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(54) **Refrigerating apparatus with water distributor**

(57) A refrigeration apparatus (1) is described, which is fitted with a refrigerated water distributor (6) supplied by a hydraulic circuit (4,12) adapted to be connected to a water supply, this being external to the apparatus, typically the public drinking water supply; the apparatus comprises a first solenoid valve (12) being located in the hydraulic circuit, a second solenoid valve (63) being located in the distributor, and an electronic control system (13); the electronic control system (13) is adapted to actuate the solenoid valves (12,63) so as to control the water flow in the circuit and the water flow in the distributor, as well as to determine the quantity of water flown.

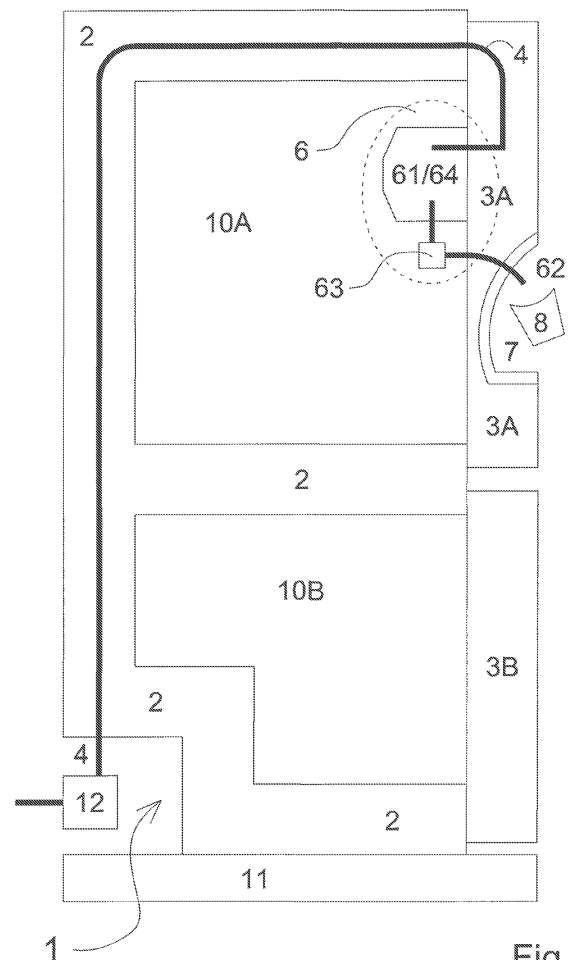


Fig.1

Description

[0001] The present invention relates to a refrigeration apparatus according to the preamble of claim 1.

[0002] Said refrigeration apparatus is fitted with a refrigerated water distributor; the latter is supplied by an hydraulic circuit being internal to the apparatus; the hydraulic circuit is adapted to be connected to a water supply this being external to the apparatus, typically the public drinking water supply.

[0003] The following description will always refer to refrigerators for domestic use, without the present invention being strictly limited thereto.

[0004] Refrigerators having these features have been widespread for decades in the USA; in fact, most refrigerators on the American market are fitted with distributors which are capable of distributing both refrigerated water and ice, and in some cases other refrigerated beverages as well; such distributors are therefore quite bulky. These refrigerators have two doors placed side by side and are very bulky; the distributor is applied to one of the doors and protrudes remarkably inward from the door; outside the refrigerator, there is a deep cavity on the door for placing e.g. a glass, in which the water and ice distribution ducts come out; so there is no substantial protrusion.

[0005] In Europe, distributor-mounted refrigerators have only recently begun to spread around.

[0006] The European market demands rather different products, i.e. products being much less bulky (60 or 70 cm wide) and offering distribution of refrigerated water only; moreover, said products must have a low cost and therefore must use simple but effective technical solutions.

[0007] The general object of the present invention is to provide a simple and effective solution related to the hydraulic system of a refrigeration apparatus fitted with a refrigerated water distributor.

[0008] In particular, a specific object of the present invention is to provide a simple but effective solution related to the hydraulic circuit of a refrigerator for domestic use being typically adapted to the European market.

[0009] Said objects are achieved by the refrigeration apparatus having the features detailed in the independent claim 1.

[0010] By means of only two solenoid valves and a simple electronic control system, it is possible to control and determine the water flow in the entire hydraulic system of the refrigeration apparatus easily and effectively.

[0011] Further aspects of the present invention are detailed in dependent claims.

[0012] The present invention will become more apparent from the following description and from the annexed drawings, wherein:

Fig. 1 shows a schematic sectional view of a refrigeration apparatus according to the present invention, Fig. 2 shows a sectional view of a solenoid valve used in the apparatus of Fig. 1,

Fig. 3 shows sectional and axonometric views of a detail of the solenoid valve of Fig. 2, and

Fig. 4 shows a diagram of the hydraulic system of the apparatus of Fig. 1.

[0013] Both said description and said drawings are to be considered as non-limiting examples.

[0014] Fig. 1 shows a schematic sectional view of a domestic-use refrigerator according to the present invention, being indicated as a whole with the reference number 1.

[0015] Said refrigerator comprises a cabinet 2 being placed on a base 11; in the illustration, the cabinet walls are very thick to indicate the presence of a thick layer of thermo-insulating material; in general, the thickness of the insulating material depends on the type of cell (in practice, on the operating temperatures of the cell) and, of course, on the type of insulating material employed; this is a common feature being well known to those skilled in the art.

[0016] Said refrigerator comprises two refrigeration cells, being indicated as a whole with the reference number 10; a cell 10A is used for fresh food and is located in the upper portion of the cabinet 2, and a cell 10B is used for frozen food and is located in the lower portion of the cabinet 2.

[0017] Two doors are provided, being indicated as a whole with the reference number 3, for closing the refrigeration cells 10; in particular, there is an upper door 3A for the cell 10A and a lower door 3B for the cell 10B.

[0018] The refrigerator 1 is fitted with a refrigerated water distributor, being indicated as a whole with the reference number 6, which is mounted on a door of the refrigerator; in the illustrated embodiment example, the distributor is mounted on the upper door 3A.

[0019] The refrigerated water distributor of the refrigerator according to the embodiment example of Fig. 1 is connected to the public drinking water supply. The water reaches the refrigerator 1 from the water supply through a pipe; the figure only shows a short length of said pipe; the water supply pipe is connected to the inlet of a first solenoid valve 12; the outlet of the solenoid valve 12 is connected to a pipe being indicated with the reference number 4. In the illustration, the connection of the distributor 6 to the water supply is represented as a single tubular element (being both simple and effective, and therefore preferable); other embodiments of the present invention may however comprise a number of interconnected tubular elements.

[0020] The pipe 4 starts from a cavity obtained in the lower portion of the cabinet 2 (also housing the solenoid valve 12) and then enters through the rear wall of the cabinet 2, runs within the insulating material up to the top of the cabinet 2, enters through the upper wall of the cabinet 2, runs within the insulating material, leaves the cabinet 2 and enters the door 3A; the pipe 4 then runs within the insulating material of the door 3A and reaches the distributor 6.

[0021] The above-mentioned cavity is also used, for example, for housing the refrigerator compressor.

[0022] The distributor 6 comprises a tank 61, which receives water through the pipe 4; the tank 61 is located within the refrigeration cell 10A, so that the water being present in said tank is refrigerated.

[0023] The distributor 6 also comprises a duct 62, being connected to the tank 61 through a second solenoid valve 63, which is used for distributing refrigerated water to the user.

[0024] The distributor 6 also comprises a filter for the refrigerated water 64.

[0025] In Fig. 1, the tank 61 and the filter 64 are represented by a single block, in that in this preferred embodiment example they are closely coupled from both the hydraulic and the mechanical viewpoints.

[0026] Of course, it is necessary to employ means for controlling the supply of water to the tank 61 and means for controlling the distribution of water through the duct 62; these means essentially comprise the solenoid valves 12 and 63 and an electronic control system 13 (not shown in Fig. 1); in domestic-use refrigerators, the electronic systems are often placed in the top wall of the refrigerator cabinet.

[0027] The electronic control system of the refrigerator of Fig. 1 is connected to a control panel 65 (not shown in Fig. 1) of the distributor 6 being located on the door 3A, facing outward, just above the recess 7; said control panel comprises a push-button allowing the user to request the distribution of refrigerated water, and a warning lamp indicating when the filter 64 is worn out.

[0028] The upper door 3A of the refrigerator according to the embodiment example of Fig. 1 has a recess 7 where the duct 62 comes out; the recess 7 is open outward and is used to receive, for example, a glass 8 (without the possibility of an effective rest), to be filled with water coming out from the duct 62.

[0029] In the example of Fig. 1, said recess is not deep and therefore does not extend inside the refrigeration cells; thus the recess 7 does not subtract volume from the refrigeration cells, and the door 3A keeps a (thinner) layer of thermo-insulating material even in the area of the recess 7.

[0030] The refrigerator doors 3A and 3B are connected to the cabinet through hinges allowing the doors to be opened and closed by the user with a rotary movement about a vertical axis. The hinges are not shown in Fig. 1 for simplicity's sake; in the field of refrigeration apparatus, different types of hinges are commonly used, which are generally known to those skilled in the art.

[0031] In the refrigerator of Fig. 1, the following elements run between the door 3A and the cabinet 2: the water pipe 4, an electric cable (typically a double-wire) to supply power to the distributor 6, and another electric cable (typically a multiwire cable) to connect the electronic control system 13 to the control panel 65; these connections require appropriate solutions to prevent the tubular elements (pipe and cables) from being damaged

due to repeated opening and closing of the door 3A; adapted solutions are already known in the refrigerator field.

[0032] In general, according to the present invention, the refrigeration apparatus is fitted with a refrigerated water distributor supplied by an hydraulic circuit adapted to be connected to a water supply being external to the apparatus, and comprises a first solenoid valve located in the hydraulic circuit, a second solenoid valve located in the distributor, and an electronic control system being adapted to control the water flow in the circuit and the water flow in the distributor, as well as to determine the quantity of water flown.

[0033] With reference to Fig. 1, the hydraulic circuit essentially consists of the solenoid valve 12 and the pipe 4, whereas the second solenoid valve corresponds to the solenoid valve 63.

[0034] Solenoid valves being particularly adapted to the present invention are simple solenoid valves having an open position and a closed position; the quantity of water flowing through a valve can be determined by calculating the opening time of said valve, so long as valve size and flow speed are known. Of course, with more valves being available it will be possible to determine the quantity of water flowing through each of them, if necessary (e.g. in the event of leaks in the circuit or in the presence of water accumulation devices).

[0035] The hydraulic system of the refrigerator of Fig. 1 is simple, as schematized in Fig. 3; therefore, by using only two solenoid valves and a simple electronic control system, it is possible to control and determine the water flow in the whole system; not only, it is also possible to determine any water accumulation and/or leaks.

[0036] An electronic control system being adapted to the present invention may be advantageously based on a microcontroller with a few additional components. Such a system may also be advantageously integrated into the electronic control system of the whole refrigerator, since it performs just a few and simple operations. Electronic control systems for refrigerators have been well known for a long time to those skilled in the art.

[0037] Typically, the distributor of the apparatus according to the present invention comprises a refrigerated water tank; this is the simplest way to deliver refrigerated water as soon as the user requests it.

[0038] Advantageously, the distributor of the apparatus according to the present invention comprises a filter for refrigerated water; this filter is very useful because the drinking water being distributed by the water supply often contains undesired, if not harmful, particles and substances (chlorine, for example, gives water a bad taste).

[0039] Preferably, the filter is connected immediately downstream the tank (if present), so as to filter the water just before it is distributed to and drunk by the user; in this way, any living creatures possibly developed in the tank due to a long accumulation time will be filtered as well.

[0040] The distributor according to the present invention generally has a refrigerated water distribution duct, indicated in the illustrated example with 62, while the second solenoid valve, indicated in the illustrated example with 63, is placed directly upstream of said duct; it is thus possible to prevent any undesired dripping from the duct.

[0041] The first solenoid valve, indicated in the illustrated example with 12, is preferably located at the beginning of the hydraulic circuit; its inlet is adapted to be connected to the water supply, and its outlet is connected to the distributor inlet preferably through a single pipe, indicated in the illustrated example with 4; this solution reduces the risk of water leaks within the refrigerator walls.

[0042] Advantageously, the distribution duct comes out in a recess this not being very deep, located on a door of the refrigeration apparatus; in this way, said recess does not subtract volume from the refrigeration cells and the door can keep a (thinner) layer of thermo-insulating material even in the area of the recess.

[0043] Typically, the refrigeration apparatus according to the present invention has a distributor control panel located on a door of the apparatus itself; preferably, said panel is located in the area of the recess; alternately, said distributor control panel may be integrated with the refrigerator control panel.

[0044] In its simplest form, the control panel may be a push-button; when the user presses the push-button, water will come out from the distribution duct; it may be so conceived, for example, that the distribution lasts as long as the user keeps the push-button pressed or that a fixed quantity of water is distributed (e.g. 100 cc, equivalent to a small glass) every time the push-button is pressed.

[0045] The solenoid valves may be of the constant-flow type (of course, the flow can never be perfectly constant); in this way, the adjustment and measurement of the water flow is much more accurate.

[0046] Good performance is obtained even by using just one constant-flow solenoid valve; in this case, this solenoid valve is preferably the first one, indicated in the illustrated example with 12, in that it has a greater effect on the whole hydraulic system.

[0047] For simplicity's sake, the electronic control system may be adapted to determine the quantity of water flown on the basis of the opening and closing times of the first solenoid valve alone, which is indicated in the illustrated example with 12; in fact, this will suffice if there are no leaks and if the quantity of water accumulated in the tank (if present) is known and constant.

[0048] Besides, the use of valves having a substantially constant flow allows to obtain a very accurate time-based measurement of the quantity of water flown.

[0049] The determination of the quantity of water flown is generally useful to monitor the operation of the hydraulic system and the distributor of the refrigeration apparatus.

[0050] If there is a filter, the determination of the quantity of water flown may advantageously be used to deter-

mine the condition of the filter as well; it is known, in fact, that the efficiency of these water filters decreases as water flows through them; a common type of filter, for instance, has a replaceable cartridge (the cartridge is designed to filter only a certain maximum quantity of water).

[0051] Downstream the first solenoid valve, indicated in the illustrated example with 12, it is extremely useful to provide a pressure being substantially constant and substantially independent from the pressure in the water supply; as a matter of fact, depending on the place, the pressure in the public drinking water supply may vary remarkably (even in the same place, the pressure may vary in the course of the day); in this way, almost the entire hydraulic system can operate at constant pressures, thereby offering uniform performance independently from the water supply.

[0052] In particular, it is useful to provide a substantially constant pressure downstream the first solenoid valve, said pressure being comprised in the range from 1 to 2 bar, preferably approx. 1.5 bar, with a pressure in the water supply between 2 and 8 bar. For lower distribution water supply pressures, the hydraulic system will still work, but with reduced performance.

[0053] These results are attained with an appropriate selection of the first solenoid valve; a particularly advantageous example of this selection is given below.

[0054] According to the present invention, for simplicity's sake, the two solenoid valves may have flow sections being substantially equal, typically between 1.6 mm and 2.0 mm.

[0055] According to the present invention, for simplicity's sake, the electronic control system can activate the solenoid valves substantially simultaneously (or, at most, delay the closing of the solenoid valve 63 slightly with respect to the solenoid valve 12); in fact, the pressure in almost the entire hydraulic system is low, and therefore there are no particular requirements as regards the release of pressure accumulated in the system as water flows during the distribution phase. Moreover, if both solenoid valves are opened and closed simultaneously when the user presses the distribution push-button, the distribution will always start and finish at the right time and without delays.

[0056] A particularly advantageous type of solenoid valve for the refrigeration apparatus according to the present invention is a solenoid valve fitted with a device for stabilizing the water flow independently from the upstream pressure (of course, this is just a substantial, not absolute, stabilization).

[0057] An example of said valve is illustrated in Fig. 2; valves like these, though not very common, can already be found on the market and are manufactured, for example, by the Italian company R.P.E..

[0058] The solenoid valve of Fig. 2 consists of an actuator assembly 121, a valve body 122 and a flow stabilization device 123; in the example of Fig. 2 (and as it is preferable) the flow stabilization device is located at the valve outlet.

[0059] Fig. 3 illustrates the device 123 in detail; it consists of an elastic diaphragm 123A and a rigid body 123B; the elastic diaphragm can have the shape like a spring washer and be made typically of rubber; the rigid body can have the shape like a rigid bush and be made typically of plastic. The washer is mounted to the bush so as to be deformed under the pressure of the water flowing through the valve and to vary the valve outlet flow section depending on the upstream pressure, i.e. within the body 122.

[0060] For simplicity's sake, a solenoid valve like the one described may only be used at the inlet of the hydraulic circuit of the refrigeration apparatus according to the present invention; in the illustrated example, the solenoid valve 12 may advantageously be of this type.

[0061] The electronic control system according to the present invention may be adapted to activate the solenoid valves so as to avoid any distribution of refrigerated water if the filter is worn out; thus, the user will always drink properly filtered water.

[0062] The electronic control system may be adapted to warn the user when the filter is almost worn out; the user will thus have the time to obtain, for example, a new filter or a new cartridge; this is particularly important if the electronic control system provides for blocking the device when the filter becomes worn out.

[0063] The above teachings are particularly advantageous for refrigeration apparatus comprising a cell for fresh food being located in the upper portion of the apparatus cabinet and having its own door, and a cell for frozen food being located in the lower portion of the apparatus cabinet and having its own door; in this case, the refrigerated water distributor is mounted on the door of the cell for fresh food; the illustrated example precisely refers to such a case.

Claims

1. Refrigeration apparatus (1) fitted with a refrigerated water distributor (6) supplied by a hydraulic circuit (4,12) adapted to be connected to a water supply this being external to the apparatus, comprising:

a first solenoid valve (12) being located in the hydraulic circuit, and
a second solenoid valve (63) being located in the distributor,

characterized in that it comprises an electronic control system (13) adapted to activate the solenoid valves (12,63) so as to control the water flow in the circuit and the water flow in the distributor, as well as to determine the quantity of water flown.

2. Refrigeration apparatus (1) according to claim 1, wherein the distributor (6) comprises a refrigerated water tank (61).

3. Refrigeration apparatus (1) according to claim 1 or 2, wherein the distributor (6) comprises a filter (64) for refrigerated water being preferably connected immediately downstream the tank (61).

4. Refrigeration apparatus (1) according to claim 1 or 2 or 3, wherein the distributor (6) comprises a duct (62) for distribution of refrigerated water and in that the second solenoid valve (63) is located immediately upstream the distribution duct (62).

5. Refrigeration apparatus (1) according to one of the previous claims, wherein the first solenoid valve (12) is located at the beginning of the hydraulic circuit and has an inlet adapted to be connected to the water supply and an outlet being connected to the inlet of the distributor (6), preferably through a single pipe (4).

6. Refrigeration apparatus (1) according to claim 4 or 5, wherein said distribution duct (62) comes out in a recess (7) this being not very deep and located on a door (3A) of the refrigeration apparatus (1).

7. Refrigeration apparatus (1) according to one of the previous claims, wherein it comprises a control panel (65) for the distributor (6), being located on a door (3A) of the refrigeration apparatus (1), preferably in the area of said recess (7).

8. Refrigeration apparatus (1) according to one of the previous claims, wherein at least one of the solenoid valves (12,63) is of the type having a substantially constant flow.

9. Refrigeration apparatus (1) according to claim 8, wherein only the first solenoid valve (12) is of the type having a substantially constant flow.

10. Refrigeration apparatus (1) according to one of the previous claims, wherein the electronic control system (13) is adapted to determine the quantity of water flown on the basis of the opening and closing times of the first solenoid valve (12) only.

11. Refrigeration apparatus (1) according to one of claims 3 to 10, wherein the electronic control system (13) is adapted to use the quantity of water flown in order to determine the condition of said filter (64).

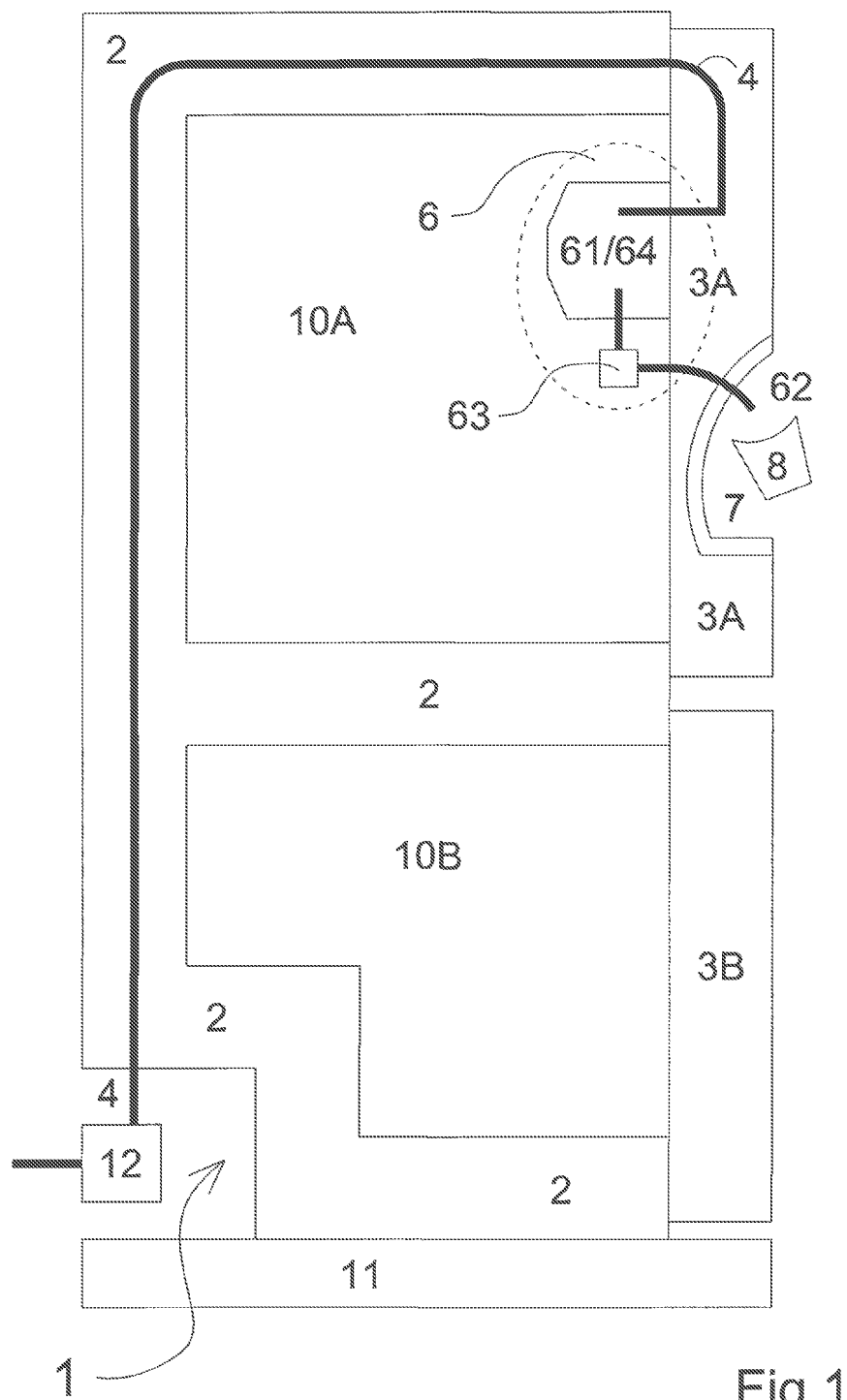
12. Refrigeration apparatus (1) according to one of the previous claims, wherein downstream the first solenoid valve (12) there is a pressure being substantially constant and substantially independent from the pressure in the water supply.

13. Refrigeration apparatus (1) according to claim 12, wherein downstream the first solenoid valve (12)

there is a pressure being substantially constant and comprised in the range between 1 to 2 bar, preferably approx. 1.5 bar, with a pressure in the water supply between 2 and 8 bar.

vantageous embodiments of the same.

- 5
- 14.** Refrigeration apparatus (1) according to one of the previous claims, wherein the two solenoid valves (12,63) have substantially equal flow sections, typically between 1.6 mm and 2.0 mm.
- 10
- 15.** Refrigeration apparatus (1) according to one of the previous claims, wherein the electronic control system (13) is adapted to activate the solenoid valves (12,63) substantially simultaneously.
- 15
- 16.** Refrigeration apparatus (1) according to one of the previous claims, wherein one or both solenoid valves (12,63) are of the solenoid type.
- 20
- 17.** Refrigeration apparatus (1) according to one of the previous claims, wherein at least one of the solenoid valves (12,63) is fitted with a device (123) for stabilizing the water flow, being preferably located at the outlet of the solenoid valve.
- 25
- 18.** Refrigeration apparatus (1) according to claim 17, wherein only the first solenoid valve (12) is fitted with a device (123) for stabilizing the water flow, being preferably located at its outlet.
- 30
- 19.** Refrigeration apparatus (1) according to one of claims 3 to 18, wherein the electronic control system (13) is adapted to activate the solenoid valves (12,63) so as to avoid any distribution of refrigerated water if the filter (64) is worn out.
- 35
- 20.** Refrigeration apparatus according to one of claims 3 to 19, wherein the electronic control system (13) is adapted to warn the user when the filter (64) is almost worn out.
- 40
- 21.** Refrigeration apparatus (1) according to one of the previous claims, comprising:
- a cell for fresh food (10A) being located in the upper portion of the cabinet (2) of the apparatus (1) and having its own door (3A), and
 - a cell for frozen food (10B) being located in the lower portion of the cabinet (2) of the apparatus (1) and having its own door (3B);
- 45
- 50
- wherein the refrigerated water distributor (6) is mounted on the door (3A) of the cell for fresh food (10A).
- 55
- 22.** Refrigeration apparatus according to the innovative teachings of the present description and of the annexed drawings, which represent preferred and ad-



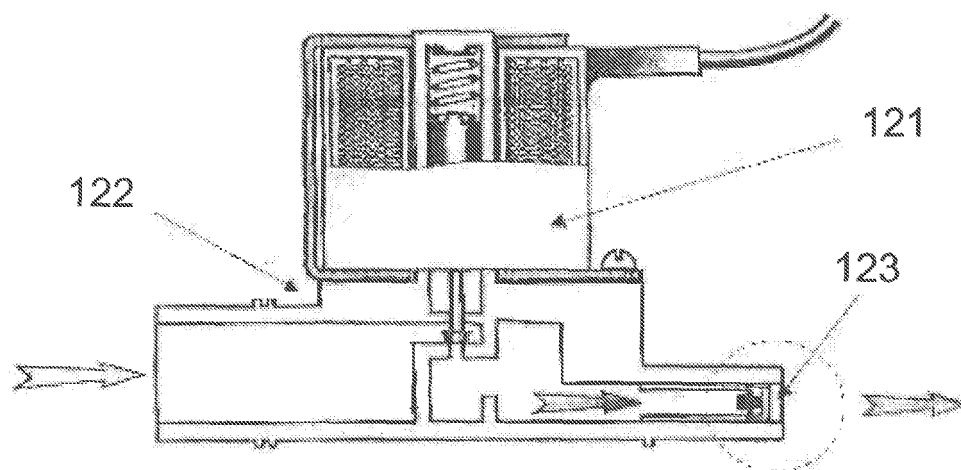


Fig.2

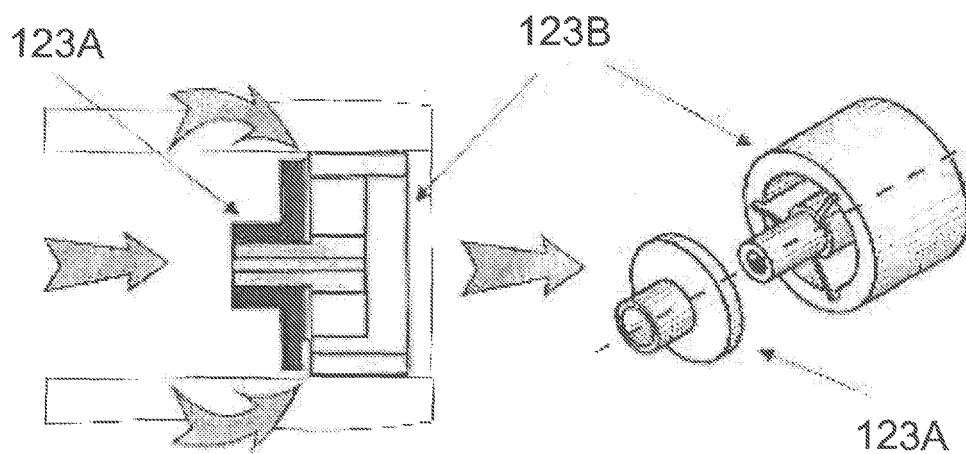


Fig.3

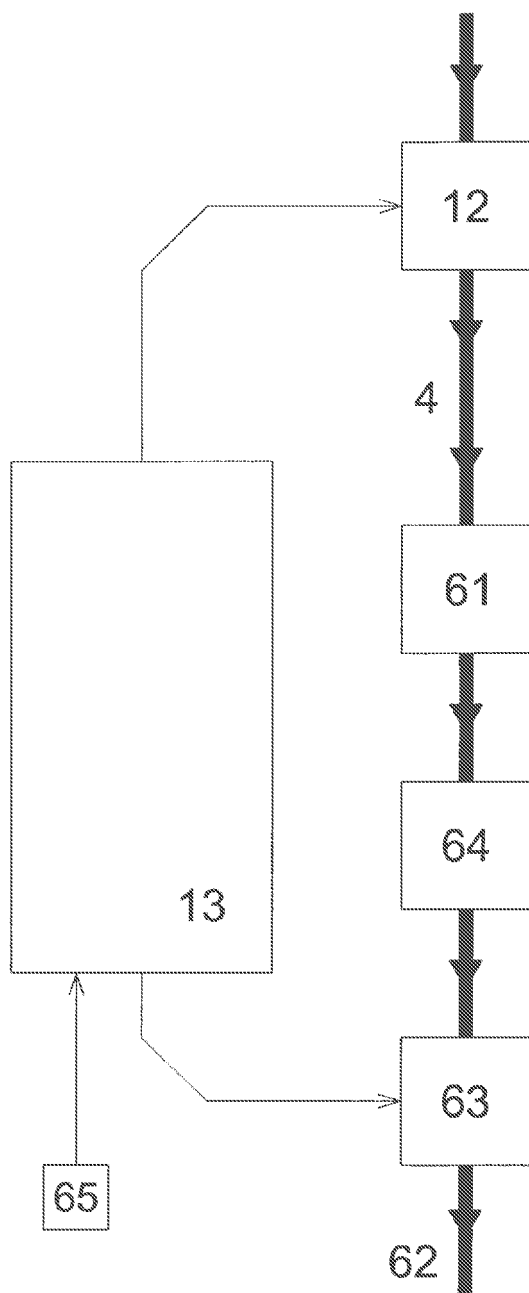


Fig.4



European Patent
Office

PARTIAL EUROPEAN SEARCH REPORT

Application Number

which under Rule 45 of the European Patent Convention EP 05 10 7108 shall be considered, for the purposes of subsequent proceedings, as the European search report

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 1 030 143 A (CANDY S.P.A) 23 August 2000 (2000-08-23)	1-3,7, 11,16, 19,20	F25D23/12
Y	* column 2, line 18 - column 4, line 5; figure 2 *	4-6,8, 10,12, 13,15,21	
Y	----- EP 1 139 045 A (CANDY S.P.A) 4 October 2001 (2001-10-04)	4-6,8, 12,13, 15,21	
A	* column 2, line 33 - column 5, line 50; figures 1,2 *	14	
Y	----- US 6 334 318 B1 (ANDO HITOSHI ET AL) 1 January 2002 (2002-01-01) * column 5, line 34 - line 35 *	10	
X	----- US 5 813 245 A (COATES ET AL) 29 September 1998 (1998-09-29) * column 3, line 17 - line 32 * * column 5, line 59 - column 6, line 43; figure 2 *	1-3,5-9, 15,16	
	-----		TECHNICAL FIELDS SEARCHED (IPC)
			F25D B67D
INCOMPLETE SEARCH			
The Search Division considers that the present application, or one or more of its claims, does/do not comply with the EPC to such an extent that a meaningful search into the state of the art cannot be carried out, or can only be carried out partially, for these claims. Claims searched completely : Claims searched incompletely : Claims not searched : Reason for the limitation of the search: see sheet C			
Place of search Munich		Date of completion of the search 9 November 2005	Examiner Zanotti, L
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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EPO FORM 1503 03/02 (P04C07)



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**INCOMPLETE SEARCH
SHEET C**

Application Number
EP 05 10 7108

Claim(s) searched completely:
1-21

Claim(s) not searched:
22

Reason for the limitation of the search (non-patentable invention(s)):

Fees under Rule 31 EPC for claim 22 not paid

**CLAIMS INCURRING FEES**

The present European patent application comprised at the time of filing more than ten claims.

- ☒ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims and for those claims for which claims fees have been paid, namely claim(s):

1-21

- ☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

- ☐ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.
- ☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.
- ☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:
- ☐ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 05 10 7108

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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09-11-2005

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