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(54) **METHOD FOR CONTROLLING A TEMPERATURE INFLUENCING SYSTEM AND TEMPERATURE INFLUENCING SYSTEM**

(57) A method for controlling a temperature influencing system (1) having a heat exchanger (2) connected to a supply pipe arrangement (3) and a fan (7) for generating an air stream (8) through the heat exchanger (2) is described, wherein a flow of a heat carrying fluid is guided through the heat exchanger (2) and a user can change the speed of the fan (7).

Such a method should work with low energy consumption.

To this end, when the user changes the speed of a fan (7) at the same time the flow of the heat carrying fluid through the heat exchanger (2) is adjusted to a size in which a temperature difference over the heat exchanger (2) is maintained at a predetermined value.

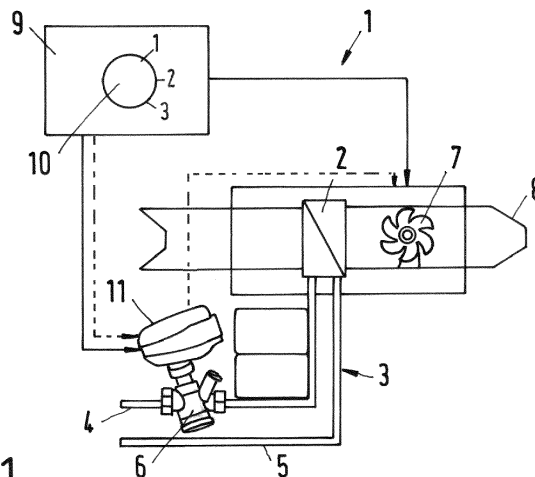


Fig.1

## Description

**[0001]** The present invention relates to a method for controlling a temperature influencing system having a heat exchanger connected to a supply pipe arrangement and a fan for generating an air stream through the heat exchanger, wherein a flow of a heat carrying fluid is guided through the heat exchanger and a user can change the speed of the fan.

**[0002]** Furthermore, the invention relates to a temperature influencing system comprising a heat exchanger connected to a supply arrangement for a heat carrying fluid and a fan having a fan speed selection device.

**[0003]** Such a system can be, for example, a HVAC system with which it is possible to influence the temperature in a room of a building. When the heat carrying fluid is warmer than the temperature of the air in the room, the air and the room are heated. When the heat carrying fluid is colder than the air in the room, the room is chilled.

**[0004]** The fan produces an air stream which can be uncomfortable for a user staying in the room. In such a situation the user often tends to reduce the speed of the fan to avoid an unpleasant draft. However, such an action is not optimal under the aspect of energy consumption.

**[0005]** The object underlying the invention is to provide a temperature influencing system having a low energy consumption.

**[0006]** This object is solved with a temperature influencing method as described at the outset, in that when the user changes the speed of the fan at the same time the flow of the heat carrying fluid through the heat exchanger is adjusted to a size in which a temperature difference over the heat exchanger or a return temperature from the heat exchanger is maintained at a predetermined value.

**[0007]** Thus, when the speed of the fan is reduced and the air stream decreases, the flow of the heat carrying fluid through the heat exchanger is reduced at the same time, so that the heat carrying fluid transports only the amount of heat through the heat exchanger which can be removed by the air stream. Thus, the temperature of the heat carrying fluid at the outlet of the heat exchanger is sufficiently low for heating or sufficiently high for cooling, so that a source of positive or negative heat influencing the heat carrying fluid can work in an optimum point of operation. A minimum temperature differential is crucial for chiller and heat pump efficiency. Furthermore, when the flow of the heat carrying fluid through the heat exchanger is lowered, when the fan speed is decreased, the power necessary for pumping the heat carrying fluid through the heat exchanger can also be reduced. Thus, energy is saved. The term "at the same time" allows a certain delay between the changement of the fan speed and the adjustment of the flow. In an alternative to the temperature difference over the heat exchanger it is also possible to use a return temperature from the heat exchanger as parameter which should be maintained at a predetermined value. Low return temperature is crucial

for district heating systems or condensing gas boilers efficiency. In this case, basically the same advantages are achieved.

**[0008]** In an embodiment of the invention the user adjusts the fan speed stepwise. Thus, the fan speed can be adjusted to a number of at least two different discrete values. Consequently, only a corresponding number of different flows of the heat carrying fluid has to be adjusted. This simplifies the implementation of the method.

**[0009]** In an embodiment of the invention the flow of the heat carrying fluid is adjusted by means of a valve. A valve is a simple means which can adjust the flow of the heat carrying fluid by adjusting an opening degree or by adjusting a duty cycle of the valve.

**[0010]** In an embodiment of the invention the valve is calibrated in a set-up step for at least two different fan speeds. Preferably, the valve is calibrated for all different fan speeds which can be adjusted. When the temperature influencing system is installed, the installer can use a flow meter to measure the flow through the heat exchanger. The temperature influencing system is designed for a specific purpose, for example for a specific building or room arrangement. Thus, the flow of the heat carrying fluid for the maximum fan speed can be determined in advance. In the same way, the flow of the heat carrying fluid for reduced fan speeds can also be determined in advance. The valve can then be actuated to achieve the desired flows and the position of the valve (or the duty cycle) can be stored to be used later in order to adjust the valve when the speed of the fan has been changed.

**[0011]** In an embodiment of the invention a valve is used having an actuator which is connected to a speed selection device of the fan or a room controller. The connection between the fan speed selection device and the actuator can be wired or wireless. The actuator can be operated with the parameters determined in the set-up step. Thus, when the user operates the fan speed selection device to adjust the fan speed, a corresponding information is automatically given to the actuator which in turn adjusts the valve, so that a flow rate of the heat carrying fluid is adjusted which is adapted to the respective fan speed.

**[0012]** The object is solved with a temperature influencing system as described at the outset in that the supply arrangement comprises means for adjusting a flow of the heat carrying fluid to a size depending on the fan speed in which a temperature difference over the heat exchanger or a return temperature from the heat exchanger is maintained at a predetermined value.

**[0013]** As described above, when the speed of the fan and thus the flow of air through the heat exchanger is changed, the flow of the heat carrying fluid through the heat exchanger is changed as well, so as to maintain a constant or predetermined temperature difference over the heat exchanger. Thus, when the fan speed is reduced, the flow of the heat carrying fluid through the heat exchanger is reduced as well. When the fan speed is

increased, the flow of the heat carrying fluid through the heat exchanger is also increased. As mentioned above, the return temperature from the heat exchanger can also be used as parameter. The use of the return temperature as parameter can be of advantage in particular in connection with a district heating system or condensing gas boiler, in which the return temperature must not exceed a predetermined level.

**[0014]** In an embodiment of the invention the fan speed selection device adjusts the fan speed stepwise. It is, for example, possible to use only two or three or four fan speeds. The consequence is that it is only necessary to adjust two, three or four different flows of the heat carrying fluid through the heat exchanger. Thus, the system can be made rather simple in construction.

**[0015]** In an embodiment of the invention the means for adjusting the flow of the heat carrying fluid comprise a valve. A valve is a simple device for adjusting a flow of a fluid.

**[0016]** In an embodiment of the invention the valve is calibrated for at least two fan speeds. For each fan speed, a flow of the heat carrying fluid can be determined in advance. In a set-up step the valve can be actuated until it has adjusted a flow which is adapted to a certain fan speed. This parameter, for example an opening degree of the valve, is stored and can be used in a later stage for adjusting the valve depending on the fan speed.

**[0017]** In an embodiment of the invention the valve comprises an actuator which is connected to the fan speed selection device or a room controller. Thus, when the speed of the fan is changed by actuating the fan speed selection device, the valve is automatically adjusted in order to allow only the flow of the heat carrying fluid which fits to the fan speed and the corresponding air stream.

**[0018]** An embodiment of the invention will now be described with reference to the drawing, in which:

Fig. 1 is a schematic illustration of a temperature influencing system,

Fig. 2 shows some graphs illustrating an embodiment of the present invention,

Fig. 3 shows some graphs illustrating another embodiment of the invention, and

Fig. 4 shows another embodiment of a temperature influencing system.

**[0019]** Fig. 1 shows schematically a temperature influencing system 1 comprising a heat exchanger 2 which is connected to a supply arrangement 3 for a heat carrying fluid. The supply arrangement 3 comprises a supply line 4 and a return line 5. A valve 6 is arranged in the supply line 4. It is also possible, to arrange the valve 6 in the return line 5.

**[0020]** A fan 7 is used to produce an air stream 8 through the heat exchanger 2.

**[0021]** The heat carrying fluid flowing through the supply arrangement 3 can be used to warm up the air stream 8 or to chill the air stream 8. In the first case, the temperature of the heat carrying fluid is higher than the temperature of the air stream 8 at the inlet of the heat exchanger 2. In the other case, the temperature of the heat carrying fluid is lower than the air temperature at the inlet of the heat exchanger 2.

**[0022]** A fan speed selection device 9 is used to adjust a speed of the fan 7. In the present case, the fan 7 can be operated in three different fan speeds, namely a max speed, a mid speed, and a min speed. It is, however, possible to use more different fan speeds. The fan speed selection device 9 can comprise, for example, a knob 10 which can be rotated in different angular positions, to select the max speed (No. 1), the mid speed (No. 2) or the min speed (No. 3). The fan speed selection device 9 can have another form, for example, can have one or more push-buttons to change the fan speed.

**[0023]** The valve 6 is provided with an actuator 11 which actuates the valve 6. In other words, the valve 6 can adjust the flow of the heat carrying fluid through the heat exchanger 2. When the valve 6 is actuated in opening direction, the flow of the heat carrying fluid through the heat exchanger 2 is increased. When the valve 6 is actuated in closing direction, the flow of heat carrying fluid through the heat exchanger 2 is decreased.

**[0024]** The fan speed selection device 9 can be directly connected to the fan 7 or it can be connected to the fan 7 via the actuator 11 or the valve 6 as indicated by a dashed line.

**[0025]** The valve 6 can be a rather simple valve, in which a size of an opening, for example the distance between a valve element and a valve seat in a seat valve or an overlap of two channels in a ball valve, can be changed in order to influence the flow of the heat carrying fluid. Each "opening degree" corresponds to a specific flow. It is also possible, to use another valve which adjusts the flow of heat carrying fluid by repeatedly open and closing completely the valve. In this case, the duty cycle of the valve determines the "opening degree".

**[0026]** The best results are achieved when the valve 6 is a pressure independent control valve (PICV) comprising a control valve of any type and a differential pressure controller. Here, the flow through the valve doesn't change when pressure across the valve is changing in variable flow HVAC-systems.

**[0027]** Not only the fan 7 is connected to the fan speed selection device 9, but also the actuator 11. Thus, when the speed of the fan 7 is selected by means of the fan speed selection device 9, the actuator 11 is operated at the same time in order to adjust the valve 6 which in turn adjusts the flow of the heat carrying fluid through the heat exchanger 2.

**[0028]** This is further illustrated with reference to Fig. 2. The horizontal axis shows the flow  $q$  of the heat carrying fluid through the heat exchanger 2 and the vertical axis shows the thermal power  $Q$  emitted to the room.

**[0029]** The system 1 is usually designed for a maximum speed of the fan 7 (corresponding to 100 % thermal power) and 100 % flow. This is illustrated by means of a graph 12. In this case, the inlet temperature of the heat carrying fluid at the inlet of the heat exchanger 2 can have a temperature of, for example, 6°C and the outlet temperature is 12°C. In other words, a temperature difference  $\Delta T$  of 6°C is achieved.

**[0030]** When the speed of the fan 7 is adjusted via the fan speed selection device 9 to mid speed, a curve 13 would result. This curve shows that at 100 % flow and an inlet temperature of 6°C an outlet temperature of 9°C would be achieved, so that the temperature difference  $\Delta T$  over the heat exchanger 2 would result to  $\Delta T = 3^\circ\text{C}$ .

**[0031]** In order to avoid a decrease of the temperature difference  $\Delta T$  the flow of the heat carrying fluid through the heat exchanger 2 is reduced at the same time, in the present example to 40 %. In this way it is possible to achieve again a temperature difference  $\Delta T = 6^\circ\text{C}$ .

**[0032]** Again, when the speed of the fan 7 is further reduced, for example to a min speed, by actuating the fan speed setting device 9, a 100 % flow of heat carrying fluid through the heat exchanger 2 would lead to an outlet temperature of 7,5°C and consequently to a  $\Delta T = 1,5^\circ\text{C}$ .

**[0033]** In order to avoid this situation, the flow of the heat carrying fluid through the heat exchanger 2 is again reduced, for example to 25 %, so that again a temperature difference  $\Delta T = 6^\circ\text{C}$  is achieved.

**[0034]** The temperature influencing system 1 is usually designed for maximum fan speed and maximum flow through the heat exchanger 2. This "maximum" is presently named "100 %". The real flow volume depends on the system and can be determined in designing the system.

**[0035]** In a set-up procedure the temperature influencing system 1 can be operated at maximum speed of the fan 7 and 100 % flow. A flow meter can be used to determine the flow through the heat exchanger. If necessary, the maximum flow can be adjusted by means of the valve 6. The opening degree for the valve 6 for maximum flow can be stored, for example in the actuator 11.

**[0036]** The flow for the mid speed of the fan 7 can also be determined in advance, like the flow for the min speed of the fan 7.

**[0037]** In a further step, the flow corresponding to the mid speed of the fan 7 is adjusted using the valve 6 and the flow meter can be used to check whether this flow has been achieved. The opening degree of the valve 6 for this flow can also be stored in the actuator 11.

**[0038]** The same procedure can be performed for the min speed of the fan 7.

**[0039]** It is furthermore possible, to check in each adjustment step, whether the desired temperature difference  $\Delta T$  of, for example, 6°C is achieved for the adjusted flow.

**[0040]** When the set-up has been finished, the flow meter can be removed, or it can be kept for continuous measurement.

**[0041]** In the subsequent operation, it is only necessary that the fan speed selection device 9 transmits an information about the selected speed of the fan 7 to the actuator 11 and the actuator 11 automatically adjusts the opening degree of the valve 6, so that the desired flow of heat carrying fluid through the heat exchanger 2 is achieved.

**[0042]** In particular in connection with cooling, it is of advantage that a minimum temperature difference over the heat exchanger 2 is maintained. Thus, the chiller or the heat pump can be operated at an optimum point of operation.

**[0043]** Fig. 3 shows the situation when the return temperature is used as parameter for adjusting the opening degree of the valve 6 depending on the speed of the fan 7 selected by means of the fan speed selection device 9.

**[0044]** When 100 % thermal power  $Q$  has to be emitted to the room, the flow  $q$  through the valve 6 is also 100 %. This results in a return temperature of 30° C.

**[0045]** If the fan speed is reduced, for example, to mid speed, a return temperature of 35° C would come out when the flow  $q$  is maintained at 100 %. Thus, the flow  $q$  is reduced by the valve 6 to 40 %, so that again the return temperature is 30° C.

**[0046]** When the speed of the fan 7 is further reduced to min speed, the return temperature would be 40° C using a flow  $q$  of 100 %. Thus, the flow  $q$  is reduced by means of the valve 6 to 25 %, so that again a return temperature of 30° C is achieved.

**[0047]** Fig. 4 shows a second embodiment of a temperature influencing system comprising in addition a room controller 14. The room controller 14 is connected to the fan speed selection device 9 and to the actuator 11 of the valve 6. Thus, the fan speed selection device 9 is connected to the fan 7 via the controller 14. The controller 14 controls the actuator 11 and the actuator 11 automatically adjusts the opening degree of the valve 6, so that the desired flow of the heat carrying fluid through the heat exchanger 2 is achieved.

## Claims

1. Method for controlling a temperature influencing system (1) having a heat exchanger (2) connected to a supply pipe arrangement (3) and a fan (7) for generating an air stream (8) through the heat exchanger (2), wherein a flow of a heat carrying fluid is guided through the heat exchanger (2) and a user can change the speed of the fan (7), **characterized in that** when the user changes the speed of the fan (7) at the same time the flow of the heat carrying fluid through the heat exchanger (2) is adjusted to a size in which a temperature difference over the heat exchanger (2) or a return temperature from the heat exchanger (2) is maintained at a predetermined value.

2. Method according to claim 1, **characterized in that** the user adjusts the fan speed stepwise.
3. Method according to claim 1 or 2, **characterized in that** the flow of the heat carrying fluid is adjusted by means of a valve (6).
4. Method according to claim 3, **characterized in that** the valve (6) is calibrated in a set-up step for at least two different fan speeds.
5. Method according to claim 3 or 4, **characterized in that** a valve (6) is used having an actuator (11) which is connected to a speed selection device (9) of the fan (7) or to a room controller.
6. Temperature influencing system (1) comprising a heat exchanger (2) connected to a supply pipe arrangement (3) for a heat carrying fluid and a fan (7) having a fan speed selection device (9), **characterized in that** the supply pipe arrangement (3) comprises means for adjusting a flow of the heat carrying fluid to a size depending on the fan speed in which a temperature difference over the heat exchanger (2) or a return temperature from the heat exchanger (2) is maintained at a predetermined value.
7. Temperature influencing system according to claim 6, **characterized in that** the fan speed selection (9) device adjusts the fan speed stepwise.
8. Temperature influencing system according to claim 6 or 7, **characterized in that** the means for adjusting the flow of the heat carrying fluid comprise a valve (6).
9. Temperature influencing system according to claim 8, **characterized in that** the valve (6) is calibrated for at least two fan speeds.
10. Temperature influencing system according to claim 8 or 9, **characterized in that** the valve (6) comprises an actuator (11) which is connected to the speed selection device (9) or to a room controller.
- Amended claims in accordance with Rule 137(2) EPC.**
1. Method for controlling a temperature influencing system (1) having a heat exchanger (2) connected to a supply pipe arrangement (3) and a fan (7) for generating an air stream (8) through the heat exchanger (2), wherein a flow of a heat carrying fluid is guided through the heat exchanger (2) and a user can change the speed of the fan (7), **characterized in that** when the user changes the speed of the fan (7) at the same time the flow of the heat carrying fluid through the heat exchanger (2) is adjusted to a size in which a temperature difference of the heat carrying fluid over the heat exchanger (2) or a return temperature from the heat exchanger (2) is maintained at a predetermined value.
2. Method according to claim 1, **characterized in that** the user adjusts the fan speed stepwise.
3. Method according to claim 1 or 2, **characterized in that** the flow of the heat carrying fluid is adjusted by means of a valve (6).
4. Method according to claim 3, **characterized in that** the valve (6) is calibrated in a set-up step for at least two different fan speeds.
5. Method according to claim 3 or 4, **characterized in that** the valve (6) is used having an actuator (11) which is connected to a speed selection device (9) of the fan (7) or to a room controller.
6. Temperature influencing system (1) comprising a heat exchanger (2) connected to a supply pipe arrangement (3) for a heat carrying fluid and a fan (7) having a fan speed selection device (9), wherein the supply pipe arrangement (3) comprises means for adjusting a flow of the heat carrying fluid to a size depending on the fan speed in which a temperature difference over the heat exchanger (2) or a return temperature from the heat exchanger (2) is maintained at a predetermined value, **characterized in that** the temperature influencing system (1) is configured such that when a user changes the speed of the fan (7) at the same time the flow of the heat carrying fluid through the heat exchanger (2) is adjusted to a size in which a temperature difference of the heat carrying fluid over the heat exchanger (2) or a return temperature from the heat exchanger (2) is maintained at a predetermined value.
7. Temperature influencing system according to claim 6, **characterized in that** the fan speed selection (9) device adjusts the fan speed stepwise.
8. Temperature influencing system according to claim 6 or 7, **characterized in that** the means for adjusting the flow of the heat carrying fluid comprise a valve (6).
9. Temperature influencing system according to claim 8, **characterized in that** the valve (6) is calibrated for at least two fan speeds.
10. Temperature influencing system according to claim 8 or 9, **characterized in that** the valve (6) comprises an actuator (11) which is connected to the speed

selection device (9) or to a room controller.

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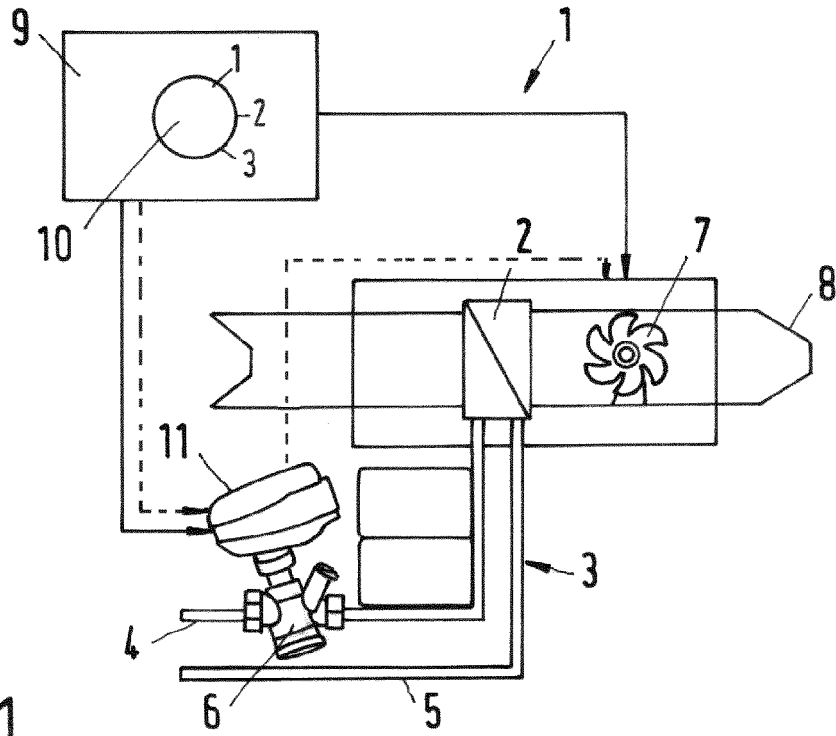


Fig.1

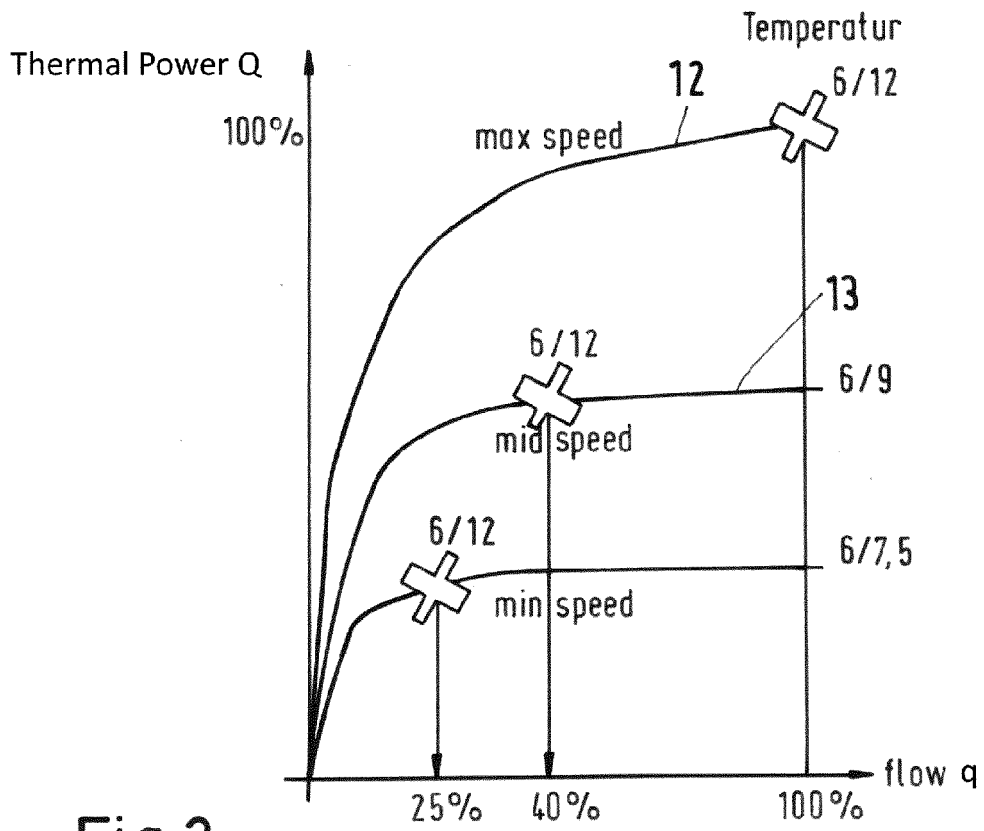


Fig.2

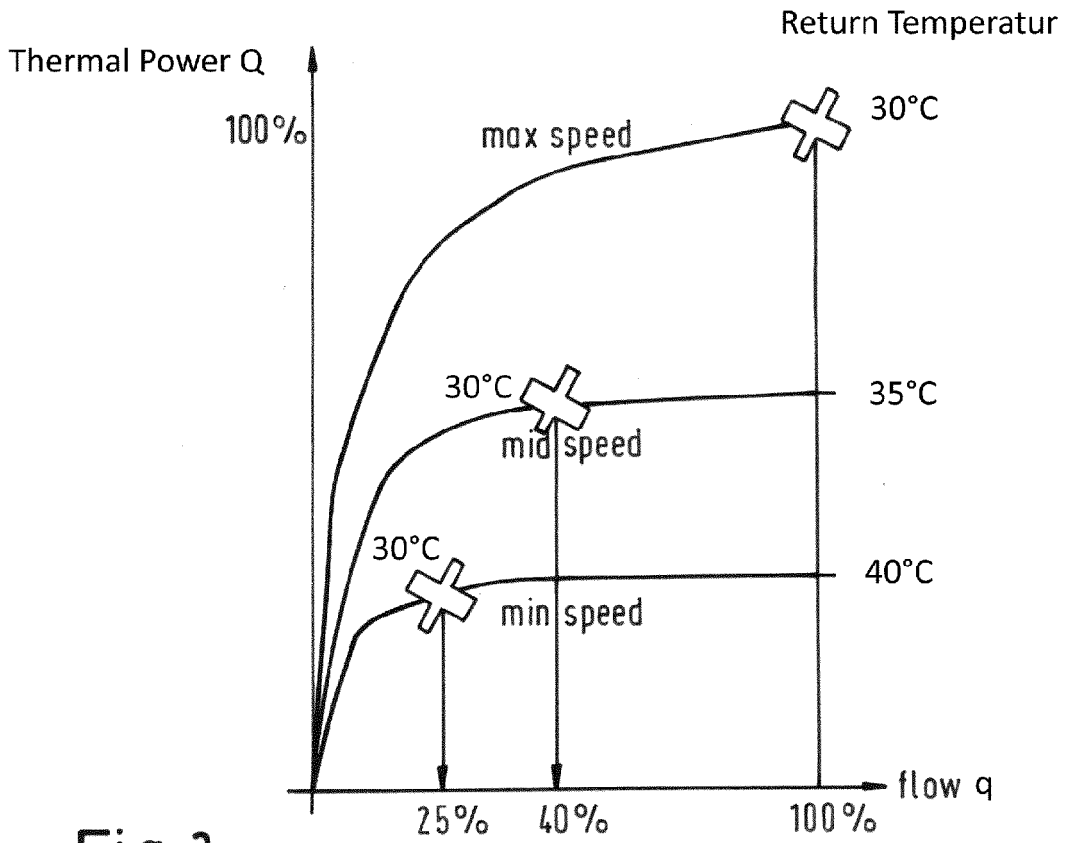


Fig. 3

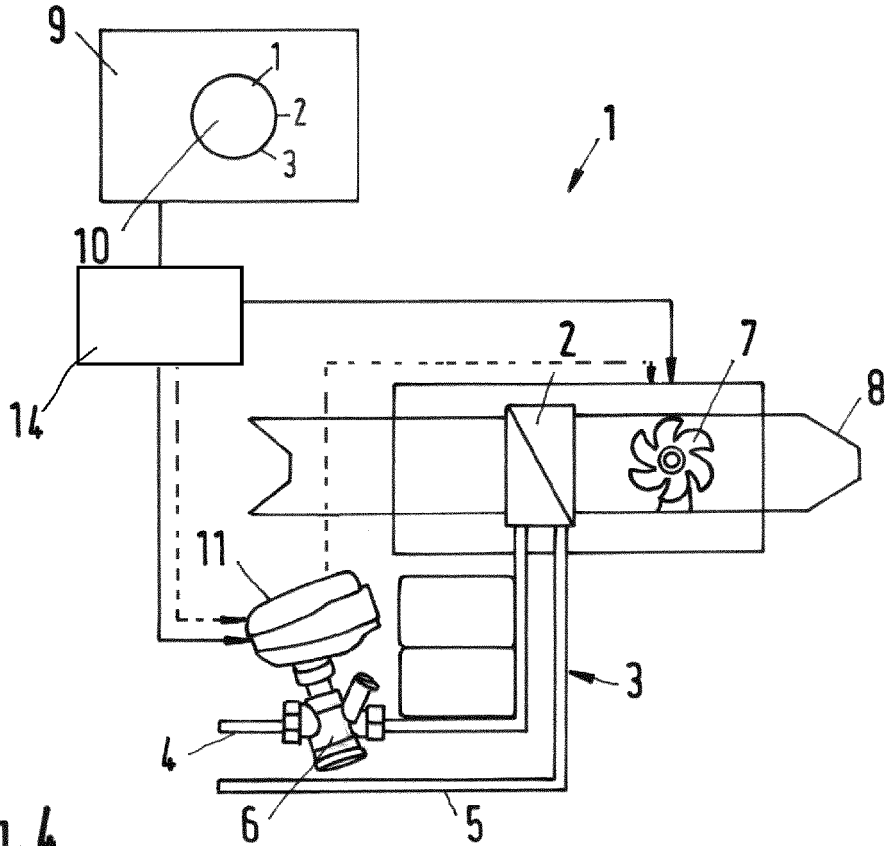


Fig. 4





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The present search report has been drawn up for all claims			
Place of search <b>Munich</b>		Date of completion of the search <b>14 February 2023</b>	Examiner <b>Anconetani, Mirco</b>
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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ANNEX TO THE EUROPEAN SEARCH REPORT  
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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.  
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