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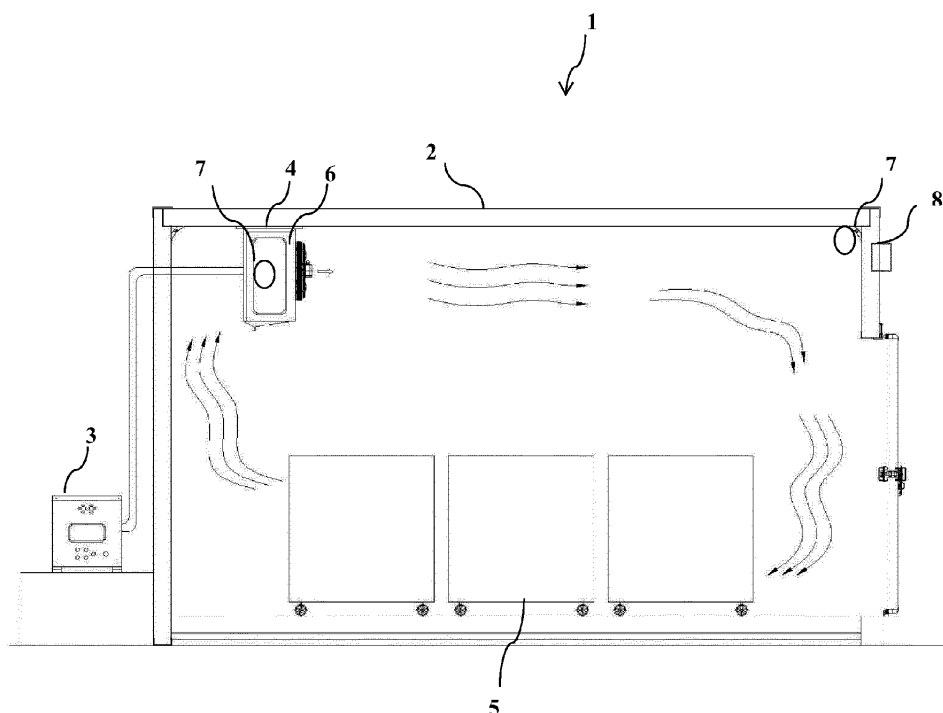
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(54) **A smart defrosting system and method**

(57) This invention is related to a smart defrosting system (1) and method (100) which ensures determination of frosting on the cooler or decrease in the melted frost mass, prevention of unnecessary defrost processes and prevention of loss of energy consumed for promptly

start and promptly end of melting process and heat loss occurred in cooling systems operating based on heat pump. The system (1) subject of invention contains cooling volume (2), condenser unit (3), cooler unit (4), Heat sensor (7) and control unit (8).

Figure 1



Description

Technical Field

[0001] This invention is related to a smart defrosting system and method which ensures determination of frosting on the cooler or decrease in the melted frost mass, prevention of unnecessary defrost processes and prevention of loss of energy consumed for promptly start and promptly end of melting process and heat loss occurred in cooling systems operating based on heat pump.

Former Technique

[0002] The moisture in the cooling volume sticks on the cooler unit and causes frosting in cooling systems. This occurred frosting prevents the heat energy on the cooler unit from being transmitted to the circulating air. The frosting occurred and the amount of frosted mass cannot be exactly determined.

[0003] Today, the start of defrosting realizes with two different applications. First of them is start of defrosting without controlling the formation of defrosting in fixed time intervals (such as timeframes of 4, 6, 12 hours). The second application is determination of defrosting in accordance with the temperature difference between the cooling volume temperature and the cooler temperature. In the second application, defrosting is finalized depending only on the target cooler unit temperature or on a certain time without determining the frosted mass after the defrosting process is started. However, changes in the temperatures of the products to be cooled due to external factors (for instance; opening of the cooling volume door) cause misdetection of frosting. All of the mass is not melted or defrosting process is continued although melting process is completed since no mass determination is performed. Cooling performance decreases when the mass is not completely melted and re-frosting formation is observed within a short time. The defrosting processes continuing although there is no frosting increases the energy consumed.

[0004] At the known status of the technique, finalization of defrosting in accordance with the target temperature in air conditioning systems is mentioned in the JP3137369 A numbered Japan patent certificate and the same application is used also for cold storage rooms.

Brief Explanation of the Invention

[0005] The purpose of this invention is to realize a smart defrosting system and method which determines and records the change amounts (rates cooling/heating) of cooler unit and cooling volume temperatures within a unit time.

[0006] Another purpose of this invention is to realize a smart defrosting system and method which determines the frosting in accordance with the difference between rates of cooling and starts the defrosting process.

[0007] Another purpose of this invention is to realize a smart defrosting system and method which controls the angle of heating curve during finalization of defrosting process; finalizes the defrosting process determining that the frosting is completely melted under instantaneous angel increases.

Detailed Explanation of the Invention

[0008] "Smart Defrosting System and Method" realized in order to reach the purpose of this invention are illustrated in the attached Figures, and these figures are;

Figure -1 Schematic Block Diagram of the system subject of invention.

Figure-2 Flow Chart related to the system subject of invention.

[0009] Parts included in the Figures are separately enumerated, and corresponding meanings of those numbers are given below.

1. System
2. Cooling volume
3. Condenser (densifier) unit
4. Cooler unit
5. Product to be cooled
6. Frosted mass
7. Heat sensor
8. Control unit
100. Method

[0010] The smart defrosting system (1) which enables prevention of loss of energy and heat occurred during melting of frosting contains the following;

- at least one cooling volume (2) where the cooling process is realized,
- at least one condenser unit (3) which ensures heat removal during cooling of the air within the cooling volume (2),
- at least one cooler unit (4) which is fed by the condenser unit (3) and cools the cooling volume (2),
- at least two heat sensors which sense the temperatures of cooling volume (2) and cooler unit (4),
- at least one control unit (8) which controls operation amounts and/or operation times of cooler unit (4) and condenser unit (3) (Figure1).

[0011] Control unit (8) adjusts the operation status of cooler unit (4) and condenser unit (3) in line with the data it obtains from heat sensor (7). Control unit (8) communicates the amount and temperature of the required air to the cooler unit (4) upon the analysis it performed. Control unit (8) is located over and near the gate of cooling volume (2) at the preferred application of the invention.

[0012] At the preferred application of the invention, the control unit (8) ensures measurement of difference val-

ues occurred between temperatures of cooling volume (2) and cooler unit (4) with former measurements, and determination of rates of cooling/heating in terms centigrade degree/seconds dividing the difference value to the timer time in line with the data it obtains from heat sensor (7).

[0013] At the preferred application of the invention, measurement of information such as operation of cooler unit (4), operation of condenser unit (3) opening of loading gate of cooled volume (2) during the period timers of heat sensors (7) operate is realized through control unit (8). Control unit (8) ensures record of rates of cooling and circulation & loading information of cooler unit (4) and cooling volume (2) adding date and time information and increasing sequence numbers. Comparison of sequentially latest information amongst the information stored through the control unit (8) in terms of rates of cooling and ensuring that the information on circulation and loading are included into the process together with the coefficients depending on the effects that they'll do on rates of cooling at the comparison stage are also realized. By inclusion of the information on circulation and loading into the process through the control unit (8), when differences occur between cooling rate of cooler unit (4) and cooling rate of cooling volume (2) in the compared and sequentially latest information amongst the stored information, then it is decided that there exists a frosting formation and initiation of defrosting process is ensured.

[0014] At the preferred application of the invention, in case the fact that there exists no frosting formation is decided through the control unit (8) when there are no differences occurred between cooling rate of cooler unit (4) and cooling rate of cooling volume (2), cooling circulation is ensured to continue in a normal manner. Control unit (8) ensures measurement of temperatures together with time information related to each measurement at a certain interval by the heat sensor (7) located on the cooler unit (4) during defrosting period. All along the defrosting period, after temperature of cooler unit (4) is recorded within unit of time, the temperature difference between the records is divided into the time difference and heating angle is determined by the control unit (8). Heating angles belonging to the defrosting process determined by the control unit (8) and date time and temperature information which form these angles are recorded. The information recorded by control unit (8) is compared by different coefficients in accordance with the defrosting system type (systems using electrical heater, temperature, gas etc.) and to the time at which the system is commenced. In case sequential measurements are over a certain threshold value after the fact either melting process of frosted mass (6) is completed or not is controlled, and comparison of stored information with the coefficients, the control unit (8) realizes finalization of defrosting process. In case sequential measurements are below a certain threshold value after comparison of stored information with the coefficients, the fact that the melting process of frosted mass (6) is not completed is decided through

control unit (8) and continuation of defrosting process is ensured.

[0015] At the preferred application of the invention, cooling volume (2) is a cold storage room operating on heat pump basis. In another application of the invention, cooling volume (2) is a chamber.

[0016] The smart defrosting method (100) which enables prevention of loss of energy and heat occurred during melting of frosting and which is applied through a control unit (8) contains the following steps

- measurement of temperatures of cooling volume (2) and cooler unit (4) at unit of time intervals by heat sensors (7) (101),
- measurement of change amounts of temperatures (rates of cooling/heating) of cooling volume (2) and cooler unit (4) at unit of time intervals with the data transmitted to the control unit (8) by heat sensors (7) (102),
- determination of circulation and loading information by the control unit (8) (103),
- storage of information by control unit (8) (104),
- analysis of the stored information by the control unit (8) (105),
- initiation of defrosting process in case existence of frosting formation is determined by the control unit (8) (106),
- return of defrosting process to the beginning stage in case non-existence of frosting formation is determined by the control unit (8) (107),
- formation of heating-time curve by the control unit (8) (108),
- determination of heating angle by the control unit (8) (109),
- record of heating angles depending on time by control unit (8) (110),
- analysis of information stored by the control unit (8) (111),
- Control of the fact if the melting process of frosted mass (6) is completed by the control unit (8) and finalization of defrosting (112),
- Control of the fact if the melting process of frosted mass (6) is not completed by the control unit (8) and continuation of defrosting process (113) (Figure 2).

[0017] In the method (100) subject of invention, firstly temperatures are measured by two separate heat sensors (7) located on the cooled volume (7) and cooler unit (4) as a result of the fact that the timer in the control unit gets full (101). Since the heat sensors (7) are placed as not to be affected from by the air flow within the cooling volume (2), a correct temperature measurement is performed.

[0018] Control unit (8) ensures measurement of difference values occurred between temperatures of cooling volume (2) and cooler unit (4) with the former measurements, and determination of rates of cooling/heating in terms centigrade degree/seconds dividing the difference

value to the timer time in line with the data obtained from heat sensors (7) (102).

[0019] Information such as operation of cooler unit (4), operation of condenser unit (3) opening of loading gate of cooled volume (2) during the period timers of heat sensors (7) operate are measured through control unit (8) (103).

[0020] Rates of cooling and circulation & loading information of cooler unit (4) and cooling volume (2) are recorded by the control unit (8) adding date and time information and increasing sequence numbers (104).

[0021] Sequentially latest information amongst the information stored by the control unit (8) is compared in terms of rates of cooling. At the comparison stage, the information on circulation and loading are included into the process together with the coefficients depending on the effects that they'll do on rates of cooling (105).

[0022] By inclusion of the information on circulation and loading into the process through the control unit (8), when differences occur between cooling rate of cooler unit (4) and cooling rate of cooling volume (2) in the compared and sequentially latest information amongst the stored information, then it is decided that there exists a frosting formation and initiation of defrosting process is ensured (106). In case the fact that there exists no frosting formation is decided through the control unit (8) when there are no differences occurred between cooling rate of cooler unit (4) and cooling rate of cooling volume (2), cooling circulation is ensured to continue in a normal manner. (107).

[0023] Temperatures together with time information related to each measurement at a certain interval by heat sensor (7) located on cooler unit (4) are measured during defrosting period (108). All along the defrosting period, after temperature of cooler unit (4) is recorded within unit of time through control unit (8), the temperature difference between records is divided into time difference and heating angle is determined (109). Heating angles belonging to the defrosting process determined and date time and temperature information which form these angles are recorded by the control unit (8) (110). The information recorded by the control unit (8) is compared by different coefficients in accordance with the defrosting system type (systems using electrical heater, temperature, gas etc.) and to the time at which the system is commenced (111). In case sequential measurements are over a certain threshold value after the fact either melting process of frosted mass (6) is completed or not is controlled, and comparison of stored information with the coefficients, the defrosting process is finalized (112). After all the steps are completed return to the beginning in the algorithm and it is ensured that the same processes are performed in certain intervals. In case sequential measurements are below a certain threshold value after comparison of stored information with the coefficients and it is decided that the melting process of frosted mass (6) is not completed and defrosting process is continued through control unit (8) (113).

[0024] It is possible to develop a wide variety of applications of system (1) and method (100) subject of invention, and the invention cannot be limited with the examples hereby defined, it is basically as indicated in the requests.

Claims

1. A method (100) enabling prevention of loss of energy and heat occurred during melting of frosting and applied through a control unit (8) which is **characterized** by the following steps:
 - measurement of temperatures of cooling volume (2) and cooler unit (4) at unit of time intervals by heat sensors (7) (101),
 - measurement of change amounts of temperatures (rates of cooling/heating) of cooling volume (2) and cooler unit (4) at unit of time intervals with the data transmitted to the control unit (8) by heat sensors (7) (102),
 - determination of circulation and loading information by the control unit (8) (103),
 - storage of information by control unit (8) (104),
 - analysis of the stored information by the control unit (8) (105),
 - initiation of defrosting process in case existence of frosting formation is determined by the control unit (8) (106),
 - return of defrosting process to the beginning stage in case non-existence of frosting formation is determined by the control unit (8) (107),
 - formation of heating-time curve by the control unit (8) (108),
 - determination of heating angle by the control unit (8) (109),
 - record of heating angles depending on time by the control unit (8) (110),
 - analysis of information stored by the control unit (8) (111),
 - Control of the fact if the melting process of frosted mass (6) is completed by the control unit (8) and finalization of defrosting (112),
 - Control of the fact if the melting process of frosted mass (6) is not completed by the control unit (8) and continuation of defrosting process (113).
2. A method (100) as in Request 1 **characterized** by measurement of temperatures by two separate heat sensors (7) located on the cooled volume (7) and cooler unit (4) as a result of the fact that a certain timer gets full (101), the control unit (8) ensuring measurement of difference values occurred between temperatures of cooling volume (2) and cooler unit (4) with the former measurements, by determination of rates of cooling/heating in terms centigrade degree/seconds dividing the difference value to the

timer time in line with the data obtained from heat sensors (7) (102), by measurement of information such as operation of cooler unit (4), operation of condenser unit (3) opening of loading gate of cooled volume (2) during the period timers of heat sensors (7) operate (103).

3. A method (100) as in any of the requests above, **characterized by** recording of rates of cooling and circulation & loading information of cooler unit (4) and cooling volume (2) by the control unit (8) adding date and time information and increasing sequence numbers (104), by comparison of sequentially latest information amongst the information stored by the control unit (8) in terms of rates of cooling and at the comparison stage, inclusion of the information on circulation and loading into the process together with the coefficients depending on the effects that they'll do on rates of cooling (105).

4. A method (100) as in any of the requests above, **characterized by** decision that there exists a frosting formation and initiation of defrosting process upon inclusion of the information on circulation and loading into the process through the control unit (8), when differences occur between cooling rate of cooler unit (4) and cooling rate of cooling volume (2) in the compared and sequentially latest information amongst the stored information (106), by measurement of temperatures together with time information related to each measurement at a certain interval by the heat sensor (7) located on the cooler unit (4) during the defrosting period (108).

5. A method (100) as in any of the requests above, **characterized by** continuation of cooling circulation in a normal manner in case the fact that there exists no frosting formation is decided through the control unit (8) when there are no differences occurred between cooling rate of cooler unit (4) and cooling rate of cooling volume (2) (107).

6. A method (100) as in any of the requests above, **characterized by** determination of temperature difference between records is divided into time difference and determination of heating angle all along defrosting period, after temperature of cooler unit (4) is recorded in unit of time via control unit (8) (109) recording heating angles belonging to defrosting process determined and date time and temperature information forming these angles by control unit (8) (110).

7. A method (100) as in any of the requests above, **characterized by** comparison of the information recorded by the control unit (8) by different coefficients in accordance with the defrosting system type (systems using electrical heater, temperature, gas etc.)

and to the time at which the system is commenced (111), by finalization of the defrosting process in case sequential measurements are over a certain threshold value after the fact if melting process of frosted mass (6) is completed is controlled, and comparison of stored information with the coefficients (112), by continuation of the defrosting process through control unit (8) in case sequential measurements are below a certain threshold value after comparison of stored information with the coefficients and it is decided that the melting process of frosted mass (6) is not completed (113).

8. A system (1) which enables prevention of loss of energy and heat occurred during melting of frosting and **characterized by** the following;

- at least one cooling volume (2) where the cooling process is realized,
- at least one condenser unit (3) which ensures heat removal during cooling of the air within the cooling volume (2),
- at least one cooler unit (4) which is fed by the condenser unit (3) and cools the cooling volume (2),
- at least two heat sensors which sense the temperatures of cooling volume (2) and cooler unit (4),
- at least one control unit (8) which controls operation amounts and/or operation times of cooler unit (4) and condenser unit (3)

9. A system (1) as in Request 8 **characterized by** a control unit (8) which adjusts the operation status of cooler unit (4) and condenser unit (3) in line with the data it obtains from heat sensor (7) and communicates the amount and temperature of the required air to the cooler unit (4) upon the analysis it performed, is (8) located over and near the gate of cooling volume (2) at the preferred application of the invention, ensures measurement of difference values occurred between temperatures of cooling volume (2) and cooler unit (4) with the former measurements, and determinates the rates of cooling/heating in terms centigrade degree/seconds dividing the difference value to the timer time in line with the data it obtains from heat sensor (7), ensures measurement of information such as operation of cooler unit (4), operation of condenser unit (3) opening of loading gate of cooled volume (2) during the period timers of heat sensors (7) operate.

10. A smart defrosting system (1) as in any of the Request 8 **characterized by** a control unit (8) which ensures record of rates of cooling and circulation & loading information of cooler unit (4) and cooling volume (2) adding date and time information and increasing sequence numbers and also ensures com-

parison of sequentially latest information amongst the information stored in terms of rates of cooling and ensuring that the information on circulation and loading are included into the process together with the coefficients depending on the effects that they'll do on rates of cooling at the comparison stage and ensures decision that there exists a frosting formation and initiation of defrosting process when differences occur between cooling rate of cooler unit (4) and cooling rate of cooling volume (2) in the compared and sequentially latest information amongst the stored information by inclusion of the information on circulation and loading into the process

is a cold storage room or a chamber operating on heat pump basis.

11. A smart defrosting system (1) as in any of the Request 8 **characterized by** a control unit (8) ensuring continuation of cooling circulation in a normal manner in case the fact that there exists no frosting formation is decided when there are no differences occurred between cooling rate of cooler unit (4) and cooling rate of cooling volume (2) and also ensuring measurement of temperatures together with time information related to each measurement at a certain interval by the heat sensor (7) located on the cooler unit (4) during the defrosting period.
12. A smart defrosting system (1) as in any of the Request 8 **characterized by** a control unit (8) which ensures division of the temperature difference between the records into the time difference and determination of heating angle all along the defrosting period, after temperature of cooler unit (4) is recorded within unit of time and (8) ensures determination of heating angles belonging to the defrosting process and record of date time and temperature information which form these angles.
13. A smart defrosting system (1) as in any of the Requests 8 **characterized by** a control unit (8) which ensures that the information recorded is compared by different coefficients in accordance with the defrosting system type (systems using electrical heater, temperature, gas etc.) and to the time at which the system is commenced and also ensures finalization of defrosting process in case sequential measurements are over a certain threshold value after the fact if melting process of frosted mass (6) is completed is controlled, and comparison of stored information with the coefficients and ensures decision of the fact that the melting process of frosted mass (6) is not completed and continuation of defrosting process in case sequential measurements are below a certain threshold value after comparison of stored information with the coefficients and contains a timer in.
14. A smart defrosting system (1) as in any of the Request 8 **characterized by** a cooling volume (2) which

Figure 1

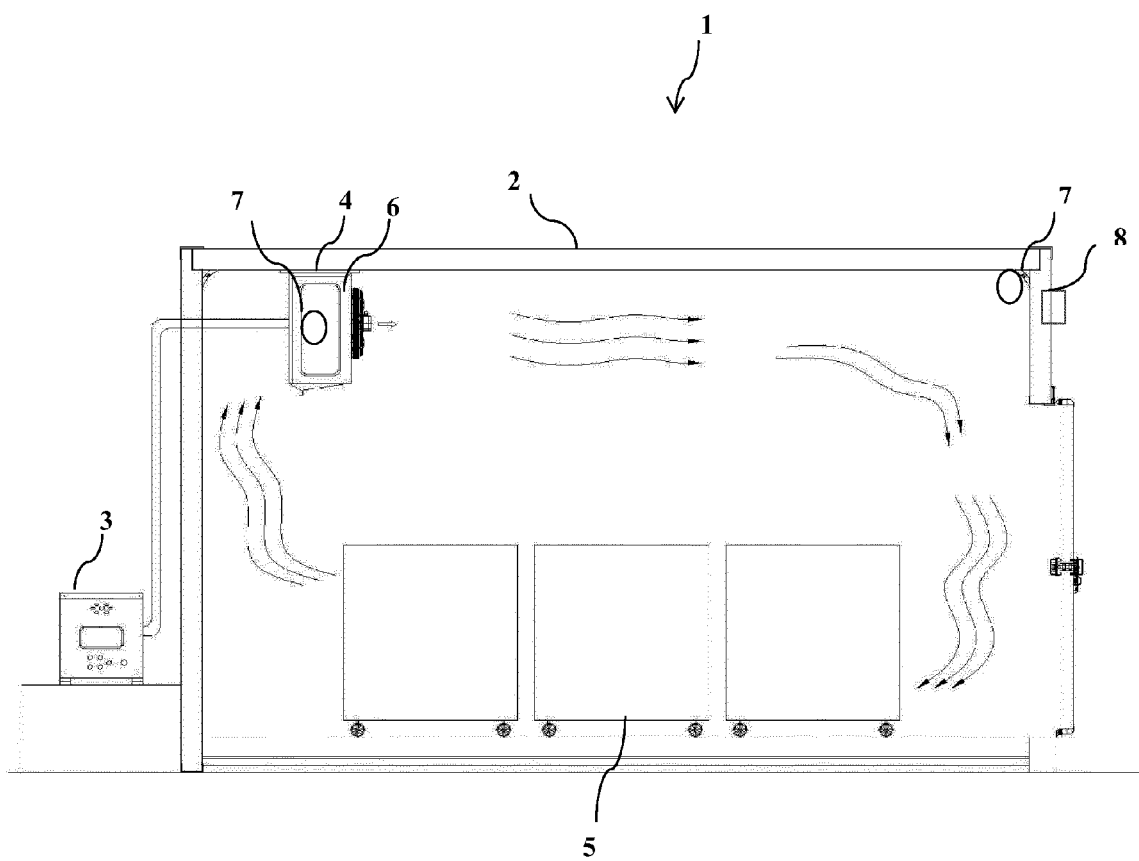
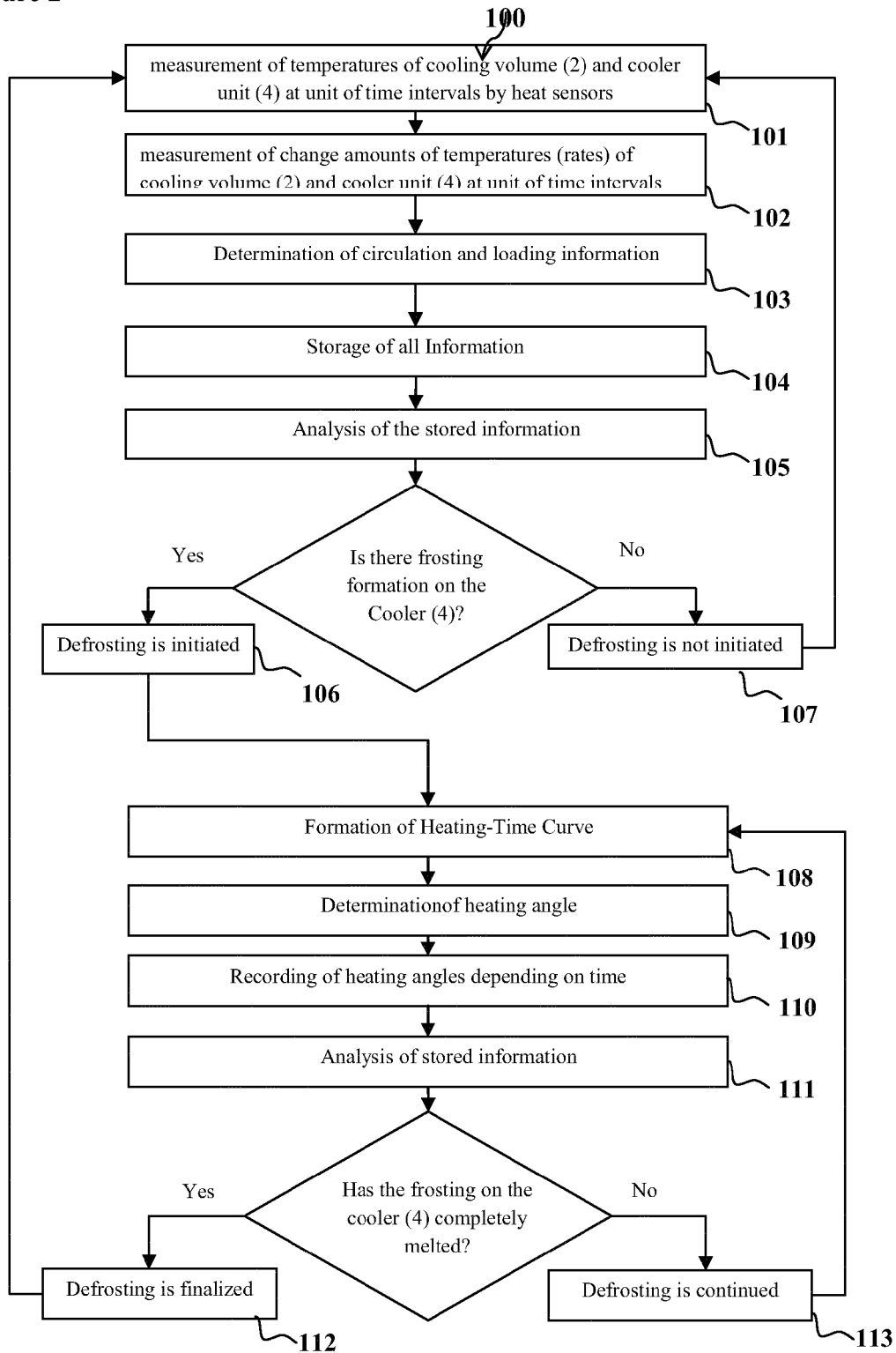


Figure 2



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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