METHODS, SYSTEMS, AND DEVICES FOR CONTROLLING ANTI-SWEAT HEATERS

Abstract: The various embodiments disclosed herein relate to anti-sweat heater systems for refrigeration units. More specifically, certain embodiments relate to anti-sweat heater control systems having one or more controllers that operate anti-sweat heaters independently of each other.

FIG. 1
METHODS, SYSTEMS, AND DEVICES FOR
CONTROLLING ANTI-SWEAT HEATERS

Field of the Invention

[001] The various embodiments disclosed herein relate to anti-sweat heater systems for refrigeration units. More specifically, certain embodiments relate to anti-sweat heater control systems having one or more controllers that operate anti-sweat heaters independently of each other.

Background of the Invention

[002] Anti-sweat heaters are used to reduce, prevent, or eliminate condensation on the doors, frame, and mullions of refrigeration units such as the large commercial refrigeration units found in grocery stores. As condensation forms on the doors (and windows in the doors), frame, and mullions of a refrigeration unit, various known heater systems operate to eliminate that condensation. The known systems typically have a single controller that is coupled to all the heaters associated with a refrigeration unit such that the controller can only activate or de-activate all of the heaters at once (it cannot activate any heaters individually).

[003] There is a need in the art for improved anti-sweat heater systems.

Brief Summary of the Invention

[004] One embodiment disclosed herein relates to a system for controlling anti-sweat heaters having a controller, at least one door heater, a first door moisture sensor, at least one frame/mullion heater, and a first frame/mullion moisture sensor. The controller has a door channel and a frame/mullion channel that is independent of the door channel. The first door moisture sensor is operably coupled to the controller and configured to transmit a door sensor resistance reading to the controller. The first frame/mullion moisture sensor is operably coupled to the controller and configured to transmit a frame/mullion sensor resistance reading to the controller.

[005] Another embodiment relates to a system for controlling anti-sweat heaters having a first controller, at least one first door heater, a first door moisture sensor, at least one first frame/mullion heater, a first frame/mullion moisture sensor, a second controller, at least one second door heater, a second door moisture sensor, at least one second frame/mullion heater, and a second frame/mullion moisture sensor. The first controller has a first door channel and a first frame/mullion channel that is independent of the first door channel. The first door moisture sensor is operably coupled to the first controller and configured to transmit a first door sensor resistance reading to the first controller. The first frame/mullion moisture sensor is operably coupled to the first controller and configured to transmit a frame/mullion sensor resistance reading to the first controller. The second controller is independent of the first controller and has a second door channel and a second frame/mullion channel that is independent of the second door channel. The second door moisture sensor is operably coupled to the second controller and configured to transmit a second door sensor resistance reading to the second controller. The second frame/mullion moisture sensor is operably
coupled to the second controller and configured to transmit a second frame/mullion sensor resistance reading to the second controller.

A further embodiment relates to a system for controlling anti-sweat heaters. The system has a controller, at least one door heater, a first detachable door moisture sensor, at least one frame/mullion heater, and a first detachable frame/mullion moisture sensor. The controller has a door channel and a frame/mullion channel that is independent of the door channel. The first detachable door moisture sensor is operably coupled to the controller, is configured to transmit a door sensor resistance reading to the controller, and is powered with AC current. The first detachable frame/mullion moisture sensor is operably coupled to the controller, is configured to transmit a frame/mullion sensor resistance reading to the controller, and is powered with AC current. The controller is configured to activate the at least one door heater when the door sensor resistance reading reaches a predetermined level and is further configured to activate the at least one frame/mullion heater when the frame/mullion sensor resistance reading reaches a predetermined level. In addition, the controller is configured to perform a programmed maintenance cycle.

While multiple embodiments are disclosed, still other embodiments of the present invention will become apparent to those skilled in the art from the following detailed description, which shows and describes illustrative embodiments of the invention. As will be realized, the invention is capable of modifications in various obvious aspects, all without departing from the spirit and scope of the present invention. Accordingly, the drawings and detailed description are to be regarded as illustrative in nature and not restrictive.

**Brief Description of the Drawings**

FIG. 1 is a front view of an anti-sweat heater control system incorporated into a refrigeration unit, according to one embodiment.

FIG. 2 is a perspective view of a controller, according to one embodiment.

FIG. 3 is a perspective view of a door sensor and a frame/mullion sensor positioned on a refrigeration unit, according to one embodiment.

FIG. 4A is a front view of a sensor, according to one embodiment.

FIG. 4B is a front view of the electrical component of the sensor of FIG. 4A.

FIG. 4C is a side view of the sensor of FIG. 4A.

FIG. 5 is a perspective view of sensor, according to another embodiment.

**Detailed Description**

The various embodiments disclosed herein relate to methods, systems, and devices for controlling anti-sweat heaters associated with various types of commercial refrigeration and freezer units having glass display doors (doors with large display windows). Certain embodiments herein relate to a control component that is configured to control at least one door heater separately and independently from any frame heaters and/or mullion heaters. In other system and device implementations, a moisture sensor is provided that is strategically placed on an outer surface of the door frame at a predetermined location where condensation initially occurs when the door heater is
not operating. In alternative aspects in which there is more than one refrigeration/freezer unit (and thus more than one set of heaters), there is a controller provided for each separate unit, such that each separate controller is associated with only one unit and is operably coupled to only the sensors and heaters associated with that unit, rather than a single controller being coupled in series to sensors and heaters on more than one unit.

[016] Generally, the embodiments disclosed herein relate to systems or methods for reducing or preventing condensation on the external surfaces of a refrigeration/freezer unit. Anti-sweat heaters are used to reduce, prevent, or eliminate that condensation. The various embodiments disclosed herein have a controller that will turn the anti-sweat heaters on and off and only allow the heaters to come on when needed, thus eliminating wasted energy while preventing condensation or frost from forming on the outside of the refrigerator case and/or glass display doors.

[017] According to one embodiment, the systems and devices herein have two sets of heaters that are installed on a commercial refrigeration case. The first set of heaters typically supplies heat to the glass display doors. These heaters are generally called "door heaters" and they supply heat to only the actual door(s) or more specifically to the display glass in the door(s). The second set of heaters typically supplies heat to the frame (the framework around the area where the door is mounted) and mullions (the vertical supports between the doors) of the display case. In this embodiment, the controller controls the door heaters separately from the frame and mullions heaters as described in further detail below. Alternatively, the systems and devices herein include three sets of heaters, including the door heaters and separate sets of frame heaters and mullion heaters. In this alternative embodiment, the controller still controls the door heaters separately from the frame heaters and the mullion heaters.

[018] FIG. 1 depicts an anti-sweat heater control system incorporated into a refrigeration unit 10, according to one embodiment. The system has a controller 12 that is coupled to the door sensor 14 via a wire 16. Separately, the controller 12 is also coupled to the mullion and frame sensor 18 via a wire 20.

[019] The sensor(s) and heaters for the doors are controlled separately and independently of the sensor(s) and heaters for the mullions and/or frame. That is, there is a "channel" provided for the door sensor(s) and the door heaters of a unit (such as the unit 10 depicted in FIG. 1), and there is a separate "channel" provided for the frame and/or mullion sensor(s) and the frame and/or mullion heaters of the unit. The word "channel" is used herein to indicate that the operable coupling of the controller to the door sensor(s) and heaters is separate and independent from the operable coupling of the controller to the frame and/or mullion sensor(s) and heaters.

[020] FIG. 2 depicts the inputs of a controller 40, according to one embodiment. In this embodiment, the controller 40 has two channels: a door sensor/heater channel 42 and a frame/mullion sensor/heater channel 44. In this embodiment, the door sensor/heater channel 42 has two inputs 42A, 42B that are configured to receive the appropriate connections to the door sensor(s) (not shown). In this embodiment, the controller 40 is coupled to only one door sensor, which has a connection received at input 42A. Similarly, the frame/mullion sensor/heater channel 44 has two inputs 44A, 44B that are configured to receive the appropriate connections to the frame and/or mullion.
sensor(s) (not shown). In this embodiment, the controller 40 is coupled to only one frame and/or mullion sensor, which has a connection received at input 44B.

Returning to FIG. 1, the door sensor 14 is positioned strategically along the side of the door 22C in the location where it has been determined that condensation first forms on that door 22C. In this particular embodiment, the sensor 14 is positioned near the bottom of the side of the door 22C that is hinged to the frame of the unit 10. Alternatively, the door sensor 14 can be removably positionable or attachable anywhere on an external surface of any of the doors 22A, 22B, 22C such that a user or employee of the supermarket, the manufacturer or marketer of the system, or any other appropriate enterprise can adjust the location of the sensor 14, thereby positioning that sensor 14 in the optimal location at which condensation first forms on the door or doors of that particular unit 10.

Alternatively, more than one door sensor can be provided according to various embodiments herein. In such an implementation, the two or more sensors can be positioned on the same door of the unit or can be positioned on different doors.

Like the door sensor 14, the frame/mullion sensor 18 is also positionable strategically on an external surface of the frame 24 or nullions 26 of the unit 10 in the location where it has been determined that condensation first forms on the frame 24 and/or nullions 26. In this particular embodiment, the sensor 18 is positioned near the bottom of the mullion 26A. Alternatively, the frame/mullion sensor 18 can be removably positionable or attachable anywhere on an external surface of any portion of the frame 24 or nullions 26A, 26B such that a user or employee can adjust and thereby optimize the location of the sensor 18. In a further alternative, more than one frame/mullion sensor can be provided. In such an implementation, the two or more sensors can be positioned anywhere on the frame 24 or nullions 26A, 26B of the unit 10.

According to another implementation as set forth in FIG. 3, a door sensor 50 is positioned on the edge of a door 54 and a frame/mullion sensor 52 is positioned on the mullion 56 as shown.

It is understood that the door sensor 14 is electrically connected (through the controller 12) to the heaters (not shown) that are associated with the doors of the unit 10. More accurately, the controller 12 is operably coupled to the door sensor 14 and to the heaters such that the sensor 14 and heaters are coupled to each other. Similarly, the controller 12 is operably coupled to the frame/mullion sensor 18 and to the frame/mullion heaters such that the sensor 18 and heaters are coupled to each other. It is further understood that the heaters are provided in the refrigeration/freezer unit in any configuration that is known in the art. Generally, the heaters are integrated into the structure of each door and into the frame and nullions.

Even though the controller 12 in FIG. 1 is depicted schematically as being positioned at a location away from the refrigeration unit, it is understood that this is simply a schematic representation. In one embodiment, the controller is positioned under the refrigeration unit 10 and behind the lower panel 28. Alternatively, the controller can be positioned anywhere on the unit 10 or even at some distance from the unit 10.
It is understood that the controller 12 is not only coupled to the sensors and heaters as shown according to one configuration in FIG. 1, but it is also coupled to the power supply. In a further embodiment, the controller 12 is also coupled to a ground wire.

In various embodiments, more than one refrigeration/freezer unit is provided. In these embodiments, a separate controller is provided for each unit, in which each such controller is coupled to the sensors and heaters of the unit to which that controller is associated. Thus, in these implementations, the sensors of the multiple units are not coupled to each other in series along a single wire and ultimately to a single controller. Instead, the sensors of each individual unit are coupled solely to the controller associated with that unit.

According to one implementation, each of the sensors 14, 18 are moisture sensors that are configured to detect moisture. FIGS. 4A, 4B, and 4C depict a sensor 60 for use with the various embodiments disclosed herein, according to one implementation. FIGS. 4A and 4B depict front views of the sensor 60, while FIG. 4C is a side view of the sensor 60. According to one embodiment, the sensor 60 has a generally oval shape as shown such that the width of the face of the sensor is reduced in comparison to other known sensors, thereby allowing the sensor to be positioned in narrower spaces than can be accomplished with the wider known sensors.

FIG. 5 depicts another embodiment of a sensor 70. This sensor 70 has a sensor connector 72 that allows the sensor 70 to be coupled to a wire connector 74 on the wire 76. In one implementation, this sensor 70 with its connector 72 allows for easy coupling to and uncoupling from the system, thereby providing for easy repair, replacement, or relocation of any such sensor 70 in the system. According to another embodiment, the coupling of the sensor connector 72 to the wire connector 74 can provide a stronger connection between the wire 76 and the sensor 70. That is, the connectors 72, 74 can provide a stronger physical connection than a simple solder connection of the wire to the sensor such that the connection between the wire 76 and the sensor 70 can withstand more physical stress or strain without disconnecting.

According to one implementation, each moisture sensor is a multi-metal sensor. In a further alternative, it is understood that any moisture sensor known in the art could be used with the various embodiments disclosed herein. For example, any of the sensors disclosed in U.S. Patents 5,899,078 or 7,240,501 (both of which are hereby incorporated herein by reference in their entireties) can be used in any of the embodiments herein.

In accordance with one embodiment, each of the sensors operate using AC current and continually transmit a resistance reading to the controller. More specifically, using FIG. 1 as an example, the controller 12 provides a constant AC current to the sensors 14, 18 and continually monitor the resistance readings provided by each of the sensors 14, 18. When the heaters are off, the outside of the refrigeration unit will begin to cool. At some point, condensation will begin to form on the outside of the refrigeration case. As the condensation forms on each of the sensors 14, 18, that impacts the resistance readings sent to the controller 12 by each of those sensors 14, 18. When the resistance reading from either sensor 14 or 18 reaches a specific predetermined level (which is adjustable), the controller activates the heaters associated with that sensor, while the other, unlinked heaters are not activated until their sensors are separately triggered by condensation. For example, if
the door sensor 14 has a resistance reading that reaches the predetermined level due to condensation forming around or on the sensor 14, the controller 12 activates the door heaters for that unit, while the frame and/or mullion heaters are not activated. When the resistance of the door sensor 14 has recovered (reversed) as a result of the door heaters reducing or eliminating the condensation, the door heaters will then be deactivated and put into an "off" state. This procedure is followed for the frame/mullion sensors 18 and the frame/mullion heaters as well.  

[033] One unexpected benefit of using AC current to power the sensors according to one embodiment, is that it can prevent or reduce problems with sensor sensitivity or failure. Known systems utilize DC current to power their sensors. When multi-metal sensors are used, the DC current can cause ion buildup on the sensors, often resulting in impaired sensor sensitivity and in many cases sensor failure. The use of AC current eliminates the ion buildup, thereby reducing the problems with sensitivity and failure.

[034] In an embodiment in which each channel has more than one input (is connected to more than one sensor, such as the controller depicted in FIG. 2, for example), either sensor can trigger activation of the heater. That is, the appropriate predetermined level of resistance does not need to be reached at both sensors in order to trigger activation of the heater - either sensor can trigger activation individually.

[035] One benefit of having separate channels for the separate sensor-heater combinations is efficiency. That is, only the appropriate heater for the actual condensation is activated, while heaters attached to doors or components without condensation are not activated. In known technologies currently on the market, condensation triggers multiple heaters to be activated, including heaters that are not associated with a component that is currently experiencing condensation, thereby resulting in wasteful consumption of energy.

[036] According to one implementation, a controller such as the controller 12 in FIG. 1 can also be programmed to include an automatic maintenance cycle. The controller 12 with this programmed maintenance cycle will automatically activate one or more of the heaters to operate for a predetermined amount of time. In one example, the controller 12 is programmed to activate each door heater channel and each frame/mullion heater channel for 15 minutes during every three hour period. Alternatively, the controller 12 can be programmed to activate every heater for any amount of time during any time period. In one embodiment, the programmed maintenance cycle causes each heater to be activated separately such that the heaters are not activated at the same time. That is, the various heaters can be activated at different times by the controller. In one implementation, the heaters are activated at different times to capture significant demand (kW) savings on the heater load. The programmed maintenance cycle prevents each of the heaters from being un-activated for extended periods of time, which can lead to moisture or ice buildup in areas that are not visible from outside the display case and/or areas where there is no moisture sensor, such as door gaskets, mullion chambers, electrical raceways, etc.

[037] Although the present invention has been described with reference to preferred embodiments, persons skilled in the art will recognize that changes may be made in form and detail without departing from the spirit and scope of the invention.
Claims

What is claimed is:

1. A system for controlling anti-sweat heaters, comprising:
   (a) a controller comprising:
       (i) a door channel comprising at least one door channel input; and
       (ii) a frame/mullion channel comprising at least one frame/mullion channel input, wherein the frame/mullion channel is independent of the door channel;
   (b) at least one door heater operably coupled to the door channel;
   (c) a first door moisture sensor configured to be positioned on a refrigeration case door, the sensor operably coupled to the controller at the at least one door channel input, the first door moisture sensor configured to transmit a door sensor resistance reading to the controller;
   (d) at least one frame/mullion heater operably coupled to the frame/mullion channel; and
   (e) a first frame/mullion moisture sensor configured to be positioned on a frame or mullion, the sensor operably coupled to the controller at the at least one frame/mullion channel input, the first frame/mullion sensor configured to transmit a frame/mullion sensor resistance reading to the controller.

2. The system of claim 1, wherein the controller is configured to activate the at least one door heater when the first door moisture sensor resistance reading reaches a predetermined level and is further configured to activate the at least one frame/mullion heater when the first frame/mullion moisture sensor resistance reading reaches a predetermined level.

3. The system of claim 1, wherein the controller is configured to transmit AC current to the first door moisture sensor and the first frame/mullion moisture sensor.

4. The system of claim 1, wherein the controller is further configured to perform a programmed maintenance cycle.

5. The system of claim 4, wherein the programmed maintenance cycle comprises a predetermined activation of at least one of the at least one door heater and the at least one frame/mullion heater by the controller for a predetermined amount of time during each predetermined period of time.
6. The system of claim 5, wherein the predetermined amount of time is 15 minutes and the predetermined period of time is three hours.

7. The system of claim 5, wherein the predetermined activation of the at least one door heater is independent of the predetermined activation of the at least one frame/mullion heater.

8. A system for controlling anti-sweat heaters, comprising:
   (a) a first controller comprising:
       (i) a first door channel comprising at least one first door channel input; and
       (ii) a first frame/mullion channel comprising at least one first frame/mullion channel input, wherein the first frame/mullion channel is independent of the first door channel;
   (b) at least one first door heater operably coupled to the first door channel;
   (c) a first door moisture sensor configured to be positioned on a first refrigeration case door, the first door moisture sensor operably coupled to the first controller at the at least one first door channel input, the first door moisture sensor configured to transmit a first door sensor resistance reading to the first controller;
   (d) at least one first frame/mullion heater operably coupled to the first frame/mullion channel;
   (e) a first frame/mullion moisture sensor configured to be positioned on a first refrigeration case frame or mullion, the first frame/mullion moisture sensor operably coupled to the first controller at the at least one first frame/mullion channel input, the first frame/mullion sensor configured to transmit a first frame/mullion sensor resistance reading to the first controller;
   (f) a second controller independent of the first controller, the second controller comprising:
       (i) a second door channel comprising at least one second door channel input; and
       (ii) a second frame/mullion channel comprising at least one second frame/mullion channel input, wherein the second frame/mullion channel is independent of the second door channel;
   (g) at least one second door heater operably coupled to the second door channel;
   (h) a second door moisture sensor configured to be positioned on a second refrigeration case door, the second door moisture sensor operably coupled to the second controller at the at least one second door channel input, the second door moisture sensor configured to transmit a second door sensor resistance reading to the second controller;
(i) at least one second frame/mullion heater operably coupled to the second frame/mullion channel; and

(j) a second frame/mullion moisture sensor configured to be positioned on a second refrigeration case frame or mullion, the second frame/mullion moisture sensor operably coupled to the second controller at the at least one second frame/mullion channel input, the second frame/mullion sensor configured to transmit a second frame/mullion sensor resistance reading to the second controller.

9. The system of claim 8, wherein the first controller is configured to activate the at least one first door heater when the first door moisture sensor resistance reading reaches a predetermined level and is further configured to activate the at least one first frame/mullion heater when the first frame/mullion moisture sensor resistance reading reaches a predetermined level.

10. The system of claim 8, wherein the second controller is configured to activate the at least one second door heater when the second door moisture sensor resistance reading reaches a predetermined level and is further configured to activate the at least one second frame/mullion heater when the second frame/mullion moisture sensor resistance reading reaches a predetermined level.

11. The system of claim 8, wherein the first controller is configured to transmit AC current to the first door moisture sensor and the first frame/mullion moisture sensor, and further wherein the second controller is configured to transmit AC current to the second door moisture sensor and the second frame/mullion moisture sensor.

12. The system of claim 8, wherein the first controller is further configured to perform a first programmed maintenance cycle and the second controller is further configured to perform a second programmed maintenance cycle.

13. The system of claim 12, wherein the first programmed maintenance cycle comprises a predetermined activation of at least one of the at least one first door heater and the at least one first frame/mullion heater by the first controller for a predetermined amount of time during each predetermined period of time.

14. The system of claim 12, wherein the second programmed maintenance cycle comprises a predetermined activation of at least one of the at least one second door heater and the at least one second frame/mullion heater by the second controller for a predetermined amount of time during each predetermined period of time.
15. A system for controlling anti-sweat heaters, comprising:
   (a) a controller comprising:
      (i) a door channel comprising at least one door channel input; and
      (ii) a frame/mullion channel comprising at least one frame/mullion channel
           input, wherein the frame/mullion channel is independent of the door
           channel;
   (b) at least one door heater operably coupled to the door channel;
   (c) a first detachable door moisture sensor configured to be positioned on a
       refrigeration case door, the sensor operably coupled to the controller at the at
       least one door channel input, the first door moisture sensor configured to transmit
       a door sensor resistance reading to the controller, wherein the first detachable
       door moisture sensor is powered with AC current;
   (d) at least one frame/mullion heater operably coupled to the frame/mullion channel;
       and
   (e) a first detachable frame/mullion moisture sensor configured to be positioned on a
       frame or mullion, the sensor operably coupled to the controller at the at least one
       frame/mullion channel input, the first frame/mullion sensor configured to transmit
       a frame/mullion sensor resistance reading to the controller, wherein the first
       detachable frame/mullion moisture sensor is powered with AC current,
       wherein the controller is configured to activate the at least one door heater when the door
       sensor resistance reading reaches a predetermined level and is further
       configured to activate the at least one frame/mullion heater when the
       frame/mullion sensor resistance reading reaches a predetermined level,
       wherein the controller is further configured to perform a programmed maintenance cycle.

16. The system of claim 15, wherein the programmed maintenance cycle comprises
    separately activating the at least one door heater and the at least one frame/mullion heater to operate for
    a predetermined amount of time during a predetermined period of time.

17. The system of claim 16, wherein the programmed maintenance cycle further comprises
    separately activating the at least one door heater and the at least one frame/mullion heater at different
    times.

18. The system of claim 15, wherein the activation of the at least one door heater by the
    controller is independent of the activation of the at least one frame/mullion heater by the controller.
19. The system of claim 15, wherein the activation of the at least one door heater by the controller comprises activation of the door channel and further wherein the activation of the at least one frame/mullion heater by the controller comprises activation of the frame/mullion channel.

20. The system of claim 19, wherein the frame/mullion channel is independent of the door channel such that the activation of the frame/mullion channel is independent of the activation of the door channel.
## INTERNATIONAL SEARCH REPORT

**International application No**

PCT/US 09/65189

### A CLASSIFICATION OF SUBJECT MATTER

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<th>IPC(8)</th>
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<td>F25D 21/06 (2009.01)</td>
<td>Y</td>
<td>US 2005/0229614 A1 (ANSTED) 20 October 2005 (20 10 2005), entire document especially Fig 1A-2, para [0022]-[0025]</td>
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<td>F25D 21/06 (2009.01)</td>
<td>Y</td>
<td>US 2006/0026975 A1 (BUNCH et al) 09 February 2006 (09 02 2006), entire document especially Fig 1-4, para [0015]-[0022]</td>
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<tr>
<td>571-272-4300</td>
<td>Y</td>
<td>US 5,899,078 A (MAGER) 04 May 1999 (04 05 1999), Fig 2, col 3, in 27-28</td>
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**Category**

- Y: Published document relevant to the claimed invention
- X: Document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- T: Later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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- O: Document referring to an oral disclosure, use, exhibition or other means
- P: Document published prior to the international filing date but later than the priority date claimed

## C DOCUMENTS CONSIDERED TO BE RELEVANT

**D Further documents are listed in the continuation of Box C**

**Date of the actual completion of the international search**

29 December 2009 (29 12 2009)

**Date of mailing of the international search report**

13 JAN ZMU

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