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(54) Title: SMART DELIVERY BOX WITH PASSIVE HEATING AND COOLING

(57) Abstract: The present invention relates generally to food containers, and more particularly to method for controlling temperature in smart delivery box with passive heating and cooling. The method for controlling temperature in smart delivery box with passive heating and cooling, the smart delivery box having main body housing cooling chamber and heating chamber, each designed to maintain specific temperatures suitable for payloads stored therein, the method comprises determining optimal temperatures for cooling and heating chamber, monitoring actual temperatures of the cooling and heating chamber using respective temperature sensors. Further, method discloses comparing actual temperatures of cooling and heating chamber with their respective optimal temperatures. Finally, method discloses selectively activating first blower of cooling chamber to cool cooling chamber when actual temperature of the cooling chamber is greater than optimal temperature of cooling chamber and activating second blower of heating chamber to heat-up the heating chamber when actual temperature of heating chamber is less than optimal temperature of heating chamber.

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Total No. of Sheet(s): 8
Sheet No. 1 of 8

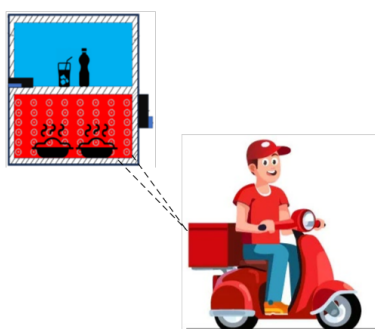


FIGURE 1A



FORM 2

THE PATENTS ACT 1970

(39 OF 1970)

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The Patent Rules, 2003

Complete Specification

(See Section 10 and Rule 13)

1. TITLE OF THE INVENTION

SMART DELIVERY BOX WITH PASSIVE HEATING AND COOLING

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3. PREAMBLE TO THE DESCRIPTION

COMPLETE

The following specification particularly describes the invention and the manner in which it is to be performed

TECHNICAL FIELD

The present invention relates generally to a field of food storage solutions, and more particularly, to a smart delivery box with passive heating and cooling to maintain optimal temperature for the food stored therein.

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BACKGROUND

A Food Delivery System has become an integral part of our modern lifestyle. The food delivery system serves as a bridge between the delectable offerings of restaurants and the diverse preferences of consumers. In recent times, the food delivery system provides flexibility to customers to order from their favorite restaurants sitting anywhere, anytime. The customer may order via an application which also recommends or suggests meals to customers based on their food tastes. However, in recent times, the food delivery system may use artificial intelligence to study and record customers' shopping behaviors and preferences. Based on the customer's desire, the system may also recommend similar dishes or cuisines.

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The existing technology discloses various mechanisms to improve the quality of service and may try to attract customers by providing discounts, coupons and the like. One of the existing technologies focuses to preserve the food for longer during with specialized packing mechanism which includes multiple holes or edges through which the air may be circulated when it is placed in the storage containers.

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However, it is necessary to keep the food at the desired temperature to maintain the quality of food during transit as well. In other words, it is important to maintain the desired temperature to avoid spoiling perishable food items or to otherwise prevent degradation of the quality of the food which might otherwise occur if the food were stored in an uncontrolled environment.

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Therefore, there is a need for a method and system that transports perishable goods and medicines without compromising the quality and integrity of the goods, without compromising on the environmental norms and maintaining the desired temperature as set.

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The information disclosed in this background of the disclosure section is only for enhancement of understanding of the general background of the invention and should not

be taken as an acknowledgement or any form of suggestion that this information forms the prior art already known to a person skilled in the art.

SUMMARY

5 One or more shortcomings discussed above are overcome, and additional advantages and features are provided by the present disclosure. Other embodiments and aspects of the disclosure are described in detail herein and are considered a part of the disclosure.

10 In a non-limiting embodiment of the present disclosure, a smart delivery box with passive heating and cooling. The smart delivery box includes a main body housing, a cooling chamber and a heating chamber, each designed to maintain specific temperatures suitable for payloads stored therein. Further, the cooling chamber comprises a first temperature sensor configured to monitor the temperature of the cooling chamber and a cooling unit integrated with a door of the cooling chamber. The cooling unit comprises a removable phase-changing materials (PCM)
15 container. Further, the cooling unit comprises a plurality of heat exchangers coupled with the removable PCM container. The cooling unit of the first chamber includes a first blower positioned to draw high-temperature air inside the cooling chamber from one side of the cooling unit, pass the high-temperature air through the plurality of heat exchangers, and supply low-temperature air into the cooling chamber through other side of the cooling unit. Further,
20 the smart delivery box comprises the heating chamber which comprises a second temperature sensor configured to monitor temperature of the heating chamber. Further, a heater coil on a backside of the heating chamber to generate heat and a perforated plate arranged parallel to the heater coil in inner side of heating chamber. The heating chamber also includes a second blower arranged on opposite side of the perforated plate in a manner to draw air from outside of the
25 delivery box and supply the air into the heating chamber through perforated plate via the heater coil as heated air. A control unit is operationally coupled with the first temperature sensor, the second temperature sensor, the first blower, and the second blower, wherein the control unit is configured to determine respective optimal temperatures of the cooling chamber and the heating chamber. The control unit is configured to compare the actual temperature of the
30 cooling chamber and the actual temperature of the heating chamber with the respective optimal temperatures of the cooling chamber and the heating chamber. Further the control unit is configured to activate the first blower to cool the cooling chamber when the actual temperature of the cooling chamber is greater than the optimal temperature of the cooling chamber and

activate the second blower to heat-up the heating chamber when the actual temperature of heating chamber is less than the optimal temperature of the heating chamber.

5 In yet another non-limiting embodiment of the present disclosure, the policy comprises information of at least one of time and location for the temporary slice, wherein the time indicates a time duration for availability or unavailability of the temporary slice, and wherein the location indicates a coverage area serviced by the temporary slice.

10 In another non-limiting embodiment of the present disclosure, the smart delivery box comprises at least one flap on each of the cooling chamber and the heating chamber to facilitate passage of air out of both chambers for at least one of: maintaining the optimal temperature in respective chambers and eliminating odour from the respective chamber.

15 In another non-limiting embodiment of the present disclosure, each of the cooling chamber and the heating chamber comprises a gas sensor configured to detect the presence of the odour in the cooling chamber and the heating chamber. Upon detection of the presence of the odour, the control unit is configured to activate the first blower and the second blower to facilitating passage the air out of the cooling chamber and the heating chamber through flaps to eliminate the odour.

20 In yet another non-limiting embodiment of the present disclosure, the respective optimal temperatures of the cooling chamber and the heating chamber are determined based on one of: a barcode present on the payload and user input.

25 In yet another non-limiting embodiment of the present disclosure, the smart delivery box comprises a power supply unit integrated with each of the cooling chamber and the heating chamber. The power supply units provide power to the first blower, the second blower, the control unit, the first temperature sensor, the second temperature sensor, the flaps of both the chambers, and the heating coil for operation, and the power supply units are charged by a
30 plurality of Thermoelectric Generators (TEGs) via a DC-DC converter. The plurality of TEGs converts waste heat of a vehicle carrying the smart delivery box into electric energy. The electrical energy is transformed up to a preferred voltage level using the DC-DC converter. The plurality of TEGs is arranged at least one of: engine and exhaust pipe of the vehicle to convert the waste heat of the vehicle into the electric energy.

In yet another non-limiting embodiment of the present disclosure, a method for controlling temperature in a smart delivery box with passive heating and cooling, the smart delivery box having a main body housing a cooling chamber and a heating chamber, each designed to maintain specific temperatures suitable for payloads stored therein, the method comprises determining, by a control unit of the smart delivery box, optimal temperatures for the cooling chamber and the heating chamber. Further, the method includes monitoring actual temperatures of the cooling chamber and the heating chamber using respective temperature sensors. The method further comprises comparing the actual temperatures of the cooling chamber and the heating chamber with their respective optimal temperatures. Further, selectively activating a first blower of the cooling chamber to cool the cooling chamber when the actual temperature of the cooling chamber is greater than the optimal temperature of the cooling chamber and selectively activating a second blower of the heating chamber to heat-up the heating chamber when the actual temperature of the heating chamber is less than the optimal temperature of the heating chamber.

In yet another non-limiting embodiment of the present disclosure, the method comprises the step of providing at least one flap on each of the cooling chamber and the heating chamber to facilitate passage of air out of both chambers for at least one of: maintaining the optimal temperature in respective chamber and eliminating odour from the respective chamber.

In yet another non-limiting embodiment of the present disclosure, detecting presence of the odour in the cooling chamber and the heating chamber using gas sensors, and activating the first blower and the second blower to eliminate the odour by facilitating the passage of air out of both chambers through flaps.

In yet another non-limiting embodiment of the present disclosure, the optimal temperatures for the cooling chamber and the heating chamber are determined based on information obtained using on one of: a barcode present on the payload and user input.

In another non-limiting embodiment of the present disclosure, supplying power to the first blower, the second blower, the control unit, the temperature sensors, the flaps of both the chambers, and a heating coil of the heating chamber in each of the cooling chamber and the heating chamber using power supply units. The power supply units are charged by a plurality

of Thermoelectric Generators (TEGs) via a DC-DC converter, the plurality of TEGs convert waste heat from a vehicle carrying the smart delivery box into electrical energy, wherein the electrical energy is transformed up to a preferred voltage level using the DC-DC converter. The plurality of TEGs is arranged at least one of: engine and exhaust pipe of the vehicle to convert the waste heat of the vehicle into the electric energy.

The foregoing summary is illustrative only and is not intended to be in any way limiting. In addition to the illustrative aspects, embodiments, and features described above, further aspects, embodiments, and features will become apparent by reference to the drawings and the following detailed description.

BRIEF DESCRIPTION OF SEVERAL VIEWS OF THE DRAWINGS

The embodiments of the disclosure itself, as well as a preferred mode of use, further objectives, and advantages thereof, will best be understood by reference to the following detailed description of an illustrative embodiment when read in conjunction with the accompanying drawings. One or more embodiments are now described, by way of example only, with reference to the accompanying drawings in which:

FIG. 1A illustrates an exemplary environment **100** smart delivery box with passive heating and cooling, in accordance with one embodiment.

FIG. 1B illustrates front view of the smart delivery box with passive heating and cooling, in accordance with one embodiment.

FIG. 2 illustrates a flowchart for determining optimal temperatures of the cooling chamber and the heating chamber, in accordance with the existing mechanism.

FIG. 3 illustrates a schematic diagram of the cooling unit of the smart delivery box with passive cooling mechanism, in accordance with the existing mechanism.

FIG 4 illustrates a flowchart of passive cooling mechanism of the smart delivery box, in accordance with the present invention.

FIG. 5 illustrates a schematic diagram of the heating unit of the smart delivery box with passive heating mechanism, in accordance with the existing mechanism.

FIG 6 illustrates a flowchart of passive heating mechanism of the smart delivery box, in accordance with the present invention.

FIG 7 illustrates the block diagram of control unit for smart delivery box with passive heating and cooling, in accordance with the present invention.

FIG 8. illustrates a method for controlling temperature in a smart delivery box with passive heating and cooling, in accordance with an embodiment of the present disclosure.

It should be appreciated by those skilled in the art that any block diagrams herein represent conceptual views of the illustrative systems embodying the principles of the present subject matter. Similarly, it will be appreciated that any flowchart, flow diagrams, state transition diagrams, pseudo code, and the like represent various processes which may be substantially represented in computer readable medium and executed by a computer or processor, whether or not such computer or processor is explicitly shown.

20 DETAILED DESCRIPTION

In the present document, the word "exemplary" is used herein to mean "serving as an example, instance, or illustration." Any embodiment or implementation of the present subject matter described herein as "exemplary" is not necessarily to be construed as preferred or advantageous over other embodiments.

While the disclosure is susceptible to various modifications and alternative forms, specific embodiment thereof has been shown by way of example in the drawings and will be described in detail below. It should be understood, however, that it is not intended to limit the disclosure to the particular forms disclosed, but on the contrary, the disclosure is to cover all modifications, equivalents, and alternative falling within the scope of the disclosure.

The terms “comprises,” “comprising”, or any other variations thereof, are intended to cover a non-exclusive inclusion, such that a setup, device, or method that comprises a list of components or steps does not include only those components or steps but may include other components or steps not expressly listed or inherent to such setup or device or method. In other words, one or more elements in a system or apparatus preceded by “comprises... a” does not, without more constraints, preclude the existence of other elements or additional elements in the system or apparatus.

In the following detailed description of the embodiments of the disclosure, reference is made to the accompanying drawings that form a part hereof, and in which are shown by way of illustration specific embodiments in which the description may be practiced. These embodiments are described in sufficient detail to enable those skilled in art to practice the disclosure, and it is to be understood that other embodiments may be utilized and that changes may be made without departing from the scope of the present disclosure. The following description is, therefore, not to be taken in a limiting sense.

The terms like “at least one” and “one or more” may be used interchangeably throughout the description. The terms like “a plurality of” and “multiple” may be used interchangeably throughout the description. The terms like “access type” and “AT” may be used interchangeably throughout the description. The terms like “network” and “communication network” may be used interchangeably throughout the description.

In recent times, the food delivery system focuses on maintaining preferred temperature, which is a crucial aspect. Particularly, during the transit phase of food delivery, but not limited thereto, it is important to maintain the desired temperature. In other words, home delivery of perishable goods of products is rapidly increasing. For instance, there is an increase in rate of food delivery, medicines, and e-commerce, and there is a need for preserving the quality and integrity of temperature-sensitive goods during transit. Thus, the present invention discloses a smart delivery box that aims to control temperature in a smart delivery box with passive heating and cooling. To control temperature in the smart delivery box, the smart delivery box includes a main body with a cooling chamber and a heating chamber. The heating chamber may maintain a temperature from 25 deg Celsius to 50 deg Celsius and the cooling may maintain a temperature from -15 deg Celsius to 25 deg Celsius, but not limited thereto. For instance, consider the smart delivery box may

carry goods such as food for a delivery which needs to be maintained at the desired temperature between 25 deg Celsius to 50 Celsius. Further, when the smart delivery box may carry goods such as medicines or perishable goods that need to be kept in low temperature then the smart delivery box may maintain or control temperature between -15 deg Celsius to 25 deg Celsius. Based on the identified payload, the temperature may be controlled in the cooling chamber and the heating chamber of the smart delivery box.

FIG. 1 illustrates an exemplary environment **100** smart delivery box with passive heating and cooling, in accordance with one embodiment.

The environment disclosed in figure 1A of present disclosure comprises a vehicle carrying a smart delivery box. For instance, the vehicle may include, but not limited to, car, motorcycle, and the like. The main body of the smart delivery box may include a cooling chamber 107 and a heating chamber 113 but not limited thereto. The cooling chamber 107 and the heating chamber 113 are designed to maintain specific temperature suitable for payloads stored therein. For instance, the payloads may include, but not limited to medicines, home deliveries of perishable items such as vegetables, fruits, and food items. Based on the payloads, the smart delivery box may comprise cooling-cooling chambers where both the chambers may be of cooling chambers. For instance, when the smart delivery box may carry medicines in large amounts then both the chambers are converted to cooling chambers. In an alternative embodiment, when there is a bulk food delivery order, then both the chambers of the smart delivery box are converted to heating-heating chambers. For ease of understanding, the present disclosure is explained in terms of a smart delivery box with the heating chamber and the cooling chamber.

To control the temperature in the smart delivery box with passive heating and colling, the smart delivery box may be powered via power units that are charged by plurality of thermo-electric generators (TEGs) 103, 115 via DC-DC converters. The plurality of TEGs 103, 115 may be arranged in series fashion or may be wrapped around the engine of the vehicle. The waste heat generated from the vehicle is converted to electrical energy which is fed to the power supply unit. In other words, the waste heat generated by engine of the vehicle is used by the TEGs 103, 115 to charge the power supply units. The plurality of TEGs 103, 115 are arranged at least one of: engine and exhaust pipe of the vehicle to convert the waste heat of the vehicle into the electric energy. As shown in figure 1B, the

main body of the smart delivery box is made of stainless steel 101. The stainless steel 101 are durable and may keep the food free from being exposed to harmful chemicals. The main body 101 includes a cooling chamber 107 and a heating chamber 113, each designed to maintain specific temperatures suitable for payloads stored therein. A charging port which is supported by the TEGs 103, 115 are configured at the outer wall of the main body which may be used to charge the respective chambers which further includes battery backup 105. The cooling chamber 107 and the heating chamber 113 may be separated from one another using an insulation material 109 such as polyurethanes (with minimum thickness of 5mm) but not limited thereto. The cooling chamber 107 may be used to store the payload that needs to be preserved in the range of -15 degree Celsius to 25 degrees Celsius based on identified payload. For instance, the payloads such as medicines, fruits, vegetables, cold beverages, and the like. For example, the smart delivery box may carry medicines which may be delivered from one district to another. In such cases, controlling the temperature plays an important role in preserving the medicine from any environmental effects. A cooling unit may be integrated with the cooling chamber 107 which includes a removable phase-changing materials (PCM) container and plurality of heat exchangers coupled with the removable PCM. The first temperature sensor of the cooling chamber may monitor the temperature in the cooling temperature in prior. Based on the monitored temperature, a control associated with the first temperature sensor may compare the actual temperatures of the cooling chamber with their respective optimal temperatures. The optimal temperature may be defined as the ideal temperature suitable for the payload in order to maintain the quality and freshness of the payload. For instance, the optimal temperature in to store the payload such as fruits and vegetables may be 20 degree Celsius. In yet another example, the optimal temperature to deliver food products may be 35 degree Celsius. In other words, a first blower positioned to draw high-temperature air inside the cooling chamber 107 from one side of the cooling unit, pass the high-temperature air through the plurality of heat exchangers, and supply low-temperature air into the cooling chamber through the other side of the cooling unit. For ease of understanding, when the temperature inside the cooling chamber 107 is greater than the optimal temperature, then the first blower may be activated which may draw air and pass the air through the plurality of heat exchangers and may supply low temperature air to the cooling chamber. In this way, the low temperature may be maintained in the cooling chamber.

Furthermore, when the payload such as food deliverables may be kept in the heating chamber 113, then the heater coil on backside of the heating chamber to generate heat. In other words, when the payload is identified as food deliverables, then the optimal temperature to be maintained in the heating chambers may be based on one of a barcode present on the payload and user input. Initially, the second temperature sensor configured to monitor temperature of the heating chamber 113 and based on which the heater coil may generate the heat. To keep the food deliverable warm or at the desired temperature, a perforated plate may be used in heating chamber 113 which is arranged parallel to the heater coil in the inner side of heating chamber on which the payload (food deliverables) may be placed. When the temperature inside the heating chamber is less than the optimal temperature then the second blower may be activated to heat up the heating chamber where the second blower arranged on opposite side of the perforated plate in a manner to draw air from outside of the delivery box and supply the air into the heating chamber 113 through perforated plate via the heater coil as heated air.

FIG. 2 illustrates a flowchart for determining optimal temperatures of the cooling chamber and the heating chamber, in accordance with the existing mechanism.

As the smart delivery box with passive heating and cooling with the cooling chamber and the heating chamber is designed to maintain specific temperatures suitable for payloads. It is important to determine optimal temperatures of the cooling chamber and the heating chamber which carries a wide variety of payload such as food, vegetables, medicines, fruits, and the like. The optimal temperature may be the standard or ideal temperature to maintain the quality of the payload. For instance, the optimal temperature in to store the payload such as fruits and vegetables may be 20 degree Celsius. In yet another example, the optimal temperature to deliver food products may be 35 degree Celsius. Initially, before placing the payload, it is important to detect the odour in both the chambers. Thus, a gas sensor associated with each of the cooling chamber and the heating chamber may detect the presence of the odour in the respective chamber.

The gas sensors associated with both the chambers may detect the presence of odour in the respective chambers when the vehicle is started as shown in step 203. The power supply units may provide power or charge up various components such as gas sensors, camera, PCMs, first blower, second blower, first temperature sensor and the second temperature sensor. When there is no presence of odour in the chambers of the smart delivery box,

flaps associated with the chambers may be closed and the respective blowers of the chambers may be turned off as shown in step 205. For instance, consider, an order may be received, and the payload may belong to the cooling chamber as the payload may be identified as ice-cream. Before placing the payload inside the cooling chamber, a dry run may be conducted, i.e., the gas sensor associated with the cooling chamber may detect if there is any odour in the cooling chamber. If there is no odour detected in the cooling chamber, then the flap associated with the cooling chamber may be closed and the blower of the cooling chamber is turned off. However, if the gas sensor associated with the cooling chamber detects the presence of the odour or smell inside the cooling chamber then the flaps of the cooling chamber may be open to flush out the odour out of the cooling chamber by activating the blower for approximately 5 minutes as shown in step 207. Once the odour is eliminated out of the cooling chamber, the payload may be kept inside the cooling chamber. Once the payload is kept inside the cooling chamber of the smart delivery box, a camera associated with the cooling chamber may check if the payload includes a barcode with it. The bar code is a method of representing data in a visual, machine-readable form. If the payload (ice-cream in this example) does not include a barcode, then the temperature may be set based on user input as shown in step 213. However, if the payload contains the barcode on it, then the camera may scan the barcode and the optimal temperature may be set in the cooling chamber. In other words, when there is a presence of the barcode on the payload, the camera may scan and identify the category of the payload. According to the above-mentioned example, the camera may scan the barcode and identify the payload as ice-cream and may fetch the optimal temperature for the identified payload from a predefined database as shown in step 211. Further, when the optimal temperature is fetched from the predefined database, then the temperature sensor associated with the cooling chamber may control the optimal temperature according to the payload present inside the cooling chamber until the payload is delivered to a user as shown in step 215 of Figure 2.

FIG. 3 illustrates a schematic diagram of the cooling unit 315 of the smart delivery box with passive cooling mechanism, in accordance with the existing mechanism.

Initially, before placing the payload inside the cooling chamber 107, a dry run may be conducted, i.e., the gas sensor associated with the cooling chamber 107 may detect if there is any presence of odour in the cooling chamber 107. If there is no odour detected in the cooling chamber 107, then the flap 325 associated with the cooling chamber 107 may be

closed and the blower of the cooling chamber is turned off. However, if the gas sensor associated with the cooling chamber 107 detects the presence of the odour or smell inside the cooling chamber then the flaps 325 of the cooling chamber may be open to flush out the odour out of the cooling chamber by activating the first blower 309. Once the dry run is performed, the payload may be placed inside the cooling chamber 107. The cooling chamber 107 comprises a first temperature sensor configured to monitor the temperature of the cooling chamber 107. To simplify, when the payload is placed inside the cooling chamber 107, the first temperature sensor may monitor the temperature of the cooling chamber 107. Further, door 301 of the cooling chamber 107 may be integrated with the cooling unit 315 that comprises removable phase-changing materials (PCM) container 317 and a plurality of heat exchangers 319 coupled with the removable PCM container 317 as shown in the figure 3. As the temperature in the cooling chamber 107 is monitored and if the temperature inside the cooling chamber 107 is greater than the optimal temperature which may be the standard or ideal temperature to maintain the quality of the payload, then the first blower 309 positioned inside the cooling chamber 107 may draw high-temperature air inside the cooling chamber 107 from one side of the cooling unit and pass the high-temperature air through the plurality of heat exchangers 319. In this way, low temperature air may be supplied into the cooling chamber 107 from the cooling unit 315. In other words, a control unit may be coupled with the first temperature sensor of the cooling unit and the first blower 309 of the cooling unit 315. When the actual temperature of the cooling chamber 107 is greater than the optimal temperature of the cooling then the first blower 309 to cool the cooling chamber may be activated. However, when the actual temperature of the cooling chamber 107 is the same as the optimal temperature, then the activated first blower 309 may be turned off and the flaps 325 of the cooling chamber 107 may be closed.

For instance, consider that the payload 323 to be placed in the cooling chamber 107 is medicine. The first temperature sensor may monitor the temperature of the cooling chamber 107 and may detect the temperature is 24 degrees Celsius. As the temperature of the cooling chamber is detected by the first temperature sensor, it is also important to determine the temperature that may be ideal for the payload with respect to the cooling chamber 107. As the temperature in the cooling chamber 107 is greater than the optimal temperature (18 degree Celsius), the first blower 309 positioned inside the cooling chamber 107 may draw high-temperature air inside the cooling chamber from one side of

the cooling unit 315 and pass the high-temperature air through the plurality of heat exchangers 319. As the medicines may require a low temperature of 5 degree Celsius, the first blower may be activated as the actual temperature of the cooling chamber (which is 24 degrees Celsius) is greater than the optimal temperature of the cooling chamber (5 degree Celsius). In this way, low temperature air may be supplied into the cooling chamber 107 from the cooling unit 315.

Figure 4 illustrates a flowchart of passive cooling mechanism of the smart delivery box, in accordance with the present invention.

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Initially, the payload is placed in the cooling chamber 107 as shown in step 401. The camera associated with the cooling chamber 107 may scan the payload and check if the barcode is present on the payload as shown in step 402. When the barcode on the payload is present, then the optimal temperature suitable for the payload may be fetched from the predefined database as shown in step 405. Based on the fetched optimal temperature from the predefined database, the control unit associated with the first temperature sensor may compare the actual temperature of the cooling chamber 107 with the respective optimal temperatures of the cooling chamber as shown in step 407. When the actual temperature of the cooling chamber is greater than the optimal temperature of the cooling chamber 107 then the cooling unit may a first blower 309 positioned to draw high-temperature air inside the cooling chamber 107 from one side of the cooling unit 315, pass the high-temperature air through the plurality of heat exchangers 319, and supply low-temperature air into the cooling chamber 107 through other side of the cooling unit 315 as shown in step 411. However, if the actual temperature of the cooling chamber 107 is the same as the optimal temperature of the cooling chamber 107 then the control unit may close the flap 325 and deactivate the first blower 309 and maintain the cooling effect inside the cooling chamber 107 as shown in step 415.

FIG. 5 illustrates a schematic diagram of the heating unit 113 of the smart delivery box with passive heating mechanism, in accordance with the existing mechanism.

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Initially, before placing the payload inside the heating chamber 113, a dry run may be conducted, i.e., the gas sensor associated with the heating chamber 113 may detect if there is any presence of odour in heating chamber 113. If there is no odour detected in the

heating chamber 113, then the flap 503 associated with the heating chamber 113 may be closed and the second blower 509 of the heating chamber 113 is turned off. However, if the gas sensor associated with the heating chamber 113 detects the presence of the odour or smell inside the heating chamber 113 then the flaps 503 of the heating chamber 113 may be open to flush out the odour out of the heating chamber 113 by activating the second blower 509. Once the dry run is performed, the payload 517 may be placed inside the heating chamber 113. For instance, consider that the payload 517 that was kept in heating chamber 113 may be meat which was delivered previously. However, there may be odour of meat and if the next order to be delivered may be fresh fruit or vegetables, then it is necessary to carry out the dry run to eliminate the odour.

The heating chamber 113 comprises a second temperature sensor configured to monitor the temperature of the heating chamber 113. To simply, when the payload 517 is placed inside the heating chamber, the second temperature sensor may monitor the temperature of the heating chamber. The heating chamber further includes a heater coil 511 on the backside of the heating chamber 113 to generate heat and a perforated plate 513 arranged parallel to the heater coil 511 in the inner side of heating chamber 113. In other words, the heat generated by the heater may strike the perforated plate 513 in order to keep the payload placed on the perforated plate 513 warm. However, when the actual temperature of the heating chamber is less than the optimal temperature of the heating chamber 113, the second blower 509 may be activated to heat-up the heating chamber 113. In particular, a second blower 509 arranged on opposite side of the perforated plate 513 in a manner to draw air from outside of the delivery box and supply the air into the heating chamber 113 through perforated plate 513 via the heater coil as heated air. Further, if the actual temperature is greater than the optimal temperature, then the second blower 509 may be activated which may push out the hot air out of the heating chamber 113 through the flap 503 present in the heating chamber 113. On contrary, if the temperature in the heating chamber 113 is same as the optimal temperature, then the flaps 503 on the heating chamber 113 may be closed and the second blower 509 may be deactivated/closed.

For instance, consider that the payload 517 to be placed in heating chamber 113 is food deliverable such as a meal. Then the second temperature sensor of the heating chamber 113 may monitor the temperature and may detect the temperature to be 20 degrees Celsius. As the temperature in the heating chamber 113 is less than the optimal temperature which may be the standard or ideal temperature to maintain the quality of the payload, the second

blower 509 arranged on opposite side of the perforated plate 513 in a manner to draw air from outside of the delivery box and supply the air into the heating chamber through perforated plate 513 via the heater coil 511 as heated air. As the food deliverables may require a high temperature of 25 degrees Celsius, the second blower 509 may be activated as the actual temperature of the heating chamber 113 (which is 20 degrees Celsius) is less than the optimal temperature of the heating chamber 113 (25 degrees Celsius). In this way, high temperature air may be supplied into the heating chamber 113.

Figure 6 illustrates a flowchart of passive heating mechanism of the smart delivery box, in accordance with the present invention.

Initially, the payload is placed in the heating chamber 113 as shown in step 601. The camera associated with the heating chamber 113 may scan the payload and check if the barcode is present on the payload as shown in step 602. When the barcode on the payload is present, then the optimal temperature suitable for the payload may be fetched from the predefined database as shown in step 605. When there is a barcode in the payload, then the barcode may be scanned to identify the payload 517. For instance, when the barcode is scanned it may be identified as an ice-cream, then the optimal temperature for the payload 517 identified (ice-cream) may be fetched from a predefined database example: optimal temperature for ice-cream 5 degree Celsius. Based on the fetched optimal temperature from the predefined database, the control unit associated with the second temperature sensor may compare the actual temperature of the heating chamber with the respective optimal temperatures of the heating chamber 113 as shown in step 607. When the actual temperature of the heating chamber 113 is greater than the optimal temperature of the heating chamber then the control unit may open the flap 503 of the heating chamber 113 by activating the second blower 509 as shown in 609. In an alternative embodiment, when the actual temperature of the heating chamber 113 is less than the optimal temperature of the heating chamber 113 then the control unit may activate the second blower 509 to heat-up the heating chamber 113 as shown in step 615. In yet another embodiment, if the actual temperature of the heating chamber 113 is same as the optimal temperature of the heating chamber 113, then the control unit may close the flap 503 and deactivate the second blower 509 and maintain the heating effect inside the heating chamber 113 as shown in step 619.

In an embodiment, the control unit may be operationally coupled with the first temperature sensor, the second temperature sensor, the first blower, and the second blower of the respective chambers as shown in figure 7. Further the control unit may be operationally coupled with the camera and flaps associated with the heating chamber and the cooling chamber, the heating coil of the heating chamber and the gas sensors. **FIG. 7** illustrates the control unit that may comprise various hardware components such as a processor, and a Memory but not limited thereto. The processor **402**, the memory may be communicatively coupled to each other via wired or wireless communication channels. Further, the processor may be configured to execute instructions stored in the memory and to perform various processes. The memory may also store instructions to be executed by the processor. The memory may include a Random-Access Memory (RAM) unit and/or a non-volatile memory unit such as a Read Only Memory (ROM), optical disc drive, magnetic disc drive, flash memory, Electrically Erasable Read Only Memory (EEPROM), a memory space on a server or cloud and so forth. The Memory may also store data processed by the processor and the Network Slice Admission Controller.

Initially, a dry run may be conducted, i.e., the gas sensor associated with the respective chamber may detect if there is any odour in the chamber (consider colling chamber). If there is no odor detected in the cooling chamber, then the flap associated with the cooling chamber may be closed and the blower of the cooling chamber is turned off. However, if the gas sensor associated with the cooling chamber detects the presence of odour or smell inside the cooling chamber then the flaps of the cooling chamber may be open to flush out the odour out of the cooling chamber by activating the blower for approximately 5minutes. Once the odour is eliminated out of the cooling chamber, the payload may be kept inside the cooling chamber. When the payload is placed inside the cooling chamber, the camera may capture the payload placed in the chamber to identify if there is a barcode present on the payload. If the payload does not include the bardcode, then the temperature may be set based on user input. However, if the payload contains the barcode on it, then the camera may scan the barcode and the optimal temperature may be set in the cooling chamber. The optimal temperature may be the ideal temperature to maintain the quality of the payload for long duration.

Further, when the payload is placed inside the cooling chamber, the control unit may activate the first temperature sensor to monitor the temperature of the cooling chamber.

The door of the cooling chamber may be integrated with the cooling unit that comprises a removable PCM container and a plurality of heat exchangers coupled with the removable PCM container. As the temperature is monitored and if the temperature inside the cooling chamber is greater than the optimal temperature then the control unit may activate the first
5 blower positioned inside the cooling chamber to draw high-temperature air inside the cooling chamber from one side of the cooling unit and pass the high-temperature air through the plurality of heat exchangers. In this way, low temperature air may be supplied into the cooling chamber from the cooling unit.

10 Similarly, the second temperature sensor of the heating chamber may monitor the temperature of the heating chamber. The heating chamber further includes a heater coil on the backside of the heating chamber to generate heat and a perforated plate arranged parallel to the heater coil in the inner side of heating chamber. In other words, the heat generated by the heater may strike the perforated plate in order to keep the payload placed
15 on the perforated plate warm. However, when the actual temperature of the heating chamber is less than the optimal temperature of the heating chamber, the control unit may activate the second blower to heat-up the heating chamber. In particular, a second blower arranged on opposite side of the perforated plate in a manner to draw air from outside of the delivery box and supply the air into the heating chamber through perforated plate via
20 the heater coil as heated air. Further, if the actual temperature is greater than the optimal temperature, then the second blower may be activated which may push out the hot air out of the heating chamber through the flap present in the heating chamber.

FIG 8. illustrates a method **800** for controlling temperature in a smart delivery box with
25 passive heating and cooling, in accordance with an embodiment of the present disclosure.

Although example method **800** depicts a particular sequence of operations, the sequence may be altered without departing from the scope of the present disclosure. For example, some of the operations depicted may be performed in parallel or in a different sequence
30 that does not materially affect the function of method **800**.

According to some examples, the at block **801** method **800** includes determining, by a control unit of the smart delivery box, optimal temperatures for the cooling chamber and the heating chamber. The optimal temperature may be the standard or ideal temperature to

maintain the quality of the payload. For instance, the optimal temperature in to store the payload such as fruits and vegetables may be 20 degree Celsius. In yet another example, the optimal temperature to deliver food products may be 35 degree Celsius.

5 According to some examples, at block **803**, method **800** includes monitoring actual temperatures of the cooling chamber and the heating chamber using respective temperature sensors. For example, if the cooling chamber includes a payload that belongs to fruits and vegetables category. Once the payload is placed inside the cooling chamber then the first temperature sensor may identify the actual temperature of the cooling chamber. For
10 example, the actual temperature of the cooling chamber may be 25 degree Celsius.

According to some examples, at block **805**, method **800** comparing, by the control unit, the actual temperatures of the cooling chamber and the heating chamber with their respective optimal temperatures. For instance, the payload placed in the cooling chamber is fruits and
15 vegetables and the actual temperature at which the payload placed may be 25 degree Celsius. When the actual temperature is detected, then the actual temperature is compared with the optimal temperature which may be 15 degrees for storing fruits and vegetables.

According to some examples, at block **807**, method **800** selectively, by the control unit,
20 activating a first blower of the cooling chamber to cool the cooling chamber when the actual temperature of the cooling chamber is greater than the optimal temperature of the cooling chamber. Based on the above example, as the actual temperature of the cooling chamber is greater than the optimal temperature of the cooling chamber, the first blower may be activated where the first blower positioned to draw high-temperature air inside the cooling chamber
25 from one side of the cooling unit, pass the high-temperature air through the plurality of heat exchangers, and supply low-temperature air into the cooling chamber through other side of the cooling unit.

According to some examples, at block **809**, method **800** selectively, by the control unit,
30 activating a second blower of the heating chamber to heat-up the heating chamber when the actual temperature of the heating chamber is less than the optimal temperature of the heating chamber. In the heating chamber, consider that the actual temperature of the heating chamber which contains the payload of food deliverable is 25 degree Celsius and the optimal temperature for storing the food deliverable is 40 degree Celsius. The control unit may compare
35 the actual temperature of the heating chamber with the respective optimal temperatures of the

heating chamber. When the actual temperature of heating chamber is less than the optimal temperature of the heating chamber, then the second blower may be activated which is arranged on opposite side of the perforated plate in a manner to draw air from outside of the delivery box and supply the air into the heating chamber through perforated plate via the heater coil as heated air.

While various aspects and embodiments have been disclosed herein, other aspects and embodiments will be apparent to those skilled in the art. The various aspects and embodiments disclosed herein are for purposes of illustration and are not intended to be limiting, with the true scope and spirit being indicated by the detailed description.

The order in which the various operations of the methods are described is not intended to be construed as a limitation, and any number of the method described blocks can be combined in any order to implement the method. Additionally, individual blocks may be deleted from the methods without departing from the spirit and scope of the subject matter described herein. Furthermore, the methods can be implemented in any suitable hardware, software, firmware, or combination thereof.

It may be noted here that the subject matter of some or all embodiments described with reference to **Figs. 1-8** may be relevant for the methods and the same is not repeated for the sake of brevity.

The various operations of methods described above may be performed by any suitable means capable of performing the corresponding functions. The means may include various hardware and/or software component(s) and/or module(s), including, but not limited to a circuit, an application specific integrated circuit (ASIC), or processor. Generally, where there are operations illustrated in Figures, those operations may be performed by any suitable corresponding counterpart means-plus-function components.

Furthermore, one or more computer-readable storage media may be utilized in implementing embodiments consistent with the present disclosure. A computer-readable storage medium refers to any type of physical memory on which information or data readable by a processor may be stored. Thus, a computer-readable storage medium may store instructions for execution by one or more processors, including instructions for

causing the processor(s) to perform steps or stages consistent with the embodiments described herein. The term “computer-readable medium” should be understood to include tangible items and exclude carrier waves and transient signals, i.e., non-transitory. Examples include Random Access Memory (RAM), Read-Only Memory (ROM), volatile
5 memory, nonvolatile memory, hard drives, Compact Disc (CD) ROMs, Digital Video Disc (DVDs), flash drives, disks, and any other known physical storage media.

Certain aspects may comprise a computer program for performing the operations presented herein. For example, such a computer program product may comprise a computer readable
10 media having instructions stored (and/or encoded) thereon, the instructions being executable by one or more processors to perform the operations described herein. For certain aspects, the computer program product may include packaging material.

Various components, modules, or units are described in this disclosure to emphasize
15 functional aspects of devices configured to perform the disclosed techniques, but do not necessarily require realization by different hardware units. Rather, as described above, various units may be combined in a hardware unit or provided by a collection of interoperative hardware units, including one or more processors as described above, in conjunction with suitable software and/or firmware.

As used herein, a phrase referring to “at least one” or “one or more” of a list of items refers
20 to any combination of those items, including single members. As an example, “at least one of: a, b, or c” is intended to cover: a, b, c, a-b, a-c, b-c, and a-b-c. The terms “a”, “an” and “the” mean “one or more”, unless expressly specified otherwise. The terms “including”,
25 “comprising”, “having” and variations thereof, when used in a claim, is used in a non-exclusive sense that is not intended to exclude the presence of other elements or steps in a claimed structure or method, unless expressly specified otherwise.

Finally, the language used in the specification has been principally selected for readability
30 and instructional purposes, and it may not have been selected to delineate or circumscribe the inventive subject matter. It is therefore intended that the scope of the invention be limited not by this detailed description, but rather by any claims that issue on an application based here on. Accordingly, the embodiments of the present disclosure are intended to be illustrative, but not limiting, of the scope of the invention, which is set forth
35 in the appended claims.

Reference Numerals:

Components	Ref No
Environment	100
Outer casting: Main body	101
Charging port by TEGs connected to the battery and the switch for turning the auxiliary power on/off	103, 115
Lithium battery backup	105, 111
Cooling chamber	107
Insulation material	109
Heating chamber	113
Perforated plate	117
Front door	301
Charging port by TEGs connected to the battery and the switch for turning the auxiliary power on/off	303
Lithium battery backup	305
Smart control unit for heating/cooling	307
First blower	309
Insulated box	311, 515
Insulation layer	313
Cooling unit	315
Removal PCM container	317
Heat exchanger	319
Damper/flap	321
payload	323, 517
Flap	325
Front door of heating chamber	501
Flap	503
Charging port by TEGs connected to the battery and the switch for turning the auxiliary power on/off	505

Lithium battery backup	507
Second blower	509
Heater coil	511
Perforated plate	513

WE CLAIM:

1. A smart delivery box with passive heating and cooling, comprising:
 - a main body housing a cooling chamber and a heating chamber, each designed to maintain specific temperatures suitable for payloads stored therein;
 - the cooling chamber comprises:
 - a first temperature sensor configured to monitor temperature of the cooling chamber; and
 - a cooling unit integrated with a door of the cooling chamber, wherein the cooling unit comprises:
 - a removable phase-changing materials (PCM) container;
 - a plurality of heat exchangers coupled with the removable PCM container; and
 - a first blower positioned to draw high-temperature air inside the cooling chamber from one side of the cooling unit, pass the high-temperature air through the plurality of heat exchangers, and supply low-temperature air into the cooling chamber through other side of the cooling unit; and
 - the heating chamber comprises:
 - a second temperature sensor configured to monitor temperature of the heating chamber;
 - a heater coil on backside of the heating chamber to generate heat;
 - a perforated plate arranged parallel to the heater coil in inner side of heating chamber; and
 - a second blower arranged on opposite side of the perforated plate in a manner to draw air from outside of the delivery box and supply the air into the heating chamber through perforated plate via the heater coil as heated air; and
 - a control unit operationally coupled with the first temperature sensor, the second temperature sensor, the first blower, and the second blower, wherein the control unit is configured to:
 - determine respective optimal temperatures of the cooling chamber and the heating chamber;
 - compare the actual temperature of the cooling chamber and the actual temperature of the heating chamber with the respective optimal temperatures of the cooling chamber and the heating chamber.

activate the first blower to cool the cooling chamber when the actual temperature of the cooling chamber is greater than the optimal temperature of the cooling chamber; and

activate the second blower to heat-up the heating chamber when the actual temperature of heating chamber is less than the optimal temperature of the heating chamber.

2.The smart delivery box as claimed in claim 1, further comprises at least one flap on each of the cooling chamber and the heating chamber to facilitate passage of air out of both chambers for at least one of: maintaining the optimal temperature in respective chamber and eliminating odour from the respective chamber.

3. The smart delivery box as claimed to claim 2, wherein each of the cooling chamber and the heating chamber comprises a gas sensor configured to detect presence of the odour in the cooling chamber and the heating chamber,

wherein upon detection of the presence of the odour, the control unit is configured to activate the first blower and the second blower to facilitating passage the air out of the cooling chamber and the heating chamber through flaps to eliminate the odour.

4. The smart delivery box as claimed in claim 1, wherein the respective optimal temperatures of the cooling chamber and the heating chamber are determined based on one of: a barcode present on the payload and user input.

5.The smart delivery box as claimed in claim 2, further comprising a power supply unit integrated with each of the cooling chamber and the heating chamber, wherein the power supply units provide power to the first blower, the second blower, the control unit, the first temperature sensor, the second temperature sensor, the flaps of both the chambers, and the heating coil for operation, and wherein the power supply units are charged by a plurality of Thermoelectric Generators (TEGs) via a DC-DC converter,

wherein the plurality of TEGs convert waste heat of a vehicle carrying the smart delivery box into electric energy, wherein the electrical energy is transformed up to a preferred voltage level using the DC-DC converter, and

wherein the plurality of TEGs are arranged at least one of: engine and exhaust pipe of the vehicle to convert the waste heat of the vehicle into the electric energy.

6. A method for controlling temperature in a smart delivery box with passive heating and cooling, the smart delivery box having a main body housing a cooling chamber and a heating chamber, each designed to maintain specific temperatures suitable for payloads stored therein, the method comprises:

determining, by a control unit of the smart delivery box, optimal temperatures for the cooling chamber and the heating chamber;

monitoring actual temperatures of the cooling chamber and the heating chamber using respective temperature sensors;

comparing, by the control unit, the actual temperatures of the cooling chamber and the heating chamber with their respective optimal temperatures;

selectively, by the control unit, activating a first blower of the cooling chamber to cool the cooling chamber when the actual temperature of the cooling chamber is greater than the optimal temperature of the cooling chamber; and

selectively, by the control unit, activating a second blower of the heating chamber to heat-up the heating chamber when the actual temperature of the heating chamber is less than the optimal temperature of the heating chamber.

7. The method as claimed in claim 6, further comprising the step of providing at least one flap on each of the cooling chamber and the heating chamber to facilitate passage of air out of both chambers for at least one of: maintaining the optimal temperature in respective chamber and eliminating odour from the respective chamber.

8. The method as claimed in claim 7, further comprising:

detecting presence of the odour in the cooling chamber and the heating chamber using gas sensors, and

activating the first blower and the second blower to eliminate the odour by facilitating the passage of air out of both chambers through flaps.

9. The method as claimed in claim 6, wherein the optimal temperatures for the cooling chamber and the heating chamber are determined based on information obtained using on one of: a barcode present on the payload and user input.

10. The method as claimed in claim 7, further comprising supplying power to the first blower, the second blower, the control unit, the temperature sensors, the flaps of both the chambers, and a heating coil of the heating chamber in each of the cooling chamber and the heating chamber using power supply units, wherein the power supply units are charged by a plurality of Thermoelectric Generators (TEGs) via a DC-DC converter,

wherein the plurality of TEGs convert waste heat from a vehicle carrying the smart delivery box into electrical energy, wherein the electrical energy is transformed up to a preferred voltage level using the DC-DC converter, and

wherein the plurality of TEGs are arranged at least one of: engine and exhaust pipe of the vehicle to convert the waste heat of the vehicle into the electric energy.

Dated this 03rd day of May 2024

--Digitally Signed--
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ABSTRACT

SMART DELIVERY BOX WITH PASSIVE HEATING AND COOLING

The present invention relates generally to food containers, and more particularly to method for controlling temperature in smart delivery box with passive heating and cooling. The method for controlling temperature in smart delivery box with passive heating and cooling, the smart delivery box having main body housing cooling chamber and heating chamber, each designed to maintain specific temperatures suitable for payloads stored therein, the method comprises determining optimal temperatures for cooling and heating chamber, monitoring actual temperatures of the cooling and heating chamber using respective temperature sensors. Further, method discloses comparing actual temperatures of cooling and heating chamber with their respective optimal temperatures. Finally, method discloses selectively activating first blower of cooling chamber to cool cooling chamber when actual temperature of the cooling chamber is greater than optimal temperature of cooling chamber and activating second blower of heating chamber to heat-up the heating chamber when actual temperature of heating chamber is less than optimal temperature of heating chamber.

[Fig.8]

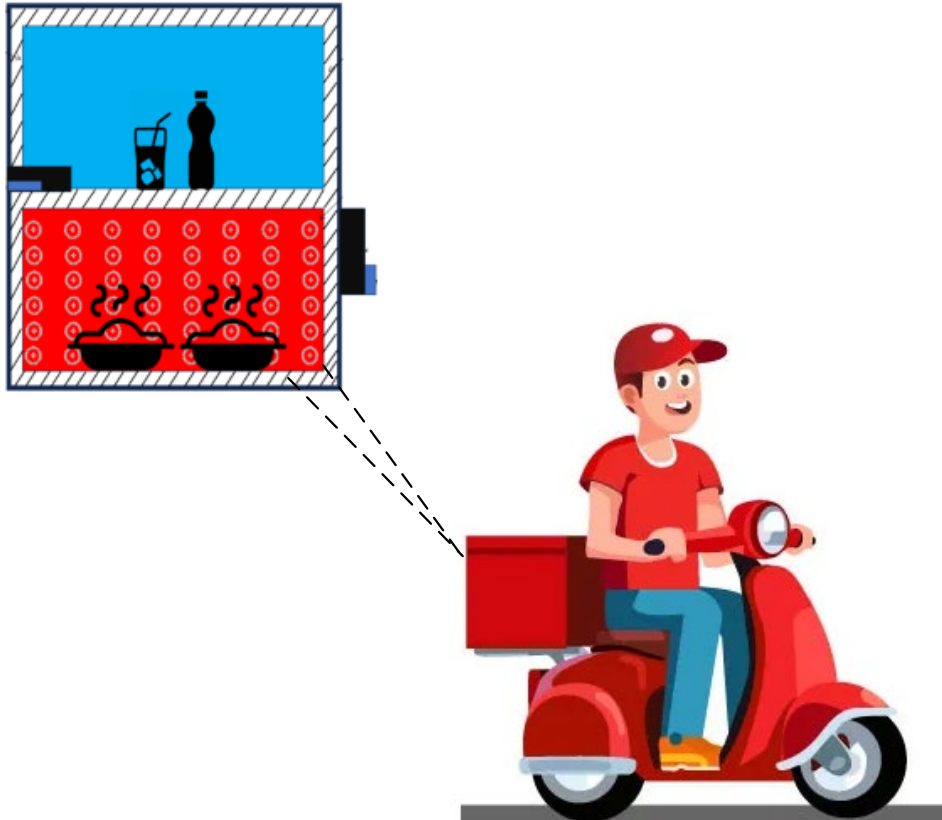


FIGURE 1A

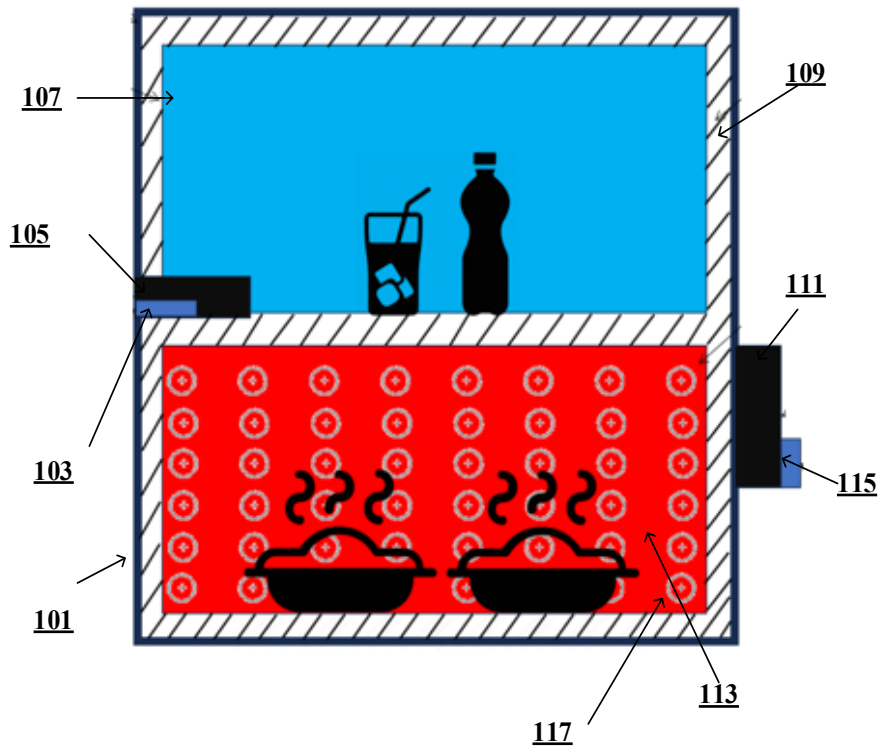


Figure 1B

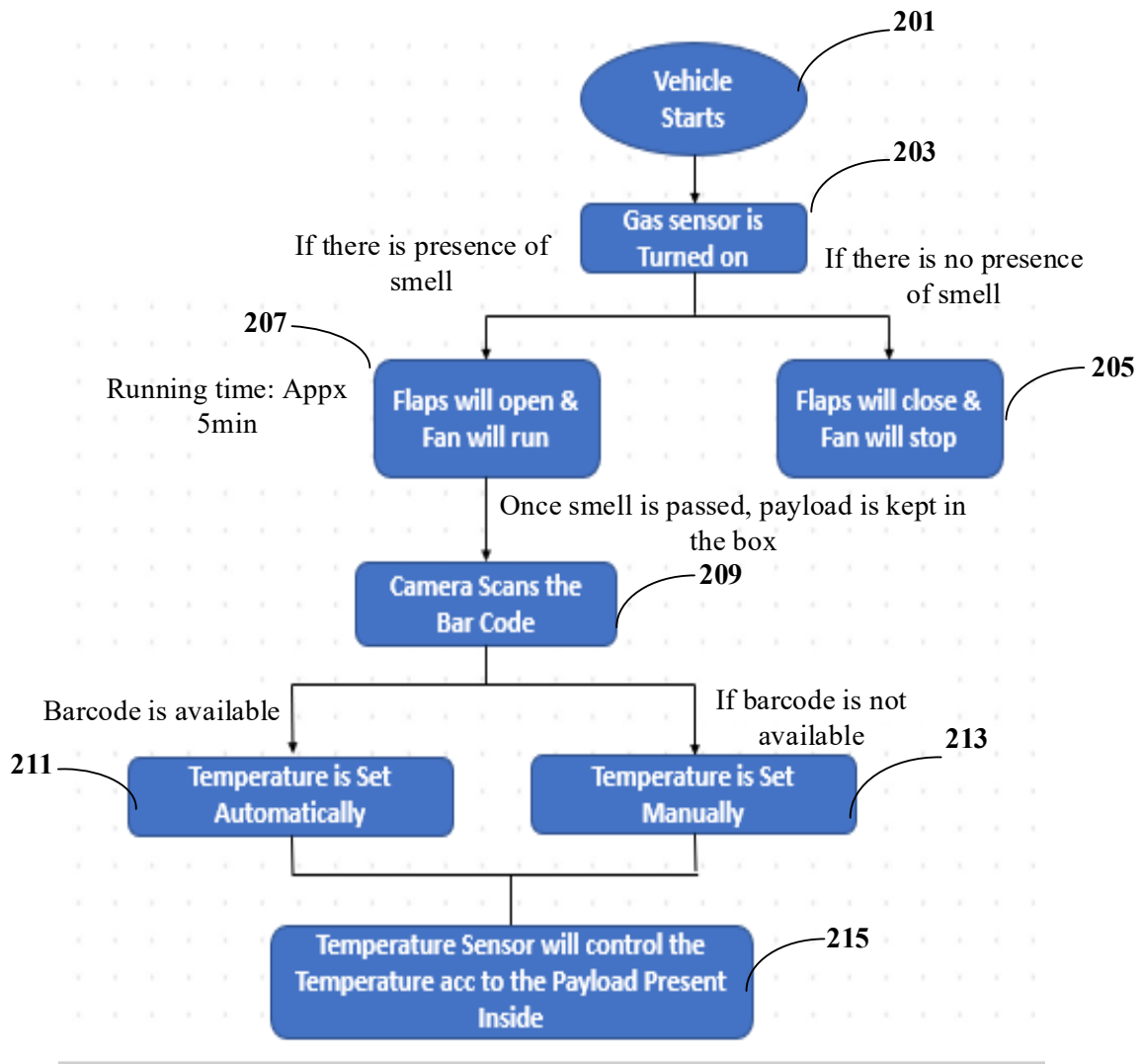


Figure 2

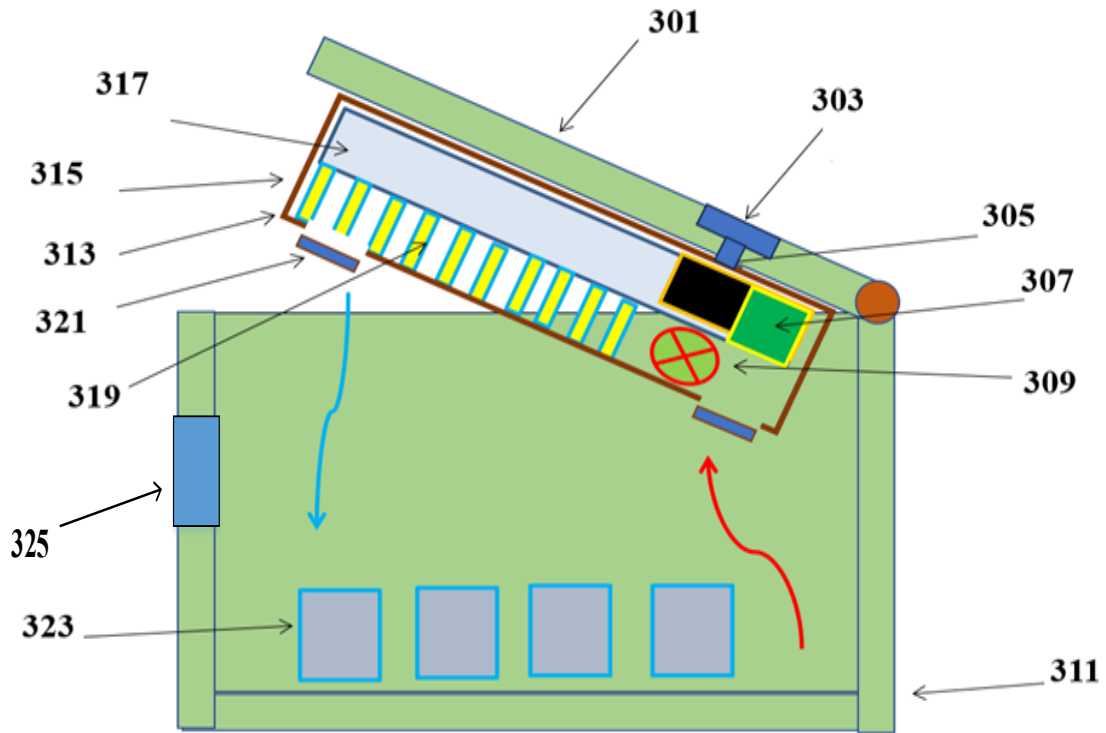


Figure 3

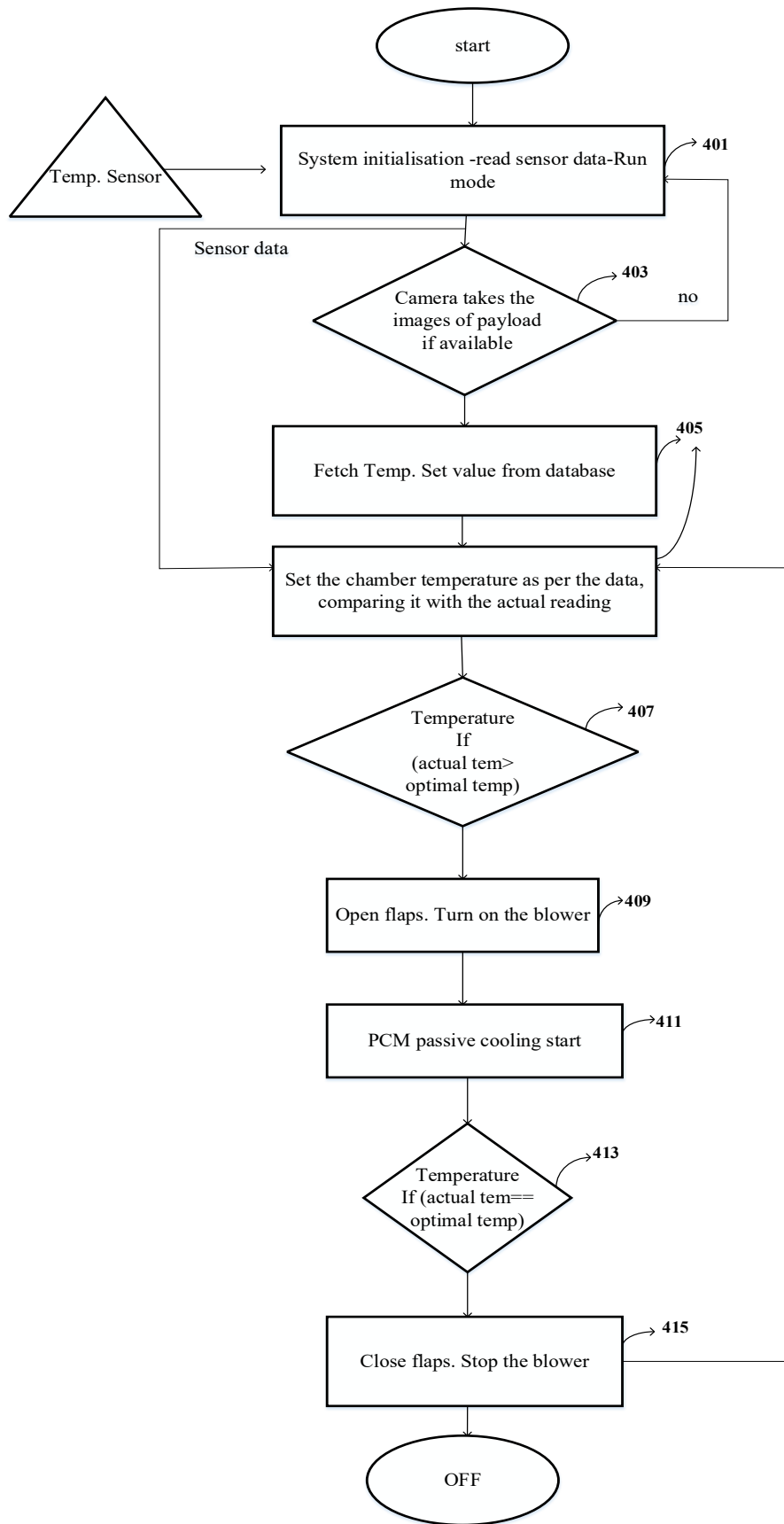


FIGURE 4

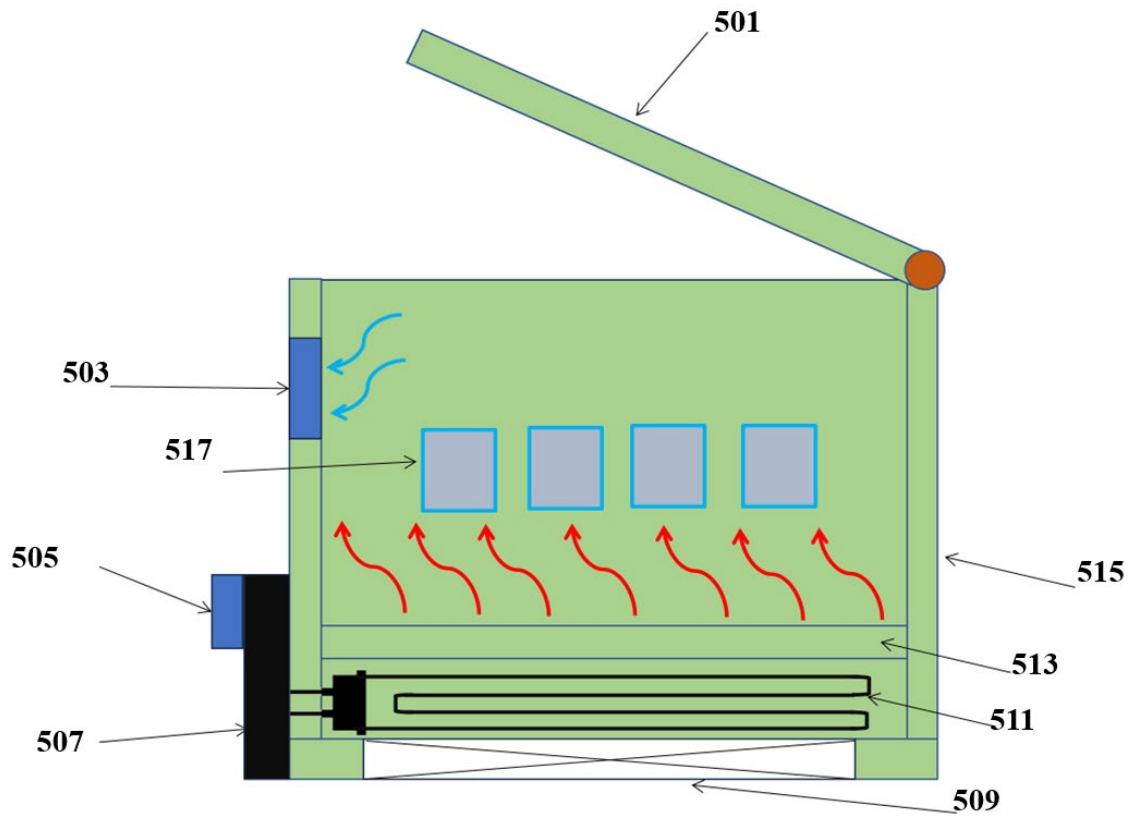


Figure 5

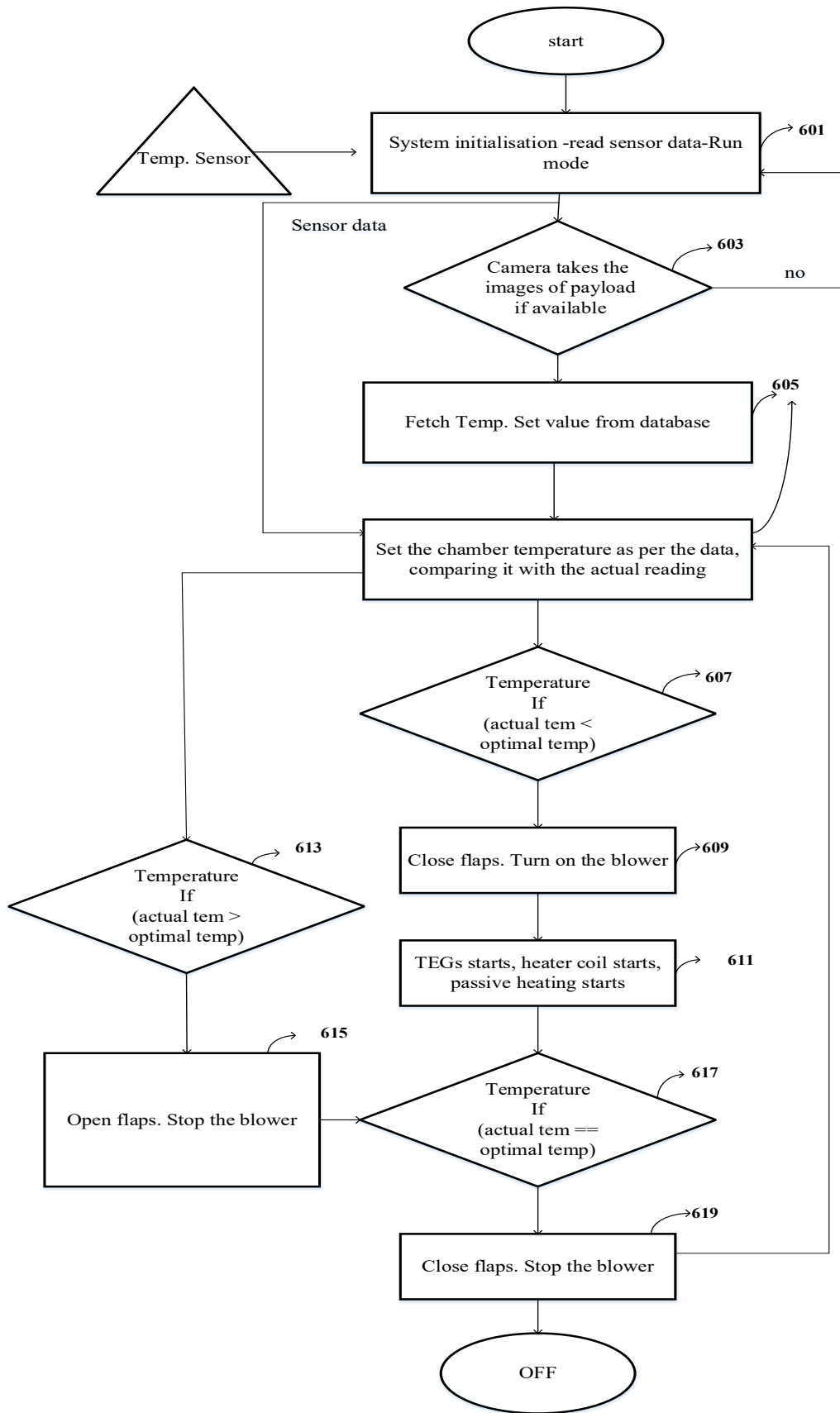


Figure 6

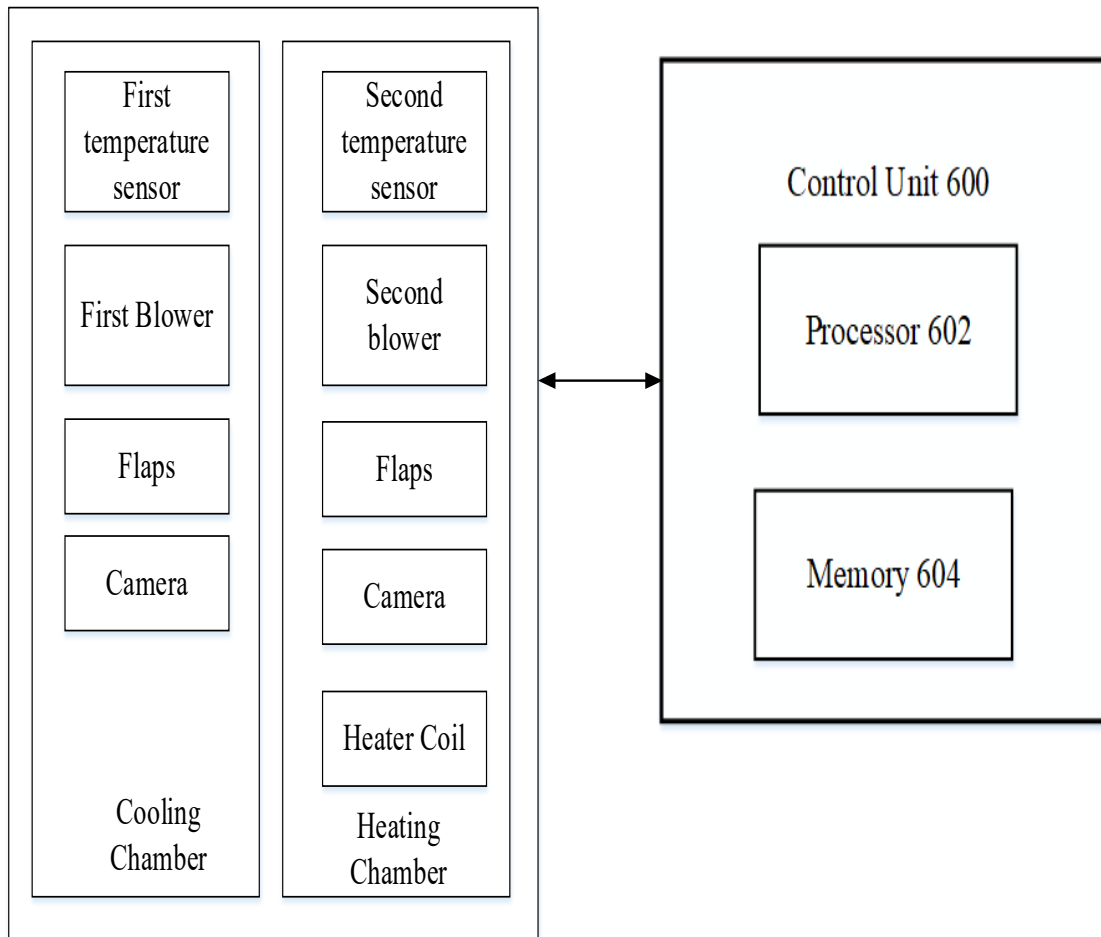


Figure 7

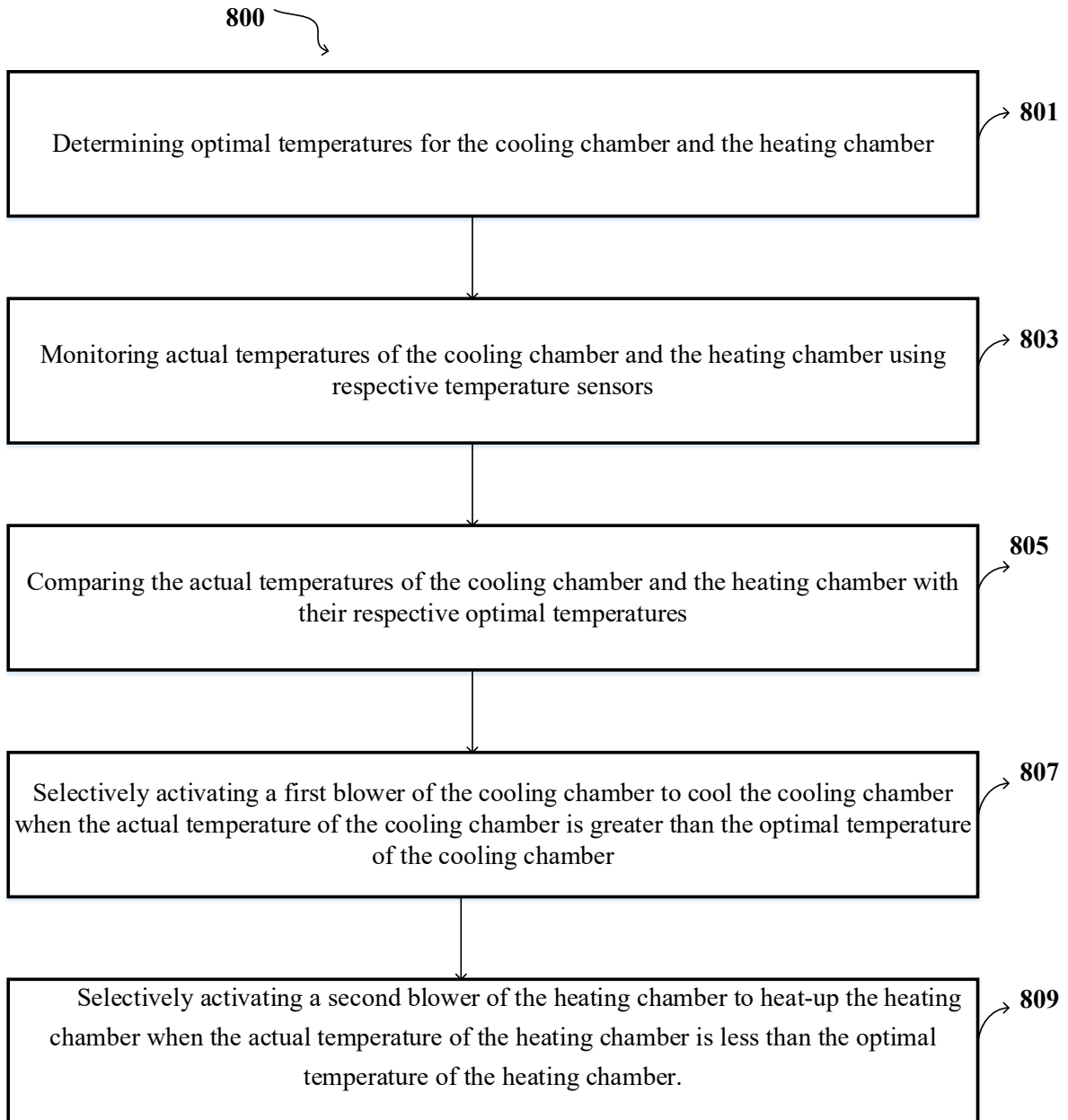


FIGURE 8