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(54) **A method for controlling the defrosting cycles in a heat-pump system**

Steuerverfahren für Abtauvorgänge in einer Wärmepumpenanlage

Procédé de commande pour des cycles de dégivrage dans un système de pompe à chaleur

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- **PATENT ABSTRACTS OF JAPAN** vol. 010, no. 222 (M-504), 2 August 1986 & JP 61 059137 A (SANYO ELECTRIC CO LTD;OTHERS: 01), 26 March 1986,
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Description

[0001] The present invention relates to a method of controlling the defrosting cycles in a heat-pump system.

[0002] A heat pump is a thermal machine which, with an expenditure of mechanical work, draws a quantity of heat from an outside environment (a source) and sends all of the thermal energy into an inside environment (a recipient) so as to heat it. Typically, the heat pump can also operate in reverse as a cooler, taking thermal energy from the inside environment (source) so as to cool it.

[0003] A problem with heat-pump systems in which an air heat-exchanger (a battery) is used in the outside environment is that, when the temperature of a surface of the battery which is in contact with the outside environment falls below 0°C, a layer of frost forms on the battery owing to atmospheric water vapour. This layer of frost obstructs the flow of air through the battery, compromising the exchange of heat.

[0004] Known heat-pump systems have a transducer which periodically measures the value of a state parameter (pressure or temperature) of a refrigerant fluid passing through the outside battery, or the temperature of the surface of the battery which is in contact with the outside environment. When this measurement falls below a predetermined threshold value, the heat-pump system performs a defrosting cycle, for example by reversing the operation of the system. The outside battery is thus heated (taking heat from the inside environment) and melts the frost formed thereon.

[0005] A disadvantage of known heat-pump systems is that, particularly when the outside temperature and the relative humidity value are low, the defrosting cycle is triggered even when the outside battery is not frosty; unnecessary defrosting cycles are therefore performed, consequently reducing the output of the system as a whole.

[0006] Another approach is proposed by WO98/36227 where a system for controlling the defrosting cycles is based on monitoring the temperature of the indoor heat exchanger: if the measured temperature differs from the maximum temperature T_{MAX} reached by the indoor heat exchanger, subsequently to the last performed defrosting cycle, by more than a predetermined amount ΔT , this means that the heat exchanger efficiency is compromised by frost formation in the outdoor heat exchanger.

[0007] This approach, which relies on a temperature measurement, and not of other parameters, such as pressure, is suitable only in heat-pump systems where the temperature changes measured at the indoor heat exchanger having low thermal inertia "mirror" the temperature changes of the recirculating fluid at the outdoor heat exchanger.

[0008] Moreover it is difficult to implement where the indoor heat exchanger is not easily accessible for measurement.

[0009] The object of the present invention is to prevent the afore mentioned drawbacks. To achieve this object, a method as described in the first claim is proposed.

[0010] The method of the present invention triggers the defrosting cycle in dependence on the actual conditions of the outside battery. The frequency of the defrosting cycles can thus be reduced considerably. This achieves a greater output and improved performance of the heat-pump system with a consequent considerable energy saving.

[0011] Further characteristics and advantages of the method according to the present invention will become clear from the following description of a preferred embodiment thereof, given by way of nonlimiting example, with reference to the appended drawings, in which:

Figure 1 is a basic block diagram of a heat-pump system in which the method according to the invention can be used,

Figure 2 is a flow chart of an embodiment of the method according to the present invention.

[0012] With reference, in particular, to Figure 1, a heat-pump system, indicated 100, is constituted, in particular, by an air-conditioner for winter heating and for summer cooling; the method of the present invention may, however, also be used in different applications, for example, in a central heating plant, in a distillation device, etc. The heat-pump system 100 uses a refrigerant fluid (for example, Freon) which is subjected to a thermodynamic cycle (as described in detail below) and which flows through a circuit 103 formed by suitable pipes.

[0013] The heat-pump system 100 includes a heat exchanger 130 which is in contact with an outside environment and which operates as a heat source or as a heat recipient during winter and summer, respectively. The exchange of heat takes place in air; in particular, the heat exchanger 130 (the battery) is constituted by pipes, generally having fins, the refrigerant fluid flowing through the pipes and the air passing over them externally. Typically, the air circulation is forced by means of a fan 135 or takes place by natural convection.

[0014] A similar battery 140 in contact with an inside environment operates as a heat recipient or a heat source in winter and in summer, respectively; a fan 145 forces, for example, the air circulation in the inside environment from an intake duct 151 to an outlet duct 153. The present invention may, however, also be used with internal heat exchangers of different types, for example, with an exchange of heat in water, in the floor, etc.

[0015] In the embodiment in question, the heat-pump system 100 is constituted by a single body; alternatively, two separate units are provided in the outside environment and in the inside environment, respectively.

[0016] Between the outside battery 130 and the inside battery 140 there is a compressor unit 150 connected by means of a three-way valve (not shown in the draw-

ing) for the winter-summer reversal of the circuit 103, and two expansion valves 155, 156 (or, alternatively, small calibrated holes or sections of capillary tube) for the winter and summer refrigerant-fluid circuits, respectively.

[0017] A transducer 160 periodically measures a state parameter relating to the refrigerant fluid and supplies a value S indicative of this measurement to an electronic microprocessor board 165 (or other equivalent logic means). In a particularly inexpensive embodiment, a temperature transducer with a defrosting probe disposed inside the battery 130 is used; alternatively, in certain circumstances, the temperature transducer may be disposed in the inside battery 140, or a pressure transducer is used. The microprocessor 165 is connected to the compressor 150 in order to control the operation of the heat-pump system 100 by means of suitable control signals and to perform a cycle for defrosting the outside battery 130.

[0018] In winter when the system 100 is operating as a heat pump, the refrigerant fluid in the vapour state at the output of the outside battery 130 is compressed in the unit 150. In this condition, the battery 140 operates as a condenser in which the refrigerant fluid cools until it condenses to the liquid state, supplying heat to the inside environment. The refrigerant fluid then expands with partial vaporization in the valve 155 so as to regulate the flow-rate of the refrigerant fluid so that it is completely vaporized in the battery 130 (which acts as an evaporator) owing to the heat taken from the outside environment. In summer, on the other hand, when it is operating as a cooler, the outside battery 130 acts as a condenser; the refrigerant fluid expands partially in the valve 156 and the inside battery 140 acts as an evaporator so as to take heat from the inside environment. As an alternative to the above-described vapour compression system, however, the present invention may also be used in a water-vapour, air, or absorption system etc.

[0019] In winter, when the system 100 is operating as a heat pump, a defrosting cycle is performed periodically (as described in detail below) in order to melt a layer of frost deposited on an outside surface of the battery 130. In particular, the operation of the system 100 is reversed, so that the outside battery 130 (acting as a condenser) is heated, melting the frost. Alternatively, the operation of the heat-pump system 100 is interrupted and the frost is melted by electrical heating, by a flow of air or of water at a suitable temperature, or by the injection of hot gas coming from inside the outside battery.

[0020] With reference now to Figure 2, a method 200 of controlling the defrosting cycles in the heat-pump system described above, starts in box 203, in which the system is activated, for example, when it is switched on, when it leaves a stand-by state, or when it starts up again after a thermostatic intervention to regulate the temperature of the inside environment. Going on to box 206, a parameter S_{Th} which represents a threshold temperature for the implementation of the defrosting cycle

is set at a predetermined initial (default) value, for example, equal to a few degrees centigrade below zero, such as -2°C . A parameter T_{Wait} , which represents a minimum waiting time between two consecutive defrosting cycles or between the activation of the system and a first defrosting cycle (used for limiting the repetition of the defrosting cycles with regard to time) is preferably set at a further predetermined initial value, for example, of a few minutes, such as 15 minutes. It should be noted that, in general, the time is measured in relation to the operation of the heat-pump system, for example, as the period of operation of the compressor.

[0021] Going on to box 207, the value S of the temperature measured by the defrosting probe is then acquired. In box 209, the method checks whether a first defrosting cycle has been carried out since the heat-pump system was activated; this preferably enables the parameters (S_{Th} and T_{Wait}) of the system to be modified only after this first defrosting cycle. If the answer is negative, the method goes on to box 212 (described below). If the answer is affirmative, the method checks, in box 215, whether the operating time T_D which has elapsed since the last defrosting cycle exceeds a predetermined minimum value, for example, of a few minutes, such as 10 minutes; the system parameters are preferably modified only after this operating period, so as to allow the system to reach a steady state. If the answer is negative, the method goes directly to box 212. If the operating time T_D since the last defrosting cycle is greater than 10 minutes, the method according to the present invention calculates a value correlated with a maximum value of the measured temperature S . In a preferred embodiment, an average value of the measured temperatures S is calculated periodically for this purpose. For example, in the box 221, an average value S_{Ave} of the temperatures S measured since a last modification cycle is updated. The method then goes on to box 223 in which it is checked whether a predetermined period of time, for example of 1 minute, has elapsed since a last modification cycle. If the answer is negative, the method goes directly to box 212. If 1 minute has elapsed since the last modification cycle, the method then goes on to box 224 in which it is checked whether the average value S_{Ave} is greater than a maximum temperature value S_{Max} (set initially at an invalid value). If the answer is affirmative, in box 227 the value S_{Max} is set at the average value S_{Ave} and the method then goes on to box 230. If the average value S_{Ave} is not greater than the maximum value S_{Max} , the method goes directly to box 230. With reference now to box 230, the method according to the present invention modifies the parameter S_{Th} which is representative of the threshold temperature for performing the defrosting cycle in dependence on the maximum value S_{Max} ; the parameter S_{Th} is preferably set at the maximum value S_{Max} minus a predetermined value, for example, of a few degrees centigrade, such as 3°C .

[0022] The parameter T_{Wait} which is representative of the minimum waiting time between two consecutive de-

frosting cycles is advantageously modified in dependence on the value of the parameter S_{Th} . For example, in box 233, the method checks whether the parameter S_{Th} is below a predetermined minimum value, for example, of a few degrees centigrade below zero, such as -4°C . If the answer is negative, the method goes directly to box 212. If the parameter S_{Th} is below the minimum value, the parameter T_{Wait} is set at a higher predetermined value, for example, 45 minutes, in box 236. The method then goes on to box 212.

[0023] With reference now to box 212, the method checks whether a defrosting cycle is in operation. If not, the method goes to box 239 in which it is checked whether the measured temperature S is below the parameter S_{Th} and whether the time T_D since the last defrosting cycle (or since the activation of the system) is greater than the parameter T_{Wait} . If at least one of these conditions is not satisfied, the method goes to box 242 (described below). If, on the other hand, both of the conditions are satisfied, the method goes to box 245 in which a defrosting cycle is started, for example, by the reversal of the operation of the heat-pump system; if this is the first defrosting cycle, the parameter T_{Wait} is also modified, preferably to a predetermined value, for example, of 30 minutes, between the initial value (15 minutes) and the value set in box 236 (45 minutes). The method then goes to box 242.

[0024] Returning to box 212, if a defrosting cycle is in progress, the method preferably controls the duration of this operation. For example, in box 248 it is checked whether a predetermined minimum time T_{Min} , for example, of 2.5 minutes, has elapsed since the start of the defrosting cycle. In general, it is in fact preferable for the defrosting cycle to have a minimum duration since excessively frequent reversals of the operation of the heat-pump system may cause excessive leakage of oil in the compressor with consequent damage to the system. If the minimum defrosting time T_{Min} has not elapsed, the method goes directly to box 242. Otherwise, the method goes to box 251 in which it is checked whether the measured temperature S is greater than a predetermined maximum end of defrosting temperature S_{End} , for example, of a few tens of degrees centigrade, such as 20°C , or whether a predetermined maximum time T_{Max} , for example, of 6 minutes, has elapsed since the start of the defrosting cycle. If at least one of these conditions is satisfied, the defrosting cycle is terminated in box 253 and the method then goes to box 242. If neither of the conditions is satisfied, however, the method goes directly to box 242.

[0025] With reference now to box 242, the method preferably checks whether the time T_D which has elapsed since the last defrosting cycle is greater than a predetermined maximum value, for example of a few tens of minutes, such as 90 minutes. If not, the method returns to box 207 in order to repeat the steps described above. If a longer time has elapsed, however, the method goes back to box 206 so as to reset the initial values

of the parameters of the system.

[0026] Naturally, in order to satisfy contingent and specific requirements, an expert in the art may apply to the above-described method of controlling the defrosting cycles in a heat-pump system many modifications and variations, all of which, however, are included within the scope of protection of the invention as defined by the following claims.

Claims

1. A method (200) of controlling the defrosting cycles of an outdoor air heat exchanger (130) in a heat-pump system (100), comprising the steps of:

periodically measuring (207), in said outdoor air heat exchanger (130), a first value (S) indicative of a state parameter relating to a refrigerant fluid, used in the system (100),
 comparing (239) the first value (S) with a threshold value (S_{Th}),
 performing (245) a defrosting cycle in dependence on a result of the comparison,
 determining (221,227) a second value (S_{Max}) correlated with a maximum value of the periodically measured first value (S), and
 modifying (230) the threshold value (S_{Th}) in dependence on the second value (S_{Max}).

2. A method (200) of controlling the defrosting cycles of an outdoor air heat exchanger (130) in a heat-pump system (100), comprising the steps of:

periodically measuring (207) a first value (S) indicative of a state parameter relating to a refrigerant fluid, used in the system (100),
 comparing (239) the first value (S) with a threshold value (S_{Th}),
 performing (245) a defrosting cycle in dependence on a result of the comparison,
 determining (221,227) a second value (S_{Max}) correlated with a maximum value of the periodically measured first value (S),
 modifying (230) the threshold value (S_{Th}) in dependence on the second value (S_{Max}),

wherein said step of determining (221,227) the second value (S_{Max}) includes the steps of:

periodically calculating (221,223) an average value (S_{Ave}) of the first value (S), and
 setting (224,227) the second value (S_{Max}) at a maximum of the average values (S_{Ave}).

3. A method (200) according to claim 1 or Claim 2, in which the step of modifying (230) the threshold value (S_{Th}) consists in setting the threshold value (S_{Th})

at the second value (S_{Max}) minus a first predetermined value.

4. A method according to any one of Claims 1 to 3, further comprising the step of setting (206) the threshold value (S_{Th}) at a predetermined initial value upon each activation of the system (100). 5
5. A method according to Claim 4, further comprising the step of setting (242, 206) the threshold value (S_{Th}) at the predetermined initial value when a period of operation (T_D) since a last defrosting cycle is greater than a first predetermined maximum value. 10
6. A method (200) according to any one of Claims 1 to 5, in which the step of modifying (230) the threshold value (S_{Th}) is carried out only (209) after a first defrosting cycle after the activation of the system (100). 15
7. A method (200) according to any one of Claims 1 to 6, in which the step of modifying (230) the threshold value (S_{Th}) is carried out only (215) when the period of operation (T_D) since the last defrosting cycle is greater than a first predetermined minimum value. 20
8. A method according to any one of Claims 1 to 7, in which the defrosting cycle (239, 245) is carried out only if, at the same time, the period of operation (T_D) since the last defrosting cycle or since the activation of the system (100) is greater than a further threshold value (T_{Wait}), the method (200) further comprising the steps of setting (206) the further threshold value (T_{Wait}) at a further predetermined initial value each time the system (100) is activated, modifying (245) the further threshold value (T_{Wait}) to a second predetermined value greater than the further predetermined initial value after the execution of the first defrosting cycle, and modifying (233, 236) the further threshold value (T_{Wait}) to a third predetermined value greater than the second predetermined value when the threshold value (S_{Th}) is below a second predetermined minimum value. 25
9. A method according to Claim 8, further comprising the step of setting (242, 206) the further threshold value (T_{Wait}) at the further predetermined initial value when the period of operation (T_D) since the last defrosting cycle is greater than the first predetermined maximum value. 30
10. A method (200) according to any one of Claims 1 to 9, in which a duration of each defrosting cycle is greater than a third predetermined minimum value (248) and the defrosting cycle is terminated (253) when the first value (S) exceeds a second prede-

termined maximum value or the duration exceeds a third predetermined maximum value (251).

11. A method (200) according to any one of Claims 1 to 10, in which the step of performing (245) the defrosting cycle consists of the reversal of the operation of the heat-pump system (100) in order to heat the outdoor air heat exchanger (130). 35
12. A method (200) according to any one of Claims 1 to 11 in which the state parameter is a temperature. 40
13. A heat-pump system (100) for carrying out the method of any of the Claims from 1 to 12 comprising an outdoor air heat exchanger (130), detection means (160) for periodically measuring, in said outdoor air heat exchanger (130), a first value (S) indicative of a state parameter relating to a refrigerant fluid used in the system (100), logic means (165) for comparing the first value (S) with a threshold value (S_{Th}) and performing a cycle for defrosting the outdoor air heat exchanger (130) in dependence on a result of the comparison, and logic means (165) for determining a second value (S_{Max}) correlated with a maximum value of the first value (S) and modifying (230) the threshold value (S_{Th}) in dependence on the second value (S_{Max}). 45
14. A heat-pump system (100) for carrying out the method of any of the Claims from 2 to 12 comprising an outdoor air heat exchanger (130), detection means (160) for periodically measuring a first value (S) indicative of a state parameter relating to a refrigerant fluid used in the system (100), logic means (165) for comparing the first value (S) with a threshold value (S_{Th}) and performing a cycle for defrosting the outdoor air heat exchanger (130) in dependence on a result of the comparison, and logic means (165) for periodically calculating (221, 223) an average value (S_{Ave}) of the first value (S), setting a second value (S_{Max}) at a maximum of the average values (S_{Ave}) and modifying (230) the threshold value (S_{Th}) in dependence on said second value (S_{Max}). 50
15. A heat-pump system (100) according to Claim 13 or 14, in which the detection means (160) include a temperature transducer disposed in the outdoor air heat exchanger (130). 55
16. A heat-pump system (100) according to Claim 13 or 14 or 15, in which the system (100) is an air-conditioner.

Patentansprüche

1. Verfahren (200) zur Steuerung der Enteisungszy-

klen eines Freiluft-Luftwärmetauschers (130) in einem Wärmepumpensystem (100), mit den Schritten:

periodisches Messen (207) eines ersten Wertes (S), der einen Zustandsparameter betreffend ein Kältefluid, das in dem System (100) verwendet wird, anzeigt, in dem Freiluft-Luftwärmetauscher (130),
Vergleichen (239) des ersten Wertes (S) mit einem Schwellenwert (S_{th}),
Durchführen (245) eines Enteisungszyklus in Abhängigkeit von dem Ergebnis des Vergleichs,
Bestimmen (221, 227) eines zweiten Wertes (S_{max}), der mit einem Maximalwert des periodisch gemessenen ersten Wertes (S) korreliert, und
Modifizieren (230) des Schwellenwertes (S_{th}) in Abhängigkeit von dem zweiten Wert (S_{max}).

2. Verfahren (200) zur Steuerung der Enteisungszyklen eines Freiluft-Luftwärmetauschers (130) in einem Wärmepumpensystem (100), mit den Schritten:

periodisches Messen (207) eines ersten Wertes (S), der einen Zustandsparameter betreffend ein Kältefluid, das in dem System (100) verwendet wird, anzeigt,
Vergleichen (239) des ersten Wertes (S) mit einem Schwellenwert (S_{th}),
Durchführen (245) eines Enteisungszyklus in Abhängigkeit von dem Ergebnis des Vergleichs,
Bestimmen (221, 227) eines zweiten Wertes (S_{max}), der mit einem Maximalwert des periodisch gemessenen ersten Wertes (S) korreliert,
Modifizieren (230) des Schwellenwertes (S_{th}) in Abhängigkeit von dem zweiten Wert (S_{max}),

wobei der Schritt des Bestimmens (221, 227) des zweiten Wertes (S_{max}) die Schritte beinhaltet:

periodisches Berechnen (221, 223) eines Mittelwertes (S_{ave}) des ersten Wertes (S), und
Setzen (224, 227) des zweiten Wertes (S_{max}) auf ein Maximum der Mittelwerte (S_{ave}).

3. Verfahren (200) nach Anspruch 1 oder 2, bei dem der Schritt des Modifizierens (230) des Schwellenwertes (S_{th}) im Setzen des Schwellenwertes (S_{th}) auf den zweiten Wert (S_{max}) minus einem ersten vorgegebenen Wert besteht.
4. Verfahren nach einem der Ansprüche 1 bis 3, weiter mit dem Schritt des Setzens (206) des Schwellen-

wertes (S_{th}) auf einen vorgegebenen Anfangswert bei jeder Inbetriebnahme des Systems (100).

5. Verfahren nach Anspruch 4, weiter mit dem Schritt des Setzens (242, 206) des Schwellenwertes (S_{th}) auf den vorgegebenen Anfangswert, wenn eine Betriebsdauer (T_D) seit einem letzten Enteisungszyklus größer als ein erster vorgegebener Maximalwert ist.
6. Verfahren (200) nach einem der Ansprüche 1 bis 5, bei dem der Schritt des Modifizierens (230) des Schwellenwertes (S_{th}) nur (209) nach einem ersten Enteisungszyklus nach der Inbetriebnahme des Systems (100) ausgeführt wird.
7. Verfahren (200) nach einem der Ansprüche 1 bis 6, bei dem der Schritt des Modifizierens (230) des Schwellenwertes (S_{th}) nur (215) ausgeführt wird, wenn die Betriebsdauer (T_D) seit dem letzten Enteisungszyklus größer als ein erster vorgegebener Minimalwert ist.
8. Verfahren nach einem der Ansprüche 1 bis 7, bei dem der Enteisungszyklus (239, 245) nur ausgeführt wird, wenn gleichzeitig die Betriebsdauer (T_D) seit dem letzten Enteisungszyklus oder seit der Inbetriebnahme des Systems (100) größer als ein weiterer Schwellenwert (T_{wait}) ist, wobei das Verfahren (200) weiter die Schritte des Setzens (206) des weiteren Schwellenwertes (T_{wait}) auf einen weiteren vorgegebenen Anfangswert bei jeder Inbetriebnahme des Systems (100), des Modifizierens (245) des weiteren Schwellenwertes (T_{wait}) auf einen zweiten vorgegebenen Wert größer als der weitere vorgegebene Anfangswert nach der Ausführung des ersten Enteisungszyklus, und des Modifizierens (233, 236) des weiteren Schwellenwertes (T_{wait}) auf einen dritten vorgegebenen Wert größer als der zweite vorgegebene Wert, wenn der Schwellenwert (S_{th}) unter einem zweiten vorgegebenen Minimalwert liegt, aufweist.
9. Verfahren nach Anspruch 8, weiter mit dem Schritt des Setzens (242, 206) des weiteren Schwellenwertes (T_{wait}) auf den weiteren vorgegebenen Anfangswert, wenn die Betriebsdauer (T_D) seit dem letzten Enteisungszyklus größer als der erste vorgegebene Maximalwert ist.
10. Verfahren (200) nach einem der Ansprüche 1 bis 9, bei dem eine Zeitdauer jedes Enteisungszyklus größer als ein dritter vorgegebener Minimalwert (248) ist und der Enteisungszyklus beendet wird (253), wenn der erste Wert (S) einen zweiten vorgegebenen Maximalwert übersteigt oder die Zeitdauer einen dritten vorgegebenen Maximalwert (251) übersteigt.

11. Verfahren (200) nach einem der Ansprüche 1 bis 10, bei dem der Schritt des Durchführens (245) des Enteisungszyklus aus der Funktionsumkehr des Wärmepumpensystems (100) zum Erwärmen des Freiluft-Luftwärmetauschers (130) besteht. 5
12. Verfahren (200) nach einem der Ansprüche 1 bis 11, bei dem der Zustandsparameter eine Temperatur ist. 10
13. Wärmepumpensystem (100) zum Ausführen des Verfahrens nach einem der Ansprüche 1 bis 12, mit einem Freiluft-Luftwärmetauscher (130); einem Detektor (160) zum periodischen Messen eines ersten Wertes (S), der einen Zustandsparameter betreffend ein in dem System (100) verwendetes Kältefluid anzeigt, in dem Freiluft-Luftwärmetauscher (130); einer Logikvorrichtung (165) zum Vergleichen des ersten Wertes (S) mit einem Schwellenwert (S_{th}) und Durchführen eines Zyklus zum Enteisen des Freiluft-Luftwärmetauschers (130) in Abhängigkeit von dem Ergebnis des Vergleichs; und einer Logikvorrichtung (165) zum Bestimmen eines zweiten Wertes (S_{max}), der mit einem Maximalwert des ersten Wertes (S) korreliert, und Modifizieren (230) des Schwellenwertes (S_{th}) in Abhängigkeit von dem zweiten Wert (S_{max}). 15 20 25
14. Wärmepumpensystem (100) zum Ausführen des Verfahrens nach einem der Ansprüche 2 bis 12, mit einem Freiluft-Luftwärmetauscher (130); einem Detektor (160) zum periodischen Messen eines ersten Wertes (S), der einen Zustandsparameter betreffend ein in dem System (100) verwendetes Kältefluid anzeigt; einer Logikvorrichtung (165) zum Vergleichen des ersten Wertes (S) mit einem Schwellenwert (S_{th}) und Durchführen eines Zyklus zum Enteisen des Freiluft-Luftwärmetauschers (130) in Abhängigkeit von dem Ergebnis des Vergleichs; und einer Logikvorrichtung (165) zum periodischen Berechnen (221, 223) eines Mittelwertes (S_{ave}) des ersten Wertes (S), Setzen des zweiten Wertes (S_{max}) auf ein Maximum der Mittelwerte (S_{ave}) und Modifizieren (230) des Schwellenwertes (S_{th}) in Abhängigkeit von dem zweiten Wert (S_{max}). 30 35 40 45
15. Wärmepumpensystem (100) nach Anspruch 13 oder 14, bei dem der Detektor (160) einen in dem Freiluft-Luftwärmetauscher (130) angeordneten Temperaturempfänger enthält. 50
16. Wärmepumpensystem (100) nach Anspruch 13 oder 14 oder 15, bei dem das System (100) ein Klimagerät ist. 55

Revendications

1. Procédé (200) de commande des cycles de dégivrage d'un échangeur de chaleur à air extérieur (130) dans un système de pompe à chaleur (100) comprenant les étapes suivantes :
 - on mesure périodiquement (207) dans ledit échangeur de chaleur à air extérieur (130) une première valeur (S) indicative d'un paramètre d'état se rapportant à un fluide réfrigérant utilisé dans le système (100),
 - on compare (239) la première valeur (S) à une valeur de seuil (S_{Th}),
 - on exécute (245) un cycle de dégivrage en fonction d'un résultat de la comparaison,
 - on détermine (221, 227) une seconde valeur (S_{Max}) corrélée avec une valeur maximum de la première valeur (S) mesurée périodiquement, et
 - on modifie (230) la valeur de seuil (S_{Th}) en fonction de la seconde valeur (S_{Max}).
2. Procédé (200) de commande des cycles de dégivrage d'un échangeur de chaleur à air extérieur (130) dans un système de pompe à chaleur (100), comprenant les étapes suivantes :
 - on mesure périodiquement (207) une première valeur (S) indicative d'un paramètre d'état se rapportant à un fluide réfrigérant utilisé dans le système (100),
 - on compare (239) la première valeur (S) à une valeur de seuil (S_{Th}),
 - on effectue (245) un cycle de dégivrage en fonction d'un résultat de la comparaison,
 - on détermine (221, 227) une seconde valeur (S_{Max}) corrélée avec une valeur maximum de la première valeur (S) mesurée périodiquement,
 - on modifie (230) la valeur de seuil (S_{Th}) en fonction de la seconde valeur (S_{Max}),
 - dans lequel l'étape de détermination (221, 227) de la seconde valeur (S_{Max}) inclut les étapes suivantes :
 - on calcule périodiquement (221, 223) une valeur moyenne (S_{Ave}) de la première valeur (S), et

on règle (224, 227) la seconde valeur (S_{Max}) à un maximum des valeurs moyennes (S_{Ave}).

3. Procédé (200) selon la revendication 1 ou 2 dans lequel l'étape de modification (230) de la valeur de seuil (S_{Th}) consiste dans le réglage de la valeur de seuil (S_{Th}) à la seconde valeur (S_{Max}) moins une première valeur prédéterminée.
4. Procédé selon l'une quelconque des revendications 1 à 3 comportant de plus l'étape de réglage (206) de la valeur de seuil (S_{Th}) à une valeur initiale prédéterminée lors de chaque activation du système (100).
5. Procédé selon la revendication 4 comprenant en outre l'étape de réglage (242, 206) de la valeur de seuil (S_{Th}) à la valeur initiale prédéterminée quand une période de fonctionnement (T_D) depuis un dernier cycle de dégivrage est supérieure à une première valeur maximum prédéterminée.
6. Procédé (200) selon l'une quelconque des revendications 1 à 5 dans lequel l'étape de modification (230) de la valeur de seuil (S_{Th}) n'est exécutée qu'après (209) un premier cycle de dégivrage après l'activation du système (100).
7. Procédé (200) selon l'une quelconque des revendications 1 à 6 dans lequel l'étape de modification (230) de la valeur de seuil (S_{Th}) n'est exécutée (215) que quand la période de fonctionnement (T_D) depuis le dernier cycle de dégivrage est supérieure à une première valeur minimum prédéterminée.
8. Procédé selon l'une quelconque des revendications 1 à 7 dans lequel le cycle de dégivrage (239, 245) n'est exécuté que si, au même moment, la période de fonctionnement (T_D) depuis le dernier cycle de dégivrage ou depuis l'activation du système (100) est supérieure à une autre valeur de seuil (T_{Wait}), le procédé (200) comportant en outre les étapes de réglage (206) de l'autre valeur de seuil (T_{Wait}) à une autre valeur initiale prédéterminée chaque fois que le système (100) est activé, de modification (245) de l'autre valeur de seuil (T_{Wait}) à une seconde valeur prédéterminée supérieure à l'autre valeur initiale prédéterminée après l'exécution du premier cycle de dégivrage, et de modification (233, 236) de l'autre valeur de seuil (T_{Wait}) à une troisième valeur prédéterminée supérieure à la seconde valeur prédéterminée quand la valeur de seuil (S_{Th}) est au-dessous d'une seconde valeur minimum prédéterminée.
9. Procédé selon la revendication 8 comprenant en outre l'étape de réglage (242, 206) de l'autre valeur de seuil (T_{Wait}) à l'autre valeur initiale prédétermi-

née quand la période de fonctionnement (T_D) depuis le dernier cycle de dégivrage est supérieure à la première valeur maximum prédéterminée.

- 5 10. Procédé (200) selon l'une quelconque des revendications 1 à 9 dans lequel une durée de chaque cycle de dégivrage est supérieure à une troisième valeur minimum prédéterminée (248), et le cycle de dégivrage est terminé (253) quand la première valeur (S) dépasse une seconde valeur maximum prédéterminée ou quand la durée dépasse une troisième valeur maximum prédéterminée (251).
- 10 11. Procédé (200) selon l'une quelconque des revendications 1 à 10 dans lequel l'étape de réalisation (245) du cycle de dégivrage consiste dans l'inversion du fonctionnement du système de pompe à chaleur (100) de façon à chauffer l'échangeur de chaleur à air extérieur (130).
- 15 12. Procédé (200) selon l'une quelconque des revendications 1 à 11 dans lequel le paramètre d'état est une température.
- 20 13. Système de pompe à chaleur (100) pour exécuter le procédé selon l'une quelconque des revendications 1 à 12 comprenant un échangeur de chaleur à air extérieur (130), des moyens de détection (160) pour mesurer périodiquement, dans ledit échangeur de chaleur à air extérieur (130), une première valeur (S) indicative d'un paramètre d'état se rapportant à un fluide réfrigérant utilisé dans le système (100), des moyens logiques (165) pour comparer la première valeur (S) à une valeur de seuil (S_{Th}) et pour faire exécuter un cycle de dégivrage par l'échangeur de chaleur à air extérieur (130) en fonction d'un résultat de la comparaison, et
 - des moyens logiques (165) pour déterminer une seconde valeur (S_{Max}) corrélée avec une valeur maximum de la première valeur (S) et pour modifier (230) la valeur de seuil (S_{Th}) en fonction de la seconde valeur (S_{Max}).
- 25 14. Système de pompe à chaleur (100) pour mettre en oeuvre le procédé selon l'une quelconque des revendications 2 à 12, comprenant un échangeur de chaleur à air extérieur (130), des moyens de détection (160) pour mesurer périodiquement une première valeur (S) indicative d'un paramètre d'état se rapportant à un fluide réfrigérant utilisé dans le système (100), des moyens logiques (165) pour comparer la première valeur (S) avec une valeur de seuil (S_{Th}) et pour effectuer un cycle pour dégivrer l'échangeur de chaleur à air extérieur (130) en fonction d'un résultat de la comparaison, et
 - des moyens logiques (165) pour calculer périodiquement (221, 223) une valeur moyenne (S_{Ave}) de la première valeur (S), pour établir une seconde
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valeur (S_{Max}) à un maximum des valeurs moyennes (S_{Ave}) et pour modifier (230) la valeur de seuil (S_{Th}) en fonction de ladite seconde valeur (S_{Max}).

15. Système de pompe à chaleur (100) selon la revendication 13 ou 14 dans lequel les moyens de détection (160) comprennent un transducteur de température disposé dans l'échangeur de chaleur à air extérieur (130).

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16. Système de pompe à chaleur (100) selon la revendication 13 ou 14 ou 15 dans lequel le système (100) est un conditionneur d'air.

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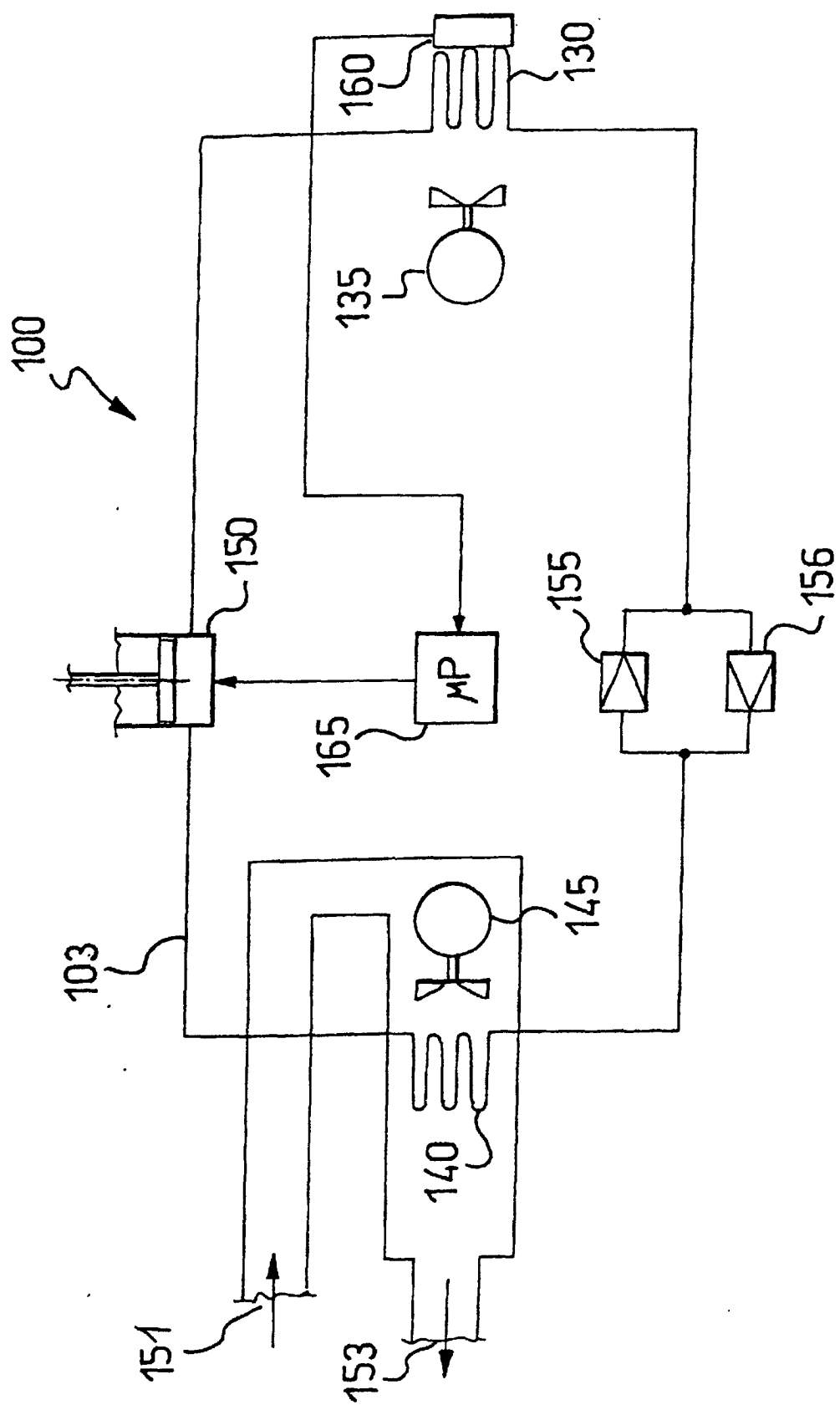


FIG.1

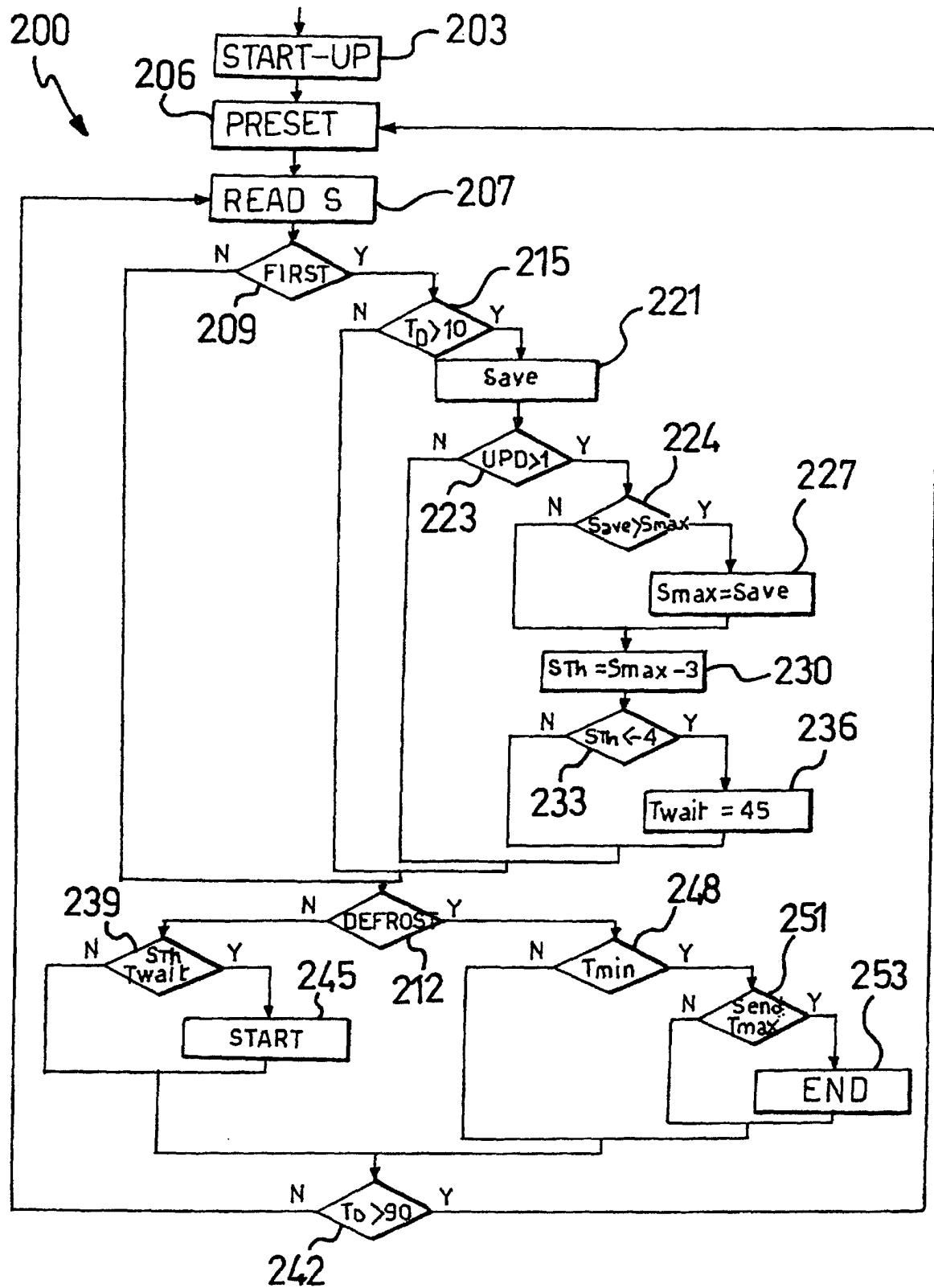


FIG. 2