleaning, it is possible that the arm **840** could be subjected to impacts, such as an operator banging the arm against a sink or other structure. In such cases the nozzle guards **858** should take the brunt of any impact instead of the nozzle port **850**, thereby preventing or limiting damage/deformation of the nozzle port **850**, which could adversely affect the spray pattern of the nozzle.

[**0037**] It is to be clearly understood that the above description is intended by way of illustration and example only and is not intended to be taken by way of limitation. For example, while the nozzles are primarily described in association with manifolds in the form of stationary or rotating wash arms and/or rinse arms, it is recognized that other manifold types could be used, such as an oscillating arm or the wall of a wash chamber housing where the area behind the wall constitutes a manifold and nozzles are fixed in openings of the wall. Further, a manifold is not required, as each nozzle could be supplied with its fluid (liquid or gas) by an individual line not associated with any manifold. While it is contemplated that the delivery of any one fluid (e.g., any one of a rinse liquid, wash liquid or drying gas) will most often utilize multiple nozzles, it is possible that a machine could use a single nozzle to deliver a given fluid, or that the same nozzle or nozzles could be used to deliver multiple different fluids during different stages of a ware wash operation. Further, while the primary embodiments and examples described above contemplate nozzles that are fixed relative to some type of manifold, it is recognized that the nozzles could move relative to the structure to which they are mounted. Further, the terms "rinse liquid" and "wash liquid" are to be construed broadly, as each could be comprised of heated or unheated water, any heated or unheated water solution (e.g., water plus detergent as a wash liquid or water plus a rinse agent or/sanitizing agent as a rinse liquid), or in some cases non-aqueous liquids. Other changes and modifications could be made.

What is claimed is:

1. A ware wash machine, comprising:

a housing including an area for receiving wares to be washed;

at least one variable stream orientation nozzle positioned within the housing and arranged for outputting a stream of fluid with an instantaneous direction that varies over time relative to a nozzle axis, the stream at least sometimes directed towards the area for contacting wares.

2. The ware wash machine of claim 1 wherein the variable stream orientation nozzle is a fluidic oscillator nozzle connected with a source of liquid.

3. The ware wash machine of claim 2, further comprising:

at least one liquid manifold located within the housing and acting as the source of liquid and having a plurality of fluidic oscillator nozzles associated therewith, each one of the fluidic oscillator nozzles arranged for outputting an oscillating stream of liquid towards the area for contacting wares.

4. The machine of claim 3 wherein the at least one liquid manifold comprises at least one rinse arm supplied by a rinse liquid.

5. The machine of claim 4 wherein the rinse arm is stationary.

6. The machine of claim 5 wherein the rinse arm extends in a direction across a conveying direction of a ware conveyor that extends through the housing, the fluidic oscillator nozzles are located to assure that rinse liquid covers an entire lateral area of the conveyor, and each of the plurality of fluidic oscillator nozzles is oriented to prevent its output oscillating stream from interfering with oscillating streams output by adjacent fluidic oscillator nozzles.

7. The machine of claim 5 wherein each of the fluidic oscillator nozzles is oriented to output its oscillating stream such that oscillating movement of ejected liquid occurs at an angle offset from a longitudinal axis of the rinse arm.

8. The machine of claim 4 wherein the at least one rinse arm includes a first rinse arm located below a ware conveyor that extends through the housing and a second rinse arm located above the ware conveyor.

9. The machine of claim 4 wherein the rinse arm is connected for movement within the housing.

10. The machine of claim 4 wherein when the rinse arm is supplied by rinse liquid at 20 psi, rinse liquid is collectively output by the plurality of fluidic oscillators associated with the rinse arm at no more than about 3 gallons/min.

11. The machine of claim 10 wherein each of the plurality of fluidic oscillator nozzles outputs rinse liquid at no more than about 0.3 gallons/min.

12. The machine of claim 11 wherein each of the plurality of fluidic oscillators outputs rinse liquid with an average drop size at least twenty-five percent greater than that output by a fanjet nozzle having the same flow rate.

13. The machine of claim 3 wherein the manifold comprises at least one wash arm supplied by a wash liquid.

14. The machine of claim 3 wherein the at least one liquid manifold comprises a tubular member with a plurality of openings therein and a multiplicity of the fluidic oscillators are each positioned in a respective one of the openings.

15. The machine of claim 14 wherein the tubular member includes at least one substantially flat side and the openings are located in the substantially flat side.

16. The machine of claim 14 wherein each of the multiplicity of the fluidic oscillator nozzles is constructed entirely of plastic.

17. The machine of claim 14 wherein each of the multiplicity of the fluidic oscillator nozzles includes a first portion internal of the tubular member and a second portion extending from the tubular member, each second portion extending no more than about 0.4 inches from the tubular member.

18. The machine of claim 14 wherein each of the multiplicity of the fluidic oscillator nozzles is formed by first and second pieces that are pressed together.

19. The machine of claim 18 wherein the first and second pieces are identical to each other.

20. The machine of claim 19 wherein the first and second pieces are press-fit together.

21. The machine of claim 20 wherein the first and second pieces are further welded together.

22. The machine of claim 14 wherein each of the multiplicity of the fluidic oscillator nozzles includes a portion extending from the tubular member, and such portion includes a removal notch for receiving a tool to facilitate prying the fluidic oscillator nozzle from its opening.

23. The machine of claim 14 wherein each of the multiplicity of the fluidic oscillators is snap-fit into its respective one of the openings.

24. The machine of claim 14 wherein each of the multiplicity of the fluidic oscillators is held in its respective one of the openings by a fastener.

25. The machine of claim 24 wherein each of the multiplicity of the fluidic oscillator nozzles includes a mounting flange and a gasket is positioned between the mounting flange and tubular member.

26. The machine of claim 1, further comprising:

a ware rack within the housing to locate the wares in the area.

27. The machine of claim 2 wherein each fluidic oscillator nozzle includes at least one nozzle port guard adjacent its output port.

28. The machine of claim 27 wherein each fluidic oscillator nozzle includes a raised nozzle head surrounded by a mounting flange, with a plurality of spaced apart support ribs extending from the mounting flange to the raised nozzle head.

29. The machine of claim 1, further comprising:

at least one of:

(i) a ware conveyor extending through the housing for carrying wares through the housing, and

(ii) a ware holding rack movable between a position within the housing for cleaning wares and a position exterior from the housing for loading and unloading wares.

30. The machine of claim 1 wherein the nozzle is positioned in a stationary arm within the housing.

31. The machine of claim 1 wherein the nozzle is positioned in a moving arm within the housing.

32. The machine of claim 1 wherein the source of fluid is a source of a liquid.

33. The machine of claim 32 wherein the liquid is one of a wash liquid and a rinse liquid.

34. The machine of claim 1 wherein the source of fluid is a source of a drying gas.

35. The machine of claim 1 wherein the source of fluid is a steam.

36. The machine of claim 1 wherein the instantaneous direction of the stream of fluid varies in an oscillatory manner.

37. The machine of claim 1 wherein the instantaneous direction of the stream of fluid varies in three dimensions.

38. The ware wash machine of claim 1 wherein:

at least one wash liquid variable stream orientation nozzle is located within the housing and arranged for outputting a stream of wash liquid that is at least sometimes directed towards wares within the housing; and

at least one rinse liquid variable stream orientation nozzle is located within the housing and arranged for outputting a stream of rinse liquid that is at least sometimes directed towards wares within the housing.

39. The machine of claim 38 wherein the at least one wash liquid variable stream orientation nozzle is located in a mobile wash arm within the housing and the at least one rinse liquid variable stream orientation nozzle is located in a mobile rinse arm within the housing.

40. The machine of claim 38 wherein the at least one wash liquid variable stream orientation nozzle is located in a stationary wash arm within the housing and the at least one rinse liquid variable stream orientation nozzle is located in a stationary rinse arm within the housing.

41. The machine of claim 1 wherein the nozzle axis passes through a center of an output port of the variable stream orientation nozzle.

42. A variable stream orientation nozzle, comprising:

a first nozzle side part;

a second nozzle side part connected to the first nozzle side part to form a functional variable stream orientation nozzle;

wherein the first nozzle side part and second nozzle side part are identical in shape and configuration.

43. The nozzle of claim 42 wherein both the first nozzle side part and second nozzle side part are of unitary construction.

44. The nozzle of claim 43 wherein both the first nozzle side part and the second nozzle side part are of molded plastic construction.

45. The nozzle of claim 44 wherein both the first nozzle side part and the second nozzle side part are formed of a PVDF polymer.

46. The nozzle of claim 42 wherein both the first nozzle side part and the second nozzle side part include internal sides having identical protrusions and recesses, the first nozzle side part is arranged in mirror image orientation relative to and adjacent the second nozzle side part such that the protrusions of the first nozzle side part frictionally engage into the recesses of the second nozzle side part and the protrusions of the second nozzle side part frictionally engage into the recesses of the first nozzle side part.

47. The nozzle of claim 42 wherein both the first nozzle side part and the second nozzle side part include at least one exterior mating finger and at least one exterior mating opening, the first nozzle side part is arranged in mirror image orientation relative to and adjacent the second nozzle side part such that the exterior mating finger of the first nozzle side part engages the exterior mating opening of the second nozzle side part and the exterior mating finger of the second nozzle side part engages the exterior mating opening of the first nozzle side part.

48. The nozzle of claim 42 wherein the nozzle includes at least two flexible fingers to facilitate snap-fit insertion of the nozzle into an appropriately sized and shaped opening.

49. The nozzle of claim 42 wherein the nozzle includes at least two fastener receiving bosses.

50. The nozzle of claim 42 wherein the first nozzle side part and second nozzle side part are connected by one of an adhesive, one or more fasteners, a welding operation or a brazing operation.

51. The nozzle of claim 42 wherein the nozzle comprises a fluidic oscillator nozzle.

52. The nozzle of claim 42 wherein the nozzle includes a nozzle outlet port and at least one nozzle port guard adjacent to the nozzle port.

53. The nozzle of claim 42 wherein the second nozzle side part is initially formed separate from the first nozzle side part prior to being connected thereto to form the nozzle.

54. The nozzle of claim 42 wherein the first nozzle side part and second nozzle side part are constructed together.

55. The nozzle of claim 54 wherein the first nozzle side part and the second nozzle side part are initially constructed together in a clam-shell configuration.

56. The nozzle of claim 55 wherein a hinge is provided between the first nozzle side part and the second nozzle side part, the first nozzle side part is folded adjacent the second nozzle side part to form the functional variable stream orientation nozzle.

57. A fluid dispensing arm for a ware wash machine, the arm including a plurality of variable stream orientation nozzles positioned therein, the variable stream orientation nozzles being of the type defined by claim 42.

58. A method for cleaning one or more wares such as dishes, glasses, pots and pans, comprising the steps of:

directing at least one of a wash liquid, a rinse liquid, a sanitizing liquid, a drying gas and a heating gas toward the ware through a variable stream orientation nozzle.

59. The method of claim 58 wherein the variable stream orientation nozzle is a fluidic oscillator nozzle.

60. The method of claim 58 wherein at least both wash liquid and rinse liquid are directed toward the wares through respective variable stream orientation nozzles.

61. The method of claim 58 wherein steam is directed toward the wares through the variable stream orientation nozzle.

62. The method of claim wherein rinse liquid is directed toward the wares through the variable stream orientation nozzle at a flow rate of no more than about 0.3 gallons/min.

63. The method of claim 62 wherein the rinse liquid is output from the variable stream orientation nozzle with an average drop size at least twenty-five percent greater than that output by a fanjet nozzle having the same flow rate.

64. The method of claim 63 wherein the variable stream orientation nozzle is a fluidic oscillator nozzle.

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