WASHING MACHINE WITH SPARGE TUBE

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ABSTRACT

The present invention is directed to a washing machine with improvements to the hardware for direct steam injection. One improvement is a steam delivery tube (herein called a sparge tube) that penetrates a side wall above the water level, but releases steam below the water level. One improvement is a steam delivery tube (herein called a sparge tube) that penetrates a rotating side wall above the water level, but releases steam below the water level. Another improvement is the use of a curved sparge tube that can conform within and between the contours of (typically cylindrical) rotating side walls. Another improvement is a sparge tube that releases steam in a direction at least substantially parallel to the central axis of the washing chamber. Another improvement is a temperature probe that penetrates a rotating side wall above the water level, but extends and measures temperature below the water level. A controller controls the open/shut status of steam valve. This controller uses the temperature measured by the temperature probe.

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WASHING MACHINE WITH SPARGE TUBE
RELATED APPLICATION

[0001] The present application claims priority to U.S. provisional patent application No. 61/058,360, filed on Jun. 3, 2008; all of the foregoing patent-related document(s) are hereby incorporated by reference herein in their respective entirety(ies).

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention
[0003] The present invention relates to washing machines and to tunnel style washing machines having multiple modules (for example, pre wash modules, washing modules, rinse modules).

[0004] 2. Description of the Related Art
[0005] Tunnel style washing machines are conventional. In one conventional design for a tunnel style washing machine, the washing machine includes a core, or weldment, that moves and operates as a single piece. The core defines multiple modules stacked along the axis of the core piece. For each module, the core defines: (i) vertical two end walls at the axial ends of the module; (ii) a cylindrically shaped washing chamber side wall (or waterway) centered about the horizontal axis of the core; and (iii) a cylindrically shaped laundry chamber side wall, which is also centered about the horizontal axis of the core, but is located within, and spaced apart from, the waterway. The waterway is substantially fluid tight in order to hold in the washing related fluid of its module (for example, rinse fluid).

[0006] The laundry chamber contains and guides laundry undergoing washing related operations. More specifically, the laundry chamber is shaped and rotated to guide laundry with respect to the following directions: (i) in the direction of the core axis (that is, horizontally back and forth); and (ii) in a direction of rotation about the core axis. To be even more specific, when the core, including its laundry chamber rotates, it tends to move the laundry it contains in a generally helical direction so that the laundry simultaneously rotates and moves along the core axis. The rotational component of the motion imparted by the laundry chamber helps perform washing related operations, such as washing and rinsing. The linear, core-axis-direction component of the motion imparted to the laundry by the laundry chamber moves the laundry through the module. More specifically: (i) by rotating the core piece in a first direction (let's say, counterclockwise), the laundry can be drawn into the chamber through an opening in one of the end walls; (ii) by alternating rotation in the clockwise and counterclockwise directions, the laundry will maintain an essentially constant position (for washing cycle, rinsing cycle, etc.) with respect to the direction of the core axis because the linear motions imparted by the alternating clockwise and counterclockwise motions of the laundry chamber will offset each other; and (iii) by again rotating the core, including the laundry chamber, counterclockwise by more than 360 degrees, the laundry will be directed out of the module through an opening in the opposite end wall at the end of an operational cycle.

[0007] The laundry chamber is porous so that washing related fluids can get to the laundry contained in the laundry chamber. The washing related fluids are contained by the washing chamber and the end walls. Despite the fact that the washing chamber and end walls of a given module rotate with the core piece of which they form a part, the fluid level in a given module will remain relatively constant. It is noted that in some other conventional tunnel washing machine designs, the modules rotate independently of each other, rather than rotating in unison as portions of a single core piece.

[0008] FIGS. 11 and 12 shows a cross section of a module 10 of a tunnel washing machine including: outer side wall 12, inner side wall 14; wash water feed tube 30; first end wall 44. Outer side wall 12 includes: first seal portion 41 and second portion 42. Although FIGS. 11 and 12 show only a single module, conventional washing machines generally have multiple modules aligned axially for sequential treatment of laundry to be washed. For example, there may be pre-wash chamber(s), wash chamber(s), rinse chamber(s) and/or finish chamber(s). Generally a frame and housing holds these chambers in a row so that soiled laundry can be fed through the chambers to be washed.

[0009] In operation, first end wall 44 has an opening (not shown) to allow insertion of the laundry to be washed (not shown) into the interior space defined by inner side wall 14, first end wall 44 and second end wall 45. Wash water feed tube 30 then feeds water, and/or laundry-treatment-related chemicals, in the direction of arrow W into the interior space defined by outer side wall 12, first end wall 44 and second end wall 45. The wash water rises to level 16. As shown in FIG. 12, inner wall 14 is not water tight so that the wash water can freely pass through inner wall 14, even though it holds the laundry securely inside of it. In order to move the wash water over and through the laundry and perform the washing, outer side wall 12, inner side wall 14, first end wall 44 and second end wall 45 all rotate about the central axis in the rotational direction shown by double arrow R. However, wash water feed tube 30 does not rotate.

[0010] In order to simultaneously allow for rotation of outer side wall 12 and non-rotation of the wash water feed tube, seal seam 43 is defined and provided by first seal portion 41 and second seal portion 42. The first and second seal portions are made from elastic material, such as rubber, so that these portions form a seal around the wash water feed tube. The water feed tube hardware remains stationary and the seal rotates over the portion of the wash water feed tube hardware. Importantly, except where the wash water feed tube makes contact with the seal, the seal elastically self-closes so that it holds the wash water in the interior space defined by outer wall 12 (which is sometimes called the waterway).

[0011] In some conventional washing machines, the temperature of the wash water is controlled by steam. One conventional way to accomplish this is by indirect injection of the steam. Another conventional way is by direct injection of the steam. FIG. 13 shows a conventional washing chamber 50 with direct steam injection. Chamber 50 includes: outer side wall 52, inner side wall 54; laundry-related fluid feed tube 80; and direct steam injection tube 81. The direct steam injection tube injects steam 83 through opening(s) 82. It is noted that the steam is directed at the laundry being washed. It is further noted that direct steam injection tube 81 (which is stationary) penetrates the rotating outer side wall at a location below wash water level 56.

[0012] Other publications which may be of interest may include: (i) U.S. Pat. No. 4,879,887 (“Kagi”); (ii) U.S. Pat. No. 5,333,475 (“Edmundson”); (iii) U.S. Pat. No. 5,426,958 (“Sheppard 1”); (iv) U.S. Pat. No. 5,487,283 (“Sheppard 2”); (v) U.S. Pat. No. 4,546,511 (“Kaufmann”); (vi) PCT appli-
BRIEF SUMMARY OF THE INVENTION

[0014] The present invention recognizes that the direct steam injection washing chamber shown in FIG. 13 has a couple of potential problems. Particularly, because the steam tube penetrates the rotating outer side wall below the water level, there is a potential for leakage through the seal. Also, because the steam is directed directly at the laundry being washed, the steam may cause damage and/or wear to the laundry due to direct contact with the hot steam.

[0015] The present invention is directed to a washing machine with improvements to the hardware for direct steam injection. One improvement is a steam delivery tube (herein called a sparge tube) that penetrates a side wall above the water level, but releases steam below the water level. This improvement is one steam delivery tube that penetrates a rotating side wall above the water level, but releases steam below the water level. Another improvement is the use of a curved sparge tube that can conform within and between the contours of (typically cylindrical) rotating side walls. Another improvement is a sparge tube that releases steam in a direction at least substantially parallel to the central axis of the washing chamber. Preferably, the washing machine is a tunnel washing machine with multiple modules of various types, multiple sparge tubes, multiple fluid feeding tubes and multiple temperature probes.

[0016] Various embodiments of the present invention may exhibit one or more of the following objects, features and/or advantages:

[0017] (i) reduce or eliminate leakage during normal operations where a sparge tube penetrates a washing chamber wall, especially a rotating washing chamber wall;

[0018] (ii) reduces chance of catastrophic seal failure of a seal around a sparge tube;

[0019] (iii) reduces damage resulting from any catastrophic seal failure of a seal around a sparge tube;

[0020] (iv) prevents damage and/or wear to laundry due to direct contact with hot steam;

[0021] (v) prevents damage and/or wear to seal, especially a rotating seal, due to direct contact with hot steam;

[0022] (vi) allows more accurate, precise and/or responsive control of wash water temperature;

[0023] (vii) allows higher steam feed rate;

[0024] (viii) allows use of hotter steam;

[0025] (ix) faster heating rate; and/or

[0026] (x) reduces seal inversion due to direct forces on the seal interface;

[0027] (xi) diverts flow to the waterway sidewalls and applies force to hold seal in place.

[0028] According to an aspect of the present invention, a washing machine includes: a driving device; a liquid containing chamber; liquid source hardware; and a sparge tube. The liquid containing chamber is at least substantially liquid tight and defines a central axis, an angular direction and an axial direction. The liquid containing chamber includes a first side wall, a first end wall, and a second end wall. The first side wall is at least substantially in the shape of a peripheral wall of a cylinder. The first side wall includes a first seal located around the first side wall around its angular direction. The sparge tube is structured to carry and direct steam from a steam source. The liquid source hardware is structured, connected and located to fill the liquid containing chamber with liquid up to a predetermined liquid level. The driving device and liquid containing chamber are structured, located and connected so that the driving device drives the liquid containing chamber to rotate about the central axis. The sparge tube remains stationary when the liquid containing chamber rotates. The sparge tube comprises a straight portion and a curved portion. The straight portion of sparge tube is sized, shaped and located to penetrate the first side wall through the first seal at a location above the liquid level. The first seal has a rotating seal geometry to accommodate the rotation of the liquid containing chamber relative to the sparge tube. The curved portion of the sparge tube extends in the angular direction from the vicinity of the location where the straight portion penetrates the first side wall above the liquid level down below the liquid level. The curved portion of the sparge tube defines a steam release opening located below the liquid level. The steam release opening is sized, shaped and located to release steam in a direction at least substantially parallel to the central axis.

[0029] According to a further aspect of the present invention, a washing machine includes: a liquid containing chamber; liquid source hardware; and a steam conduit structured to carry and direct steam from a steam source. The liquid containing chamber is at least substantially liquid tight and includes a first wall including a first seal. The liquid source hardware is structured, connected and located to fill the liquid containing chamber with liquid up to a predetermined liquid level. The steam conduit is sized, shaped and located to penetrate the first wall through the first seal at a location above the liquid level. The steam conduit defines a steam release opening below the liquid level.

[0030] According to a further aspect of the present invention, a washing machine includes: a generally cylindrical liquid containing chamber; a liquid source hardware; and a steam conduit structured to carry and direct steam from a steam source. The liquid containing chamber is at least substantially liquid tight. The liquid containing chamber includes a first wall shaped as a peripheral wall of a cylinder. The first wall includes a first seal, and defines a central axis. The liquid source hardware is structured, connected and located to fill the liquid containing chamber with liquid up to a predetermined liquid level. The steam conduit is sized, shaped and located to penetrate the first wall through the first seal at a location above the liquid level. The steam conduit comprises a curved portion that is curved substantially in the shape of a circular arc. The curved portion, the fluid containing portion and the first seal are located, sized and shaped so that the curved portion is at least substantially co-axial with the first wall.

[0031] According to a further aspect of the present invention, a washing machine includes: a generally cylindrical liquid containing chamber; liquid source hardware; and a
steam conduit structured to carry and direct steam from a steam source. The liquid containing chamber is at least substantially liquid tight. The liquid containing chamber includes a first wall shaped as a peripheral wall of a cylinder. The first wall includes a first seal, and defines a central axis. The liquid source hardware is structured, connected and located to fill the liquid containing chamber with fluid up to a predetermined liquid level. The steam conduit defines a steam release opening below the liquid level. The steam release opening is sized, shaped and located to release steam in a direction at least substantially parallel to the central axis.

BRIEF DESCRIPTION OF THE DRAWINGS

[0032] The present invention will be more fully understood and appreciated by reading the following Detailed Description in conjunction with the accompanying drawings, in which:
[0033] FIG. 1 is a cross sectional view of a first embodiment of a washing chamber according to the present invention;
[0034] FIG. 2 is a cross sectional view of a second embodiment of a washing chamber according to the present invention;
[0035] FIG. 3 is a orthographic bottom view of a portion of the second embodiment chamber;
[0036] FIG. 4 is a cross sectional view of a third embodiment of a washing chamber according to the present invention;
[0037] FIG. 5 is a perspective view of a first embodiment of a washing machine according to the present invention including the third embodiment washing chamber;
[0038] FIG. 6 is an orthographic side view of the first embodiment washing machine;
[0039] FIG. 7 is an orthographic view of the sparge tube used in the third embodiment washing chamber;
[0040] FIG. 8 is a perspective view of the sparge tube used in the third embodiment washing chamber;
[0041] FIG. 9 is another orthographic view of the sparge tube used in the third embodiment washing chamber;
[0042] FIG. 10 is a cutaway view of a portion of the first embodiment washing machine;
[0043] FIG. 11 is an orthographic side view of a prior art washing chamber;
[0044] FIG. 12 is a cross sectional view of the prior art washing chamber of FIG. 11; and
[0045] FIG. 13 is a cross sectional view of another prior art washing chamber;
[0046] FIG. 14 is a schematic view of a portion of the third embodiment washing machine.

DETAILED DESCRIPTION OF THE INVENTION

[0047] FIG. 1 shows a washing machine 100 according to the present invention, although it is not necessarily a preferred embodiment. Machine 100 includes water containing chamber 102; rotating laundry chamber 104; and sparge tube 108. In operation: (i) wash water source hardware (not shown) fills up the water containing chamber up to water level 106; (ii) the rotating laundry chamber rotates in the direction of arrow R; (iii) the water containing chamber remains stationary and does not rotate with the rotating laundry chamber; and (iv) steam is supplied intermittently through a steam release opening at an end of the sparge tube. The sparge tube enters the water containing chamber above the liquid level, extends downward within the water containing to below the water level and releases the steam below the water level. It is preferable to have a liquid tight seal where the sparge tube penetrates the water containing chamber, but this is not necessarily required because the sparge tube penetrates the water containing chamber at a location above the water level. It is noted that sparge tube 108 has a 90 degree bend, as shown in FIG. 1, but it is not curved into an arcuate shape.

[0048] FIGS. 2 and 3 show a washing machine 200 according to the present invention, although it is not necessarily a preferred embodiment. Machine 200 includes: housing 202; rotating laundry chamber 204; sparge tube 208; and water containing chamber 212. Water containing chamber 212 includes rotating seal 210. Sparge tube 208 includes steam release holes 214 and end cap (denoted as 246 in FIG. 2 and 216 in FIG. 3). In operation: (i) wash water source hardware (not shown) fills up the water containing chamber up to water level 206; (ii) the laundry chamber rotates in the direction of arrow R about central axis A; (iii) the water containing chamber rotates in the direction of arrow R about central axis A; (iv) the housing remains stationary and does not rotate; and (v) steam is supplied intermittently through the steam holes at an end of the sparge tube. The sparge tube enters the water containing chamber above the liquid level, extends downward within the water containing to below the water level and releases the steam below the water level. The rotating seal allows the water containing chamber to rotate while the sparge tube remains stationary. It is noted that sparge tube 208 has a 90 degree bend, as shown in FIG. 2, but it is not curved into an arcuate shape. FIGS. 2 and 3 shows how the steam release holes are oriented and positioned so that steam is released in directions D1 and D2 which are parallel to central axis A. This is a preferred feature because the axially directed steam is directed away from the rotating seal and the laundry being washed.

[0049] FIGS. 4-10 and 14 show a tunnel washing machine 300 according to the present invention. Washing machine 300 includes: water containing side wall 302; laundry containing side wall 304; sparge tube 308 (including straight portion 308a, curved portion 308b, tabs 308c, cap 308d and stem holes 308e); temperature probe 309; motor assembly 311; housing 314; laundry entrance guide 320; laundry exit guide 322; first pre-wash module 324; second pre-wash module 326; first wash module 328; second wash module 330; third wash module 332; fourth wash module 334; fifth wash module 336; first rinse module 338; second rinse module 340; third rinse module 342; fourth rinse module 344; first finish module 346; second finish module 348; third finish module 350; discharge section 351; end wall 352; and steam control sub-system 360. Steam control sub-system 360 includes temperature probe 309; steam source 361; steam conduit 362; steam valve 363; and steam release hardware controller 364.

While the present invention is not necessarily limited to multiple module, tunnel style washing machines, tunnel style washing machines are definitely a highly preferred application of the technology of the present invention. FIGS. 4 and 9 show some exemplary dimensions for machine 300.

[0050] As best seen with reference to FIGS. 5 and 6, soiled laundry is fed into the machine from above at the laundry entrance guide. The laundry then travels intermittently down the central axis of the co-axial modules 324, 326, 328, 330, 332, 334, 336, 338, 340, 342, 344, 346, 348, 350, stopping in each module to be variously pre-washed and rinsed, before emerging at the laundry exit guide. Machine 300 happens to be a 14 module machine, but the number of modules,
and the number of each type of module, is a matter of design choice. Other preferred designs have eight (8) modules or eleven (11) modules. Not every module necessarily has a sparge tube or a temperature probe. For example, if there are a series of consecutive wash modules then it is preferred to: (i) not include a sparge tube in the first module; (ii) not include a sparge tube in the last module in the series; and (iii) to include a sparge tube in each of the modules in the series between the first and last (non-inclusive).

As shown in FIG. 4, motor assembly 311 drives the core, including water containing side wall 302 and laundry containing side wall 304, to rotate about central axis A in the rotational direction of double arrow R. Sparge tube 308 does not rotate with the water containing chamber and the laundry containing chamber. Straight portion 308a penetrates the water containing side wall through a rotating seal built into the water containing side wall 302. The rotating seal is not shown in FIG. 4, but see FIG. 11 for a similar rotating seal. Temperature probe also penetrates the rotating seal. Both the sparge tube and the temperature probe penetrate the seal above the water level 306 and respectively extend to respective terminations below the water level. In this way, the potential for leakage through the rotating seal is reduced, and the potential for catastrophic failure of the seal (for example the flaps of the seal switch from a flipped in to flipped out orientation) is reduced. Curved portion 308b is in the shape of a circular arc, is located between the water containing side wall and the laundry containing side wall and is co-axial with the water containing side wall and the laundry containing side wall. The steam holes are located in the vicinity of the bottom of the water containing side wall and are located and oriented so that steam is ejected along a direction substantially parallel to central axis A.

The feature wherein the temperature probe 309 enters the waterway above the fluid level, and then descends below fluid level within the waterway is considered as inventive subject matter both in conjunction with, and in isolation from the sparge tube related technology discussed herein. Although the temperature probe 309 is shown with a bend designed to take the end of the temperature probe below the fluid level, alternatively, the temperature probe could be curved, as will be discussed in connection with the sparge tube.

FIGS. 7, 8 and 9 show the sparge tube in more detail. As shown in FIG. 7, tabs 308 are centered on the straight portion 308a. As shown in FIG. 10, tabs 308c help secure the sparge tube to washing machine frame 314 so that it remains stationary and in place between the water containing chamber and the liquid containing chamber despite the turbulent forces in the water of the washing machine.

Also shown in FIG. 10 is seal penetration plane 308c of sparge tube 308, which is the location and which the sparge tube penetrates the seal. In order to maintain integrity of the rotating seal over cycles of usage: (i) it is preferred to keep the length of the rotating seal which is penetrated by the sparge tube as small as feasible; (ii) it is preferred to keep the cross-sectional area of sparge tube penetrating the seal as small as feasible; (iii) it is highly preferred to insert extraneous sparge tube supporting hardware through the rotating seal. In the embodiment of sparge tube 308, the sparge tube is a pipe of uniform, circular cross section, which has the advantages of being cost-effective and space-efficient. However, other more complicated sparge tube cross-sectional geometries could be used. As one example, the cross section of the whole sparge tube could be maintained at its current cross-sectional area, but shaped to be eccentric and elongated along the direction of the steam in the rotating seal. As a further example, the cross-sectional profile could be made circular everywhere except in the vicinity of seal penetration plane 308c, where the cross-sectional profile could be modified to make it minimally disruptive to the integrity of the rotating seal. As still a further example, the cross-sectional area in the vicinity of seal penetration plane 308c could be made smaller than the cross sectional area of the rest of the sparge tube to minimize disruption of the rotating seal. As a further example, heat insulative material could be located around the sparge tube in the vicinity of seal penetration plane 308c to prevent the heat of the steam-carrying sparge tube from doing thermal damage to the rotating seal.

FIG. 10 also shows a portion of end wall 352. In machine 300, each water containing chamber is made up of a water containing side wall, an end wall 352 closing off each end of the generally cylindrically shaped water containing chamber. In machine 300, the side walls and end walls for all modules rotate in unison. Alternatively, tunnel washing machines according to the present invention could be designed wherein the modules rotate independently of each other.

FIG. 14 shows how steam control sub-system controls the temperature of the water through the controlled, intermittent release of steam directly into the water, below the water level. More specifically, temperature probe is connected in data communication (for example, electronic signal communication) with steam release controller 364. The steam release controller may be in the form of hardware and/or software based logic circuitry. Based on the temperature and/ or various time derivatives of the temperature, the steam release controller decides when more steam is to be released and sends appropriate signals to the steam source related hardware 361, 362, 363 to get more steam into and through sparge tube 308 and into the water.

Because sparge tube 308 penetrates the water containing chamber above the water level, it can be made relatively large. Also, the steam is released axially and therefore not released in a direction toward the laundry or toward the rotating seal. These advantageous features of the present invention can allow a relatively large steam feed rate. This means that water that is becoming too cool can quickly be correctly in its temperature.

In some non-preferred embodiments of the present invention, there is not direct injection of steam into the water. For example, instead of having steam release openings at the end of the sparge tube, a CTE, such as a Penberthy CTE (see http://www.penberthy-online.com/), may be used to deliver the steam into the water. Among other reasons, this is not preferred because: (i) steam and/or hot water will be directed at the rotating seal and/or the laundry being washed; and (ii) CTE does not heat the water as quickly as direct steam. However, the CTE is mentioned here to show the possible scope of the present invention.

Some exemplary, inventive, optional and/or preferred characteristics, parameters and/or features for making and/or using washing machines according to the present invention are as follows: (i) ¾ inch thick EPDM seals; (ii) shroud drain from each sparge tube section to allow for any runoff from section to be returned to the rinse reclaim tank and/or reused in the system; (iii) use of present invention in dynamic counterflow systems; (iv) reduce length of seal as
much as feasible to provide for tighter lateral seal to the waterway, improved seal and elimination of leakage from turnbuckles; (v) sparge tube penetrates seal perpendicular to tangent line of seal at entry point; (vi) lap design; (vii) for EPDM seals design system so that surface temperature of the sparge tube in the vicinity of the penetration plate is less than 1400 degrees F. and preferably about 340 degrees F.; (viii) static heating rate of approximately 17 degrees F. per minute; (ix) in static test able to hold 200 degrees F. temperature at 12.2 GPM water feed into the chamber at 50% valve opening; (x) 6-7 alternate rotations per minute for washing cycle; (xi) steam at 320 degrees; and/or (xii) steam feed rate of 700 pounds per hour.

DEFINITIONS

[0060] The following definitions are provided to facilitate claim interpretation:

[0061] Present invention: means at least some embodiments of the present invention; references to various feature(s) of the “present invention” throughout this document do not mean that all claimed embodiments or methods include the referenced feature(s).

[0062] First, second, third, etc. (“ordinals”): Unless otherwise noted, ordinals only serve to distinguish or identify (e.g., various members of a group); the mere use of ordinals implies neither a consecutive numerical limit nor a serial limitation.

[0063] Electrically Connected: means either directly electrically connected, or indirectly electrically connected, such that intervening elements are present; in an indirect electrical connection, the intervening elements may include inductors and/or transformers.

[0064] Mechanically connected: includes both direct mechanical connections, and indirect mechanical connections made through intermediate components; includes rigid mechanical connections as well as mechanical connection that allows for relative motion between the mechanically connected components; includes, but is not limited, to welded connections, solder connections, connections by fasteners (for example, nails, bolts, screws, nuts, hook-and-loop fasteners, knots, rivets, force fit connections, friction fit connections, connections secured by engagement added by gravitational forces, quick-release connections, pivoting or rotatable connections, slidable mechanical connections, latches and/or magnetic connections.

[0065] Data communication: any sort of data communication scheme now known or to be developed in the future, including wireless communication, wired communication and communication routes that have wireless and wired portions; data communication is not necessarily limited to: (i) direct data communication; (ii) indirect data communication; and/or (iii) data communication where the format, packetization status, medium, encryption status and/or protocol remains constant over the entire course of the data communication.

[0066] Receive/provide/send/input/output: unless otherwise explicitly specified, these words should not be taken to imply: (i) any particular degree of directness with respect to the relationship between their objects and subjects; and/or (ii) absence of intermediate components, actions and/or things interposed between their objects and subjects.

[0067] To the extent that the definitions provided above are consistent with ordinary, plain, and accustomed meanings (as generally shown by documents such as dictionaries and/or technical lexicons), the above definitions shall be considered supplemental in nature. To the extent that the definitions provided above are inconsistent with ordinary, plain, and accustomed meanings (as generally shown by documents such as dictionaries and/or technical lexicons), the above definitions shall control. If the definitions provided above are broader than the ordinary, plain, and accustomed meanings in some aspect, then the above definitions shall be considered to broaden the claim accordingly.

[0068] To the extent that a patentee may act as its own lexicographer under applicable law, it is hereby further directed that all words appearing in the claims section, except for the above-defined words, shall take on their ordinary, plain, and accustomed meanings (as generally shown by documents such as dictionaries and/or technical lexicons), and shall not be considered to be specially defined in this specification. In the situation where a word or term used in the claims has more than one alternative ordinary, plain and accustomed meaning, the broadest definition that is consistent with technological feasibility and not directly inconsistent with the specification shall control.

[0069] Unless otherwise explicitly provided in the claim language, steps in method steps or process claims need only be performed in the same time order as the order the steps are recited in the claim only to the extent that impossibility or extreme feasibility problems dictate that the recited step order (or portion of the recited step order) be used. This broad interpretation with respect to step order is to be used regardless of whether the alternative time ordering(s) of the claimed steps is particularly mentioned or discussed in this document.

What is claimed is:

1. A washing machine comprising:
   a. a driving device;
   b. a liquid containing chamber that is at least substantially liquid tight and defines a central axis, an angular direction and an axial direction, with the liquid containing chamber comprising:
      a first side wall at least substantially in the shape of a peripheral wall of a cylinder, the first side wall comprising a first seal located around the first side wall around its angular direction;
      an end wall, and
      a second end wall;
   c. liquid source hardware and
   d. a sparge tube to carry and direct steam from a steam source;
   wherein:
   the liquid source hardware is structured, connected and located to fill the liquid containing chamber with liquid up to a predetermined liquid level;
   the driving device and liquid containing chamber are structured, located and connected so that the driving device drives the liquid containing chamber to rotate about the central axis;
   the sparge tube remains stationary when the liquid containing chamber rotates;
   the sparge tube comprises a straight portion and a curved portion;
   the straight portion of sparge tube is sized, shaped and located to penetrate the first side wall through the first seal at a location above the liquid level;
   the first seal has a rotating seal geometry to accommodate the rotation of the liquid containing chamber relative to the sparge tube;
the curved portion of the sparge tube extends in the angular direction from the vicinity of the location where the straight portion penetrates the first side wall above the liquid level down below the liquid level; the curved portion of the sparge tube defines a steam release opening located below the liquid level; and the steam release opening is sized, shaped and located to release steam in a direction at least substantially parallel to the central axis.

2. The machine of claim 1 further comprising a second side wall shaped as a peripheral wall of a cylinder, located within an interior space defined by the first side wall and at least substantially co-axial with the first side wall, wherein:

a portion of the second side wall is below the liquid level; and

the curved portion of the sparge tube is located between the first side wall and the second side wall.

3. The machine of claim 2 wherein the driving device and liquid containing chamber are structured, located and connected so that the driving device drives the liquid containing chamber to rotate about the central axis with the liquid containing chamber.

4. The machine of claim 1 wherein the liquid source hardware is structured, connected and located on a supply wash water as the liquid.

5. The machine of claim 1 wherein the central axis is horizontal.

6. The machine of claim 5 wherein the first and second end walls are vertical.

7. The machine of claim 6 further comprising a steam release controller, wherein:

the steam release controller is structured, connected and/or programmed to receive the temperature data; and

the steam release control means controls the release of steam through the sparge tube based, at least in part, on the temperature data.

8. The machine of claim 6 wherein:

the temperature probe hardware is sized, shaped and located to penetrate the first side wall through the first seal at a location above the liquid level; and

the temperature probe hardware extends below the liquid level.

9. The machine of claim 1 wherein the liquid containing chamber is in the form of a first washing module, the machine further comprising a frame comprising:

a ground securing portion for securing the frame to the ground; and

a first washing module securing portion for mechanically securing the first washing module portion so that it is free to rotate about the central axis.

10. The machine of claim 9 further comprising:

a first pre-wash module; and

a first rinsing module;

wherein:

the first washing module, the first pre-wash module and the first rinsing module are at least substantially co-axially aligned.

11. A washing machine comprising:

a liquid containing chamber that is at least substantially liquid tight and comprises a first wall comprising a first seal;

a liquid source hardware; and

a steam conduit structured to carry and direct steam from a steam source;

wherein:

the liquid source hardware is structured, connected and located to fill the liquid containing chamber with liquid up to a predetermined liquid level; the steam conduit is sized, shaped and located to penetrate the first wall through the first seal at a location above the liquid level; and

the steam conduit defines a steam release opening below the liquid level.

12. The machine of claim 11 wherein:

the first wall is shaped as a peripheral wall of a cylinder defining a central axis and having a bottom; and

the steam release opening is located in the vicinity of the bottom.

13. The machine of claim 12 wherein the steam release opening is sized, shaped and located to direct steam out of the steam conduit in a direction at least substantially parallel to the central axis.

14. The machine of claim 12 further comprising a second wall shaped as a peripheral wall of a cylinder, located within an interior space defined by the first wall and at least substantially co-axial with the first wall, wherein:

the second wall is not liquid tight; a portion of the second wall is below the liquid level; and

the steam release opening is located between the first wall and the second wall.

15. A washing machine comprising:

a generally cylindrical liquid containing chamber that is at least substantially liquid tight, comprises a first wall shaped as a peripheral wall of a cylinder, with the first wall comprising a first seal, and defining a central axis; liquid source hardware; and

a steam conduit structured to carry and direct steam from a steam source;

wherein:

the liquid source hardware is structured, connected and located to fill the liquid containing chamber with liquid up to a predetermined liquid level; the steam conduit is sized, shaped and located to penetrate the first wall through the first seal at a location above the liquid level; the steam conduit comprises a curved portion that is curved substantially in the shape of a circular arc; and

the curved portion, the fluid containing portion and the first seal are located, sized and shaped so that the curved portion is at least substantially co-axial with the first wall.

16. The machine of claim 15 further comprising a second wall shaped as a peripheral wall of a cylinder, located within an interior space defined by the first wall and at least substantially co-axial with the first wall, wherein:

the second wall is not liquid tight; a portion of the second wall is below the liquid level; and

the curved portion is located between the first wall and the second wall.

17. The machine of claim 15 wherein the curved portion defines at least one steam release opening that is sized, shaped and located to direct steam out of the steam conduit in a direction at least substantially parallel to the central axis.

18. The machine of claim 15 further comprising a driving device, wherein:
the driving device and liquid containing chamber are structured, located and connected so that the driving device drives the liquid containing chamber to rotate about the central axis;
the steam conduit remains stationary when the liquid containing chamber rotates; and
the first seal has a rotating seal geometry to accommodate the rotation of the liquid containing chamber relative to the steam conduit.

19. A washing machine comprising:
a generally cylindrical liquid containing chamber that is at least substantially liquid tight, comprises a first wall shaped as a peripheral wall of a cylinder, with the first wall comprising a first seal, and defining a central axis; liquid source hardware; and
a steam conduit structured to carry and direct steam from a steam source;
wherein:
the liquid source hardware is structured, connected and located to fill the liquid containing chamber with fluid up to a predetermined liquid level;
the steam conduit defines a steam release opening below the liquid level; and
the steam release opening is sized, shaped and located to release steam in a direction at least substantially parallel to the central axis.

20. The machine of claim 19 wherein:
the first wall has a bottom; and
the steam release opening is located in the vicinity of the bottom.