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

(11) EP 1 813 873 A1

# (12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
**01.08.2007 Bulletin 2007/31**

(51) Int Cl.:
***F24D 3/04*** *(2006.01)* ***F24D 19/10*** *(2006.01)*
***G05D 16/00*** *(2006.01)*

(21) Application number: **06250425.3**

(22) Date of filing: **26.01.2006**

(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**

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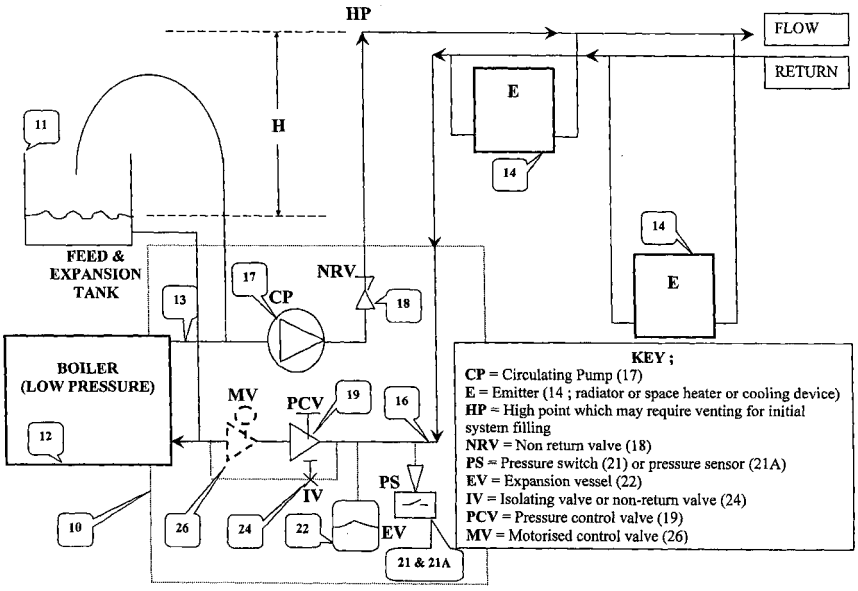
## (54) Improved circulation system

(57) A heating system (10) has an expansion tank (11) which provides water to a low pressure boiler (12) for heating. Heated water is distributed around a fluid conduit (13, 16) to one or more radiators (14) then returned to the boiler. A pump (17) is connected to the outlet conduit to assist fluid flow through the system when the system is active to provide heating. Pressure control means (18, 19, 21, 21A, 26) maintains the fluid in the distribution conduit at a positive pressure during periods when the system is quiescent and includes a non-return valve means (18) in the outlet conduit (13) and a further valve means (19; 26) to prevent fluid flowing through the return conduit (16) to the expansion tank when the system is quiescent and/or when the pressure of the fluid in the distribution conduit falls below a first predetermined threshold. A pressure responsive means (21; 21A) activates the pump (17) if the pressure in the distribution conduit falls below the first or a second predetermined threshold. The arrangement ensures that the system will operate even if one or more of the radiators (14) are disposed above the level of the fluid in the tank (11) without the need to pressurise the system and may be adapted for use with air conditioning or cooling systems.

**FIGURE 3 – IMPROVED CIRCULATION SYSTEM**

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## Description

**[0001]** This invention relates to an improved circulation system for heating, or cooling, or air conditioning of the type commonly used in central heating, cooling or air conditioning systems for buildings.

**[0002]** Conventional central heating systems comprise a boiler to heat water to a desired selected temperature and suitable pipe work to distribute the hot water heated by the boiler to one or more radiators.

**[0003]** Conventional cooling and air conditioning systems comprise a heat pump or refrigeration system to cool and/or heat water to a desired selected temperature and suitable pipe work to distribute the cold or hot water generated by the heat pump or refrigeration device to one or more space heaters or thermal emitters.

**[0004]** Usually, such systems are one of two types, either an open vented system or a pressurised system.

**[0005]** An open vented heating system is conventionally as shown in Figure 1 of the drawings. The system conventionally utilises a feed and expansion tank which supplies water to a low pressure boiler, the boiler being linked by pipe work to one or more radiators. The positioning of the tank relative to the pipe work and the radiators determines the pressure within the heating system. The feed and expansion tank must be physically located at a position higher than the boiler, radiators and all interconnecting pipe work to ensure that the system does not suffer from negative system pressures which can give rise to a number of problems, for example in filling the system and due to the formation of airlocks in the pipe work which impede the flow of water through the system.

**[0006]** A pressurised heating system of conventional form is shown in Figure 2 of the drawings. The pressurised system is usually used when it is not possible to locate the feed and expansion tank above the boiler, radiators and all pipe work, or at least sufficiently high to ensure sufficient pressure within the system. Such a situation is quite common, for example in flats in multistorey buildings where it is impossible for the tank to be located above the pipe work and radiators. In this system, a pressurised boiler is connected to one or more radiators via interconnecting pipe work as with the open vented system. However, a greater pressurisation of the boiler is required in this system and this can be achieved by connecting the boiler to a high pressure source (for example the mains water supply) temporarily to pressurise the system. Once the system is pressurised, the connection is then removed and the boiler is isolated from the main water supply. The introduced pressure prevents the development of negative pressures in the system and allows water to flow through the system unhindered.

**[0007]** Problems, additional to those mentioned above, also arise with both these conventional systems. Similar problems can also arise in cooling or air conditioning systems.

**[0008]** Whilst an open vented heating system is simple and more reliable, it can only be used where the tank can be located sufficiently above the boiler, radiators and pipework it is feeding to ensure a sufficient pressure in the system.

**[0009]** With a pressurised system, because this system is pressurised by using a high pressure source, albeit only temporarily, for safety purposes a number of additional components are needed to comply with operational and statutory requirements. For example, an expansion vessel is usually connected to the boiler and pressure and temperature relief valves are needed along with an automatic air vent and pressure gauge. A statutory requirement is that all pressurised systems must be commissioned and certified by suitably qualified installers. These needs increase significantly the cost of the system. Furthermore, if there is a leak in the system, a progressive loss of pressure will be experienced which will ultimately cause the system to fail. This will require the system to be recommissioned after repair by a suitably qualified engineer or installer. This can particularly be a problem if the system is unattended for any duration during very cold or freezing conditions. If a storage boiler or thermal store is used in such a system, the boiler needs to have increased strength to withstand the high pressures in the system. Where stronger materials are used to manufacture the boiler the cost will increase.

**[0010]** It is an object of the present invention to provide an improved circulation system for heating or cooling or air conditioning which has all the advantages of an open vented system but which can operate without problems from negative pressures even when the header tank cannot be located above the emitters and pipe work and which, when operating in this way, also avoids the problems associated with conventional pressurised heating or cooling or air conditioning systems.

**[0011]** Thus and in accordance with the present invention there is provided a heating or cooling or air conditioning system comprising a fluid source, a heating or cooling device to receive fluid from the source and to heat or cool the fluid to a desired temperature, said heating or cooling device being connected to one or more thermal emitting or absorbing devices by a fluid distribution conduit whereby heated or cooled fluid can be fed to the thermal emitting or absorbing devices from the heating or cooling device through an outlet conduit and returned to the fluid source through a return conduit, a pump connected to the outlet conduit to assist fluid flow through the system, the pump being operative to assist the flow of fluid through the system during periods when the system is active to provide heating, cooling or air conditioning but normally inoperative during periods when the system is quiescent, characterised in that the system further comprises pressure control means for maintaining the fluid in the distribution conduit at a positive pressure during periods when the system is quiescent, said pressure control means including a first valve means in the outlet conduit operative to prevent the fluid flowing back along the outlet conduit to the heating or cooling device, a further valve means in the return conduit

operative to prevent fluid flowing through the return conduit to the source during periods when the system is quiescent and/or when the pressure of the fluid in the distribution conduit falls below a first predetermined threshold, and a pressure responsive means adapted to activate the pump in response to a fall in the pressure of the fluid in the distribution conduit below the first or a second predetermined threshold.

**[0012]** With this arrangement it is possible to provide an improved heating or cooling or air conditioning system which avoids the problems associated with conventional open vent heating or cooling or air conditioning systems and pressurised heating or cooling or air conditioning systems.

**[0013]** Further features of the invention are set out in the claims dependent on claim 1.

**[0014]** The invention will now be described further by way of example only and with reference to the accompanying drawings, of which:

**Figure 1** shows a schematic representation of a conventional open vent heating system;

**Figure 2** shows a schematic representation of a conventional pressurised heating system; and

**Figure 3** shows a schematic representation of one embodiment of improved heating or cooling or air conditioning system according to the present invention.

**[0015]** Referring now to Figure 3 of the drawings, there is shown one form of improved heating or cooling or air conditioning system in accordance with the invention, namely an improved heating system.

**[0016]** The system 10 comprises a feed and expansion tank 11 that supplies water to a low pressure boiler 12 for heating. Outlet conduit 13 allows water, once heated, to be distributed to one or more radiators 14 and a return conduit 16 allows water to be returned to the boiler 12 from the emitter(s) in a manner to be described more fully hereinafter.

**[0017]** A circulating pump 17 is connected to the outlet conduit 13 to assist in the flow of water through the system and further acts to maintain a sufficient pressure within the system to allow desired flow rates to be achieved. A non-return valve 18 is also provided in the outlet conduit 13. A pressure control valve 19 is provided in the return conduit 16 and operates to ensure that water can only flow back to the boiler 12 if it is pressurised above a particular desired level as described hereinafter.

**[0018]** In use, water is fed to the boiler 12 from the feed and expansion tank 11. This water is then heated by the boiler 12 to a preselected temperature and is circulated via the outlet conduit 13 to the one or more emitters 14 in the system. After passing through the one or more emitters 14, the water is returned via the return conduit 16 to the boiler 12. The circulating pump 17 in the outlet conduit 13 assists with this circulation of the water and maintenance of a working pressure in the system.

**[0019]** Thus far, the system is almost a conventional open vent heating system. However, in the arrangement shown in Figure 3, it can be seen that the outlet 13 and return conduits 16, and at least one emitter 14 are above the level of fluid in the feed and expansion tank 11. This gives rise to a pressure head H between the fluid level in the tank 11 and the high point of the system that would normally require the use of a conventional pressurised heating system to ensure that fluid can circulate through the system without a negative pressure whereby the system can function correctly. However, in the system of the present invention, the provision of a non-return valve 18 and a pressure control valve 19 enables a systemic pressure in the fluid to be generated and maintained.

**[0020]** The pressure control valve 19 is arranged so that it only opens when the pressure across it in the fluid in the system reaches or exceeds a pressure of Z, where Z is the systemic pressure generated at the pressure control valve 19 and is additional to the working pressure of the system. Therefore the fluid in the pipework and emitter system will always have a pressure of at least Z. The pressure Z generated by the pressure control valve 19 is arranged to exceed the pressure head H in order that fluid can flow through the system correctly. In these circumstances, the circulating pump 17 must have a working pressure head that is sufficient to maintain normal working pressure in the system and additionally to generate the pressure Z in the system. Thus when the pump 17 is operating, the normal working pressure needed in the system to allow the system to function is provided and an additional pressure head of Z is also generated in the system due to the presence of the pressure control valve 19 in the return conduit 16. The additional pressure head Z generated by the pressure control valve 19 is sufficient to allow the system to operate even with the fluid level of the tank 11 below the high point (HP) of the conduits 13, 16 and/or emitters. So long as the pressure head Z is greater than the pressure head H, a positive pressure is maintained in the system even at the high points avoiding the problems associated with negative pressure in the system.

**[0021]** After the pump 17 is turned off, the non-return valve 18 provided in the outlet conduit 13 prevents pressurised fluid returning to the boiler 12 along this conduit. Furthermore, when the pressure head falls to a level Z, the pressure control valve 19 closes preventing the pressure from falling below the value Z. Therefore it will be realised that the pressure will remain at least at Z which means that there will be a positive pressure maintained at the high points.

**[0022]** To ensure that the pressurised fluid is maintained to at least pressure Z indefinitely, even in the presence of any contraction due to cooling or any low level leaks, a pressure switch 21 (or pressure sensor 21A) is fitted into the return conduit 16 which is set so as to automatically switch on the circulating pump 17 should the pressure at the pressure control valve 19 fall to, or just below, the pressure Z. With this arrangement, it is nec-

essary to generate a slightly higher value for the pressure head Z to accommodate tolerance and switching margin that are associated with the inclusion of the pressure switch 21 in the system. This is necessary to ensure that the pressure switch 21 operates at a system pressure level reliably below that of the pressure control valve 19.

**[0023]** To provide damping for transient pressure fluctuations in the system, or to avoid a too frequent operation of the pump due to operation of the pressure switch 21 where there is a leak, a small expansion vessel 22 can be fitted in the outlet or return conduit 13 or 16.

**[0024]** Where a system includes one or more emitters 14 in which the return conduit 16 along its length does not reach above the level of the tank, initial filling of the system can be speeded up by using an isolation and/or non-return valve 24 across the pressure control valve 19 as shown in Figure 3. This temporarily (or permanently if there is a non-return valve) permits the initial back filling of emitters from the boiler return conduit as is commonly carried out in heating systems.

**[0025]** Furthermore, a motorised valve 26 can be fitted in the return conduit 16 which is operable to open only when the circulating pump 17 is operational and there is a user demand for the system to operate. With such a valve 26, the pressure switch setting can be increased to near that which results, at the pressure switch 21, from the open pipe pressure head of the circulating pump.

**[0026]** This ensures that in quiescent periods when the system is not operational, the standing pressure in the emitters of the system is higher. In some systems, this would allow the provision of higher emitter interconnections and and/or lower values of Z needed for the system to function properly and hence would involve a saving in the circulating pump since a lower pump pressure rating would be needed.

**[0027]** In some such systems, the value of Z can be reduced to zero, allowing the pressure control valve 19 to be omitted.

**[0028]** The pressure control valve 19 can be omitted if the pressure switch 21 (or pressure sensor 21A), and associated electronic controller if necessary, powers the motorized valve 26 in such a way that this valve is closed when no fluid is required to be circulated.

**[0029]** The pressure control valve 19 can also be omitted if the pressure switch 21 (or pressure sensor 21A), and associated electronic controller if necessary, powers the motorized valve 26 in such a way that this valve is controlled to be partially open to effect the same or similar pressure drop across it as there would be across the pressure control valve 19 when fluid is required to be circulated.

**[0030]** It will be appreciated that the present invention allows an open vent heating or cooling or air conditioning system to be modified to allow a certain degree of pressurisation without involving the problems associated with conventional pressurised systems described above.

**[0031]** It is of course to be understood that the invention is not intended to be restricted to the details of the above embodiments that are described by way of example only.

## Claims

1. A heating or cooling or air conditioning system comprising a fluid source, a heating or cooling device to receive fluid from the source and to heat or cool the fluid to a desired temperature, said heating or cooling device being connected to one or more thermal emitting or absorbing devices by a fluid distribution conduit whereby heated or cooled fluid can be fed to the thermal emitting or absorbing devices from the heating or cooling device through an outlet conduit and returned to the fluid source through a return conduit, a pump connected to the outlet conduit to assist fluid flow through the system, the pump being operative to assist the flow of fluid through the system during periods when the system is active to provide heating, cooling or air conditioning but normally inoperative during periods when the system is quiescent, **characterised in that** the system further comprises pressure control means for maintaining the fluid in the distribution conduit at a positive pressure during periods when the system is quiescent, said pressure control means including a first valve means in the outlet conduit operative to prevent the fluid flowing back along the outlet conduit to the heating or cooling device, a further valve means in the return conduit operative to prevent fluid flowing through the return conduit to the source during periods when the system is quiescent and/or when the pressure of the fluid in the distribution conduit falls below a first predetermined threshold, and a pressure responsive means adapted to activate the pump in response to a fall in the pressure of the fluid in the distribution conduit below the first or a second predetermined threshold.

2. A heating or cooling or air conditioning system as claimed in claim 1, in which at least part of the distribution conduit and/or at least one of the thermal emitting or absorbing devices is positioned above the fluid source.

3. A heating or cooling or air conditioning system as claimed in claim 1 or claim 2, in which the first valve means comprises a non-return valve.

4. A heating or cooling or air conditioning system as claimed in any one of claims 1 to 3, in which the further valve means comprises a pressure control valve configured to generate a systemic pressure in the distribution conduit.

5. A heating or cooling or air conditioning system as claimed in claim 4 when dependent on claim 2, in which the pressure control valve is configured to gen-

erate a systemic pressure Z in the distribution conduit, the pressure Z being equal to or exceeding a pressure head H generated between the level of the fluid in the fluid source and a high point of the system.

**6.** A heating or cooling or air conditioning system as claimed in any one of the previous claims, in which the further valve means comprises a motorised valve, the system being configured such that the motorized valve is closed when the system is quiescent.

**7.** A heating or cooling or air conditioning system as claimed in claim 6, in which the motorized valve is configured to generate a systemic pressure in the distribution conduit when the system is active.

**8.** A heating or cooling or air conditioning system as claimed in any one of the previous claims in which the pressure responsive means comprises a pressure switch.

**9.** A heating or cooling or air conditioning system as claimed in any one of claims 1 to 7, in which the pressure responsive means comprises a pressure sensor and an electronic controller.

**10.** A heating or cooling or air conditioning system as claimed in any one of the previous claims, in which a non-return valve is connected in parallel across the further valve means to enable back filling of the system.

FIGURE 1 – OPEN VENTED SYSTEM

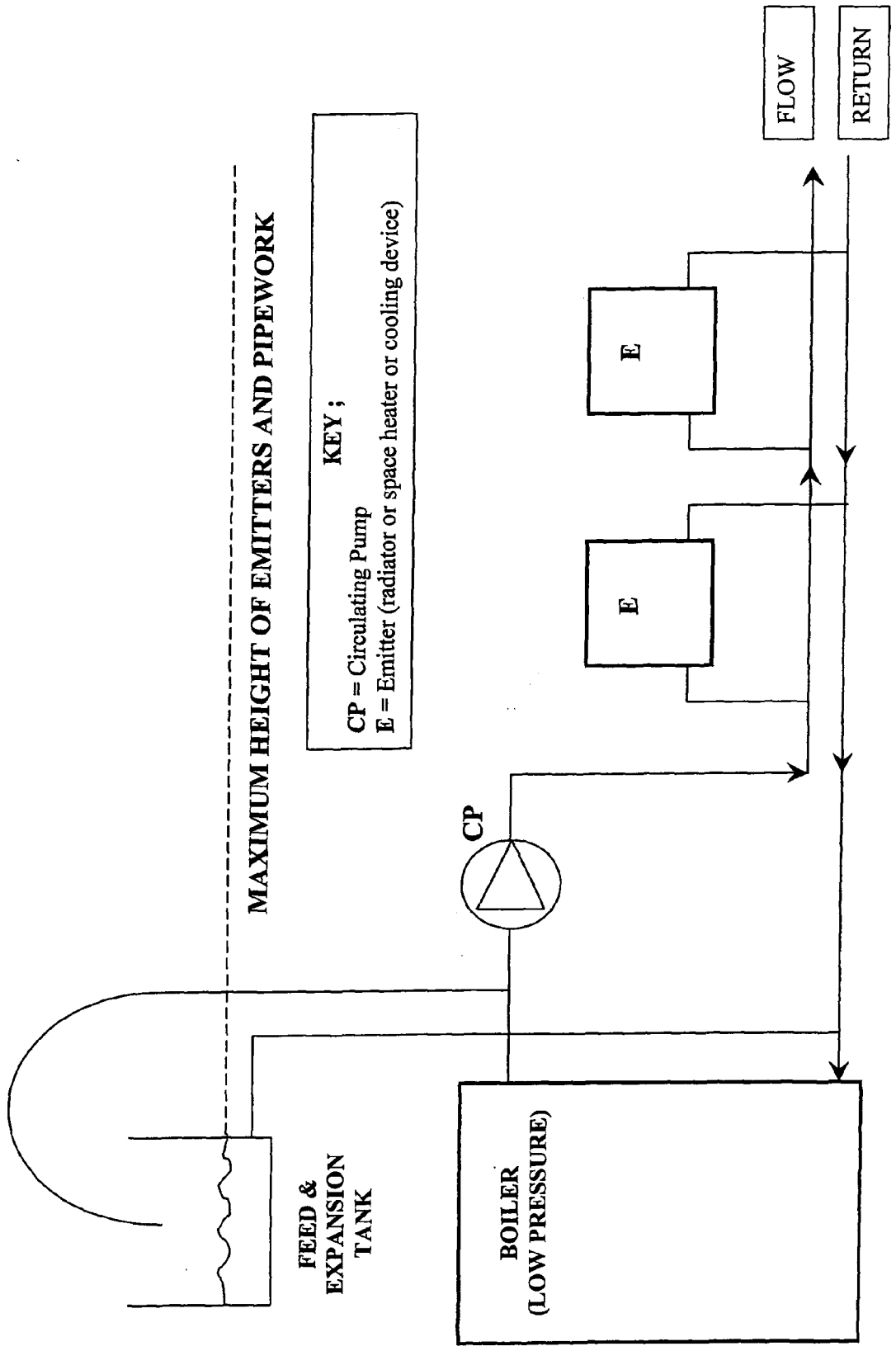


FIGURE 2 – PRESSURISED SYSTEM

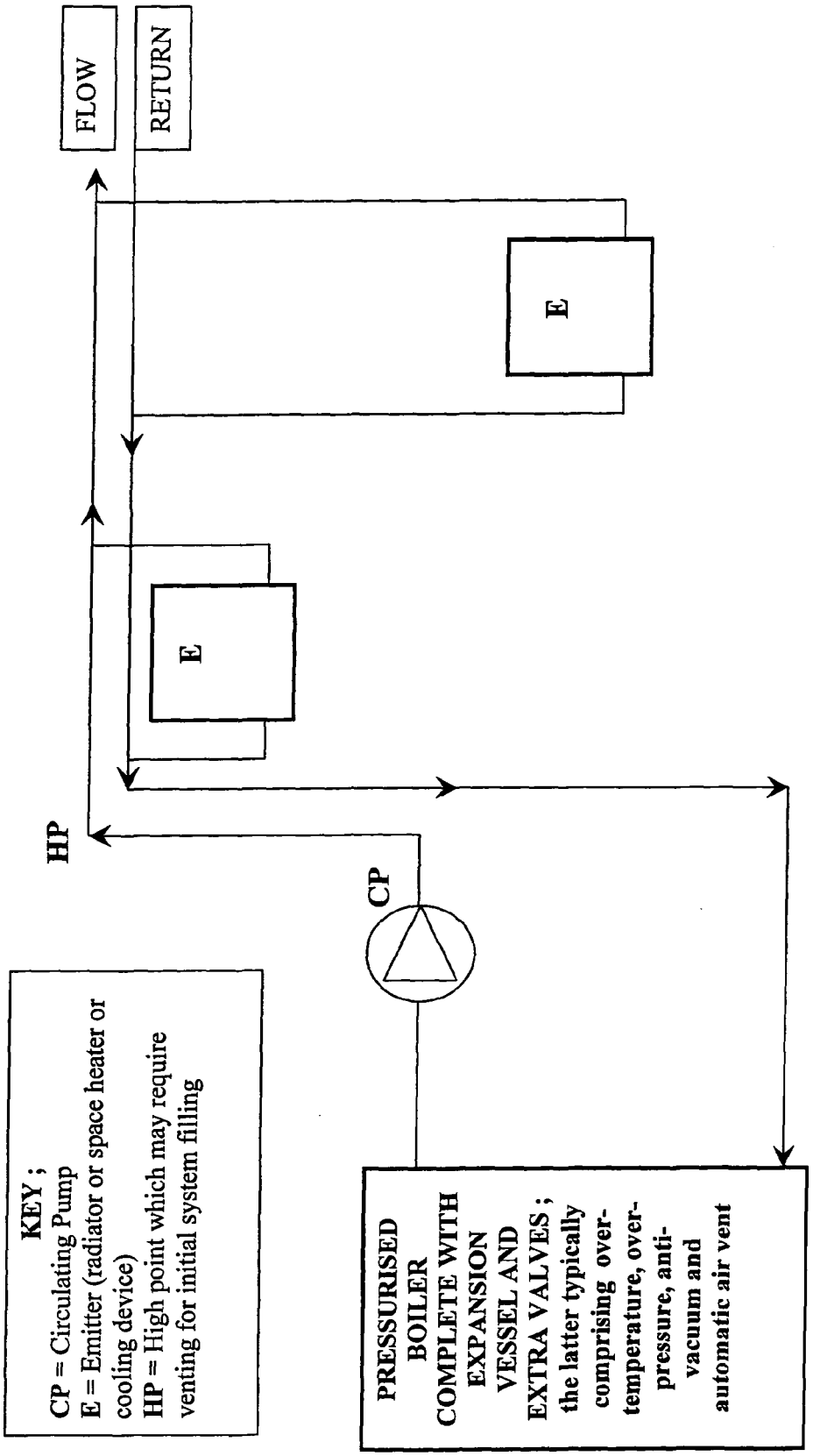
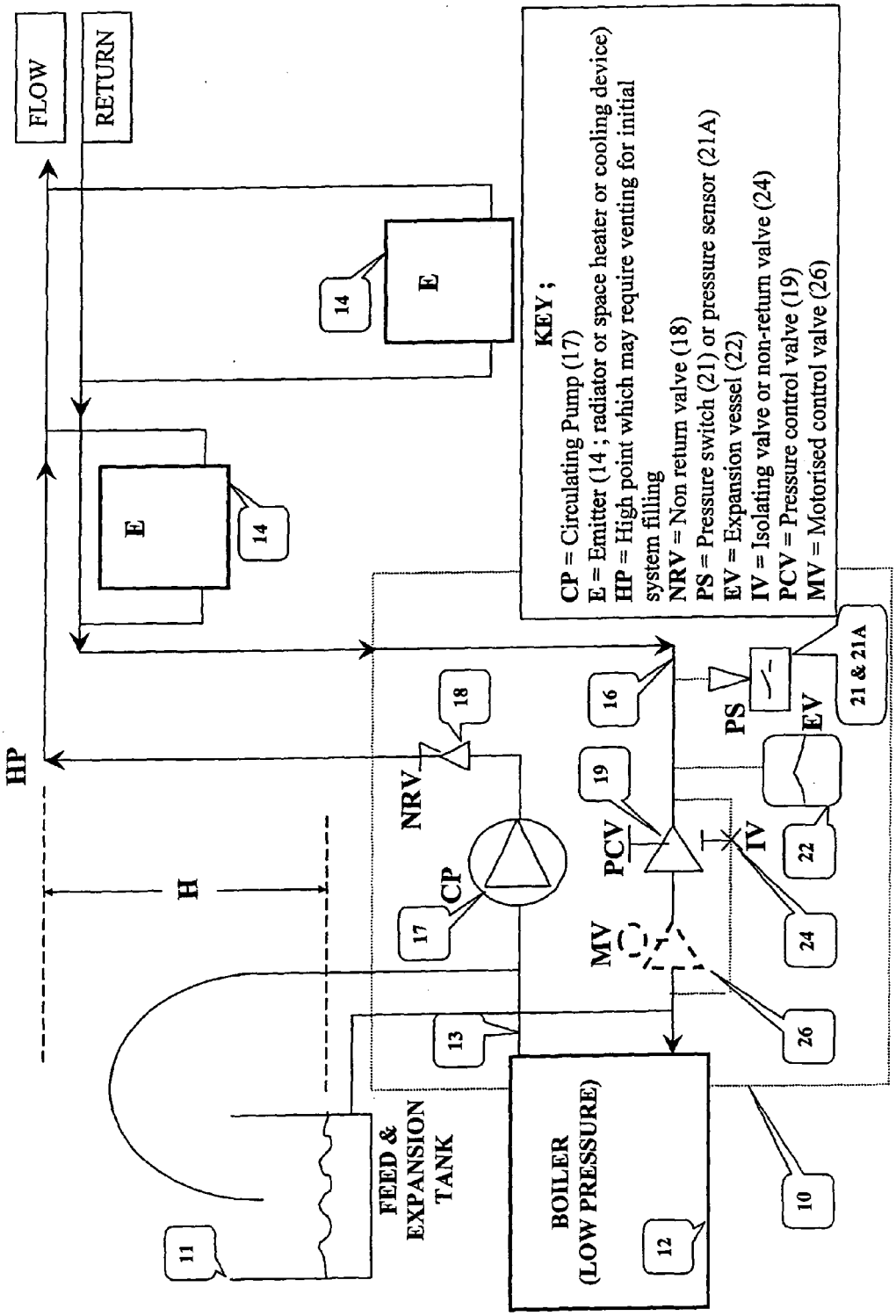


FIGURE 3 – IMPROVED CIRCULATION SYSTEM



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Application Number
EP 06 25 0425

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The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| Munich | 31 May 2006 | García Moncayo, O |

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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& : member of the same patent family, corresponding document

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Application Number
EP 06 25 0425

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