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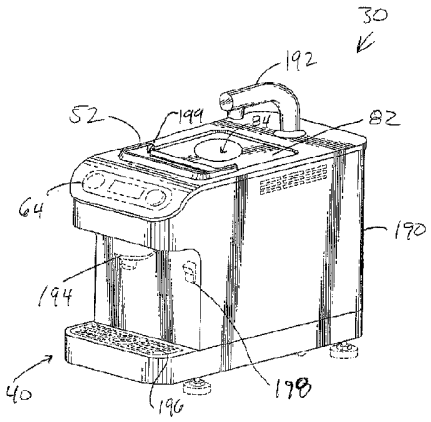
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(54) Title: MACHINE FOR BREWING A BEVERAGE SUCH AS COFFEE AND RELATED METHOD




(57) Abstract: An embodiment of a machine for brewing a beverage such as coffee includes a chamber and a piston assembly disposed in the chamber. The chamber is operable to receive a liquid such as water and a flavor base such as ground coffee, and to allow the beverage to brew from a mixture of the liquid and the base. The piston assembly is operable to filter a solid such as spent coffee grounds from the brewed beverage by moving in a first direction, and to force the filtered beverage out of the chamber by moving in a second direction. By modifying or automating some or all steps of the French press brewing technique, such a machine may control one or more of the brewing parameters with a level of precision that yields brewed coffee having a uniform taste from cup to cup. Furthermore, such a machine may brew the coffee with a speed that renders the machine suitable for use by establishments that serve significant amounts of coffee.

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# MACHINE FOR BREWING A BEVERAGE SUCH AS COFFEE AND RELATED METHOD

This application is related to U.S. Provisional Application Serial Nos. 60/670,955 filed on April 11, 2005, 60/719,069 filed on September 20, 2005, and 60/790,417 filed on April 6, 2006. This application is also related to International Application No. PCT/US2006/013930 filed on April 11, 2006, and U.S. Design Application Serial Nos. 29/257,647 filed on April 6, 2006, and 29/257,662, filed on April 6, 2006. All of the above applications are incorporated by reference.

## FIELD

**[1]** The invention relates to a machine for brewing a beverage.

## BACKGROUND

**[2]** Of the many techniques for brewing coffee, connoisseurs consider the French press technique to be one of the best for taste and efficient use of ground coffee (efficiency is proportional to the ratio of the amount of coffee brewed to the amount of ground coffee used). It is theorized that the good taste and efficiency is a result of the relatively thorough wetting of the coffee grounds that the French press technique allows. Wetting is a function of the surface area of the coffee grounds in contact with water during the brewing time, and of the portion of the brewing time during which this contact occurs. The greater the contact area and contact time, the more thorough the wetting of the coffee grounds.

**[3]** Referring to **FIGS. 1** and **2**, the French press technique is described.

**[4]** Referring to **FIG. 1**, one places ground coffee ***10*** and hot water ***12*** in a coffee container ***14***, and allows coffee to brew. Because the ground coffee ***10*** often floats to the surface of the water ***12***, one may stir or otherwise agitate the mixture of the ground coffee and the water to more thoroughly wet the individual coffee grounds that constitute the ground coffee.

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[5] Referring to **FIG. 2**, after the coffee ***15*** has brewed, one grasps a handle ***16*** of a filter ***18***, inserts the filter into the coffee container ***14***, and presses the filter down toward the bottom of the pot. For the taste of the brewed coffee to be relatively uniform from container to container, one typically uses and manually monitors a timer to measure the brew time.

[6] Because the filter ***18*** passes liquid but does not pass coffee-ground-sized particles, as one presses the filter toward the bottom of the coffee container ***14***, the substantially ground-free brewed coffee ***15*** fills the portion of the container above the filter while the filter retains the ground coffee ***10*** in the portion of the container below the filter. Of course the edge ***20*** of the filter ***18*** and the inner side ***22*** of the container ***14*** form a seal sufficient to prevent coffee grounds from passing between the edge of the filter and the inner side of the container.

[7] After one presses the filter ***18*** below a spout ***24*** of the coffee container ***14***, he can pour the substantially ground-free brewed coffee ***15*** into a cup (not shown in **FIGS. 1** and **2**) via the spout. Although one may stop pressing the filter ***18*** after the filter is below the spout ***24***, one typically presses the filter all the way to the bottom of the coffee container ***14*** to reduce the chances of undersized coffee grounds passing through the filter and into the cup.

[8] Still referring to **FIG. 2**, after one pours the desired amount of brewed coffee ***15***, he retracts the filter ***18*** from the container ***14*** by pulling on the handle ***16***, removes the ground coffee ***10*** from the container, and then cleans the filter and the container.

[9] Unfortunately, a problem with the above-described French press technique is that it is often too time consuming and too difficult for use by establishments, such as coffee shops, restaurants, and work places that serve significant amounts of coffee. The taste of brewed coffee typically depends on the brew parameters, which include the size of the coffee

grounds (*i.e.*, the grind size or consistency), the water temperature, the ratio of ground coffee to water, and the brew time. Even a slight variation in one of the brew parameters may cause a noticeable change in the taste of the brewed coffee. Because one typically controls at least some of the French press brewing parameters manually using equipment not shown in **FIGS. 1 – 2** (*e.g.*, coffee grinder, timer, thermometer, measuring cup), it is often difficult or time consuming to control all of these brewing parameters, particularly with the level of precision required to brew many containers of coffee having a substantially uniform taste from container to container. And because each cup of brewed coffee poured from the same container typically "sat" in the container for a different length of time, the taste of the brewed coffee may even change significantly from cup to cup.

## SUMMARY

**[10]** An embodiment of a machine for brewing a beverage such as coffee includes a chamber and a piston assembly disposed in the chamber. The chamber is operable to receive a liquid such as water and a flavor base such as ground coffee, and to allow the beverage to brew from a mixture of the liquid and the base. The piston assembly is operable to filter a solid such as spent coffee grounds from the brewed beverage by moving in a first direction, and to force the filtered beverage out of the chamber by moving in a second direction.

**[11]** By modifying or automating some or all steps of the French press brewing technique, such a machine may control one or more of the brewing parameters with a level of precision that yields brewed coffee having a uniform taste from cup to cup. Furthermore, such a machine may brew the coffee with a speed that renders the machine suitable for use by establishments that serve significant amounts of coffee. In addition, such a machine may allow one to easily change the brewing recipe from cup to cup, where the recipe may be customized for a particular coffee varietal or to the preference of a particular customer. Other advantages of such a

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machine include freshness (the coffee is made to order and doesn't sit), selection (because the machine can brew coffee one cup at a time, one's selection is not limited to pre-brewed/batch-brewed coffee that the coffee shop prepared in advance), speed (one embodiment of the machine brews coffee in approximately ¼ the time of competing technologies), and cleanability (one embodiment of the machine may be cleaned relatively quickly and easily after each cup).

## BRIEF DESCRIPTION OF THE DRAWINGS

**[12]** **FIGS. 1 – 2** illustrate a conventional French press technique for brewing coffee.

**[13]** **FIG. 3** is a block diagram of a machine for brewing a beverage such as coffee according to an embodiment of the invention.

**[14]** **FIG. 4** is a cut-away side view of the brewing unit of **FIG. 3** according to an embodiment of the invention.

**[15]** **FIG. 5** is an exploded isometric view of the filter of **FIG. 4** according to an embodiment of the invention.

**[16]** **FIG. 6** is an isometric view of the filter base of **FIG. 4** according to an embodiment of the invention.

**[17]** **FIGS. 7 – 12** illustrate a brewing cycle of the beverage-brewing machine of **FIG. 3** according to an embodiment of the invention.

**[18]** **FIGS. 13 – 15** illustrate a residual-evacuation cycle of the brewing machine of **FIG. 3** according to an embodiment of the invention.

**[19]** **FIGS. 16 – 19** illustrate a brewing cycle of the beverage-brewing machine of **FIG. 3** according to another embodiment of the invention.

**[20]** **FIGS. 20 – 22** illustrate a portion of a brewing cycle of the brewing machine of **FIG. 3** according to yet another embodiment of the invention.

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[21] **FIG. 23** is a perspective view of the beverage-brewing machine of **FIG. 3** according to an embodiment of the invention.

[22] **FIG. 24** is a view of an optical coffee grinder that may be used in conjunction with the beverage-brewing machine of **FIGS. 3** and **23** according to an embodiment of the invention.

## DETAILED DESCRIPTION

[23] The following discussion is presented to enable a person skilled in the art to make and use one or more embodiments of the invention. The general principles described herein may be applied to embodiments and applications other than those detailed below without departing from the spirit and scope of the invention. Therefore the present invention is not intended to be limited to the embodiments shown, but is to be accorded the widest scope consistent with the principles and features disclosed or suggested herein.

[24] **FIG. 3** is a block diagram of a machine ***30*** for brewing a beverage according to an embodiment of the invention. The beverage-brewing machine ***30*** can brew coffee one cup at a time using a modified and partially to fully automated French press technique, which allows the machine to brew coffee more quickly and more uniformly from cup to cup than can a human operator performing the conventional French press technique described above in conjunction with **FIGS. 1 – 2**. Consequently, the machine ***30*** is often more suitable for establishments that brew and serve significant amounts of coffee than is a human operator performing the conventional French press technique.

[25] The machine ***30*** includes the following components: a water filter ***32***, a flow meter ***34***, a water-reservoir-and-heating unit ***36***, a water-temperature-control unit ***38***, a cup-holder-and-overflow/waste-drain unit ***40***, a beverage-dispensing unit ***42***, a beverage-transporting unit ***44***, a beverage-brewing unit ***46***, a cup-sensing unit ***48***, a liquid-waste disposal unit ***50***, a

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solid-waste-disposal unit ***52***, a barrier ***54***, and a controller ***58***. And although the machine ***30*** may brew beverages (*e.g.*, tea, cocoa) other than coffee, for purposes of explanation the structure and operation of the machine are described in conjunction with the machine brewing coffee.

**[26]** The water filter ***32*** filters the water that is used to brew the coffee. But one may omit the filter ***32*** from the beverage-brewing machine ***30***, particularly where the machine is installed in an establishment that has a water-purification system (not shown in **FIG. 3**) separate from the machine.

**[27]** The flow meter ***34*** measures the volume of water that the water-reservoir-and-heating unit ***36*** provides to the beverage-brewing unit ***36***, and thus allows the controller ***58*** to control the volume of brewed coffee. For example, if one desires to brew a 16-ounce cup of coffee, then the controller ***58*** opens a fill valve (not shown in **FIG. 3**) in the unit ***36***, electronically monitors the flow meter ***34***, and closes the fill valve when the flow meter indicates that 16 ounces of water (or another volume of water predetermined to provide 16 ounces of coffee) has passed into the unit ***36*** (and thus out of the unit ***36*** as described below). Because the flow meter ***34*** is located on the inlet (*i.e.*, cold-water) side of the unit ***36***, the meter may be less expensive, more reliable, and have a longer operating life than if located on the outlet (*i.e.*, hot-water) side of the unit ***36***.

**[28]** The water-reservoir-and-heating unit ***36*** receives cold tap water via the water filter ***32*** and the flow meter ***34***, stores this water, and, under the control of the controller ***58***, heats the stored water to a desired temperature, for example a temperature in the range from 150°F to just below the boiling point of water. The unit ***36*** includes a saturated boiler, one or more heating elements, a flow deflector, and one or more temperature sensors (these components not shown in **FIG. 3**). Each of the heating elements may be electric or any other type of conventional heating element, and the flow deflector causes the boiler to fill from one side (*e.g.*, the bottom) with cold water and to empty from another side (*e.g.*, the top) with

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hot water that is substantially unmixed with the incoming cold water. Each temperature sensor indicates to the controller ***58*** a temperature of the water at a respective location within the boiler; where multiple sensors and heating elements are present, the controller can determine and control a temperature profile within the boiler (either open- or closed-loop control) to more precisely control the temperature of the water provided to the brewing unit ***50***. In one implementation, the capacity of the boiler and the thermal output of the heating element(s) are such that the machine ***30*** can brew a 16 ounce cup of coffee in approximately 40-60 seconds, and can continue this output indefinitely. Alternatively, the reservoir-and-heating unit ***36*** may include a manually settable thermostat (not shown in **FIG. 3**) that maintains the temperature of the water at the temperature to which the thermostat is set.

**[29]** The water-reservoir-and-heating unit ***36*** may include other conventional components (not shown in **FIG. 3**), such as a pressure-relief valve, a thermal cutoff, a strainer, a pressure regulator, an anti-siphoning check valve, and insulation. The pressure-relief value prevents and the boiler pressure from exceeding a predetermined safe pressure, and may empty into the liquid-waste disposal unit ***50*** via the overflow/waste drain unit ***40***. The thermal cutoff disables the heating element(s) if the temperature within the boiler exceeds a predetermined safe temperature. The strainer traps large particles that may escape the filter ***32*** and lodge in downstream components , and the pressure regulator, which may be located between the filter and flow meter ***34***, regulates the pressure at which water enters the flow meter to, *e.g.,* 40 PSI for consistent performance in varied environments. A flow regulator could also be used in place of a pressure regulator. The anti-siphoning check valve prevents water in the boiler from flowing "backwards" through the meter ***34*** and filter ***32*** into the tap-water supply, and the insulation slows heat loss from the boiler.

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[30] The water-temperature-control unit ***38*** can alter the temperature of the water from the reservoir unit ***36*** to allow a different brew temperature from cup to cup. The temperature-control unit ***38*** receives water from the reservoir ***36*** during a beverage-brewing cycle, and, in response to the controller ***64***, adjusts the temperature of the water received from the reservoir. In one implementation, the reservoir and heating unit ***36*** heats the water in the reservoir to a predetermined maximum temperature and the temperature-control unit ***38*** includes a valve assembly (not shown in **FIG. 3**) for mixing the heated water from the reservoir ***36*** with colder unheated water from the flow meter ***34***. The colder water lowers the temperature of the water used to brew coffee from the temperature of the water in the reservoir. The temperature-control unit ***38*** may operate in an open-loop configuration by relying on a thermodynamic algorithm that, using the sensed temperatures of the heated and cold water, regulates the amount of cold water mixed with the heated water to provide brew water having a desired temperature. Alternatively, the temperature-control unit ***38*** may operate in a closed-loop configuration by sensing the temperature of the water provided to the brewing unit ***46*** and, in response to the sensed temperature, regulating the amount of cold water mixed with the heated water to provide brew water having the desired temperature. If the temperature of the cold water is known and relatively stable, then one can enter this temperature into the memory ***62*** via the control panel ***64***, and the temperature-control unit ***38*** may operate in an open-loop configuration. Moreover, instead of actually mixing cold tap water from the meter ***34*** with the heated water, the temperature-control unit ***38*** may include a heat exchanger that allows the cold water to cool the heated water without actually mixing with the heated water. Using this technique, the cooling water may bypass the filter ***32*** and meter ***34***, thus potentially extending their operating lifetimes. The temperature control unit ***38*** may also have the

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ability to heat the brew water above the temperature of the water in the reservoir ***36***.

**[31]** Alternatively, one may omit the temperature-control unit ***38*** from the machine ***30***, and depend on the reservoir-and-heating unit ***36*** to heat the water to the desired temperature. For example, the unit ***36*** may maintain the water in the reservoir at a predetermined minimum temperature, and then heat the water to a respective desired temperature at the beginning of each brew cycle. If, however, the unit ***36*** heats the water beyond the desired brew temperature, then the machine ***30*** may partially or fully purge the boiler one or more times to reduce the water temperature to a desired level.

**[32]** An advantage of the temperature-control unit ***38*** is that it provides water at the desired brew temperature relatively quickly to immediately if the water in the reservoir ***36*** is at or higher than the desired brew temperature; a disadvantage is that the unit ***38*** may add complexity and expense to the machine ***30***.

**[33]** Comparatively, although omitting the temperature-control unit ***38*** may slow the machine's brewing speed, the reservoir-and-heating unit ***36*** can heat the water used to brew each cup of coffee from a predetermined minimum temperature to any desired brewing temperature under software control (via the controller ***64***) without adding any expense or complexity to the machine. One can design the boiler (not shown in **FIG. 3**) such that the cold tap water entering the reservoir ***36*** to replace the expelled brew water drops the temperature of the water in the reservoir to or below the predetermined minimum temperature, thus readying the reservoir for the next cup.

**[34]** The cup-holder-and-overflow/waste-drain unit ***40*** holds a cup (not shown in **FIG. 3**) while the beverage-dispensing unit ***42*** fills the cup with the brewed beverage. The unit ***40*** also includes a drain portion to absorb,

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*e.g.*, spillage from the cup, drippings from the dispensing unit ***42*** after the cup has been removed, rinsant from a rinse cycle, and cleaner solution from a cleaning cycle (the rinsing and cleaning cycles are described below in conjunction with **FIGS. 7-12**. The drain portion of the unit ***40*** may be removable for emptying, or may be connected to the liquid-waste disposal unit ***50*** or directly to a waste-water line (not shown in **FIG. 3**) of the establishment in which the machine ***30*** is installed. And as discussed above, a pressure-relief valve of the water-reservoir-and-heating unit ***36*** may vent to the drain portion of the unit ***40***, particularly where the drain portion is connected to the liquid-waste disposal unit ***50*** or directly to a waste-water line.

**[35]** The beverage-dispensing unit ***42*** includes a spout (not shown in **FIG. 3**), and dispenses the brewed beverage into the cup (not shown in **FIG. 3**) as discussed in the preceding paragraph. Alternatively, the unit ***42*** may include multiple interchangeable spouts for cups and beverages of different sizes.

**[36]** The beverage-transporting unit ***44*** transports the brewed beverage from the brewing unit ***46*** to the dispensing unit ***42***, and may also transport liquid waste to the liquid-waste disposal unit ***50***. The unit ***48*** may include an electronically controllable valve (not shown in **FIG. 3**), which, in response to the controller ***58***, opens after the brewing unit ***46*** has brewed the beverage to allow the beverage to flow to the dispensing unit ***42***. To prevent the dispensing unit ***42*** from dispensing a beverage when no cup is present, the controller ***58*** may close the valve if the cup sensor ***48*** indicates that no cup is present in the cup-holder portion of the unit ***40***. The controller ***58*** may also close the valve at other times and otherwise operate the valve as described below in conjunction with **FIGS. 7 – 15**. Alternatively, the beverage-transporting unit ***44*** may include multiple valves as described below in conjunction with **FIGS. 16 – 19**.

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[37] The beverage-brewing unit ***46*** receives heated water from the water-reservoir-and-heating unit ***36*** (via the water-temperature-control unit ***38*** if present), receives ground coffee from an operator (not shown in **FIG. 3**), brews coffee according to a modified French press technique, and then provides the brewed coffee to the beverage-dispensing unit ***42*** via the beverage-transporting unit ***44***. Of course the brewing unit ***46*** may brew beverages other than coffee (*e.g.*, tea). The brewing unit ***46*** is further described below in conjunction with **FIGS. 4 – 12** and **20 – 22**.

[38] As discussed above, the cup-sensing unit ***48*** indicates to the controller ***58*** whether a cup (not shown in **FIG. 3**) is present in the cup-holder portion of the cup-holder-and-overflow/waste-drain unit ***40***. If the cup is not present after the brewing unit ***46*** has brewed coffee, then the controller ***58*** may deactivate the beverage-transporting unit ***44*** to prevent the beverage-dispensing unit ***42*** from dispensing brewed coffee directly into the drain portion of the unit ***40***. Alternatively, if the cup is present during a rinse or cleaning cycle (described below), then the controller ***58*** may deactivate the beverage-transporting unit ***44*** to prevent rinsant or cleaning solution from entering the cup. The cup-sensing unit ***48*** may include any type of sensor, such as an optical (reflective or interrupt), mechanical, or ultrasonic sensor.

[39] The liquid-waste disposal unit ***50*** receives liquid waste from the cup-holder-and-overflow/waste-drain unit ***40*** and/or from the beverage-transporting unit ***44*** as discussed above, and disposes of this waste. The disposal unit ***50*** may include a conduit (not shown in **FIG. 3**) that is connected to the waste-water line (not shown in **FIG. 3**) of the establishment in which the machine ***30*** is installed, or to a liquid-waste container (not shown in **FIG. 3**). Alternatively, the disposal unit ***50*** may receive liquid waste from one or more other components of the machine ***30***.

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**[40]** The solid-waste disposal unit ***52*** receives spent coffee grounds and disposable filters (if used) from the brewing unit ***46*** as discussed below. The disposal unit ***52*** may include a receptacle that one periodically removes from the machine ***30*** for emptying, or may include a chute that empties into an electronic garbage disposer, directly into the waste-water line of the establishment in which the machine ***30*** is installed, or into a receptacle that requires periodic emptying. In addition, the solid-waste-disposal unit ***52*** may be connected to receive tap water, and may use the tap water to flush spent coffee from the disposal unit into the garbage disposer or directly into the waste-water line. The disposal unit ***52*** may periodically commence an automatic flushing sequence, *e.g.,* after brewing each cup of coffee. Or, one may commence or perform the flushing sequence manually.

**[41]** The moisture barrier ***54*** may separate the controller ***58*** and associated circuitry (not shown in **FIG. 3**) from other components of the machine ***30***. For example, steam from hot water and brewing or brewed coffee may condense and damage or otherwise render inoperable the controller ***58***. Furthermore, condensation on the conduits that carry cold tap water may cause similar problems. Therefore, the moisture barrier ***54*** helps keep the controller ***58*** and associated circuitry dry. Alternatively, the brew chamber (not shown in **FIG. 3**) of the brewing unit ***46*** may act as a moisture barrier such that the separate moisture barrier ***54*** may be omitted.

**[42]** The controller ***58*** controls the operation of some or all of the other components of the brewing machine ***30*** as discussed above, and includes a processor ***60***, a memory ***62***, a control panel and display ***64***, and a communications port ***66***.

**[43]** The processor ***60*** executes a software program stored in the memory ***62*** or in another memory (not shown), and controls the operations of the components of the machine ***30*** as described above and as described below.

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[44] In addition to storing one or more software programs, the memory ***62*** (which may be nonvolatile or include a nonvolatile portion) may store sets of predetermined brew parameters as discussed below in conjunction with **FIGS. 7 – 12**, and may provide working memory for the processor ***60***. The memory ***62*** may also log the total number of cups, the number of cups of each cup size, the total volume of water passing through the machine ***30***, or the total volume of beverage brewed since the first use of the machine, since the last service call, or since the replacement of a part, as a way to schedule maintenance. The memory ***62*** may also log the number of rinsing and cleaning cycles to document how well the machine has been maintained for warranty purposes. In addition, the memory ***62*** may log machine errors to facilitate a technician's diagnosing a problem during a service call. The memory ***62*** may save time stamps (the controller ***58*** may include a real-time clock to generate the time stamps) for one or more of the above-described events. Furthermore, the memory ***62*** may store flags to indicate the state of the machine ***30*** from use to use. For example, if the reservoir unit ***36*** is drained one day but not refilled, then the memory ***62*** may store a corresponding flag that causes the display ***64*** to generate a warning to refill the reservoir the next time the brewing machine ***30*** is activated. Moreover, the memory ***62*** may log tasks and task details in addition to those discussed above. For example, the memory ***62*** may log with time stamps every action the brewing machine ***30*** takes. For example, the memory ***32*** may log for each brew cycle a time stamp indicating when the cycle begins and ends, the beverage size, desired water temperature, the actual water temperature, whether the brew cycle was cancelled (and a time stamp indicating when), and whether and how long the machine ***30*** had to wait for the water to reach the brewing temperature. In addition, the memory ***62*** may log for every rinsing and cleaning cycle a time stamp indicating when the cycle begins and ends, and the desired and actual water temperatures. The memory ***62*** may also log a time stamp indicating

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each power up of the machine ***30***. Such detailed logs may provide to a coffee-shop owner or coffee roaster desired usage/demographic information such as the times of the day when the most coffee is brewed/sold and the types of coffee being purchased.

**[45]** The control panel and display ***64*** allows an operator (not shown in **FIG. 3**) to enter brewing options (*e.g.,* coffee type, cup size, and brewing parameters, and work flow) or to select brewing options from a menu that the processor ***60*** may generate on the display. For example, the operator may select via the control panel and display ***64*** individual brewing parameters (*e.g.*, water temperature, cup size, and brewing time), or a set of predetermined brewing parameters stored in the memory ***62***. As an example of the latter, a coffee roaster may have determined preferred brewing parameters for its coffee. One may then store these preferred parameters in the memory ***62*** as a set, and associate the set with an identifier, such as the name or type of the coffee. Therefore, instead of entering or selecting each brewing parameter individually, which may be tedious, the operator merely enters or selects from a menu the identifier, and the controller ***58*** causes the machine ***30*** to brew coffee according to the set of parameters corresponding to the identifier.

**[46]** The communications port ***66*** allows the processor ***60***, memory ***62***, and control panel and display ***64*** to communicate with one or more devices external to the machine ***30***. For example, the port ***66*** may be connected to a computer (not shown in **FIG. 3**) so that one can program or run diagnostics from the computer. Or, the port ***66*** may be connected to the internet, so that one can download into the machine's memory ***62*** data such as sets of brewing parameters from coffee roasters or suppliers, or upload from the memory via the internet machine usage/demographic information such as described above and below, service/error logs, or machine settings. Where the processor ***60*** executes a web interface (not shown in **FIG. 3**), then one may access the brewing machine ***30*** via a web browser over a

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secure channel that requires, *e.g.*, one to enter a username and password before gaining remote access to the machine. In addition, the port ***66*** may receive data via a wireless channel, such as a set of brewing parameters from a RFID tag or a barcode on a container of coffee or on a coffee cup (the tag may hold the cup owner's preferred coffee type, cup size, or brew parameters). Furthermore, the port ***66*** may allow the processor ***60*** to upload demographic information, such as coffee-drinker preferences and number of cups brewed, to a coffee roaster or supplier or to the manufacturer/supplier of the machine ***30***. Moreover, the port ***66*** may be connected to and receive information (*e.g.*, the number of beverages ordered, price, size) from other machines (*e.g.*, a cash register) in the coffee shop, and act as a portal for downloading/uploading data to/from these other machines.

**[47]** Still referring to **FIG. 3**, alternative embodiments of the beverage-brewing machine ***30*** are contemplated. For example, the machine ***30*** may include one or more components (not shown), one or more of the above-described units or components may be omitted, the function of multiple units may be consolidated into fewer units, or the function of a single unit may be divided among multiple units. Moreover, the brewing machine ***30*** (**FIG. 3**) may have a modular design that allows one to remove the brewing unit ***46*** and one or more of the other units of the machine as respective units; therefore, the modular design may facilitate repair or replacement of the removable units. Furthermore, the machine ***30*** may be automated such that an operator need not provide ground coffee to the brewing unit ***46***. Such an automated version of the machine ***30*** may include a coffee-bean hopper, a coffee grinder, a ground-coffee transporting unit, and one or more other components such as described in International Application No. PCT/US2006/013930 filed on April 11, 2006, which was previously incorporated by reference.

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[48] **FIG. 4** is a cut-away side view of the beverage-brewing unit ***46*** of **FIG. 3** according to an embodiment of the invention. As discussed above in conjunction with **FIG. 3**, the brewing unit ***46*** allows the machine ***30*** to brew coffee according to a modified French press technique, and to brew other beverages (*e.g.*, tea) as well.

[49] The beverage-brewing unit ***46*** includes a chamber block ***70***, a brewing chamber ***72*** disposed within the chamber block, a piston assembly ***74*** disposed within the brewing chamber, a drive shaft ***76***, a motor ***78*** for driving the piston assembly up and down within the brewing chamber, and a thermal insulator ***80*** disposed around the brewing chamber.

[50] The chamber block ***70*** has a flat top surface ***82***.

[51] The brewing chamber ***72***, which may be cylindrical, includes an opening ***84***, a stainless-steel side wall ***86***, a plastic end cap ***88***, and an exit port ***90***, and holds the ground coffee and water (neither shown in **FIG. 4**) while the coffee brews. The end cap ***88*** is sloped toward the exit port ***90*** so as to direct liquid (e.g. brewed coffee, rinsant, cleaning solution) to the port for dispensing via the beverage-transporting and –dispensing units ***44*** and ***42*** (**FIG. 3**) or for disposing via the liquid-waste-disposal unit ***50*** (**FIG. 3**). Although the tops of the thermal insulator ***80*** and the side wall ***86*** are shown as being coplanar with the surface ***82***, the surface ***82*** may extend over and cover one or both of the insulator and side wall.

[52] The piston assembly ***74*** is the same shape as the brewing chamber ***72***, and includes a seal ***92*** (made from, *e.g.*, PTFE [marketed as Teflon®]), a seal-urging member ***94*** (*e.g.*, a rubber gasket), and a filter assembly ***96***. The seal-urging member ***94*** forces the seal ***92*** against the side wall ***86*** of the brewing chamber ***72*** such that the piston assembly ***74*** forms a water-tight seal with the side wall. The filter assembly ***96***, which is further described below in conjunction with **FIGS. 5-6**, includes a filter ***98*** and a base ***100*** having one or more check valves ***102***. As further described

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below in conjunction with **FIGS. 7-12**, as the piston assembly ***74*** moves upward, the filter assembly ***98*** filters spent coffee grounds from the brewed coffee; and as the piston assembly moves downward, the filter assembly forces the brewed coffee out of the brewing chamber ***72*** via the exit port ***90***. Furthermore, the base ***100*** of the filter assembly ***96*** may threaded onto or otherwise removably attached to the drive shaft ***76*** to facilitate repair or replacement of the piston assembly ***74***.

**[53]** The drive shaft ***76*** may be a conventional screw shaft that moves the piston assembly ***74*** upward when the motor ***78*** rotates in one direction and downward when the motor rotates in the opposite direction. The chamber block ***70*** may include anti-rotation stops or other components (not shown in **FIG. 4**) that prevent the piston assembly ***74*** from rotating with the shaft ***76*** and motor ***78***.

**[54]** The motor ***78***, which is responsive to the controller ***58*** (**FIG. 3**), may be any type of motor, such as a stepper motor, suitable to drive the piston assembly ***74***. The chamber block ***70*** or the motor ***78*** may include a sensor assembly (not shown in **FIG. 4**), such as one or more limit switches, that indicates to the controller ***58*** the position, speed, and traveling direction of the piston assembly ***74***.

**[55]** The insulator ***80*** may allow a more precise control of the brewing temperature by limiting heat loss through the side wall ***86*** of the brew chamber ***72***. The insulator ***80*** may also include a heating element and a temperature sensor (neither shown in **FIG. 4**) that allow the controller ***58*** to maintain the side wall ***86*** at a predetermined temperature. Alternately, the insulator ***80*** may include a water jacket (not shown) that the water-reservoir-and-heating unit ***36*** (or the water-temperature-control unit ***38*** if present) of **FIG. 3** or another source (not shown in **FIG. 4**) fills with hot water. Using the temperature sensor, the controller ***58*** may implement closed-loop control of the side-wall temperature by regulating the flow of

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water through the jacket. And to cool the side wall ***86***, the controller ***58*** may route tap water through the jacket.

**[56]** Still referring to **FIG. 4**, alternative embodiments of the beverage-brewing unit ***46*** (**FIG. 3**) are contemplated. For example, the machine may include components not shown, or may exclude one or more of the components that are shown. Furthermore, the components may be made from any suitable materials. Moreover, although shown oriented vertically, the brewing chamber ***72*** may be oriented in another direction, such as horizontal, with appropriate modification (such as a seal (not shown) over the chamber opening ***84***) to the brewing machine ***30***.

**[57]** **FIG. 5** is an exploded isometric view of the filter ***98*** of **FIG. 4** according to an embodiment of the invention where the brewing chamber ***72*** (**FIG. 4**) is cylindrical.

**[58]** The filter ***98*** includes one or more (here three) wire-mesh layers ***110***, ***112***, and ***114*** mounted to a plate ***116***.

**[59]** The mesh layers ***110***, ***112***, and ***114*** may be sintered or otherwise attached together and to the plate ***116***, and may be formed from stainless steel or any other suitable material. The top mesh layer ***110*** may have openings with diameters in the range of 30 – 150 microns (μm) (*e.g.*, 70 μm) or within another range depending on the filter resolution desired for the filter ***98***. The middle layer ***112*** may have larger openings than the top layer ***110***, and the bottom layer ***114*** may have openings larger than those of the middle layer. Having openings with diameters that increase from the top layer ***110*** to the bottom layer ***114*** helps prevent filtrate (e.g. spent coffee grounds) from clogging the filter ***98***, and also allows the lower layers to provide structure to the filter without restricting fluid flow. Alternately, one or more of the layers ***110***, ***112***, and ***114*** may have etched openings. An advantage of the top layer ***110*** having etched openings is that the etched openings may provide the top layer with a flatter surface, which may

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facilitate removal of filtered matter (*e.g.*, coffee grounds) from the top layer by, *e.g.*, wiping with a squeegee.

**[60]** The mounting plate ***116*** may be formed from stainless steel or any other suitable material, may have multiple large openings ***118*** and captive fastening features ***120***, and, along with the lower layers ***112*** and ***114***, may provide strength and rigidity to the filter ***98***.

**[61]** Although not shown, a paper filter may be disposed on the top layer ***110*** and removed after each use. The paper filter may provide a finer filtration than the filter ***98***.

**[62]** **FIG. 6** is an isometric view of the filter base ***100*** of **FIG. 4** according to an embodiment of the invention where the brewing chamber ***72*** (**FIG. 4**) and the filter ***98*** (**FIGS. 4 – 5**) are cylindrical.

**[63]** The base ***100*** is a plate that may be made from stainless steel or from any other suitable material, and, in addition to the one or more (here three) check valves ***102***, includes one or more check-valve ports ***130***, one or more filter-mounting recesses ***132***, a bottom ***134***, and a threaded shaft receptacle ***136*** (dashed line).

**[64]** Referring to **FIGS. 4** and **6**, each check valve ***102*** is made from a flexible material such as silicone rubber, is mounted within a respective port ***130***, and includes one or more openings ***138***, an elastic shaft ***140***, and a head ***142***. As the piston assembly ***74*** moves downward when the lower portion of the brewing chamber ***72*** beneath the piston assembly is filled with a liquid (*e.g.*, brewed coffee), the pressure generated by the piston movement forces the head ***142*** against the base ***100*** such that the head forms a liquid-tight seal with the base; consequently, no gas or liquid flows past the head and through the respective port ***130***. If the beverage-transporting unit ***44*** (**FIG. 3**) opens the exit port ***90***, then the piston assembly ***74*** transmits the pressure to the liquid, forcing it out of through the exit port. Conversely, as the piston assembly ***74*** moves upward

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when the upper portion of the brewing chamber ***72*** above the piston assembly contains a liquid and the beverage-transporting unit ***44*** closes the exit port ***90***, the pressure in the lower portion of the brewing chamber lessens. This lessening pressure generates a suction that pulls the head ***142*** away from the base ***100*** — the stretching of the elastic shaft ***140*** allows this pulling away of the head; consequently, the suction also pulls the liquid in the upper portion of the brewing chamber through the openings ***138*** and the port ***130*** and into the lower portion of the brewing chamber ***72***. But the filter ***98*** prevents solids such as ground coffee from passing into the lower portion of the brewing chamber ***72***, thus filtering the liquid.

**[65]** Referring again to **FIG. 6**, the filter-mounting receptacles ***132*** are sized to receive the captive fastening features ***120*** on the filter-mounting plate ***116*** (**FIG. 5**), and screws (not shown in **FIG. 6**) inserted through the receptacles from the bottom of the base ***100*** engage the threaded standoffs to secure the base to the filter ***98*** (**FIG. 5**). O-rings (not shown in **FIG. 6**) or other sealing members may be placed in the receptacles ***132*** to prevent liquid from leaking through the screw threads.

**[66]** The bottom ***134*** of the base ***100*** may be contoured to direct liquid toward the check-valve ports ***130*** while the piston assembly ***74*** (**FIG. 4**) moves upward.

**[67]** The threaded shaft receptacle ***136*** allows removable attachment of the piston assembly ***74*** (**FIG. 4**) to the shaft ***76*** (**FIG. 4**).

**[68]** **FIGS. 7-12** illustrate operation of the beverage-brewing machine ***30*** of **FIG. 3** during a beverage-brewing cycle according to an embodiment of the invention, with reference to the beverage-transporting unit ***44*** of **FIG. 3** and the beverage-brewing unit ***46*** of **FIGS. 3-4**. In this embodiment, the beverage-transporting unit ***44*** includes a valve ***150***, which connects the exit port ***90*** to the beverage-dispensing unit ***42*** (**FIG. 3**) in a first position (shown, *e.g.*, in **FIG. 7**), and which connects the exit port to the

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liquid-waste disposal unit ***50*** (**FIG. 3**) in a second position (shown, *e.g.*, in **FIG. 8**). Furthermore, although it may not be explicitly stated, the controller ***58*** (**FIG. 3**) may control one or more of the below-described steps. Moreover, although the operation of the machine ***30*** is described for brewing coffee, the operation for brewing another beverage, such as tea, may be the same as or similar to the described operation.

**[69]** Referring to **FIGS. 3 - 4** and **7 – 12**, the operation of the beverage brewing machine ***30*** during a beverage-brewing cycle is discussed according to an embodiment of the invention.

**[70]** Referring to **FIG. 7**, after a human operator (not shown in **FIGS. 3 – 4** and **7 – 12**) activates the machine ***30*** by, *e.g.*, turning "on" a power switch (not shown in **FIGS. 3 - 4** and **7 – 12**), the machine ***30*** performs a self-check/initialization during which the piston assembly ***74*** moves into a respective "home" position if it is not already in this position. For example, the piston assembly ***74*** may move into a position that is a predetermined distance below the chamber-block surface ***82***, where the distance creates a space sufficiently large to receive ground coffee ***152*** from the operator. Alternatively, the piston assembly ***74*** may already be in its respective home position from the last brew cycle, or may move into any other non-home position that is suitable for starting the brew cycle. While the piston assembly ***74*** is moving into its home position or another starting position, the valve ***150*** is in its first position (*e.g.*, connects the exit port ***90*** to the beverage-dispensing unit ***42***) so that no pressure or suction is created in the lower portion of the chamber ***72*** beneath the piston assembly. Furthermore, to make sure that the chamber ***72*** is empty of liquid (*e.g.*, brewed coffee, water), as part of the self-check/initialization, the machine ***30*** may first perform a purge routine that expels "left-over" liquid from the chamber via the exit port ***90*** (or via a separate waste port per **FIGS. 16 – 18**). Although the machine ***30*** may not "know" the volume of this "left-over" liquid, it may "assume" that a maximum volume of liquid (*e.g.*, 16 ounces) is in the

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chamber ***72***. This "left-over" liquid may result from the interruption of a previous brewing, rinsing, or cleaning cycle due to, *e.g.*, a power failure, system error, or operator error. The purging routine may be the same or similar to the beverage-dispensing routine described below in conjunction with **FIG. 11**. After performing the purge routine, the machine ***30*** continues with the self-check/initialization routine per above. In addition to the above-described functions, the machine ***30*** may perform other functions (*e.g.*, turning on the boiler) during the self-check/initialization routine.

**[71]** Next, the operator enters a beverage size (*e.g.*, 8 ounces, 16 ounces), and one or more brewing parameters (*e.g.*, water temperature, brew time) via the control panel ***70***. The machine ***30*** may allow the operator to enter a custom beverage size (*e.g.*, 9 ounces, 11 ounces), or may constrain the operator to one or more predetermined sizes (*e.g.*, from 6 to 16 ounces in 2-ounce increments). Moreover, the operator may enter each brewing parameter separately, or may enter an identifier, such as the name of the selected roast, to select a set of predetermined brew parameters that are stored in the memory ***62*** and associated with the identifier. If the operator enters the brew parameters separately, but fails to enter one or more required parameters, then the machine ***30*** may assign a default value to each of the parameters not entered. And if the operator enters a set of brewing parameters via an identifier, he may alter one or more of these pre-programmed parameters either directly or abstractly. An example of the latter is where the operator selects an "abstract" brewing strength (*e.g.*, weak, normal, strong) that the controller ***58*** converts into an actual brew time or temperature in a pre-programmed manner. In addition, the machine ***30*** may, via the display ***64***, remind the operator to place a cup (not shown in **FIG. 7**) in the cup holder ***40***.

**[72]** Then, the operator measures and grinds an amount of coffee at a particular grind size using a coffee grinder (not shown in **FIG. 7**) separate from the machine ***30***, and loads the ground coffee ***152*** into the chamber ***72***

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via the opening ***84***. The controller ***58*** may, via the display ***64***, indicate to the operator the amount of coffee that the operator should grind and the grind size based on the beverage size and brew parameters previously entered by the operator. One may preprogram the memory ***62*** with a look-up table that associates the amount and grind size with the beverage size and brewing parameters, or the controller may calculate the amount and grind size from one or more of the beverage size and brewing parameters (*e.g.*, brewing strength) that the operator entered or selected.

**[73]** Referring to **FIG. 8**, after the operator loads the ground coffee ***152*** into the brewing chamber ***72***, the motor ***78*** moves the piston assembly ***74*** downward to or near the bottom of the chamber. When the piston assembly is in the desired position, the valve ***150*** moves into its second position (*e.g.*, connects the exit port ***90*** to the liquid-waste disposal unit ***50***), which effectively closes the outlet from the brewing chamber ***72***.

**[74]** While the operator is grinding and loading the coffee ***152*** into the brewing chamber ***72*** and the piston assembly ***74*** is moving downward, the water-reservoir-and-heating unit ***36*** is heating the water to a predetermined temperature if the water is not already at this temperature. In one example, the unit ***36*** heats the water above the desired brewing temperature so that the water-temperature-control unit ***38*** can provide to the chamber ***72*** water at the desired brewing temperature by mixing the heated water from the reservoir with cold tap water as described above in conjunction with **FIG. 3**. In another example, the reservoir-and-heating unit ***36*** heats the water to the brewing temperature, and the temperature-control unit ***38*** is inactive or omitted. If the water temperature is too high in this latter example (*e.g.*, from a previous brewing cycle), then the machine ***30*** may purge a calculated or predetermined amount of water from the boiler within the reservoir unit ***36*** to cool the water to or below the desired temperature; in the latter case, the reservoir-and-heating unit ***36*** then heats

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the water to the desired temperature. These and other techniques allow control of the brewing temperature from cup to cup.

**[75]** Next, the reservoir-and-heating unit ***36*** fills the brewing chamber ***72*** with a desired amount of water ***154*** having the desired brewing temperature via a nozzle (not shown in **FIGS. 3 – 4** and **7 – 12**). The controller ***58*** opens a valve (not shown in **FIGS. 3 – 4** and **7 – 12**) so that water flows from the filter ***32***, through the flow meter ***34***, and into the reservoir ***36***. The cold water flowing into the reservoir ***36*** forces the hot water at the top of the reservoir out and into the brewing chamber ***72***. When the flow meter ***34*** indicates that the desired volume of water ***154*** has entered the chamber ***72***, the controller ***58*** closes the valve. The operator may then agitate the water and coffee mixture in the chamber ***72*** by, *e.g.*, stirring the mixture. Such agitation facilitates the thorough wetting of the ground coffee. The spray pattern of the nozzle may also agitate the mixture, or the controller ***58*** may pulse the water through the nozzle for additional agitation.

**[76]** Referring to **FIG. 9**, after the desired amounts of ground coffee ***152*** and water ***154*** are in the chamber ***72***, the mixture remains in the chamber for the selected brewing time. During the brewing time, the controller ***58*** may activate a heating element (not shown in **FIGS. 3 - 4** and **7 – 12**) in the insulator ***80*** to maintain the brewing temperature as discussed above in conjunction with **FIG. 4**. Alternatively, the heating element in the insulator ***80*** may be continuously activated, or activated before the brew cycle.

**[77]** Referring to **FIG. 10**, after the brewing time has expired, the piston assembly ***74*** moves upward to filter the coffee grounds ***152*** from the brewed coffee ***156***. As discussed above in conjunction with **FIG. 4**, as the piston assembly ***74*** moves upward, suction pulls the brewed coffee ***156*** from above the piston assembly ***74***, through the filter ***98*** and the

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check-valve ports ***130***, to below the piston assembly. The filter ***98*** blocks the coffee grounds ***152*** from flowing through the check-valve ports ***130***. The piston assembly ***74*** continues moving upward until all of the brewed coffee ***156*** is below the piston assembly, and all of the coffee grounds ***152*** are resting on the filter ***98***. A pressure sensor (not shown in **FIGS. 3 - 4** and **7 – 12**) may be located within the brewing chamber ***72***, and the controller ***58*** may control the speed of the piston assembly ***74*** in a closed-loop manner to maintain the suction force beneath the piston assembly within a desired range that prevents damage to, *e.g.,* the valve ***150***. Alternatively, the movement of the piston assembly ***74*** may be according to another suitable profile, such as in an open-loop manner. For example, the piston assembly ***74*** may move continuously at a constant velocity or may move in steps, with respective periods of non-movement between consecutive steps. This may allow the flow rate through the check-valve ports ***130*** to "catch up" with the suction below the piston assembly ***74***.

**[78]** Referring to **FIG. 11**, the piston assembly ***74*** continues moving upward until the top surface of the filter ***98*** is coplanar with the surface ***82*** of the chamber block ***70***.

**[79]** Next, the operator removes the coffee grounds ***152*** from the filter ***98*** by, *e.g.,* wiping the grounds off of the filter, onto the surface ***82***, and into the solid-waste-disposal unit ***52*** with a squeegee or other instrument (not shown in **FIG. 11**). The operator may indicate via the control panel ***64*** that the grounds are removed, and in response to this indication, the brew cycle continues.

**[80]** Alternatively, the piston assembly ***74*** does not move into a position where the filter ***98*** is coplanar with the surface ***82***, or does not stay in this position long enough for the operator to remove the coffee grounds ***152***. In this alternative, the operator subsequently removes the coffee grounds ***152*** as discussed below in conjunction with **FIG. 12**.

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[81] Then, the cup sensing unit ***48*** indicates whether a cup (not shown in **FIGS. 3 - 4** and **7 – 12**) is in the holder ***40*** — in one example, the cup holder is a drip tray. If a cup is not in the holder ***40***, then the controller ***58*** may halt the brewing cycle, and may sound an audio or visual alarm, until the operator places a cup in the holder. If a cup is in the holder ***40***, then the brewing cycle continues as described below.

[82] After the piston assembly ***74*** stops moving upward and a cup is in the holder ***40***, the valve ***150*** moves into its first position to connect the exit port ***90*** to the beverage-dispensing unit ***42***.

[83] Next, the piston assembly ***74*** begins moving downward to dispense the brewed coffee ***156*** into the cup (not shown in **FIGS. 3 - 4** and **7-12**) via the exit port ***90*** and the valve ***150***. The downward movement of the piston assembly ***74*** may be continuous or stepped, and may have any suitable velocity/acceleration profile. As discussed above in conjunction with **FIG. 4**, as the piston assembly ***74*** moves downward, the check valves ***102*** close to prevent the brewed coffee ***156*** and any other fluids (*e.g.*, air, water vapor) from flowing back through the filter ***98***. Consequently, the piston assembly ***74*** forces the brewed coffee ***156*** out of the port ***90*** and through the valve ***150***. The piston assembly ***74*** may move downward only a predetermined distance corresponding to the beverage size to prevent the forcing of air through the beverage-dispensing unit ***42***. Alternatively, the piston assembly ***74*** may moved downward enough to expel some air through the beverage-dispensing unit ***42*** to force the last bit of brewed coffee ***156*** out of the dispensing unit and into the cup. After the piston assembly ***74*** has finished moving downward, the valve ***150*** may switch to its second position.

[84] Referring to **FIG. 12**, after the brewed coffee ***156*** is dispensed, the piston assembly ***74*** moves upward and back into the home position. Of course if the piston assembly 74 is already in the home position, it remains

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in its current position. Furthermore, the controller ***58*** may indicate to the operator via the display ***64*** or other indicator (not shown in **FIGS. 3 - 4** and **7 – 12**) that he may remove the coffee-filled cup from the cup holder ***40***.

**[85]** Next, the valve ***150*** moves to its second position (if it has not already done so) so that any residual brewed coffee in the beverage-transporting unit ***44*** or in the conduit between the valve and the beverage-transporting unit can drain via gravity to the liquid-waste-disposal unit ***50***.

**[86]** Where the operator has not yet removed the coffee grounds ***152*** from the filter ***98*** as discussed in conjunction with **FIG. 11**, the piston assembly ***74*** first moves upward into a position where the top surface of the filter is coplanar with the surface ***82***.

**[87]** After the operator removes the coffee grounds ***152***, the piston assembly ***74*** moves downward and back into the home position. As discussed above, the operator may indicate that the coffee grounds are removed via the display ***64***. Alternatively, the piston assembly ***74*** may remain in this coplanar position until the next cycle so that the operator can more easily determine whether the assembly has been wiped clean, and wipe the assembly clean if it hasn't already been wiped clean.

**[88]** Still referring to **FIGS. 3 – 4** and **7 – 12**, other embodiments of the above-described brewing cycle are contemplated. For example, the order of the above-described steps may be altered, the steps described as being performed concurrently may be performed at different times, and steps described as being performed at different times may be performed concurrently. Furthermore, some of the steps may be omitted, and other steps not described above may be added.

**[89]** **FIGS. 13 – 15** illustrate operation of the beverage-brewing machine ***30*** of **FIG. 3** during a residual-liquid-removal cycle according to an

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embodiment of the invention. Although it may not be explicitly stated, the controller ***58*** (**FIG. 3**) may control one or more of the below-described steps.

**[90]** Referring to **FIG. 13** and as discussed above in conjunction with **FIG. 12**, after the completion of a beverage-brewing cycle, the piston assembly ***74*** returns to its home position in anticipation of the next brewing cycle.

**[91]** But because of the surface tension of water (or other liquid used to brew the beverage), a small, *i.e.*, residual, portion of the brewed beverage may cling to the chamber side wall ***86*** and to the piston assembly ***74*** even after the beverage is dispensed.

**[92]** Over time, this residual ***160*** runs downward; because the valve ***150*** is in its second position to allow residual in the beverage-transporting unit ***44*** (a conduit in this embodiment) to drain, the residual ***160*** collects at the bottom of the brewing chamber ***72***.

**[93]** Referring to **FIG. 14**, to drain the residual ***160*** from the brewing chamber ***72***, the valve ***150*** moves into its second position, and thus allows the residual to collect in the valve and in the beverage-transporting unit ***44***.

**[94]** Next, referring to **FIG. 15**, to drain the residual ***160*** from the valve ***150*** and the beverage-transporting unit ***44***, the valve moves back into its second position, and thus allows the residual to drain to the liquid-waste-disposal unit ***50*** (also a conduit in this embodiment).

**[95]** Referring to **FIGS. 14 – 15**, the brewing machine ***30*** (**FIG. 3**) may repeat the switching of the valve ***150*** between its first and second positions one or more times to drain additional residual ***160*** that may subsequently collect at the bottom of the brewing chamber ***72***. Furthermore, the machine ***30*** may begin this switching of the valve ***150*** immediately after the completion of a brew cycle, or at a predetermined time thereafter to allow time for the residual to collect at the bottom of the brewing chamber ***72***.

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**[96]** Referring again to **FIGS. 7 – 12**, a rinse cycle of the brewing machine ***30*** (**FIG. 3**) is described according to an embodiment of the invention. The rinse cycle may be similar to the brewing cycle described above in conjunction with **FIGS. 3-4** and **7-12**, except that no coffee or other flavor base is loaded into the chamber as shown in **FIG. 7**, and the water need not sit in the chamber ***72*** for the entire brew time. Furthermore, the machine ***30*** may not wait for the water in the reservoir unit ***36*** to heat to any particular temperature, and, because there is no flavor base to inhibit the movement of water through the filter ***98***, the piston assembly ***74*** may move a fraction of the distance that it moves during a beverage-brewing cycle. Moreover, the machine ***30*** may halt the rinse cycle if the cup sensing unit ***48*** (**FIG. 3**) senses a cup in the holder unit ***40***, and may sound an alarm (*e.g.*, audio or visual) to notify the operator (not shown in **FIGS. 7-12**); this prevents the dispensing of rinse water into the cup. The machine ***30*** may perform the rinse cycle one or more times to flush residue of the brewed beverage from the chamber ***72***, the beverage-transporting unit ***44***, and the beverage-dispensing unit ***42***, and into the waste-drain unit ***40***.

**[97]** After a rinse cycle, the brewing machine ***30*** may perform the residual-liquid-removal cycle described above in conjunction with **FIGS. 13-15** to drain residual rinse water from the chamber ***72***.

**[98]** Still referring to **FIGS. 7 – 12**, a cleaning cycle of the brewing machine ***30*** (**FIG. 3**) is described according to an embodiment of the invention. The cleaning cycle may be similar to the brewing cycle described above in conjunction with **FIGS. 3-4** and **7-12**, except that instead of coffee or another flavor base, the operator (not shown in **FIGS. 3-4** and **7-12**) loads a detergent or other cleaning substance (*e.g.*, vinegar) into the chamber per **FIG. 7**. Furthermore, where the detergent or other cleaning substance is a liquid, then the machine ***30*** may perform the cleaning cycle without introducing water into the chamber ***72***. Moreover, the machine ***30*** may move the piston assembly ***74*** in steps, for example in five steps upward and

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in five steps downward, with a predetermined time such as one minute between each of the steps to increase the soak time and the cycling of the cleaning substance through the piston assembly ***74***. In addition, the machine ***30*** may halt the cleaning cycle if the cup sensing unit ***48*** (**FIG. 3**) senses a cup in the holder unit ***40***, and may sound an, *e.g.,* audio or visual, alarm to notify the operator (not shown in **FIGS. 7-12**); this prevents the dispensing of cleaning solution into the cup. Furthermore, the display ***64*** (**FIG. 3**) may request the operator to wipe and scrub the top of the filter ***98*** (**FIG. 4**) when the filter top is coplanar with the surface ***82***, and the operator may indicate via the control panel ***64*** when he is done wiping/scrubbing. Moreover, the reservoir ***36*** may periodically introduce water into the chamber ***72*** during the soak portion of the cleaning cycle to agitate the cleaning solution. After the cleaning cycle, the machine ***30*** may perform the above-described rinse cycle one or more times to flush residue of the cleaning solution from the chamber ***72***, the beverage-transporting unit ***44***, and the beverage-dispensing unit ***42***, and into the waste-drain unit ***40***. Furthermore, the machine ***30*** may perform one or more rinse cycles before the cleaning cycle to dislodge and remove solids, *e.g.,* coffee grounds.

**[99]** **FIGS. 16-19** illustrate operation of the beverage-brewing machine ***30*** of **FIG. 3** during a beverage-brewing cycle according to another embodiment of the invention, with reference to the beverage-transporting unit ***44*** of **FIG. 3** and the beverage-brewing unit ***46*** of **FIGS. 3-4**. In this embodiment, the beverage-transporting unit ***44*** includes two valves, the valve ***150*** and a valve ***170***, and the beverage-brewing unit includes two exit ports, the dispense exit port ***90*** and a waste exit port ***172***. The valve ***170*** connects the waste exit port ***172*** to the liquid-waste disposal unit ***50*** (a conduit in this embodiment) in a first position, and disconnects the waste exit port from the liquid-waste disposal unit in a second position. Furthermore, although it may not be explicitly stated, the controller ***58*** (**FIG. 3**) may control one or more of the below-described steps. Moreover,

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although the operation of the machine ***30*** is described for brewing coffee, the operation for brewing another beverage, such as tea, may be the same as or similar to the described operation.

**[100]** Referring to **FIGS. 3 - 4** and **16 – 19**, the operation of the beverage brewing machine ***30*** during a beverage-brewing cycle is discussed according to another embodiment of the invention. Unless otherwise stated, the steps of the below-described brewing cycle are similar to the steps of the brewing cycle described above in conjunction with **FIGS. 3-4** and **7-12**. Therefore, some of the steps and functions common to both brewing cycles may be omitted for brevity.

**[101]** Referring to **FIG. 16**, after an operator (not shown in **FIGS. 3 - 4** and **16 – 19**) activates the machine ***30*** by, *e.g.,* turning "on" a power switch (not shown in **FIGS. 3 - 4** and **16 – 19**), the machine ***30*** performs a self-check/initialization during which the piston assembly ***74*** moves into a respective "home" position if it is not already in its respective home position. While the piston assembly ***74*** is moving into its home position or another starting position, the valve ***150*** is in its second position (*i.e.,* connecting the liquid-waste-disposal unit ***50*** to the beverage-transporting unit ***44***) to allow residual liquid in the beverage-transporting and -dispensing units ***44*** and ***42*** to drain; this prevents residual liquid from being forced through the units ***44*** and ***42*** while the piston assembly ***74*** moves downward. Furthermore, the valve ***170*** is in its first position (*i.e.,* connecting the port ***172*** to the disposal unit ***50***) such that no pressure or suction is created in the portion of the chamber ***72*** beneath the piston assembly ***74***.

**[102]** Referring to **FIG. 17**, after the operator loads the ground coffee ***152*** into the brewing chamber ***72***, the motor ***78*** moves the piston assembly ***74*** downward to or near the bottom of the chamber.

**[103]** After the piston assembly ***74*** is in the desired position, the valve ***150*** remains in its second position (i.e., connecting the liquid-waste-disposal

unit ***50*** to the beverage-transporting unit ***44***), and the valve ***170*** switches to its second position (*i.e.*, disconnecting the port ***172*** from the liquid-waste-disposal unit ***50***).

**[104]** Next, the reservoir-and-heating unit ***36*** fills the brewing chamber ***72*** with a desired amount of water having the desired brewing temperature, and the mixture of water and ground coffee remains in the chamber for the selected brewing time.

**[105]** After the brewing time has expired, the piston assembly ***74*** moves upward to filter the coffee grounds ***152*** from the brewed coffee ***156***.

**[106]** Referring to **FIG. 18**, after the piston assembly ***74*** stops moving upward, the valve ***150*** moves into its second position to connect the exit port ***90*** to the beverage-transporting unit ***44***, and the valve ***170*** remains in its second position.

**[107]** Then, the piston assembly ***74*** begins moving downward to dispense the brewed coffee ***156*** into the cup (not shown in **FIGS. 3-4** and **16-19**) via the exit port ***90*** and the valve ***150***.

**[108]** Referring to **FIGS. 3** and **19**, after the brewed coffee ***156*** is dispensed, the valve ***150*** moves back into its first position to allow residual ***160*** to drain from the beverage-transporting and -dispensing units ***44*** and ***42***, and the valve ***170*** moves into its first position to allow residual ***160*** to drain from the chamber ***72***. The valves ***150*** and ***170*** may remain in their respective first positions until the next brewing, rinsing, or cleaning cycle.

**[109]** Still referring to **FIGS. 3 – 4** and **16 – 19**, other embodiments of the above-described brewing cycle are contemplated. For example, the order of the above-described steps may be altered, the steps described as being performed concurrently may be performed at different times, and steps described as being performed at different times may be performed concurrently. Furthermore, some of the steps may be omitted, and other

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steps not described above in conjunction with **FIGS. 16-19** (such as steps described above in conjunction with **FIGS. 7-12**) may be added.

**[110]** Referring again to **FIGS. 16 – 19**, rinse and clean cycles of the brewing machine ***30*** (**FIG. 3**) may be similar to the brewing cycle described above in conjunction with **FIGS. 3-4** and **16-19**, and may also be similar to, and include steps from, the rinse and clean cycles described above in conjunction with **FIGS. 7-12**.

**[111]** **FIGS. 20 - 22** illustrate operation of the beverage-brewing machine ***30*** of **FIG. 3** during a portion of a beverage-brewing cycle according to another embodiment of the invention, with reference to the beverage-brewing unit ***46*** of **FIGS. 3-4**. In this embodiment, the water from the reservoir-and-heating unit ***36*** enters the brewing chamber ***72*** from one or more inlets ***180*** (only one shown in **FIGS. 20-22**) instead of from a nozzle (not shown in **FIGS. 3-4**) disposed over the chamber opening ***84***, and the width(s) of the inlet(s) ***180*** is/are no thicker than the thickness of the piston assembly ***74***. Furthermore, although it may not be explicitly stated, the controller ***58*** (**FIG. 3**) may control one or more of the below-described steps. Moreover, although the operation of the machine ***30*** is described for brewing coffee, the operation for brewing another beverage, such as tea, may be the same as or similar to the described operation. In addition, although the operation of the machine ***30*** is described for an embodiment of the beverage-brewing unit ***46*** having only one inlet ***180***, the operation for an embodiment having multiple inlets ***180*** may be similar.

**[112]** Referring to **FIGS. 3 - 4** and **20 – 22**, the operation of the beverage brewing machine ***30*** during a portion of the beverage-brewing cycle is discussed according to another embodiment of the invention.

**[113]** Referring to **FIG. 20**, after the operator (not shown in **FIGS. 3-4** and **20-22**) loads the ground coffee into the chamber ***72***, the piston assembly ***74*** moves below the inlet ***180***.

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**[114]** Next, a valve ***182*** (which may be part of one of the units ***36***, ***38***, and ***46*** of **FIG. 3**) opens to allow water from the reservoir unit ***36*** to enter the chamber ***72*** via the inlet ***180***, which may have a shape designed to agitate the mixture of water and ground coffee. For example, the inlet ***180*** may cause the mixture to swirl within the chamber ***72***.

**[115]** Referring to **FIG. 21**, while water is entering the chamber ***72*** via the inlet ***180***, the piston assembly ***74*** begins moving upward.

**[116]** Referring to **FIG. 22**, the piston assembly ***74*** stops when the top surface of the piston assembly is above the inlet ***180***, and then the valve ***182*** closes. Maintaining the valve ***182*** open until the top surface of the piston assembly ***74*** is above the inlet ***180*** allows the flow of water from the inlet to prevent ground coffee or other solids from clogging or otherwise migrating into the inlet.

**[117]** The coffee ***156*** is then allowed to brew.

**[118]** While dispensing the brewed coffee ***156***, the machine ***30*** may limit the downward movement of the piston assembly ***74*** so that the filtered coffee grounds (not shown in **FIGS. 20-22**) on top of the piston assembly remain above, and thus to not clog or migrate into, the inlet ***180***.

**[119]** Referring again to **FIGS. 20-22**, the inlet ***180*** may also facilitate agitation of a detergent and water during a cleaning cycle of the beverage-brewing machine ***30*** (**FIG. 3**). During a cleaning cycle, the top surface of the piston assembly ***74*** may remain below the inlet ***180*** for a predetermined time so that cleaning solution contacts and cleans the inlet.

**[120]** **FIG. 23** is a perspective view of the beverage-brewing machine ***30*** according to an embodiment of the invention.

**[121]** Referring to **FIGS. 3 – 4** and **23**, in addition to the cup-holder-and-drain unit ***40***, the solid-waste-disposal unit ***52***, the control panel and display ***64***, the surface ***82***, and the brew-chamber opening ***84***, the machine

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***30*** includes a stainless steel and plastic housing ***190***, a water-fill nozzle ***192***, a beverage dispensing spout ***194***, a tray ***196***, and a power switch ***198***.

**[122]** The disposal unit ***52*** has an opening ***199*** that is contiguous with the surface ***82*** such that when the top of the piston assembly ***74*** is coplanar with the surface ***82***, an operator (not shown in **FIGS. 3 – 4** and **23**) may use a squeegee or other instrument (not shown in **FIGS. 3 – 4** and **23**) to wipe coffee grounds or other filtrate from the piston assembly, across the surface ***82***, and into the disposal unit.

**[123]** The nozzle ***192*** is part of the beverage-brewing unit ***46***, and directs water from the water-reservoir-and-heating unit ***36*** into the brewing chamber ***72*** via the opening ***84***, the nozzle ***192*** provides clearance (*e.g.,* 25 inches) sufficient to allow the wiping of coffee grounds from the filter ***98*** (**FIG. 4**) into the unit ***52***, and to allow the removal of the piston assembly ***74*** (**FIG. 4**). The nozzle ***192*** may be designed to promote wetting of the coffee grounds and agitation of the water-coffee mixture (neither shown in **FIG. 23**). For example, the nozzle ***192*** may include multiple angled orifices arranged in an angled radial pattern like a shower head, or may have a single, larger diameter jet. Parameters of the nozzle ***192*** that may be varied to provide the desired spray pattern include: the number of jets; flow rate; jet diameter; nozzle outlet angle; and, nozzle inlet pressure. Factors that one may take into account when designing the nozzle ***192*** include the desired fill time for filling the brewing chamber ***72*** (**FIG. 4**), and the water heat loss as the water travels from the nozzle to the brew chamber.

**[124]** The dispensing spout ***194*** is part of the beverage-dispensing unit ***42***, and the tray ***196***, which is removable for cleaning, is part of the cup-holder-and-drain unit ***40***. The spout ***194*** may be one of a number of different-sized interchangeable spouts for different beverage or cup sizes.

**[125]** Still referring to **FIG. 23**, alternate embodiments of the machine ***30*** are contemplated. For example, the placement and design of the

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components (*e.g.*, disposal unit ***52***, controller and display ***64***, nozzle ***192***, dispenser ***194***, and tray ***196***) may change, and the machine ***30*** may be made from a suitable material other than stainless steel and plastic. Furthermore, although shown placed between the chamber opening ***84*** and the front of the machine ***30*** so that the operator can wipe the coffee grounds from the piston assembly ***74*** by pulling a squeegee toward the machine front, the disposal unit ***52*** may be disposed in another location adjacent to the chamber opening. In addition, the machine ***30*** may include an automatic wiping assembly to wipe the coffee grounds from the piston assembly ***74*** into the disposal unit ***52***. Moreover, instead of including only one spout ***194***, the machine ***30*** may include multiple spouts, and the brew chamber ***72*** (**FIG. 4**) may have a multi-cup capacity, so that the machine ***30*** can brew multiple cups of coffee simultaneously. Or, the machine ***30*** may include multiple brew chambers ***72*** so that the machine can simultaneously brew multiple beverage recipes. Furthermore, the communications port ***66*** (**FIG. 3**) may be connected to one or more cash registers to allow direct input of beverage recipes, and a batch/queue of orders; this can be done via the control panel ***64*** too. Moreover, where multiple cups of the same recipe are ordered, the machine ***30*** can simultaneously brew the total volume, and then dispense each cup separately via one or more of the spouts ***194***. For example, where the machine ***30*** dispenses each cup via a single spout ***194***, the machine may fill the first cup, prompt the operator to replace the first filled cup with a second empty cup and to indicate via the control panel ***64*** when the second cup is in place, fill the second cup, and repeat this procedure for subsequent cups.

**[126]** **FIG. 24** is a view of a coffee grinder ***200*** having an optical coffee measuring unit ***202*** according to an embodiment of the invention.

**[127]** In addition to the measuring unit ***202***, the coffee grinder ***200*** includes a motor ***204***, a grind head ***206***, a whole-coffee inlet ***208*** for

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receiving coffee beans ***209***, and a transparent ground-coffee outlet ***210*** through which the grind head discharges ground coffee ***211***.

**[128]** The measuring unit ***202*** may include a pixel array, an illumination source such as a light-emitting diode (LED) or semiconductor laser, a processor (none of these components shown in **FIG. 24**) and other components. These components may be off-the-shelf parts that are also used in optical computer mice.

**[129]** In operation, one loads the coffee beans ***209*** into the inlet ***208***, and the grind head ***206*** grinds the beans and provides the ground coffee ***211*** via the outlet ***210***.

**[130]** As the ground coffee ***211*** passes through the transparent outlet ***210***, the measuring unit ***202*** takes pictures of the ground coffee at periodic intervals. By analyzing these pictures using one or more image-analysis techniques, the unit ***202*** can determine the amount of ground coffee ***211*** that passes through the outlet ***210***. Specifically, the unit ***202*** searches for motion vectors between successive images, and determines the two-dimensional flow rate of the coffee ***211*** from these vectors. The unit ***202*** then determines the volumetric flow rate through the outlet ***210*** by multiplying the two-dimensional flow rate and the cross-sectional area of the outlet. Alternatively, the unit ***202*** may determine only a one-dimensional flow rate (in a direction away from the coffee grinder ***200***) and determine the volumetric flow rate through the outlet ***210*** by multiplying the one-dimensional flow rate and the cross-sectional area of the outlet.

**[131]** Still referring to **FIG. 24**, alternate embodiments of the measuring unit ***202*** are contemplated. For example, although described as measuring ground coffee ***211***, the unit ***202*** may be used to measure other substances. Furthermore, although described as being incorporated in a stand-alone coffee grinder, the unit ***202*** may be incorporated in the machine ***30*** or an automatic coffee brewer such as described in International

Application No. PCT/US2006/013930 filed on April 11, 2006, which is incorporated by reference. Further, U.S. Design Application Serial Nos. 29/257,647 filed on April 6, 2006 and 29/257,662, filed on April 6, 2006 are also incorporated by reference.

**[132]** In this specification where a document, act or item of knowledge is referred to or discussed, this reference or discussion is not an admission that the document, act or item of knowledge or any combination thereof was at the priority date publicly available, known to the public, part of the common general knowledge or known to be relevant to an attempt to solve any problem with which this specification is concerned.

**[133]** The word 'comprising' and forms of the word 'comprising' as used in this description and in the claims does not limit the invention claimed to exclude any variants or additions.

**[134]** From the foregoing it will be appreciated that, although specific embodiments have been described herein for purposes of illustration, various modifications may be made without deviating from the spirit and scope of the invention. Furthermore, where an alternative is disclosed for a particular embodiment, this alternative may also apply to other embodiments even if not specifically stated.

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WHAT IS CLAIMED IS:

1 A machine for brewing a beverage, the machine comprising:

(a) a chamber operable to receive a liquid and a flavor base and to allow the beverage to brew; and

(b) a piston assembly disposed within the chamber and operable to

(i) filter a solid from the brewed beverage by moving in a first direction, and

(ii) dispense the filtered beverage from the machine by moving in a second direction.

2 The machine of claim 1, further comprising a controller operable to control the movement of the piston assembly.

3 The machine of claim 1 or claim 2 wherein the chamber and the piston assembly are cylindrical.

4 The machine of any one of the preceding claims wherein:

(a) the chamber has an end and a beverage-dispensing conduit disposed in the end;

(b) the piston assembly moves away from the chamber end while moving in the first direction; and

(c) the piston assembly moves toward the chamber end while moving in the second direction.

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5 The machine of any one of the preceding claims wherein:

(a) the chamber has a bottom and a beverage-dispensing conduit disposed in the bottom;

(b) the piston assembly moves away from the chamber bottom while moving in the first direction; and

(c) the piston assembly moves toward the chamber bottom while moving in the second direction.

6 The machine of any one of the preceding claims wherein:

(a) the flavor base comprises coffee grounds;

(b) the liquid comprises water; and

(c) the solid comprises spent coffee grounds.

7 The machine of any one of the preceding claims wherein the piston assembly comprises a filter assembly that is operable to:

(a) filter the flavor base from the brewed beverage by passing the brewed beverage from a first portion of the chamber on a first side of the piston assembly to a second portion of the chamber on a second side of piston assembly and by preventing passage of the solid from the first chamber portion to the second chamber portion as the piston assembly moves in the first direction, and

(b) dispense the filtered beverage by preventing passage of the filtered beverage from the second chamber portion to the first chamber portion as the piston assembly moves in the second direction.

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8 The machine of any one of the preceding claims wherein the piston assembly comprises:

(a) a filter assembly; and

(b) a valve that is operable to

(i) allow the brewed beverage to pass through the filter assembly as the piston assembly moves in the first direction; and

(ii) prevent the filtered beverage from passing through the filter assembly as the piston assembly moves in the second direction.

9 The machine of any one of the preceding claims, further comprising a reservoir operable to hold the liquid, to heat the liquid to a predetermined temperature, and to provide the heated liquid to the chamber.

10 The machine of any one of the preceding claims, further comprising:

(a) a reservoir operable to hold the liquid and to heat the liquid to a first predetermined temperature; and

(b) a temperature-control unit operable to receive the heated liquid from the reservoir, to change the temperature of the liquid from the first predetermined temperature to a second predetermined temperature, and to provide the liquid having the second predetermined temperature to the chamber.

11 The machine of any one of the preceding claims, further comprising:

(a) a reservoir operable to hold the liquid and to heat the liquid to a first predetermined temperature; and

(b) a temperature-control unit operable to receive the heated liquid from the reservoir, to cool the liquid to a second predetermined temperature, and to provide the cooled liquid to the chamber.

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12 The machine of any one of the preceding claims, further comprising:

(a) a holder operable to hold a beverage cup; and

(b) wherein the piston assembly is operable to dispense the beverage into the cup.

13 The machine of any one of the preceding claims, further comprising:

(a) a holder operable to hold a beverage cup;

(b) a sensor operable to indicate whether the beverage cup is in the holder; and

(c) wherein the piston assembly is operable to force the beverage out of the chamber and into the beverage cup if the sensor indicates that the cup is in the holder.

14 The machine of any one of the preceding claims, further comprising:

(a) wherein the chamber has a wall; and

(b) a heating assembly coupled to the wall and operable to maintain the wall at a predetermined temperature.

15 The machine of any one of the preceding claims, further comprising:

(a) wherein the chamber has an opening;

(b) a substantially flat surface contiguous with the opening; and

(c) wherein the piston assembly has a surface and is operable to move into a wipe position where the piston-assembly surface is substantially coplanar with the contiguous surface.

16 The machine of any one of the preceding claims, further comprising:

(a) wherein the chamber has an opening;

(b) a substantially flat surface contiguous with the opening;

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(c) wherein the piston assembly has a surface; and

(d) wherein after forcing the beverage out of the chamber the piston assembly is operable to move into a wipe position where the piston-assembly surface is substantially coplanar with the contiguous surface.

17 The machine of any one of the preceding claims, further comprising:

(a) wherein the chamber has an opening;

(b) a substantially flat surface contiguous with the opening;

(c) wherein the piston assembly has a surface; and

(d) wherein after filtering the beverage but before forcing the beverage out of the chamber the piston assembly is operable to move into a wipe position where the piston-assembly surface is substantially coplanar with the contiguous surface.

18 The machine of a any one of the preceding claims, further comprising:

(a) wherein the chamber has an opening; and

(b) a nozzle disposed outside of the chamber adjacent to the opening and operable to provide the liquid to the chamber.

19 The machine of any one of the preceding claims, further comprising:

(a) wherein the chamber has a wall; and

(b) an opening in the chamber wall operable to provide the liquid to the chamber.

20 The machine of any of the preceding claims, wherein the second direction is opposite to the first direction.

21 A machine for brewing a beverage, the machine comprising:

(a) a brew chamber; and

(b) a piston assembly slideably disposed within the chamber and including

(i) a filter assembly having a plurality of filter layers, and

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(ii) a filter base plate including one or more openings for respectively receiving one or more one-way valves, wherein the filter assembly is coupled to the filter base plate.

22 The machine of claim 21, wherein the one or more valves comprises one or more check valves.

23 The machine of claim 21 or claim 22 wherein each of the one or more valves is flexible.

24 A method, comprising:

(a) producing a beverage in a chamber from a flavor base and a liquid;

(b) filtering a solid from the beverage by moving a piston in a first direction within the chamber; and

(c) dispensing the filtered beverage by moving the piston in a second direction within the chamber.

25 The method of claim 24 wherein producing the beverage comprises brewing coffee in the chamber from ground coffee and water.

26 The method of claim 24 or claim 25 wherein the solid comprises residual flavor base.

27 The method of any one of claims 24 to 26 wherein producing the beverage comprises:

(a) introducing the flavor base into the chamber;

(b) introducing the liquid into the chamber; and

(c) stirring the liquid containing the flavor base.

28 The method of any one of claims 24 to 27, further comprising wiping a solid residue from the piston into a waste-disposal unit after dispensing the beverage.

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29 The method of any one of claims 24 to 27, further comprising wiping a solid residue from the piston into a waste-disposal unit after filtering but before dispensing the beverage.

30 The method of any one of claims 24 to 29, further comprising:

(a) receiving a beverage-producing parameter; and

(b) producing the beverage according to the parameter.

31 The method of any one of claims 24 to 29, further comprising:

(a) electronically receiving a beverage-producing parameter; and

(b) producing the beverage according to the parameter.

32 The machine of claim 1, wherein the piston assembly's operation of forcing the filtered beverage out of the chamber comprises dispensing the filtered beverage from the machine.

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FIG. 1
(PRIOR ART)

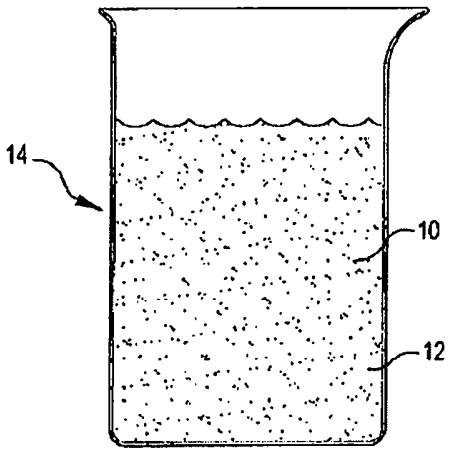



FIG. 2
(PRIOR ART)

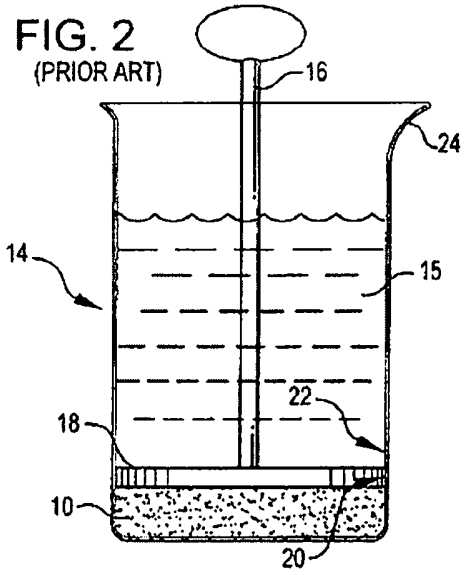
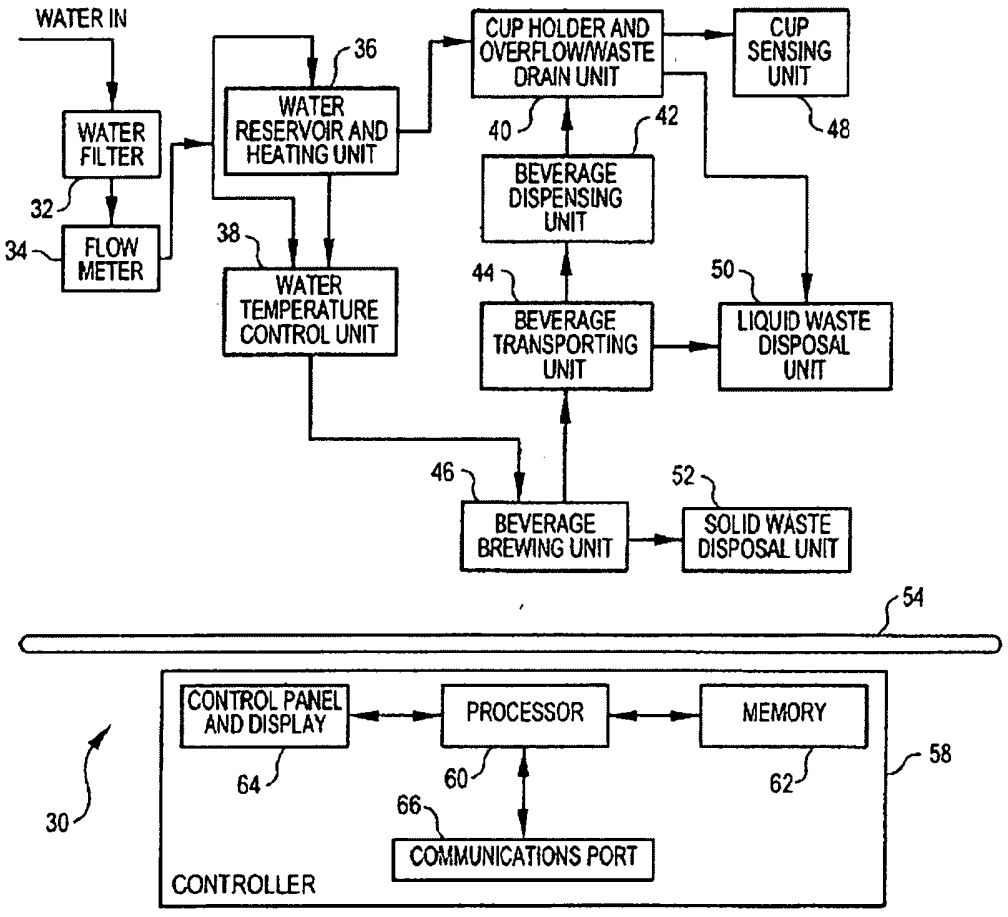



FIG. 3



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FIG. 4

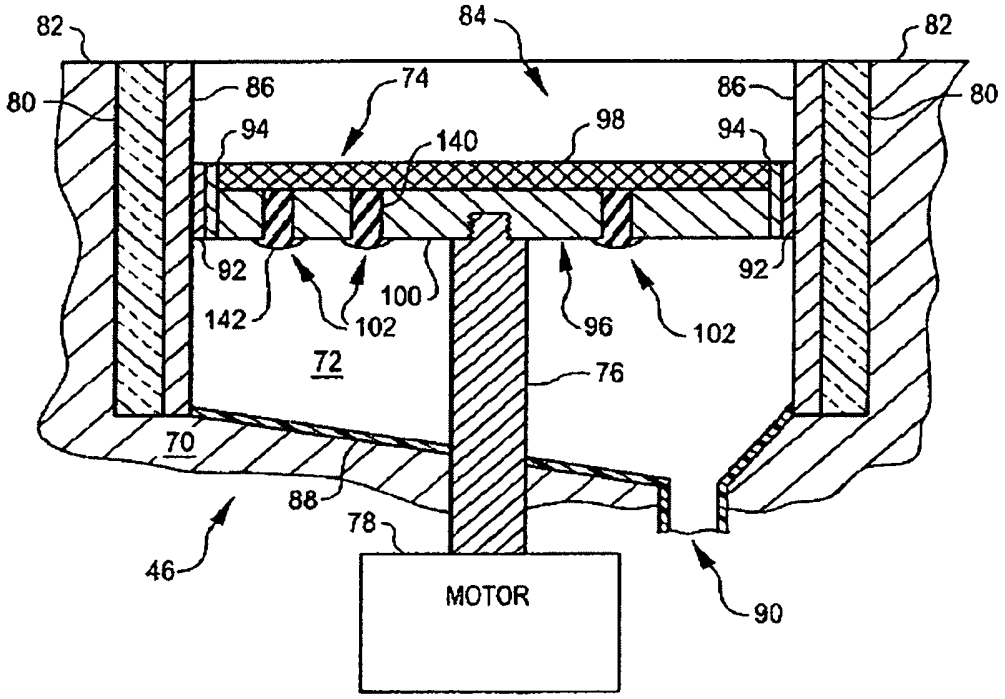
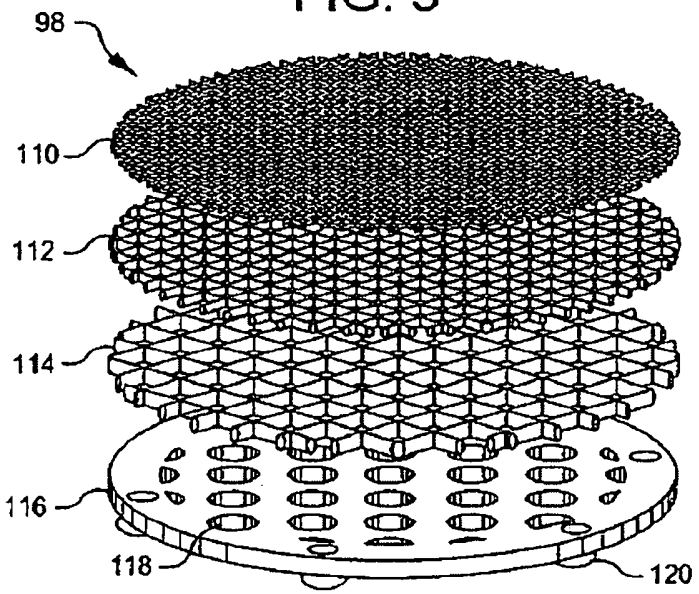



FIG. 5



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FIG. 6

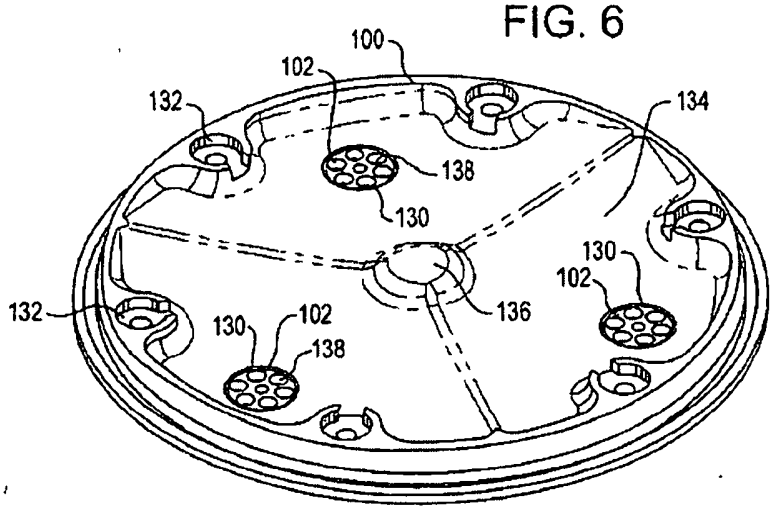



FIG. 7

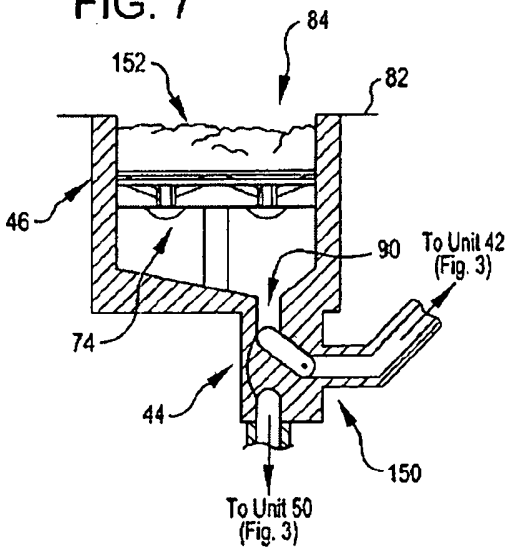



FIG. 8

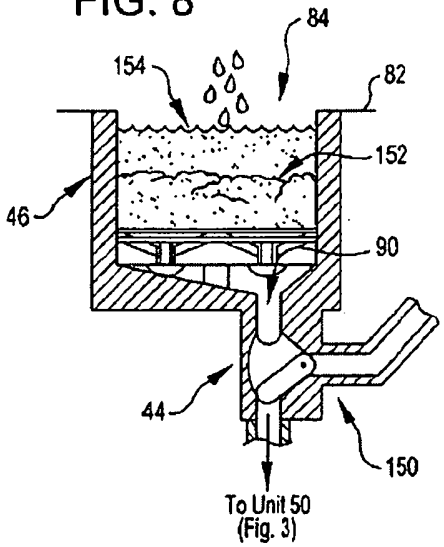



FIG. 9

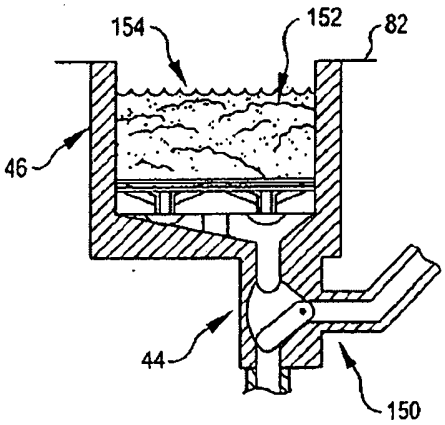


FIG. 10

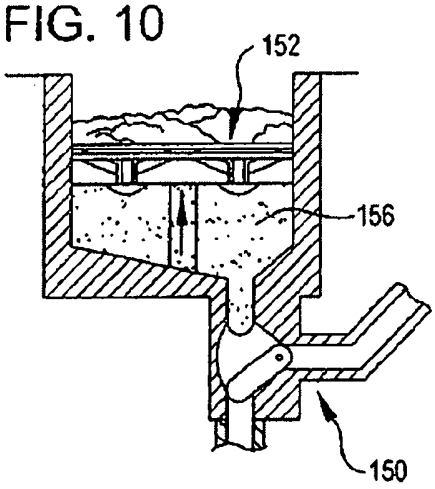



FIG. 11

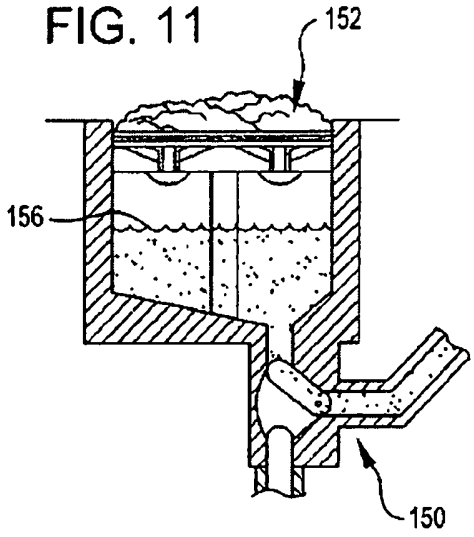



FIG. 12

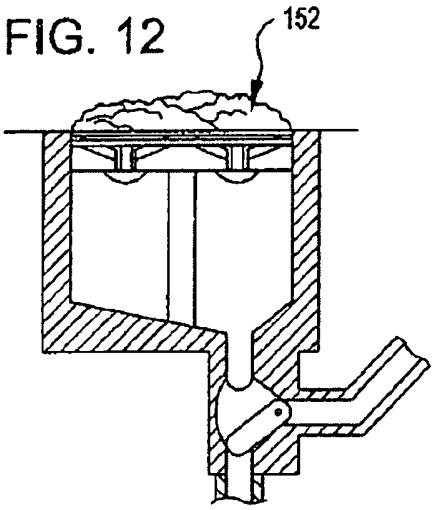



FIG. 13

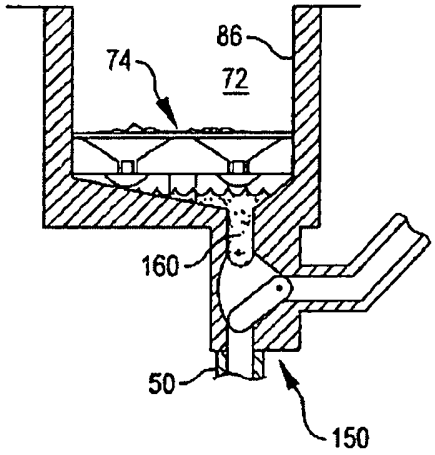



FIG. 14

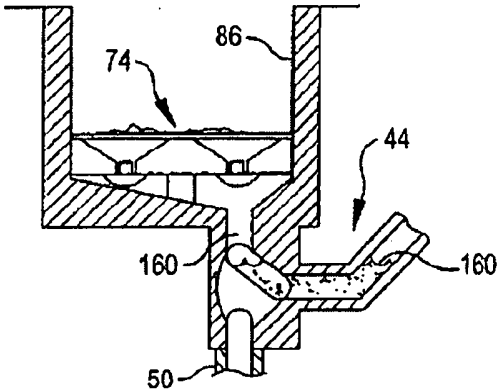
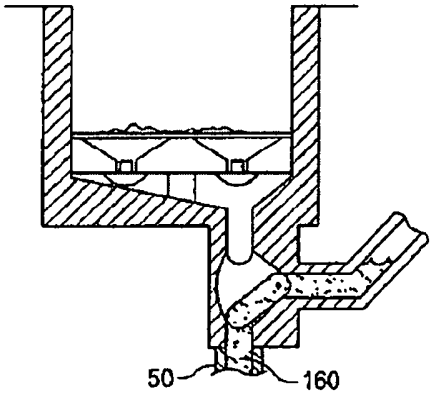



FIG. 15



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FIG. 16

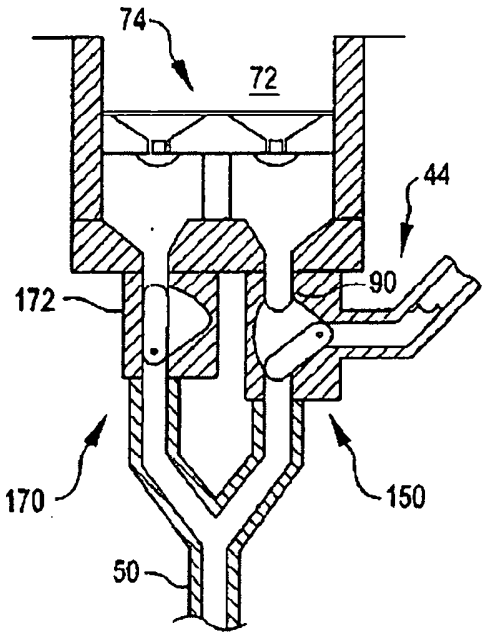



FIG. 17

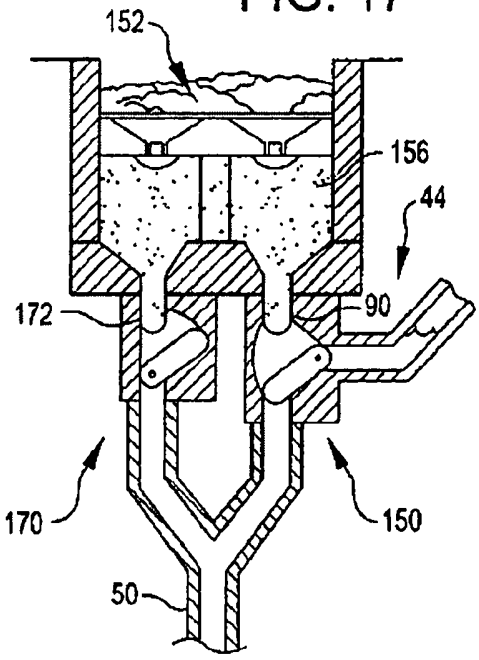



FIG. 18

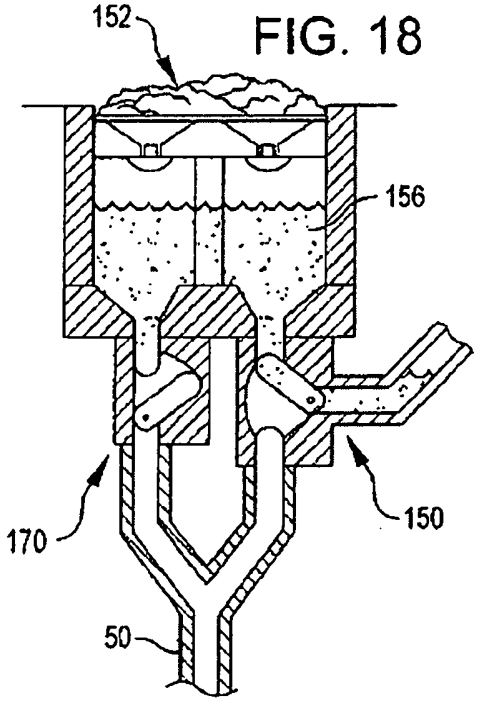
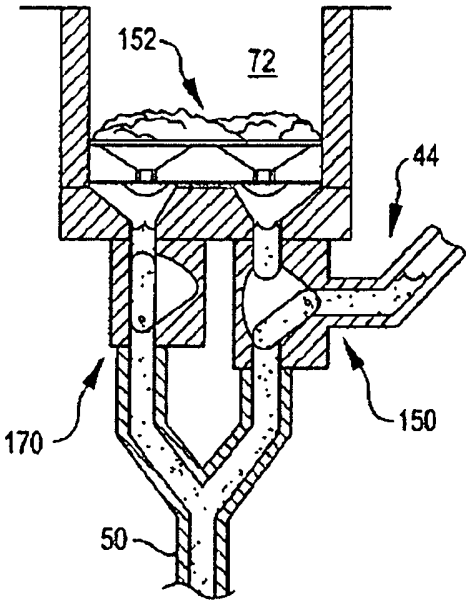



FIG. 19



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FIG. 20

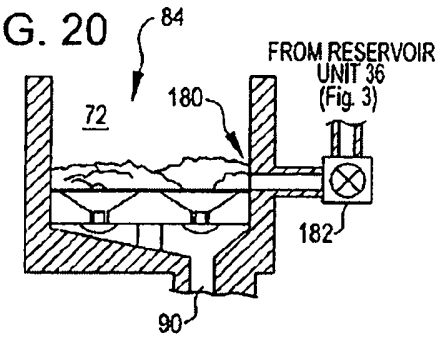



FIG. 21

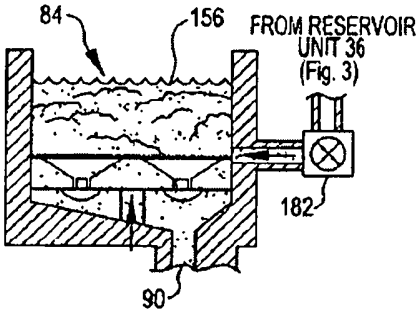



FIG. 22

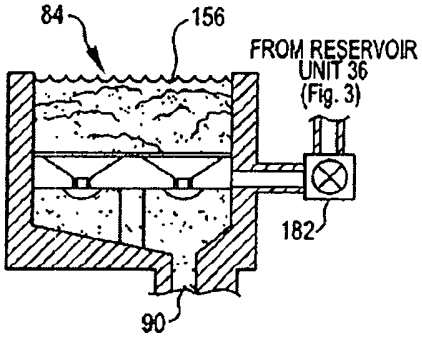
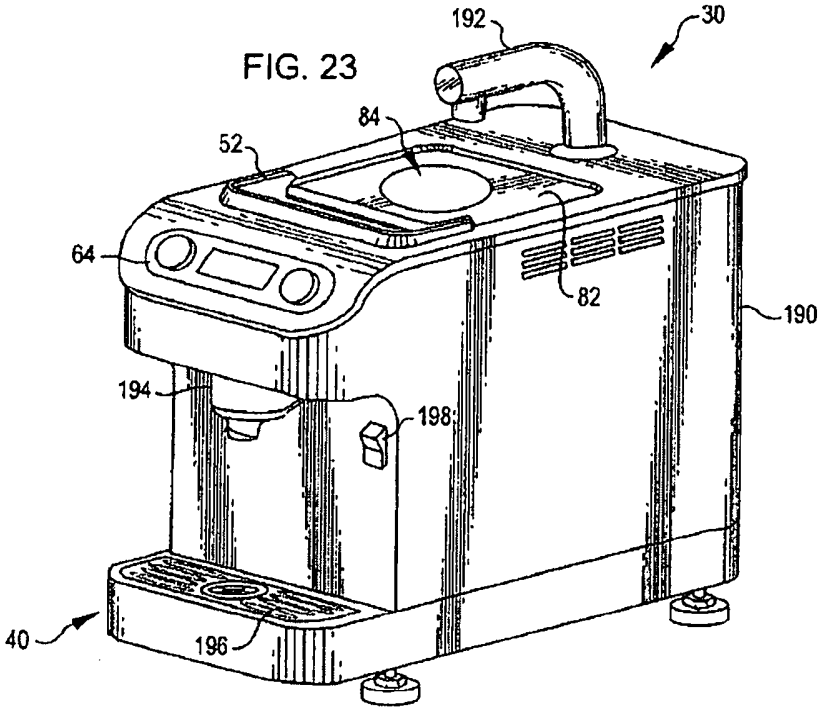



FIG. 23



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FIG. 24

