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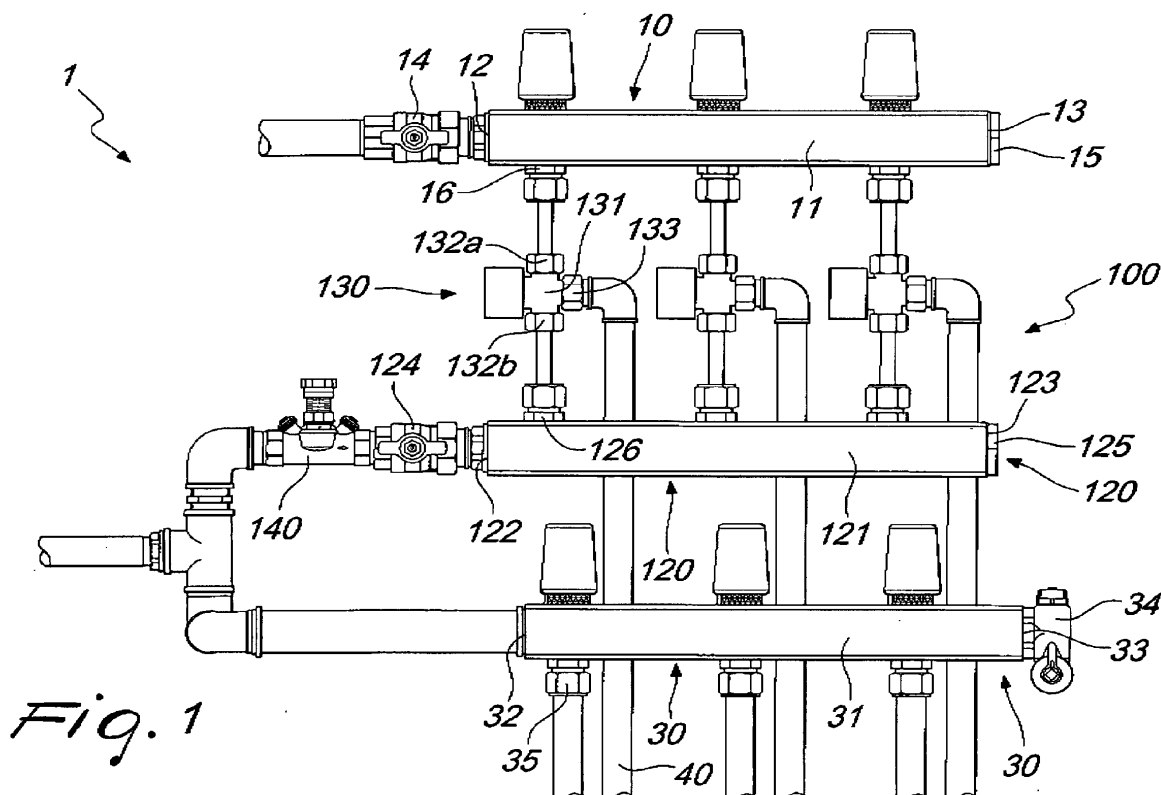
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(54) **Apparatus and method for controlling thermal systems, namely radiant systems**

(57) An apparatus and method for controlling thermal systems, namely radiant systems, including a first feed manifold (10) and a return manifold (30); in an active condition, the first feed manifold distributes heat transfer fluid to user circuits (40) at feed temperature; the return

manifold collects heat transfer fluid from the user circuits at return temperature. A temperature equalizing system (100) associated with the first feed manifold and which, in the active condition, distributes the thermal emission homogeneously along each individual user circuit.



Description

[0001] The present invention relates to an apparatus and a method for controlling thermal systems, namely radiant heating systems.

[0002] In conventional modern radiant heating systems a warm heat transfer fluid circulates at low temperature, generally between 30°C and 40°C, through the various structural components of the thermal system.

[0003] Conventionally, there are substantially two ways of regulating the temperature of the heated rooms.

[0004] According to a first system, the temperature of the heat transfer fluid is adjusted as a function of the external temperature, by means of a mixing valve and of an adapted electronic apparatus for temperature control. A circulating pump feeds the fluid at the same temperature to all the circuits connected to the mixing valve. The circuits are generally constituted by one or more distribution manifolds,

[0005] In the other regulating system, the feed temperature is preset at a fixed value by using a thermostatic valve or an electronic regulator that operates a motorized valve. The feed temperature is the same for all the circuits connected to the system; however, it is possible to adjust the temperature of each room independently by using thermostats which close the corresponding circuit when a desired ambient temperature is reached.

[0006] If the temperature of the heat transfer fluid conveyed in the circuits is lowered to values around 16°C, the same thermal system can be used to cool the rooms.

[0007] In such case too, the feed temperature is the same for all the circuits connected to the system and its value must be such as to prevent condensation on the surfaces.

[0008] The humidity may be reduced by means of adapted air treatment machines, which can operate purely by dehumidification, with post-heating batteries, or also by cooling. The temperature of the feed fluid of the air treatment machines is normally lower than the temperature of the fluid that flows in the circuits in order to have a better performance.

[0009] As described above, in the conventional heating systems, the feed temperature of the heat transfer fluid is the same for all circuits and is set to the value required to meet the least favoured room. The radiating bodies are also sized as a function of this temperature.

[0010] In the conventional heating systems of the above described type, if it is required to increase or decrease the temperature in a single room, the feed temperature of the heat transfer fluid must necessarily be increased or decreased, subjecting all the rooms to the variation.

[0011] In order to obviate this drawback, a room thermostat is generally installed, setting the feed temperature of the heat transfer fluid to a value that is certainly higher than necessary, if the system is operating in heating mode, and lower than necessary, if the system is in the cooling mode.

[0012] The adjustment is entrusted to local thermostats, which close the corresponding circuit when the desired temperature is reached in the room; however, such temperature is subject to continuous variations.

[0013] In the conventional heating system, it is also required to use separate temperature control systems in order to provide different feed temperatures.

[0014] For example, if it is necessary to supply high-temperature heating bodies, such as radiators or heated towel rails, and low-temperature heating bodies, such as floor panels, wall panels or ceiling panels, it is necessary to use two distinct temperature controls: one for the low temperature and one for the high temperature.

[0015] A similar drawback also arises if the system is preset for cooling and it is necessary to supply air treatment machines in addition to the circuits installed in the various rooms.

[0016] A heating system with one feed temperature entails a further problem: in rooms that require a lower heat emission per unit surface, the pipes must be spaced further apart, however, excessively wide spacing of the pipes may lead to an increase in the time required by the system to reach the steady state.

[0017] A further problem of the conventional temperature control systems is that they are difficult to calibrate efficiently. In fact, in the case of climate-related temperature adjustments of low-temperature radiant thermal systems, over the course of a season, a 25°C variation of the outside temperature generally corresponds to a 20°C variation of the feed temperature of the system, which means that a 1°C variation of the outside temperature leads to a variation of the feed temperature of 0.8°C.

[0018] In the case of heating systems of the radiant type, the thermal emission at the surface that covers the piping proximate to the feed of the heat transfer fluid is higher than the thermal emission at the surface that covers the piping at the end of the user circuit; because of this, the standards prescribe that average thermal emission must be considered as the design thermal emission but that the temperature measured at the point at the highest temperature must be considered as the maximum surface temperature.

[0019] For example, if the feed temperature is 40°C and the return temperature is 30°C, a temperature of 35°C is considered for the heat transfer fluid for thermal emission, but the temperature obtained above the piping, in which the heat transfer fluid temperature is 40°C, is considered as the maximum surface temperature.

[0020] Accordingly, in order to increase the thermal emission for an equal maximum surface temperature or decrease the maximum surface temperature for an equal thermal emission, the temperature difference, that usually occurs between the return temperature and the feed temperature, should be cancelled out or limited.

[0021] The aim of the invention is therefore to solve the problems described above, providing an apparatus and a method for controlling thermal systems, namely radiant systems, that allow to maximize the thermal per-

formance, by reducing the difference between the feed temperature and the return temperature.

[0022] Within the scope of this aim, a particular object of the invention is to provide an apparatus and a method that allow to obtain a substantially constant thermal flow along all the piping that forms a user circuit.

[0023] Another object of the invention is to provide an apparatus and a method that facilitate the adjustment of the room temperature by making it independent from the precision of the feed temperature of the system.

[0024] A further object of the invention is to provide an apparatus and a method that can be used for regulating the temperature of radiant systems, regardless of whether they are preset for heating or for cooling.

[0025] A further important object of the invention is to provide an apparatus and a method that allow to reduce the speed of the heat transfer fluid in user circuits, also reducing the electric power of the circulation pump assigned to the operation of the system.

[0026] This aim, as well as these and other objects that will become better apparent hereinafter, are achieved by an apparatus for controlling thermal systems, namely radiant systems, comprising at least one feed manifold and at least one return manifold; in an active condition, said first feed manifold distributes heat transfer fluid to a plurality of user circuits, at feed temperature, and said return manifold collects heat transfer fluid from said user circuits, at return temperature; said apparatus is characterized in that it comprises a temperature equalizing means associated with said first feed manifold; in said active condition, said temperature equalizing means distributes the thermal emission homogeneously along each individual user circuit.

[0027] The aim and objects described above are also achieved by a method for controlling thermal systems, namely radiant systems, characterized in that it comprises the following steps:

- during a first distribution period, introducing heat transfer fluid in a user circuit at feed temperature;
- during a second distribution period, introducing heat transfer fluid in said user circuit at return temperature;
- cyclically alternating said first distribution period and said second distribution period.

[0028] Further characteristics and advantages will become better apparent from the description of a preferred but not exclusive embodiment of an apparatus for controlling heating systems, particularly for radiant systems, according to the invention, illustrated by way of non-limiting example in the accompanying drawings, wherein:

Figure 1 is a view of an apparatus according to the invention;

Figure 2 is a view of a thermal system provided with the apparatus according to the invention;

Figure 3 is a diagram of the system of figure 2.

[0029] With reference to the cited figures, an apparatus for controlling thermal systems, namely radiant systems, is generally designated by the reference numeral 1.

[0030] The apparatus 1 comprises a first feed manifold 10 and a return manifold 30, which control and distribute a heat transfer fluid to the user circuits 40 of a thermal system 1000.

[0031] The user circuits 40 may be constituted by coils of radiating panels, by radiators, by other heating accessories or by any other heating body.

[0032] The first feed manifold 10 is constituted by a first tubular body 11, which is provided, at one end, with a first inlet 12 for the heat transfer fluid at feed temperature that arrives from a heating and refrigeration source.

[0033] A first threaded coupling 13, at the opposite end, allows the connection of other substantially equivalent feed manifolds.

[0034] The flow through the first inlet 12 is adjusted by a first ball valve 14, while the first threaded coupling 13 is closed by a first plug 15, when the first feed manifold 10 is capable of autonomously meeting the requirements of the thermal system 1000.

[0035] Feed branches 16 are provided on the side wall of the first tubular body 11. In an active condition such feed branches 16 distribute the heat transfer fluid at feed temperature to the user circuits 40.

[0036] The return manifold 30 includes a third tubular body 31, which is provided at one end with an outlet 32 for the heat transfer fluid at return temperature to be conveyed toward the heating and refrigeration source. At the opposite end, the return manifold 30 also includes a third threaded coupling 33, which allows the connection of other substantially equivalent return manifolds.

[0037] If the return manifold 30 autonomously meets the requirements of the thermal system 1000, the third threaded coupling 33 is closed by an overpressure valve 34.

[0038] Return branches 35 are provided on the side wall of the third tubular body 31. In the active condition, the return branches 35 collect the heat transfer fluid at return temperature that arrives from the user circuits 40.

[0039] In this embodiment of the invention, the thermal system 1000 is preset for winter heating and the heating and refrigeration source is preferably constituted by the secondary circuit of a heat exchanger 1001, the primary circuit of which interacts with a boiler, which is not shown in the figures.

[0040] The heat exchanger 1001 is connected to the first inlet 12 and to the outlet 32 of the apparatus 1 and interacts with a circulation pump 50 which is preferably arranged at the same outlet 32.

[0041] The heat exchanger 1001 separates the boiler circuit from the circuit related to the heating bodies and prevents the flow rates between the primary and secondary circuits from affecting each other.

[0042] Preferably, the thermal system 1000 also comprises an automatic air vent valve 1002, which is arranged substantially at the first inlet 12.

[0043] According to the invention, the apparatus 1 comprises a temperature equalizing means 100, which is associated with the first feed manifold 10 in order to uniformly distribute the thermal emission along each user circuit 40,

[0044] The temperature equalizing means 100 is substantially constituted by a second feed manifold 120, which is associated with the first feed manifold 10, and a series of switching units 130 which interact with the two feed manifolds.

[0045] In the active condition, the second feed manifold 120 mainly has the function of distributing the heat transfer fluid, at return temperature, to the user circuits 40. The switching units 130 alternate the heat transfer fluid at feed temperature, distributed by the first feed manifold 10, with the heat transfer fluid at return temperature, distributed by the second feed manifold 120, substantially at the feed of each user circuit 40.

[0046] The second feed manifold 120 comprises a second tubular body 121, which is provided at one end with a second inlet 122 for the heat transfer fluid at return temperature that arrives from the user circuits 40.

[0047] A second ball valve 124 adjusts the flow in the second inlet 122. The second inlet valve 122 is connected to the outlet 32 of the return manifold 30, directly or by means of the interposed circulation pump 50.

[0048] A second threaded coupling 123 is provided at the free end of the second tubular body 121 and allows to connect other substantially equivalent feed manifolds or to apply a second plug 125.

[0049] Branches 126 are formed on the side wall of the first tubular body 11 and are connected to the switching units 130.

[0050] Each switching unit 130 includes a three-way valve 131 which is controlled automatically and is provided with a first inlet 132a. The first inlet 132a is connected to a feed branch 16 of the first feed unit 10. The three-way valve 131 is also provided with a second inlet 132b, which is connected to the corresponding branch 126 of the second feed unit 120, and with an outlet 133. The outlet 133 is connected to a user circuit 40.

[0051] The three-way valve 131 connects the outlet 133 alternately to the first inlet 132a and to the second inlet 132b.

[0052] The apparatus 1 also comprises a balancing valve 140, which is arranged at the second inlet 122 in order to adjust the pressure difference between the first feed manifold 10 and the second feed manifold 120, in a fixed or variable manner.

[0053] The operation of the apparatus according to the invention is as follows.

[0054] In a thermal system 1000 to which multiple user circuits 40 are connected, the heat transfer fluid at feed temperature arrives from a heating and refrigeration source and gathers in the first feed manifold 10, while the heat transfer fluid at return temperature arrives from the user circuits 40 and gathers in the second feed manifold 120.

[0055] Considering, for the sake of simplicity of the description, one user circuit 40, among the ones connected to the thermal system 1000, in the active condition the outlet 133 of the corresponding three-way valve 131 is connected to the first inlet 132a. The heat transfer fluid at feed temperature flows initially in the user circuit 40.

[0056] After a first distribution period, the flow of heat transfer fluid at feed temperature is throttled and the outlet 133 of the three-way valve 131 is connected to the second inlet 132b, causing heat transfer fluid at return temperature to flow in the user circuit 40.

[0057] After a second distribution period, the flow of heat transfer fluid at return temperature also is throttled and the outlet 133 of the three-way valve 131 is again connected to the first inlet 132a, repeating the entire cycle.

[0058] The alternation between heat transfer fluid at feed temperature and heat transfer fluid at return temperature allows the apparatus 1 to utilize the thermal capacity of the piping in which the fluid flows, as explained hereinafter with an example.

[0059] The duration of the two distribution periods determines the average heating power of the user circuit 40.

[0060] If the outlet 133 of the three-way valve 131 is constantly connected to the second inlet 132b, the user circuit 40 is crossed by heat transfer fluid at return temperature and, accordingly, the heat exchange between the piping of the user circuit 40 and the environment is substantially nil.

[0061] Vice versa, if the outlet 133 of the three-way valve 131 is constantly connected to the first inlet 132a, the user circuit 40 is crossed by heat transfer fluid at feed temperature and, accordingly, the heat exchange between the piping of the user circuit 40 and the environment is maximum.

[0062] This last circumstance is particularly advantageous if the thermal system 1000 requires different feed temperatures in order to supply not only floor panels, wall panels or ceiling panels but also heating bodies such as radiators and/or heated towel rails, if it operates in heating mode, or air treatment machines, if it is operating in cooling mode.

[0063] After supplying the user circuit 40, the heat transfer fluid gathers in the return manifold 30 and, propelled by the circulation pump 50, returns to the heating and refrigeration source.

[0064] The effects linked to the alternation between the flows of heat transfer fluid at feed temperature and the flows of heat transfer fluid at return temperature, will now be described, merely by way of example, with reference to a thermal system 1000, preset to operate in heating mode.

[0065] With this assumption, the heat transfer fluid at feed temperature that arrives from the heat exchanger 1001 is heat transfer fluid at high-temperature, while the heat transfer fluid at return temperature that arrives from the user circuits 40, in which heat transfer has occurred, is heat transfer fluid at a low-temperature.

[0066] When the outlet 133 of the three-way valve 131 is connected to the first inlet 132a, the first distribution period begins and the piping that forms the user circuit 40 increases its temperature as a function of the thermal gradient between the heat transfer fluid and the piping and accumulates heat, which it partly transmits externally.

[0067] Subsequently, the outlet 133 of the three-way valve 131 is connected to the second inlet 132b and the second distribution period begins, during which part of the heat accumulated in the piping is transferred to the low-temperature heat transfer fluid that flows through the user circuit 40.

[0068] In this manner, while the low-temperature heat transfer fluid increases its own temperature, because of the heat collected along the piping previously heated by the high-temperature heat transfer fluid, the thermal emission of the radiating surface at the feed piping decreases by the amount of heat that is transferred to the low-temperature heat transfer fluid.

[0069] The heat that at a certain point of the piping reaches the surface of the floor and is transferred to the environment is therefore determined by the difference between the heat transferred by the high-temperature heat transfer fluid and the heat absorbed by the low-temperature heat transfer fluid.

[0070] It should be noted that, by virtue of the characteristics of the apparatus 1, a substantially constant heat flow is achieved along the entire piping, thereby achieving a heating performance which is higher than that of the conventional systems, which generally operate with a difference in temperature between the feed and the return of approximately 5°C.

[0071] If the thermal system 1000 is preset to operate in cooling mode, the heat transfer fluid at feed temperature that arrives from the heat exchanger 1001 is heat transfer fluid at low-temperature, while the heat transfer fluid at return temperature that arrives from the user circuits 40, in which heat absorption has occurred is heat transfer fluid at high-temperature.

[0072] Also in this case, the alternation between the heat transfer fluid at feed temperature and the heat transfer fluid at return temperature allows to utilize the thermal capacity of the piping by means of processes that are substantially equivalent to the ones that have already been described.

[0073] The present invention also relates to a method for controlling thermal systems, namely radiant systems, which can be used advantageously with temperature control systems that are substantially equivalent to the apparatus 1 described earlier,

[0074] The method according to the invention substantially comprises supplying a user circuit of a thermal system with heat transfer fluid at feed temperature alternated with heat transfer fluid at return temperature.

[0075] During a first distribution period, heat transfer fluid at feed temperature is introduced in the user circuit; subsequently, during a second distribution period that

immediately follows the first distribution period, heat transfer fluid at return temperature is introduced in the user circuit.

[0076] The two distribution periods, which have adjustable durations, are alternated cyclically.

[0077] The heat transfer fluid at return temperature is preferably constituted by part of the fluid that arrives from the user circuits.

[0078] In practice it has been found that the apparatus and the method for controlling thermal systems, namely radiant systems, according to the invention fully achieve the intended aim, allowing a substantially constant heat flow along the entire piping of a user circuit, with a thermal performance that is higher than that of the conventional systems, which operate with a difference in temperature between the feed and the return of approximately 5°C.

[0079] Also, the apparatus and the method according to the invention facilitate the adjustment of the room temperature because such temperature is no longer linked to the precision of the feed temperature but rather to the number of high-temperature cycles that are activated through the day.

[0080] Moreover, whereas in a conventional system the speed of the heat transfer fluid in the circuits must be rather high, in order to have a low thermal gradient, in the apparatus and the method according to the invention the speed of the fluid can be considerably reduced and, accordingly, the electric power of the circulation pump assigned to the operation of the system is also reduced.

[0081] Also, the adjustment of the frequency and duration of the various distribution periods allows to achieve high stability of the ambient temperature regardless of whether the thermal system is preset for winter heating or for summer cooling.

[0082] This application claims the priority of Italian Patent Application No. V12010A000106, filed on April 16, 2010, the subject matter of which is incorporated herein by reference.

Claims

1. An apparatus for controlling thermal systems, namely radiant systems, comprising at least one feed manifold and at least one return manifold; in an active condition, said first feed manifold distributes heat transfer fluid to a plurality of user circuits, at feed temperature, and said return manifold collects heat transfer fluid from said user circuits, at return temperature; said apparatus is **characterized in that** it comprises a temperature equalizing means associated with said first feed manifold; in said active condition, said temperature equalizing means distributes the thermal emission homogeneously along each individual user circuit.
2. The apparatus according to the preceding claim, **characterized in that** said temperature equalizing

means comprises a second feed manifold associated with said first feed manifold; the inlet of said second feed manifold is connected to the outlet of said return manifold; in said active condition, said second feed manifold distributes heat transfer fluid at return temperature to said user circuits. 5

fluid at return temperature is part of the fluid that arrives from said user circuits.

3. The apparatus according to one or more of the preceding claims, **characterized in that** said temperature equalizing means comprises a plurality of switching units which interact with said first feed manifold and with said second feed manifold; in said active condition, said switching units distribute to said user circuits heat transfer fluid at feed temperature that arrives from said first feed manifold, alternating it with heat transfer fluid at return temperature that arrives from said second feed manifold. 10 15
4. The apparatus according to one or more of the preceding claims, **characterized in that** each one of said switching units comprises at least one automatically controlled three-way valve provided with two inlets and one outlet; said two inlets are connected respectively to said first feed manifold and to said second feed manifold; said outlet is connected to a user circuit; in said active condition, said outlet is alternately connected to one of said inlets. 20 25
5. The apparatus according to one or more of the preceding claims, **characterized in that** it comprises a balancing valve arranged at the inlet of said second feed manifold. 30
6. A method for controlling thermal systems, namely radiant systems, **characterized in that** it comprises the following steps: 35
 - during a first distribution period, introducing heat transfer fluid in a user circuit at feed temperature; 40
 - during a second distribution period, introducing heat transfer fluid in said user circuit at return temperature;
 - cyclically alternating said first distribution period and said second distribution period. 45
7. The method according to the preceding claim, **characterized in that** said second distribution period is immediately subsequent to said first distribution period. 50
8. The method according to one or more of the preceding claims, **characterized in that** the duration of said first distribution period and of said second distribution period is adjustable. 55
9. The method according to one or more of the preceding claims, **characterized in that** said heat transfer

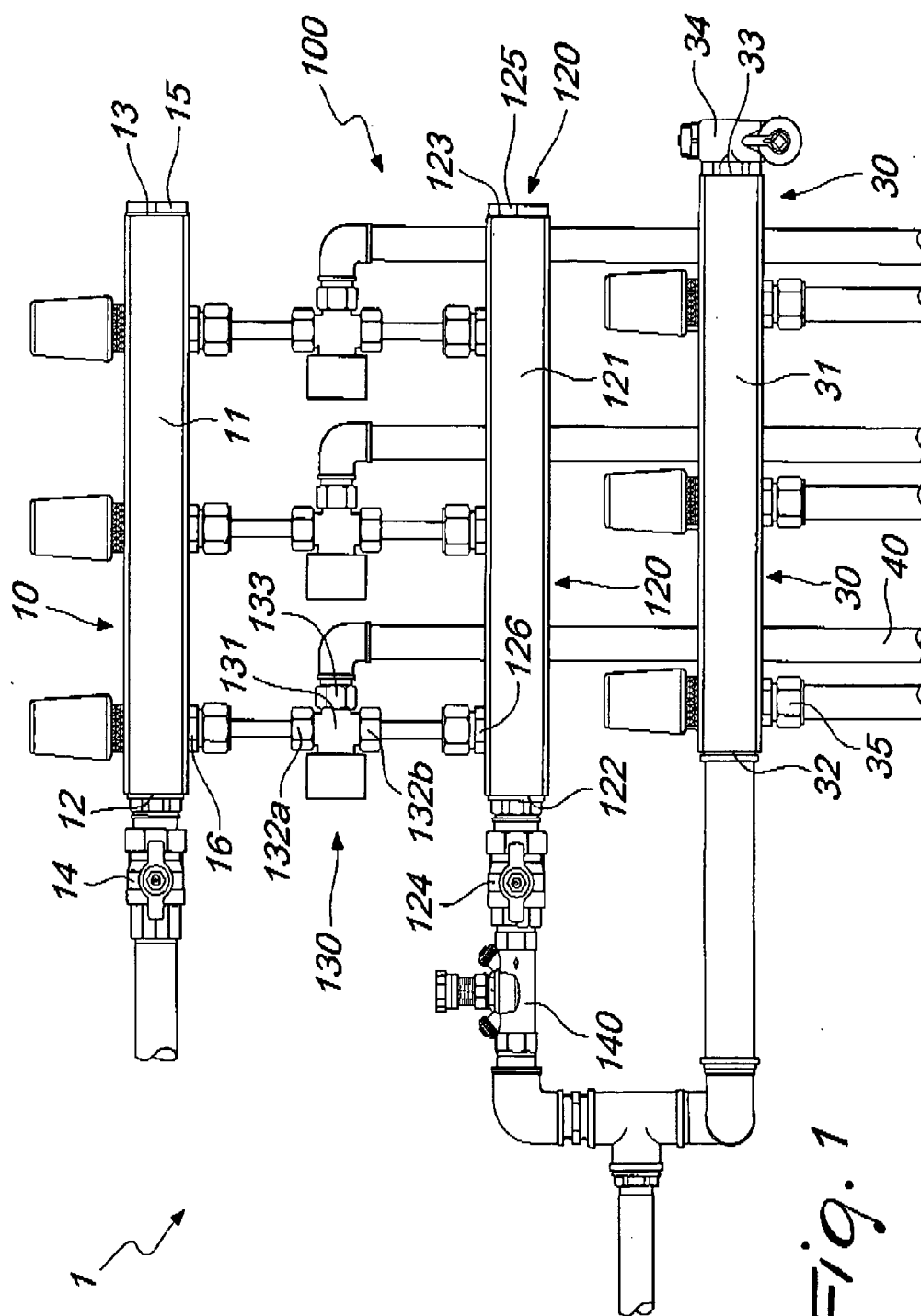


Fig. 1

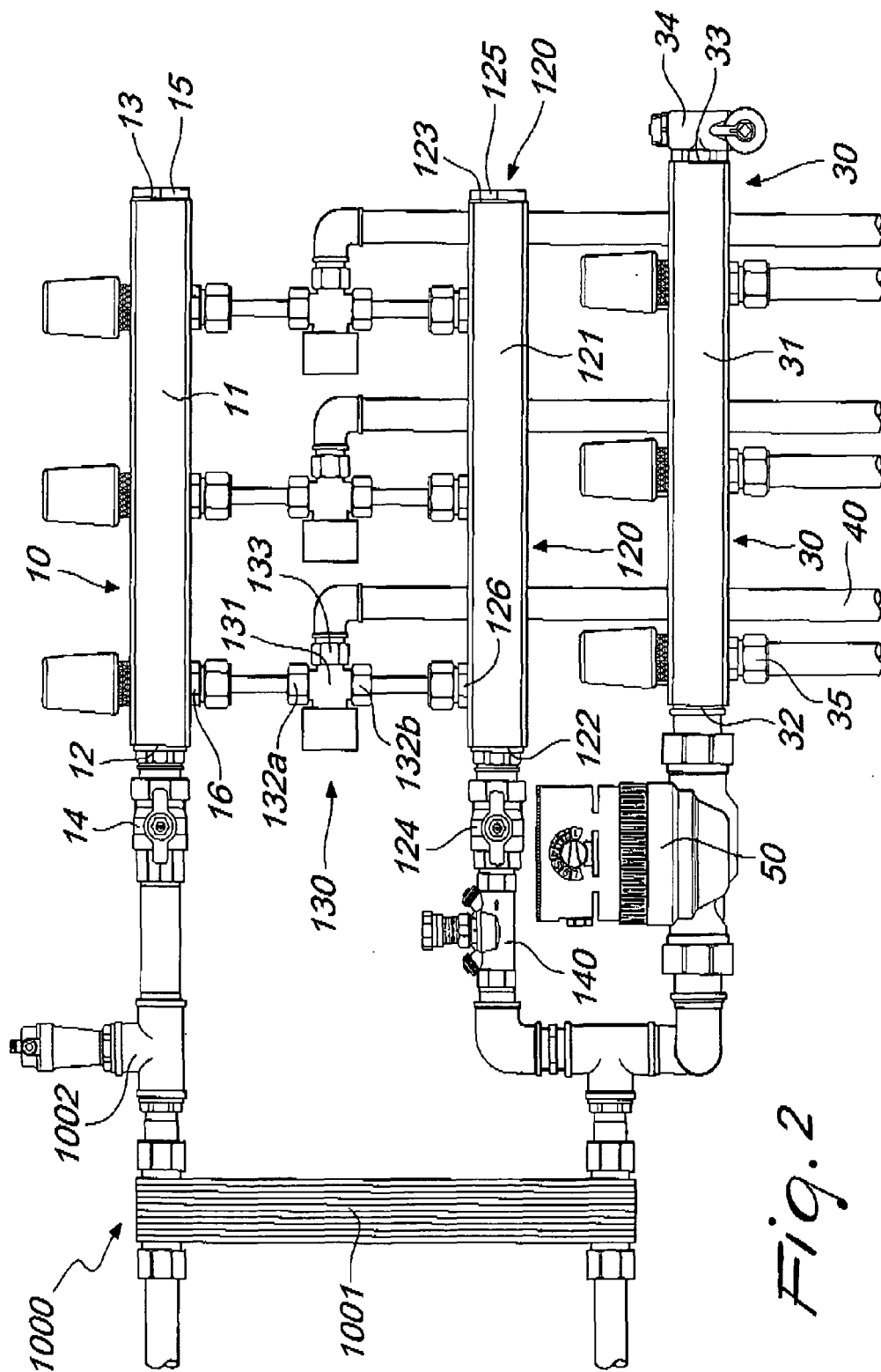


Fig. 2

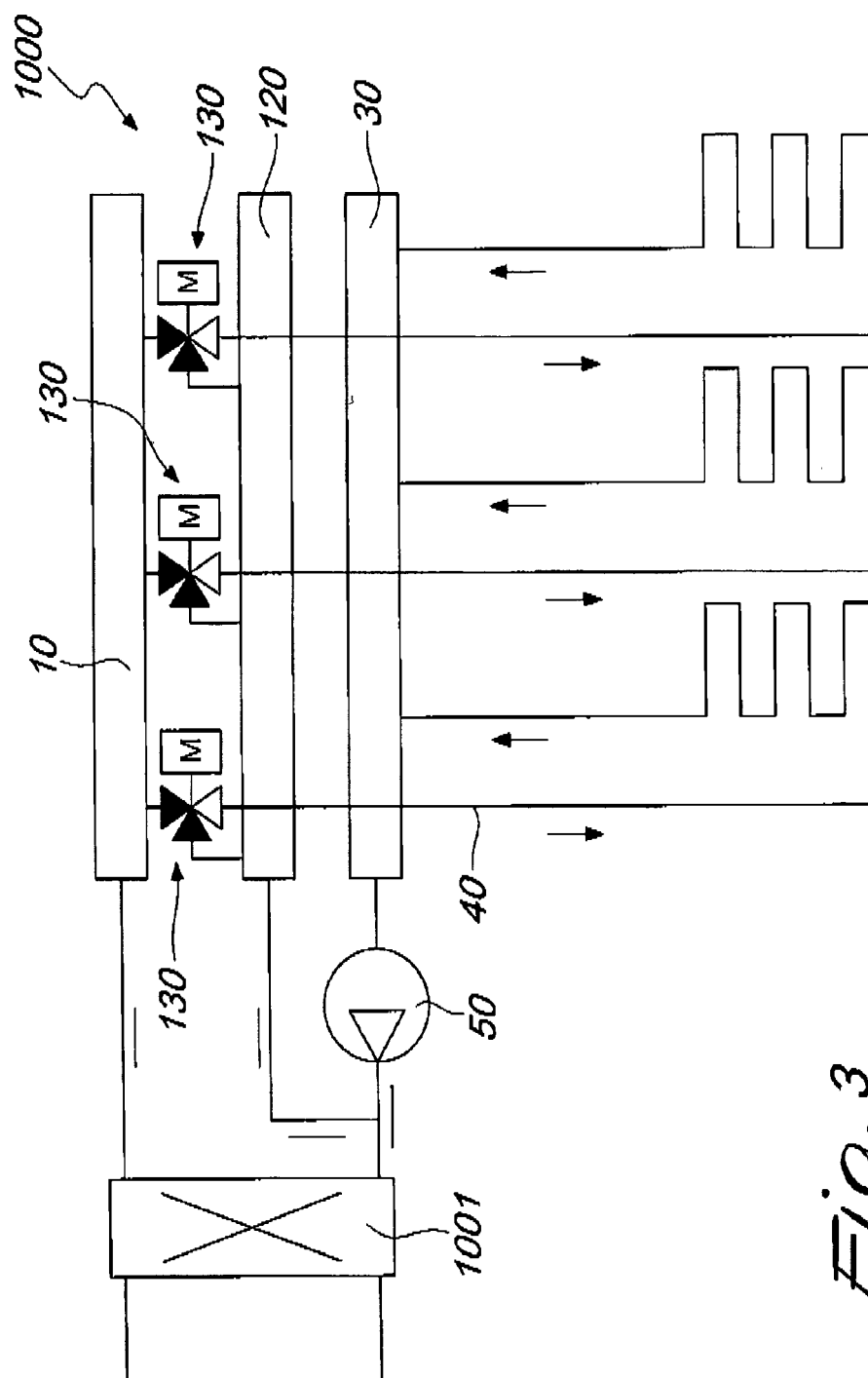


Fig. 3



EUROPEAN SEARCH REPORT

Application Number
EP 11 00 3006

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 A	US 5 707 007 A (FIEDRICH JOACHIM [US]) 13 January 1998 (1998-01-13) * column 14, line 35 - column 15, line 22; figure 8 *	1 6	INV. F24D3/10
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			F24D
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 12 October 2011	Examiner Pileri, Pierluigi
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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 11 00 3006

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12-10-2011

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