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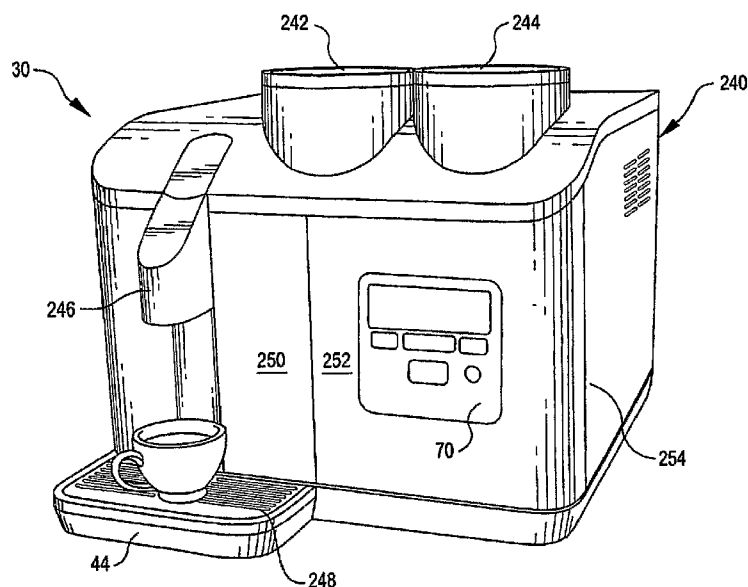
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(54) Title: MACHINE FOR BREWING A BEVERAGE SUCH AS COFFEE AND RELATED METHOD



(57) Abstract: A machine for brewing a beverage such as coffee includes a chamber and a piston disposed in the chamber. The piston is operable to move to a first position to allow the chamber to receive a liquid and a flavor base such as ground coffee, to remain in the first position for a time sufficient for the beverage to brew, and to move to a second position to dispense the beverage by forcing the beverage out of the chamber. By modifying some or all steps of the French press brewing technique, the machine can typically control coffee-brewing parameters with a level of precision that yields brewed coffee having a uniform taste from cup to cup, and can typically 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

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CLAIM OF PRIORITY

[1] This application claims priority to U.S. Provisional Application Serial Nos. 60/670,955 filed on April 11, 2005, 60/719,069 filed on September 20, 2005, and ____ (attorney docket number 2402-001-05 titled IMPROVED MAGNOLIA AND PHINNEY BREWER) filed on April 6, 2006.

10 All of the above applications are incorporated by reference.

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 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.

25 [4] Referring to **FIG. 1**, one places ground coffee **10** and hot water **12** in a coffee pot **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.

[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 pot **14**, and presses
5 the filter down toward the bottom of the pot.

[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 pot **14**, the substantially ground-free brewed coffee **15** fills the portion of the pot above the filter while the filter retains the ground coffee **10**
10 in the portion of the pot below the filter. Of course the edge **20** of the filter **18** and the inner side **22** of the pot **14** form a seal sufficient to prevent coffee grounds from passing between the edge of the filter and the inner side of the pot.

[7] After one presses the filter **18** below a spout **24** of the coffee
15 pot **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 ideally 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 pot **14** to reduce the chances of undersized coffee grounds passing through the filter and into the
20 cup.

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

25 [9] Unfortunately, a problem with the above-described French press technique is that it is often too time consuming and 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**
5 **– 2** (*e.g.*, coffee grinder, thermometer, measuring cup), it is often difficult and time consuming to control these brewing parameters, particularly with the level of precision required to brew many pots of coffee having a substantially uniform taste from pot to pot. And because each cup of
10 brewed coffee poured from the same pot typically sat in the pot 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
15 coffee includes a chamber and a piston disposed in the chamber. The piston is operable to move to a first position to allow the chamber to receive a liquid and a flavor base such as ground coffee, to remain in the first position for a time sufficient for a beverage to brew, and to move to a second position to dispense the beverage by forcing the beverage out of the
20 chamber.

[11] By modifying or automating some or all steps of the French press brewing technique, such a machine can typically control the brewing parameters with a level of precision that yields brewed coffee having a uniform taste from cup to cup, and can typically brew the coffee with a
25 speed that renders the machine suitable for use by establishments that serve significant amounts of coffee.

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 using a modified French press technique according to an embodiment of the invention.

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

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

[16] **FIGS. 6A – 6B** are side views of the filter and wiper shuttle assembly of **FIGS. 4 – 5** according to an embodiment of the invention.

10 [17] **FIGS. 7A – 7C** are side views of the filter and wiper shuttle assembly of **FIGS. 4 – 6B** and of a filter and wiper cleaning assembly according to an embodiment of the invention.

[18] **FIG. 8** is an isometric view of the filter and wiper cleaning assembly of **FIGS. 7A – 7C** according to an embodiment of the invention.

15 [19] **FIG. 9** is a block diagram of the grinding-and-measuring unit of **FIG. 3** according to an embodiment of the invention.

[20] **FIG. 10** is a cut-away side view of the measuring assembly of the grinding-and-measuring unit of **FIG. 9** according to another embodiment of the invention.

20 [21] **FIG. 11** is a cut-away side view of the measuring assembly of the grinding-and-measuring unit of **FIG. 9** according to yet another embodiment of the invention.

[22] **FIG. 12** is a block diagram of the brewing chamber of **FIG. 4** and the measuring assembly of the grinding-and-measuring unit of **FIG. 9**
25 according to still another embodiment of the invention.

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

[24] **FIG. 19** is a perspective view of the beverage-brewing machine of **FIG. 3** according to an embodiment of the invention.

DETAILED DESCRIPTION

[25] 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.

[26] **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 an automated and modified 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.

[27] The machine **30** includes the following components: a water filter **32**, cleaner-dispensing unit **34**, water-reservoir-and-heating unit **36**, water-temperature-control unit **38**, water-and-cleaner-measuring-and-transporting unit **40**, liquid-waste-disposal unit **42**, cup-holder-and-overflow/waste-drain unit **44**, beverage-dispensing unit **46**, beverage-transporting unit **48**, beverage-brewing unit **50**, cup-sensing unit **52**, grind-transporting unit **54**, solid-waste-disposal unit **56**, hopper unit **58**, grinding-and-measuring unit **60**, barrier **62**, and controller **64**. 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.

[28] The water filter **32** filters the water that is used to brew the
5 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 separate from the machine.

[29] The cleaner-dispensing unit **34** stores a cleaning solution that
10 the beverage-brewing machine **30** may use to clean some of the above-described components during a cleaning cycle, which is described in more detail below in conjunction with **FIG. 16**. Suitable cleaning solutions include vinegar, ammonia, soap-based solutions, and mixtures thereof.

[30] The water-reservoir-and-heating unit **36** receives and stores
15 water from the water filter **32**, and, under the control of the controller **64**, 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 heating element may be electric or any other type of conventional heating element, and a sensor (not shown in **FIG. 3**) indicates to the controller **64** the
20 temperature of the water in the reservoir. In one implementation, the capacity of the reservoir and the thermal output of the heating element are such that the machine **30** can brew a 16 ounce cup of coffee in approximately 50 seconds, and can brew ten 16 ounce cups of coffee in approximately 10 minutes. Alternatively, the reservoir-and-heating unit **36** may include a manually settable thermostat that maintains the temperature
25 of the water at the temperature to which the thermostat is set.

[31] 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 temperature-control unit **38** mixes the heated water from the reservoir **36** with colder water from the filter **32** to lower 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 water having a desired temperature. Alternatively, the temperature control unit **38** may operate in a closed-loop configuration by sensing the temperature of the provided water and, in response to the sensed temperature, regulating the amount of cold water mixed with the heated water to provide water having the desired temperature. Moreover, instead of actually mixing cold tap water from the filter **32** 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. The temperature control unit **38** may also be able to heat the water used to brew the coffee above the temperature of the water in the reservoir **36**.

[32] Alternatively, one may omit the water-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. An advantage of the temperature-control unit **38** is that it provides water at the desired brew temperature relatively quickly 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**. 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 base temperature to any desired brewing temperature under software control (via the controller **64**) without adding

any expense or complexity to the machine. Typically, 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 baseline temperature, thus readying the reservoir for the next cup.

- 5 **[33]** The water-and-cleaner-measuring-and-transporting unit **40** transports a predetermined amount of water from the temperature-control unit **38** to the brewing unit **50** during a brewing cycle, and transports a predetermined amount of cleaning solution to the brewing unit during a cleaning cycle. The measuring-and-transporting unit **40** may also direct
- 10 liquid waste from the brewing unit **50** to the liquid-waste disposal unit **42** as discussed below in conjunction with **FIGS. 13 – 18**. The unit **40** includes one or more electronically controllable valves, which, in response to the controller **64**, direct the water, cleaning solution, and liquid waste as described above and as described below in conjunction with **FIGS. 13 – 18**.
- 15 Furthermore, the unit **40** measures the water and cleaning solution transported to the brewing chamber **50** as described below in conjunction with **FIGS. 13 – 18**. Moreover, the unit **40** may provide hot water directly to the beverage dispensing unit **46** so that one can obtain hot water for any desired use.
- 20 **[34]** The liquid-waste disposal unit **42** receives liquid waste from the measuring-and-transporting unit **40** and disposes of this waste. The disposal unit **42** may include a drain (not shown in **FIG. 3**) that is connected to the sewer line (not shown in **FIG. 3**) of the establishment in which the machine **30** is installed. Alternatively, the disposal unit **42** may receive
- 25 liquid waste from the beverage transporting unit **48** or from another component of the machine **30**.

[35] The cup-holder-and-overflow/waste-drain unit **44** holds a cup (not shown in **FIG. 3**) while the beverage-dispenser unit **46** fills the cup with the brewed beverage (or hot water as described above). The unit **44** also

includes a drain portion to absorb, e.g., spillage from the cup and drippings from the dispenser unit **46** after the cup has been removed. The drain portion of the unit **44** may be removable for emptying, or may be connected to the liquid-waste disposal unit **42** or directly to the sewer line of the establishment in which the machine **30** is installed.

[36] The beverage-dispensing unit **46** 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.

[37] The beverage-transporting unit **48** transports the brewed beverage from the brewing unit **50** to the dispensing unit **46**. The unit **48** may include an electronically controllable valve (not shown in **FIG. 3**), which, in response to the controller **64**, opens after the brewing unit **50** has brewed the beverage to allow the beverage to flow to the dispensing unit **46**. To prevent the dispensing unit **46** from dispensing a beverage when no cup is present, the controller **64** may close the valve if the cup sensor **52** indicates that no cup is present in the cup-holder portion of the unit **44**. The controller **64** may also close the valve at other times as described below in conjunction with **FIGS. 13 – 18**.

[38] The beverage-brewing unit **50** receives heated water from the measuring-and-transporting unit **40**, receives ground coffee from the grind-transporting unit **54**, brews coffee, and then provides the brewed coffee to the beverage-dispensing unit **46** via the beverage-transporting unit **48**. The brewing unit **50** is further described below in conjunction with **FIGS. 4 – 8** and **13 – 18**.

[39] As discussed above, the cup-sensing unit **52** indicates to the controller **64** whether a cup (not shown in **FIG. 3**) is present in the cup holder **44**. If the cup is not present after the brewing unit **50** has brewed coffee, then the controller **64** may deactivate the beverage-transporting unit **48** to prevent the beverage-dispensing unit **46** from dispensing brewed

coffee directly into the drain portion of the drain unit **44**. Alternatively, if the cup is present during a cleaning cycle, then the controller **64** may deactivate the beverage-transporting unit **48** to prevent cleaning solution from entering the cup. The cup-sensing unit **52** may include any type of sensor, such as
5 an optical, mechanical, or ultrasonic sensor.

[40] The grind-transporting unit **54** may include one or more electronically controllable valves, which, in response to the controller **64**, route ground coffee from the grinding-and-measuring unit **60** to either the brewing unit **50** or to the solid-waste-disposal unit **56**. The controller **64**
10 may cause the unit **54** to route ground coffee to the disposal unit **56** when one wishes to “grind through” the remaining coffee beans in a hopper (not shown in **FIG. 3**) of the hopper unit **58** before filling the hopper with new coffee beans. Such grinding through may prevent cross contamination between different types of coffee beans.

15 [41] The solid-waste disposal unit **56** receives “ground through” coffee from the grind-transporting unit **54** per the preceding paragraph, and receives spent coffee grounds and disposable filters (if used) from the brewing unit **50** as discussed below. The disposal unit **56** may include a receptacle that one periodically removes for emptying, or that is connected
20 to an electronic garbage disposer or directly to the sewer line of the establishment in which the machine **30** is installed. In addition, the solid-waste-disposal unit **56** may be connected to receive tap water, and may use the tap water to flush “ground-through” and spent coffee from the disposal unit into the garbage disposer unit or directly into the sewer line. The
25 disposal unit **56** may periodically commence an automatic flushing sequence, e.g., after brewing each cup of coffee. Or, one may commence the flushing sequence manually.

[42] The hopper unit **58** includes one or more hoppers for holding coffee beans (neither shown in **FIG. 3**), which are gravity fed to the grinding-
30 and-measuring unit **60**. Where the hopper unit **58** includes multiple

hoppers, then one can load different types of coffee beans into each hopper, thus providing the coffee drinker with a selection of coffees. In one implementation, each hopper can hold slightly more than one pound of coffee beans, e.g., 1¼ pounds. Because coffee beans typically come in
5 one-pound containers, a hopper having a greater-than-one-pound capacity allows one to refill the hopper with a whole container of coffee beans before the hopper is completely empty.

[43] In response to the controller **64**, the grinding-and-measuring unit **60** grinds coffee beans (not shown in **FIG. 3**) from the hopper unit **50**,
10 and then provides to the grind-transporting unit **54** a predetermined amount of ground coffee. In one implementation, the grinding-and-measuring unit **60** continually indicates to the controller **64** the rate at which the unit is generating ground coffee, and the controller keeps track of the cumulative amount of ground coffee generated. When the cumulative amount of
15 ground coffee equals a predetermined amount, then the controller **64** deactivates the unit **60**. Techniques for indicating the rate at which the unit **60** generates ground coffee and other techniques for measuring the ground coffee are discussed below in conjunction with **FIGS. 9 – 12**. Furthermore, the unit **60** may allow one to select, via the controller **64**, one of multiple
20 grind sizes (e.g., coarse, normal, fine), as the grind size may affect the taste and other characteristics of the brewed coffee.

[44] The barrier **62** separates the controller **64** 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
25 condense and damage or otherwise render inoperable the controller **64**. Furthermore, condensation on the conduits that carry cold tap water may cause similar problems. Therefore, a moisture barrier **62** helps keep the controller **64** and associated circuitry dry.

[45] The controller **64** controls the operation of some or all of the
30 other components of the brewing machine **30** as discussed above, and

includes a processor **66**, a memory **68**, a control panel and display **70**, and a communications port **72**.

[46] The processor **66** executes a software program stored in the memory **68** or in another memory (not shown), and controls the operations
5 of the components of the machine **30** as described above and as described below.

[47] In addition to storing one or more software programs, the memory **68** may store sets of predetermined brew parameters as discussed below in conjunction with **FIGS. 13 – 18**, and may provide working memory
10 for the processor **66**.

[48] The control panel and display **70** allows an operator (not shown in **FIG. 3**) to enter brewing options (e.g., coffee type, cup size, and brewing parameters) or to select brewing options from a menu that the processor **66** may generate on the display. For example, the operator may select via the
15 control panel and display **66** individual brewing parameters (e.g., grind size, water temperature, brewing time, and the coffee-ground-to-water ratio), or a set of predetermined brewing parameters stored in the memory **68**. As an example of the latter, a coffee roaster may have determined preferred brewing parameters for its coffee. One may then store these preferred
20 parameters in the memory **68** 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 **64** causes the machine **30** to brew coffee according to the
25 set of parameters corresponding to the identifier.

[49] The communications port **72** allows the processor **66**, memory **68**, and control panel and display **70** to communicate with one or more devices external to the machine **30**. For example, the port **72** 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 **72** may be connected to the internet, so that one can download into the memory **68** data such as sets of brewing parameters from coffee roasters or suppliers. In addition, the port **72** 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 **72** may allow the processor **66** to download 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**.

[50] Still referring to **FIG. 3**, alternate embodiments of the machine **30** are contemplated. For example, 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.

[51] **FIG. 4** is a cut-away side view of the beverage-brewing unit **50** of **FIG. 3** according to an embodiment of the invention. As discussed above in conjunction with **FIG. 3**, the brewing unit **50** allows the machine **30** to brew coffee according to a modified French press technique.

[52] The beverage-brewing unit **50** includes a brewing chamber **80** having a top opening **82** and a side wall **84** and disposed in a chamber block **86** having a top surface **88**, a piston **90** disposed within the chamber and having a top surface **92** and side **94**, a motor **96** for driving the piston, and a filter and wiper shuttle assembly **98**. The shuttle assembly **98** is illustrated in a disengaged position in which it is not sealing the opening **82**. In a closed position (not illustrated in **FIG. 4**), the shuttle assembly **98** covers and seals the opening **82** while coffee brews in the chamber **80**.

[53] The brewing chamber **80**, which may be cylindrical, holds the ground coffee and water (neither shown in **FIG. 4**) while the coffee brews.

One may design the shape and other features of the chamber **80** to promote agitation of the water-and-ground-coffee mixture as discussed below.

[54] The piston **90** is the same shape as the brewing chamber **80**, the side **94** of the piston forms a water-tight seal with side wall **84** of the brewing chamber, and the motor **96** moves the piston up and down within the chamber. The motor **96**, which is responsive to the controller **64** (**FIG. 3**), may be any motor, such as a stepper motor, suitable to drive the piston **90**, and may include a sensor, such as one or more limit switches, that indicates to the controller the position, speed, and traveling direction of the piston.

[55] The shuttle assembly **98** includes an inlet **100**, a nozzle **102**, separator ribs **104**, a filter **106**, an outlet **108**, and a wiper **110**. A shuttle-assembly driver (not shown in **FIG. 4** but described below in conjunction with **FIGS. 7A – 7C**) moves the shuttle assembly **98** across the chamber opening **82**, and causes the shuttle assembly to seal the chamber opening while coffee is brewing in the chamber **80**.

[56] The inlet **100** is a conduit that routes hot water or cleaning solution from the water-measuring-and-transporting unit **40** (**FIG. 3**) to the nozzle **102**.

[57] The nozzle **102** directs the water from the inlet **100** in a spray pattern to agitate the mixture of the water and the ground coffee (not shown in **FIG. 4**) within the chamber **80** so that the coffee grounds are more thoroughly wetted. For example, the nozzle **102** may create a pattern that causes the mixture of water and coffee grounds within the chamber **80** to swirl around as if one were stirring the mixture. Moreover, the water-measuring-and-transporting unit **40** (**FIG. 3**) may include a pump or other device that can, in response to the controller **64** (**FIG. 3**), impart a predetermined pressure to the water in the inlet **100** to increase the agitation of the water-and-coffee-ground mixture. The nozzle **102** may also

hold the filter **106** in place as discussed below in conjunction with **FIG. 5**. Furthermore, the nozzle **102** may be positioned such that it is in the center of the chamber opening **82** when the shuttle assembly covers the brewing chamber **80**, or may be positioned in any non-centered location. Moreover, the nozzle **102** may cause the water to enter the chamber at an angle to promote agitation of the water-and-coffee-ground mixture as discussed above.

[58] The separator ribs **104** create a space **112** between the filter **106** and a bottom surface **114** of the shuttle assembly **98** to facilitate the flow of brewed coffee from the chamber **80** to the outlet **108**. The ribs **104** may be attached to or integral with either the filter **106** or the bottom surface **114**.

[59] The filter **106** effectively separates spent coffee grounds from brewed coffee. After the coffee brews in the chamber **80**, the motor **96** extends the piston **90** upward at a controlled speed to force the brewed coffee through the filter **106**, into the space **112**, and to the beverage-transporting unit **48** (**FIG. 3**) via the outlet **108**. Although the filter **106** passes liquid (in this case brewed coffee), it does not pass solids (in this case coffee grounds) having a grain size greater than a predetermined diameter. Therefore, the filter **106** retains the coffee grounds in the chamber **80** so that the grounds do not contaminate the dispensed brewed coffee.

[60] The wiper **110** transports the spent coffee grounds from the brewing unit **50** into the solid-waste disposal unit **56** (**FIG. 3**). Specifically, after the piston **90** extends to force the brewed coffee out of the chamber **80** as discussed in the preceding paragraph, the controller **64** (**FIG. 3**) causes the shuttle-assembly driver (not shown in **FIG. 4**) to raise the shuttle assembly **98** a predetermined distance so that the bottom edge of the wiper **110** is substantially even with the surface **88** of the chamber block **86**. Next,

the controller **64** causes the motor **96** to further extend the piston **90** until the surface **92** of the piston is substantially coplanar with the surface **88**. Then, the controller **64** causes the shuttle-assembly driver to move the shuttle assembly **98** in a direction (here to the right of **FIG. 4**) that is

5 substantially perpendicular to the direction in which the piston **90** moves such that the wiper **110** sweeps the spent coffee grounds from the piston surface **92**, onto the surface **88**, and into the solid-waste-disposal unit **56** (**FIG. 3**). As discussed below in conjunction with **FIGS. 7A – 7C**, the brewing unit **50** may also include a cleaning assembly for cleaning the wiper

10 **110** and the filter **106**.

[61] To provide a more precise control of the brewing temperature, the brewing unit **50** may include a temperature sensor and a heating/cooling mechanism (neither shown in **FIG. 4**). The heating/cooling mechanism may be, e.g., electric or gas. Alternatively, the heating/cooling mechanism may

15 include a water jacket that is disposed along the side wall **84** of the chamber **80**, or on the outside of the chamber block **86**. To heat the water-and-ground-coffee mixture with the chamber **80**, the machine **30** (**FIG. 3**) fills the jacket with hot water from the reservoir **36** (**FIG. 3**) or from another source; similarly, to cool the mixture the machine **30** fills the jacket with cold water

20 from the filter **32** or directly from the tap. Using the temperature sensor, the controller **64** may implement closed-loop control of the brewing temperature by regulating the flow of water through the jacket.

[62] **FIG. 5** is a perspective view of the shuttle assembly **98** of **FIG. 4** according to an embodiment of the invention where the brewing chamber

25 **80** of **FIG. 4** is cylindrical.

[63] The filter **106** may be a screen made of metal or of another suitable material, may be made from a cloth or from paper, or may be a combination of a screen to filter larger coffee grounds and cloth/paper to filter smaller coffee grounds. The filter **106** and space **112** are the same

shape as the chamber opening **82**. Furthermore, the filter **106** may be flat, or may be slightly concave with an inner curvature facing the chamber **80**.

[64] The separating ribs **104** are arranged to form a manifold. That is, the ribs **104** are arranged so that they direct brewed coffee flowing from
5 the chamber **80** through the filter **106** into the outlet **108**.

[65] The inlet **100** and nozzle **102** are threaded so that one can screw the nozzle into the inlet; and, as discussed above in conjunction with **FIG. 4**, the nozzle secures the filter **106** when the nozzle is screwed into the inlet.

10 [66] In addition to the inlet **100**, the nozzle **102**, the ribs **104**, the filter **106**, the outlet **108**, and the wiper **110**, the shuttle assembly **98** includes a gasket **120**, upper and lower portions **122** and **124**, linkage members **126** and **128**, which connect the upper and lower portions, and track guides **130**, **132**, **134**, **135**, and **137** (the counterparts to the guides
15 **134**, **135**, and **137** are not present in **FIG. 5**).

[67] Referring to **FIGS. 4** and **5**, the gasket **120** forms a water-tight face seal around the perimeter of the chamber opening **82** while the water-measuring-and-transporting unit **40** introduces water into the brew chamber **80**, while the coffee brews, and while the piston **90** (**FIG. 4**) extends to
20 dispense the brewed coffee. Alternatively, the shuttle assembly **98** may be designed to make a bore seal with the chamber opening **82**.

[68] The upper and lower portions **122** and **124**, the linkage members **126** and **128**, and the track guides **130**, **132**, **134**, **135**, and **137** are further described below in conjunction with **FIGS. 6A** and **6B**.

25 [69] **FIG. 6A** is a cut-away side view of the brewing unit **50** and the shuttle assembly **98** disengaged from the brewing unit according to an embodiment of the invention. While disengaged, the lower portion **122** of the shuttle assembly **98** is raised substantially the thickness of the wiper **110** above the surface **88** of the chamber block **86** such that the gasket **120**

(**FIG. 5**) is spaced from the surface of the chamber block, and thus does not seal the chamber opening **82**. Consequently, the wiper **110** can sweep the spent coffee grounds (not shown in **FIG. 6A**) off of the piston **90** as discussed above in conjunction with **FIG. 4**. The upper track guides including guides **130**, **132**, and **134** (**FIG. 5**) engage an upper track **136**, and the lower track guides including guides **135** and **137** engage a lower track **138**. The upper and lower tracks **136** and **138** are part of a shuttle-assembly drive, which is further described below in conjunction with **FIGS. 7A – 7C**. The upper guides **130**, and **132**, and **134** allow the upper portion **122** of the shuttle assembly **98** to move back and forth along the upper track **136**, and the lower guides **135** and **137** allow the lower portion **124** of the shuttle assembly to move back and forth along the lower track **138**. Furthermore, while the shuttle assembly **98** is disengaged from the brewing unit **50**, the linkage members **126** and **128** make an acute angle relative to the upper track **136**.

[70] **FIG. 6B** is a cut-away side view of the brewing unit **50** and the shuttle assembly **98** engaged with the brewing unit **50** according to an embodiment of the invention. In this position, the lower track guides including the guides **135** and **137** engage vertical portions **140** and **142** of the lower track **138**, and force the lower portion **122** of the shuttle assembly **98** against the surface **88** of the chamber block **86** such that the gasket **120** (**FIG. 5**) seals the chamber opening **82**.

[71] Referring to **FIGS. 6A** and **6B**, the operation of the shuttle assembly **98** is described according to an embodiment of the invention.

[72] After the grind-transporting unit **54** (**FIG. 3**) loads ground coffee into the chamber **80** via the opening **82**, the shuttle assembly **98** moves leftward from its position in **FIG. 6A**.

[73] When the lower track guides **135**, **137**, etc. respectively engage the vertical portions **140** and **142**, the linkage members straighten, and thus

force the lower portion **122** of the shuttle assembly **98** toward and against the surface **88** such that the gasket **120** (**FIG. 5**) seals the brewing chamber **80**.

[74] After the coffee brews, the piston **90** (**FIG. 4**) extends to
5 dispense the brewed coffee from the chamber **80**. Because the tracks **136** and **138** compose an over-the-center-toggle configuration, the pressure generated against the lower portion **22** by the piston **90** forces the shuttle assembly **98** to the left. But because the shuttle assembly **98** can travel little or no distance to the left, the shuttle assembly remains in the engaged
10 position of **FIG. 6B**. Therefore, the tracks **136** and **138** implement a stable seal, because even in the absence of force on the shuttle assembly **98** in the leftward direction, pressure within the chamber **80** will reinforce the seal, and will not cause the seal to “blow” by forcing the shuttle assembly **98** rightward.

15 [75] After the piston **90** dispenses the brewed coffee, the shuttle assembly **98** moves rightward from its position in **FIG. 6B**. As the shuttle assembly **98** moves rightward, the lower track guides **135**, **137**, etc. disengage the vertical portions **140** and **142** such that the lower portion **122** of the shuttle assembly **98** moves upward and away from the surface **86**.
20 Vertically engaging and disengaging the chamber opening **82** may significantly extend the life of the gasket and other components that form the seal with the chamber opening of the chamber.

[76] Next, the piston **90** (**FIG. 4**) extends further until the piston surface **92** (**FIG. 4**) is substantially coplanar with the surface **86**. While the
25 piston **90** is extending further, the shuttle assembly **98** may temporarily halt its rightward movement.

[77] Then, as the shuttle assembly **98** continues moving rightward, the wiper **110** wipes the used coffee grounds (not shown in **FIGS. 6A** and

6B) off of the piston surface **92** and into the solid-waste-disposal unit **56** (**FIG. 3**).

[78] After the wiper **110** moves past the edge of the surface **88**, the shuttle assembly **98** stops, and remains in this “home” position (not shown in **FIGS. 6A** and **6B**) until the brewing chamber **80** brews another cup of coffee, at which time the shuttle assembly repeats the above-described sequence.

[79] **FIG. 7A** is side view of a portion of the brewing unit **50**, the shuttle assembly **98** in a first disengaged position, and a shuttle-assembly drive **150** according to an embodiment of the invention.

[80] The shuttle-assembly drive **150** may include a drive belt **152**, drive gears **154** and **156**, an attachment member **158**, a solenoid plunger **160**, and a cleaning assembly **162**, which includes a scraper **164**, optional water jets (not shown in **FIG. 7A**), and pivots **166** (only one shown in **FIG. 7A**). The plunger **160** is operable to engage and disengage the cleaning assembly **162** as described below in conjunction with **FIGS. 7A – 8**.

[81] The member **158** attaches the shuttle assembly **98** to the belt **152**, and the drive gears **154** and **156** turn clockwise to move the shuttle assembly to the left, and turn counterclockwise to move the shuttle assembly to the right. The shuttle-assembly drive **150** may also include one or more stops (not shown) to limit the distance that the shuttle assembly **98** can move in the left or right directions. In one implementation, the ends of the tracks **136** and **138** (**FIGS. 6A – 6B**) provide such stops.

[82] **FIGS. 7B** and **7C** show rightward movement of the shuttle assembly **98** relative to the shuttle assembly’s position in **FIG. 7A** according to an embodiment of the invention.

[83] **FIG. 8** is an isometric view of the cleaning assembly **162** of **FIGS. 7A – 7C** according to an embodiment of the invention. The scraper **164** may be made out of metal, rubber, or any other suitable material, and is

disposed over the solid waste disposal unit **56** (**FIG. 3**). And if the filter **106** (**FIGS. 4 – 7C**) is concave, the scraper **164** has the same contour so that it can contact the filter across its entire diameter. In addition to the scraper **164** and the pivots **166**, the cleaning assembly **162** may include water jets **168**, which are adjacent to the scraper. Although not shown, the water-measuring-and-transporting unit **40** (**FIG. 3**) may feed to the jets **168** heated water from the reservoir **36** (**FIG. 3**), or may feed to the jets heated water from the reservoir mixed with cleaning solution from the cleaner-dispensing unit **34** (**FIG. 3**). Flexible tubing or another type of conduit may connect the water-measuring-and-transporting unit **40** to the water jets **168**. Alternatively, the water jets **168** may be fed directly from the tap-water inlet (**FIG. 3**) or from another water or cleaning-solution source.

[84] Referring to **FIGS. 7A – 8**, the operation of the cleaning assembly **162** is described according to an embodiment of the invention.

15 [85] The scraper **164** and water (or cleaning solution) discharged from the water jets **168** clean the filter **106** and the wiper **110**.

[86] As discussed above in conjunction with **FIGS. 6A – 6B** and as shown in **FIG. 7A**, after the brewing unit **50** brews coffee, the shuttle-assembly drive **150** moves the shuttle assembly **98** upward and to the right such that the wiper **110** begins sweeping the spent coffee grounds from the surface **92** of the piston **90** into the solid-waste-disposal unit **56**.

[87] In addition, the controller **64** (**FIG. 3**) extends the plunger **160** toward the brewing unit **50** to rotate the cleaning assembly **162** about the pivots **166** such that the top edge of the scraper **164** is substantially coplanar with the underside of the filter **106**. The solenoid plunger may be designed to extend no further than the desired position, or a sensor (not shown) may indicate to the controller **64** when the scraper **164** is in the desired position. Alternatively, the plunger may not be a solenoid plunger,

but may instead be a spring-loaded plunger that forces the cleaning assembly **162** into the proper position.

[88] Referring to **FIG. 7B**, as the shuttle assembly **98** continues to move rightward, the scraper **164** contacts the underside of the filter **106** and dislodges spent coffee grounds and, if present, other residue (neither shown in **FIGS. 7A – 7C**) that stuck to the underside of the filter as the piston **90** was forcing brewed coffee through the filter. Water (or cleaning solution) discharged from the jets **168** facilitates the dislodging of the spent coffee grounds and residue from the filter **106**, and, depending on the jets' spray pattern, may also keep the scraper **164** free of coffee grounds and other residue. Because the scraper **164** and jets **168** are positioned over the solid-waste-disposal unit **56** (**FIG. 3**), the dirty water, dislodged coffee grounds, and other residue fall into the disposal unit. And if the filter **106** includes a disposable cloth or paper portion on its underside, then the scraper **164** may also remove this portion such that it falls into the disposal unit **56** along with the spent coffee grounds and other residue.

[89] Referring to **FIG. 7C**, after the filter **106** moves over the scraper **164**, the wiper **110** moves over the scraper, which contacts the bottom of the wiper. The scraper **164**, together with water (or cleaning solution) discharged from the jets **168**, dislodges spent coffee grounds and, if present, other residue stuck to the wiper. As discussed above, because the scraper **164** and the jets **168** are positioned over the solid-waste-disposal unit **56** (**FIG. 3**), the coffee grounds and other residue dislodged from the wiper **110** fall into the disposal unit. After the wiper **110** moves rightward past the scraper **164**, the jets **168** may continue to discharge water to dislodge coffee grounds, and, if present, other residue from the scraper, such that the dirty water and dislodged material fall into the solid-waste-disposal unit **56**.

[90] **FIG. 9** is a block diagram of the grinding-and-measuring unit **60** of **FIG. 3** according to an embodiment of the invention.

[91] The grinding-and-measuring unit **60** includes an electric motor **170** that is powered by a supply voltage **V** and that is responsive the
5 controller **64** (**FIG. 3**), a shaft **172**, a grinder **174**, and a discharge port **176**. The grinding-and-measuring unit may also include a current sensor **178** or a temperature sensor **180**.

[92] The motor **170** drives the grinder **174** via the shaft **172** in response to the controller **64** (**FIG. 3**).

10 [93] The grinder **174** may be any suitable device for grinding coffee beans or another substance from which a beverage may be brewed.

[94] The discharge port **176** provides the ground coffee from the grinder **174** to the grind-transporting unit **54** (**FIG. 3**), or directly to the beverage-brewing unit **50** (**FIG. 3**) if the brewing machine **30** (**FIG. 3**) lacks
15 the grind-transporting unit.

[95] The current sensor **178** generates and provides to the controller **64** (**FIG. 3**) a signal that indicates the amount of current that the motor **172** draws, and the temperature sensor **180** generates and provides to the controller a signal that indicates the temperature of the motor.

20 [96] In operation, the controller **64** (**FIG. 3**) determines that the amount of ground coffee discharged from the port **176** equals the product of the grind rate of the grinder **174** — the grind rate may be stored in the controller memory **68** — and amount of time that the motor **170** is “on”. Because the instantaneous grind rate of the grinder **174** may depend on the
25 amount of material that the grinder is grinding, and thus discharging through the port **176**, at that instant, the controller **64** may also base the ground-coffee measurement on the current that the motor **170** draws, on the temperature of the motor, or both the current drawn and the temperature. At any one instant, the load on the motor **170** is proportional to the amount

of ground coffee that the grinder **176** discharges through the port **176**, and the current that the motor draws is proportional to the load. Therefore, the higher that rate at which the grinder **174** discharges ground coffee through the port **176**, the higher the load on the motor **170**, and thus the higher the current that the motor draws. Furthermore, the grind rate is proportional to the motor efficiency, which is typically inversely proportional to the motor temperature. Therefore, the higher the temperature of the motor **170**, the smaller the amount of ground coffee that the grinder **174** is discharging through the port **176**. Consequently, the controller **64** can measure the amount of coffee discharged from the port **176** by monitoring the signals from the current and temperature sensors **178** and **180** and applying an algorithm that relates the values of these signals to the rate at which the grinder **174** discharges ground coffee through the port **176**. Alternatively, the grinding and measuring unit **60** may omit one or both of the current and temperature sensors **178** and **180**, and the controller **64** may measure the amount of ground coffee discharged from the port **176** by monitoring only the signal from the included one of the current and temperature sensors (if one is included).

[97] When the controller **64** (**FIG. 3**) determines that the grinder **174** has generated and discharged through the port **176** a predetermined amount of ground coffee, the controller deactivates the motor **170**.

[98] **FIG. 10** is a side view with portions broken away of a ground-coffee measuring assembly **190** of the grinding-and-measuring unit **60** of **FIG. 3** according to another embodiment of the invention, where like numbers reference components common to **FIGS. 9 – 10**. The assembly **190** can replace or supplement the controller's calculation of the amount of ground coffee discharged via the discharge port **176** based on the grind rate of the grinder **174** (**FIG. 9**) and the signals from none, one, or both of the current and temperature sensors **178** and **180** of **FIG. 3**, and is disposed

within the discharge port. Alternatively, the assembly **190** may be disposed in another suitable location within the grinding-and-measuring unit **60**.

[99] The assembly **190** includes a motor **192**, a speed sensor **194**, a shaft **196**, and a disk **198** having an upper surface **200**.

5 [100] The motor **192** is an electric or other suitable motor that is separate from the grinder motor **170** (**FIG. 9**) and that spins the shaft **196** and the disk **198** at a substantially constant speed when the disk is able to rotate freely, *i.e.*, when nothing, such as ground coffee, impedes the rotation of the disk.

10 [101] The speed sensor **194** generates a signal that indicates the rotational speed of the disk **198**, and provides this signal to the controller **64** (**FIG. 3**).

[102] The disk **198** is substantially flat, relatively lightweight, and is formed from plastic or another suitable material. Furthermore, the disk **198**
15 may have holes (not shown in **FIG. 10**) sufficiently wide to pass coffee grounds.

[103] In operation, the controller **64** (**FIG. 3**) measures the amount of ground coffee (indicated by the arrows) discharged from the port **176** based on the rotational speed of the disk **198**. As ground coffee (indicated by the
20 arrows) flows from the coffee grinder **174** (**FIG. 9**) to the port **176**, the ground coffee collects on the upper surface **200** of the disk **198** before flowing over the sides (through the holes) of the disk and through the port as indicated by the arrows. Because the ground coffee collected on the
surface **200** has a mass, it effectively changes the disk's rotational moment
25 of inertia by an amount proportional to the mass of collected coffee. This change in the disk's moment of inertia changes the speed at which the disk **198** spins by an amount proportional to the change in the moment of inertia. The controller **64** monitors the speed of the disk **198** via the signal generated by the sensor **194**. Consequently, by integrating the speed of the

disk **198** with respect to time, the controller **64** can use an algorithm that relates the integrated disk speed to the amount of ground coffee that collects on the disk surface **200** over time to determine the amount of ground coffee discharged from the port **176**.

5 **[104]** Furthermore, the controller **64** (**FIG. 3**) may use any of the above-described measuring techniques to “learn” a more accurate algorithm for determining the amount of ground coffee based on grind rate of the grinder **174** (**FIG. 9**). That is, the controller can calculate the amount of ground coffee that the grinder **174** generates in two ways: 1) based on a
10 predetermined grind rate multiplied by the “on” time of the grind motor **170** (**FIG. 9**) and none, one, or both of the motor temperature and current draw as described above in conjunction with **FIG. 9**; and, 2) using the disk **198**. Because the second calculation may be more accurate than the first, the controller **64** compares the results yielded by both calculations, and then
15 adjusts the algorithm for the first calculation so that it yields a new result that is closer or equal to the result yielded by the second calculation. This “learning”, which the controller **64** may accomplish using known neural-network or other techniques, may allow the controller **64** to accurately measure the amount of discharged ground coffee if, e.g., the assembly **190**
20 fails.

[105] When the controller **64** (**FIG. 3**) determines that the port **176** has discharged a predetermined amount of ground coffee, the controller deactivates the grinder motor **170** (**FIG. 3**) and the motor **192**.

[106] **FIG. 11** is a side view with portions broken away of a
25 ground-coffee measuring assembly **210** of the grinding-and-measuring unit **60** of **FIG. 3** according to another embodiment of the invention, where like numbers are used to reference components common to **FIGS. 9 – 11**. The assembly **210** can replace or supplement the controller’s calculation of the amount of ground coffee discharged via the port **176** based on the grind rate

of the grinder **174** (**FIG. 9**) and the signals from none, one, or both of the current and temperature sensors **178** and **180** of **FIG. 9**; and, like the assembly **190** of **FIG. 10**, the assembly **210** is disposed within the discharge port **176**. Alternatively, the assembly **210** may be disposed in another
5 suitable location within the grinding-and-measuring unit **60**.

[107] The assembly **210** includes an emitter **212** and a sensor **214**. The emitter **212** emits a beam **216** of electromagnetic energy such as light to the sensor **214**, which detects the intensity of the beam, generates a signal that indicates the intensity of the beam, and provides this signal to the
10 controller **64** (**FIG. 3**). For example, the emitter **212** may be a light-emitting diode (LED), or a laser diode, and the sensor **214** may be a photo detector.

[108] In operation, the controller **64** (**FIG. 3**) measures the amount of ground coffee discharged from the port **176** based on the intensity of the beam **216** detected by the sensor **214**. As ground coffee (indicated by the
15 arrows) flows from the coffee grinder **174** (**FIG. 9**) to the port **176**, at least some of the ground coffee passes through the beam **216**. The more ground coffee passing through the beam **216** at any instant, the smaller the portion of the beam that strikes the sensor **214**, and thus the lower the beam intensity detected by the sensor. The controller **64** monitors the intensity of
20 the beam **216** via the signal generated by the sensor **214**. Consequently, by integrating the intensity of the beam **216** with respect to time, the controller **64** can use an algorithm that relates the integrated intensity to the amount of ground coffee that passes through the beam over time to determine the amount of ground coffee discharged from the port **176**.

25 [109] Furthermore, the controller **64** may use the above-described measuring technique to “learn” a more accurate algorithm for determining the amount of ground coffee based on the grind rate of the grinder **174** (**FIG. 9**) as described above in conjunction with **FIG. 10**.

[110] When the controller **64** (**FIG. 3**) determines that the port **176** has discharged a predetermined amount of ground coffee, the controller deactivates the grinding motor **170** (**FIG. 3**).

[111] Moreover, in another implementation of the assembly **210**, the emitter **212** is replaced with a combination emitter and detector, and the sensor **214** is replaced with a reflector. Therefore, the emitter/detector **212** emits the beam **216**, the reflector **214** reflects the beam, and the emitter/detector detects the intensity of the reflected beam. The controller **64** (**FIG. 3**) measures the amount of ground coffee discharged through the port **176** based on the intensity of the reflected beam as described above.

[112] **FIG. 12** is a diagram of the beverage-brewing unit **50** and a ground-coffee measuring assembly **220** of the grinding and measuring unit **60** of **FIG. 3** according to another embodiment of the invention, where like numbers are used to reference components common to **FIGS. 9 – 12**. The assembly **220** can replace or supplement the controller's calculation of the amount of ground coffee discharged via the port **176** based on the grind rate of the grinder **174** (**FIG. 9**) and the signals from none, one, or both of the current and temperature sensors **178** and **180** of **FIG. 9**, and is disposed external to the discharge port **176**. Alternatively, the assembly **220** may be disposed in another suitable location within the grinding-and-measuring unit **60**. Furthermore, although for purposes of explanation the assembly **220** is shown transporting ground coffee directly to the brewing chamber **80**, the assembly **220** transports the ground coffee to the ground-transporting unit **54** (**FIG. 3**) where the brewing machine **30** (**FIG. 3**) includes the ground-transporting unit. Alternatively, the assembly **220** may compose all or part of the ground-transporting unit **54**.

[113] The assembly **220** includes a measuring, *i.e.*, dosing, cup **222**, a scale **224**, and a cup drive assembly (the operation of which is indicated by the dashed line in **FIG. 12**). The dosing cup **222** is kinematically

decoupled from the cup drive assembly when the cup is on the scale **224**.

“Kinematically decoupled” means that the drive assembly exerts no force on the cup **222**, so that the weight indicated by the scale **224** is not corrupted by the drive assembly.

5 **[114]** The dosing cup **222** receives ground coffee (represented by the solid line arrow) discharged from the port **176**, and the scale **224** weighs the ground coffee and the cup and provides to the controller **64** (**FIG. 3**) a signal that indicates this weight. Because the scale **224** may be sensitive to vibrations caused by the beverage-brewing machine **30** (**FIG. 3**) or present
10 in the environment in which the machine is located, the scale may weigh the ground coffee and cup multiple times, and the controller **64** may determine the weight of the ground coffee and cup to be the average of these multiple weights. For example, when the measured weight is close to the desired weight, the controller **64** may turn off the grinder motor **170** (**FIG. 9**) to
15 eliminate the vibrations therefrom, measure the weight of the cup **222** and coffee inside, and repeat this sequence until the desired amount of ground coffee is in the cup.

20 **[115]** The cup drive assembly (represented by the dashed line) moves the cup **222** from the scale **224** to the opening **82** of the brewing chamber **80**, and tips the cup such that the ground coffee falls from the cup into the brewing chamber. The drive assembly may also “bang” the cup **222** to dislodge into the brewing chamber **80** ground coffee that is stuck to the bottom or sides of the cup.

25 **[116]** In operation, the controller **64** (**FIG. 3**) determines from the signal (or multiple signals per above) generated by the scale **224** the weight of ground coffee discharged from the port **176**. Ground coffee (indicated by the arrows) exits the port **176** and enters the cup **222**. The scale **224** weighs the cup **222** and the ground coffee in the cup, and, as discussed above, generates one or more signals that each represent the combined
30 weight of the coffee and the cup. The controller **64** monitors the combined

weight of the coffee and the cup via the one or more signals generated by the scale **224**. From the combined weight of the ground coffee and the cup **222**, the controller **64** determines the weight of the coffee by subtracting from the combined weight the known weight of the cup, which may be
5 determined beforehand and stored in the memory **68** (**FIG. 3**). To prevent overfilling of the cup **222**, the controller **64** may stop the grinder motor **170** (**FIG. 9**) when the weight of the ground coffee in the cup is below the desired weight, and then weigh the coffee, pulse the motor, and repeat this sequence one or more times until the desired weight of ground coffee is in
10 the cup.

[117] When the controller **64** (**FIG. 3**) determines that the port **176** has discharged a predetermined weight of ground coffee into the cup **222**, the controller deactivates the grinding motor **170** (**FIG. 9**) and causes the cup drive assembly (represented by the dashed line) to dump the ground
15 coffee in the cup **222** into the brewing chamber **180**. Then the controller **64** causes the cup **222** to return to its "home" position on the scale **224**.

[118] **FIGS. 13 – 18** illustrate the operation of the beverage-brewing machine **30** of **FIG. 3** during a beverage-brewing cycle according to an embodiment of the invention, where like numbers reference components
20 common to **FIGS. 3 – 18**. For clarity of explanation, **FIGS. 13 – 18** omit some features discussed above in conjunction with **FIGS. 3 – 12**, it being understood that these features may be present even though they are not shown or discussed. For example, although **FIGS. 13 – 18** do not show the linkage members **126** and **128** and track guides **130**, **132**, **134**, **135**, and
25 **137**, (**FIGS. 5 – 7C**) of the shuttle assembly **98**, the shuttle assembly may include these linkage members and track guides. Furthermore, although it may not be explicitly stated, the controller **64** 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,
30 such as tea, may be the same as or similar to the described operation.

[119] Referring to **FIGS. 3** and **13 – 18**, the operation of the beverage brewing machine **30** during a beverage-brewing cycle is discussed according to an embodiment of the invention.

[120] Referring to **FIG. 13**, after a human operator (not shown in **FIGS. 3** and **13 – 18**) activates the machine **30** by, e.g., turning “on” a power switch (not shown in **FIGS. 3** and **13 – 18**), the machine **30** performs a self-check/initialization during which the piston **90** and shuttle assembly **98** move into respective “home” positions if they are not already in their respective home positions. For example, the piston **90** moves into a position where the piston surface **92** is substantially coplanar with the block surface **88**, and the shuttle assembly **98** moves into a position in which the opening **82** of the brew chamber **80** is partially or fully exposed. Alternatively, the piston **90** and shuttle assembly **98** may already be in their respective home positions from the last brew cycle, or may move into any other respective non-home positions that are suitable for starting the brew cycle.

[121] Next, the operator enters a coffee selection (if multiple coffees are available), a beverage size (e.g., 8 ounces, 16 ounces), and one or more brewing parameters (e.g., grind size, ground-coffee-to-water ratio, water temperature, and brew time) via the control panel **70**. For example, if the hopper unit **58** holds two or more roasts of coffee beans, then the operator may select a desired roast by name or by another identifier, such as the name or number of the hopper (not shown in **FIGS. 3** and **13 – 18**) holding the beans of the desired roast. Furthermore, 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., 8 ounces, 16 ounces). 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 **68** and associated with the identifier.

Alternatively, the present operator, another operator, or the machine **30** (via,

e.g., the internet or RFID tag) may have already entered the brewing parameters when the coffee beans were loaded into the hopper. 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 later is where the operator selects an "abstract" brew strength (e.g., weak, normal, strong) that the controller **64** converts into an actual coffee-to-water ratio in a pre-programmed manner. In addition, the machine **30** may, via the display **70**, remind the operator to place a cup in the cup holder **44**.

[122] Then, referring to **FIG. 14**, the piston **90** retracts a predetermined distance to leave enough room in the chamber **80** for receiving ground coffee **230**. Alternatively, if the home position of the piston **90** leaves sufficient room in the chamber **80**, then the piston need not retract.

[123] Next, the grinding-and-measuring unit **60** and, if present, the grind-transporting unit **54**, load the brewing chamber **80** with a predetermined amount of the ground coffee **230**. If the grinding-and-measuring unit **60** can provide different grind sizes (e.g., coarse, fine), then the unit generates the ground coffee **230** having the selected grind size. Alternatively, the unit **60** may provide different portions of the ground coffee **230** having different grind sizes. For example, the unit **60** may provide an intermediate grind consistency by finely grinding the first half of the ground coffee **230** and coarsely grinding the second half of the ground coffee. Furthermore, because the grind size may affect the grind rate of the grinder **174** (**FIG. 9**), the controller **64** may take into account the grind size when measuring the ground coffee **230**, particularly when using the (grind rate) x (grinding time) measuring technique described above in conjunction with **FIG. 9**.

[124] Referring to **FIG. 15**, after the grinding-and-measuring unit **60**, and, if present, the grind-transporting unit **54**, load the ground coffee **230** into the chamber **80**, the shuttle assembly **98** seals the opening **82** of the brewing chamber **80** as described above in conjunction with **FIGS. 6A – 6B**.

5 [125] While the grinding-and-measuring and grind-transporting units **60** and **54** are loading the ground coffee **230** into the chamber **80** and while the shuttle assembly **98** is sealing the chamber, 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
10 the water above the desired brewing temperature so that the water-temperature-control unit **38** can provide to the chamber **80** water at the desired brewing temperature by cooling 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
15 brewing temperature, and the temperature-control unit **38** is inactive or omitted. Either technique allows control of the brewing temperature from cup to cup.

[126] Next, the water-measuring-and-transporting unit **40** fills the sealed brewing chamber **80** with a desired amount of water **232** having the
20 desired brewing temperature via the nozzle **102**. In one example, the water-and-measuring unit **40** includes a pump that forces the desired amount of water **232** through the nozzle **102**. In another example, the water-measuring-and-transporting unit **40** lacks a pump, and the water **232** is gravity fed from the reservoir unit **36** to the nozzle **102** via the water-
25 measuring-and-transporting unit. In these two techniques, the beverage-transporting unit **48** may open the outlet **108** to allow air in the chamber **80** to escape via the outlet as the water **232** enters the chamber. In yet another example, the outlet **108** is closed and the piston **90** retracts to create a suction that draws the water **232** from the reservoir **36** into the
30 chamber **80** via the measuring-and-transporting unit **40** and the nozzle **102**.

In still another example, a combination of the pump and piston suction is used to fill the chamber **80** with water.

[127] Still referring to **FIG. 15**, techniques for measuring the water that the water-measuring-and-transporting unit **40** provides to the brewing chamber **80** are discussed. In one implementation, the unit **40** includes a solenoid pump, which pumps water at a highly consistent rate. Therefore, the controller **64** determines the amount of water that the unit **40** provides to the brewing chamber **80** as being equal to the product of the pump rate and the amount of time that the pump is active. Because the pump rate may vary with the pressure and temperature of the water from the temperature-control unit **38**, the temperature-control unit or the water-transporting unit **40** may include sensors to indicate the pressure and temperature of the water, and the controller **64** may take into account the pressure or temperature when measuring the amount of water **232** provided to the brewing chamber **80**.

[128] And in an implementation where the piston **90** draws in the water **232** by retracting, then the controller **64** may measure the amount of water that enters the chamber **80** by measuring the distance that the piston **90** retracts, and using an algorithm to relate the distance retracted to the amount of water drawn. Because the amount of water that the piston **90** draws into the chamber **80** may depend on the temperature of the water and the temperature and pressure of the gas in the chamber and in other parts of the machine **30**, the machine may include temperature and pressure sensors in these parts of the machine, and the controller **64** may take into account these temperatures and pressures when measuring the amount of water **232** drawn into the chamber.

[129] In still another example, the water **232** enters the chamber **80** or is measured using a combination or sub-combination of the above-described techniques.

[130] In a related implementation, the controller **64** adjusts the amount of water **232** introduced to the chamber **80** based on the amount of ground coffee **230** introduced to the chamber. This maintains the coffee-to-water ratio, which is one of the brewing parameters that significantly affects taste, more accurate from cup to cup. The error in the ground-coffee-to-water ratio is the sum of the water-measurement error and the coffee-measurement error. To reduce the ratio error, the controller **64** can adjust the amount of one of the ground coffee **230** and water **232** based on the measurement of the other. Because the water measurement is typically more accurate than the coffee measurement, the controller **64** adjusts the amount of water based on the measured amount of ground coffee **230** in the chamber **80**. For example, assume that the coffee-to-water ratio is 3 grams/ounce, so a 10-ounce cup of coffee calls for 30 grams of ground coffee and 10 ounces of water. However, suppose that the controller **64** determines that 33 grams of coffee were introduced into the chamber **80**. To maintain the 3/1 ratio, the controller **64** causes the water-measuring- and transportation unit **40** to introduce 11 ounces of water into the cylinder. The machine **30** can then discard one ounce of the brewed coffee via the liquid-waste disposal unit **42** as further described below in conjunction with the discussion of "silt" so that only the desired 10 ounces of coffee fill the operator's coffee cup (not shown in **FIGS. 3** and **13 – 18**). Although the coffee-to-water ratio may still be off due to errors in measuring the coffee **230** and water **232**, the ratio is typically more accurate than it would have been had the amount of water not been adjusted as described above. The controller **64** may use this technique when too little coffee **230** is in the chamber **80** by introducing less water into the chamber, although this will result in less than the selected amount of coffee in the operator's cup. Alternatively, the controller **64** may cause the grinder **174** (**FIG. 9**) to grind some additional coffee.

[131] Still referring to **FIG. 15**, after the desired amounts of ground coffee **230** and water **232** are in the chamber **80**, the machine **30** agitates the mixture of the ground coffee and the water to thoroughly wet the ground coffee. In one example, the spray pattern from the nozzle **102** performs this
5 agitation while the water **232** is entering the chamber **80**. To enhance the agitation, the water **232** may enter the chamber **80** in multiple bursts. In another example, a mechanical member (not shown in **FIGS. 3** and **13 – 17**) performs the agitation while the water **232** is entering the chamber **80**, after the water enters the chamber, or both while and after the water enters the
10 chamber. In yet another example, both the nozzle **102** and the mechanical member perform the agitation.

[132] Next, the mixture of the ground coffee **230** and the water **232** remains in the chamber **80** for the selected brewing time. During the brewing time, the brewing unit **50** may heat or cool the mixture within the
15 chamber **80** as discussed above in conjunction with **FIG. 4**.

[133] Then, the cup sensing unit **52** indicates whether a cup (not shown in **FIGS. 3** and **13 – 18**) is in the holder **44**. If a cup is not in the holder, then the controller **64** halts the brewing cycle, and may sound an audio or visual alarm, until the operator places a cup in the holder **44**. If a
20 cup is in the holder **44**, then the brewing cycle continues as described below.

[134] Referring to **FIG. 16**, after the brewing time has expired, the piston **90** extends to expel the brewed coffee **234** from the chamber **80** and into a coffee cup (not shown in **FIGS. 3** and **13 – 18**) in the cup holder **44**
25 via the beverage-transporting and -dispensing units **48** and **46**. The piston **90** forces the brewed coffee **234** through the filter **106**, into the space **112**, and through the outlet **108** to the beverage transporting unit **48**. In one implementation, the piston **90** extends in multiple steps to allow the spent coffee grounds **230** to settle on the surface **92** of the piston. In another

implementation, a pressure sensor (not shown in **FIGS. 3** and **13 – 18**) is located within the brewing chamber **80**, and the controller **64** controls the extension speed of the piston **90** in a closed-loop manner to maintain the pressure within the brewing chamber **80** at a desired level that prevents damage to, e.g., the filter **106** and the seal between the shuttle assembly **98** and the brewing chamber.

[135] Still referring to **FIG. 16**, sometimes “silt” or other undesirable debris (not shown in **FIGS. 3** and **13 – 18**) that are too fine to be retained in the brewing chamber **80** by the filter **106** float near or to the top of the brewed coffee **234**. To keep this debris out of the coffee cup (not shown in **FIGS. 3** and **13 – 18**), before the piston **90** begins to extend the beverage-transporting unit **48** closes and the water-transporting unit **40** opens. Therefore, as the piston **90** extends, a predetermined amount of the brewed coffee **234** including the debris is expelled into the liquid-disposal unit **42**. After the piston **90** expels the predetermined amount of brewed coffee **234** into the disposal unit **42**, the beverage-transporting unit **48** opens and the water-transporting unit **40** closes such that the extending piston expels the remaining, and substantially debris free, brewed coffee **234** to the beverage-dispensing unit **46**. The controller **64** may cause the piston **90** to expel the desired amount of brewed coffee **234** into the disposal unit **42** by measuring the distance that the piston extends, and using an algorithm to determine the amount of brewed coffee expelled based on the distance that the piston extends (this algorithm may be the same as or similar to the one used to determine the amount of water drawn into the chamber **80** by the retracting piston **90** as described above). Furthermore, the controller **64** may introduce additional ground coffee **230** and water **232** into the chamber **80** to compensate for the debris-removal step. For example, if the operator wants an 8 ounce cup of coffee brewed with 24 grams of ground coffee (a 3 gram to 1 ounce ratio), then the controller **64** may introduce 27 grams of ground coffee **230** and 9 ounces of water **232** into the chamber **80**. This

maintains the desired coffee-to-water ratio and cup size while allowing the piston **90** to expel 1 ounce of debris-ridden brewed coffee **234** into the liquid-waste disposal unit **42**.

[136] Referring to **FIG. 17**, the piston **90** stops extending and
5 expelling the brewed coffee **234** (not shown in **FIG. 17**) when the piston
surface **92** is a predetermined distance below the block surface **88**. This
predetermined distance is sufficient to prevent the spent coffee grounds **234**
from pressing against the filter **106** with a force sufficient to damage the
filter, the seal between the chamber **80** and the shuttle assembly **98**, or
10 other components of the shuttle assembly.

[137] Then, the controller **64** may indicate to the operator via the
display **70** or other indicator (not shown in **FIGS. 3** and **13 – 18**) that he may
remove the coffee-filled cup (not shown in **FIGS. 3** and **13 – 18**) from the
cup holder **44**.

15 [138] Referring to **FIG. 18**, the shuttle assembly **98** next moves
upward and away from the chamber **80**, and the piston **90** extends until the
piston surface **92** is substantially coplanar with the block surface **88**.

[139] Next, the shuttle assembly **98** moves rightward such that the
wiper **110** sweeps the spent coffee grounds **230** from the piston **90** and into
20 the solid waste disposal unit **56**.

[140] Still referring to **FIGS. 3** and **13 – 18**, 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
25 described as being performed at different times may be performed
concurrently. Furthermore, some of the steps may be omitted.

[141] Referring to **FIGS. 3** and **16**, the operation of the beverage-
brewing machine **30** during a cleaning cycle is described according to an
embodiment of the invention. Although not specifically discussed, some or

all of the techniques discussed above in conjunction with the brewing cycle of **FIGS. 13 – 18** may perform or be modified to perform the same or similar functions during the cleaning cycle.

5 [142] After an operator (not shown in **FIGS. 3** and **16**) activates the machine **30** by, e.g., turning “on” a power switch (not shown in **FIGS. 3** and **16**), he may initiate a cleaning cycle via the control panel **70**, or the machine may initiate the cleaning cycle automatically. For example, the machine **30** may automatically initiate the cleaning cycle at a predetermined time each day.

10 [143] Next, the shuttle assembly **98** seals the brewing chamber **80**.

[144] While the shuttle assembly **98** is sealing the chamber **80**, the water reservoir and heating unit **36** heats 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 cleaning temperature so that
15 the water temperature control unit **38** can provide to the chamber **80** water at the desired cleaning temperature by cooling the heated water with cold tap water. In another example, the reservoir-and-heating unit **36** heats the water to the cleaning temperature, and the temperature-control unit **38** is inactive or omitted.

20 [145] Then, the water-and-cleaner-measuring-and-transporting unit **40** fills the sealed brewing chamber **80** via the nozzle **102** with a mixture comprising a predetermined amount of water and cleaning solution (e.g., vinegar) from the cleaner dispensing unit **34**. The unit **40** may measure the mixture using the same techniques and components used to measure the
25 water during a brewing cycle as discussed above in conjunction with **FIGS. 13 – 18**. For example, the cleaning dispenser **34** may provide a steady flow of cleaning solution to the transporting unit **40**, which provides a predetermined amount of water to the chamber **80**. Because the unit **34** dispenses the cleaning solution at a known rate, the amount of cleaning

solution dispensed is proportional to the amount of water that the transporting unit **40** provides to the chamber **80**. Furthermore, while the cleaning mixture enters the chamber **80**, the beverage-transporting unit **48** may open the outlet **108** to allow air in the chamber to escape. In another
5 implementation, the outlet **108** is closed and the piston **90** retracts to creating a suction that draws the mixture of water and cleaning solution into the chamber **80** via the measuring-and-transporting unit **40** and the nozzle **102**. With this technique, the controller **64** can measure the amount of
10 cleaning mixture that enters the chamber **80** using the same techniques to measure drawn-in water as discussed above in conjunction with **FIGS. 13 – 18**. In yet another implementation, the water-and-cleaner mixture enters the chamber **80** using a combination or sub-combination of the above-described techniques. In still another implementation, the operator may pour the cleaning solution into the chamber **80** via the chamber opening **82**.

15 **[146]** Next, the machine **30** agitates the mixture of the cleaning solution and water. In one implementation, the spray pattern from the nozzle **102** performs this agitation while the mixture is entering the chamber **80**. To enhance the agitation and cleaning of the chamber **80**, the mixture may enter the chamber in multiple bursts. In another example, a
20 mechanical member (not shown in **FIGS. 3** and **16**) performs the agitation while the mixture is entering the chamber **80**, after the mixture enters the chamber, or both while and after the mixture enters the chamber. In yet another example, both the nozzle **102** and the mechanical member agitate the cleaning mixture.

25 **[147]** Then, the cleaning mixture remains in the chamber **80** for a predetermined cleaning time, during which the piston **90** may move up or down to enhance the cleaning of the chamber **80** and the piston.

[148] After the cleaning time has expired, the cup sensing unit **52** indicates to the controller **64** whether a cup is in the cup holder **44**. If a cup

is present, then the controller **64** halts the cleaning cycle and may sound an audible or visible alarm until the cup is removed from the holder.

[149] If the cup sensing unit **52** indicates that no cup is in the cup holder **44**, the piston **90** extends to expel the cleaning mixture from the chamber **80** and into the drain unit **44** via the beverage-transporting-and-dispensing units **48** and **46**. The piston **90** forces the cleaning mixture through the filter **106**, into the space **112**, and through the outlet **108** to the beverage-transporting unit **48**. The cleaning mixture cleans the filter **106**, the space **112**, the outlet **106**, the beverage-transporting-and-dispensing units **48** and **46**, the cup-holder-and-drain unit **44**, and the conduits connecting these components as the mixture passes through.

[150] The piston **90** stops extending and expelling the cleaning mixture when the piston surface **92** is substantially coplanar with the block surface **88**.

15 [151] Next, the machine **30** repeats the above-described cycle one or more times with water only to rinse the cleaned components and conduits.

[152] Then, the shuttle assembly **98** disengages the chamber **80** in preparation of the next brewing cycle.

20 [153] Still referring to **FIGS. 3** and **16**, other embodiments of the cleaning cycle are contemplated. For example, instead of mixing cleaning solution with water, the cleaner-measuring unit **40** may provide straight (*i.e.*, unmixed with water) cleaning solution from the dispenser **34** to the brewing chamber **80**. Furthermore, 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. Moreover, some of the steps may be omitted.

25 [154] **FIG. 19** is a perspective view of the machine **30** according to an embodiment of the invention.

[155] Referring to **FIGS. 3** and **19**, in addition to the cup-holder-and-drain unit **44** and the control panel and display **70**, the machine **30** includes a stainless steel and plastic housing **240**, hoppers **242** and **244**, a beverage dispensing spout **246**, a tray **248**, and three doors or panels **250**, **252**, and **254**. Each of the hoppers **242** and **244**, which are part of the hopper unit **58**, can hold the same or different types of coffee beans. The dispensing spout **246** is part of the beverage-dispensing unit **48**, and the tray **248**, which is removable for cleaning, is part of the cup-holder-and-drain unit **44**. The door/panel **250** allows access for emptying or servicing the solid-waste-disposal unit **56**, and the door/panel **252** allows access for servicing some or all of the components above the barrier **62** in **FIG. 3**. The door/panel **254** allows access for servicing the printed circuit board (not shown in **FIGS. 3** and **19**) on which the processor **66**, memory **68**, communications port **72**, and perhaps other electronic components are located. The height of the machine **30** is 18 inches or less so that the machine can fit on a counter top under standard-height cabinets (neither shown in **FIG. 19**). Because this height may be too small to allow water from the reservoir unit **36** to gravity feed into the brewing chamber **80** (not shown in **FIGS. 3** and **19**), the water-transporting unit **40** may include a pump, or the piston **90** may retract to draw water into the brewing chamber as described above in conjunction with **FIGS. 13 – 18**.

[156] 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.

WHAT IS CLAIMED IS:

1. A machine for brewing a beverage, the machine comprising:
a chamber; and
5 a piston disposed within the chamber and operable to move to a first position to allow the chamber to receive a liquid and a flavor base, to remain in the first position for a time sufficient for the beverage to brew, and to move to a second position to dispense the beverage by forcing the beverage out of the chamber.
- 10 2. The machine of claim 1, further comprising a controller operable to control the movement of the piston.
3. The machine of claim 1 wherein the chamber and piston are cylindrical.
4. The machine of claim 1 wherein:
15 the first position of the piston comprises a retracted position; and
the second position of the piston comprises an extended position.
5. The machine of claim 1 wherein:
the flavor base comprises coffee; and
the liquid comprises water.
- 20 6. The machine of claim 1, further comprising:
wherein the flavor base comprises a solid; and
a filter operable to pass the beverage and retain the solid in the chamber while the piston moves from the first position to the second position.
- 25 7. The machine of claim 1, further comprising:
wherein the flavor base comprises a solid; and
a wiper operable to remove the solid from the piston after the beverage is dispensed.
8. The machine of claim 1, further comprising:
30 a hopper operable to store coffee beans; and

a grinder operable to receive the coffee beans from the hopper, to grind the coffee beans, and to provide the ground coffee to the chamber as the flavor base.

5 9. The machine of claim 1, further comprising:
a hopper operable to store the flavor base; and
a measuring unit operable to receive the flavor base from the hopper and to provide a predetermined amount of the flavor base to the chamber.

10 10. The machine of claim 1, further comprising:
a hopper operable to store the flavor base; and
a transporter operable to provide the flavor base from the hopper to the chamber during a first operating mode and operable to provide the flavor base to a disposal unit during a second operating mode.

15 11. The machine of claim 1, 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.

20 12. The machine of claim 1, further comprising:
a reservoir operable to hold the liquid and to heat the liquid to a first predetermined temperature; and
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.

25 13. The machine of claim 1, further comprising:
a reservoir operable to hold the liquid and to heat the liquid to a first predetermined temperature; and
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.

30 14. The machine of claim 1, further comprising:
a reservoir operable to hold a cleaner; and

a transporter operable to provide the cleaner from the reservoir to the chamber during a cleaning operating mode.

15. The machine of claim 1, further comprising:
a holder operable to hold a beverage cup; and
5 wherein the piston is operable to dispense the beverage into the cup.

16. The machine of claim 1, further comprising:
a holder operable to hold a beverage cup;
a sensor operable to indicate whether the beverage cup is in the
holder; and

10 wherein the piston is operable to dispense the beverage if the sensor indicates that the beverage cup is in the holder.

17. A method, comprising:
brewing a beverage in a chamber from a flavor base and a liquid; and
forcing the beverage out of the chamber by moving a piston within the
15 chamber.

18. The method of claim 17 wherein producing the beverage comprises brewing coffee in the chamber from ground coffee and water.

19. The method of claim 17 wherein forcing the beverage comprises forcing the beverage through a filter to remove a solid from the
20 beverage.

20. The method of claim 17, further comprising:
introducing the flavor base into the chamber; and
introducing the liquid into the chamber in a manner that mixes the
flavor base and the liquid.

25 21. The method of claim 17, further comprising:
introducing the flavor base into the chamber; and
introducing the liquid into the chamber in multiple bursts.

22. The method of claim 17, further comprising wiping a solid
residue from the piston into a waste-disposal unit after forcing the beverage
30 out of the chamber.

23. The method of claim 17, further comprising:

receiving a beverage-producing parameter; and
producing the beverage according to the parameter.

24. The method of claim 17, further comprising:
electronically receiving a beverage-producing parameter; and
producing the beverage according to the parameter.

25. A machine for brewing coffee, the machine comprising:
a brew chamber having an opening operable to receive ground
coffee;

a reservoir operable to hold water, to heat the water to a first
predetermined temperature, and to provide heated water to the brew
chamber;

a filter;

a piston disposed in the chamber and operable to force brewed coffee
out of the chamber through the filter; and

a wiper operable to sweep the ground coffee off of the piston after the
piston forces the brewed coffee out of the chamber.

26. The machine of claim 25, further comprising:

a hopper operable to store coffee beans; and

a grinding-and-measuring unit operable to receive coffee beans from
the hopper, to grind the beans into ground coffee, and to introduce a
predetermined amount of ground coffee into the brew chamber.

27. The machine of claim 26 wherein the grinding and measuring
unit comprises an optical sensor operable to indicate an amount of ground
coffee that the unit introduces to the brew chamber.

28. The machine of claim 26 wherein the grinding and measuring
unit comprises an ultrasonic sensor operable to indicate an amount of
ground coffee that the unit introduces to the brew chamber.

29. The machine of claim 26 wherein the grinding and measuring
unit comprises a disk operable to indicate an amount of ground coffee that
the unit introduces to the brew chamber.

30. The machine of claim 26 wherein the grinding and measuring unit comprises:

a grinding motor; and

5 a current sensor operable to indicate an amount of ground coffee that the unit introduces to the brew chamber based on a current drawn by the grinding motor.

31. The machine of claim 26 wherein the grinding and measuring unit comprises:

a grinding motor; and

10 a temperature sensor operable to indicate an amount of ground coffee that the unit introduces to the brew chamber based on a temperature of the grinding motor.

32. The machine of claim 26 wherein the grinding-and-measuring unit comprises:

15 a container operable to hold the ground coffee;

a mass sensor operable to indicate a mass of the ground coffee held in the container; and

a mechanism to dump the ground coffee in the container into the brew chamber.

20 33. The machine of claim 26 wherein the grinding-and-measuring unit comprises:

a container operable to hold ground coffee; and

a mechanism to dump the ground coffee in the container into the brew chamber.

25 34. The machine of claim 26 wherein the grinding-and-measuring unit comprises:

a container operable to hold ground coffee; and

a mass sensor operable to indicate a mass of the ground coffee held in the container.

30 35. The machine of claim 25, further comprising a water transporting unit disposed between the reservoir and the brew chamber and

operable to receive heated water from the reservoir and to introduce a predetermined amount of the heated water into the chamber via the opening.

36. The machine of claim 25 further comprising a water transporting
5 unit disposed between the reservoir and the brew chamber and operable to receive heated water from the reservoir and to introduce a predetermined amount of the heated water into the chamber via the opening, wherein the water transporting and measuring unit comprises a pump that introduces the water into the brew chamber at a rate that is proportional to a time during
10 which the pump is active.

37. The machine of claim 25 wherein the piston is operable draw a predetermined amount of heated water from the reservoir into the chamber by moving a distance that corresponds to the predetermined amount.

38. The machine of claim 25 wherein:
15 the filter is operable to cover the opening of the brew chamber; and the piston is operable to force the brewed coffee out of the chamber via the opening and through the filter.

39. The machine of claim 25, further comprising a temperature unit disposed between the reservoir and the water transporting and measuring
20 unit and operable to cool the water from the reservoir to a second predetermined temperature.

40. The machine of claim 25 wherein the wiper and the filter are attached to a common assembly.

41. The machine of claim 25, further comprising an electronic
25 controller operable to control operation of the grinding and measuring unit, the reservoir, the water transporting and measuring unit, the piston, and the wiper.

42. The machine of claim 25, further comprising:
a substantially flat surface contiguous with the opening of the brew
30 chamber;

wherein the piston has a surface and is operable to move into a wipe position where the piston surface is substantially coplanar with the contiguous surface after the piston forces the brewed coffee out of the chamber; and

- 5 wherein the wiper is operable to sweep the ground coffee from the piston surface when the piston is in the wipe position.

43. The machine of claim 25, further comprising a cleaning mechanism operable to remove ground coffee from the filter and the wiper after the wiper sweeps the coffee grounds from the piston.

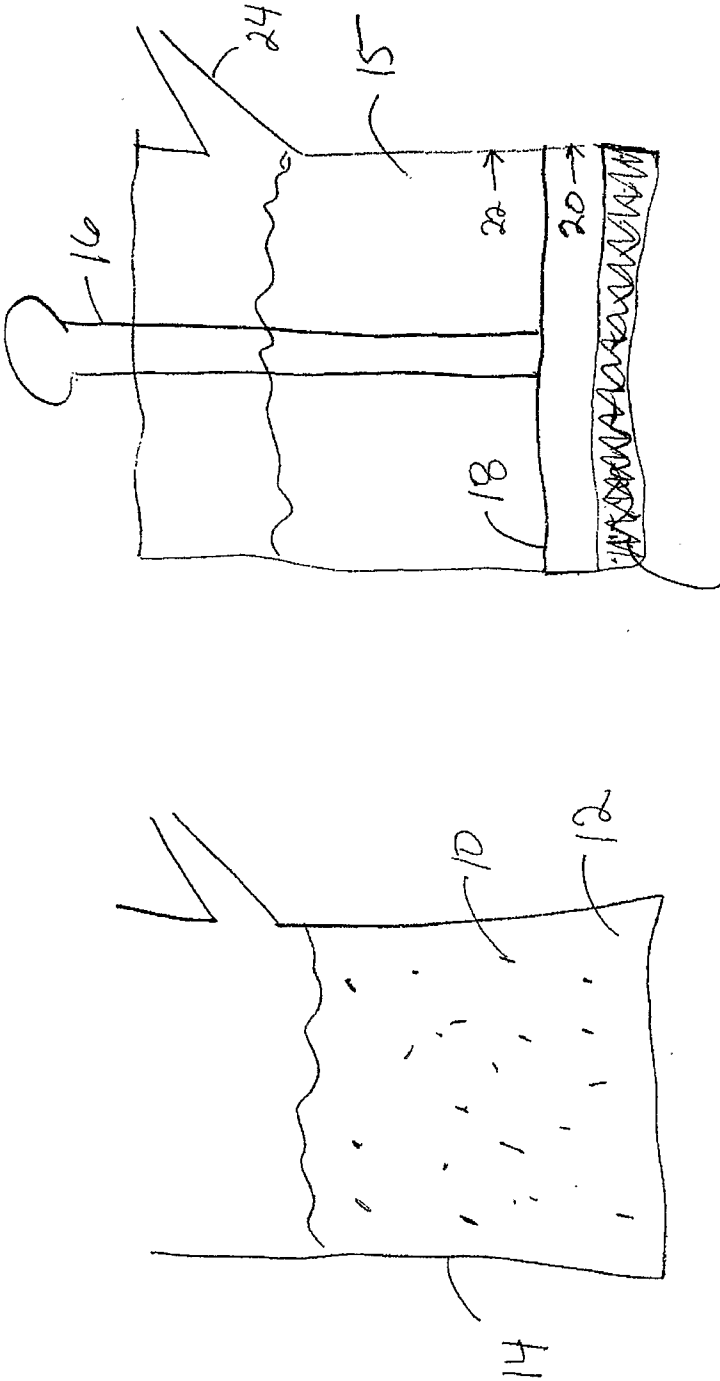
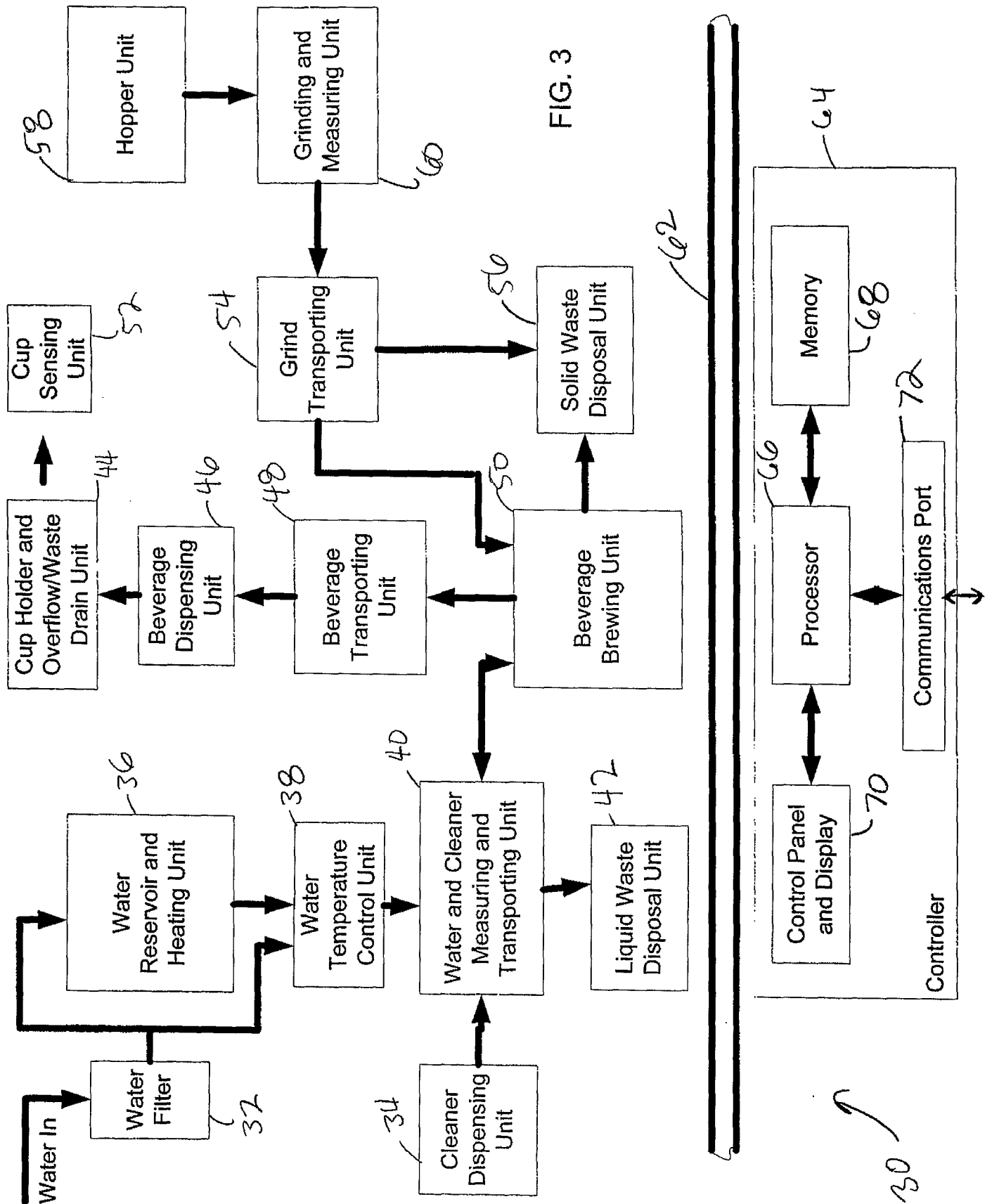


FIG. 1 (PRIOR ART)

FIG. 2 (PRIOR ART)

FIG. 3



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From the Water Reservoir
and Transporting Unit 40
(Fig. 3)

To the Beverage
Transporting Unit 48
(Fig. 3)

Ground Coffee
from the Grinding
and Reservoir Unit 60 (Fig. 3)

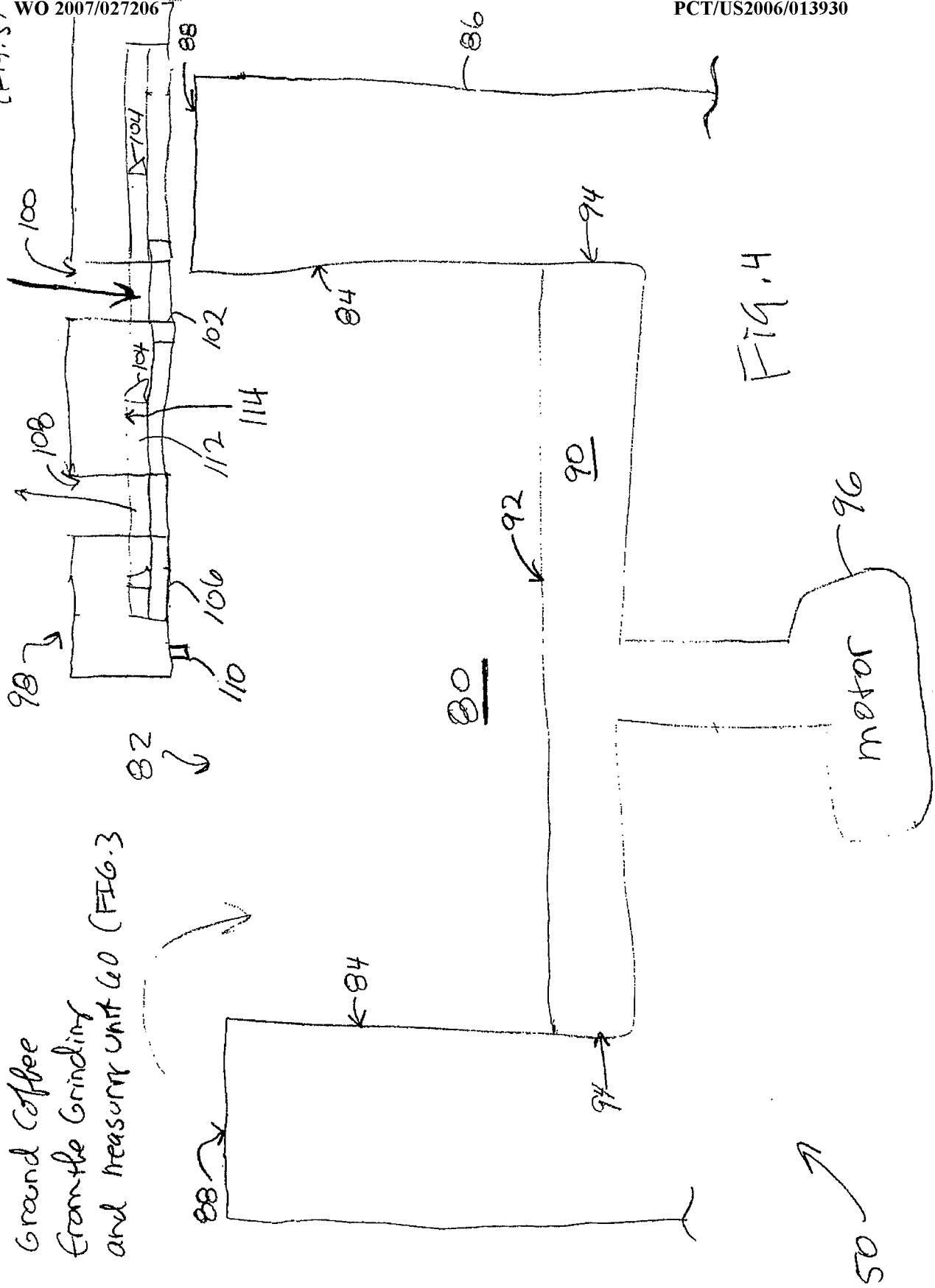
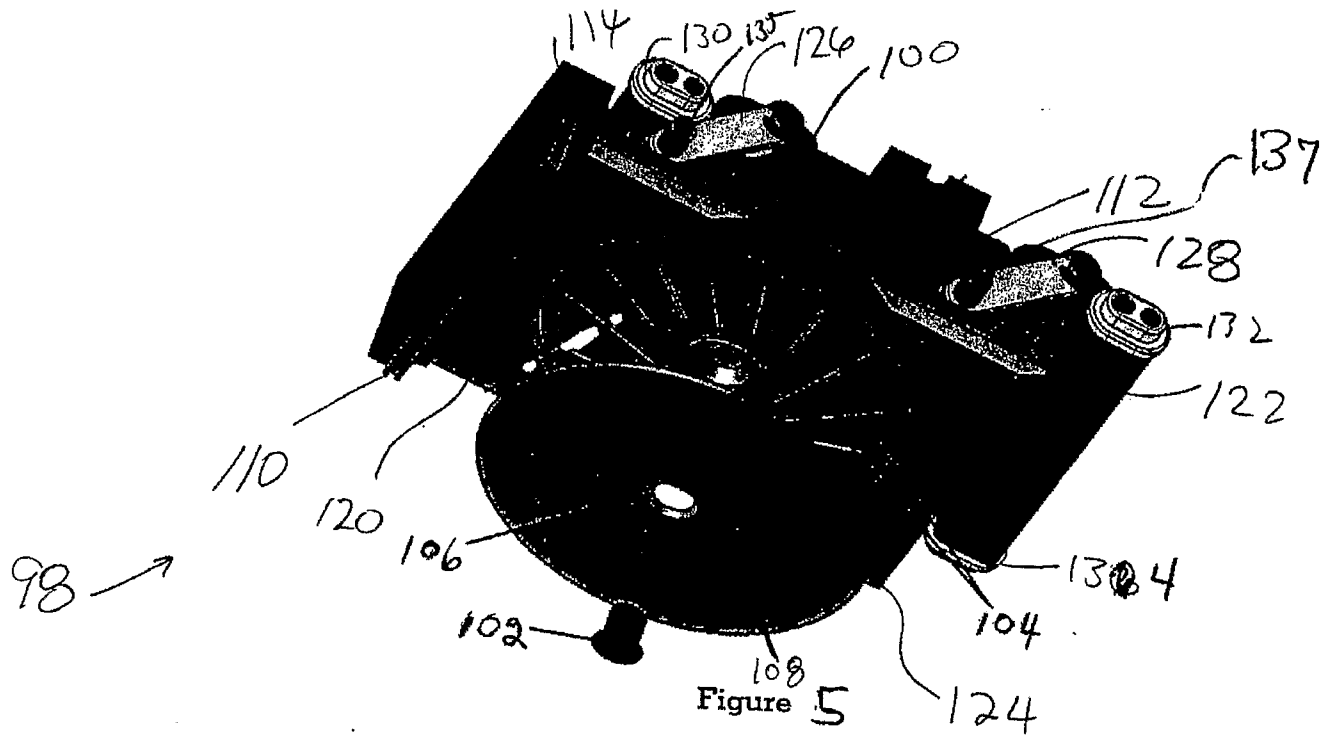
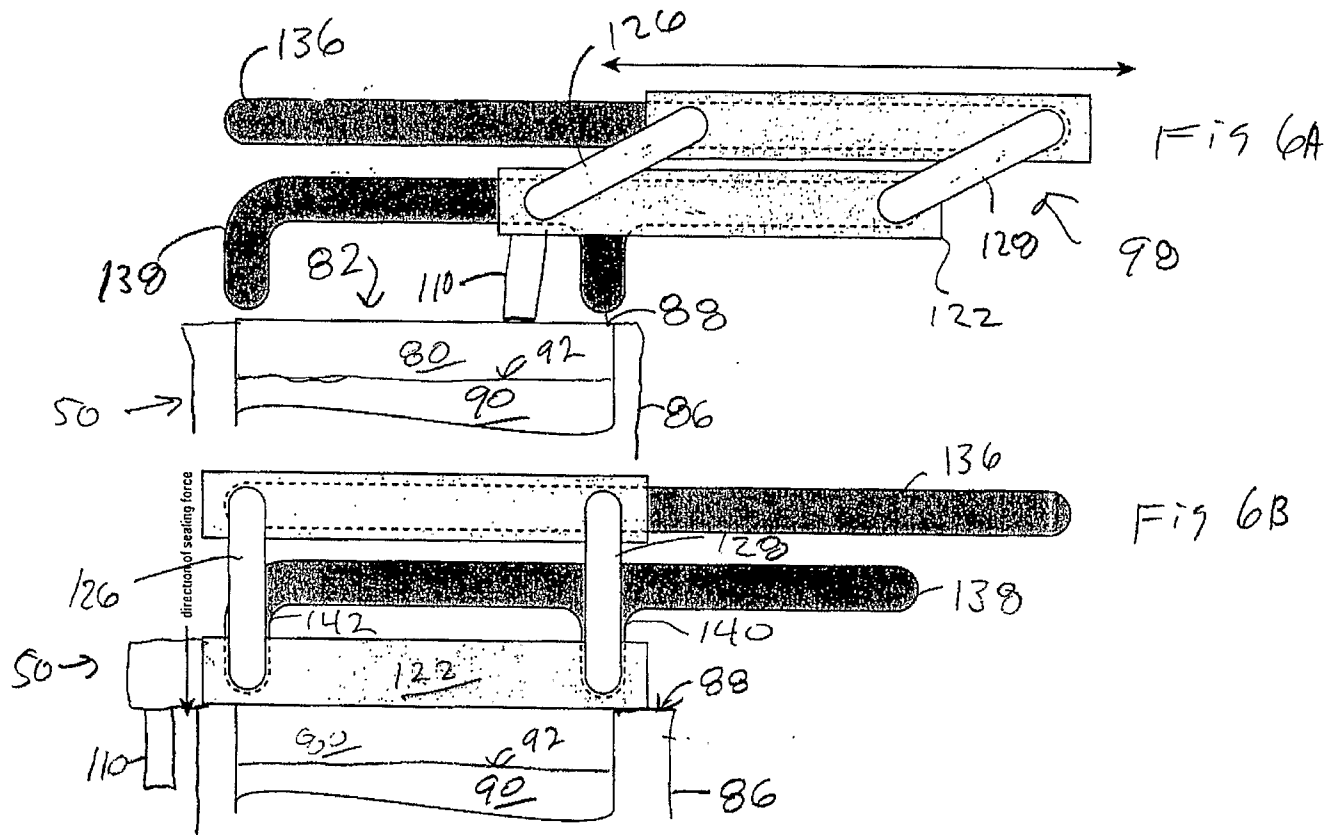
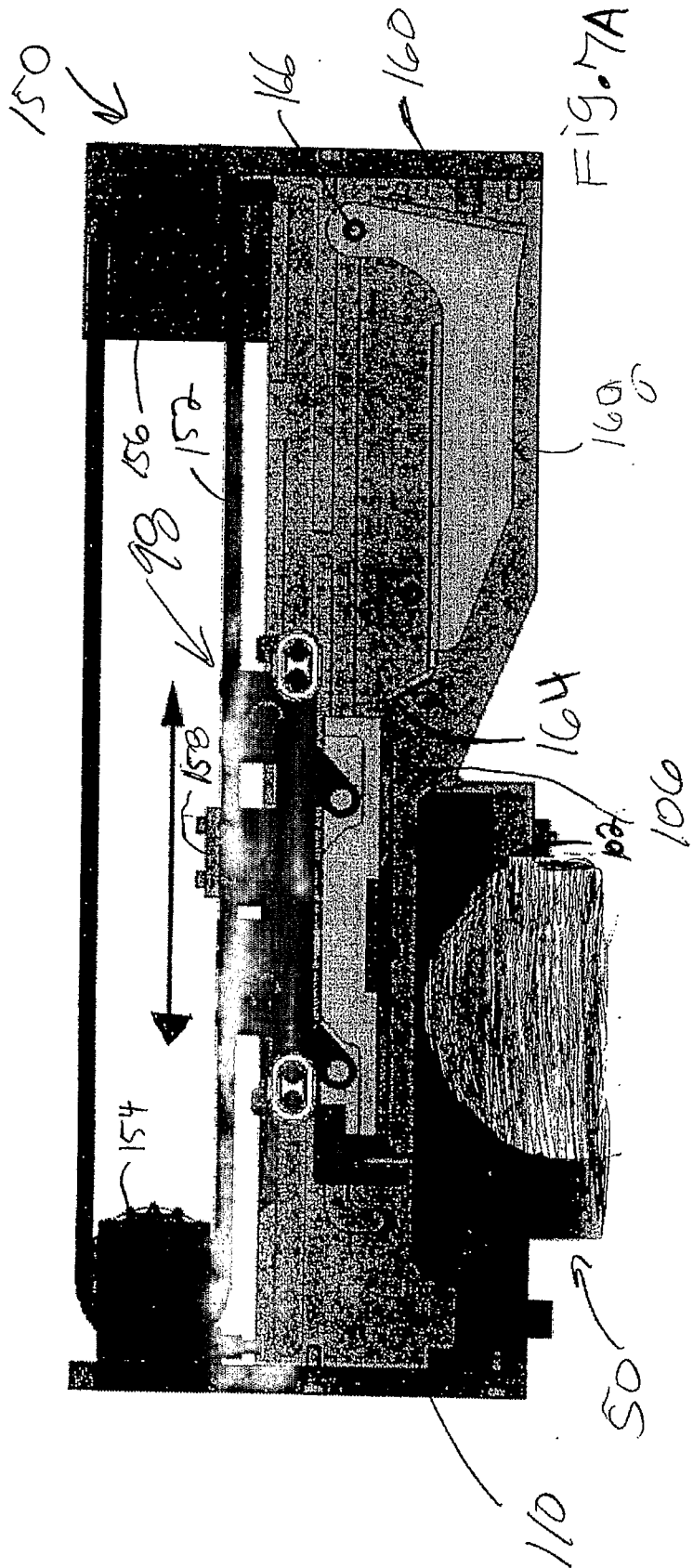
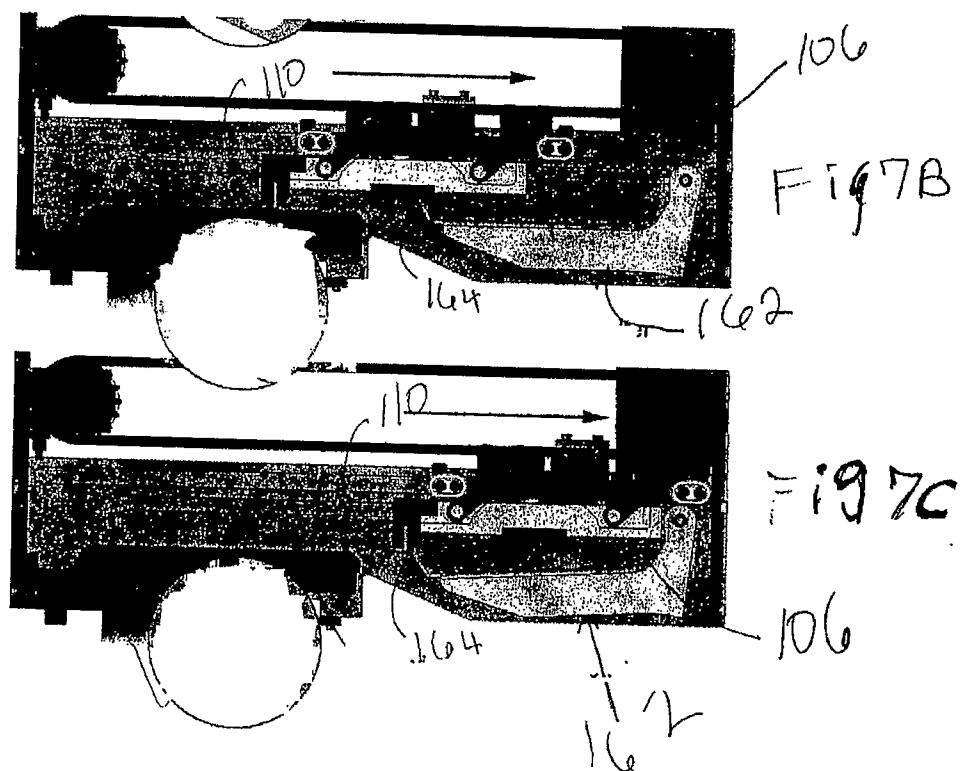


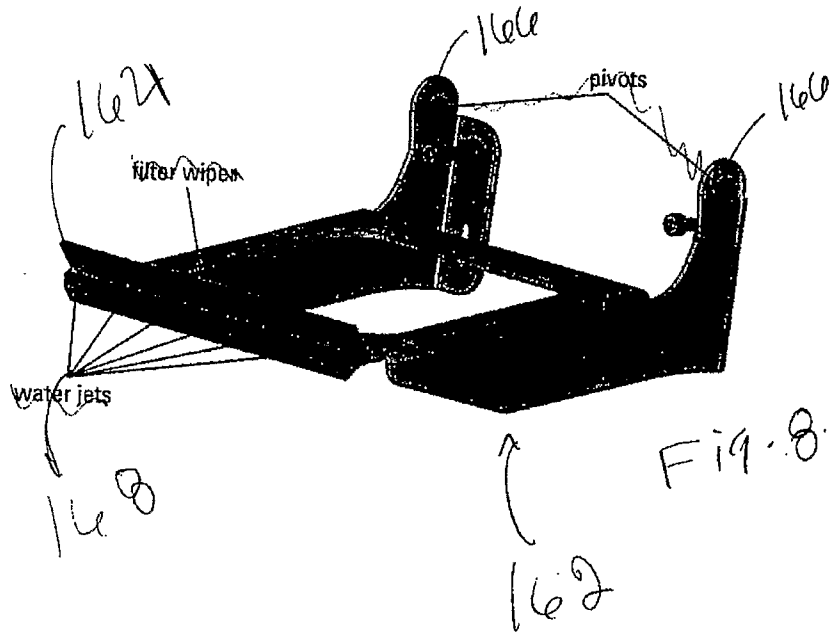
Fig. 4

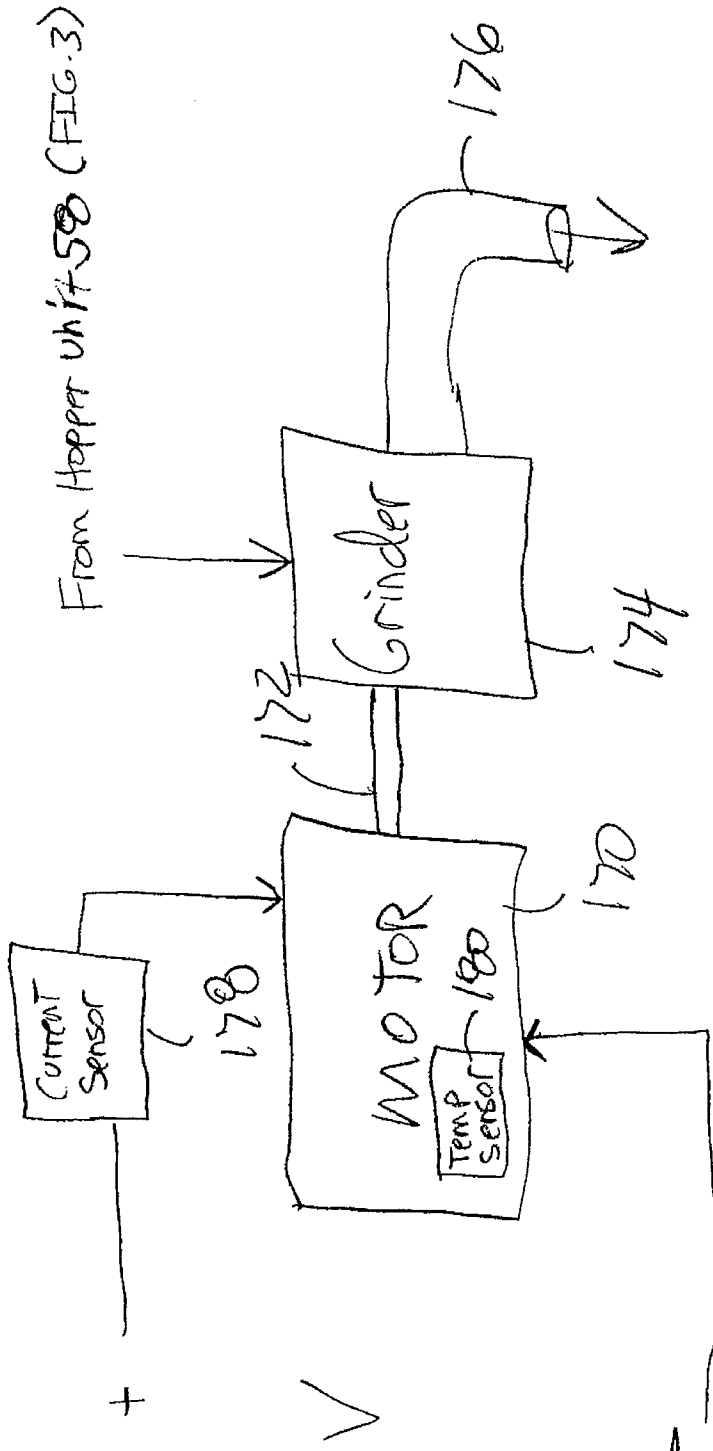












60 9

FIG. 9

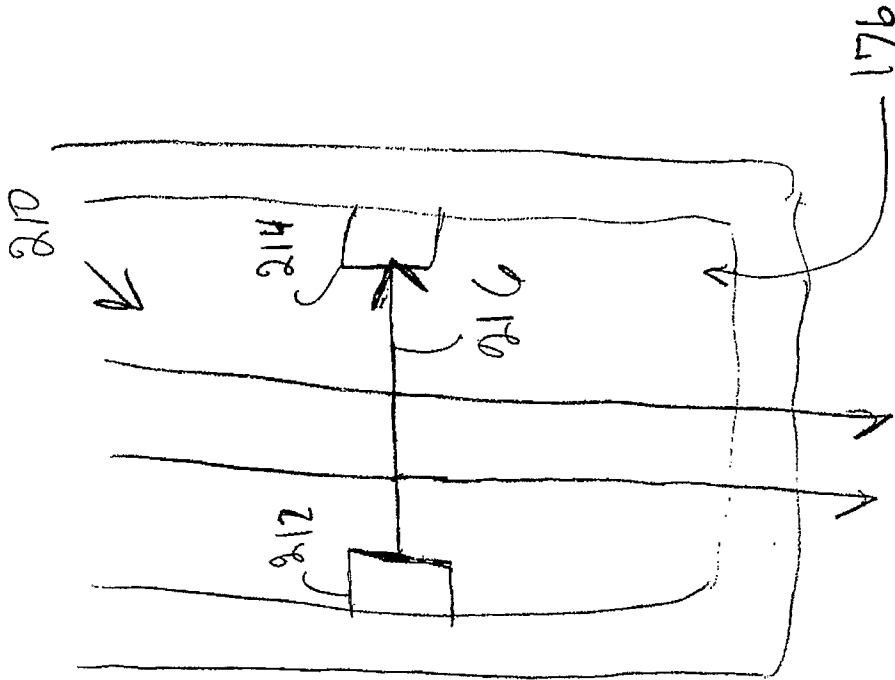


FIG. 11

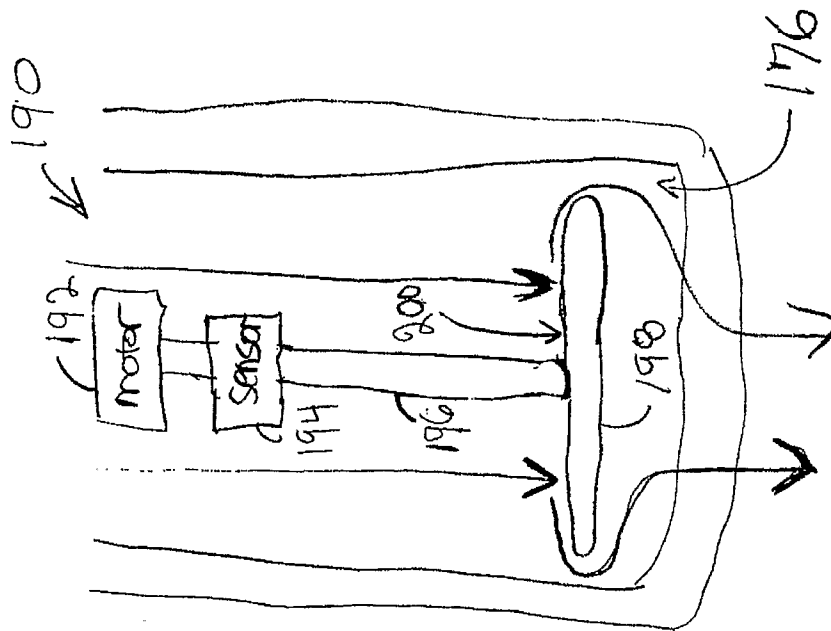


Fig. 10

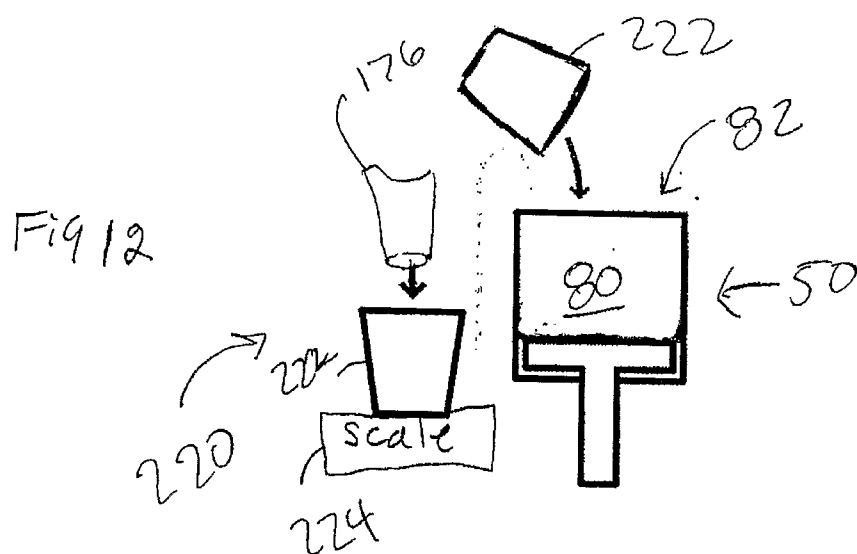
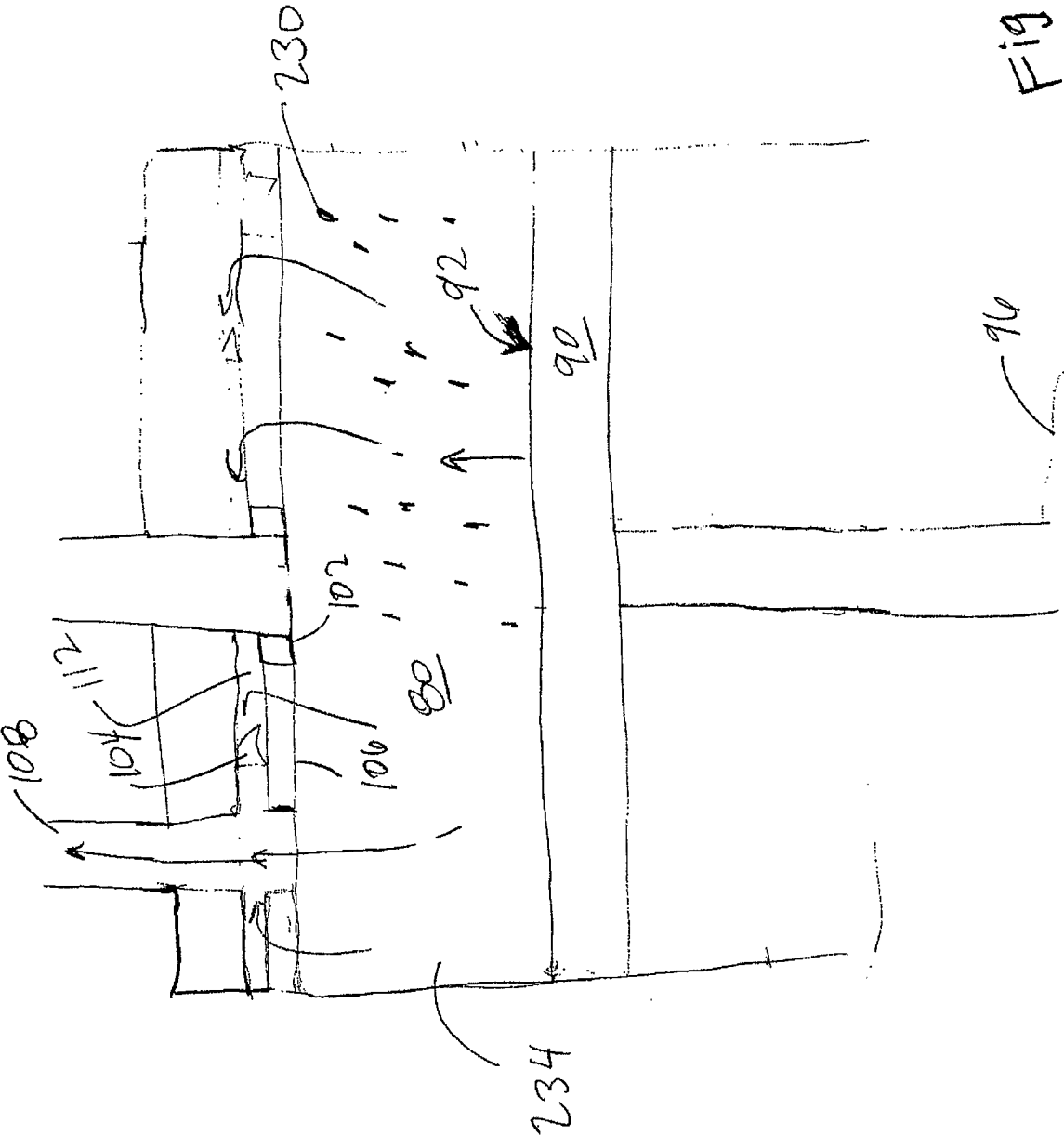


Fig.16



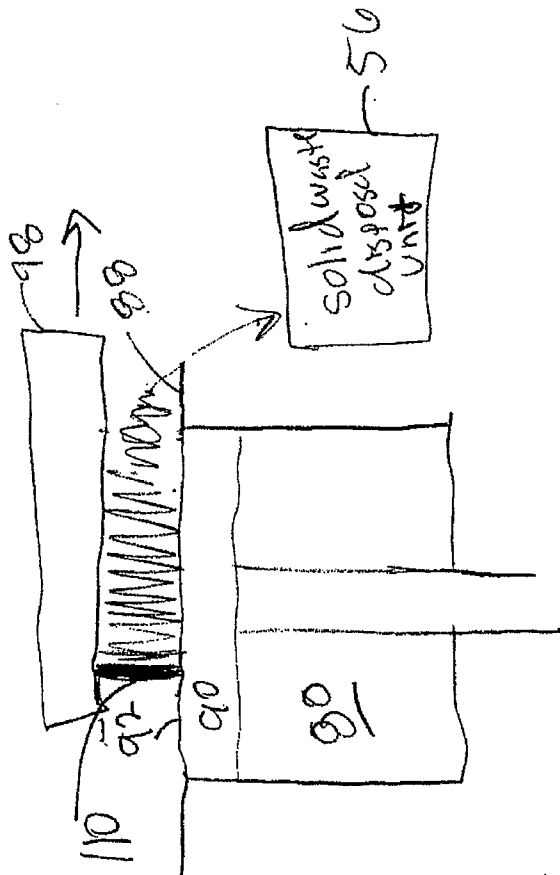


Fig. 18

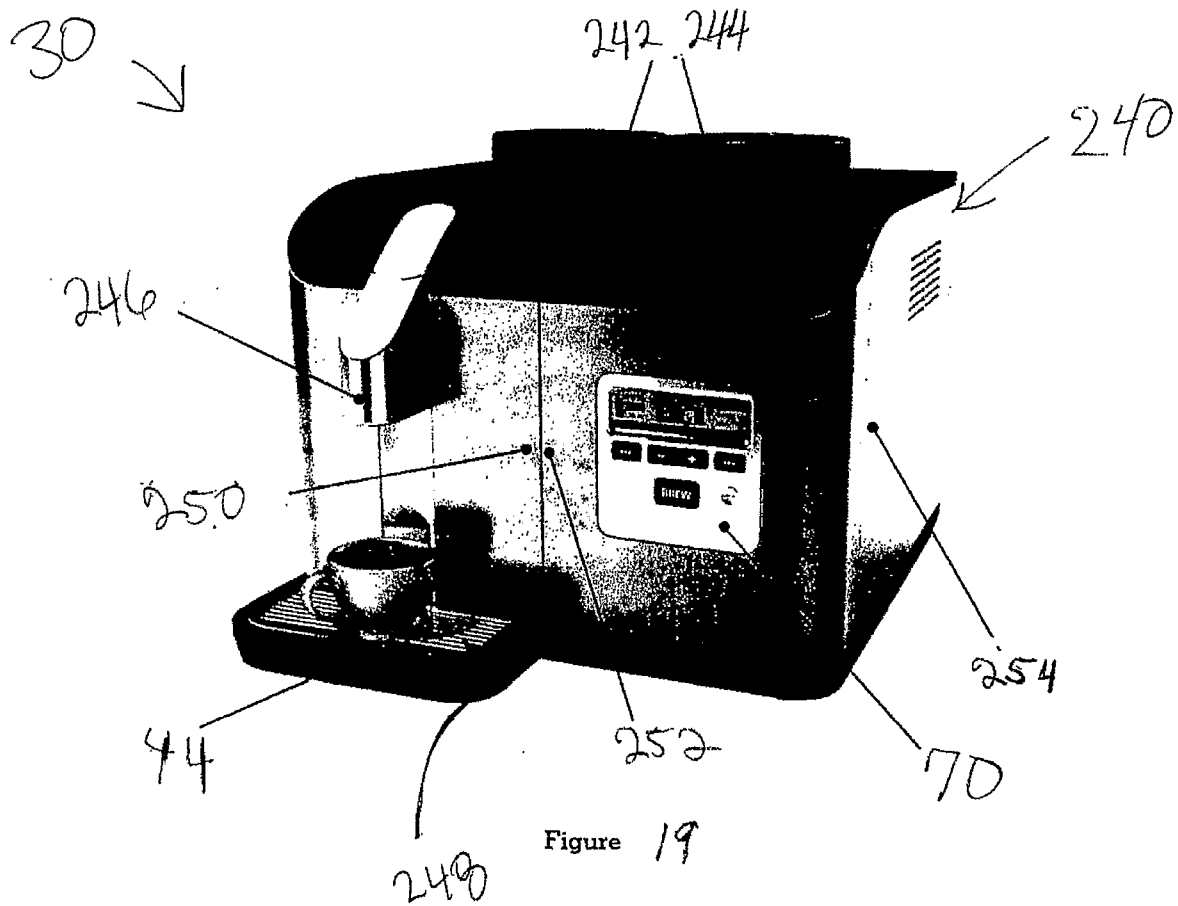
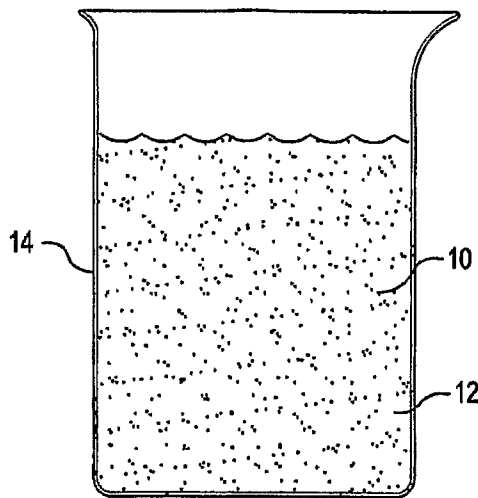
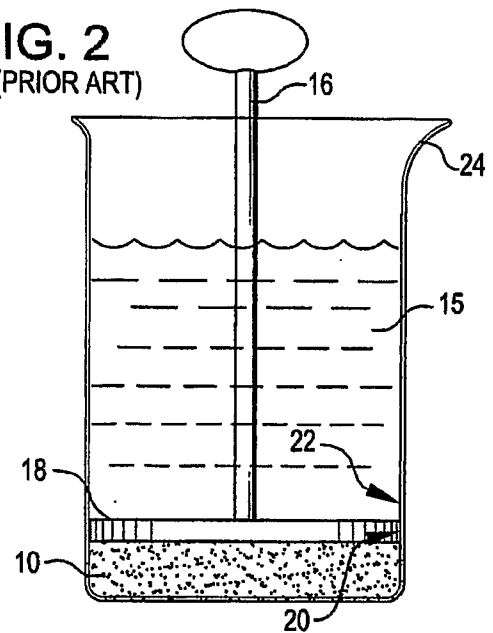
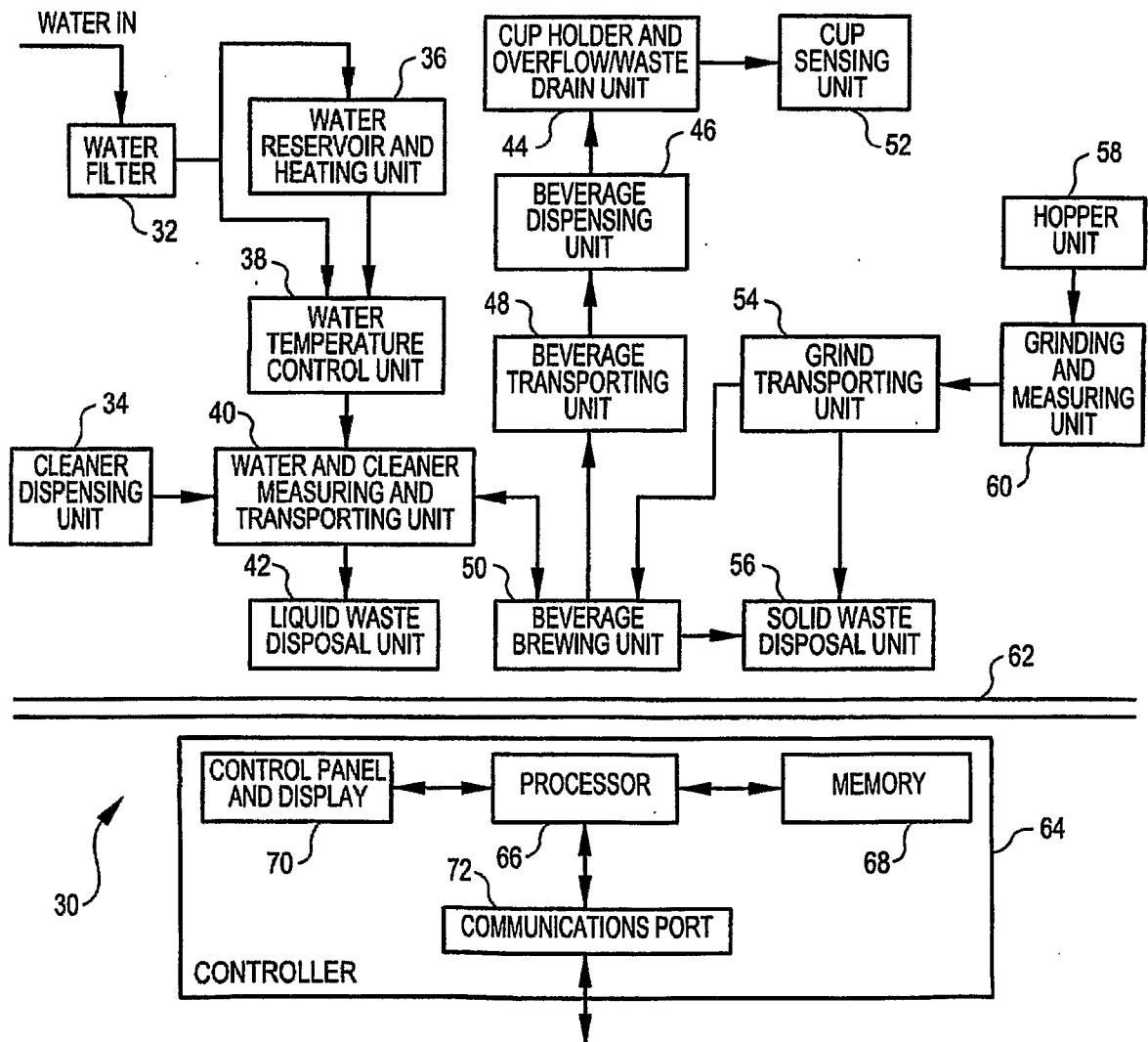


Figure 19

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FIG. 1
(PRIOR ART)**FIG. 2**
(PRIOR ART)**FIG. 3**

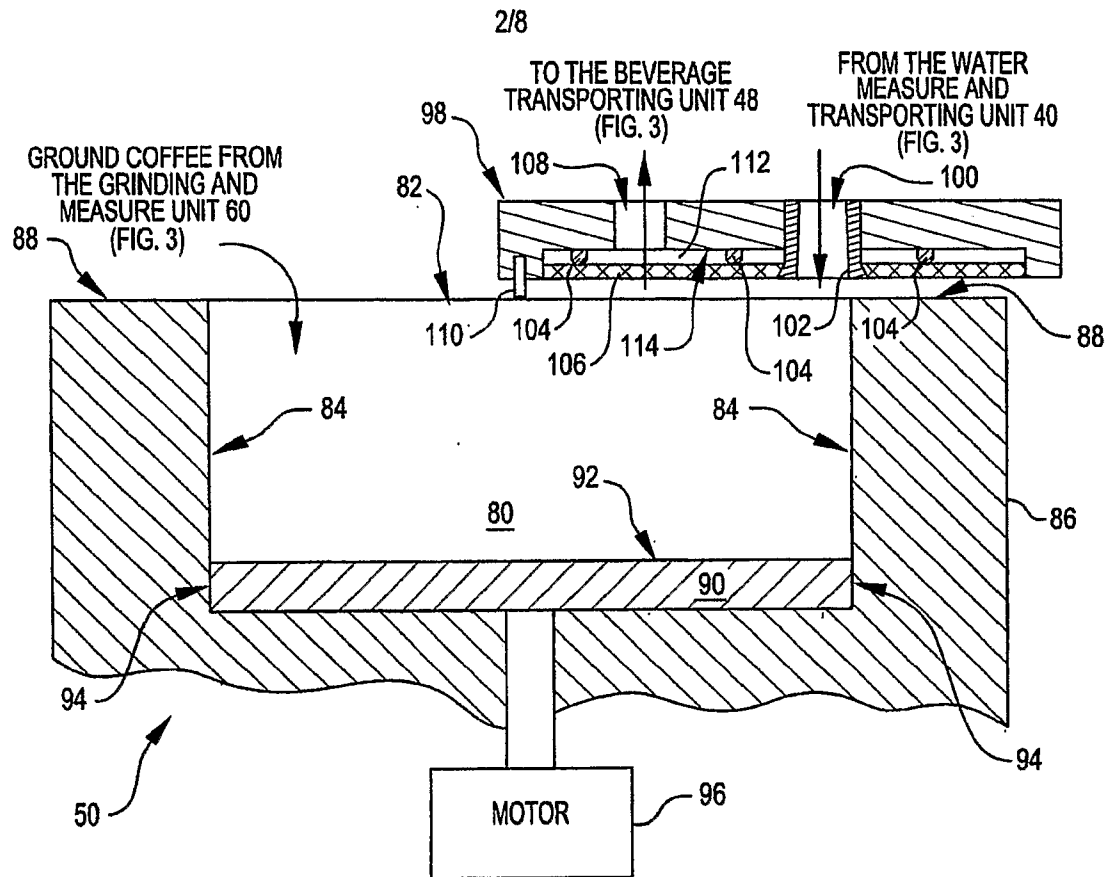
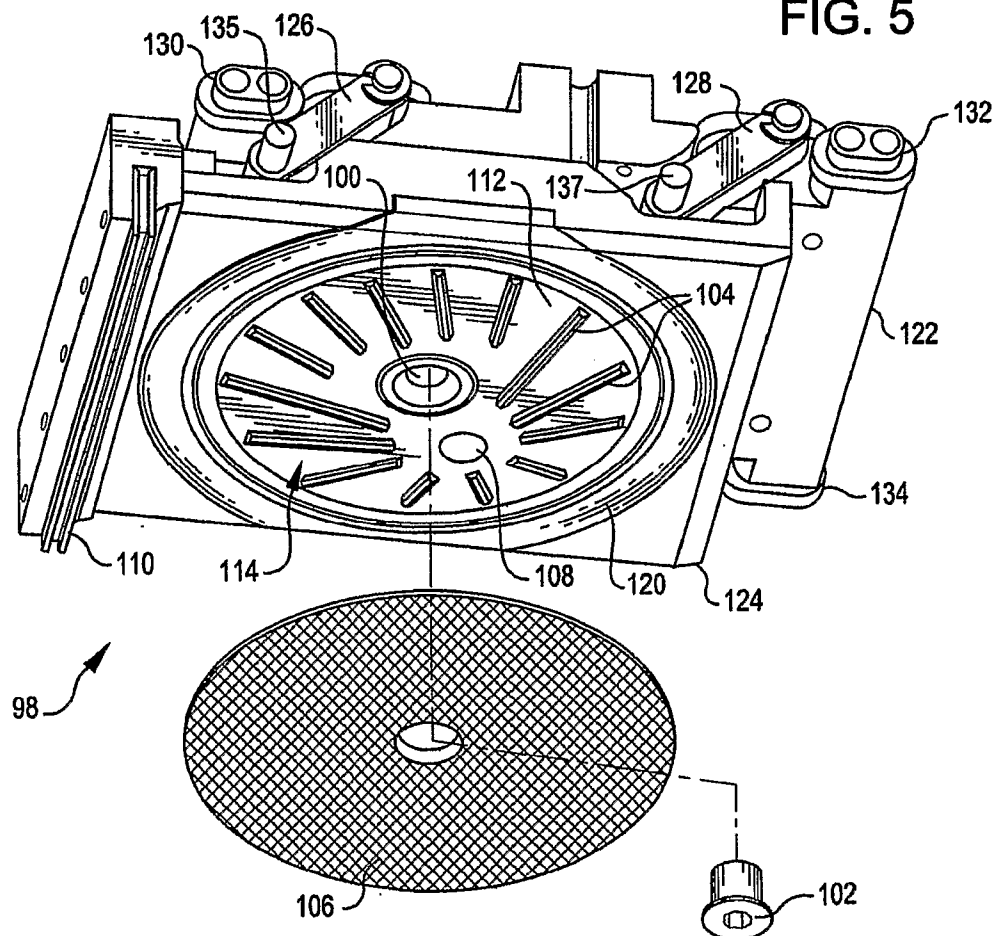


FIG. 5



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FIG. 6A

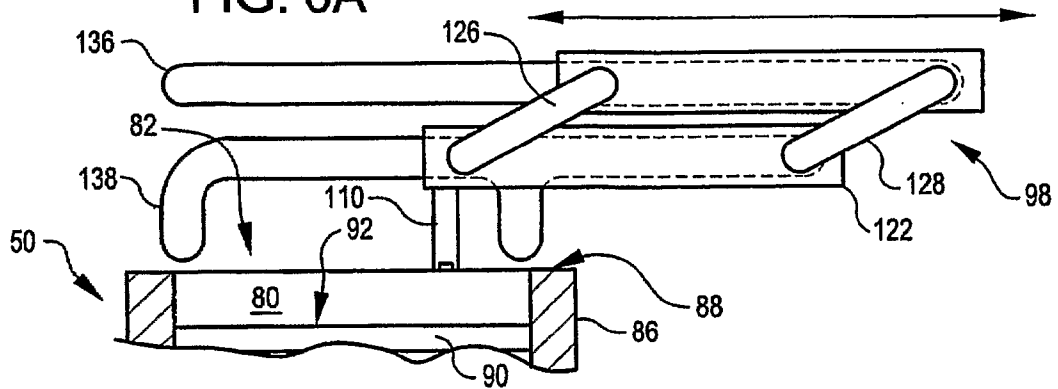


FIG. 6B

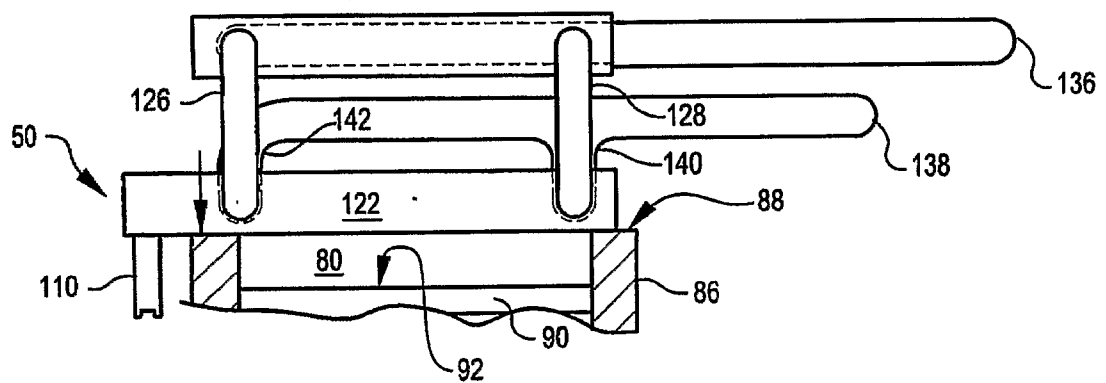


FIG. 7A

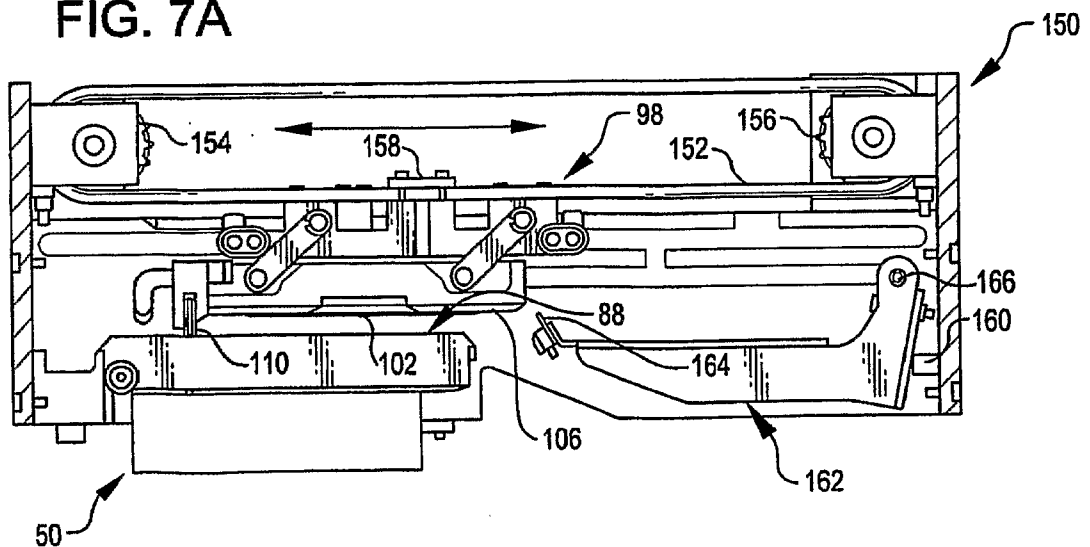


FIG. 7B

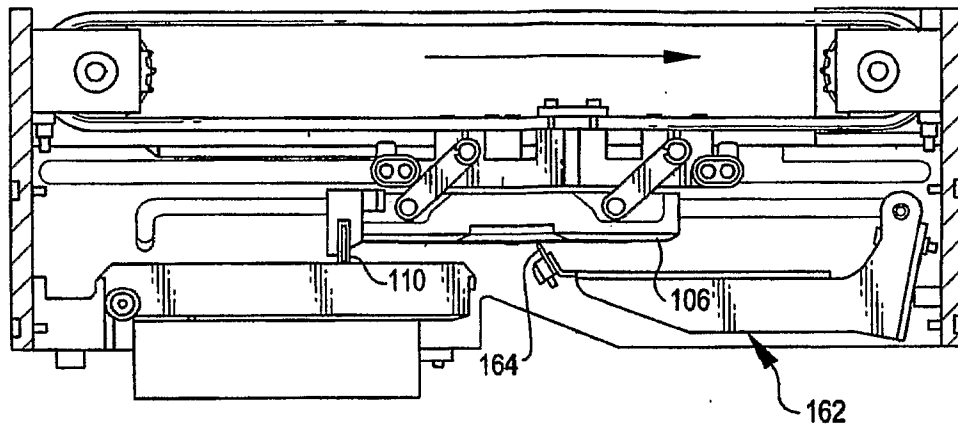


FIG. 7C

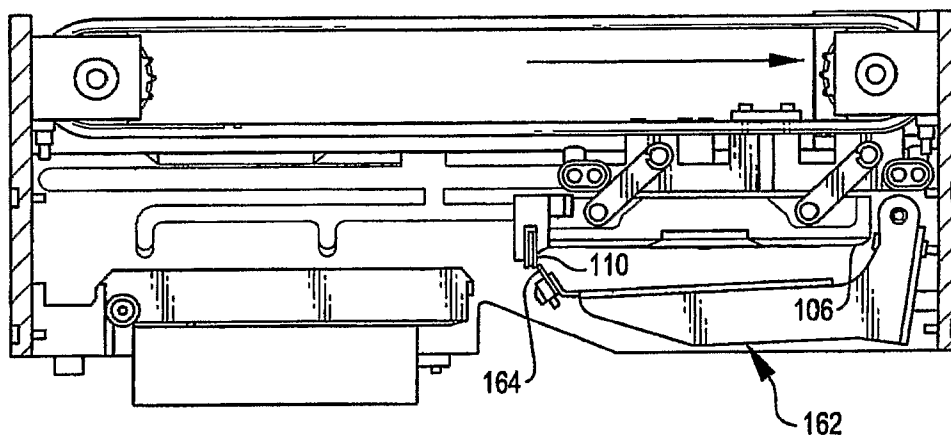
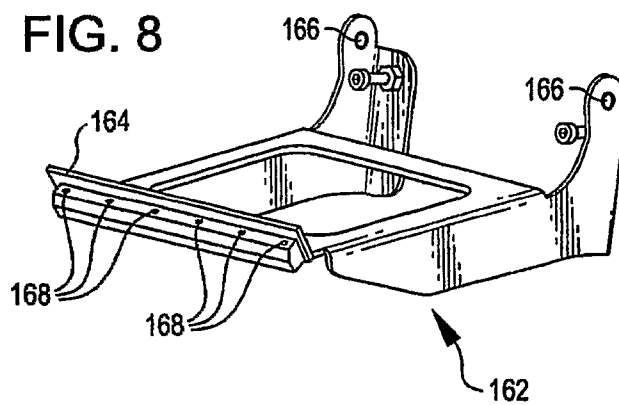
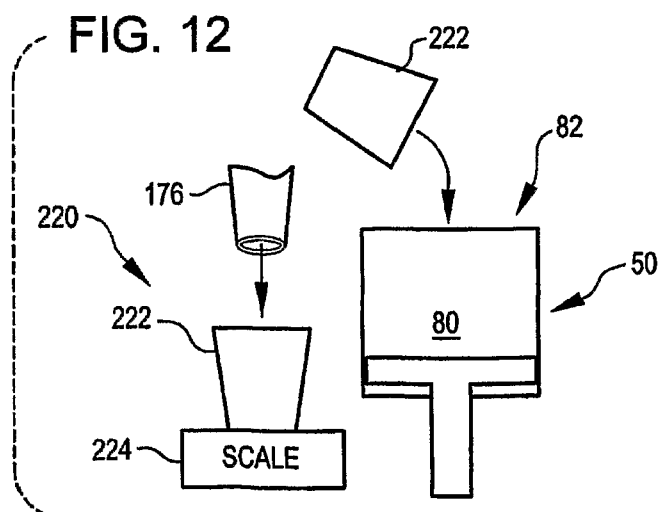
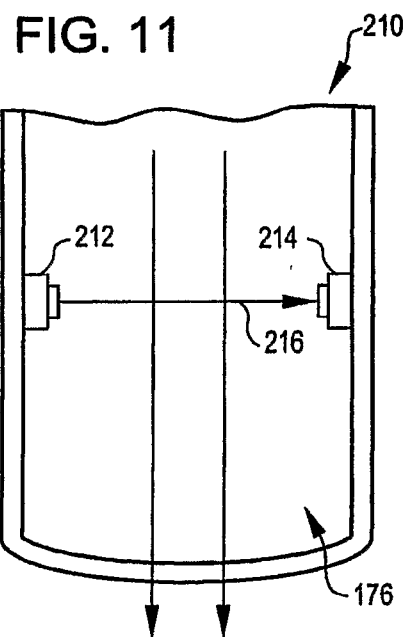
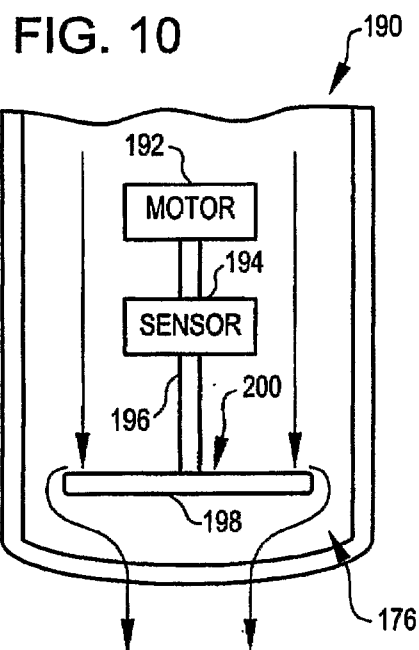
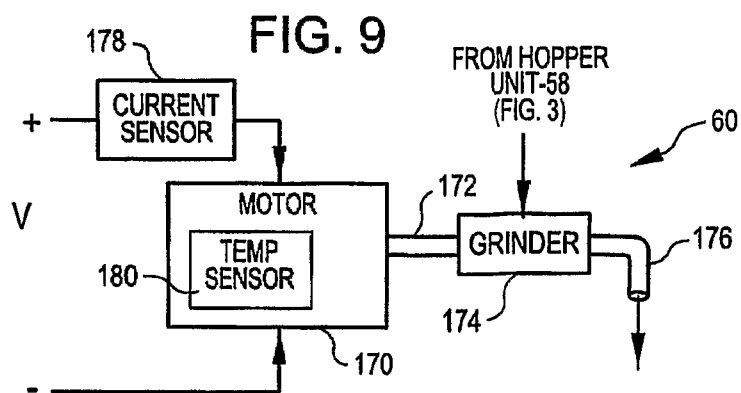


FIG. 8



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FIG. 13

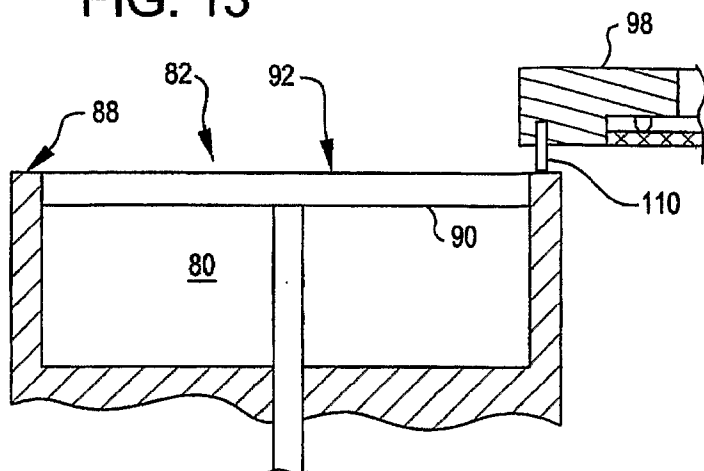


FIG. 14

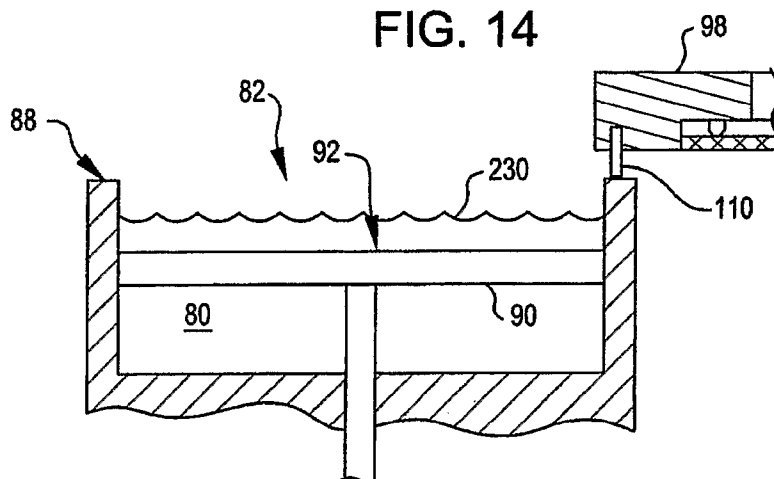
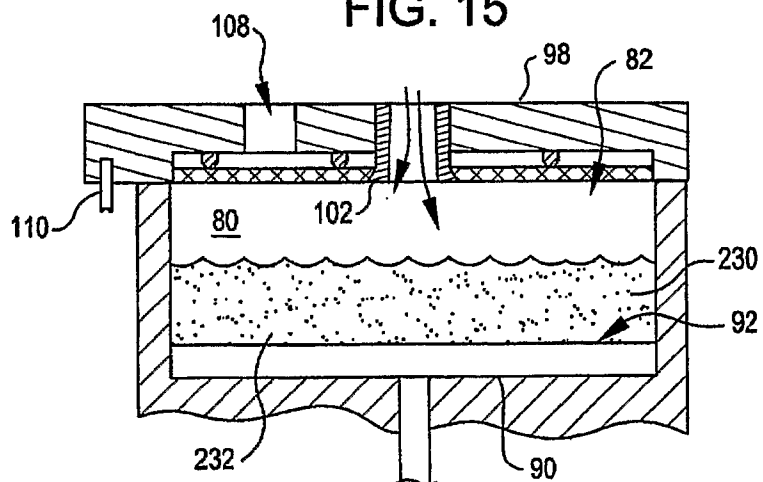


FIG. 15



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