(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 617 150 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
18.01.2006 Bulletin 2006/03

(51) Int Cl.:
F24D 19/08 *(2006.01)*

(21) Application number: **05106011.9**

(22) Date of filing: **01.07.2005**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI SK TR
Designated Extension States:
AL BA HR MK YU

(30) Priority: **16.07.2004 FI 20040992**

(71) Applicant: **Tekno-Innovaatio Oy**
20810 Turku (FI)

(72) Inventor: **Kärkkäinen, Aatos**
20810, Turku (FI)

(74) Representative: **Maskula, Silla Marjatta**
Turun Patenttitoimisto Oy,
P.O. Box 99
20521 Turku (FI)

Remarks:
Amended claims in accordance with Rule 86 (2) EPC.

(54) Method and arrangement for air removal and filling of a liquid circulation system

(57) The invention relates to a method for removing air from a liquid circulation system, in which method the air in the liquid circulation system is removed before the system is filled with circulating liquid. The method according to the invention is characterized in that air is displaced by replacement steam that is generated of a liquid the steam pressure of which at the temperature of 20º C is higher than the steam pressure of water at the temperature of 20º C. When liquids having a higher steam pressure than the steam pressure of water are used for generating replacement steam, the steam can be generated in such low temperatures, that condensation of steam does not take place in the system, or condensation is very slight. This, in turn, makes it possible to use equipment that is simple and has a low efficiency. The invention also relates to an arrangement for removing air from the liquid circulation system.

EP 1 617 150 A1

Description

[0001] The present invention relates to a method and an arrangement for the air removal and filling of liquid circulation systems presented below in the preambles of the independent claims.

[0002] Air refers to a gaseous as well as a mixture dissolved in liquid of nitrogen and oxygen and other atmospheric gases in liquid circulation systems. Liquid circulation system refers to systems or the like arrangements intended for cooling and heating, for example radiator systems in residential properties, where water is typically used as circulating liquid. The term system is equal with the term liquid circulation system.

[0003] A new liquid circulation system is full of air before it is filled with liquid. The air is to be removed as carefully as possible, because it causes disturbances in the functioning of the system. Further problems are also caused by air, which has dissolved in the circulating liquid, and which has a tendency to get released at the highest points of the system, especially in the heating systems in winter season, when the temperature of the circulating water is high. In this relation, the situation is further made more difficult by the fact that tap water is typically used for filling liquid circulation systems, which tap water usually is almost saturated in relation to the dissolved air.

[0004] Oxygen, the substance of air, also causes corrosion in the materials typically used in the system.

[0005] Conventionally, air has been removed from the venting screws connected to the heating or cooling elements at the same time as the system is being filled with liquid. It is also common to install automatic venting globes at the highest points of the system. Also rather generally, a so-called air remover is installed in a fixed manner in the heating system to the main flow pipe after the heat source. Due to a rise in temperature, air can separate from water, which air discharges through a venting globe at the upper part of an air separator.

[0006] In some cases, part of the liquid in the liquid circulation system is supplied through a special vessel to be installed in the system, in which vessel the pressure of the circulating liquid is periodically reduced considerably below the atmospheric pressure, as presented in the patent publication EP 0652406 B. Air is thus discharged from the circulating liquid, as can be concluded by virtue of Henry's law. The separated air rises to the upper part of the vessel, from where it exits to the atmosphere when, after the air separation phase, the vessel pressure is increased above atmospheric pressure.

[0007] Despite all of this, air from all the radiators in a radiator system, for example, usually has to be removed while filling the system with water. Apartments have to be visited even several times for air removal. In addition, the air remaining in the system often causes failure in balancing the system.

[0008] By applying the principles of the present invention, practice of air removal based on the above-described prior art can totally be abandoned when filling new liquid circulating systems or those emptied for repair. The essential difference compared with the prior art is the fact that a complete air removal of the liquid circulation system in an entire building can be performed at one point. Furthermore, the above-described problems can be eliminated and also savings can be generated in equipment costs.

[0009] Another aim of the present invention is a method, with which the air in the liquid circulation system is removed before it is filled with circulating liquid.

[0010] Another aim of the present invention is also an arrangement, with which the air in the liquid circulation system is removed before the system is filled with circulating liquid.

[0011] The invention is characterized in what is defined further below in the characterizing part of the independent claims.

[0012] Some preferred embodiments according to the invention are disclosed in the dependent claims presented further below.

[0013] In a method according to the invention, air is removed from the liquid circulation system before the system is filled with circulation liquid by leading replacement steam through the system. Replacement steam is steam that displaces air in the liquid circulation system. Replacement steam is generated from a liquid the steam pressure of which at the temperature of 20º C is higher than the steam pressure of water at the temperature of 20º C.

[0014] According to an advantageous embodiment of the invention, replacement steam can be sucked also to the liquid circulation system while air is being removed from the system by means of a vacuum pump.

[0015] When the process is started, the system is filled only with air, which is gradually replaced with replacement steam. The result of air discharge is measured with a measuring device by measuring the concentration of some component in the air/steam mixture discharging from the system, such as the oxygen concentration, for example.

[0016] Filling of the system with circulating liquid is started when air concentration of the system is lowered to a sufficiently low level. When filling the system, replacement steam condenses and mixes with circulating liquid. In some cases, the replacement steam will not reach a saturated state during the filling phase. In that case, the replacement steam does not condense into liquid. However, the liquid used for generating replacement steam can, in this case, be chosen so that the replacement steam remaining in the system totally dissolves in the circulating liquid.

[0017] Naturally, the air in the system cannot be totally removed. It is also difficult to measure the actual amount of air remaining in the system, due to the fact that after the procedure, air is not homogeneously distributed into the system. Based on the analyses made, it can be assumed, however, that at least 99 % of the air originally

existing in the system can be removed therefrom.

According to an embodiment of the invention, the liquid circulation system, from which air is almost totally removed by the manner presented above, can also be filled with circulating liquid, from which the air dissolved in the liquid has been removed as carefully as possible, for example, by applying thermal water treatment, low pressure technique or both together. This way, an almost completely airless system can be obtained, regarding free as well as dissolved air. One equipment suitable for this purpose is presented in the Utility Model application No. FI U20040160 of the applicant.

[0018] In winter time, changing of the radiator valves has to be done at the most a few lines at a time, so that the building will not cool off too much. It is possible to flexibly utilize the invention also in this case, by using the method and arrangement disclosed in the invention.

[0019] The invention also relates to an arrangement for removing air from the liquid circulation system, which arrangement comprises a vacuum pump, arranged detachably in the liquid circulating system for sucking air and steam from the liquid circulation system. The arrangement is characterised in that it further comprises a replacement steam source arranged detachably in the liquid circulation system, which source is arranged to generate steam from a liquid the steam pressure of which at the temperature of 20º C is higher than the steam pressure of water at the temperature of 20º C.

[0020] According to one embodiment of the invention, the replacement steam source is a boiling vessel or a liquefied gas container, which contains liquid used for generating replacement steam. In some embodiments of the invention, replacement steam can be generated by means of low pressure or heat energy supplied to the boiling vessel.

[0021] The invention further relates to a use of ethanol, methanol, acetone, dimethyl ether or a mixture of these for removing air from the liquid circulation systems.

[0022] In one embodiment of the invention, a single radiator system line is emptied by pumping the circulating liquid in the line to another part of the system.

[0023] The invention can advantageously be applied for removing air for example from floor heating pipings. Removing air from a floor heating system is very difficult by using air removal methods according to prior art. By using a method according to the invention, replacement steam can be supplied through a floor heating system, whereby the air in the system is displaced and removed from the system. Then, the system from which air has been removed, can be filled with circulating liquid. The invention is also suitable to be used in process industry for removing air from different pipings.

[0024] In the following, the invention will be described in more detail with reference to the appended schematic drawings:

Fig. 1 shows schematically one embodiment of the method and arrangement according to the invention.

Fig. 2 shows schematically another embodiment of the method and arrangement according to the invention.

[0025] Fig. 1 shows the principle of air removal in the liquid circulation system as applied in a radiator system. A radiator system usually comprises several ascending lines, but only one ascending line is drawn in the figure 1. Typically the system has shut-off valves 2 and 3 on both sides of a heat distribution centre 1.

[0026] The boiling vessel 4, in which replacement steam is generated, is attached to a valve 5 and the vacuum pump 6 to a valve 7. In case the valves 5 and 7 do not exist in the system, they are installed when needed. The boiling vessel 4 is provided with an electric resistance 8 and a measuring device 9, that measures the oxygen concentration of an air/steam mixture to be sucked, is installed on a suction side of the vacuum pump 6.

[0027] The vacuum pump 6 is started and the valve 7 is opened, whereby the system pressure is reduced when the air leaves the system. At a suitable moment, the valve 2 is closed and the valve 5 is opened. If, at that time, the system pressure is lower than the steam pressure of the liquid in the boiling vessel, the liquid in the boiling vessel 4 starts to boil, wherefore liquid temperature decreases and boiling slows down or even totally stops. With the electric resistance 8 it is ensured that a sufficient amount of replacement steam is generated. The replacement steam generated in the boiling vessel 4 passes through the entire liquid circulation system. When the measuring device 9 indicates a sufficiently low oxygen concentration, the process can be stopped. After this, the system is filled by pumping water to the system by using the valve 7, for example. Because tap water usually contains large amounts of dissolved air, according to one advantageous embodiment of the invention tap water is treated before pumping to the system with a special water treatment device, in which the air that has dissolved in tap water, is removed from tap water as carefully as possible.

[0028] In some embodiments, it is appropriate to reduce the steam pressure in the valve 5. The valve 5 operates thus also as a control valve.

[0029] It can also be assumed, that the passage time of replacement steam through the system is determined by calculation or by basing on experimental facts, whereby the measuring device 9 is not needed.

[0030] Circulation direction of the replacement steam has no effect on the process. When the liquid circulation system in question comprises several houses, air can be removed from the system one house at a time by utilizing house-specific shut-off valves. Thus, the replacement steam is supplied to a house-specific input pipe to the house side of the shut-off valves, and the vacuum pump sucks at the corresponding location on the return side. When emptying the systems in connection with repair works, the pipes between the houses do not usually become empty of circulating liquid. Thus, it is absolutely

necessary to remove air from one house at a time, because the liquid in the pipes between the houses will prevent replacement steam from travelling.

[0031] One essential idea of the invention is to generate replacement steam at a temperature that nearly equals the temperature of the system from which air is to be removed, or is even lower than that. Steam is thus prevented from condensing to the system, wherefore the efficiency needed for generating steam is very small.

[0032] When emptying fairly large radiator systems with a vacuum pump, it has been observed that a pressure of 5-10 kPa can be achieved with reasonable effort in the systems. Achieving significantly lower pressures remarkably increases the emptying time and also requires the use of very high quality vacuum pumps.

[0033] In the following examination it is assumed, that the system and the space surrounding it is at a 20 ºC temperature when starting to supply system with replacement steam. The steam pressure of water at the temperature of 20 ºC is 2.4 kPa. Thus, water does not boil at the temperature of 20 ºC while the pressure is 5 kPa, which, according to what is shown above, is the lowest pressure to be achieved in the system with reasonable effort. Boiling temperature of water at pressure 5 kPa is 33 ºC. When the temperature of the environment is 20 ºC the heat emission efficiency of radiators even in a medium-sized apartment building can be in the order of 200 kW, the average temperature of the radiators being about 50 ºC. Thus, steam ought to be generated with a very high efficiency and it would largely condense in the radiators. Thus, it is worthwhile to generate replacement steam with liquid the steam pressure of which at the temperature of 20º C is higher than the steam pressure of water at the temperature of 20º C. The steam pressure of the liquid to be used ought be, at the temperature of the system, higher than the pressure prevailing in the system at the location from where the air/replacement steam mixture is discharged from the system. This enables generating replacement steam at the system temperature and also enhances passing of the steam through the system. Of course, replacement steam cannot be generated precisely at the system temperature, and also the systems can be at very different temperatures when starting the procedure. Taking this into account, another significant advantage cannot be achieved by the invention, considering the radiator systems, for example, if the temperature of the displacement steam is over 40 ºC. According to one advantageous embodiment of the invention, the air in the liquid circulation system is displaced by using replacement steam having a temperature of 0-40 ºC.

[0034] For example, the steam pressure of ethanol at the temperature of 20 ºC is 5.8 kPa. Thus, it is possible to generate replacement steam with ethanol at the temperature of 20 ºC, if the pressure in the system can be maintained at level 5 kPa. If a vacuum pump is used for sucking ethanol steam, the suction flow rate of which pump is 20 m^3/h at pressure of 5 kPa, the vaporizing efficiency corresponding to this steam flow is about 0.5 kW when using ethanol. This efficiency is easily available at plugs all over the house.

[0035] If the advantageous properties of the replacement steam are further investigated, it can be concluded, that it is advantageous if the steam pressure of the liquid to be used for generating the replacement steam is even higher than the steam pressure of ethanol presented above.

[0036] For example, steam pressure of methanol at the temperature of 20 ºC is 12.8 kPa. At this pressure, density of the saturated methanol steam is 0.17 kg/m^3. A portion of the liquid formed from methanol steam remaining in the system is rather insignificant, only about 0.017% weight %. This concentration does not cause any health risk. The steam pressure of acetone at the temperature of 20 ºC is 24 kPa. This substance is thus very advantageous when considering the embodiment according to the invention.

[0037] For generating replacement steam, it is also possible to use liquids, the steam pressure of which at the temperature 20 ºC is higher than the atmospheric pressure. Thus, it is possible to drive the replacement steam through the system even without a vacuum pump. Replacement steam can thus be generated totally without an external energy source, because the heat energy required for generating replacement steam transfers from the surroundings to the replacement steam source, the temperature of the replacement steam source decreasing below the temperature of the surroundings. According to one embodiment of the invention, the air in the liquid circulation system can be displaced by using steam that is overpressurized in relation to the atmospheric pressure, which steam is generated without an external energy source.

[0038] Also the liquid used for generating replacement steam has to be kept under pressure. For example, conventional liquefied gas containers or the vessels of corresponding type are well suited to be used as transportation and storage containers. A separate replacement steam source is thus not needed, but the liquefied gas container, containing liquid used for generating replacement steam, is used also as the replacement steam source.

[0039] The temperature can decrease even remarkably below the temperature of the surroundings while the generation of steam strongly continues. However, considering practical applications, it is advantageous to limit the replacement steam flow so that its temperature does not decrease below 0 ºC.

[0040] For generating replacement steam, dimethyl ether, for example, can be used, steam pressure of which is 520 kPa at the temperature of 20 ºC. Let it be assumed, that when starting to fill the system, the pressure of dimethyl ether steam in the system is, for example, 10 kPa, and the temperature is 20 ºC, whereby the steam density is 0.19 kg/m^3. Replacement steam is thus very far from a saturated state. When filling the system with circulating

liquid, the replacement steam compresses and transfers mainly to the upper part of the system, where a pressure of 150-300 kPa typically prevails after filling. Therefore, replacement steam does not condense into liquid, because a saturated state is not achieved. Dimethyl ether, however, dissolves in water quite well so that the steam in the system dissolves in water or in circulating liquid that contains mainly water. Dissolution is intensified when a circulation pump is started. Regarding heating systems, it must also be ensured, that the replacement steam remains totally dissolved in the circulating liquid when the water temperature being at its maximum value.

[0041] On the basis of what is said above, it can be concluded, that possible liquids from which replacement steam can be generated, are among others ethanol, methanol, acetone, dimethyl ether or mixture of these.

[0042] On the basis of the previous examination, it can be concluded that the amount of liquid required for generating replacement steam is small, even though the liquid circulation system to be emptied comprises several cubic meters. Thus, it is possible that the vessel in which the replacement steam is generated is very small and easily moved in a building.

[0043] Figure 2 shows one advantageous embodiment of the invention with its required arrangements in case the radiator valves have to be changed one or few lines at a time, such as in inhabited buildings in winter time.

[0044] Figure 2 shows the principle of the radiator system in a schematic view, in which only one heating line is drawn, for the sake of simplicity. Changing of the valves is started by changing the shut-off valves 10 in all lines, which valves are provided with an emptying cock 11, as well as the specially structured line control valves 14 which are provided with two emptying cocks 12 and 13. The line control valves 14 are also used in the normal way as shut-off valves. In this embodiment of the invention, the arrangement thus comprises a valve system having emptying cocks on both sides of the shutting part of the valve.

[0045] Line control valves and shut-off valves can usually be changed rather fast, or they can be changed already at summer time. After changing, the air in the system is centrally removed by applying the method according to the invention. After this, water is pumped into the system, from which water air dissolved in water has been removed as carefully as possible with a special water treatment device that has been brought to the building for the time of filling.

[0046] By advantageously applying the invention, the airless water in the line is saved by pumping it into the system for the time of changing the radiator valves 15, 15' and 15". The line control valve 14 and the shut-off valve 10 are thus closed and the water in the line is pumped into the system by attaching the pipe 17 of the suction side of the pump 16 to the valve 12 and the pipe 18 of the pressure side to the valve 13. By opening the valve 11 sufficiently enough, a successful pumping is ensured. After the procedure has been performed, the valves 12 and 13 are closed and the pump 16 is detached from the system. In one embodiment of the invention, the volume of the water that is to be pumped from the emptying line is received by an expansion vessel/arrangement 19, that is a fixed part in the heating system, or a separate expansion vessel/arrangement 20, that is attached to the system for the time of changing the radiator valves. The expansion arrangement refers to an arrangement, which comprises a vessel to which the water coming from the system travels via an overflow valve, and a pump that pumps water from the vessel to the system controlled in such a manner that the system pressure remains within the desired limits.

[0047] After the radiator valves 15, 15' and 15" have been changed, the air in the system is removed by attaching a suction pipe of the underpressure pump to the valve 12, for example, and the boiling vessel to the valve 11. When the replacement steam generated in the boiling vessel has displaced the air in the system, the valves 11 and 12 are closed. After this procedure, the shut-off valve 10 and the line control valve 14 are opened, whereby the line is filled and it is totally ready for operation regarding the air removal.

[0048] It is obvious to a person skilled in the art that the invention is not limited to the solutions described above, but the inventive idea can be applied in numerous ways within the scope of the claims.

Claims

1. Method for removing air from a liquid circulation system, in which method air in the liquid circulation system is removed before filling the system with circulating liquid, **characterized in that** air is displaced by replacement steam that is generated from a liquid the steam pressure of which at the temperature of 20º C is higher than the steam pressure of water at the temperature of 20º C.

2. Method according to claim 1, **characterized in that** replacement steam is sucked into the liquid circulation system while air is being removed from the system by means of a vacuum pump.

3. Method according to claim 1, **characterized in that** the air in the liquid circulation system is displaced by using replacement steam having a temperature in the range between 0-40 ºC.

4. Method according to claim 1, **characterized in that** the air in the liquid circulation system is displaced by using steam that is overpressurized in relation to the atmospheric pressure, which steam is generated without an external energy source.

5. Method according to claim 1, **characterized in that** the replacement steam is generated by means of

underpressure or by means of heat energy supplied to a boiling vessel.

6. Method according to claim 1, **characterized in that** the replacement steam is generated from liquid the steam pressure of which at the temperature of a system being the object of the procedure is higher than the pressure prevailing during the emptying at a certain point of the system from which air is removed from the system.

7. Method according to claim 1, **characterized in that** the replacement steam is generated by using ethanol, methanol, acetone, dimethyl ether or mixture of these.

8. Method according to claim 1, **characterized in that** the composition of the steam/air mixture discharging from the liquid circulation system is measured with a measuring device.

9. Method according to claim 1, **characterized in that** after air removal, the liquid circulation system is filled with circulating liquid, from which air dissolved in the liquid has been removed as carefully as possible thermally, by utilizing underpressure or both the above-mentioned methods.

10. Method according to claim 1, **characterized in that** a single radiator system line is emptied by pumping the circulating liquid in the line to another part of the system.

11. Arrangement for removing air from a liquid circulation system, which arrangement comprises a vacuum pump (6) for sucking air and steam from the liquid circulation system, the pump being arranged detachably in the liquid circulation system, **characterized in that** the arrangement further comprises a replacement steam source (4) arranged detachably in the liquid circulation system, which source is arranged to generate steam from liquid the steam pressure of which at the temperature of 20º C is higher than the steam pressure of water at the temperature of 20º C.

12. Arrangement according to claim 11, **characterized in that** the replacement steam source (4) is a boiling vessel or a liquefied gas container, which contains liquid used for generating replacement steam.

13. Method according to claim 11, **characterized in that** the arrangement further comprises a measuring device (9) that measures the composition of the steam/air mixture discharging from the liquid circulation system.

14. Arrangement according to claim 11, **characterized in that** the arrangement comprises an expansion vessel or an expansion arrangement (20) arranged detachably in the liquid circulation system.

15. Arrangement according to claim 14, **characterized in that** the arrangement comprises a valve system having emptying cocks (12, 13) on both sides of the shutting part of the valve.

16. Use of ethanol, methanol, acetone, dimethyl ether or a mixture of these for removing air from the liquid circulation systems.

Amended claims in accordance with Rule 86(2) EPC.

1. Method for removing air from a liquid circulation system, in which method air in the liquid circulation system is removed before filling the system with circulating liquid, **characterized in that** air is displaced by replacement steam that is generated from a liquid the steam pressure of which at the temperature of 20° C is higher than the steam pressure of water at the temperature of 20° C.

2. Method according to claim 1, **characterized in that** replacement steam is sucked into the liquid circulation system while air is being removed from the system by means of a vacuum pump (6).

3. Method according to claim 1, **characterized in that** the air in the liquid circulation system is displaced by using replacement steam having a temperature in the range between 0-40 °C.

4. Method according to claim 1, **characterized in that** the air in the liquid circulation system is displaced by using steam that is overpressurized in relation to the atmospheric pressure, which steam is generated without an external energy source.

5. Method according to claim 1, **characterized in that** the replacement steam is generated by means of underpressure or by means of heat energy supplied to a boiling vessel.

6. Method according to claim 1, **characterized in that** the replacement steam is generated from liquid the steam pressure of which at the temperature of a system being the object of the procedure is higher than the pressure prevailing during the emptying at a certain point of the system from which air is removed from the system.

7. Method according to claim 1, **characterized in that** the replacement steam is generated by using ethanol, methanol, acetone, dimethyl ether or mixture of these.

8. Method according to claim 1, **characterized in that** the composition of the steam/air mixture discharging from the liquid circulation system is measured with a measuring device (9).

9. Method according to claim 1, **characterized in that** after air removal, the liquid circulation system is filled with circulating liquid, from which air dissolved in the liquid has been removed as carefully as possible thermally, by utilizing underpressure or both the above-mentioned methods.

10. Method according to claim 1, **characterized in that** a single radiator system line is emptied by pumping the circulating liquid in the line to another part of the system.

11. Arrangement for removing air from a liquid circulation system, which arrangement comprises a vacuum pump (6) for sucking air and steam from the liquid circulation system, the pump being arranged detachably in the liquid circulation system, **characterized in that** the arrangement further comprises a replacement steam source (4) arranged detachably in the liquid circulation system, which source is arranged to generate steam from liquid the steam pressure of which at the temperature of 20° C is higher than the steam pressure of water at the temperature of 20° C.

12. Arrangement according to claim 11, **characterized in that** the replacement steam source (4) is a boiling vessel or a liquefied gas container, which contains liquid used for generating replacement steam.

13. Arrangement according to claim 11, **characterized in that** the arrangement further comprises a measuring device (9) that measures the composition of the steam/air mixture discharging from the liquid circulation system.

14. Arrangement according to claim 11, **characterized in that** the arrangement comprises an expansion vessel or an expansion arrangement (20) arranged detachably in the liquid circulation system.

15. Arrangement according to claim 14, **characterized in that** the arrangement comprises a valve system having emptying cocks (12, 13) on both sides of the shutting part of the valve.

16. Use of ethanol, methanol, acetone, dimethyl ether or a mixture of these for removing air from the liquid circulation systems comprising an arrangement according to claim 11.

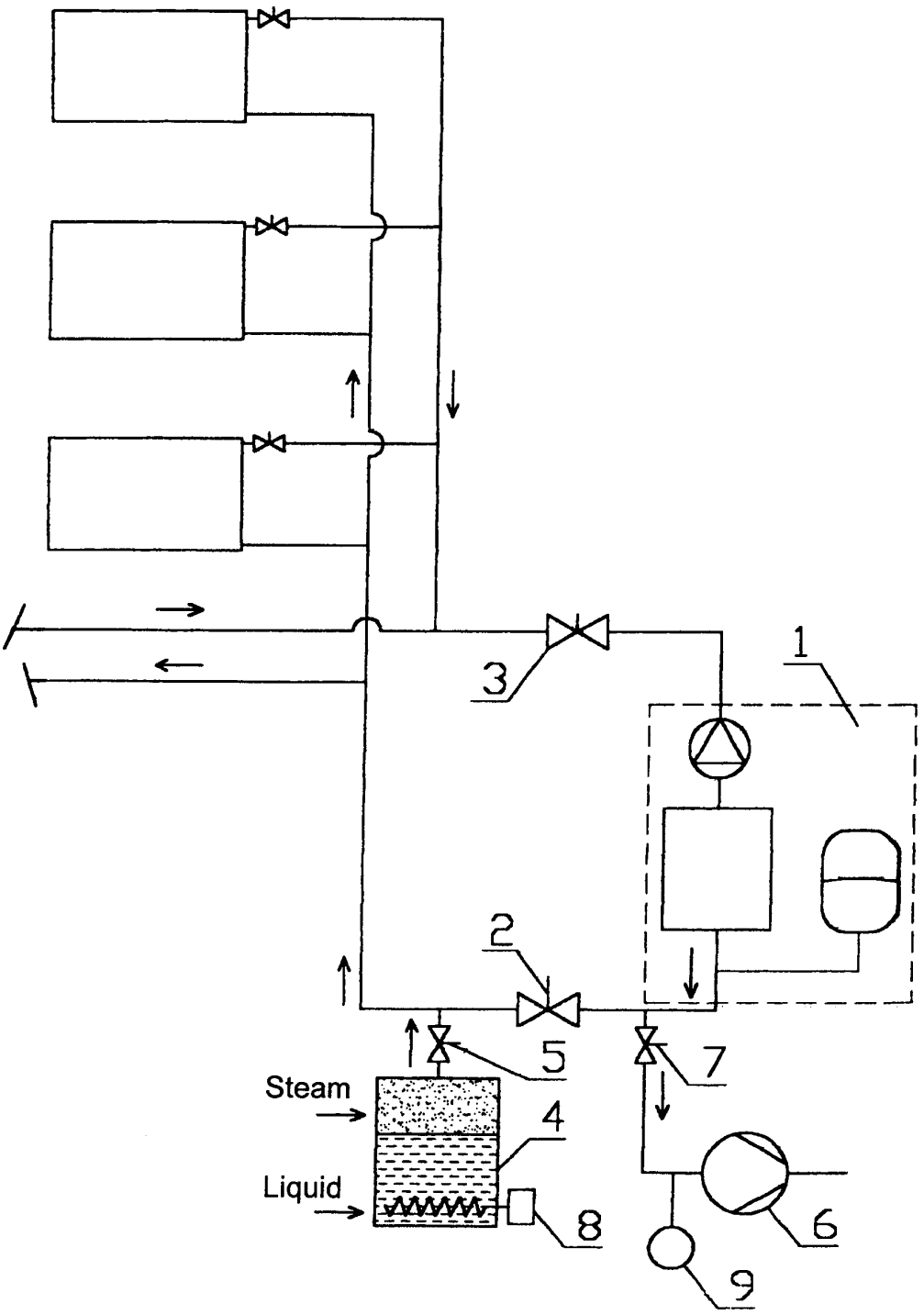

FIG. 1

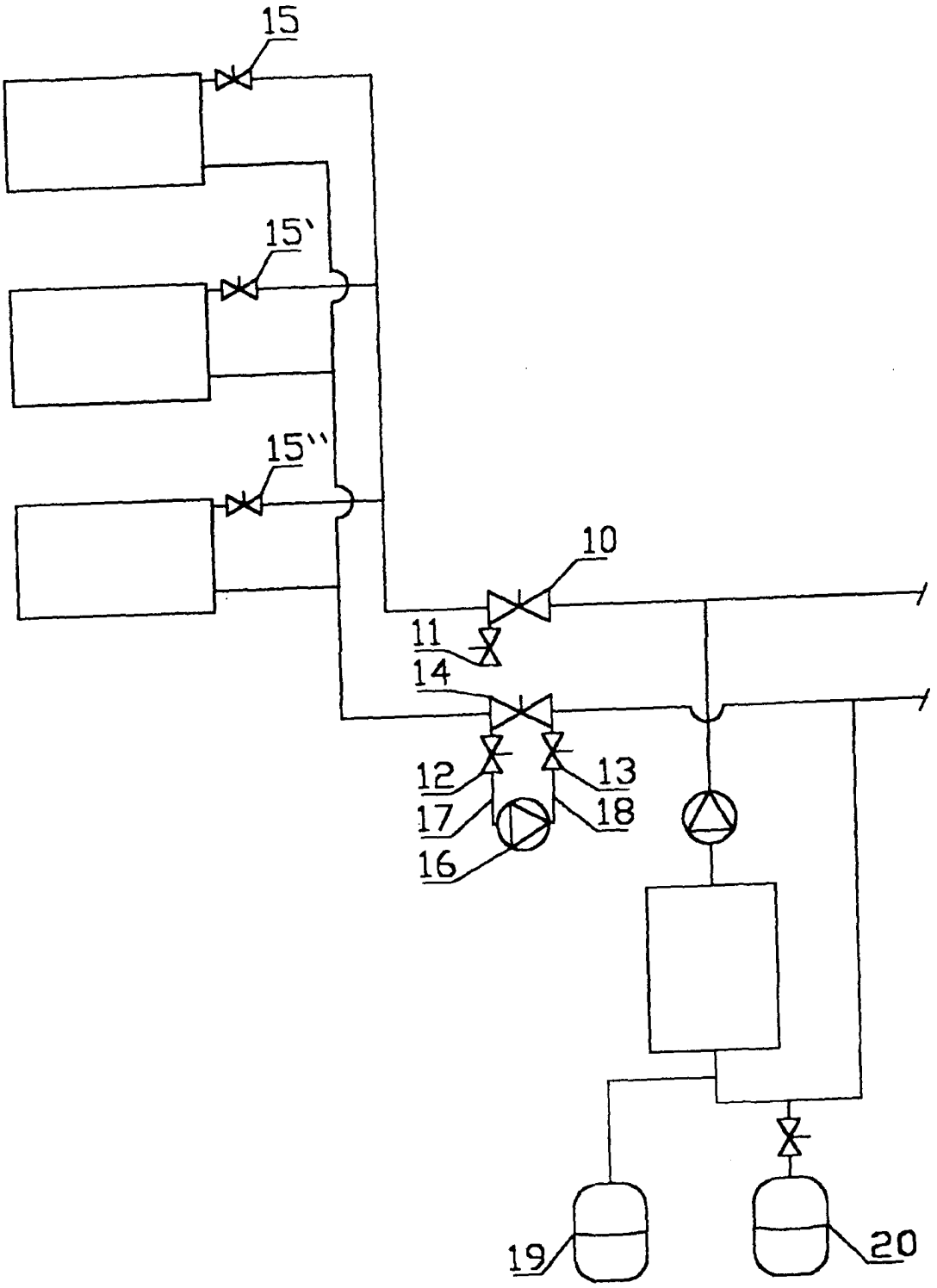

FIG. 2

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 05 10 6011

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A,D	EP 0 652 406 A (SPIRO RESEARCH B.V) 10 May 1995 (1995-05-10) * abstract; figure 1 * -----	1-16	F24D19/08
A	US 3 091 098 A (BOWERS HERBERT L) 28 May 1963 (1963-05-28) * column 1 - column 2 * -----	1-16	
A X	GB 2 012 181 A (ZIRCONAL PROCESSES LTD) 25 July 1979 (1979-07-25) * abstract * -----	7 16	
X	US 3 887 487 A (CAMP ET AL) 3 June 1975 (1975-06-03) * column 1, line 1 - line 8 * * column 5, line 18 * -----	16	

TECHNICAL FIELDS SEARCHED (Int.Cl.7)

F24D
B01D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	13 October 2005	García Moncayo, O

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

1

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 05 10 6011

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
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

13-10-2005

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0652406 A	10-05-1995	AT 177189 T	15-03-1999
		CA 2134284 A1	05-05-1995
		DE 69416781 D1	08-04-1999
		DE 69416781 T2	01-07-1999
		DK 652406 T3	27-09-1999
		ES 2128507 T3	16-05-1999
		FI 944943 A	05-05-1995
		JP 2740458 B2	15-04-1998
		JP 7185526 A	25-07-1995
		KR 185196 B1	15-04-1999
		NL 9301908 A	01-06-1995
		NO 944190 A	05-05-1995
		US 5601635 A	11-02-1997
US 3091098 A	28-05-1963	NONE	
GB 2012181 A	25-07-1979	NONE	
US 3887487 A	03-06-1975	BE 794875 A1	01-08-1973
		CA 997247 A1	21-09-1976
		CH 567874 A5	15-10-1975
		DE 2305257 A1	16-08-1973
		ES 411217 A1	01-12-1975
		FR 2170827 A1	21-09-1973
		GB 1426013 A	25-02-1976
		IT 972734 B	31-05-1974
		JP 886537 C	28-10-1977
		JP 48088082 A	19-11-1973
		JP 52010430 B	24-03-1977
		NL 7301099 A	06-08-1973
		SE 376847 B	16-06-1975

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82