US 20140069279A1

(19) **United States**

(12) **Patent Application Publication**

Upston et al.

(10) **Pub. No.: US 2014/0069279 A1**

(43) **Pub. Date: Mar. 13, 2014**

(54) **APPARATUS AND METHOD FOR AN IMPROVED COFFEE MAKER**

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(21) Appl. No.: **14/116,327**

(22) PCT Filed: **May 10, 2012**

(86) PCT No.: **PCT/AU2012/000501**

§ 371 (c)(1),
(2), (4) Date: **Nov. 7, 2013**

(30) **Foreign Application Priority Data**

May 10, 2011 (AU) 2011901751
Aug. 11, 2011 (AU) 2011903195
Feb. 21, 2012 (AU) 2012900647

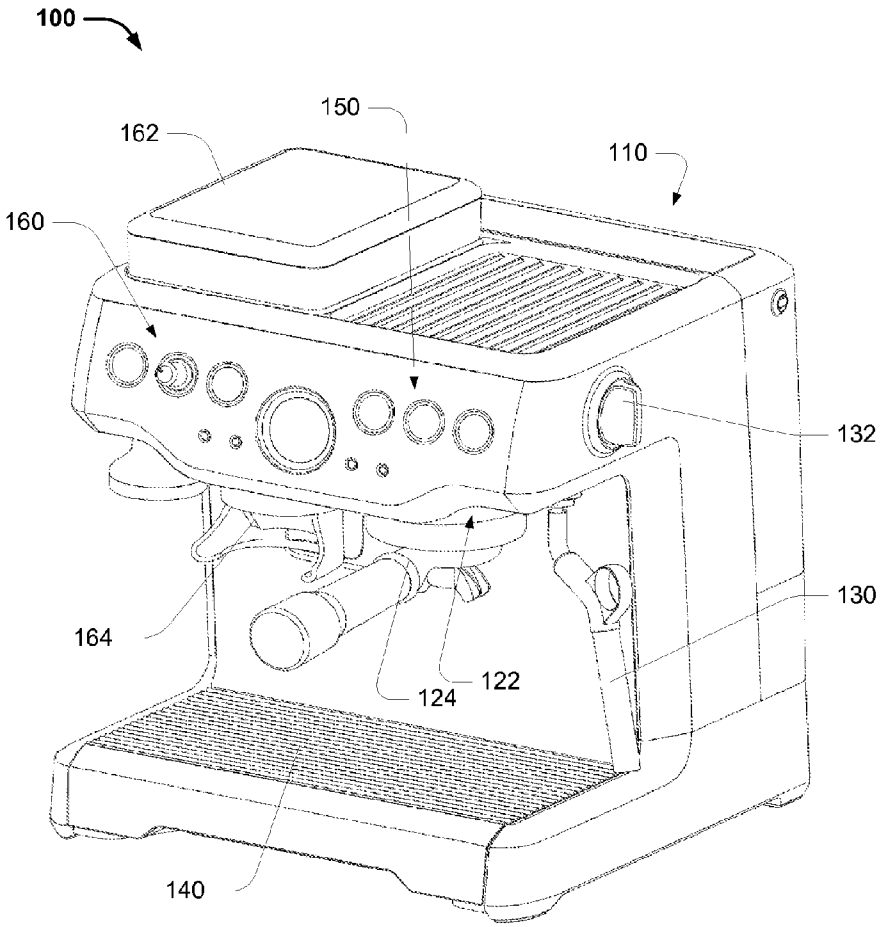
Publication Classification

(51) **Int. Cl.**
A47J 31/44 (2006.01)

(52) **U.S. Cl.**
CPC ***A47J 31/4403*** (2013.01)
USPC **99/283**

(57) **ABSTRACT**

A coffee making device has a body with a drip tray and a removeable water tank that supplies water to a heat system of the device. The water tank is internal to the device and removeable by a user. The body has a fluid refill opening that leads to the tank. The tank includes a overflow channel or conduit that dispenses into the drip tray.



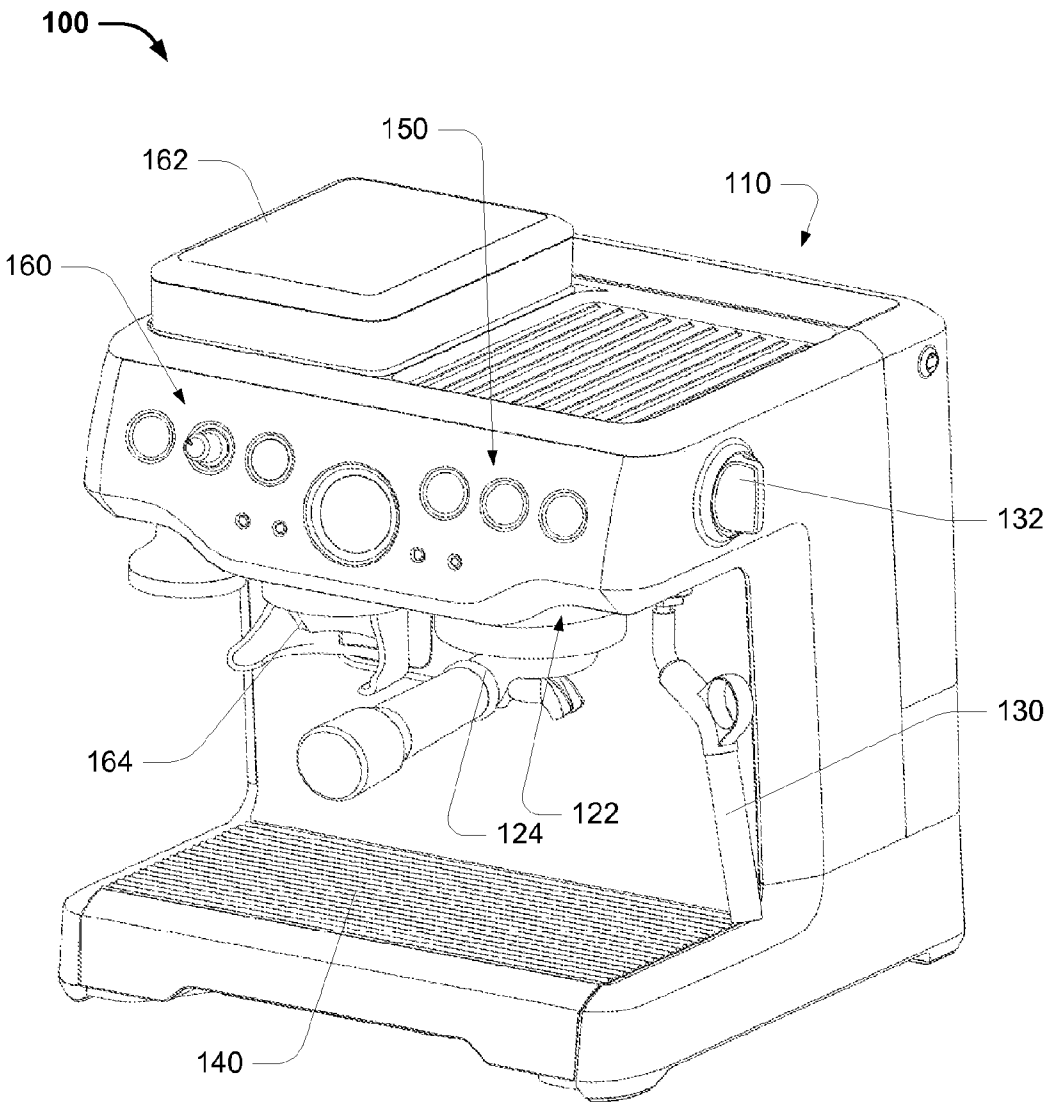


FIG. 1

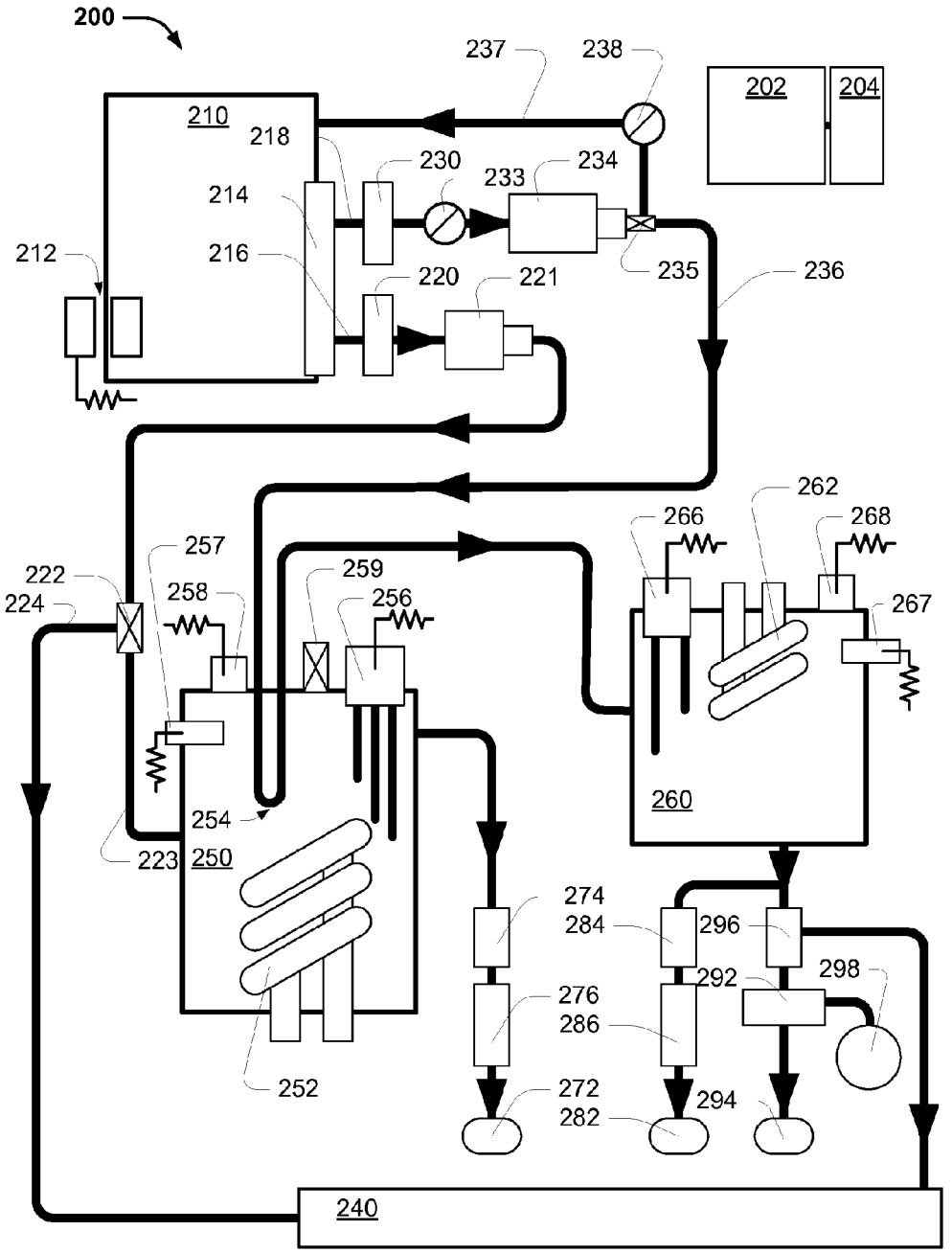

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FIG. 2

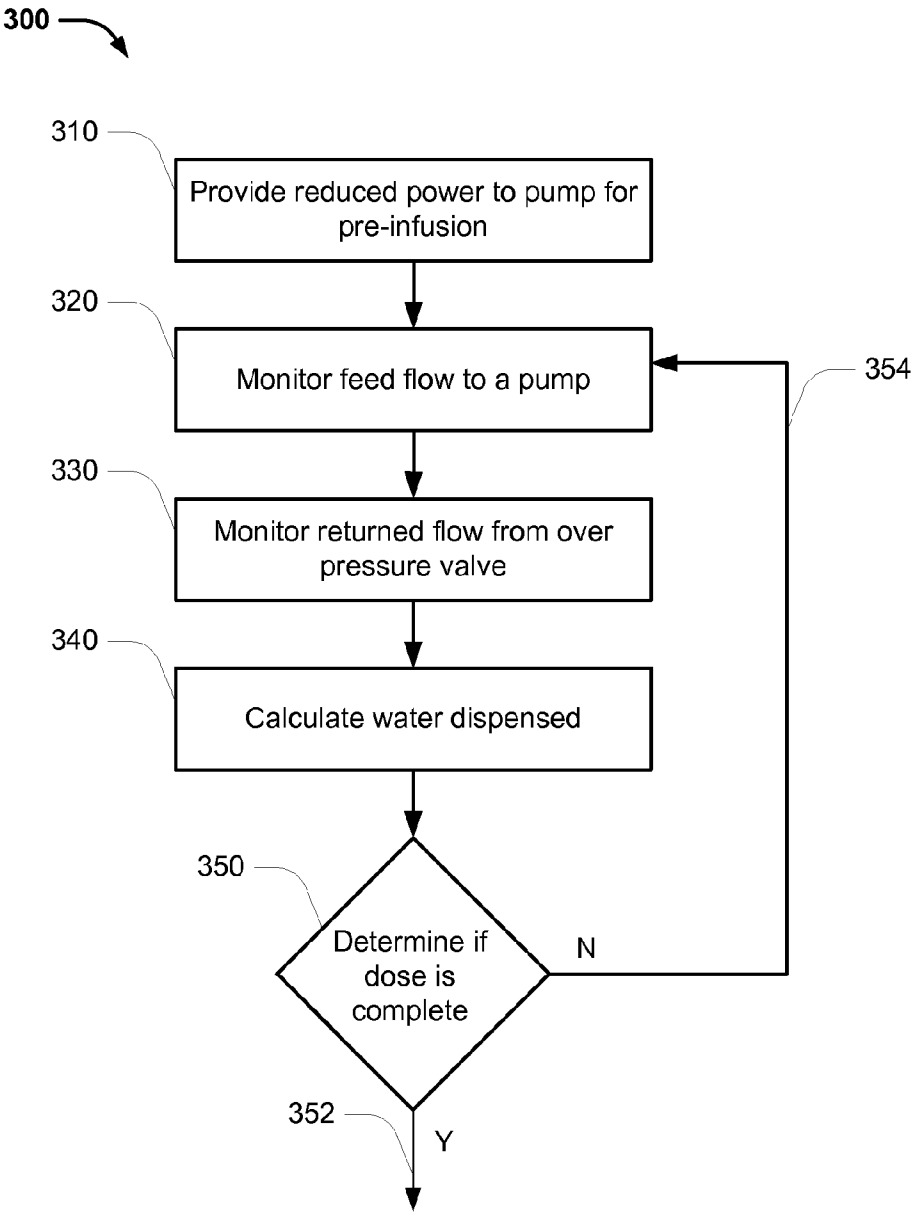

300
310
Provide reduced power to pump for pre-infusion
320
Monitor feed flow to a pump
354
330
Monitor returned flow from over pressure valve
340
Calculate water dispensed
350
Determine if dose is complete
N
352
Y

FIG. 3

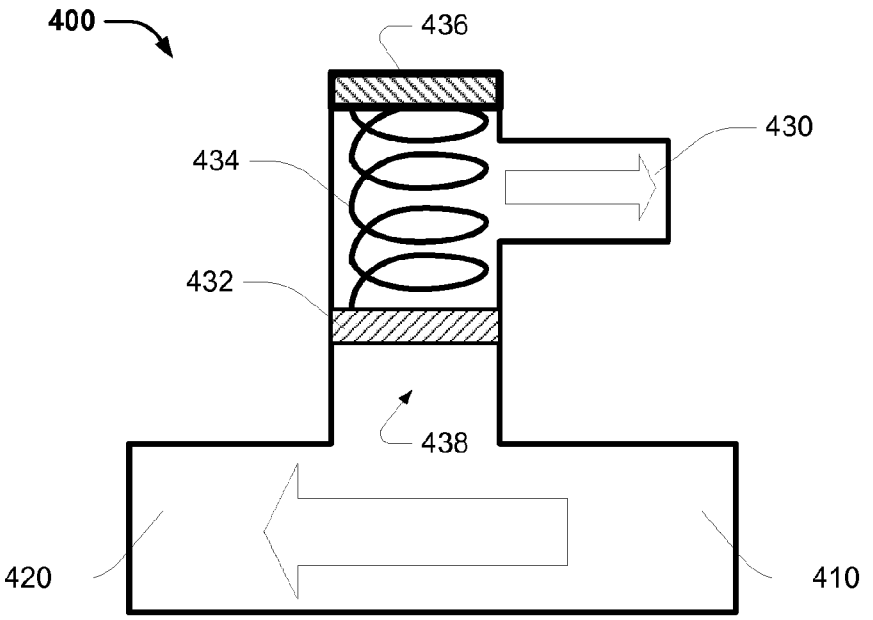
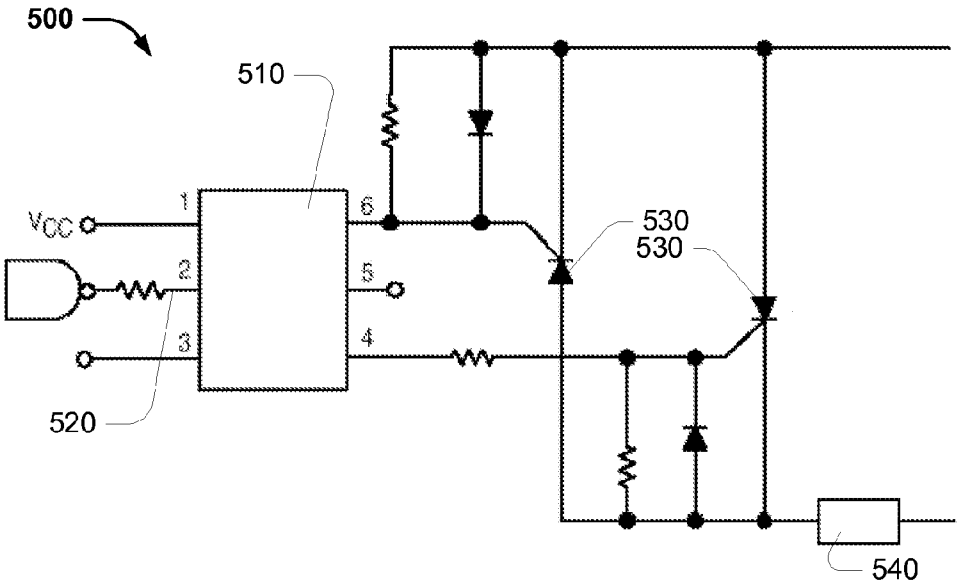


FIG. 4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510
V_{CC}
1
2
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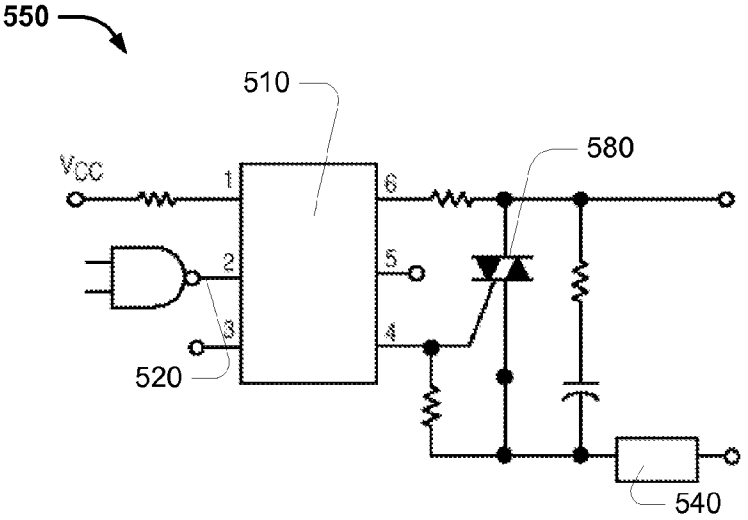
4
530
530
520
540

FIG. 5A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V_{CC}
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5
4
580
520
540

FIG. 5B

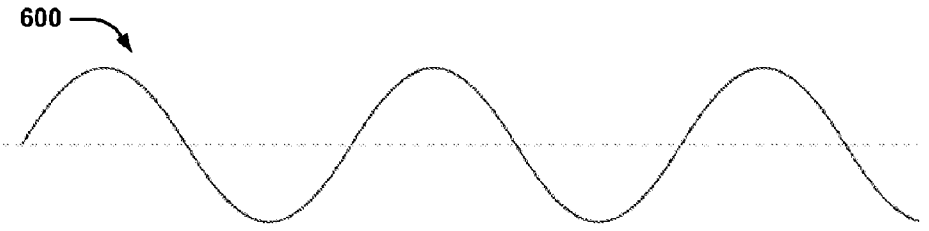

FIG. 6A

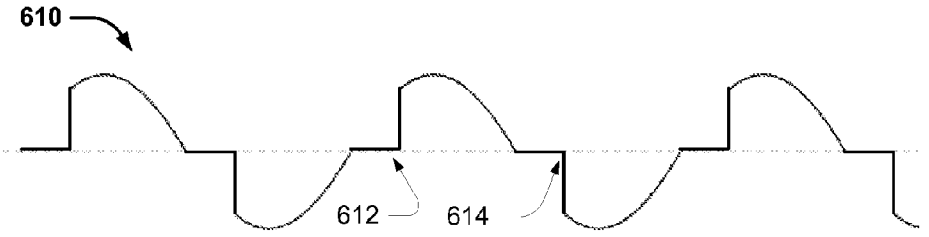

FIG. 6B

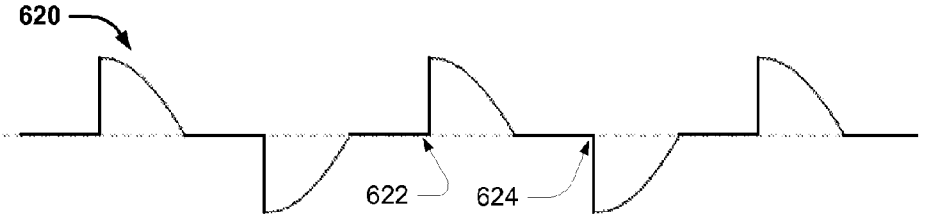

FIG. 6C

FIG. 6D

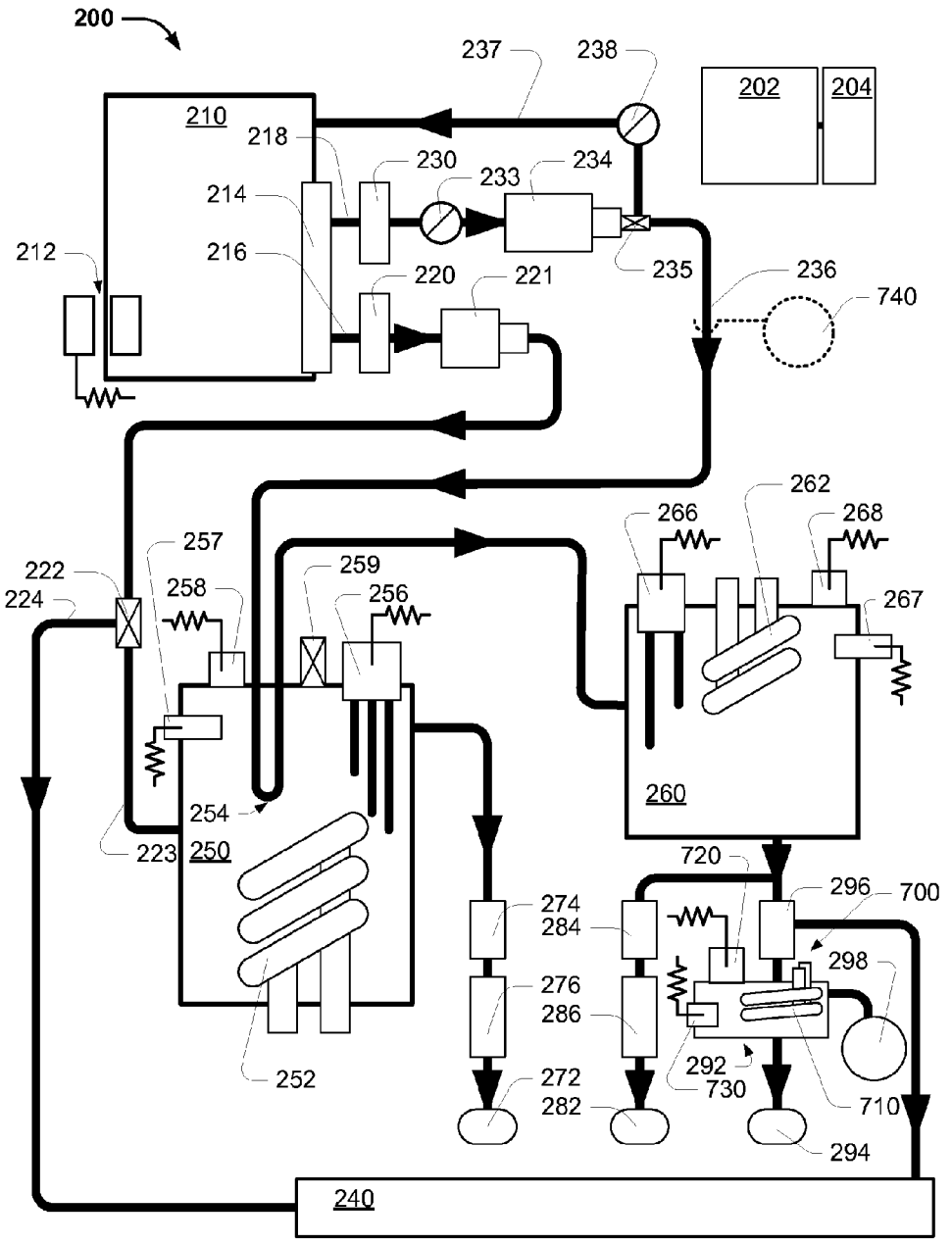
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FIG. 7

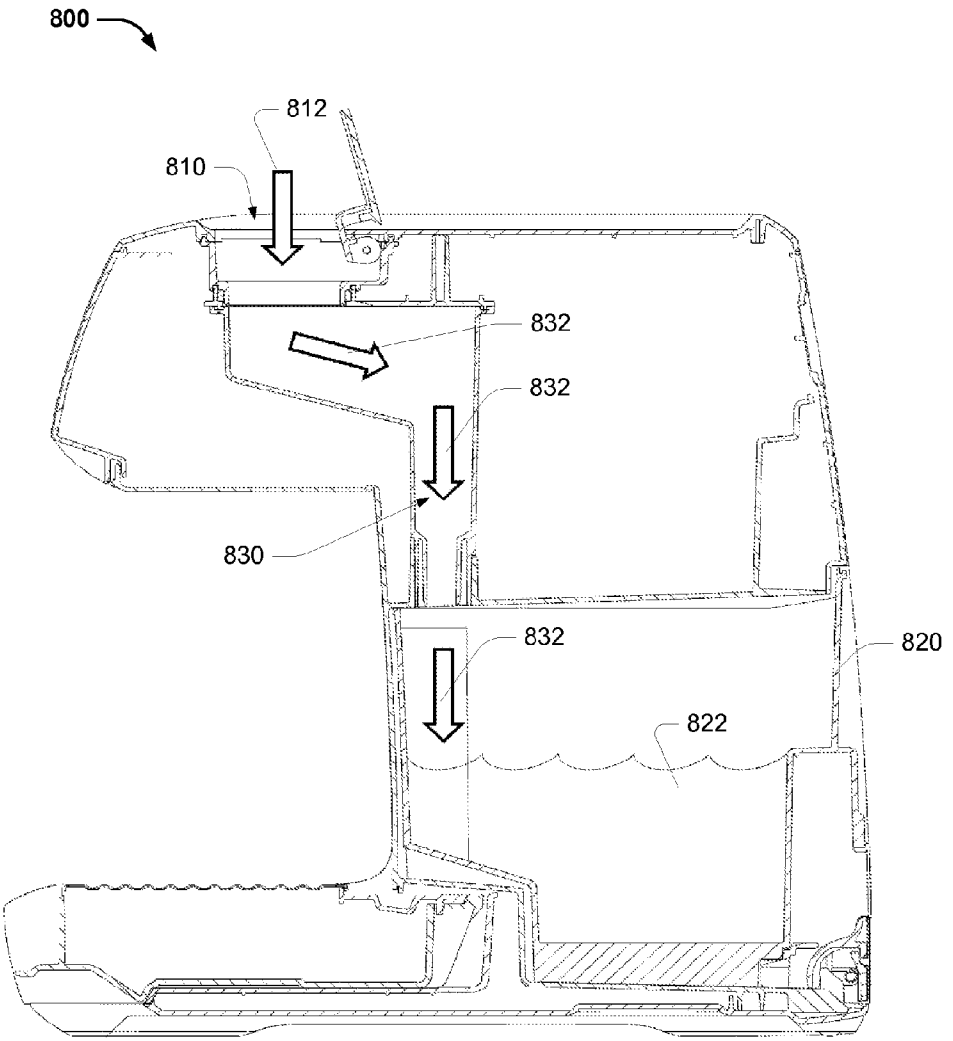


FIG. 8

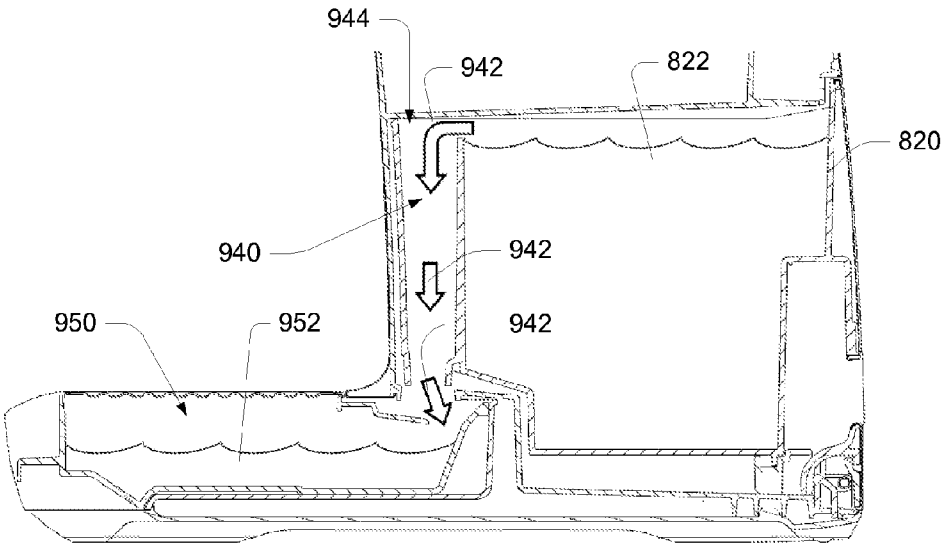


FIG. 9

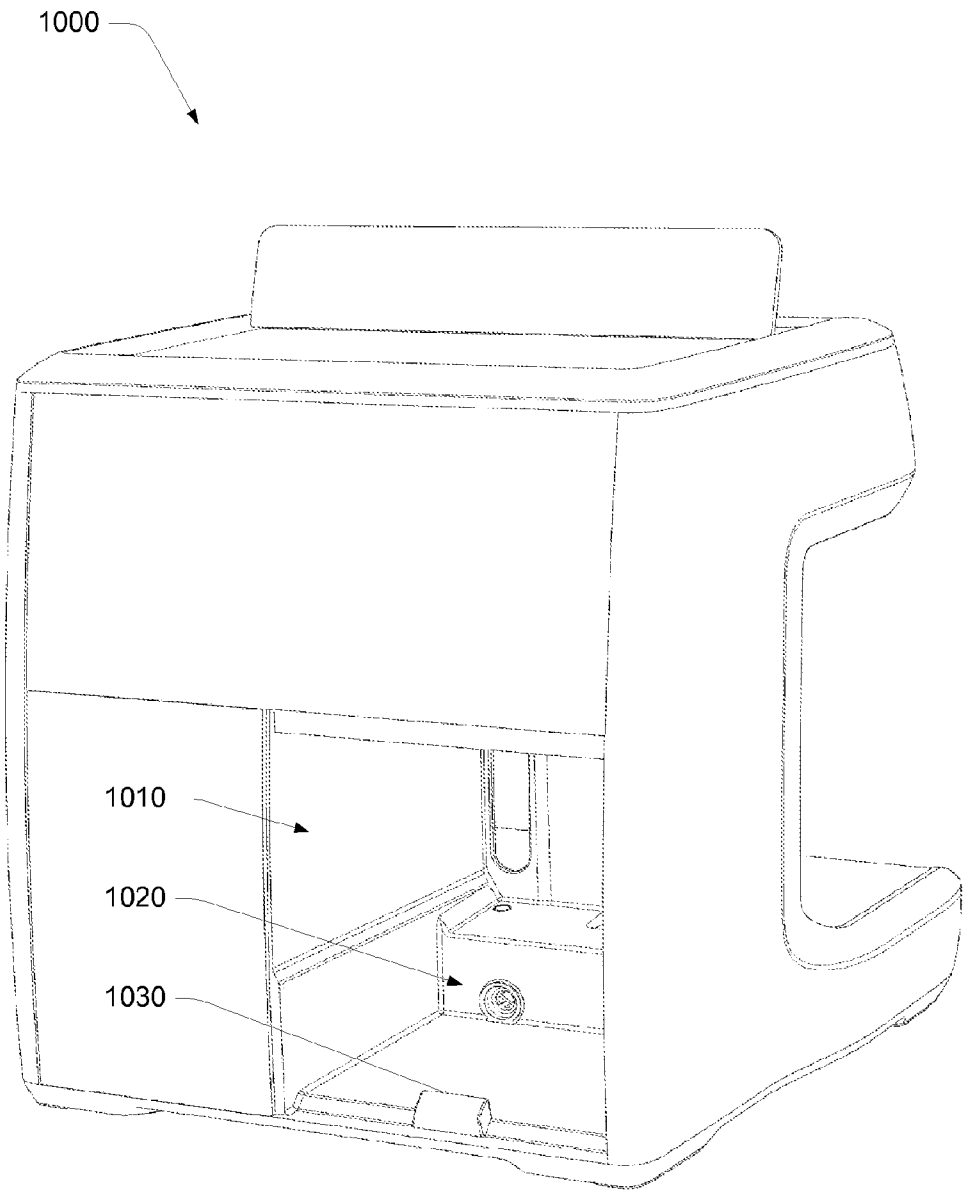


FIG. 10

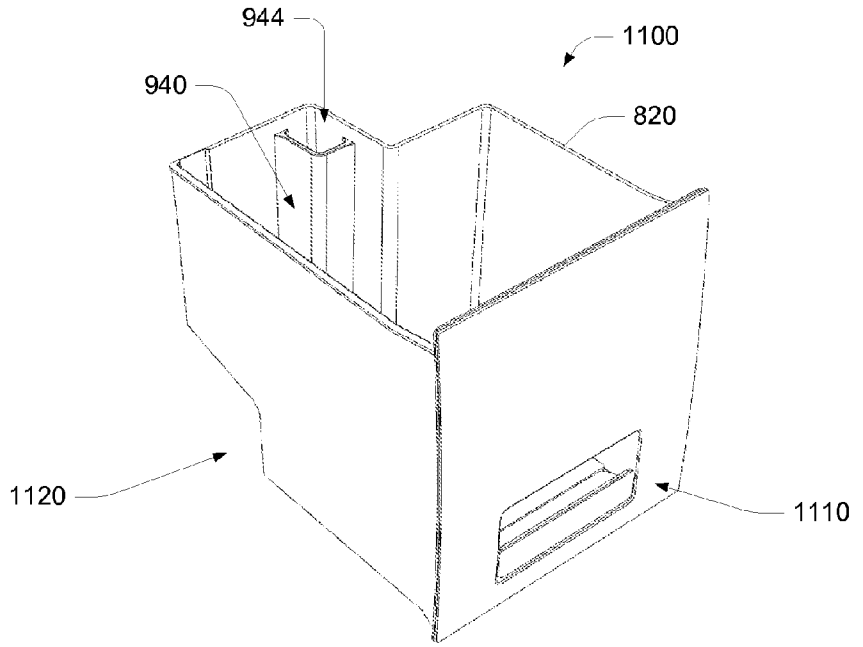


FIG. 11A

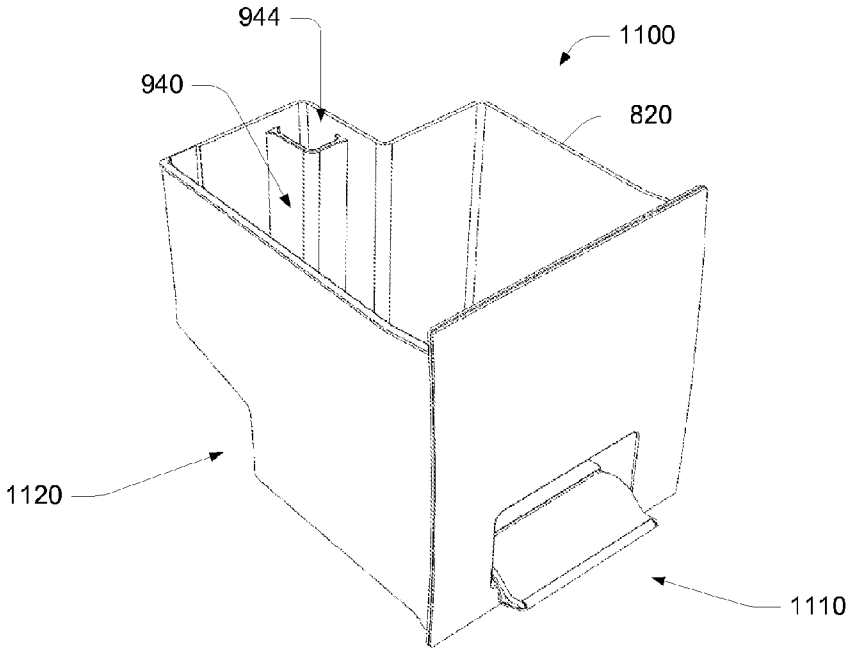


FIG. 11B

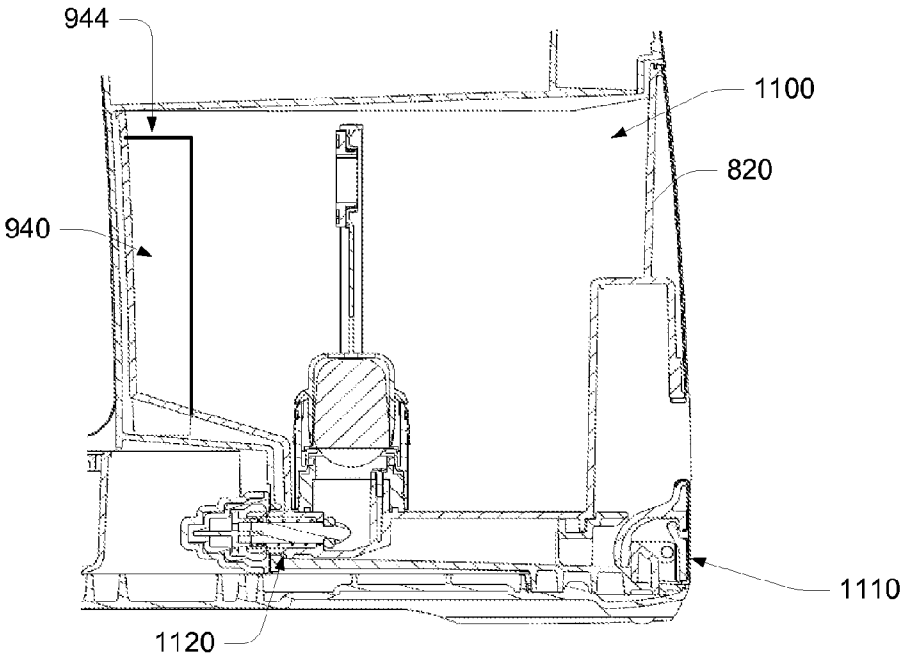


FIG. 12A

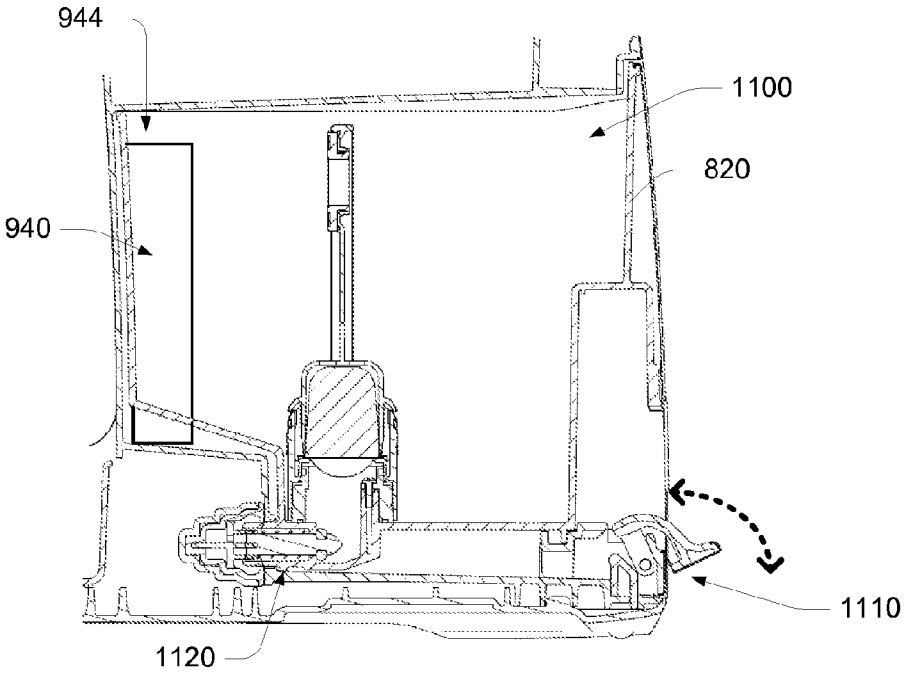


FIG. 12B

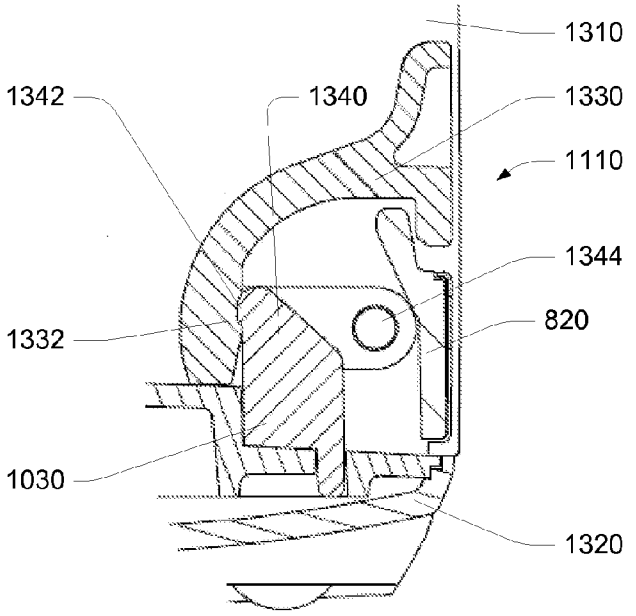


FIG. 13A

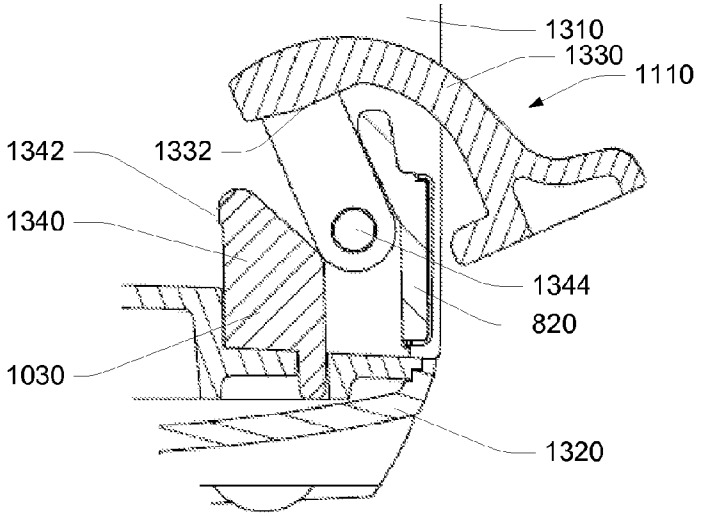


FIG. 13B

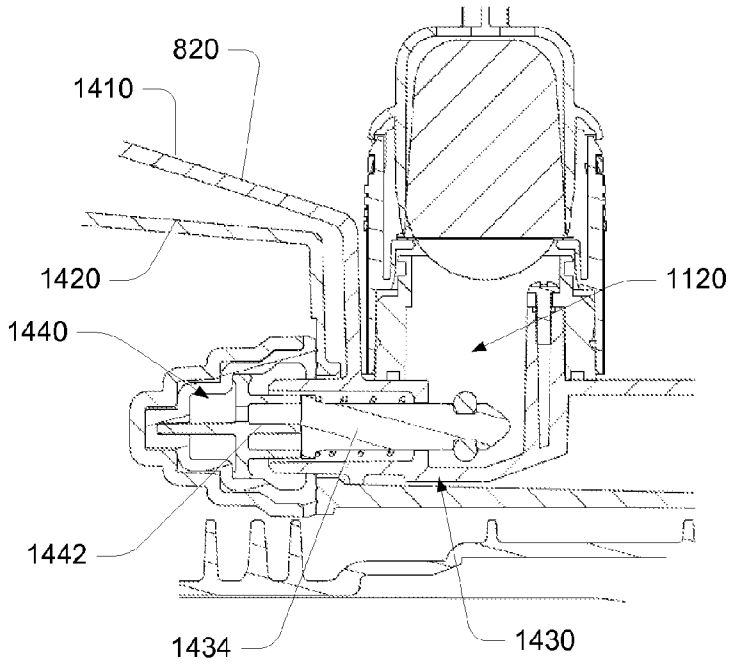


FIG. 14A

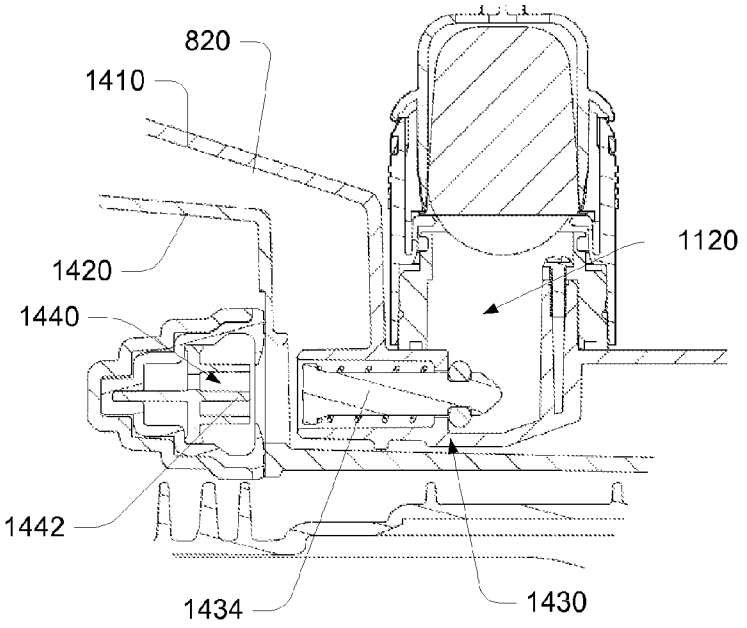
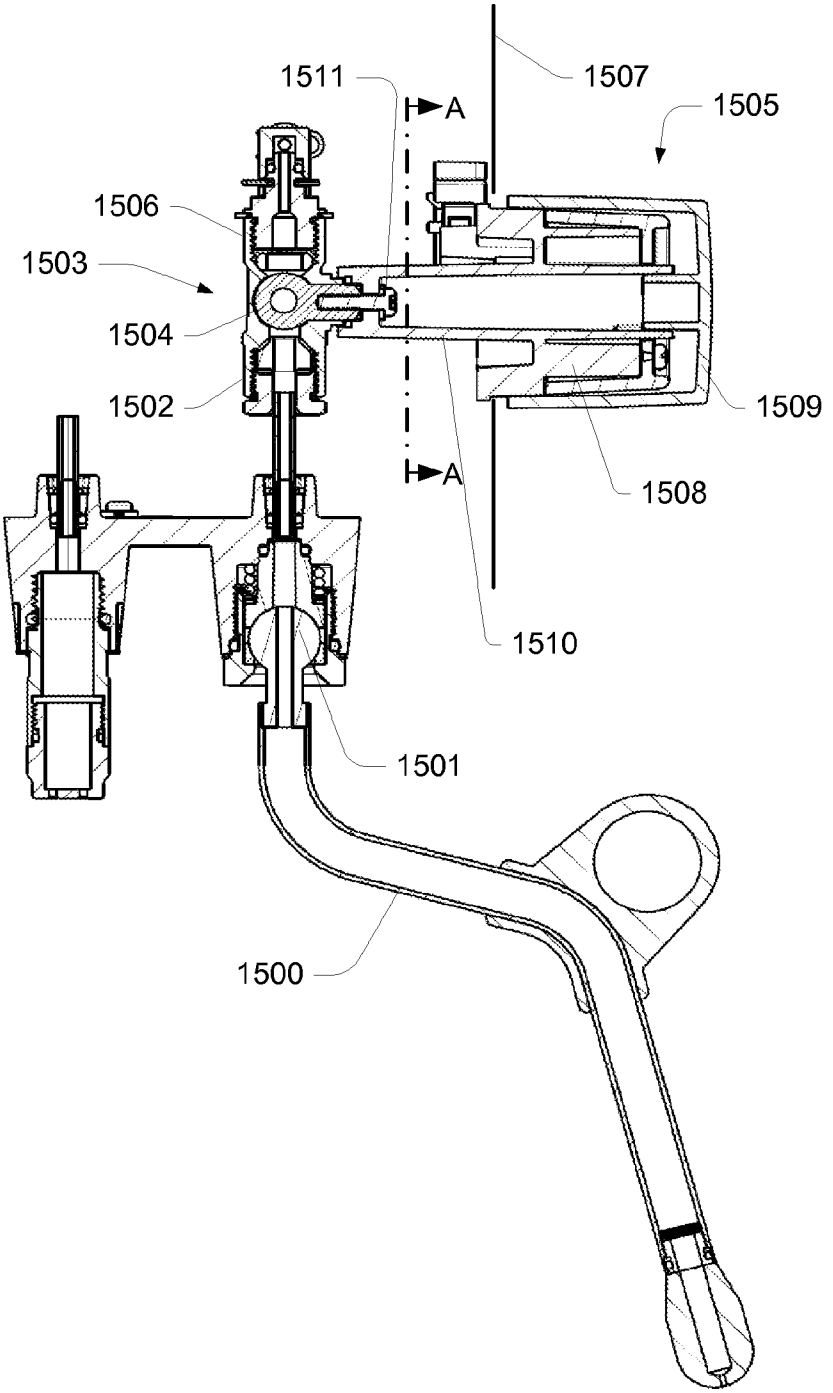


FIG. 14B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1502
1509
A
1508
1510
1501
1500

FIG. 15

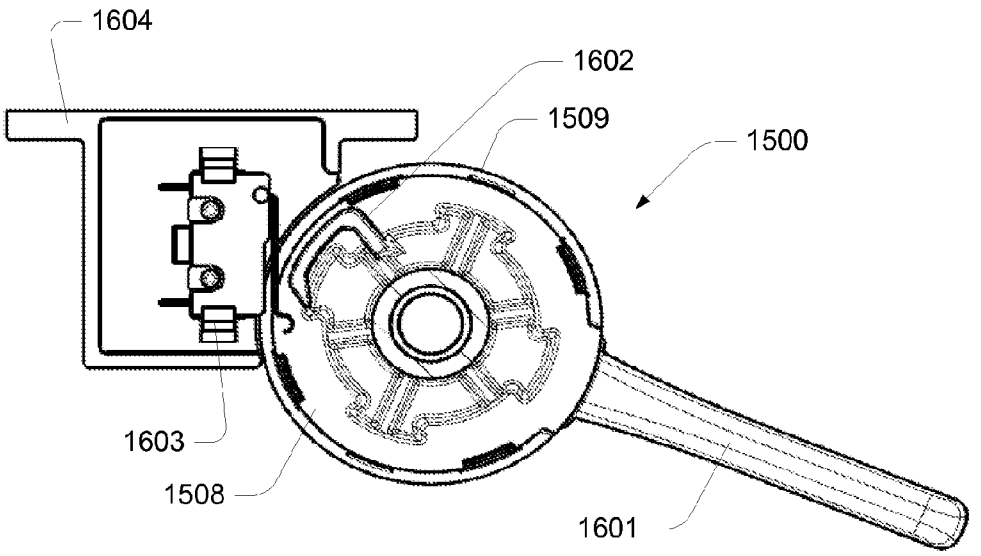

FIG. 16

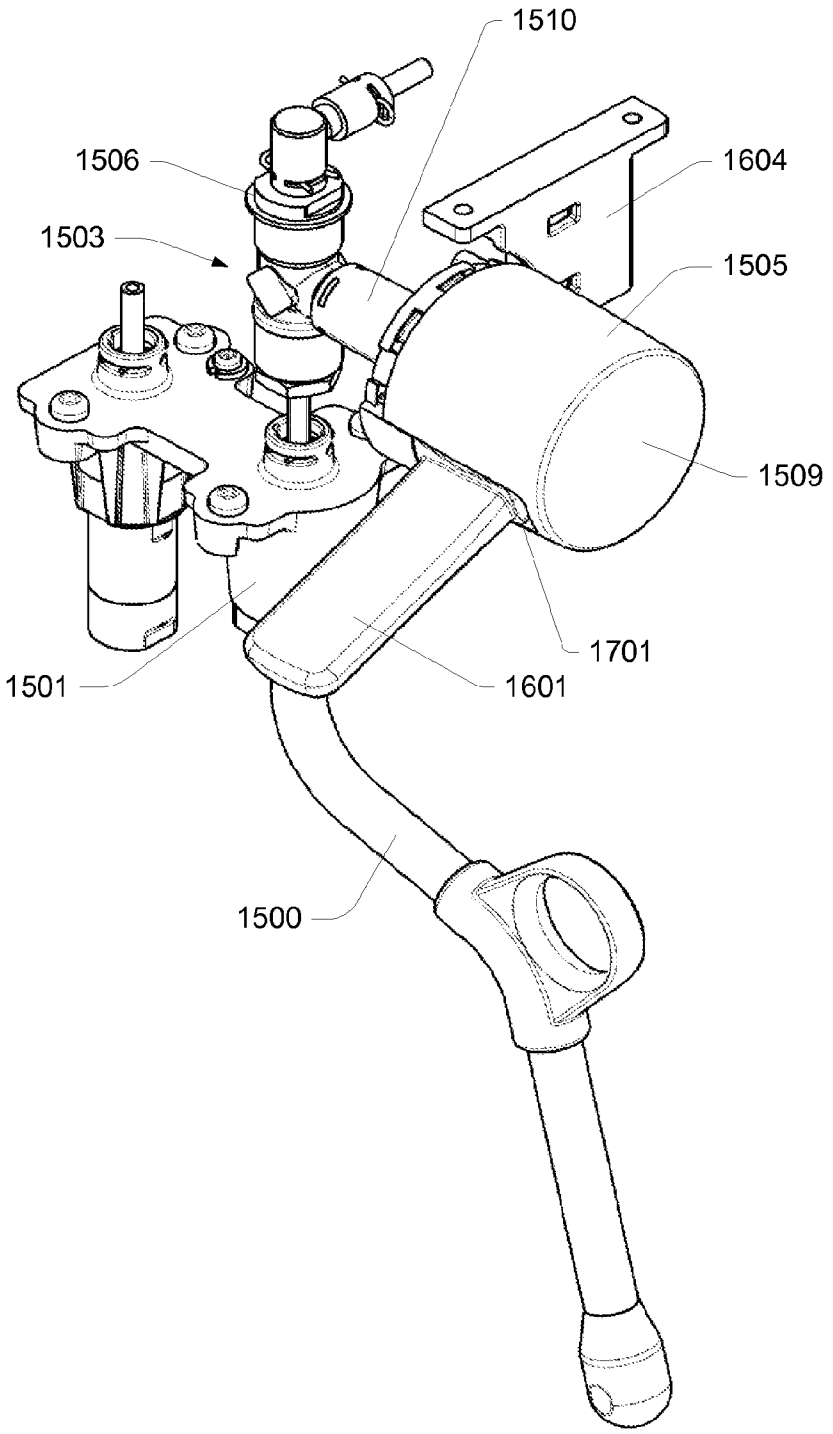

FIG. 17

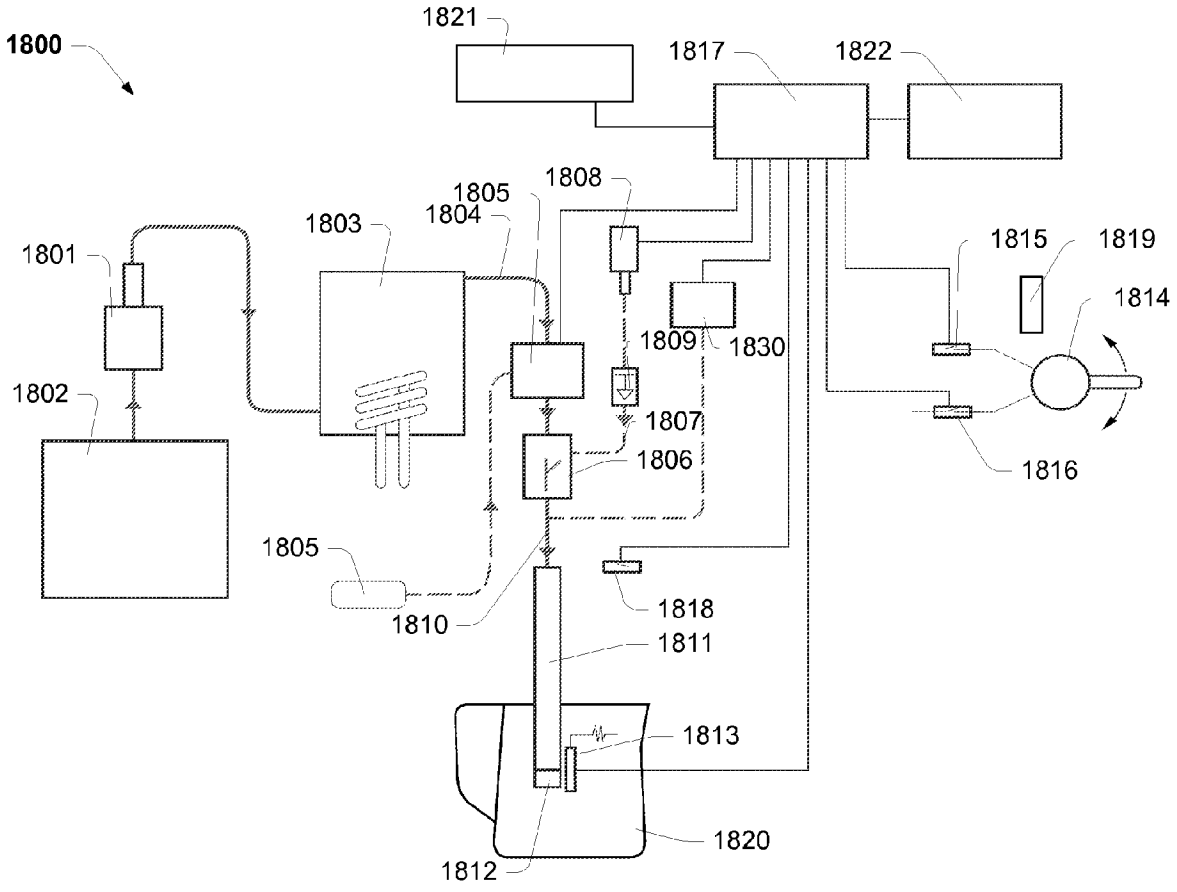
1800
1821
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FIG. 18

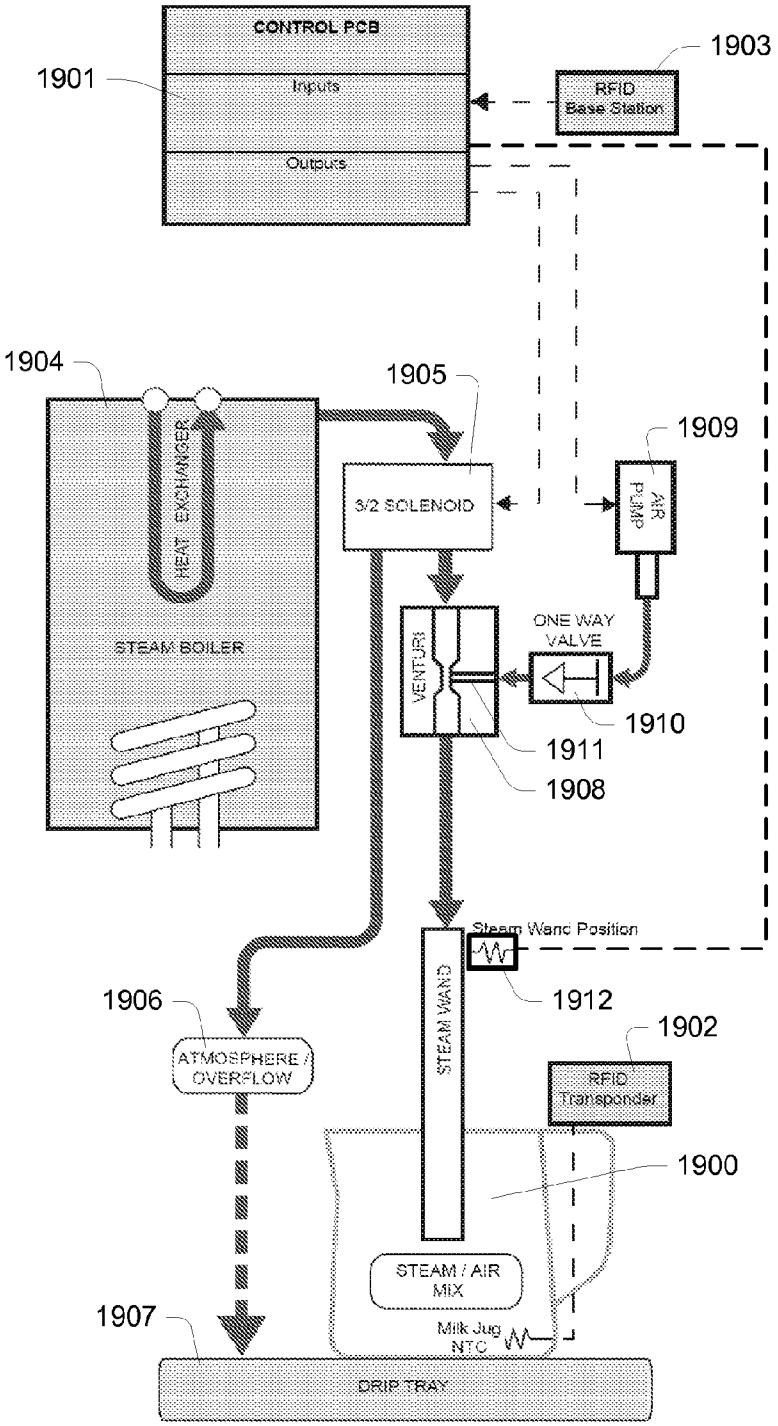
CONTROL PCB
Inputs
Outputs
1901
1903
RFID Base Station
1904
1905
1909
HEAT EXCHANGER
STEAM BOILER
3/2 SOLENOID
AIR PUMP
ONE WAY VALVE
VENTURI
1910
1911
1908
Steam Wand Position
1912
1906
1902
ATMOSPHERE / OVERFLOW
STEAM WAND
RFID Transponder
1900
STEAM / AIR MIX
1907
Milk Jug NTC
DRIP TRAY

FIG. 19

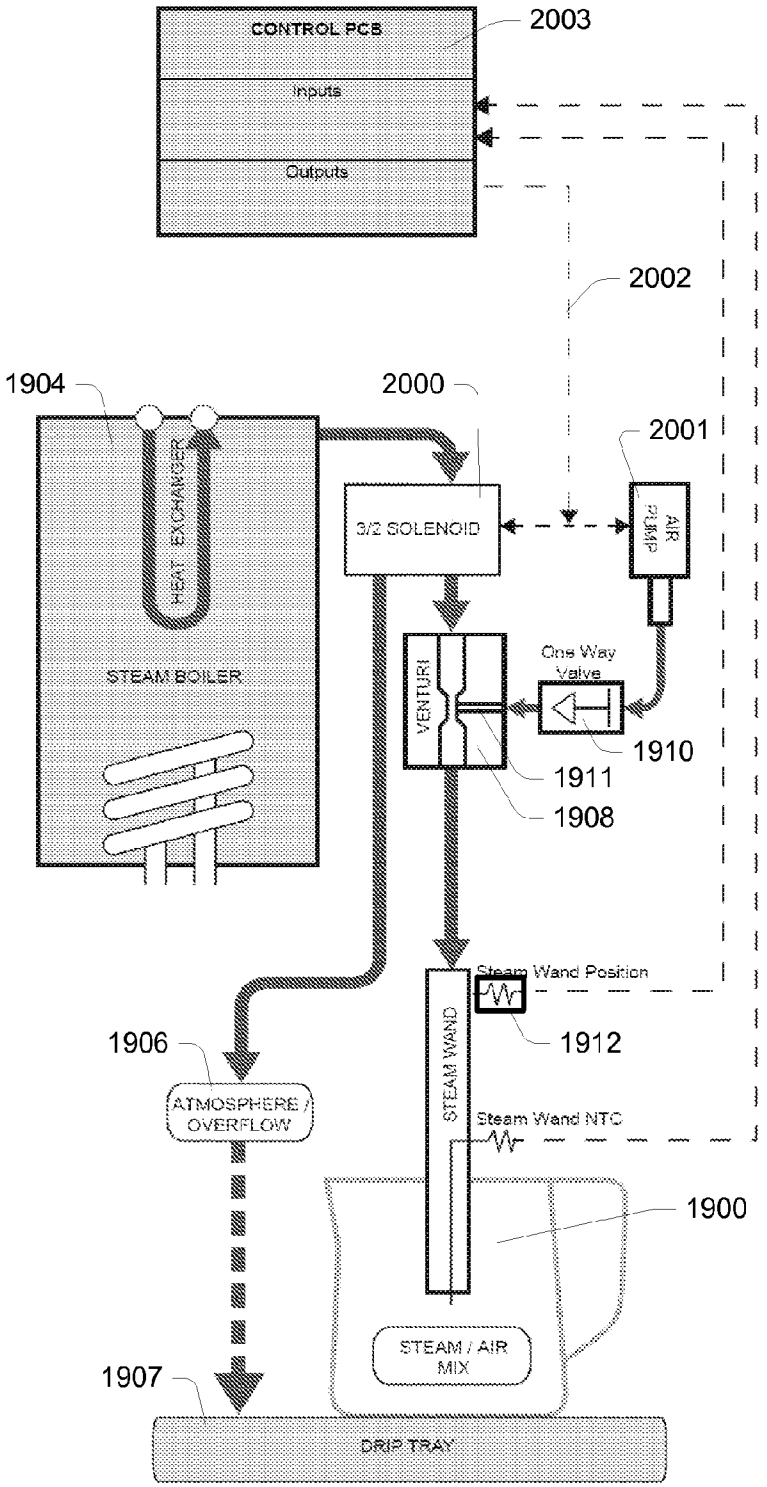
CONTROL PCB
Inputs
Outputs
2003
2002
1904
2000
2001
HEAT EXCHANGER
STEAM BOILER
3/2 SOLENOID
AIR PUMP
VENTURI
One Way Valve
1910
1911
1908
Steam Wand Position
1912
1906
ATMOSPHERE / OVERFLOW
STEAM WAND
Steam Wand NTC
1900
STEAM / AIR MIX
1907
DRIP TRAY

FIG. 20

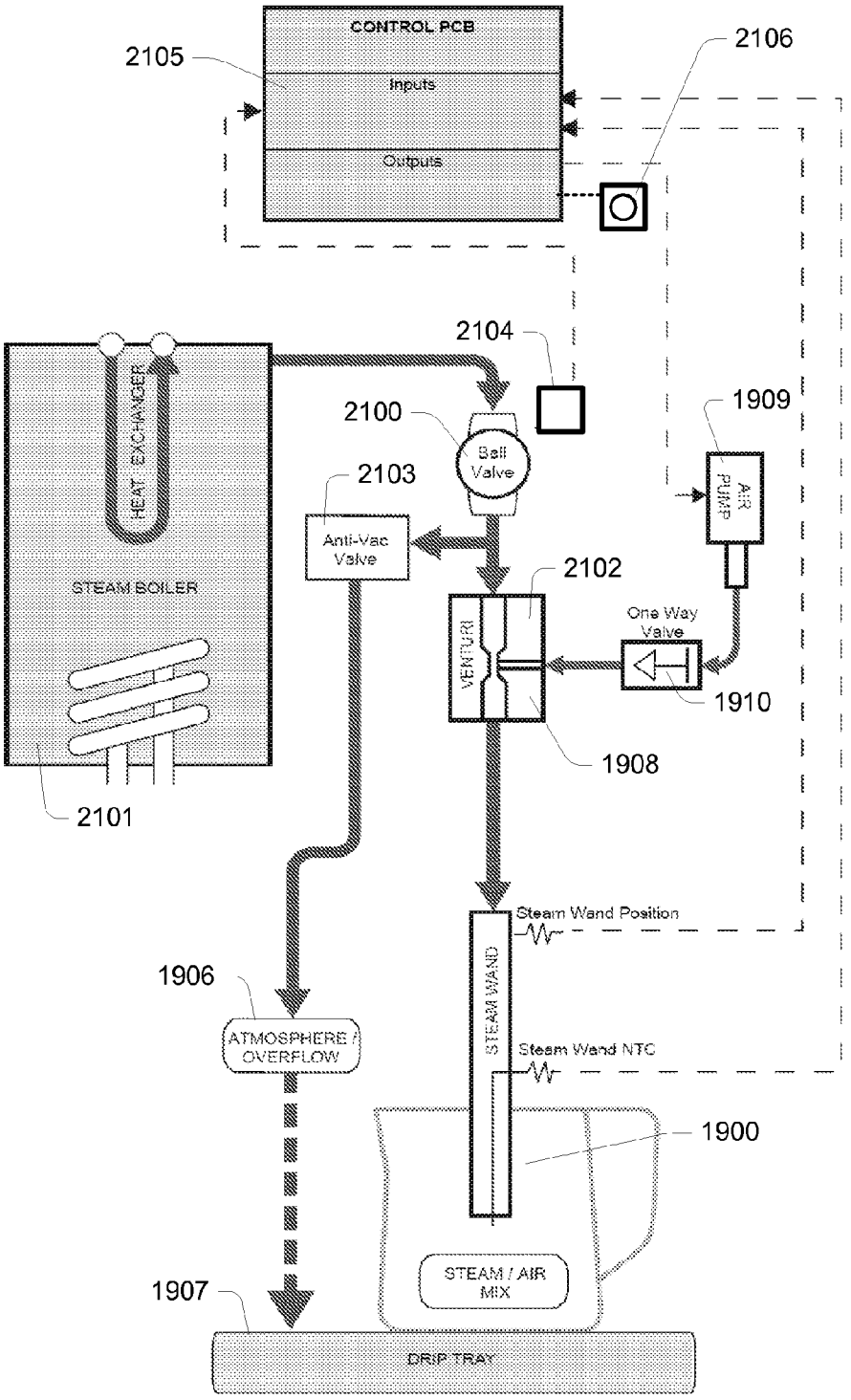
CONTROL PCB
Inputs
Outputs
2105
2106
2104
2100
Ball Valve
1909
AIR PUMP
2103
Anti-Vac Valve
2102
One Way Valve
VENTURI
1910
1908
HEAT EXCHANGER
STEAM BOILER
2101
Steam Wand Position
1906
STEAM WAND
ATMOSPHERE / OVERFLOW
Steam Wand NTC
1900
STEAM / AIR MIX
1907
DRIP TRAY

FIG. 21

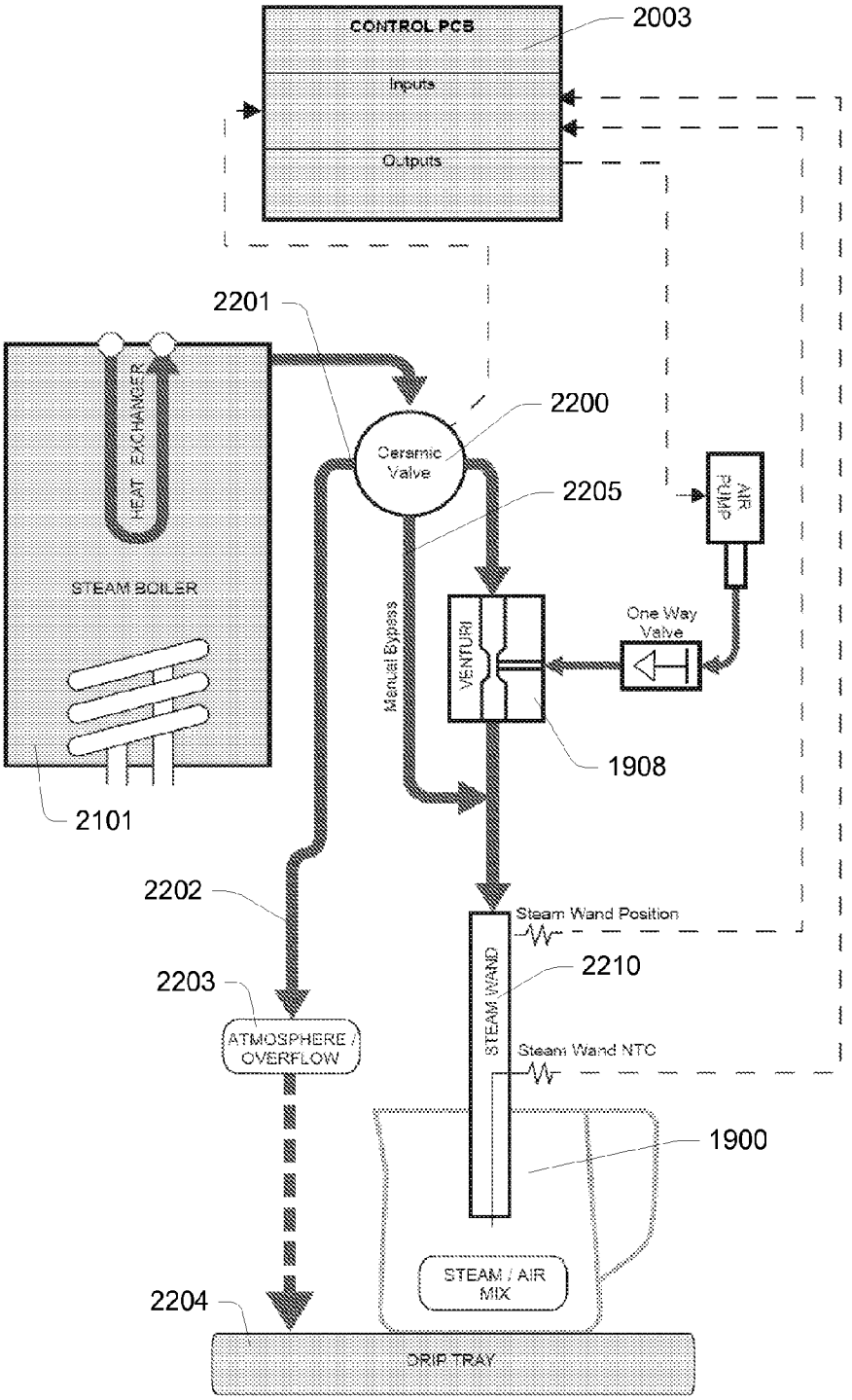
CONTROL PCB
2003
Inputs
Outputs
2201
2200
Ceramic Valve
2205
AIR PUMP
HEAT EXCHANGER
STEAM BOILER
Manual Bypass
VENTURI
One Way Valve
1908
2101
2202
Steam Wand Position
2203
2210
STEAM WAND
ATMOSPHERE / OVERFLOW
Steam Wand NTC
1900
STEAM / AIR MIX
2204
DRIP TRAY

FIG. 22

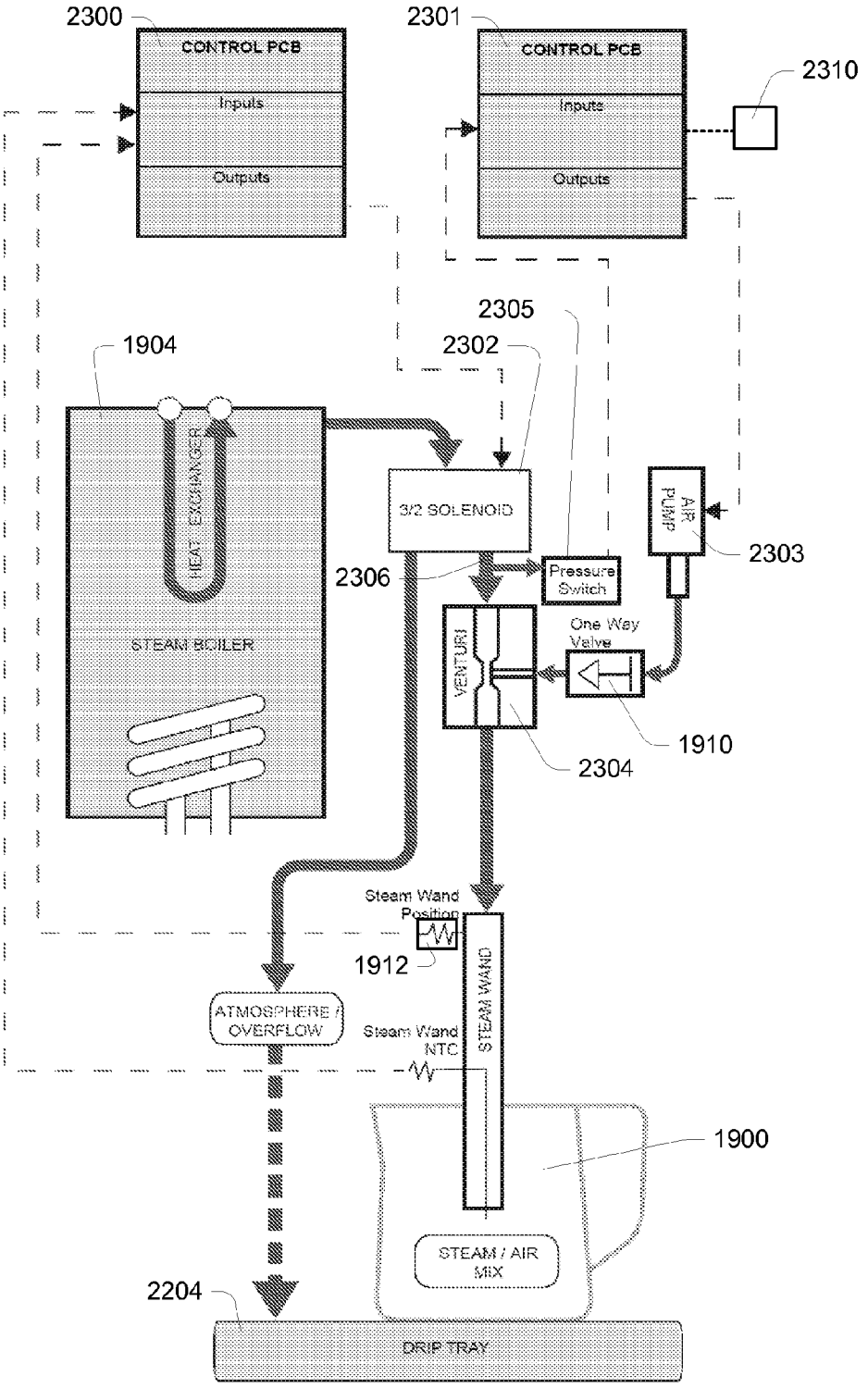
2300
CONTROL PCB
Inputs
Outputs
2301
CONTROL PCB
Inputs
Outputs
2310
2305
2302
1904
HEAT EXCHANGER
STEAM BOILER
3/2 SOLENOID
AIR PUMP
2303
2306
Pressure Switch
One Way Valve
VENTURI
1910
2304
Steam Wand Position
1912
STEAM WAND
ATMOSPHERE / OVERFLOW
Steam Wand NTC
1900
STEAM / AIR MIX
2204
DRIP TRAY

FIG. 23

APPARATUS AND METHOD FOR AN IMPROVED COFFEE MAKER

FIELD OF THE INVENTION

[0001] The present invention relates to fluid boilers and in particular to regulated control of fluid boilers.

[0002] The invention has been developed primarily for use as a controlled boiler method and apparatus of an espresso machine and will be described hereinafter with reference to this application. However, it will be appreciated that the invention is not limited to this particular field of use.

BACKGROUND OF THE INVENTION

[0003] Any discussion of the prior art throughout the specification should in no way be considered as an admission that such prior art is widely known or forms part of the common general knowledge in the field.

[0004] Known espresso machine control both the pressure and dose of water delivered in producing a shot of espresso coffee. It will be appreciated that the pressure is typically set to between nine and ten bar. The dose is typically about 30 mL, and is delivered in between twenty to forty seconds.

[0005] A pre-infusion stage has been used to wet the coffee grinds to allow expansion within a filter basket, thereby assisting in trapping fine grinds and restricting water from tracking though the filter. To enable wetting without forcing water though the coffee grinds, the water delivered in this pre-infusion stage usually has a pressure between one to five bar.

[0006] There is a need for an efficient method and apparatus for providing a dose having a regulated pressure and volume. There is also a need to provide an efficient method and apparatus for enabling an espresso machine water pumps to deliver a controlled low pressure pre-infusion.

[0007] Espresso machines are also known to have steam wands. The steam wand omits steam that can be used, for example, to heat and froth milk. In some machines, the steam output is regulated by a valve such as a needle valve. A needle valve provides a variable steam output but must be rotated numerous times when proceeding from a closed state to a fully opened state.

[0008] Accordingly, there is also a need for a steam output control that provides greater ease of use than a needle valve.

OBJECT OF THE INVENTION

[0009] It is an object of the present invention to overcome or ameliorate at least one of the disadvantages of the prior art, or to provide a useful alternative.

[0010] It is an object of some embodiments of the invention in a preferred form to provide an improved coffee machine. It is an object of some embodiments of the invention in a preferred form to provide an improved espresso coffee machine.

[0011] It is an object of some embodiments of the invention in a preferred form to provide an espresso machine that can provide a dose having a regulated pressure and volume.

[0012] It is an object of other embodiments of the invention in a preferred form to provide an espresso machine that can provide a controlled low pressure pre-infusion.

[0013] It is a further object of the invention in a preferred form to provide an espresso machine that represents a reasonable alternative to a needle valve controller for the steam output.

SUMMARY OF THE INVENTION

[0014] According to an aspect of the invention there is provided a flow measurement apparatus for measuring a resultant flow delivered by a pump coupled to an over pressure valve, the apparatus comprising:

[0015] a first flow meter for measuring feed flow to the pump;

[0016] a second flow meter for measuring return flow from the over pressure valve; and

[0017] wherein a resultant flow delivered by a pump can be determined by subtracting measured return flow from measured feed flow.

[0018] Preferably, resultant flow can be determined (or calculated) in real time, and used to stop the operation of the pump when a suitable dose has been delivered.

[0019] According to an aspect of the invention there is provided an espresso machine comprising a flow measurement apparatus as herein disclosed, for measuring a shot dose delivered by a pump coupled to an over pressure valve. Preferably, the espresso machine further comprises a pump power modification module as herein disclosed, for providing pre-infusion.

[0020] According to an aspect of the invention there is provided an espresso machine comprising a pump power modification module as herein disclosed, for providing pre-infusion. Preferably, the espresso machine further comprises a flow measurement apparatus as herein disclosed, for measuring a shot dose delivered by a pump coupled to an over pressure valve.

[0021] Preferably, the pump power modification module can enable pressure profiling during an espresso production cycle. More preferably, the pressure profile can be preset or user configurable. Most preferably, the pressure profile can take the form of power-time profile indicative of electrical power delivered to a respective pump.

[0022] According to an aspect of the invention there is provided a method of flow measurement for measuring a resultant flow delivered by a pump coupled to an over pressure valve, the method comprising the steps of:

[0023] (a) measuring, using a first flow meter, feed flow to the pump;

[0024] (b) measuring, using a second flow meter, return flow from the over pressure valve; and

[0025] (c) calculating resultant flow, at least in part, by subtracting measured return flow from measured feed flow.

[0026] Preferably, calculating resultant flow can be performed in real time, and used to stop the operation of the pump when a suitable dose has been delivered.

[0027] According to an aspect of the invention there is provided an espresso machine comprising a processor device adapted to perform a method of flow measurement as herein disclosed, for measuring a shot dose delivered by a pump coupled to an over pressure valve.

[0028] According to an aspect of the invention there is provided an apparatus for controlling overflow from a fluid reservoir, the apparatus comprising:

[0029] a body;

[0030] a removable fluid reservoir;

[0031] a fluid refill aperture in fluid communication with the reservoir; and

[0032] a drip tray, wherein the reservoir includes a overflow aperture in fluid communication with the drip tray.

[0033] According to an aspect of the invention there is provided an espresso machine comprising:

[0034] an espresso machine body;

[0035] a removable water tank;

[0036] a water refill aperture located at the front or top of the espresso machine, in fluid communication with the water tank;

[0037] a front loading drip tray,

[0038] wherein the water tank includes a overflow aperture in fluid communication with the drip tray.

[0039] Preferably, the water tank is inserted from the rear of the espresso machine body. Alternatively, the water tank is preferably inserted from the side of the espresso machine body.

[0040] According to an aspect of the invention there is provided an apparatus for receiving a removable fluid reservoir, the apparatus comprising:

[0041] a body; and

[0042] a removable fluid reservoir, wherein the reservoir includes a lock assembly and a fluid release valve.

[0043] According to an aspect of the invention there is provided an espresso machine comprising:

[0044] an espresso machine body;

[0045] a removable water tank;

[0046] wherein the water tank includes a lock assembly and a fluid release valve.

[0047] Preferably, the water tank is inserted from the rear of the espresso machine body. Alternatively, the water tank is preferably inserted from the side of the espresso machine body.

[0048] Preferably, the water tank includes a overflow aperture in fluid communication with a drip tray.

[0049] Preferably, the espresso machine includes a flow measurement apparatus.

[0050] According to an aspect of the invention there is provided an apparatus for providing control of a steam output, the apparatus comprising:

[0051] a body;

[0052] a steam wand assembly coupled to the body and having a steam output;

[0053] the output being controlled by a valve that is internal to the body;

[0054] the valve being controlled by a rotatable control element.

[0055] Preferably, the apparatus further comprising a pump that draws a fluid from a fluid reservoir, and supplies the fluid it to a steam boiler; the boiler supplying steam a solenoid activated valve used to start and stop the flow of steam from the boiler to the wand assembly.

[0056] According to an aspect of the invention there is provided an espresso machine comprising:

[0057] a steam wand having a steam output;

[0058] the output is controlled by a valve that is internal to the espresso machine;

[0059] the valve being controlled by a rotating paddle.

[0060] Preferably, the valve is a ball valve.

[0061] Preferably, a paddle is affixed to a knob.

[0062] According to an aspect of the invention there is provided an a steam control apparatus for an espresso machine comprises:

[0063] a ball valve in fluid communication with a steam wand;

[0064] a hub having a radially extending lever element; the hub being rotatable mounted with respect to the espresso machine; the hub and lever element being operative coupled to the ball valve; and

[0065] wherein the apparatus can be configured from a fully closed configuration to a fully open configuration by rotation of the hub of less that 180 degrees.

[0066] Preferably, the steam control apparatus includes a switch sensor element for providing a data (or lodging) signal to a computing module. More preferably, the data signal is indicative for the apparatus being in a fully open configuration wherein output of the steam wand is in fluid communication with a steam boiler.

[0067] Preferably, the valve is a ball valve in fluid communication with the steam wand assembly; and the rotating control element comprises a hub having a radially extending lever element; the hub being rotatably mounted with respect to the body; the hub and lever element being operative coupled to the ball valve; and wherein the apparatus can be configured from a fully closed configuration to a fully open configuration by rotation of the hub.

[0068] Preferably, allowable rotation of the control element is less than 180 degrees.

[0069] Preferably, the apparatus includes a switch sensor element for providing a data signal to a processor module. More preferably, the data signal is indicative for the apparatus being in a fully open configuration wherein output of the steam wand assembly is in fluid communication with a steam boiler.

[0070] Preferably, the apparatus further comprising a pump that draws a fluid from a fluid reservoir, and supplies the fluid it to a steam boiler; the boiler supplying steam a solenoid activated valve used to start and stop the flow of steam from the boiler to the wand assembly. More preferably, the solenoid activated valve is a three way two position solenoid valve used to start and stop the flow of steam from the boiler to the wand assembly.

[0071] Preferably, the wand assembly is substantially constructed in plastics so as to isolate heat in a wand nozzle.

[0072] Preferably, a temperature sensor element monitors temperature of the wand nozzle. More preferably, the temperature sensor element is a thermistor. Most preferably, the steam wand assembly has an output steam nozzle associated with a thermistor.

[0073] Preferably, when the solenoid valve is closed, a steam path is an open flow path to the atmosphere for restricting milk from being siphoned back into the wand assembly. More preferably, the solenoid valve is adapted to supply either unadulterated steam from the boiler, or to allow flow of atmosphere to the venturi.

[0074] Preferably, the rotatable control element activates one or more switch element for controlling a steam generation process.

[0075] Preferably, the steam wand assembly is associated with a switch element for enabling detection that the steam wand assembly has been returned to a predetermined home position.

[0076] Preferably, the apparatus further comprises a pressure sensor element for monitoring the steam pressure at the steam wand.

[0077] It will be appreciated that the apparatus disclosed herein can be a coffee machine. More particularly the apparatus disclosed herein can be an espresso coffee machine.

[0078] It will be further appreciated that the apparatus disclosed herein can be used as a coffee machine. More particularly the apparatus disclosed herein can be used as an espresso coffee machine.

BRIEF DESCRIPTION OF THE DRAWINGS

[0079] A preferred embodiment of the invention will now be described, by way of example only, with reference to the accompanying drawings in which:

[0080] FIG. **1** is a perspective view of an espresso machine;

[0081] FIG. **2** is a schematic view of an espresso machine;

[0082] FIG. **3** is a flow chart of a method of controlling an espresso machine;

[0083] FIG. **4** is a schematic view of an over pressure valve of FIG. **2**;

[0084] FIG. **5**A is a schematic view of a circuit used to modify power supplied to a pump, shown using a silicon controlled rectifier (SCR);

[0085] FIG. **5**B is a schematic view of a circuit used to modify power supplied to a pump, shown using a triode for alternating current (TRIAC);

[0086] FIG. **6**A is a waveform plot power supply signal;

[0087] FIG. **6**B is a waveform plot of a modification to the power supply signal of FIG. **6**A;

[0088] FIG. **6**C is a waveform plot of a modification to the power supply signal of FIG. **6**A;

[0089] FIG. **6**D is a waveform plot of a modification to the power supply signal of FIG. **6**A;

[0090] FIG. **7** is a schematic view of an espresso machine, shown having a heated group head;

[0091] FIG. **8** is a schematic view of an apparatus enabling water fill of an espresso machine according to the invention;

[0092] FIG. **9** is a schematic view of an apparatus enabling water fill of an espresso machine according to the invention, showing an overflow path;

[0093] FIG. **10** is a perspective rear view of an espresso machine according to the invention, showing the aperture for receiving a water tank;

[0094] FIG. **11**A is a perspective rear view of a water tank;

[0095] FIG. **11**B is a perspective rear view of a water tank of FIG. **11**A, shown in the unlocked configuration;

[0096] FIG. **12**A is a partial sectional side view of the espresso machine of FIG. **8**, shown with the water tank engaged;

[0097] FIG. **12**B is a partial sectional side view of the espresso machine of FIG. **8**, showing the water tank in an unlocked configuration;

[0098] FIG. **13**A is a partial sectional side view of espresso machine of FIG. **8**, showing a lock assembly in an locked engaged configuration;

[0099] FIG. **13**B is a partial sectional side view of espresso machine of FIG. **8**, showing a lock assembly in a unlocked disengaged configuration;

[0100] FIG. **14**A is a partial sectional side view of espresso machine of FIG. **8**, showing a water flow valve in a open engaged configuration;

[0101] FIG. **14**B is a partial sectional side view of espresso machine of FIG. **8**, showing a water flow valve in a closed sealed configuration;

[0102] FIG. **15** is a cross section through a steam wand, valve and rotating paddle control;

[0103] FIG. **16** is a cross section through line A-A of FIG. **15**;

[0104] FIG. **17** is a perspective view of the valve, wand and lever depicted in FIG. **15**;

[0105] FIG. **18** is a schematic diagram of a further embodiment of the technology;

[0106] FIG. **19** is a schematic diagram of a further embodiment of the steam wand assembly, using a wireless communication element;

[0107] FIG. **20** is a schematic diagram of a further embodiment of the steam wand assembly, using a dependant air stream;

[0108] FIG. **21** is a schematic diagram of a further embodiment of the steam wand assembly, using a ball valve and anti-vacuum valve;

[0109] FIG. **22** is a schematic diagram of a further embodiment of the steam wand assembly, using a ceramic type valve; and

[0110] FIG. **23** is a schematic diagram of a further embodiment of the steam wand assembly, using two independent controllers.

PREFERRED EMBODIMENT OF THE INVENTION

[0111] It will be appreciated that espresso machines are widely used in making hot beverages. Shots of espresso are typically brewed by the pressurised flow of hot water through densely-packed finely-ground coffee. This forced diffusion of water through coffee grounds, results in the production of espresso coffee. Quality, flavour and taste of any resultant espresso coffee are influenced by a plurality of factors, which include the texture of the ground coffee, the density of the ground coffee packing, and temperature and pressure of the water used. By maintaining these factors in appropriate proportions, it is possible to produce substantially consistent shots of espresso.

[0112] Pump based espresso machines rely, at least in part, upon the pressure (usually measured in bars) of the pump to make a suitable espresso coffee. Referring to FIG. **1**, these pump based coffee machines **100** can include: a water reservoir **110** (typically internal), showerhead or distributor **122**, and filter basket **124** (for holding the coffee grounds). A steam wand **130** and steam valve **132** may be included for frothing milk. A drip tray **140** is typically provided for collecting spillages and excess water. A series of user control inputs **150** can be provided for setting at least some of the parameters (or factors) associated with producing espresso coffee.

[0113] It will be appreciated that some espresso machines have an integrated coffee grinder **160**. This can include a hopper **162** for feeding coffee beans to a grinder and an output **164** for filling the filter basket (when provided there below) with coffee grounds.

[0114] With water in the water reservoir, and the coffee grounds in the filter basket, water is heated and pumped to the showerhead **122**. Upon heated water reaching the showerhead **122**, a forced diffusion of water through coffee grounds in the filter basket occurs, resulting in the production of espresso coffee.

[0115] FIG. **2** shows an schematic for an espresso coffee machine **200**. This coffee machine comprises a water reservoir **210**, having a reed switch tank level sensor **212**. Egress from the water reservoir includes passing though a filter **214** that is in fluid communications with two egress flow paths **216** and **218**.

[0116] In this embodiment, a first egress path **216** is for communicating or delivering water from the reservoir **210** to

a steam boiler **250**. This egress path includes a protection filter **220** that communicates water to a pump **221** that supplies water at a pre-determined pressure. A safety relief valve **222** is included to limit the water pressure provided to the steam boiler **250**. In the event of over pressure occurring in this fluid line, the relief valve **222** provides or diverts water to the drip tray **240** using fluid line **224**. By way of example, the pump **221** provides water with about three bar pressure to the steam boiler **250** (using fluid line **223**). For steam system, the pump is supplied the water at approx. 3 bar to refill the boiler. The safety relief valve **222** is set to activate at a higher pressure, and is used for protection.

[0117] By way of example, the steam boiler **250** is used to convert water provided by fluid line **223** to steam. The boiler includes a heating element **252**, a water level probe **256**, a temperature sensing element (for example a thermistor) **257**, a thermal fuse and thermostat **258**, and vacuum breather valve **259**. In this example, the steam boiler is a 0.80 litre boiler. By way of example only, this boiler **250** can be constructed from any one or more materials in a set comprising diecast-aluminium (preferably teflon-lined), stainless steel or brass. The heating element **252** is preferably an immersed 1000 watt heater element. By way of example only, this heating element can be constructed from any one or more materials in a set comprising stainless steel and Incoloy. It will be appreciated that the heating element can have alternative power ratings that are suitable for creating steam within the boiler. The water level probe **256** preferably uses three probes to monitor water level and is substantially comprised of stainless steel probes. By way of example only, the thermistor **257** has a maximum temperature rating of about 200 degrees Celsius.

[0118] By way of example, egress steam **272** from the steam boiler **250** is released from a continuously variable delivery ball valve **274** though a steam wand **274**. Preferably, the ball valve has a maximum temperature rating of about 150 degrees Celsius, a nominal working pressure of about two bar and a maximum pressure rating of about eight bar. In this embodiment, a second water egress path **218** communicates water from the water tank **210** to a coffee boiler **260**. This egress path includes a protection filter **230**, a first flow meter **233** and a pump **234**. The pump **234** further includes an over pressure (or safety relief) valve **235**. This over pressure valve **235** is adapted to limit the water pressure provided to line **236**, typically to between nine bar and ten bar. The over pressure valve **235** is typically set to a pressure set-point, typically about ten bar, such that when water pressure exceeds this set-point a portion of the water is fed back through a return line **237** to the reservoir **210**, thereby maintaining a pressure set-point. The amount of water fed back through a return line **237** can be measured by a second flow meter **238**. The main egress path **236** proceeds through the steam boiler **250** via a heat exchanger **254** and then to the coffee boiler **260**.

[0119] By way of example, the coffee boiler **260** includes a heating element **262**, a water level probe **266**, a thermistor **267** and a thermal fuse and thermostat **268**. In this example, the coffee boiler **260** is a 0.30 litre boiler. By way of example only, this boiler **260** can be constructed from any one or more materials in a set comprising diecast-aluminium (preferably teflon-lined), stainless steel, or brass. By way of example only, the heating element **262** is an immersed stainless steel 600 watt heating element. The water level probe **266** preferably uses two probes to monitor water level and is substantially comprised of stainless steel probes. By way of example only, the thermistor **267** has a maximum temperature rating of about 150 degrees Celsius.

[0120] By way of example, egress from the coffee boiler is used to provide hot water **282**, via a continuously variable output needle valve **284**, though a hot water wand **286**. In this example, the needle valve **282** preferably has a maximum temperature rating of about 120 degrees Celsius and a working pressure of about fifteen bar.

[0121] By way of example, egress from the coffee boiler is also used to provide hot water to a coffee showerhead **292** for providing coffee **294**. A solenoid **296** releases hot water to the showerhead **292** for making coffee. The showerhead **294** further has a pressure gauge **298** for displaying the pressure of hot water provided by the coffee boiler. By way of example only, the solenoid **296** has a maximum working pressure of about sixteen bar, and a maximum fluid temperature of about 160 degrees Celsius. By way of example only, the solenoid **296** body can be constructed from any one or more materials in a set comprising stainless steel and brass. Different protective coatings can be applied to the solenoid, including nickel-plating.

[0122] It will be appreciated that, by way of example only, the fluid lines are either Teflon tubing or silicon tubing.

[0123] It will be appreciated that pumps **221** and **234** can be vibration (displacement) pumps, although alternative pump technologies can be used. Vibration pumps typically produce around fifteen bar to eighteen bar unregulated pressure, which is typically considered too high for espresso extraction. To regulate the pressure, a fixed or variable over pressure valve can be installed. However, with such a valve installed, a known method of measuring the dose includes having a flow meter located proximal to the showerhead. It will be appreciated that any installation in the flow proximal to the showerhead requires that the over pressure valve be suited to operation in a high temperature and a high pressure environment. The construction and operation of over pressure valves will be discussed in more detail below.

[0124] In an embodiment, the apparatus **200** includes a processor **202** for receiving inputs from user interface **204** and water level probes, thermistors, and thermal fuse/thermostats. The processor is also used to control/activate heating elements and pumps.

[0125] In an embodiment, a pair of flow meters are used, the first flow meter **230** to measure the feed flow to the pump and the second flow meter **237** to measure return flow from an over pressure valve **235**. In this arrangement, the resultant flow delivered to the coffee boiler **260** (and therefore to the showerhead **296**) can be calculated by subtracting the return flow from the feed flow. By calculating resultant flow over a time period of coffee production, a dose measure can be determined. It will be appreciated that this calculation can be performed in real time, and used to stop the pump when a suitable dose has been delivered through the showerhead.

[0126] In one embodiment, a flow measurement apparatus, for measuring a resultant flow delivered by a pump coupled to an over pressure valve has a first flow meter for measuring feed flow to the pump, and a second flow meter for measuring return flow from the over pressure. A resultant flow delivered by a pump can be determined by subtracting measured return flow from measured feed flow.

[0127] Referring to FIG. **3**, a method **300** of flow measurement for measuring a resultant flow delivered by a pump coupled to an over pressure valve, the method comprising the

steps of monitoring (or measuring), using a first flow meter, feed flow to the pump **320**; monitoring (or measuring), using a second flow meter, return flow from the over pressure valve **330**; and calculating resultant flow, at least in part, by subtracting measured return flow from measured feed flow **340**.

[0128] It will be appreciated that this calculation can be performed in real time, and used to stop the pump (**350**) when a suitable dose has been delivered through the showerhead. The pressure, dose amount, duration can be preset or user configurable (using user interface **204** and the machine's controller).

[0129] A pre-infusion stage is often initiated to wet the coffee grinds to allow expansion within a filter basket, thereby assisting in trapping fine grinds and restricting water tracking though the filter. To enable wetting without forcing water though the coffee grinds, the water delivered in this pre-infusion stage is usually provided at a pressure of about three bar. However, it will be appreciated that pre-infusion pressure can range from 1 to 5 bar.

[0130] In this embodiment, the pump **230** can be controlled to provide a lower (or reduced) pressure pre-infusion stage. This can be achieved by reducing the electrical power supplied to the pump during this stage. Typically, a power modification module, as discussed in more detail below, can be utilised to enable processor control of electrical power supplied to the pump. Preferably, during the pre-infusion stage, the electrical power supplied to the pump enables the pump to produce a lower than normal pressure. The water flowing during the pre-infusion stage may (or may not) be counted toward a subsequent dose has been delivered through the showerhead.

[0131] Power control and flow measurement can be combined to enable measurement of a resultant pre-infusion dose. In an embodiment, the pressure, dose amount, duration can be preset or user configurable (using user interface **204**).

[0132] In an alternative embodiment, where the system pressure is not measured and the pressure may not be configurable to a unit value, a percentage of the maximum pump pressure available can be configured. For example, a pressure profile could comprise 30% of the maximum pressure for 5 seconds, then 100% pressure for 20 seconds, then 70% pressure for a final 5 secs. Similarly, in another example embodiment, the system may exercise a method of volume output configured such that the delivery would entail a 5 ml at 30%, a 20 ml at 100%, and a 5 ml at 70% distribution.

[0133] It will be appreciated that a power modification module can further enable pressure profiling during an espresso production cycle. A pressure profile can be preset or user configurable (using user interface **204** and the machine's controller). Pressure profiling can take the form of power-time profile indicative of electrical power delivered to a respective pump.

[0134] It will be appreciated that the illustrated apparatus discloses an espresso machine that can provide a dose having a regulated pressure and volume.

[0135] It will be appreciated that the illustrated apparatus further discloses an espresso machine that can provide a controlled low pressure pre-infusion.

Over Pressure Valve

[0136] An over pressure valve (OPV), also known as an expansion valve, can be used to regulate water flow pressure within an espresso machine. The regulated pressure can be fixed or adjusted. For an espresso machine, an over pressure valve can regulate pressure down, to between nine bar to ten bar on many vibration pump based machines.

[0137] Referring to FIG. **4**, an over pressure valve **400** comprises an ingress part or aperture **410** and an egress part or aperture **420**. An over pressure part or aperture **430** is included for releasing water to substantially maintain a pressure set-point. A release seal **432**, typically in the form of a ball, rubber pad on brass piston or similar, is biased to a closed position by a spring **434** (the tension or compression on the spring can be adjusted **436**) against an exit aperture **438**. When pressure exceeds in the set-point, the release seal **432** opens allowing water to flow toward the over pressure aperture **430**.

[0138] The exit aperture is in fluid communication with the over pressure aperture, typically for routing excess water back to the tank.

[0139] It will be appreciated that alternative over pressure valves are adapted to be fixed to a 'T' piece, wherein the 'T' piece defines an ingress aperture and an egress aperture. Flow rate capability is typically determined by the size of the over pressure valve.

Power Modification

[0140] Phase controlled power modification is a method of providing alternating current power to a load only during periods of an alternating current power cycle. FIG. **6**A shows a sine wave **600** indicative of alternating current power (voltage or current). Each time the line equals the neutral or ground line, a 'Zero Crossing' occurs.

[0141] Circuit diagrams power modification is provided by Motorola data sheet for MOC30xx variants. It has applicability to inductive and resistive loads.

[0142] FIG. **5**A shows a schematic view of a circuit **500** used to modify power supplied to a pump, shown using silicon controlled rectifier (SCR) **530**;

[0143] It will be appreciated that a silicon controlled rectifier (SCR) is typically considered as a device which is either on or off Once turned on, it will only turn off when there is no current flowing through it. The gate requires a small current to switch the SCR on. An SCR will only conduct current one way, so if the current changes polarity, it will turn off, because it won't allow any current to flow.

[0144] FIG. **5**B shows a schematic view of a circuit **550** used to modify power supplied to a pump, shown using a triode for alternating current (TRIAC) **580**.

[0145] It will be appreciated that a TRIAC schematically resembles two SCRs back to back, with only one gate terminal from one of the anodes. This allows AC operation, but every time the current changes polarity the TRIAC turn off (unless the gate is held high).

[0146] Phase Control enables only portions of the AC cycle to be coupled to the load **540**. This can be performed by a TRIAC, or two back to back SCRs.

[0147] It will be appreciated that alternating current sources have two zero crossings every cycle, in which no current should be flowing. In North America the frequency of zero crossings is about 120 times a second, while in Europe the frequency of zero crossings is about 100 times a second.

[0148] As the TRIAC turns off at each zero crossing, if less power is desired to be delivered, the TRIAC can be turned on for a period after a zero crossing, for example at time **612** and time **614**, as shown in FIG. **6**B.

[0149] Referring to FIG. **6**C, if half the power is required, the TRIAC can be enabled at the midpoint between each

zero-crossing (time **622** and time **624**). Referring to FIG. **6**D, by activating the TRIAC just prior to each zero crossing (time **632** and time **634**) less than half the power can be provided.

Heated Group Head

[0150] It will be appreciated that it is beneficial for an espresso machine (commercial or consumer/domestic) to:

[0151] maintain accurate brew temperature consistently over multiple coffee extractions and intra extraction (such as, during a pour);

[0152] allow simultaneous coffee extraction and milk steaming without affecting the performance of either process;

[0153] ensure that the first coffee extraction that the machine makes, after being switched on, is delivered at the correct extraction temperature; and

[0154] provide good performance and thermal stability with minimal and efficient power consumption.

[0155] A typical domestic electrical output (1700-2400 W) can limit the available power for achieving these beneficial outcomes, particularly when required to supply continuous high volume output (multiple coffees, hot water and steaming milk).

[0156] This can be further exacerbated in commercial/domestic espresso machines that typically use lighter weight (lower thermal mass) boiler units. For example stainless steel boilers used in some espresso machines have a relatively low thermal mass. The low thermal mass typically limits the amount of fluid flow that can be achieved while maintaining a constant temperature and/or pressure.

[0157] It will be appreciated that combining a steam boiler, a brew boiler, a heat exchanger and heated group head can be beneficial for reducing the power requirements of the heater associated with the brew boiler.

[0158] FIG. **7** shows a schematic view of an embodiment espresso machine similar to FIG. **2**, shown having a heated group head **700**. This embodiment, enables a 3 stage progressive heating process for brew water, wherein:

[0159] A. cold water is pre-heated by heat exchanger **254** in steam boiler **250**;

[0160] B. pre-heated water from heat exchanger (below optimum brew temperature) is then heated in a brew boiler **260** to an optimum brew temperature (for example to about 92 deg Celsius); and

[0161] C. water from brew boiler passes through heated group head **700** (to maintain optimum brew temperature) and is infused into coffee grinds.

[0162] The heated group head **700** comprises a heating element **710** (typically embedded), thermal cut-out fuse **720**, and thermistor **730**.

[0163] This enables a heat system for an espresso machine that enables three heating elements to operate independently and simultaneously. The brew boiler and group head are typically temperature controlled using proportional—integral—derivative (PID) control module.

[0164] In an embodiment, a boiler capacity ratio of 10:3 (steam boiler:brew boiler) is utilised. A heating element power (wattage) ratio of 10:6:1 (steam boiler:brew boiler: heated group head) can also be utilised.

[0165] In one embodiment, boiler capacity to heating element power (wattage) ratio can be established as follows:

[0166] steam boiler volume to steam boiler heater wattage being 1000 ml:1000 W or 1 ml:1 W;

[0167] brew boiler volume to brew boiler heater wattage being 300 ml:600 W or 1 ml:2 W.

[0168] In an alternative embodiment, an optional pressure sensor (or transducer) **740** can be included to monitor water pressure in the flow line **236**. This sensor **740** is coupled to an MCU (or processor module) to provide a feedback loop operation for controlling a selected pressure to be maintained in real-time, whereby power supplied to the respective pump is varied according to resultant pressure feedback from the sensor and subsequent instructions from the MCU, controller or processor. In this embodiment, the second flow meter **238** need not be included. It will be appreciated that this adaptation can be applied to other steam control systems (for example the espresso machine **200**).

Water Fill Assembly

[0169] It will be appreciated that a removable water tank located at the rear of the machine, is typically difficult to obtain regular access for refilling. However, refilling the water tank in situ can result in user error causing overfilling of the tank resulting in potential water ingress issues for the espresso machine body.

[0170] Referring to FIG. **8**, an embodiment espresso machine **800** includes a water fill ingress aperture **810** located on the top or the front (or the front portion of the top) of the machine for relative easy access. The aperture **810** may be covered by a hinged door or other lid. The water fill aperture is in fluid flow communication with the water tank **820** (typically via an internal horizontal diverter conduit **830**—or funnel). Water **812** can be poured through the aperture **810**, which progresses first vertically **810**, then horizontally through an enlarged accumulator portion and vertically again **832** to a water reservoir **822** in the water tank **820** located adjacent to the base of the machine.

[0171] Referring to FIG. **9**, to avoid overfilling of the tank, and ingress issues to the espresso machine body, a maximum volume diversion channel, cavity or conduit **940** provides a fluid overflow path **942** for enabling excess water to be directed vertically into the rear of the drip tray **950** for fluid collection **952**. The diversion channel is defined by a partial height wall that is located between the reservoir **822** and a front-most wall of the tank **820**.

[0172] In the present embodiment, by way of example only, the diversion channel **940** defines an aperture **944** located within the water tank, at a maximum fill height, for receiving overflow water. The diversion channel **940** is at least partially integrally formed with the water tank and directs overflow water, still within the confines of the tank, to the drip-tray **950**.

[0173] Using a diversion channel in fluid flow (overflow) communication with a drip tray mounted at the front of an espresso machine body, can reduce risk of ingress of water into the espresso machine components during water filling operation, while providing visual (and preferably audible) feedback to the user for establishing completion of the water filling operation. This can enable refilling of the water tank from the top of the espresso machine.

[0174] In an embodiment, an espresso machine comprises:

[0175] a removable water tank;

[0176] a water refill aperture located at the front or top of the espresso machine, in fluid communication with the water tank;

[0177] a front loading drip tray,

[0178] wherein the water tank includes a overflow aperture in fluid communication with an the drip tray.

Water Tank Lock Assembly

[0179] An unsecured water tank can move due to vibration caused by operation of the machine causing the tank to at least partially disengage from the espresso machine.

[0180] The water tank is typically in fluid flow communication with the espresso machine boilers by way of a releasable valve coupling. The release valve restricts fluid flow from the water tank during removal of the tank (typically during filling and/or cleaning).

[0181] A partially engaged/disengaged connection between the water tank and boiler (via an inlet valve) can result in leakage, lower brew pressure during operation, or restriction of water flow from the water tank to the boiler.

[0182] In an embodiment, a locking assembly can be incorporated to enable secure engagement between the water tank and espresso machine body. The locking assembly can restrict unintentional or undesired disengagement of the water tank from the espresso machine body.

[0183] FIG. **10** shows a perspective rear view of an embodiment espresso machine **1000**, showing an aperture **1010** for receiving a water tank. A releasable valve coupling element **1020** is adapted to receive a release valve (not shown). A lock abutment surface **1030** is adapted for engaging a lock assembly operatively associated with the water tank.

[0184] In this embodiment, the water tank assembly is fitted to the espresso machine body in a substantially horizontal direction.

[0185] FIG. **11**A, FIG. **11**B, FIG. **12**A and FIG. **12**B, show an embodiment water tank assembly **1100** comprising:

[0186] a lock assembly **1110** (best shown in FIG. **13**A and FIG. **13**B) in the form mechanical over centre cam lock for securing the water tank position and ensuring that inlet valve connection is fully engaged; and

[0187] a release valve **1120** (best shown in FIG. **14**A and FIG. **14**B) in the form of a spring biased plunger valve for connecting in a horizontal direction to the water inlet valve coupling element.

[0188] FIG. **11**A shows the water tank **1100** having the lock assembly in a locked configuration, and FIG. **11**B shows the water tank **1100** having the lock assembly in an unlocked configuration.

[0189] FIG. **12**A shows a partial sectional side view of an espresso machine, shown with the water tank in the engaged configuration. In this configuration, the lock assembly **1110** is in the locked configuration, and the release valve **1120** is in the open engaged configuration for enabling fluid flow from the tank.

[0190] FIG. **12**B shows a partial sectional side view of an espresso machine, shown with the water tank in the disengaged configuration. In this configuration, the lock assembly **1110** is in the unlocked configuration, and the release valve **1120** is in the closed sealed configuration for restricting fluid flow from the tank, best shown in FIG. **14**B

[0191] Referring to FIG. **13**A and FIG. **13**B, engaging of the water tank **1310** with the espresso machine body **1320**, brings the a lock assembly **1330** proximal to a lock abutment surface **1340**. Upon engagement of the water tank, the lock assembly handle can be rotated to a locked configuration (as best shown in FIG. **13**A), wherein a camming lobe **1332** engages a camming abutment surface **1342** for defining an over centre locked configuration. During disengagement, referring to FIG. **13**B, rotation of the lock assembly (about pin **1344**) disengages the a camming lobe **1332** from the camming abutment surface **1342** to define an unlocked configuration that enables the water tank to be withdrawn. The over-centre cam configuration can restrict unintentional or undesired disengagement of the water tank from the espresso machine body.

[0192] It will be appreciated that the camming engagement draws the tank into the espresso machine body to the engaged configuration, and the over-centre cam configuration (whereby the axis of rotation defined by the pin **1344** is above the abutment surface) restricts unintentional or undesired disengagement of the locking assembly.

[0193] Referring to FIG. **14**A and FIG. **14**B, engaging of the water tank **1410** with the espresso machine body **1420** brings the release valve assembly **1430** into engagement with a releasable valve coupling element **1440**. As the release valve assembly **1430** is brought into engagement with valve coupling element **1440**, a spring biased release valve **1434** engages an abutment surface **1442** and moving the valve to an open engaged configuration for enabling fluid flow from the tank. During disengagement, referring to FIG. **14**B, the release valve assembly **1430** is moved away from the with valve coupling element **1440**, causing the spring biased release valve **1434** to disengage the abutment surface **1442** and moving the valve to a closed disengaged configuration for restricting fluid flow from the tank.

Steam Control

[0194] FIG. **15** through FIG. **17** show, by way of example only, an embodiment steam control apparatus for an espresso machine.

[0195] As shown in FIG. **15**, an espresso machine can comprises a steam wand **1500** that pivots about a ball joint **1501**. Steam is delivered to the wand **1500** via the output port **1502** of a valve **1503**. Rather than utilising a multi-turn needle valve, some embodiments utilise a continuously variable output ball valve **1504** to regulate the amount of steam delivered (continuously from no steam to full steam) to the steam wand **1500**. The ball valve **1504** is mechanically operated and mechanically coupled to a rotating paddle **1505** for more authoritative user control. Because the ball valve only needs preferably about 90 degrees of rotation (or at least less than 180 degrees) to go from fully closed to fully open, the user operated paddle **1505** only preferably needs to move through 90 degrees or less to effect full control over the output of the wand **1500**. Up to 180 degrees may be acceptable. In this embodiment, the inlet port **1506** receives steam from a steam boiler (for example, a steam boiler **260** as shown in FIG. **2** and FIG. **7**). The ball valve **1504** is within the external housing **1507** of the espresso machine.

[0196] With reference to FIG. **15**, FIG. **16** and FIG. **17**, it will be appreciated that the rotating paddle **1505** consists of a lever hub **1508** that carries a radially extending paddle or lever **1601**. The lever **1601** provides a convenient grip and a way for the user to apply more torque (accurately) to the valve **1503**. The hub carries an external cover **1509** in which is formed a slot **1701** through which extends the lever **1601**. The hub **1508** also has a longitudinal extension in the form a hollow shaft **1510** through which is inserted a fastener **1511** that connects the shaft **1510** to the rotating element of the valve **1504**, in this example, a ball valve.

[0197] As shown in FIG. **15** and FIG. **16**, an interior (or interior facing portion) of the hub **1508** is formed as, or carries, a cam surface **1602**. The cam surface **1602** cooperates with a micro switch **1603** that may be located within a mounting bracket or housing **1604**. The cam surface **1602** is adapted

to bear against the micro switch **1603** and thereby activate it when the lever **1601** is rotated into a position that allows the valve to deliver steam through the wand **1500**. Thus, the micro switch **1603** can deliver to the espresso machine's MCU, a data (or logging) signal that can be used by the MCU for a variety of purposes. In one example, if the machine is switched on while the micro switch **1603** is activated, the MCU will recognise the output of the micro switch as being indicative that the output of the steam wand is in fluid communication with a steam boiler. This being an undesirable condition, the MCU will either prevent the steam boiler from heating or will block the output to the steam wand until the situation is rectified by the user. In preferred embodiment, both the cam surface **1602** and micro switch **1605** are internal to the housing **1507**.

[0198] In an embodiment, a steam control apparatus for an espresso machine comprises:

[0199] a ball valve in fluid communication with a steam wand;

[0200] a hub having a radially extending lever element; the hub being rotatable mounted with respect to the espresso machine; the hub and lever element being operative coupled to the ball valve, which can operating in a variable state;

[0201] wherein the apparatus can be configured from a fully closed configuration to a fully open configuration by rotation of the hub of less that 180 degrees.

[0202] Typically, the steam control apparatus includes a switch sensor element for providing a data (or lodging) signal to a computing module. The data signal can be indicative for the apparatus being in a fully open configuration wherein output of the steam wand is in fluid communication with a steam boiler.

[0203] A further embodiment of the invention is disclosed schematically in FIG. **18**. As shown in that diagram, an espresso machine **1800** comprises a pump **1801** that draws water from a water tank **1802** and supplies it to a steam boiler **1803**. Steam from the boiler **1804** is supplied to a solenoid activated valve **1805**. The three way two position solenoid valve **1805** is used to start and stop the flow of steam from the boiler **1803** to the wand **1811**. In preferred embodiments, a large majority of the wand assembly is constructed in plastic so as to isolate the universal heat in the nozzle **1812**. The temperature of the nozzle being monitored by the thermistor **1813** and being generally representative at the temperature of the liquid or milk surround the nozzle **1812**. When the solenoid **1805** is closed, it allows the steam path to have an open flow path to the atmosphere. Exposing the steam flow path to the atmosphere prevents milk from being siphoned back into the wand **1811** and the venturi **1806**. Milk in these areas can cause contamination, foul odours and blockages. The valve **1805** is adapted to supply either unadulterated steam from the boiler **1803**, or to allow flow of atmosphere to the venturi. The venturi **1806** is also supplied with air, preferably pressurized air **1807** that is supplied from an air pump **1808**. The supply of air from the air pump **1808** passes through a one way valve **1809**. A blockage in the steam wand **1811** can cause back pressure in the steam path that can potentially damage the air pump **1808**. The check valve **1809** prevents damaging back pressure events from adversely effecting the air pump **1808**. The output **1810** of the venturi is supplied to a steam wand **1811**. The steam wand **1811** has an output steam nozzle **1812** having attached to or adjacent to it or associated with it a thermistor such as an NTC thermistor **1813**. A rotating steam lever **1814** activates switches such as micro switches **1815**, **1816**. One of the micro switches **1815** modulates the automatic steam generation process. The other micro switch **1816** is used to govern manual steaming operations. The state of the switches **1815**, **1816** is monitored by a micro processor control unit (MCU) **1817**. The MCU also reads the output of the thermistor **1813** and serves to control the air pump **1808** and solenoid activated valve **1805**. The MCU also detects a signal from a third microswitch **1818** that is controlled in accordance with the position of the steam wand **1811**. In particular, the micro switch adjacent the steam wand **1818** detects when the steam wand **1811** has returned to an upright or home position and is thus in a position that is compatible with a purging of the steam wand, in particular an automatic purging as will be explained.

[0204] For automatic steam operation, a user momentarily activates the lever **1814** so that a first micro switch **1815** is contacted. In preferred embodiments, the steam wand **1814** acts against a spring or other resilient bias **1819** so that the lever returns to its original, neutral position when released. The signal from the micro switch **1815** (or lack of signal) detected by the micro processor **1817** causes the solenoid valve **1805** to open and let steam from the boiler **1804** to flow the venturi **1806**. At the venturi, steam from the boiler is mixed with air **1807** from the pump **1808**. The steam air mixture travels through the steam wand **1811** and exits the nozzle **1812** directly into a container **1820**, preferably containing milk. The temperature sensor **1813** measures the temperature and transmits the relevant signal to the MCU **1817**. The MCU then causes the display of the milk temperature **1821**. Preferably, the display **1821** is located on a front panel of the espresso machine or stand alone milk frothing device. The milk temperature can be preset by the user using a separate control located in an interface. When the milk in the container **1820** reaches a predetermined temperature both the solenoid **1805** and the air pump **1808** are disabled or deactivated. When the solenoid **1805** is deactivated, the steam passageway to the wand **1811** is open to the atmosphere **1805**.

[0205] The air pump can act independently such that it can activate and deactivate according to a preset temperature, time and or combined logic.

[0206] In a manual steaming operation, the user activates the steam lever **1814** in an opposite direction and against the second micro switch **1816**. This causes the solenoid **1805** to open and lets steam flow from the boiler **1804** flow to the venturi. In this mode, steam passes directly through the venturi and air **1805** is not introduced into the steam passageway. Steam travels through the steam wand **1911** and exits the nozzle **1812** directly into the container **1820**. The temperature sensor **1813** measures the temperature of the milk in the container **1820** and then appropriate signal is transmitted to the micro processor **1817**. The micro processor causes a display **1821** on the body to show the milk temperature. When enough steam has been delivered, the user deactivates the steam lever **1819** back into the home or neutral position. When deactivated in this way, the solenoid **1805** is open to the atmosphere. By opening the steam passageway to atmospheric pressure, the condensation of the hot steam in the steam passageway does not cause milk from the container **1820** to be drawn back into the nozzle **1812**.

[0207] An alternative semi-automatic operation—a user can select a (factory pre-set or custom) temperature, such that when a user froths milk, a sensor recognises and/or calculates

an approach of user selected temperature and indicates to the user via audio and or visually displayed feedback to switch off the steam delivery.

[0208] In preferred embodiments, after an automatic steam generating function has been performed and the container **1820** has been removed, the wand position micro switch **1818** will identify when the wand has returned to the "home" or safely down position. The signal from the micro processor **1818** will be detected by the MCU **1817** and will cause the solenoid **1805** to open for short bursts (e.g. 1 second) or a series of short burst for the purpose of clearing the opening in the nozzle **1812**. This can be an automatic function to purge the line of frothing debris. In some embodiments, an audible or visual warning may precede this function to alert the user that steam will be ejected from the nozzle **1812**. The presence of the wand position sensor switch or micro switch **1818** allows other automated functions to be performed when the steam wand is in a home or fully down position. The flow or rate of delivery of air from the air pump **1808** can be controlled, for example, by pulse width modulation. This rate of air flow can be controlled by the user through the user interface **1822**. The control of the output of the air pump **1808** has the effect of determining the texture of the frothed milk produced in the container **1820**. A high flow rate will create a more textured or airy foam whereas a low flow rate will result in a denser, less textured foam.

[0209] In an embodiment, a pressure sensor **1830** can be use in enabling the processor MCU **1817** to monitor the steam pressure at the steam wand **1811**. In this embodiment, the pressure sensor is coupled to steam path between the venturi **1806** and steam wand **1811**. It would be appreciated that this enables: detection of the steam wand being partially or fully blocked (typically due to a build up of residue in steam wand outlets), which would enable the MCU to stop the steam function and/or alert user of problem; and providing live/real-time feedback of combined steam/air pressure for allowing the MCU to control that air pump flow rate to achieve a preset pressure parameter.

[0210] As shown in FIG. **19**, the temperature of the liquid being steamed in the jug **1900** can be communicated to the input of the control PCB **1901** wirelessly. In this example, the jug **1900** includes a thermistor such as an NTC thermistor and a transponder **1902** such as an RFID, Wifi, bluetooth or infrared transponder. The transponder **1902** emits a wireless (or other radio frequency) signal that is received by a cooperating receiver chip or base station **1903**. The receiver or base station **1903** supplies the appropriate signal to the input of the PCB **1901**. As with previously mentioned embodiments, the steaming device depicted in FIG. **19** includes a steam boiler **1904** that supplies steam to a 3/2 solenoid **1905**. The solenoid controls the flow of steam into the venturi **1908** while simultaneously allowing for overflow or excess pressure to be discharged to the atmosphere **1906**, particularly contemplating discharge into the drip tray **1907** that is located below the jug **1900**. As with other embodiments, the venturi receives air or pressurized air from an air pump **1909**. A protective one way valve **1910** is interposed between the air pump and the venturi suction inlet **1911**.

[0211] As illustrated in FIG. **19**, the steam wand is associated with a steam wand position sensor **1912**. The position sensor **1912** supplies a signal to the control PCB **1901**. When engaging in manual steaming operations, the control PCB **1901** will allow steam to be discharged through the solenoid **1905** when the wand is in any position. However, in automated steaming operations (where the user is not directly controlling the steam output with a button on knob) or during automated cleaning of the steam wand, the PCB **1901** will only allow the solenoid **1905** to operate when the steam wand is in a specified (the "down") position, as determined by the position sensor **1912**.

[0212] As shown in FIG. **20**, some embodiments of the invention require the primary steam solenoid **2000** to be controlled jointly or simultaneously or otherwise in a slave relationship with the air pump **2001**. The onset of the operation of the air pump can be delayed relative to the onset of the steam flow. To accomplish this, a single output **2002** from the control PCB **2003** is used to control the on and off operation of both the solenoid **2000** and the air pump **2001**.

[0213] As shown in FIG. **21**, a manually operated valve such as a ball valve **2100** is used to provide the user with control over the steam output of the steam boiler **2101**. Steam flowing through the ball valve **2100** is delivered to the venturi **2102**. An anti-siphon or anti-vacuum valve **2103** is interposed between the ball valve **2100** and the venturi **2102**. The anti-vacuum valve **2103** prevents vacuum pressure above the venturi from allowing ingress of fluid into the ball valve, boiler or other aspects of the machine that are upstream from the valve **2103**. The ball valve **2100** is associated with a sensor **2104**. The sensor transmits the operative position of the ball valve of the control PCB **2105**. Having information regarding the ball valve position from the sensor **2104**, the control PCB can use this information to illuminate a warning light **2106** on an exterior surface of the steaming or espresso making machine that indicates, for example, that the steam pathway to the wand is open. In some embodiments, when the sensor **2104** indicates that the ball valve is open, the control PCB **2105** will now allow power to be delivered to the steam boiler **2101**. This prevents inadvertent operation of the boiler when first turning on the machine and the ball valve **2100** is open.

[0214] As shown in FIG. **22**, a multi-ported ceramic valve **2200** may be used in place of the ball valve **2100** depicted in FIG. **21**. The ceramic valve provides additional flexibility by allowing for numerous different flow pathways to be controlled from a single rotating valve stem, being the valve stem associated with the ceramic valve **2200**. Thus, the ceramic style valve **2200** can incorporate an overflow discharge port **2201** that leads to an overflow pathway **2202** that discharges either to atmosphere **2203** or more particularly to the drip tray **2204** that lies below the jug **1900**. The rotating ceramic style valve **2200** can also incorporate a manual bypass flow path **2205** that allows steam from the boiler **2101** to bypass the venturi **1908**. Because the venturi is essentially a restriction in the flow path, the manual bypass flow path **2205** is capable of delivering a greater volume of steam to the steam wand **2210**.

[0215] As shown in FIG. **23**, two separate control PCBs **2300**, **2301** are used in the control of the primary steam solenoid **2302** and the air pump **2303** that delivers air to the venturi **2304**. In one embodiment, a pressure detecting sensor or switch **2305** detects pressure in the line **2306** between the solenoid **2302** and the venturi **2304**. When the pressure sensor or switch detects the presence of pressure, a signal is sent to the input of the second PCB **2301**. The second PCB **2301** interprets that signal as a command to supply power to the air pump **2303**. In other embodiments, the pressure switch **2305** is not required. Instead, a user operated control **2310** provides the second control PCB **2301** with a signal or switch state that is interpreted as a command to supply power to the air pump

2303. If required, the user operated switch **2310** can be disabled in other ways when the primary solenoid **2302** is closed,

Interpretation

[0216] It would be appreciated that, some of the embodiments are described herein as a method or combination of elements of a method that can be implemented by a processor of a computer system or by other means of carrying out the function. Thus, a processor with the necessary instructions for carrying out such a method or element of a method forms a means for carrying out the method or element of a method. Furthermore, an element described herein of an apparatus embodiment is an example of a means for carrying out the function performed by the element for the purpose of carrying out the invention.

[0217] In alternative embodiments, the one or more processors operate as a standalone device or may be connected, e.g., networked to other processor(s), in a networked deployment, the one or more processors may operate in the capacity of a server or a client machine in server-client network environment, or as a peer machine in a peer-to-peer or distributed network environment.

[0218] Unless specifically stated otherwise, as apparent from the following discussions, it is appreciated that throughout the specification discussions utilizing terms such as "processing", "computing", "calculating", "determining" or the like, can refer to the action and/or processes of a computer or computing system, or similar electronic computing device, that manipulate and/or transform data represented as physical, such as electronic, quantities into other data similarly represented as physical quantities.

[0219] In a similar manner, the term "processor" may refer to any device or portion of a device that processes electronic data, e.g., from registers and/or memory to transform that electronic data into other electronic data that, e.g., may be stored in registers and/or memory. A "computer" or a "computing machine" or a "computing platform" may include one or more processors.

[0220] The methodologies described herein are, in one embodiment, performable by one or more processors that accept computer-readable (also called machine-readable) code containing a set of instructions that when executed by one or more of the processors carry out at least one of the methods described herein. Any processor capable of executing a set of instructions (sequential or otherwise) that specify actions to be taken is included.

[0221] Unless the context clearly requires otherwise, throughout the description and the claims, the words "comprise", "comprising", and the like are to be construed in an inclusive sense as opposed to an exclusive or exhaustive sense; that is to say, in the sense of "including, but not limited to".

[0222] Similarly, it is to be noticed that the term "coupled", when used in the claims, should not be interpreted as being limitative to direct connections only. The terms "coupled" and "connected", along with their derivatives, may be used. It should be understood that these terms are not intended as synonyms for each other. Thus, the scope of the expression a device A coupled to a device B should not be limited to devices or systems wherein an output of device A is directly connected to an input of device B. It means that there exists a path between an output of A and an input of B which may be a path including other devices or means. "Coupled" may mean that two or more elements are either in direct physical or electrical contact, or that two or more elements are not in direct contact with each other but yet still co-operate or interact with each other.

[0223] As used herein, unless otherwise specified the use of the ordinal adjectives "first", "second", "third", etc., to describe a common object, merely indicate that different instances of like objects are being referred to, and are not intended to imply that the objects so described must be in a given sequence, either temporally, spatially, in ranking, or in any other manner.

[0224] Reference throughout this specification to "one embodiment" or "an embodiment" means that a particular feature, structure or characteristic described in connection with the embodiment is included in at least one embodiment. Thus, appearances of the phrases "in one embodiment" or "in an embodiment" in various places throughout this specification are not necessarily all referring to the same embodiment, but may refer to the same embodiment. Furthermore, the particular features, structures or characteristics may be combined in any suitable manner, as would be apparent to one of ordinary skill in the art from this disclosure, in one or more embodiments.

[0225] Similarly it should be appreciated that in the above description of exemplary embodiments of the invention, various features of the invention are sometimes grouped together in a single embodiment, figure, or description thereof for the purpose of streamlining the disclosure and aiding in the understanding of one or more of the various inventive aspects. This method of disclosure, however, is not to be interpreted as reflecting an intention that the claimed invention requires more features than are expressly recited in each claim. Rather, as the following claims reflect, inventive aspects lie in less than all features of a single foregoing disclosed embodiment. Thus, the claims following the Detailed Description are hereby expressly incorporated into this Detailed Description, with each claim standing on its own as a separate embodiment of this invention.

[0226] Furthermore, while some embodiments described herein include some but not other features included in other embodiments, combinations of features of different embodiments are meant to be within the scope of the invention, and form different embodiments, as would be understood by those in the art. For example, in the following claims, any of the claimed embodiments can be used in any combination.

[0227] In the description provided herein, numerous specific details are set forth. However, it is understood that embodiments of the invention may be practiced without these specific details. In other instances, well-known methods, structures and techniques have not been shown in detail in order not to obscure an understanding of this description. Although the invention has been described with reference to specific examples, it will be appreciated by those skilled in the art that the invention may be embodied in many other forms.

1.-**8**. (canceled)

9. A coffee making apparatus for providing pressure feedback control of brew water output during a coffee production cycle, the apparatus comprising:

a pump for supplying water; the pump being in fluid flow connection with a water flow line;

a pressure sensor element that provides a pressure signal indicative of water pressure in the water flow line;

a processor module coupled to the pressure sensor element to receive the pressure signal as real-time pressure feed-

back for controlling power supplied the pump to thereby enable a predetermined water pressure to be substantially maintained in the water flow line;

the water flow line being in fluid communication with a boiler that supplies heated brew water to a filter basket adapted to hold coffee grounds;

wherein heated brew water supplied to the coffee grounds is substantially maintained at the predetermined water pressure.

10. The apparatus according to claim **1**, wherein predetermined water pressure is a pressure profile, the processor module enabling brew water to be supplied according to the pressure profile during a production cycle.

11. The apparatus according to claim **2**, wherein the pressure profile is the form of pressure-time profile used to control electrical power delivered to the pump.

12. The apparatus according to claim **3**, wherein the pressure profile is preset.

13. The apparatus according to claim **4**, wherein the pressure profile is user selected using a user interface.

14. The apparatus according to claim **3**, wherein the pressure profile is user configurable.

15. The apparatus according to claim **6**, wherein the pressure profile is user configurable using a user interface.

16. The apparatus according to claim **2**, wherein the pressure profile is user selected using a user interface.

17. The apparatus according to claim **2**, wherein the pressure profile is user configurable using a user interface.

18. The apparatus according to claim **1**, wherein the processor module can enable brew water to be supplied according to a pressure profile during a pre-infusion cycle.

19. The apparatus according to claim **10**, wherein the pressure profile during the pre-infusion cycle provides a controlled low pressure pre-infusion.

20. The apparatus according to claim **11**, wherein the pressure profile during the pre-infusion cycle provides a controlled low pressure pre-infusion that enables the coffee grounds to be wet without forcing water through.

21. The apparatus according to claim **11**, wherein water delivered in the pre-infusion stage is provided at a pressure of about three bar.

22. The apparatus according to claim **11**, wherein water delivered in this pre-infusion stage is provided at a pressure from one to five bar.

23. The apparatus according to claim **1**, wherein the processor module is coupled to a power modification module for controlling electrical power delivered to the pump; the processor module controls the power modification module to enable brew water to be supplied according to the predetermined water pressure.

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