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(71) Applicant (for all designated States except US): **KEURIG, INCORPORATED** [US/US]; 101 Edgewater Drive, Wakefield, MA 01880 (US).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **STREETER, Richard, B.** [US/US]; Brookside Avenue, 66 Brookside Avenue, Winchester, MA 01890 (US). **JACOBS, William,**

**T.** [US/US]; 66 Beech Avenue, Melrose, MA 02176 (US). **LAZARIS, Nicholas, G.** [US/US]; 1947 Beacon Street, Newton, MA 02168 (US). **SQUIRES, Charles, F.** [US/US]; 21 Gibson Road, Newtonville, MA 02460 (US).

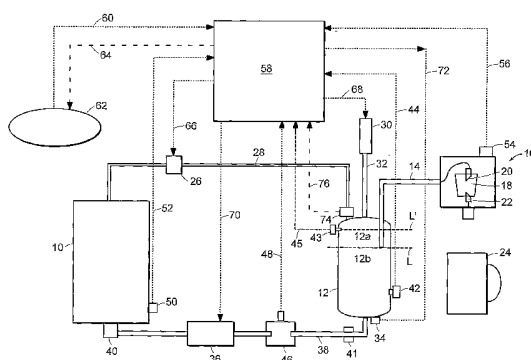
(74) Agents: **HONEYMAN, Jason, M.** et al.; Wolf, Greenfield & Sacks, P.C., 600 Atlantic Avenue, Boston, MA 02210-2206 (US).

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(54) Title: SYSTEM FOR DISPENSING METERED VOLUMES OF HEATED WATER TO THE BREW CHAMBER OF A SINGLE BEVERAGE BREWER



(57) Abstract: A system for dispensing a metered volume of heated water to the brew chamber (16) of a single serve beverage dispenser. The system includes a storage tank (10) for containing a supply of unheated water and a dispensing tank (12). A delivery line (14) communicates with the brew chamber and with the dispensing tank at an intermediate level (L) demarcating the interior of dispensing tank into upper and lower compartment (12a, 12b). The volume of the upper compartment (12a) is equal to the metered volume. A vent valve (26) communicates via a vent line (28) with the upper compartment. A supply line (38) connects the storage tank (10) to the lower compartment (12b). An air pump (30) is arranged to deliver pressurized air to the upper compartment. A water pump (36) in the supply line is arranged to deliver water from the storage tank to the lower compartment. A heater (34) for heating water received in the dispensing tank. A sensing mechanism for generating control signals indicative of the level and temperature of water in the dispensing tank. A controller (58) enabled by control signals generated by the sensing means and operative in response to a brew signal (60) for operating the air and water pumps (30, 36) in conjunction with the opening and closure of the vent valve to fill the upper compartment with heated water displaced from the lower compartment and to discharge the thus displaced heated water from the upper compartment to the brew chamber.



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SYSTEM FOR DISPENSING METERED VOLUMES OF HEATED WATER TO  
THE BREW CHAMBER OF A SINGLE BEVERAGE BREWER

5 PRIORITY INFORMATION

This application is a continuation-in-part of U.S. Serial No. Unknown which is a continuation-in-part of U.S. Serial No. 10/832,474 filed on April 26, 2004, which is a continuation-in-part of U.S. Serial No. 10/734,657 filed on December 12, 2003.

10 BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates generally to beverage brewers of the type having brew chambers configured and dimensioned to accept and pierce disposable single serve beverage cartridges as well as those brewers that accept disposable single serve  
15 beverage pods that have soluble beverage materials confined between layers of film media, and is concerned in particular with a system for dispensing metered volumes of heated water to such brew chambers for infusion with the soluble beverage materials contained in such cartridges or pods.

20 2. Description of the Prior Art

Hot water dispensing systems of the type disclosed in U.S. Patent No. 6,142,063 are in widespread use. While such systems operate reliably with an adequate degree of metering accuracy, certain of their metering components are difficult to manufacture with the precision necessary to achieve a high degree of  
25 metering accuracy. Moreover, when processing water having elevated mineral levels, the accuracy and reliability of the metering components can be compromised by mineral deposits.

Although other dispensing systems employ less expensive components that are less likely to be compromised by mineral deposits, any such advantages are more than  
30 offset by reduced dispensing accuracy and reliability.

There exists a need, therefore, for an improved hot water dispensing system that not only employs lower cost components that are substantially immune to mineral deposits, but that also is capable of consistently operating with a high degree of dispensing accuracy.

## SUMMARY OF THE INVENTION

In accordance with the present invention, a system is provided for dispensing a metered volume of heated water to the brew chamber of a single serve beverage dispenser that uses single serve beverage cartridges or pods. The system includes a storage tank for containing a supply of unheated water, and a separate dispensing tank of substantially reduced volume as compared to the storage tank. A delivery line communicates with the brew chamber and with the dispensing tank at an intermediate level demarcating the interior of the dispensing tank into upper and lower compartments, with the volume of the upper compartment being equal to the metered volume to be dispensed to the brew chamber during a brew cycle. The upper compartment is connected via a vent line to a vent valve, and via an air line to an air pump. The vent line and air line may be connected separately and directly to the dispensing tank, or may be joined to a common manifold line connected to the dispensing tank.

A supply line connects the storage tank to the lower compartment of the dispensing tank, and a water pump in the supply line serves to deliver water from the former to the latter. A water heater heats water received in the dispensing tank. Sensors are strategically positioned to generate control signals indicative of the water temperature and water level in the dispensing tank. A controller is enabled by the sensor control signals and a brew signal generated by the user. The water and air pumps, the heater and the vent valve operate in response to command signals from the controller to fill the upper compartment of the dispensing tank with heated water displaced from its lower compartment by unheated make up water received via the supply line from the storage tank, and to empty the upper compartment via the delivery line to the brew chamber.

Other features and attendant advantages will now be described in greater detail with reference to the accompanying drawing, wherein:

## BRIEF DESCRIPTION OF THE DRAWING

Figure 1 is a schematic diagram of a system in accordance with a first embodiment of the present invention;

Figure 2 is a schematic diagram of a system in accordance with a second embodiment of the invention; and

Figure 3 is a schematic diagram of a system in accordance with a third

embodiment of the invention.

#### DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

With reference initially to Figure 1, a system in accordance with the present  
5 invention has a removable and refillable storage tank 10 for unheated water, and a  
substantially smaller dispensing tank 12. Typically, tank 10 will hold about 1.7 liters  
of water, and tank 12 will hold approximately 700ml. A delivery line 14  
communicates at one end with the brew chamber 16 of a single serve beverage  
10 brewer, and at its opposite end with the dispensing tank 12 at an intermediate level  
“L” demarcating the tank interior into upper and lower compartments 12a, 12b. The  
volume of the upper compartment 12a is equal to the metered volume of hot water to  
be delivered to the brew chamber during a brew cycle.

The brew chamber 16 is of the type described for example in U.S. Patent No.  
6,079,315, the description of which is herein incorporated by reference. The brew  
15 chamber is adapted to receive a filter cartridge 18 containing a dry soluble beverage  
material, and to pierce the cartridge with inlet and outlet probes 20, 22. The inlet  
probe is connected to the delivery line 14 and serves to infuse the dry beverage  
material with the metered volume of heated water received from the upper tank  
compartment 12a. The outlet probe serves to direct the resulting brewed beverage  
20 downwardly into a cup 24 or the like. Alternatively, with a pod system, the brew  
chamber includes a device for holding the pod in place, with entrance and exit ports  
operative respectively on the inlet and outlet sides of the pod. The incoming water  
from the inlet port or ports passes through the inlet side of the filter media, dissolves  
the beverage material to thereby produce a beverage, and the beverage passes out the  
25 outlet side of the filter media and then through the outlet port or ports.

A vent valve 26 is connected via a vent line 28 to the upper compartment 12a  
and to the storage tank 10. An air pump 30 is operable to deliver pressurized air to  
the upper compartment 12a via air line 32.

A heater 34 operates to heat water received in the lower tank compartment  
30 12b. A water pump 36 serves to pump make up water via a supply line 38 from the  
storage tank 10 to the lower compartment 12b of the dispensing tank 12. A check  
valve 40 allows outward flow from and prevents reverse flow back to the tank 10. A  
check valve 41 between water pump 36 and dispensing tank 12 prevents reverse flow  
back from tank 12 to tank 10.

For reasons that will hereinafter become apparent, the flow capacity of the vent line 28 is preferably less than that of the supply line 38.

Sensors are strategically placed throughout the system to monitor operating conditions and generate representative control signals. These include: a temperature  
5 sensor 42 that generates a control signal 44 representative of water temperature in the lower tank compartment 12b; a pressure transducer 46 that generates a control signal 48 representative of the pressure in tank 12 by measuring the pressure in the water pump delivery side of supply line 38; a water level sensor 50 that generates a control  
10 signal 52 if the water level in the storage tank 10 drops below a preselected minimum; and a status indicator 54 that generates a control signal 56 indicating that the brew chamber has been loaded with a cartridge or a pod, as applicable, and is thus ready to commence a brewing cycle.

A controller 58 is enabled by the aforesaid control signals. The controller provides a status signal 64 to the control panel 62 indicating if and when the system is  
15 ready to brew. The controller is operative in response to a brew signal 60 generated at a control panel to operate the system through a brew cycle.

During a typical brew cycle, the controller 58 will issue command signals 66, 68, 70 and 72 respectively to operate the vent valve 26, air pump 30, water pump 36 and heater 34 in the following sequential stages:

- 20 (i) open vent valve 26;
- (ii) activate water pump 36 to pump unheated make up water from storage tank 10 into the lower compartment 12b of dispensing tank 12, thus displacing heated water from compartment 12b upwardly into compartment 12a;
- (iii) energize heater 34 to heat make up water received in compartment  
25 12b;
- (iv) deactivate water pump 36 when tank compartment 12a is filled, and the signal 48 from pressure transducer 46 indicates a rise in pressure in tank 12 resulting from water being directed into the smaller vent line 28;
- (v) close vent valve 26;
- 30 (vi) activate air pump 30 to deliver compressed air to the upper tank compartment 12a, thereby displacing heated water therefrom to the brew chamber 16 for infusion with the beverage material in the filter package 18 (or pod in the case of a pod system). Pressure transducer 46 will sense the increased pressure in tank 12 during delivery of water to the brew chamber, and its control signal 48 will register a

pressure drop when the compartment 12a has emptied and air is escaping via line 14 through the brew chamber during a concluding purge; and

(vii) deactivate air pump 30 after a programmed delay to accommodate the aforesaid purge.

5       The brew signal 60 may be generated prior to stage (i), when the upper tank compartment 12a is empty. The system will thus cycle from stage (i) through stage (vii). At the conclusion of stage (iv) when the water pump is deactivated, any water delivered to tank 12 in excess of the volume of upper compartment 12a will be received and trapped in the vent line 28 by closure of the vent valve 26. That excess  
10       water will not be drained back into tank 12 until the vent valve 26 is reopened, and thus will not adversely affect the accuracy of delivery to the brew chamber.

          Alternatively, the brew signal 60 may be generated between stages (iv) and (v), when the upper compartment 12a of tank 12 is already filled with water heated to the selected brew temperature. The system cycles through stages (v) to (vii), and then  
15       through stages (i) to (iv). This alternative minimizes the elapsed time between generation of the brew signal and the commencement of water delivery to the brew chamber. However, the next brew cycle is necessarily delayed by the time required to refill the tank 12 with make up water after the brew cycle is complete.

          In still another alternative, the controller 58 interrupts the operation of the  
20       water pump 36 during stage (iv) when the upper tank chamber 12a is only partially filled to a level  $L'$  based on having the water pump operate for a specified period of time that is shorter than that required to completely fill compartment 12a of tank 12. During normal full volume delivery, e.g., eight ounces, the controller 58 records, stores and averages the time necessary to fill compartment 12a. Partial volumes then  
25       can be selected via the brew signal 60. When a partial volume is selected, the controller 58 will adjust the run time of water pump 36 during stage (iv) to deliver the desired volume based on time rather than a pressure rise detected by pressure transducer 46. Thus, for example, a six ounce volume delivery would be obtained by timing the water pump 36 to run only 75% of the averaged run time to deliver a full  
30       eight ounces. Other volumes can be similarly delivered by appropriately adjusting the run time of water pump 36. At the commencement of a brew cycle, the brew signal 60 reactivates the water pump to complete stage (iv) and then continue through stages (v) to (vii) and from stage (i) to another interruption of stage (iv). With this alternative, the successive brew cycles are delayed by the time required to partially fill

compartment 12a, and the time elapsed between generation of the brew signal and commencement of water delivery to the brew chamber is delayed by the time required to complete the filling of compartment 12a.

As an alternative to timing the interruption of water pump 36 during stage (iv),  
5 a temperature transducer 43 can be located in dispensing tank 12 at level L'. The transducer 43 will emit a control signal 45 when heated water displaced from the lower tank compartment 12b reaches level L'. If the brew signal 60 selects the partial volume provided at level L', the controller 58 will react to the control signal 45 by deactivating the water pump 36 during stage (iv).

10 Instead of locating the pressure transducer 46 as shown in the supply line 38, it may alternatively be located in brew line 14, vent line 28, air pump line 32 or tank 12. These placements provide a signal representative of pressure in tank 12, similar to that shown in Figure 1.

Instead of employing the increased pressure signal 48 from pressure  
15 transducer 46 to conclude stage (iv), a sensor 74 might be employed to generate a control signal 76 indicative of the presence of water in vent line 28. The sensor 74 could be of a type responsive to the elevated temperature of water entering the vent line from chamber 12a, or it could be responsive to a flow of water in the vent line. Temperature sensing elements such as thermocouples or thermistors could be used to  
20 detect the rising level of hot water. Level or flow measuring devices such as reed switches, flow sensors, sensors responsive to the electrical conductivity of water or other level sensing instruments could also be employed to detect the rising column of water in the vent line 28.

A second embodiment of a system in accordance with the present invention is  
25 illustrated in Figure 2. Components of the second embodiment that are common to those of the first embodiment are identified with the same reference numerals.

In the second embodiment, the pressure transducer 46 of the first embodiment is eliminated in favor of a sensing resistor 78 connected in series with the power supply to the air pump 30, the latter being driven electrically by a D.C. motor. The  
30 voltage drop across the sensor resistor 78 is directly proportional to the current draw of the air pump and will indicate an increase in power consumption which indicates higher load or an increase in work. A control signal 80 relays changes in power consumption to the controller 58.

In response to a brew signal 60, the controller 58 of the system of Figure 2



operates initially to close the vent valve 26 and to simultaneously operate both the water pump 36 and the air pump 30. As heated water is displaced from compartment 12b into compartment 12a, air is displaced from compartment 12a. This displaced air, together with the air being pumped into that compartment by the air pump 30, is exhausted via vent line 28. The exhaustion of air via vent line 28 reduces the work load on the air pump, allowing it to operate at a relatively low level of power consumption. However, when compartment 12a is eventually filled with water, the level of power consumption of the air pump climbs to a second higher level as a result of the increased work required to discharge water as opposed to air through the vent line 28. In response to the control signal 80 representative of this increased level of power consumption, the controller closes vent valve 26 and deactivates the water pump 36. Continued operation of the air pump 30 now causes air to displace the water in compartment 12a via delivery line 14 to the brew chamber 16.

When compartment 12a has been emptied, and air is now being exhausted via delivery line 14 through the brew chamber 16 and the punctured cartridge or pod, the decrease in work now required to pump air will result in a decrease in voltage drop across the sensing resistor 78. The controller 58 will interpret this sudden rate of voltage\_change as the completion of the water dispensing process and will maintain the air pump 30 in operation for an additional short period of time, e.g., about 3 seconds, to achieve purging of any remaining water in the delivery system.

The third embodiment shown in Figure 3 is similar to the Figure 2 embodiment, except that the sensor resistor 78' is connected in series with the power supply to the water pump 36. The voltage drop across sensor resistor 78' is again directly proportional to the current draw of the water pump and will indicate an increase in power consumption when the upper compartment 12a of dispensing tank 12 is filled with water and water is now being forced into the vent line 28. A control signal 80' relays changes in power consumption of the water pump to the controller 58.

The brew cycle of the third embodiment is identical to that of the first embodiment, except that in stage (iv), the water pump 36 is deactivated in response to the control signal 80' indicating a rise in water pump power consumption when the upper tank compartment 12a has been filled with water.

In light of the foregoing, those skilled in the art will appreciate that the systems of the present invention are also useful in delivering unheated water by

simply deactivating or eliminating the heater 34 and temperature sensor 42.

We claim:

- 1           1.     A system for dispensing a metered volume of heated water to the brew  
2 chamber of a single serve beverage dispenser, said system comprising:  
3                 a storage tank for containing a supply of unheated water;  
4                 a dispensing tank;  
5                 a delivery line communicating with said brew chamber and with said  
6                         dispensing tank at an intermediate level demarcating the  
7                         interior of dispensing tank into upper and lower compartments,  
8                         the volume of said upper compartment being equal to said  
9                         metered volume;  
10                a vent valve communicating via a vent line with said upper  
11                         compartment;  
12                a supply line connecting said storage tank to said lower compartment;  
13                an air pump arranged to deliver pressurized air to said upper  
14                         compartment;  
15                a water pump in said supply line arranged to deliver water from  
16                         said storage tank to said lower compartment;  
17                a heater for heating water received in said dispensing tank;  
18                sensing means for generating control signals indicative of the level and  
19                         temperature of water in said dispensing tank; and  
20                a controller enabled by control signals generated by said sensing means  
21                         and operative in response to a brew signal for operating said air  
22                         and water pumps in conjunction with the opening and closure  
23                         of said vent valve to fill said upper compartment with heated  
24                         water displaced from said lower compartment and to discharge  
25                         the thus displaced heated water from said upper compartment  
26                         to said brew chamber.

1           2.     The system of claim 1 wherein said controller is operative sequentially to:

- 2                   (i)     open said vent valve;
- 3                   (ii)    activate said water pump to pump unheated make up water from
- 4                        said storage tank into said lower compartment of said dispensing
- 5                        tank, thus displacing heated water from said lower compartment
- 6                        upwardly into said upper compartment;
- 7                   (iii)   energize said heater to heat make up water received in said
- 8                        lower compartment;
- 9                   (iv)    deactivate said water pump when said upper compartment is
- 10                       filled;
- 11                   (v)     close said vent valve;
- 12                   (vi)   activate said air pump to deliver pressurized air to said upper
- 13                        tank chamber to displace heated water therefrom to said brew
- 14                        chamber; and
- 15                   (vii)   deactivate said air pump.

1           3.     The system as claimed in claim 2 wherein said brew signal is generated prior to

2     operational stage (i).

1           4.     The system as claimed in claim 2 wherein said brew signal is generated between

2     operational stages (iv) and (v).

1           5.     The system as claimed in claim 2 wherein said brew signal is generated during an

2     interruption in operational stage (v).

1           6.     The system as claimed in claims 1 or 2 wherein said sensing means includes

2     means for sensing the pressure in said dispensing tank.

1           7.     The system as claimed in claims 1 or 2 wherein said sensing means includes a

2     sensor for measuring the presence of water in said vent line.

1           8.     The system as claimed in claim 7 wherein said sensor is temperature responsive.

1           9.     The system as claimed in claim 7 wherein said sensor is responsive to the flow of

2     water in said vent line.

1           10.    The system as claimed in claim 7 wherein said sensor is responsive to electrical  
2 conductivity of water in said vent line.

1           11.    The system as claimed in claims 1 or 2 wherein said sensing means includes a  
2 temperature sensor for measuring the temperature of water in said dispensing tank.

1           12.    The system as claimed in claims 1 or 2 wherein said sensing means includes a  
2 water level sensor responsive to the level of water in said storage tank.

1           13.    The system as claimed in claim 2 wherein said controller deactivates said water  
2 pump at stage (iv) when said upper compartment is partially filled.

1           14.    The system as claimed in claim 13 wherein said controller deactivates said water  
2 pump at the conclusion of a time period calculated as a percentage of the average time required  
3 to completely fill said upper compartment.

1           15.    The system as claimed in claim 13 wherein said controller deactivates said water  
2 pump when the heated water in said upper compartment reaches a second level above said  
3 intermediate level.

1           16.    The system as claimed in claim 15 wherein said controller is enabled to deactivate  
2 said water pump by a control signal generated by a temperature sensor in said dispensing tank at  
3 said second level.

1           17.    A system for dispensing a metered volume of water to the chamber of a single  
2 serve beverage dispenser, said system comprising:

3                   a storage tank for containing a supply of water;

4                   a dispensing tank;

5                   a delivery line communicating with said chamber and with said

6                               dispensing tank at an intermediate level demarcating the interior of

7                               dispensing tank into upper and lower compartments, the volume of said

8                               upper compartment being equal to said metered volume;

9                   a vent valve communicating via a vent line with said upper compartment;

10                  a supply line connecting said storage tank to said lower compartment;

11                  an air pump for delivering pressurized air to said upper compartment;

12 a water pump in said supply line for delivering water from said storage tank  
13 to said lower compartment;  
14 sensing means for generating control signals indicative of the level  
15 of water in said dispensing tank; and  
16 a controller enabled by control signals generated by said sensing means and  
17 operative in response to a delivery signal for operating said air and water  
18 pumps in conjunction with the opening and closure of said vent valve to  
19 fill said upper compartment with water displaced from said lower  
20 compartment and to discharge the thus displaced water from said upper  
21 compartment to said chamber.

1 18. The system of claim 17 wherein said controller is operative sequentially to:  
2 (i) open said vent valve;  
3 (ii) activate said water pump to pump make up water from  
4 said storage tank into the lower compartment of said  
5 dispensing tank, thus displacing water from said lower  
6 compartment upwardly into said upper compartment;  
7 (iii) deactivate said water pump when said upper  
8 compartment is filled;  
9 (iv) close said vent valve;  
10 (v) activate said air pump to deliver pressurized air to said  
11 upper tank chamber to displace water therefrom to said chamber;  
12 and  
13 (vi) deactivate said air pump.

1 19. The system of claim 17 wherein said air pump is electrically powered, wherein  
2 the power consumption of said air pump is at a first level when its air delivery to said upper  
3 compartment is exhausted from said upper compartment via said vent line, and wherein said  
4 power consumption is at a second higher level when said upper compartment is filled with water  
5 and said air delivery serves to displace water from said upper compartment.

1 20. The system of claim 19 wherein said sensing means includes resistor means for  
2 sensing the level of power consumption of said air pump and for generating a control signal  
3 representative of said level.

1           21.     The system of claim 20 wherein in response to said delivery signal, said controller  
2 opens said vent valve and initially operates said water and air pumps simultaneously to displace  
3 water from said lower compartment into said upper compartment while exhausting air from said  
4 upper compartment via said vent line, thereby maintaining the power consumption of said air  
5 pump at said first level, and in response to a control signal from said resistor means indicating  
6 that the power consumption of said air pump has elevated to said second level, said controller  
7 closes said vent valve and deactivates said water pump while continuing to operate said air pump  
8 to thereby displace water from said upper compartment via said delivery line to said chamber.

1           22.     The system of claim 17 wherein said water pump is electrically powered, wherein  
2 the power consumption of said water pump is at a first level when its water delivery to said lower  
3 compartment displaces water into said upper compartment and the thus displaced water displaces  
4 air from said upper compartment via said vent line, and wherein said power consumption is at a  
5 second higher level when said upper compartment is filled with water and water is displaced  
6 from said upper compartment into said vent line.

1           23.     The system of claim 22 wherein said sensing means includes resistor means for  
2 sensing the level of power consumption of said water pump and for generating a control signal  
3 representative of said level.

1           24.     The system of claim 23 wherein in response to said delivery signal, said controller  
2 opens said vent valve and initially operates said water pump to displace water from said lower  
3 compartment into said upper compartment while exhausting air from said upper compartment via  
4 said vent line, thereby maintaining the power consumption of said water pump at said first level,  
5 and in response to a control signal from said resistor means indicating that the power  
6 consumption of said water pump has elevated to said second level, said controller closes said  
7 vent valve, deactivates said water pump and activates said air pump to thereby displace water  
8 from said upper compartment via said delivery line to said chamber.

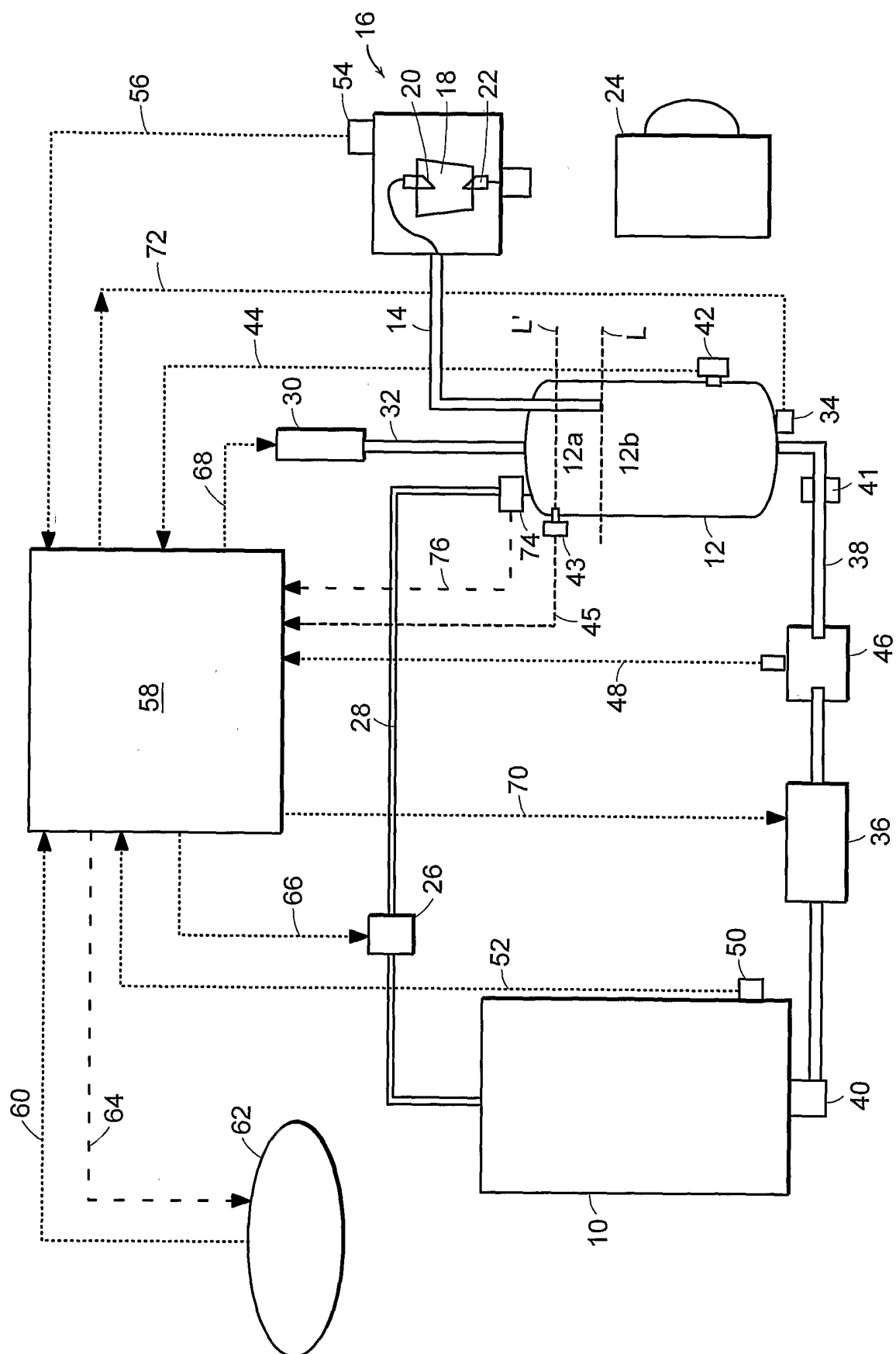


FIG. 1



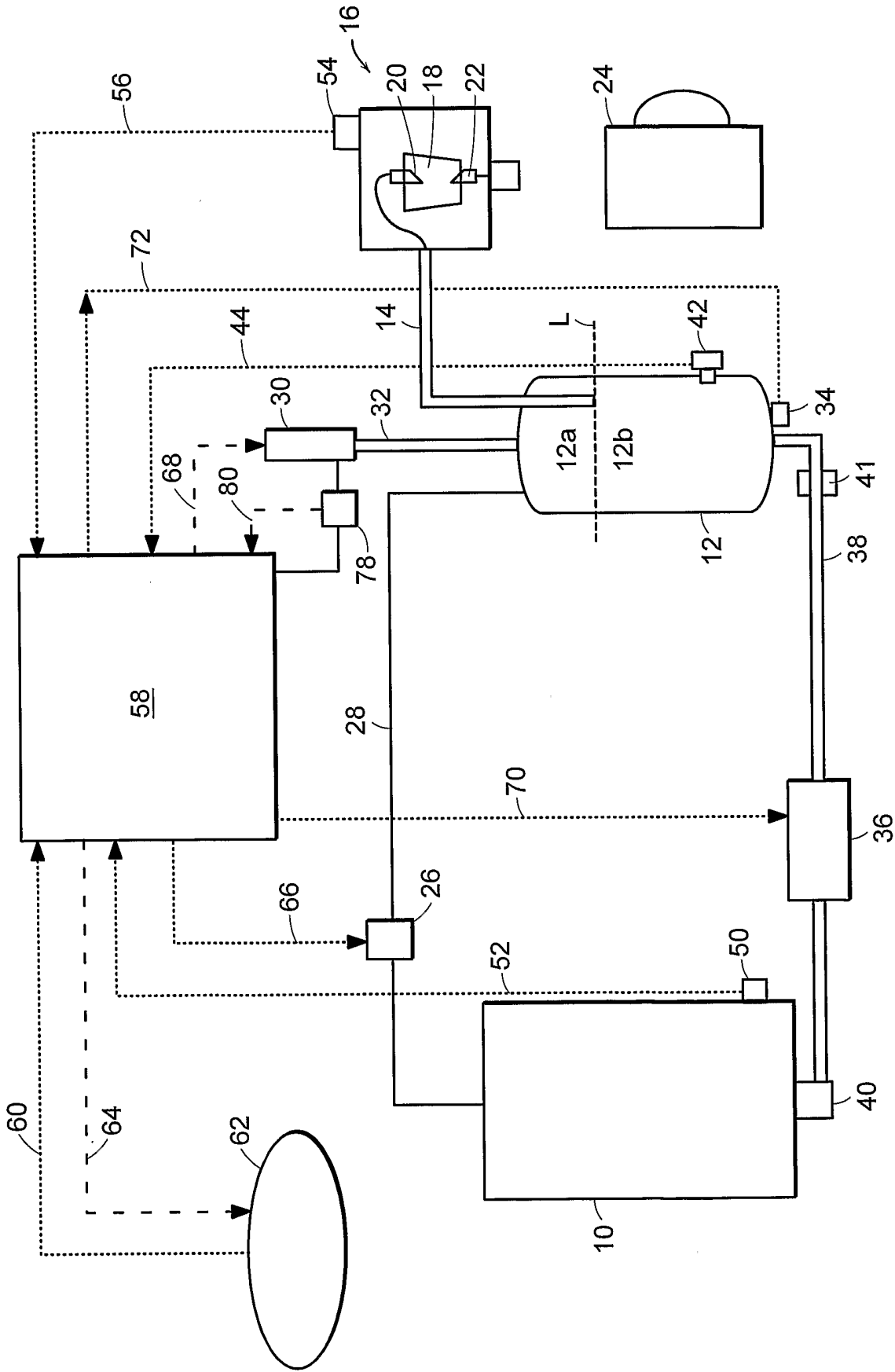


FIG. 2

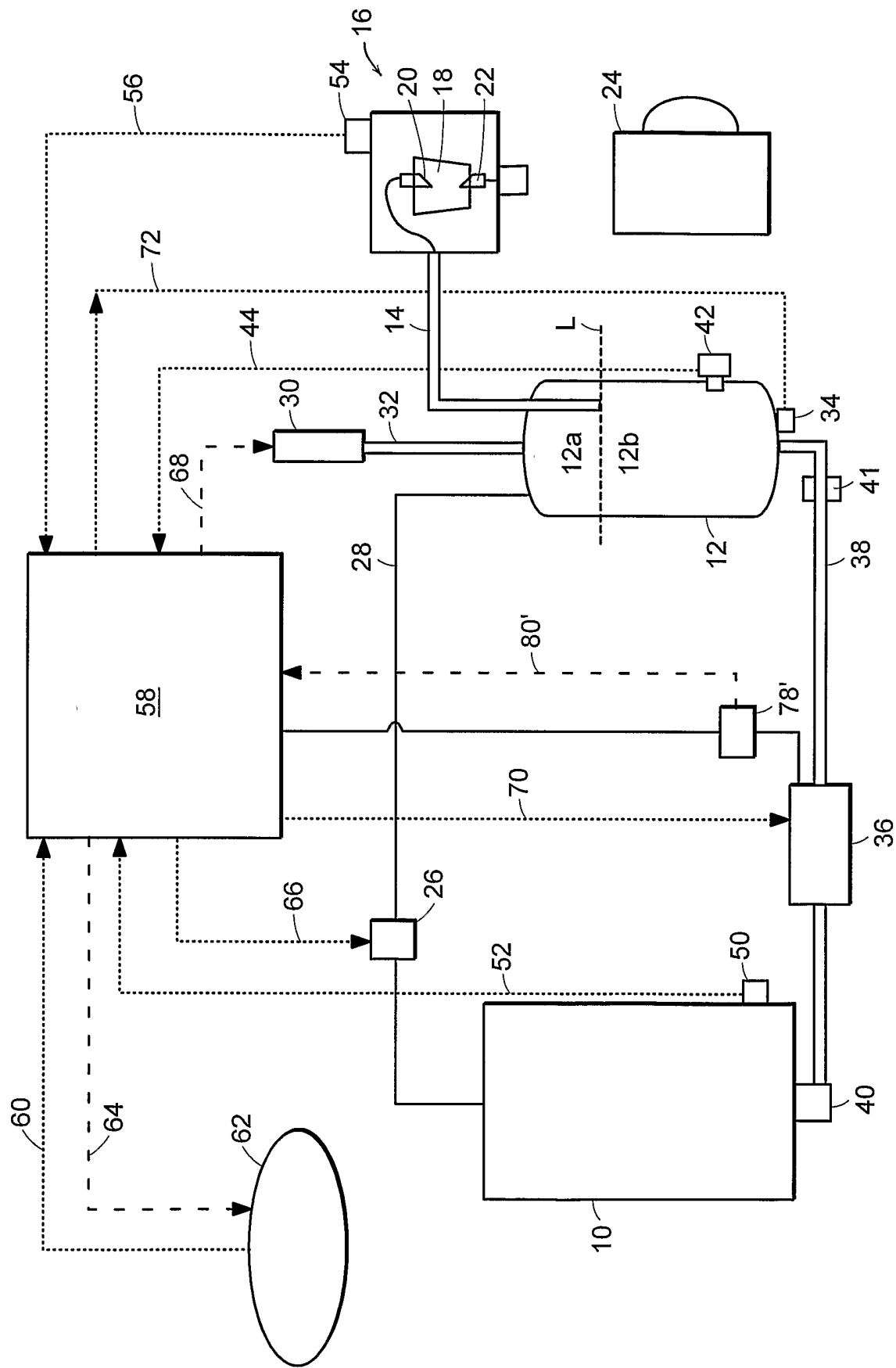


FIG. 3

# INTERNATIONAL SEARCH REPORT

International Application No.

.../US2004/041037

**A. CLASSIFICATION OF SUBJECT MATTER**

IPC 7 A47J31/32 A47J31/40 A47J31/56

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 A47J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6 142 063 A (BEAULIEU ET AL) 7 November 2000 (2000-11-07) cited in the application column 2, line 27 - column 3, line 4 column 3, lines 46-52 column 5, line 17 - column 6, line 16; figure 1	1,17
A	US 4 143 589 A (WEBER ET AL) 13 March 1979 (1979-03-13) column 2, lines 26-55 column 5, line 57 - column 7, line 65; figure 1	1,17

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

15 March 2005

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Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+31-70) 340-3016

Authorized officer

Novelli, B

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

T/US2004/041037

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 6142063	A	07-11-2000	CA 2290601 A1	19-07-2000
US 4143589	A	13-03-1979	NONE	